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# Wildfire Hazard and Risk Assessment of Louisville Public Lands

October 9, 2023

FINAL

## Executive Summary

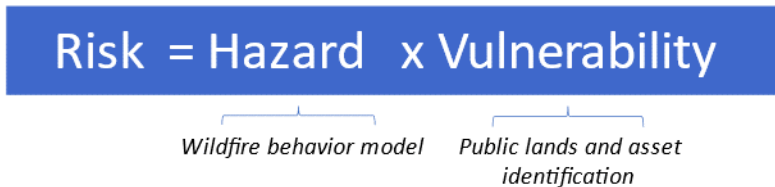
In response to the devastating Marshall Fire in December 2021, the City of Louisville initiated a new wildfire hazard and risk assessment for public lands in and around the city. The purpose of the project is to develop a comprehensive, science-based wildfire hazard and risk assessment and to provide mitigation recommendations for the City of Louisville’s public lands and facility grounds to be more resilient against future events. General mitigation best practices summarized in this report can be used to inform short- and long-term management decisions by the City of Louisville as the community continues to recover from the Marshall Fire and adapt to the increasing occurrence of large wildfires in Colorado.

### Wildfire Risk Assessment

The City of Louisville wildfire risk assessment was developed using output from the 2022 Colorado Wildfire Risk Assessment (CO-WRA), also called the Wildfire Risk Viewer, which is part of the Forest Atlas suite of modeling tools developed by the Colorado State Forest Service (<https://coloradoforestatlas.org/>). The fire behavior model outputs include burn probability and flame length, which are used to characterize the fire hazard.

Wildfire vulnerability is the potential impact of fire on a community’s resources, which is defined as the product of exposure and susceptibility in risk assessments. The City’s resources were categorized into three groups: public lands, building facility grounds, and water facility grounds. Additionally, two non-City resources were categorized to quantify wildfire risk to and from adjacent properties and landscapes: the wildland-urban interface (WUI), and other public and private lands.

Wildfire risk was calculated for the City of Louisville and adjacent areas using the wildfire hazard and vulnerability datasets developed for this project.



### Key Findings from the Risk Assessment

The wildfire risk assessment indicates that the regions of the City of Louisville with the highest wildfire risk are located along the western and northern municipal boundary, from the Howard Berry Water Treatment Plant (WTP) on Marshall Road to the North WTP and North Open Space, including Davidson Mesa and adjacent public and private land. The City of Louisville properties with the highest wildfire risk include:

- Highest Risk: Howard Berry Water Treatment Plant
- High Risk: Keith Helart Park, Annette Brand Park
- Moderate Risk: North Open Space, Davidson Mesa and Damyanovich Open Space, the pressure release valve on Dillon Road, Gateway Open Space, the North WTP
- Low Risk: the Coal Creek Regional Trail Corridor

The land along the western boundary of the City of Louisville has the highest burn probability (a measure of the likelihood that a fire will occur), including Davidson Mesa and the Howard Berry Water Treatment Plant (WTP), but also extending north of South Boulder Road by Louisville Reservoir. Flame length is used as a measure of fire intensity, where higher flame lengths can deliver more potential damage. Within the City of Louisville, flame lengths are most likely to be 2-4-feet and 4-6-feet in length, due to the grass-dominated surface fuels in and around the city. Some areas to the north (near the North WTP and North Open Space) and along Coal Creek to the south have the potential for higher flame lengths, greater than 8 feet.

### **Mitigation Assessment**

An on-the-ground assessment of conditions at City of Louisville open spaces, parks, and other sites was conducted to identify strategic opportunities to mitigate wildfire risk. These properties were selected by the City at the beginning of the project, before fire modeling occurred, to serve as example areas with a goal of identifying mitigation opportunities that could then be applied to highest risk properties. As part of the assessment, 14 City of Louisville properties were examined to look at fuel conditions, topography, potential wildfire exposure of structures on and adjacent to City properties, defensible space and hardening of structures on City properties, and features that could assist with or create challenges for wildfire suppression. The site assessment provides guidance based on observations from the field assessment, research findings, best management practices, and experience with firefighting in the wildland-urban interface. The recommendations include treatments such as perimeter mowing to create fuel breaks, restoration of prairie ecosystems to reduce fire hazard, woody vegetation management, and ditch maintenance, as identified on site maps in Section 1.1.

The City is currently engaged in the following mitigation efforts: mowing trail corridors, mowing select property boundaries and properties, limbing trees, removing burned trees, coordinating with the ditch company on vegetation removal in select ditches, grazing using cattle and goats, and evaluating facility materials on public lands. The mitigation alternatives and site assessments build on the activities implemented by the City and provide recommendations to guide future treatment efforts.

### **Key Findings from the Mitigation Assessment**

In addition to the site assessments conducted as a part of this risk assessment, a comprehensive summary of mitigation treatment alternatives, their pros and cons, applications to City-owned properties, and associated costs are summarized in Section 4.2. Additional key findings related to mitigation strategies are identified below:

- There are benefits and tradeoffs to different actions to mitigate wildfire risk, and there are no mitigation strategies that can optimize all values for public land and minimize wildfire risk at the same time. Social values, ecological impacts, feasibility, cost, and likelihood of success should be considered when deciding where to conduct different mitigation options. Reducing wildfire risk is a balance between these social and ecological considerations with economic costs. This report is not a land management plan, and the recommendations acknowledge that these public lands are managed by the City for multiple uses—tiers of treatment options and pathways are provided consistent with the City’s Open Space mission. Becoming a fire adapted community requires a comprehensive approach and coordinated action to address shared risk. Fuel treatments on properties managed by the City of Louisville are just one piece of fire resilience and treatments on adjacent private property may be more cost-effective in some instances.

Partnerships between agencies, landowners, and homeowners are necessary for meaningful progress towards fire resiliency. This includes outreach, education, and incentive programs.

- Fuel loads and potential fire behavior are widely variable across properties managed by the City of Louisville. Some properties have abundant native grasses with patches of bare soil in between—conditions that can result in low flame lengths and moderate fire rates of spread. Other properties are covered in continuous carpets of non-native grasses that dry out early in the growing season and can support high flame lengths and rapid rates of fire spread. Herbicides such as Glyphosate may be needed to convert these non-native grasslands to native grasslands. Fuel loads on grasslands also vary from year to year due to weather patterns, meaning wildfire risk is not static over time and should be subject to adaptive management.
- Substantial challenges exist to grassland management and wildfire risk mitigation in this area due to the widespread cover of non-native grasses, fragmented landownership patterns, and proximity of homes to parks and open space.
- A variety of mitigation measures are available to create fire resiliency, but tradeoffs are unavoidable. There are no management strategies that can optimize all values for public land and minimize wildfire risk at the same time. Many management approaches must be used in tandem—for example, reducing wildfire risk and restoring native grasslands often requires prescribed fire, grazing and herbicide. Social values, ecological impacts, feasibility, cost, and likelihood of success must be considered when deciding where to conduct different management options.
- Given the range of values provided by public land and the uncertainty around wildfire occurrence and fuel treatment effectiveness, the best frameworks for enhancing wildfire resilience are those that have co-benefits in addition to wildfire risk reduction. For example, restoration of native grasslands that can burn with lower intensity than grasslands invaded by non-native grasses while also creating wildlife habitat and increasing biodiversity. Hardening structures and creating defensible space around important infrastructure can increase the likelihood of structures surviving wildfire and reduce maintenance costs, reduce heating and cooling costs, and reduce water use by landscaping.
- Fuel treatments can create opportunities for firefighters to engage in suppression and reduce the chance of fire spreading into neighborhoods under moderate to high fire weather conditions. However, fuel treatments are less effective under extreme weather conditions. Fuel treatments can never prevent embers from blowing across managed land into neighborhoods.
- Fire mitigation implementation will require a fiscal commitment from the city to invest in a combination of personnel, equipment, or contractual work.



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# 1. Introduction

## 1.1. Background

The Marshall Fire on December 30, 2021, was Colorado's most destructive fire in history, with more than 6,000 acres burned, more than 1,000 homes and businesses destroyed, and 35,000 people displaced. Dry conditions and high winds allowed for the fire to spread rapidly across unincorporated Boulder County and to quickly reach the towns of Superior and Louisville causing an estimated 2 billion in damages (Paterson, 2022).

As part of the recovery process from the Marshall Fire, the City of Louisville initiated a new wildfire hazard and risk assessment for public lands in and around the city<sup>1</sup>. Louisville owns an interest in approximately 2,600 acres of open space and parks, and facility grounds. This land provides recreational opportunities along neighborhood corridors, supports a variety of plant and animal species, houses critical infrastructure and community amenities, and creates visual and physical buffers between adjacent communities. The wildfire risk assessment will be used to understand the wildfire hazard that exists within the City of Louisville, the lands and structures vulnerable to wildfire, and the relative risk throughout the City. Following the 2021 Marshall Fire, the City of Louisville and its citizens are interested in mitigating wildfire risk and creating wildfire resilience on public and private land, building off lessons from the 2021 Marshall Fire Facilitated Learning Analysis (Holstrom et al., 2023).

This project is one of several underway by the City in response to the Marshall Fire. The City has hosted an education and outreach series ([Resilient Louisville](#)) and hosted resources for its residents on the [Louisville Rebuilds](#) webpage. The City is actively involved in the Boulder County community wildfire protection plan (CWPP). Additionally, the City is conducting mitigation treatments including mowing trail corridors, mowing select property boundaries and properties, limbing trees, removing burned trees, coordinating with the ditch company on vegetation removal in select ditches, grazing using cattle and goats, and evaluating facility materials on public lands.

## 1.2. Purpose

The purpose of this project is to develop a comprehensive, science-based wildfire hazard and risk assessment and to provide mitigation recommendations for the City of Louisville's public lands to be more resilient against future events. This report will serve as a tool for the City to direct limited resources to areas that will benefit most from future mitigation actions. General mitigation best practices and site-specific guidance can be used to inform short- and long-term decisions by the City of Louisville as the community continues to recover from the Marshall Fire and adapt to the increasing occurrence of large wildfires in Colorado.

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<sup>1</sup> The City of Louisville had previously conducted a wildfire hazard and risk assessment in 2012.



The report is organized as follows:

- Section 1 explains the background and purpose of the project and introduces the concepts of wildfire mitigation and resilience.
- Section 2 defines the lands for which the assessment is taking place and describes all data and model inputs needed for the analysis, including parameters needed to develop the risk assessment framework and run the wildfire behavior model used to calculate wildfire risk.
- Section 3 summarizes the wildfire model results, including burn probability and flame length across the model domain, as well as overall wildfire risk for specific areas of interest.
- Section 4 presents the mitigation assessment which outlines general recommendations, specific site analyses, and a discussion about the benefits and costs of mitigation treatments. It also discusses current mitigation practices undertaken by the City of Louisville.
- Section 5 provides wildfire resources that may be helpful to disseminate to the public following this project's outreach efforts.
- Section 6 provides any additional recommendations and conclusions for the City's to consider as they increase their wildfire resilience and prepare for future fires on public lands.

### 1.3. Stakeholder Engagement

Stakeholder engagement was a critical part of the project allowing for two-way communication with the community, both to provide project updates and to solicit feedback. Two open house meetings were held to engage with the community about the project objectives, approach, and results (February 9 and May 24, 2023). The meetings also served as an opportunity for the community to ask questions and provide comments, which allowed the project team to understand residents' concerns about wildfire risk and mitigation after the Marshall Fire. Residents expressed their opinions on a variety of topics including the balance between ecological management and approaches to fire mitigation, education about wildfire risk to inform scientific-based decision-making, and better communication between the government and community. The project team provided project updates to the Open Space Advisory Board on May 10 and July 12 that included a summary of the wildfire risk framework, modeling results, and the applicability of various mitigation treatments on different public lands owned by the City of Louisville. The project findings were presented to the City Council on October 17, 2023.



*Figure 1-1: Wildfire Risk Assessment Open House at the Louisville Recreation Center*



recommendations are balanced with community values acknowledging that mitigation is a tiered approach, and no single solution will eliminate wildfire risk.

## 1.5. Study Limitations

It is important to note that this is an assessment of Louisville public lands and does not explicitly analyze private property and private land. While the risk framework accounts for public and private buildings to characterize the wildland-urban interface (WUI), the project does not provide a property-based risk assessment. Additionally, the mitigation recommendations are not meant to protect against all possible fire events. Mitigation efforts are unlikely to stop urban conflagrations driven by extreme windspeeds and producing prolific ember cast like the 2021 Marshall Fire. Fuel treatments cannot prevent embers from blowing into treatment areas or onto surrounding structures. This information is meant to focus on actions that are effective in reducing wildfire hazards and increasing resiliency, recognizing that mitigation is a layered approach and works best using multiple strategies together at different scales. Uncontrollable factors will always play a role in home loss during extreme wildfires where minute-to-minute shifts in wind directions, unexpected wind gusts, and extreme fire behavior and growth that overwhelm suppression efforts can result in home loss regardless of mitigation efforts prior to the fire.

**Terms related to wildfire risk mitigation and resilience:**

**Burn probability:** The likelihood that a fire will occur in a given area within a year as simulated using a wildfire behavior model.

**Defensible space:** The area around a building where fuels have been treated, cleared, or reduced to slow the spread of fire and reduce exposure to radiant heat and direct flame (CSFS, 2021; NWCG, 2018).

**Ecological restoration:** The process of assisting the recovery of an ecosystem that has been damaged, degraded, or destroyed (SER, 2004).

**Fire break:** A natural or constructed linear feature where all vegetation and organic matter have been removed down to bare mineral soil. Fire breaks are used to stop or slow wildfires or to provide a control line from which to work (NWCG, 2018).

**Fire-resistant plants (aka, firewise plants or low flammability plants):** Plants with structural, chemical, and phenological properties that make them less flammable and more resistant to wildfire. Properties include low resin content, compact stature, and green stems that retain moisture content later in the fire season (Carter et al., 2023).

**Fire resilient landscape:** A socio-ecological system that accepts the presence of fire, whilst preventing significant losses through landscape management, community engagement, and effective recovery (Thacker et al., 2023).

**Flame length:** The height of a flame as measured from the tip of the flame to its base (i.e., the ground). Often used as a measure of fire intensity.

**Fuel:** Any combustible material, including vegetation, petroleum-based products, homes, and other man-made materials that might combust during a wildfire in the wildland-urban interface (NWCG, 2018).

**Fuel treatment:** Manipulation, combustion, or removal of fuels via burning, mechanical, chemical, biological, or manual means to reduce the likelihood of ignition, lessen potential damage from wildfires, and decrease resistance to control (NWCG, 2018).

**Fuel break:** A natural or constructed linear feature with altered fuel characteristics that result in fire behavior that can be more readily controlled. Fuel breaks differ from fire breaks due to the continued presence of vegetation and organic soil (NWCG, 2018).

**Greenstrip:** A managed linear feature that converts existing vegetation to stands of persistent perennial species with fire-resistant properties and a lower potential for extreme fire behavior (Weise et al., 2023).

**Home (or structure) hardening:** Steps taken to reduce structure ignitability and potential for ember penetration by changing building materials, installation techniques, and structural characteristics of homes and other structures (California Fire Safe Council, 2020).

**Risk:** Wildfire risk is a measure of the potential impact from fire on resources of interest. In this project it is calculated as the product of fire hazard and vulnerability.

**Vulnerability:** Vulnerability is a measure of potential weaknesses of resources as measured by the location of the resources and their susceptibility to fire.

**Wildland urban interface:** Any area where the built environment meets wildfire-prone areas—places where wildland fire can move between natural vegetation and the built environment and result in negative impacts on the community (Forge, 2018).

## 2. Data and Methods

This section presents the geospatial data used in the wildfire analysis, reviews the wildfire behavior model used in the analysis, and presents the elements of wildfire risk framework used to calculate wildfire risk for the City of Louisville.

### 2.1. Geospatial Data

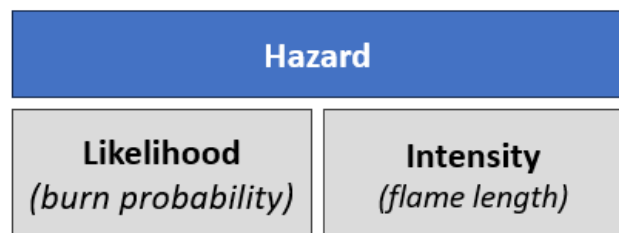
The City of Louisville provided data for their parks and open space lands, public works facilities, jointly-owned properties and mitigation activities. Parcel and municipality boundary geospatial data was sourced from Boulder and Broomfield Counties. Correspondence with the City of Louisville staff provided more granular information such as irrigated versus non-irrigated public land and details differentiating public and private land ownership. Flame length, burn probability, and surface fuels data were retrieved from the 2022 Colorado Wildfire Risk Assessment (CO-WRA), developed by the Colorado State Forest Service (CSFS) and Technosylva (Technosylva, 2023). Buildings within the City of Louisville were identified from the 2022 Microsoft Building footprint data. The data used in this wildfire risk analysis are summarized in Table .

**Table 2-1. Data sources used in the wildfire risk assessment.**

Data	Source
Louisville Public Lands	Combination of Parcel data and information from the City of Louisville staff
Flame length, burn probability, surface fuels	Colorado State Forest Service <a href="#">Wildfire Risk model (2022)</a>
Parcel, Municipality boundaries	<a href="#">Boulder County</a> ; <a href="#">Broomfield County</a>
Ditches	2019 data: <a href="#">Division 1 Canals - Irrigation canals, ditches, and ditch service areas.</a> Maintenance: City of Louisville map
Building footprint	<a href="https://github.com/Microsoft/USBuildingFootprints">https://github.com/Microsoft/USBuildingFootprints (2022 data)</a>
Marshall Fire extent	City of Louisville
Analysis Area	½ mile buffer beyond the City of Louisville municipal boundary

### 2.2. Wildfire Hazard

Wildfire hazard is the threat that fire poses for a given region, which is calculated as the product of the burn probability, the annual probability or likelihood of a fire, and the flame length, a measure of the fire intensity or severity. This project uses the State’s wildfire behavior model (CO-WRA) to quantify burn probability and flame length. The State’s goal is to update the wildfire behavior model every five years. The previous release was in 2017-2018, and the latest model was released to the public in July 2023. The wildfire risk viewer is available online at <https://coloradoforestatlas.org/>.



**Figure 2-1: Wildfire hazard**



### 2.2.1. Model Description

The state’s wildfire risk model was developed by Technosylva using their proprietary modeling suite called Wildfire Analyst. A full report for the 2022-2023 model is available online (Technosylva, 2023). The new model boasts improvements in classification of fuels, among other improvements. The model specifications include:

- 20-meter gridded model domain Fuels map
- Fuels data based on satellite imagery, LiDAR data, LANDFIRE fuels model, and a custom fuels classification to better capture fire behavior
- Updated weather data

The traditional model outputs include burn probability and flame length, which are used to calculate wildfire risk. The burn probability is the annual probability of a fire, or a measure of the likelihood that a fire will occur. The flame length is a measure of the height of the flame from its base to the flame tip, which is used as a measure of fire intensity.

Although the state’s wildfire behavior model is an improvement over the previous version, it is still limited by its underlying assumptions and datasets, which are imperfect representations of the true environment. The model should not be used to make inferences finer than its native resolution (20-meters) and is used in the study to guide and inform decision-making around risk reduction and mitigation treatment.

### 2.3. Wildfire Vulnerability

Wildfire vulnerability is the potential impact of fire on a community’s resources, which is defined as the product of exposure and susceptibility in risk assessments. The City’s geospatial data (public lands, building grounds, etc.) was used to calculate exposure (Section 2.3.1), while the susceptibility was quantified using damage response functions (Section 2.4.2). These elements are combined into a wildfire risk framework, which groups community resources according to the features and wildfire response. This section further explains each element that went into developing Louisville Public Lands wildfire vulnerability.

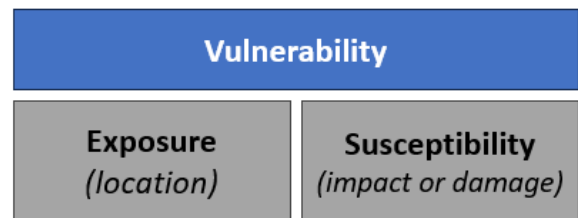


Figure 2-2: Wildfire vulnerability

#### 2.3.1. Public Lands and Asset Identification

Areas of interest vulnerable to wildfire are organized in a risk assessment framework to quantify their wildfire risk. Highly Value Resource or Assets (HVRAs) are used to categorize landscape elements that may be affected by fire. HVRAs are selected in a stakeholder driven process to represent the lands, buildings, and other high value assets that are of interest for the project. In short, HVRAs should be limited to those most valued resources. HVRAs can include land (e.g., forests, grasslands) or critical infrastructure (e.g., water treatment facilities, hospitals), and they will be used to guide management decisions around wildfire risk.

Lynker and City staff identified the following HVRA categories: (1) Louisville Public Lands, (2) Louisville Facility Grounds (built structures), (3) City Water Facility Grounds, (4) the Wildland Urban

Interface (WUI) representing buildings, and (5) Non-Louisville Lands (adjacent lands). Categories 1-3 represent City-owned land and facilities of interest as a part of this project. Categories 4 and 5 represent land and buildings not owned by the City of Louisville but included in this study to properly define adjacent wildfire risk. The HVRA categories are presented in Table . Each HVRA category is then further differentiated into HVRA subcategories to define wildfire susceptibility and community values for the risk assessment detailed in appendix.

**Table 2-2. Primary HVRA categories for Louisville properties.**

HVRA #	Category
1	City Public Lands
2	City Facility Grounds (built structures)
3	Water Facility Grounds
4	WUI (adjacent buildings)
5	Other Public and Private Lands

**City public lands** were classified as open space, irrigated and non-irrigated portions of the Coal Creek Golf Course, irrigated and non-irrigated parks and City-owned undesignated land. A complete list of public lands is provided in the appendix (Table 8-1). City undesignated lands include medians and other parcels that did not fall into the defined categories but are still maintained by the City. The differentiation between irrigated and non-irrigated was implemented because these lands respond differently to wildfire and have different potential impacts (damages) from fire.

HVRA	Sub-HVRA	
<b>#1: Public Lands</b>	City Open Space	
	Golf course	Irrigated
		Non-irrigated
	City parks	Irrigated
		Non-irrigated
	Golf course	
	City parks	
City undesignated land		

HVRA	Sub-HVRA
<b>#2: City facility grounds</b>	City Services Facility
	Police Station
	Recreation Center
	Golf Clubhouse
	Golf Maintenance Building
	Louisville Historical Museum
	Louisville Public Library
	Louisville City Hall
	Louisville Center for the Arts
	Steinbaugh Pavilion

**City facility grounds** are buildings and their surrounding land that are owned by the City function and community engagement. City staff selected the building grounds evaluated as part of the wildfire risk assessment: the City Services facility, Police Station and Municipal Court, Recreation Center, Golf Clubhouse, Golf Maintenance building, Louisville Historical Museum, Louisville Public Library, Louisville City Hall, Louisville Center for the Arts, and Steinbaugh Pavilion (Table 8-3 in the appendix). A 300-meter buffer was used around all city facility grounds, to ensure

adjacent fire hazards were incorporated the risk framework. The buffer was calculated as the

average spotting distance, the distance embers are carried for new potential fires, across City of Louisville properties from the wildfire behavior model.

The **water facility grounds** include the Howard Berry water treatment plant (South WTP), North water treatment plant (North WTP), wastewater treatment plant (WWTF), Harper Lake and pump station, North pump station, North End lift station, CTC lift station, Steel Ranch lift station, and four pressure relief valves (PRV) (Table 8-4 in the appendix).

A map showing all identified City resources is provided in Figure 2-3.

HVRA	Sub-HVRA
<b>#3: Water facility grounds</b>	WWTF
	WTP South
	WTP North
	Harper Lake & Pump Station
	Northern Pump Station
	North End Lift Station
	CTC Lift Station
	Steel Ranch Lift Station
	PRVs

The **wildland-urban interface (WUI)** is the interface between where people live and the natural environment. The WUI is not a static feature, but changes as communities grow and interact with their surrounding landscapes. Therefore, there are many estimations of WUI and different methods to calculate the WUI (Technosylva, 2018, Schug et al., 2023). Although this project is focused on public land, it was still essential to identify the WUI because of its significance in characterizing wildfire risk to and from public lands. With the release of the updated CO-WRA model, the state’s WUI and its seven classifications of housing density was used in the analysis (Figure 2-4).

**Other public and private lands** represent lands within or adjacent to the City of Louisville that are privately owned or land not solely owned or maintained by the City (Figure 2-5). These lands are important to include because they often represent open space or undeveloped land with surface fuels (e.g., grasses, shrubs) that are associated with wildfire hazard. Other public lands are those owned by Boulder County, City of Boulder Open Space and Mountain Parks (OSMP), and the City of Lafayette. Shared lands are properties that are jointly owned by the City of Louisville and another municipality or Boulder County. Private lands are parcels that are conservation easements or properties with large, undeveloped, or open lands.

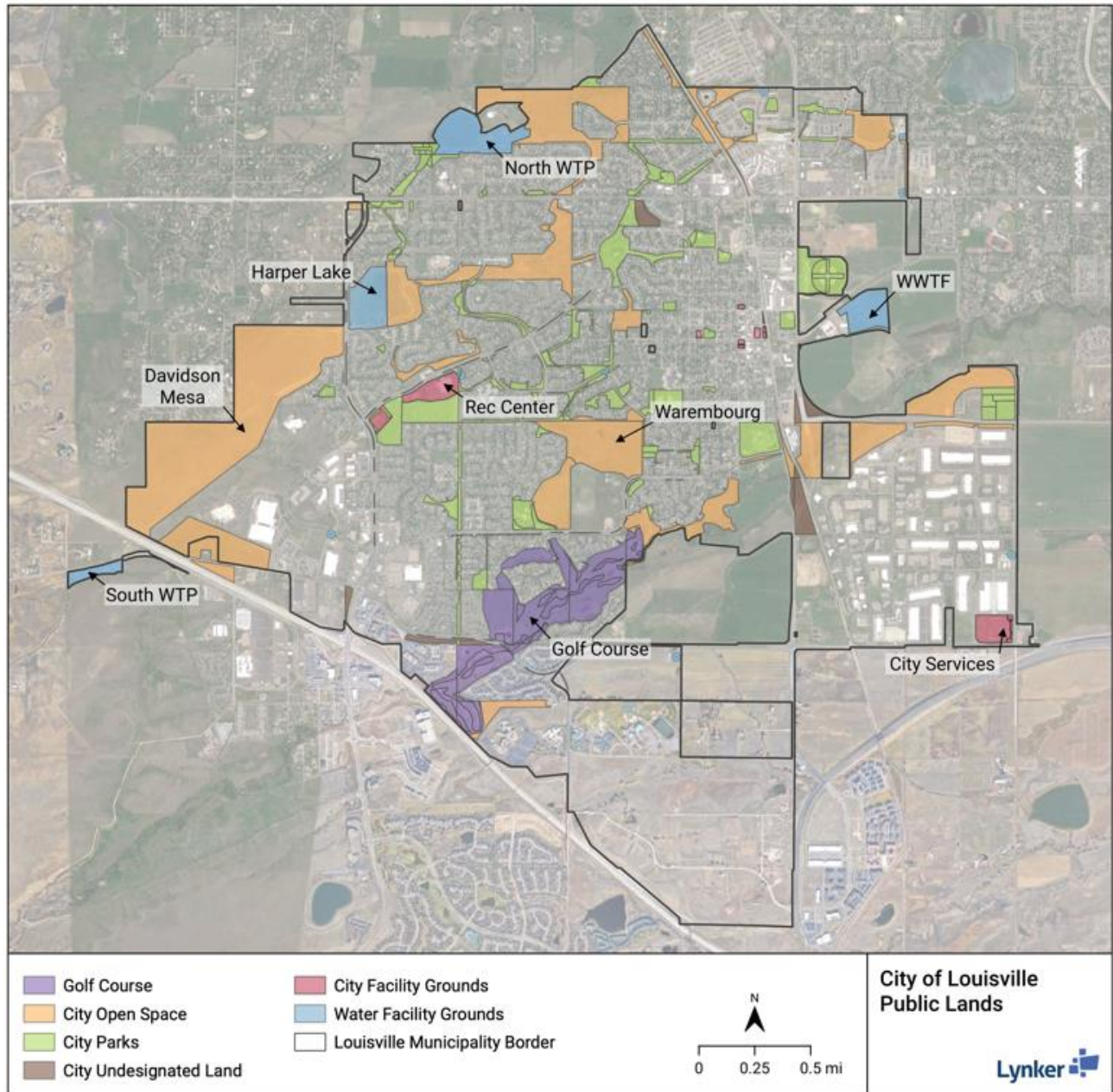


Figure 2-3. City of Louisville Public Lands: land, building grounds and water facilities (HVRA categories #1-3).



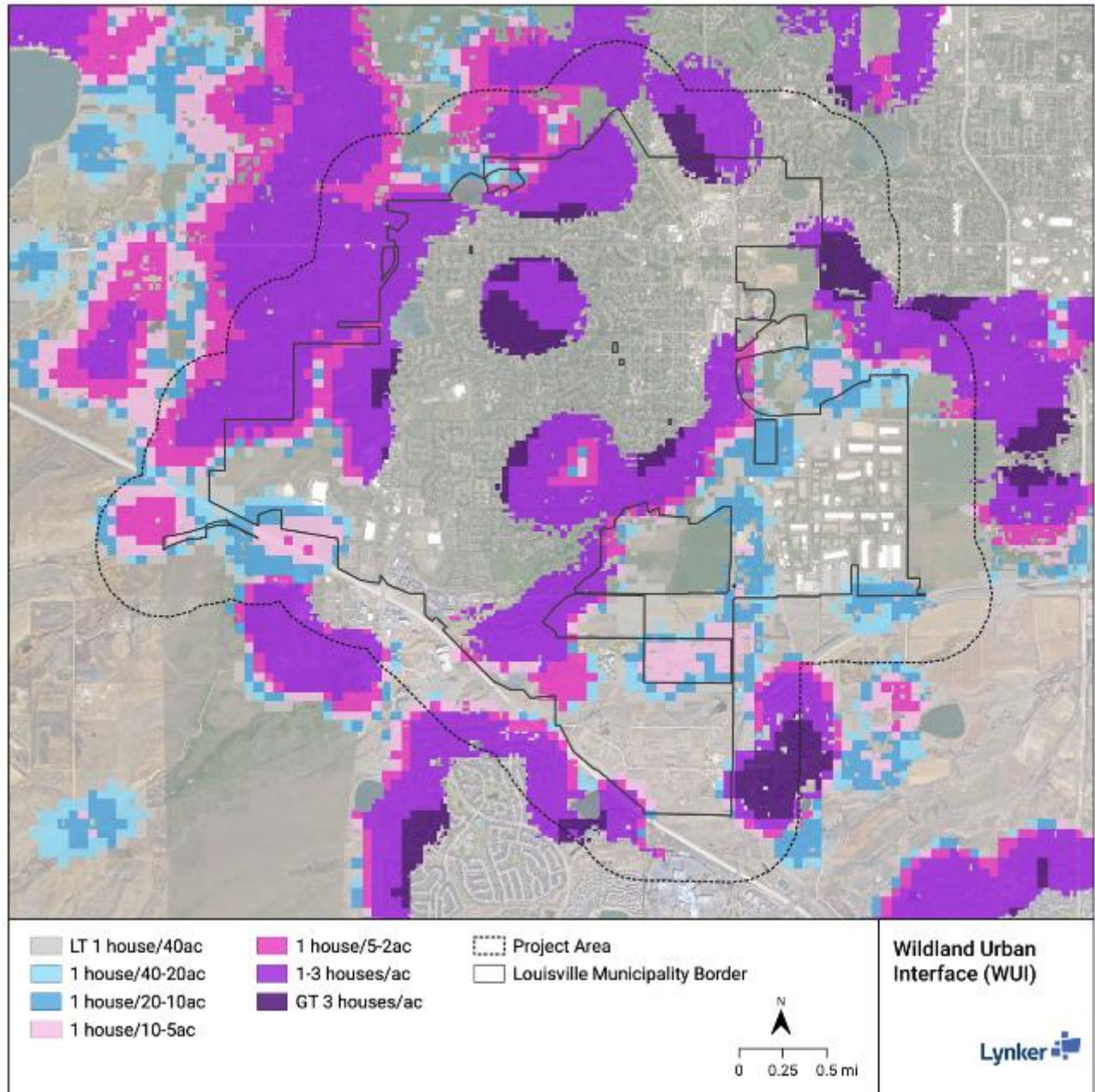


Figure 2-4. Louisville WUI from the CO-WRA model (HVRA #4).



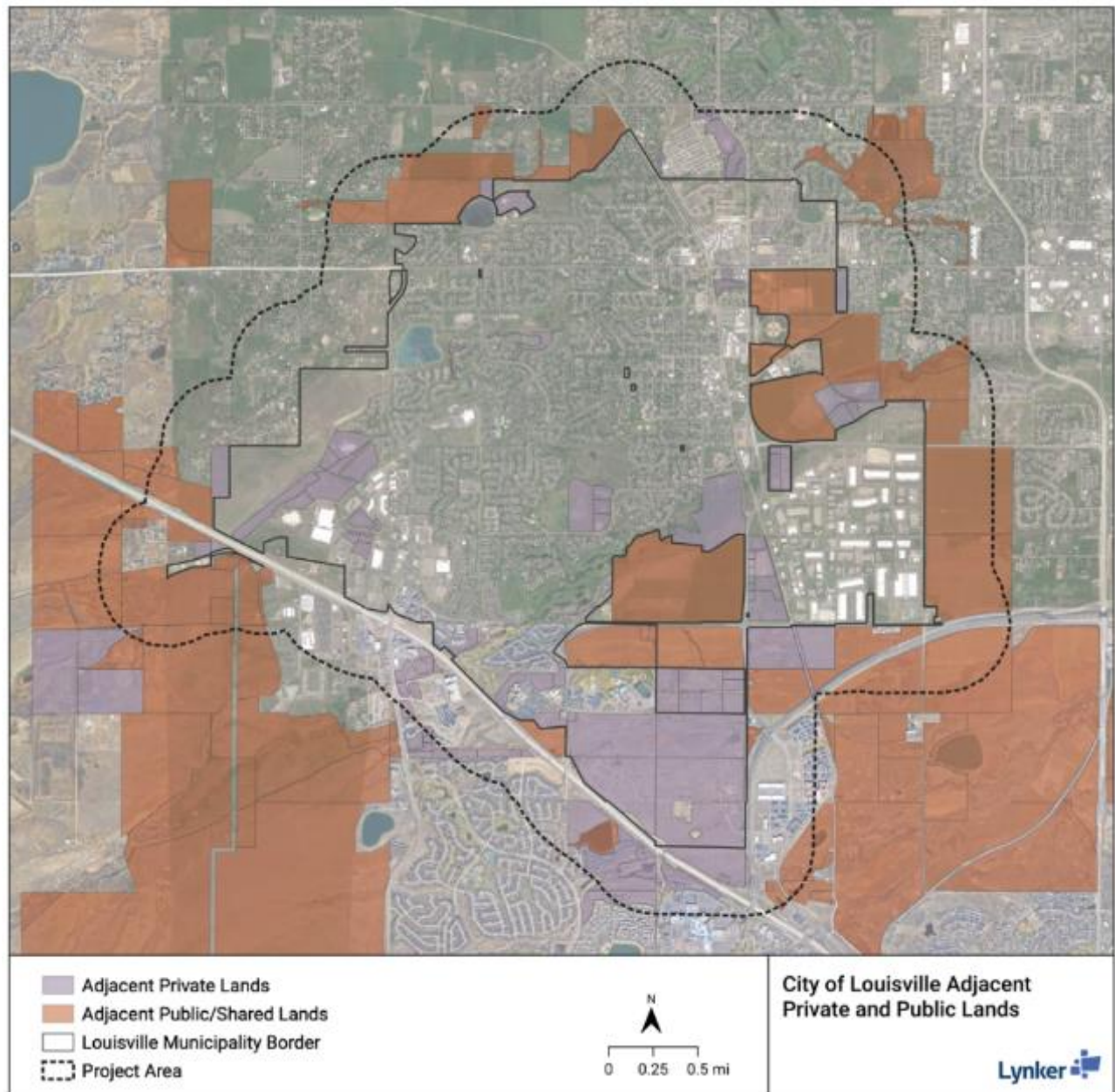


Figure 2-5. Other public and private lands in and adjacent to Louisville (HVRAs #5).

## 2.4. Risk Assessment Framework

### 2.4.1. Relative Importance

When conducting a risk assessment with different types of lands and assets (HVRAs), the wildfire risk ultimately needs to be consolidated into a single risk metric. Relative importance rankings were used to explicitly define the City of Louisville’s value of the HVRAs, and standardize wildfire impacts to water treatment facilities, public lands, and building grounds into a single framework. Risk is calculated as the product of wildfire hazard and the potential damage to vulnerable HVRAs.

Therefore, the relative importance weighting are needed to quantify risk across different HVRA. Relative Importance (RI) values are widely used in wildfire risk assessment to enable “weighted integration of risk across multiple HVRA”, which “allows for simpler mapping and visualization, and can facilitate prioritization decisions” (Scott et al., 2017). These scores are based on a variety of factors like community interest, monetary value, and critical function; for example, a water treatment plant holds value in all three categories, so its RI score is high.

Scoring begins with giving the ‘most important’ primary HVRA category an absolute importance score of 100, then the other primary HVRA categories scores from 0 to 100. Similarly, within each primary HVRA category, the top ranked sub-HVRA was given a score of 100 and all other sub-HVRAs within the category a score of 0 to 100. Thus, the RI is calculated as the HVRA’s absolute value over the total of the category’s absolute values to get a percent RI. These values were comprehensively reviewed, critiqued, and refined by relevant City of Louisville departments to ensure the risk assessment framework encapsulated each HVRA’s importance to the City and community (Table 2-3). The sub-HVRA relative importance values can be found in Table 8-5 in the appendix.

**Table 2-3. HVRA relative importance.**

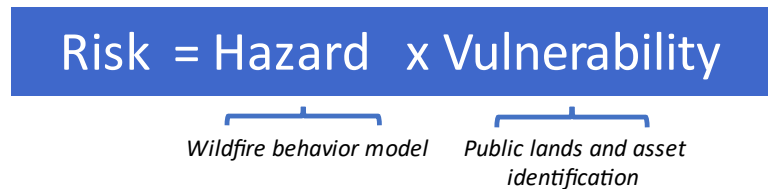
HVRA #	Category	Absolute Importance	Relative Importance
1	City Public Lands	50	14%
2	City Facility Grounds (built structures)	90	25%
3	Water Facility Grounds	100	27%
4	WUI (adjacent buildings)	100	27%
5	Other Public and Private Lands	25	7%
<b>Total</b>			<b>100%</b>

### 2.4.2. Response Functions

Response functions govern how much damage a sub-HVRA will incur for a given flame length category (see Section 3 for a discussion of flame length). The wildfire behavior model uses six flame length categories (0-2 feet (ft), 2-4 ft, 4-6 ft, 6-8 ft, 8-12 ft, and 12 feet or greater) each have a corresponding response function with values ranging from +100 to -100. Positive values from 0 to 100 indicate a benefit from fire, with larger values indicating a great benefit. Negative values from 0 to -100 indicate a loss from fire, with larger negative values indicating greater damage. Typically, the response function values change as flame length increases. Since fire is a natural phenomenon, it can provide benefits to some natural habitats and ecosystems (a positive value in the response function). However, most flame length categories are associated with damage and are therefore given negative values, with increasingly negative values associated with higher flame lengths. As with the relative importance values, determining response functions require expert judgement and a thorough literature review of other studies. Response functions were reviewed and refined as part of this study.

## 2.5. Wildfire Risk

Wildfire risk is an estimation of the impact or damage from a fire, calculated as the product of wildfire hazard and vulnerability (Figure 2-6). The wildfire behavior model quantifies the wildfire hazard, including the annual burn probability and fire intensity (flame length), and the asset identification and HVRA development quantify the vulnerability to wildfire defined by the location of resources and their susceptibility to fire. This definition of wildfire risk is often referred to as the expected net value change or eNVC, capturing both the likelihood of fire and its potential impacts.



*Figure 2-6: Calculation of Wildfire Risk*

### 3. Wildfire Risk Model Results

This section presents the burn probability and flame length outputs from the State's wildfire behavior modeling as outlined in Section 2.2. The burn probability and flame length maps use the same defined legend for outputs throughout the state, so the color scales were determined in relation to the diverse landscapes seen throughout Colorado (e.g., forested land, Colorado Plateau, eastern plains, etc.). Therefore, burn probability and flame lengths in and around Louisville are characterized within the context of results throughout Colorado.

#### 3.1. Burn Probability

The state's wildfire behavior model (CO-WRA) estimated burn probability by running more than one million simulations, with ignitions informed by historical ignition patterns, to quantify the frequency and duration of simulated burning across the model domain (Colorado).

The burn probabilities in the Louisville municipality are generally low, compared to values from across the state, but the western and southeastern portions of the city exhibit higher probabilities (Figure 3-1). Land along the western boundary of Louisville has the highest burn probability, including Davidson Mesa and the South Water Treatment Plant, but also extending north of South Boulder Road by Louisville Reservoir. These areas are defined as grassland and grass-shrub fuel types. In the southeast, the undeveloped private land adjacent to Highway 36 and Northwest Parkway have higher burn probabilities, because of the vast grasslands that contribute to surface fuels (dry climate grass fuels).

Landscape connectivity also plays a role in the modeled burn probabilities. In areas to the west and south of Louisville, large contiguous stretches of fine fuels (grasses) provide more opportunity for burning in the wildfire behavior model. Conversely, the urban core of Louisville has much lower burn probabilities due to the developed landscape (including roads, buildings, irrigated landscapes, etc.) with fuels designated as unburnable. Grass responds quickly to changes in weather (e.g., air temperature, precipitation, relative humidity), so these fine fuels cure at faster rates. Fires that occur can spread more quickly through cured grasses.



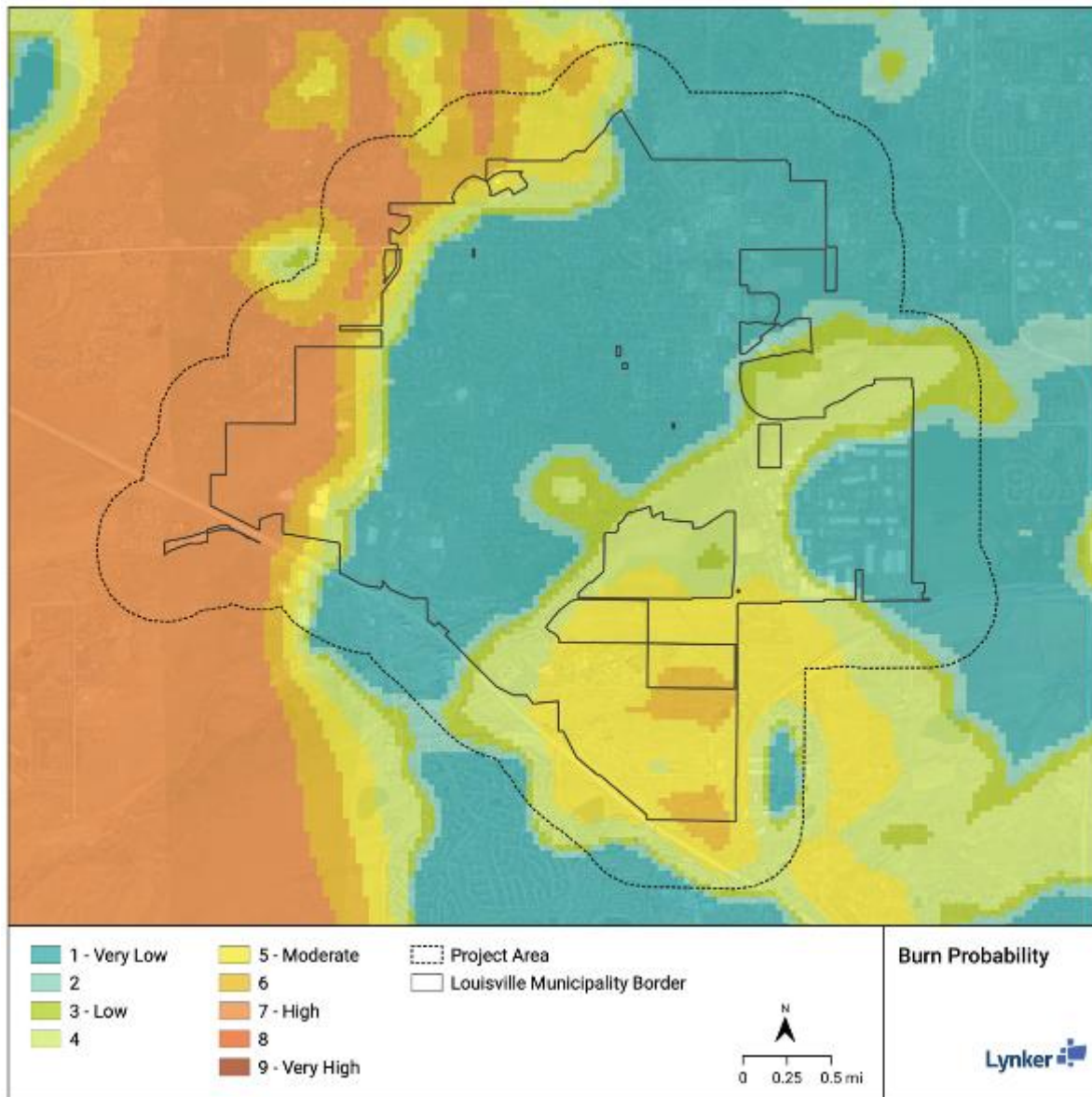


Figure 3-1. Burn probabilities in the Louisville area.

### 3.2. Flame Length

Modeled flame lengths are categorized according to six standard bins of flame length height to characterize the intensity of a fire: 0-2 feet (ft), 2-4 ft, 4-6 ft, 6-8 ft, 8-12 ft, and 12 feet or greater. Since flame length is used as a measure of fire intensity, higher flame lengths can deliver more potential damage to surrounding landscapes. The flame length maps for the six bins are presented in Figure 3-2. Within the City of Louisville, flame lengths are most likely to be 2-4-feet and 4-6-feet in length, as depicted by the darker orange and red colors in their respective map squares. Some areas to the north (near the North WTP and North Open Space) and along Coal Creek to the south have the potential for flame lengths 8-12 feet or greater than 12 feet. Additionally, areas adjacent to and outside of the city, especially to the northwest, have the potential for higher flame lengths of 8 or more feet.



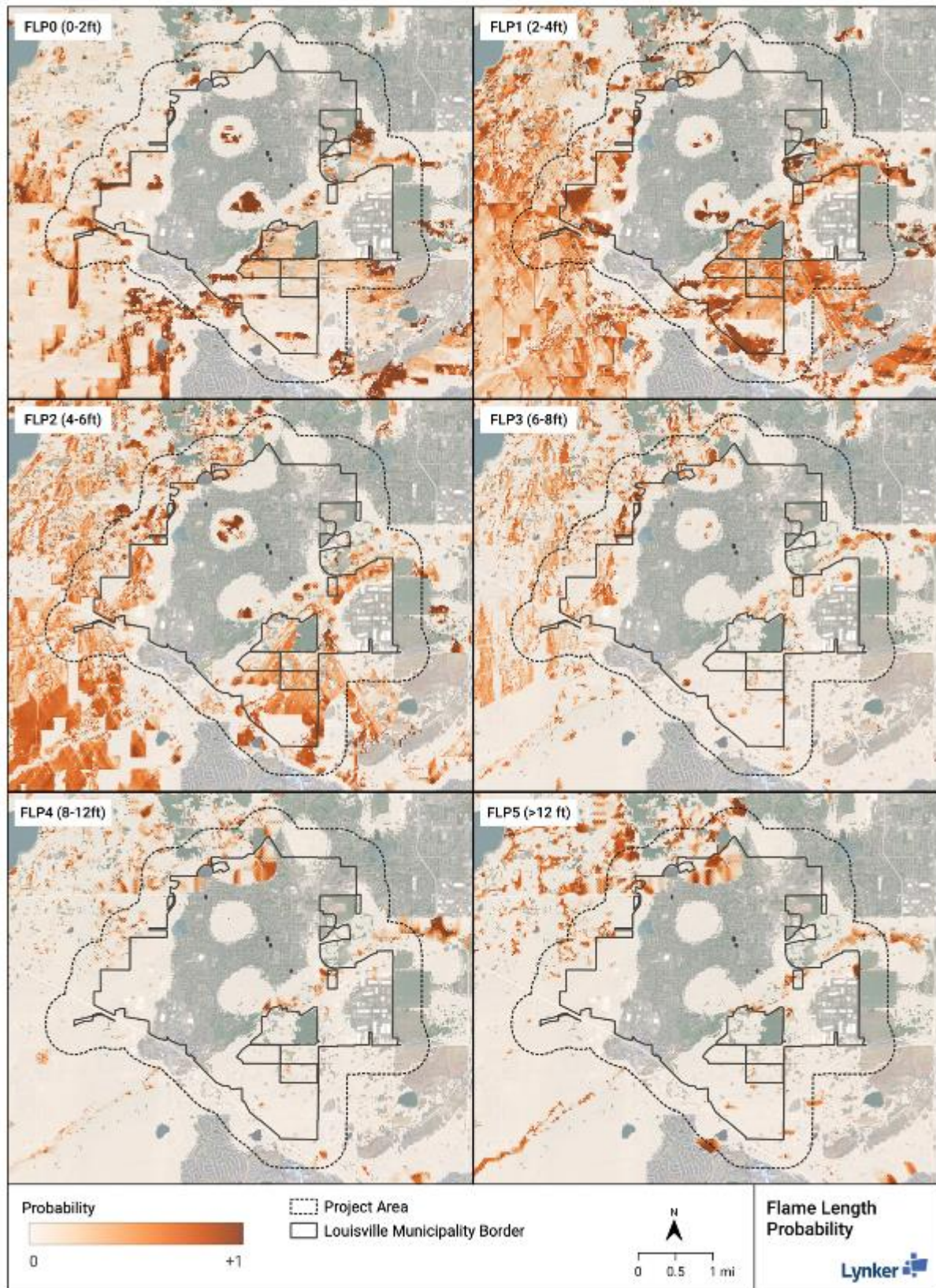


Figure 3-2. Flame length categories in the Louisville area.



### 3.3. Wildfire Risk

Wildfire risk for the City of Louisville public lands is presented as the expected net value change (eNVC) by model grid cell, within the municipal boundary (solid black line) and within half a mile of the city boundary shown by the dotted black line. The quantitative risk scores (eNVC) have been translated into five risk categories to align with the State’s risk framework (lowest risk, low risk, moderate risk, high risk, highest risk). Warmer colors (oranges and reds) indicate higher wildfire risk, while lighter cooler colors (green and yellow) indicate lower risk (Figure 3-3). The results indicate that the regions of the City of Louisville with the highest wildfire risk are located along the western and northern municipal boundary, from the Howard Berry Water Treatment Plant (WTP) on Marshall Road to the North WTP and North Open Space, including Davidson Mesa and adjacent public and private land. Additional moderate and low wildfire risk areas exists in the southeast portion of the City, along the Coal Creek Regional Trail Corridor, Dutch Creek Open Space, and on jointly owned open space land (Bowes, Admor) and private property.

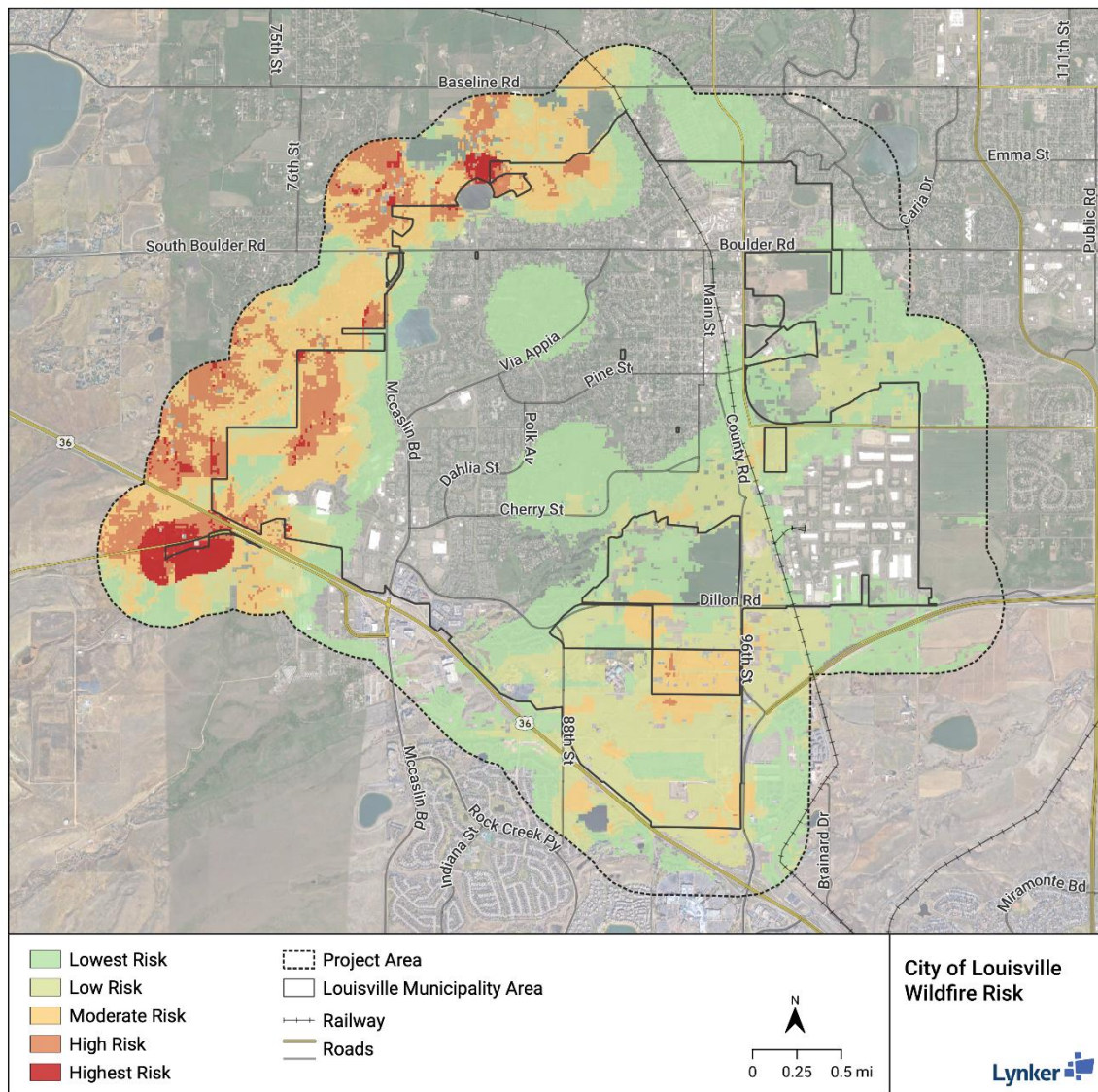


Figure 3-3. Wildfire risk for the City of Louisville public lands.

Although many parts of the City are characterized as having lowest risk (green in Figure 3-3) or no quantified wildfire risk (areas without a colored risk overlay), the results are subject to the limitations and assumptions of the wildfire behavior model. The fuels within the inner core of the city are typically characterized as unburnable, therefore, no risk is attributed to those regions in the wildfire risk modeling framework. In reality, fires can spread through radiant heat and ember production in urban areas, as was observed during the Marshall Fire. The 2022 Colorado Wildfire Risk Assessment represents an improvement in wildfire modeling throughout the state, but it still is an imperfect representation of real-world conditions.

Much of the highest wildfire risk in Louisville is located along the western City boundary. Figure 3-4 shows wildfire risk overlaid with land ownership type including Louisville properties (black diagonal lines), adjacent public lands (areas with an orange crosshatch), and adjacent private lands (areas with a blue crosshatch). The Howard Berry Water Treatment Plant (WTP) has the highest risk of City facilities due to higher burn probabilities and adjacent grassland fuels, combined with the importance of this facility. Lands in and around Davidson Mesa and Damyanovich Open Space also possess moderate wildfire risk because of the proximity of homes and buildings to grassland fuels.



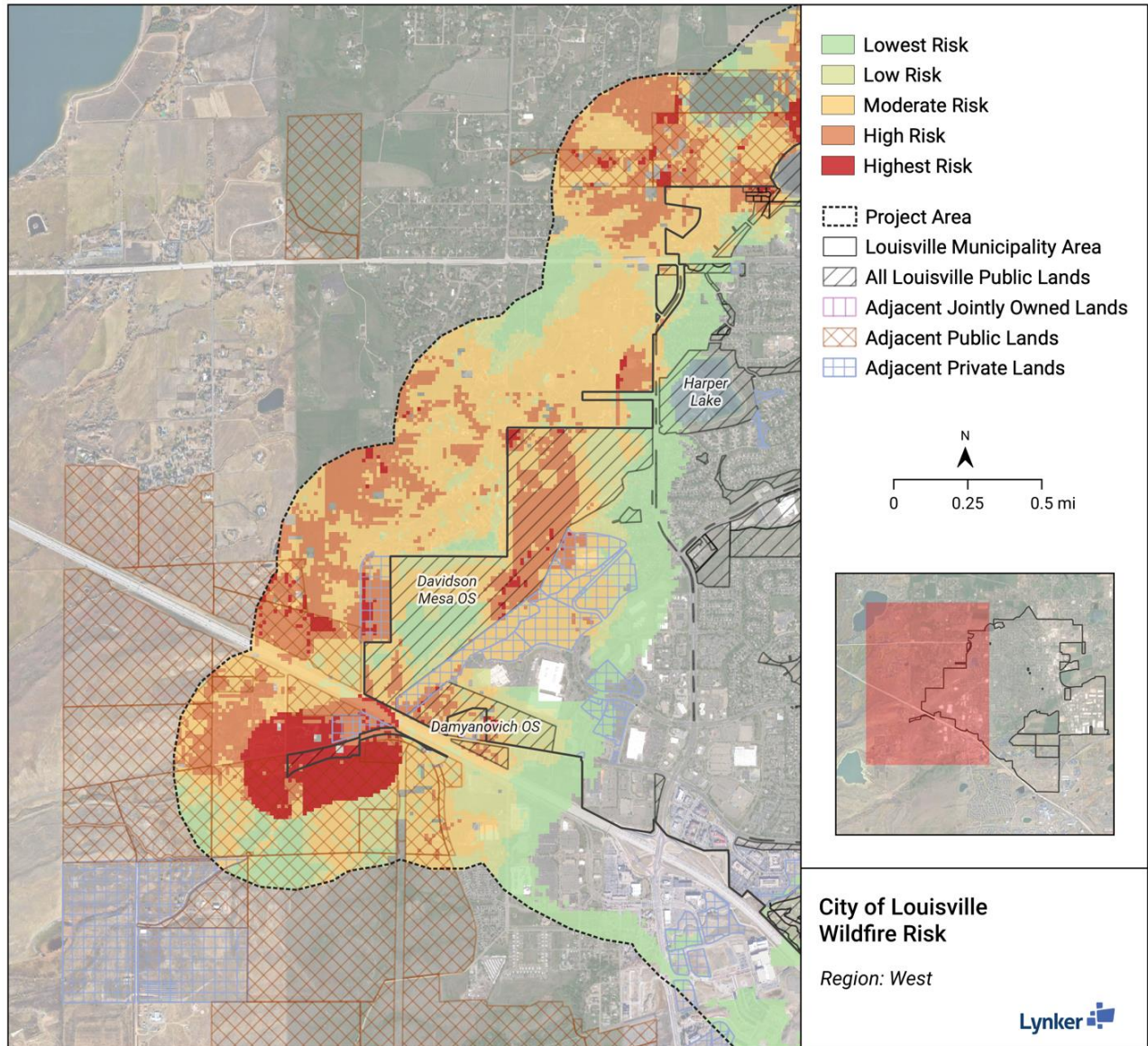


Figure 3-4. Wildfire risk to western Louisville.

The southern part of the City of Louisville consists of many private lands (areas with a blue crosshatch), jointly owned public land (areas with purple vertical lines), and City owned lands (areas with black diagonal lines). For public lands shown in Figure 3-5, the pressure relief valve on Dillon Road has moderate risk, the Coal Creek Trail corridor has low risk, and Dutch Creek Open Space has low risk.



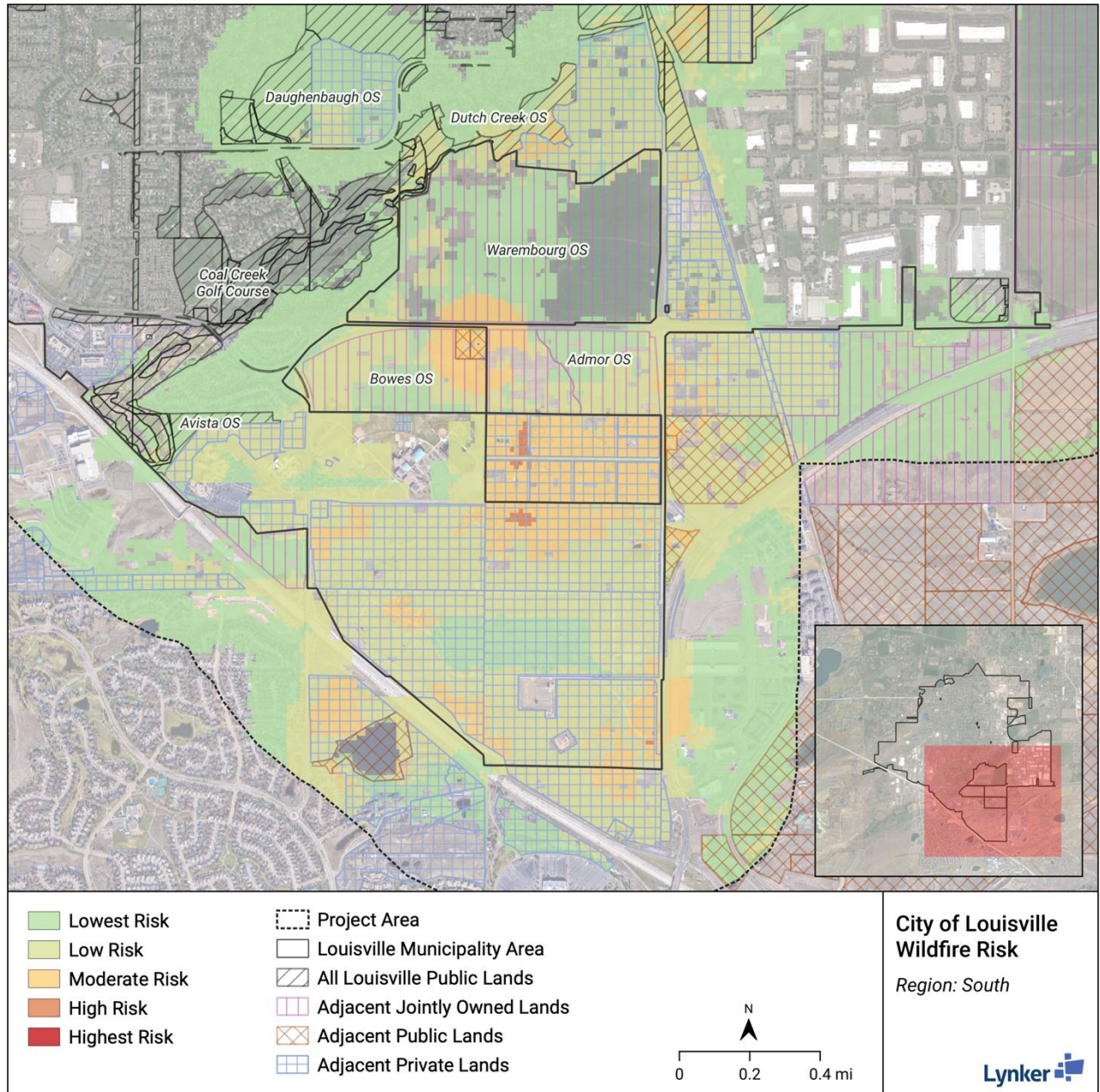


Figure 3-5. Wildfire risk to southeastern Louisville.

The northern boundary of the City of Louisville has some of the highest modeled wildfire risk. Keith Helart Park (high risk), Anette Brand Park (high risk), North Open Space (moderate risk), Gateway Open Space (moderate risk), and the City of Louisville Water Treatment Plant (moderate risk) are included in the upper left region of Figure 3-6. The map shows that much of the urban core of the City has little associated risk, since the wildfire behavior model does not implement burnable fuels in these areas.



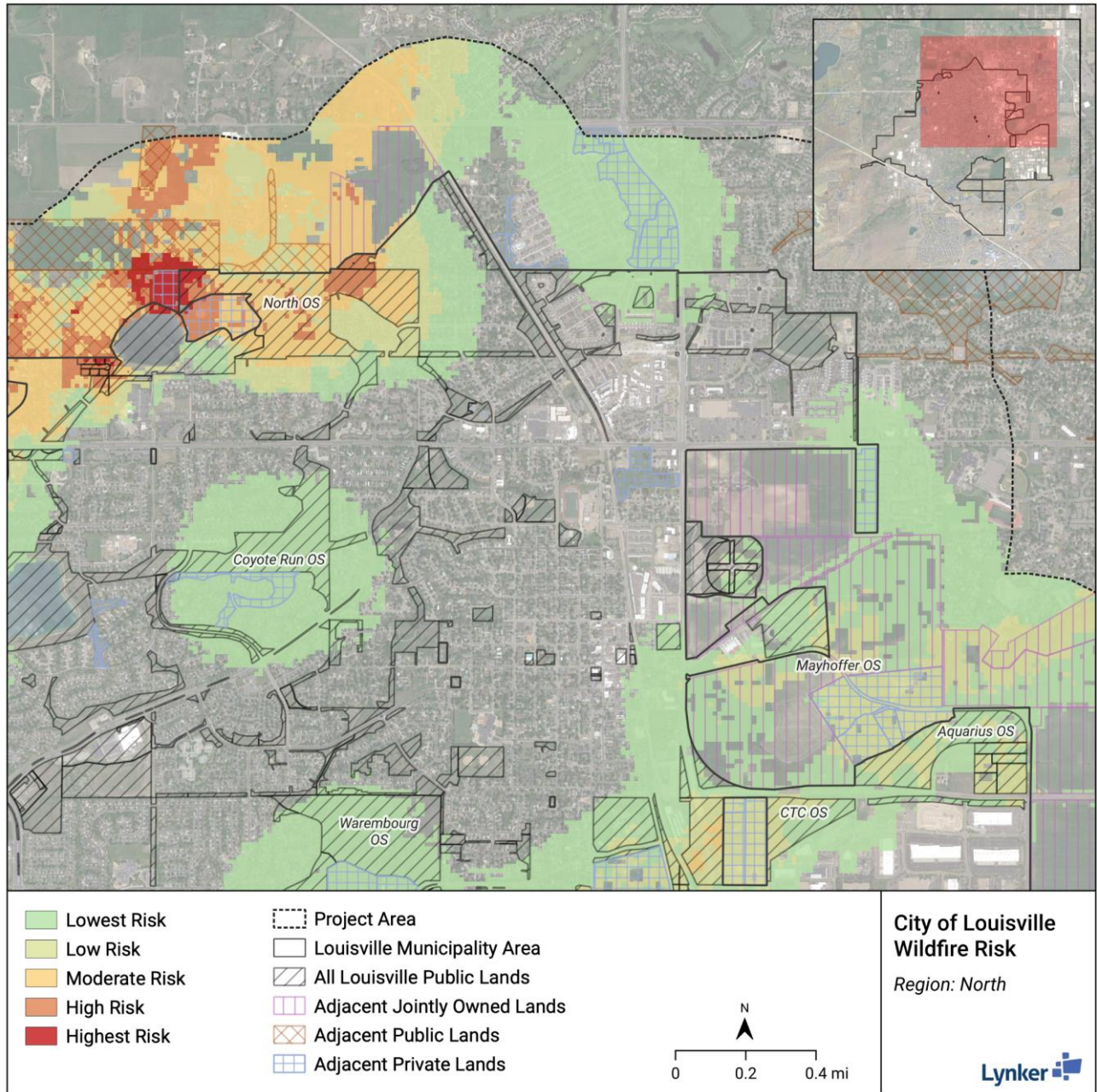


Figure 3-6. Wildfire risk to central and northeastern Louisville.

### 3.3.1. Risk Rankings

Within the City of Louisville, the areas with the highest wildfire risk were identified to help prioritize resources for mitigation treatments. A list of the 10 areas with the highest wildfire risk are shown in decreasing order in Table 3-1, where areas with the highest risk are presented at the top of the list. In order, the highest average relative risk properties are the South WTP (Howard Berry WTP), Keith Helart Park, Annette Brand Park, North Open Space, and North WTP (City of Louisville WTP). Additional areas within this list include Davidson Mesa, Damyanovich, and Gateway Open Space areas, as well as the Coal Creek Regional Trail Corridor.

The Howard Berry WTP near the town of Superior has some of the highest burn probabilities (Figure 3-1) for City of Louisville properties, which helps to increase its risk. The WTP is also surrounded by mostly grasslands characterized as dry climate grass and timber-grass-shrub. In the public lands to the north (Keith Helart Park, Annette Brand Park, North Open Space, and North WTP), there are moderate burn probabilities combined with higher flame length probabilities (Figure 3-2) which determine the higher relative risk. Davidson Mesa and Damyanovich Open Space both have areas of moderate and high burn probabilities combined with grasslands that produce moderate flame lengths. In North Open Space, there are low to moderate burn probabilities, but higher flame length probabilities produce similar wildfire risk. The risk framework also influences the risk rating, by accounting for relative importance of the HVRA and sub-HVRA category.

**Table 3-1. Highest wildfire risk at City of Louisville properties.**

Location	Average Risk	Relative Risk
<b>Howard Berry Water Treatment Plant</b>	Highest Risk	
Keith Helart Park	High Risk	
Annette Brand Park	High Risk	
North Open Space	Moderate Risk	
<b>Davidson Mesa Open Space</b>	Moderate Risk	
<b>Damyanovich Open Space</b>	Moderate Risk	
Pressure release valve (PRV) - 9182 W Dillon Rd	Moderate Risk	
Gateway Open Space	Moderate Risk	
City of Louisville Water Treatment Plant	Moderate Risk	
Coal Creek Regional Trail Corridor	Low Risk	

Note: **bolded text** indicates properties that were burned during the Marshall Fire.

A list of all areas within the City of Louisville with quantifiable wildfire risk is provided in Table 3-2. This includes additional City properties that were burned by the Marshall Fire, such as Avista Open Space, Harper Lake, and the Coal Creek Golf Course. One notable exception is the Louisville Recreation Center, which did not have modeled wildfire risk despite being affected by the Marshall Fire.

**Table 3-2. List of all City of Louisville properties with modeled wildfire risk.**

Rank	Location	Wildfire Risk	Rank	Location	Wildfire Risk
1	<b>Howard Berry Water Treatment Plant</b>	Highest Risk	28	Heritage Park	Lowest Risk
2	Keith Helart Park	High Risk	29	Outlot	Lowest Risk
3	Annette Brand Park	High Risk	30	Coyote Run Open Space	Lowest Risk
4	North Open Space	Moderate Risk	31	Dutch Creek Park	Lowest Risk
5	<b>Davidson Mesa Open Space</b>	Moderate Risk	32	Warembourg Open Space	Lowest Risk
6	<b>Damyanovich Open Space</b>	Moderate Risk	33	Tyler Avenue	Lowest Risk
7	PRV - 9182 W Dillon Rd	Moderate Risk	34	City Services	Lowest Risk
8	Gateway Open Space	Moderate Risk	35	Steinbaugh Pavilion	Lowest Risk
9	City of Louisville Water Treatment Plant	Moderate Risk	36	Bullhead Gulch Open Space	Lowest Risk
10	Coal Creek Regional Trail Corridor*	Low Risk	37	North End Open Space	Lowest Risk
11	Dutch Creek Open Space	Low Risk	38	Centennial Drive Corridor	Lowest Risk
12	Garfield Utility Corridor	Low Risk	39	City Trail	Lowest Risk
13	Corridor	Low Risk	40	Paschal Dr Median	Lowest Risk
14	Louisville Cemetery	Low Risk	41	Kaylix Ave Median	Lowest Risk
15	CTC Open Space	Low Risk	42	Neighborhood Outlot	Lowest Risk
16	Concrete Trail	Low Risk	43	Sundance Park	Lowest Risk
17	Median	Low Risk	44	Miner's Field	Lowest Risk
18	Elephant Park	Low Risk	45	Hammer Run Park	Lowest Risk
19	City of Louisville Branch Recycling Site	Lowest Risk	46	Mission Greens Park	Lowest Risk
20	Aquarius Open Space	Lowest Risk	47	Lake Park	Lowest Risk
21	Highline Lateral Ditch	Lowest Risk	48	Cowboy Park	Lowest Risk
22	<b>Coal Creek Golf Course</b>	Lowest Risk	49	Steel Ranch Park	Lowest Risk
23	Louisville Wastewater Treatment Plant	Lowest Risk	50	Louisville Sports Complex	Lowest Risk
24	<b>Avista Open Space</b>	Lowest Risk	51	Joe Carnival Park	Lowest Risk
25	Daughenbaugh Open Space	Lowest Risk	52	Hackberry Park	Lowest Risk
26	<b>Harper Lake</b>	Lowest Risk	53	Steel Ranch Lift Station	Lowest Risk
27	Louisville Community Park / Dog Park	Lowest Risk	54	North End Lift Station	Lowest Risk

Note: **bolded text** indicates properties that were burned during the Marshall Fire.

\* This area comprises the Coal Creek Regional Trail bordering the northeast portion of the Golf Course and areas east/northeast of the Dutch Creek Open Space until the railroad.

### 3.3.2. Irrigation Ditches

Irrigation ditches transfer and store water but also provide habitat and have the potential to accumulate biomass. Several irrigation ditches pass through the City of Louisville, but with the exception of Community Ditch, most of the ditches are not owned by the City. Ditches within the City of Louisville operate using easements, where the property owner is responsible for land maintenance. However, the ditch companies can supersede landowners for the ditch maintenance necessary to operate the ditches for the conveyance and delivery of water. Therefore, maintenance

for fire mitigation and other land use needs is often outside of the limits of the ditch company and require work to be completed by the landowner (Peterson, 2023).

In Figure 3-7 the ditches, ditch ownership, and landowners are overlaid on top of the wildfire risk results. The map shows that the ditches in North Open Space and Davidson Mesa Open Space have the highest wildfire risk as well as the ditches near the Howard Berry WTP to the south. Ditches within the interior of the City generally have a lower wildfire risk, but the risk increases on the south side of the City. The City works with ditch owners to develop memoranda of understanding to share maintenance responsibilities for ditches that may become overgrown with vegetation. The City should prioritize the ditches that have the highest risk where they own the land, such as the ditches near North Open Space.



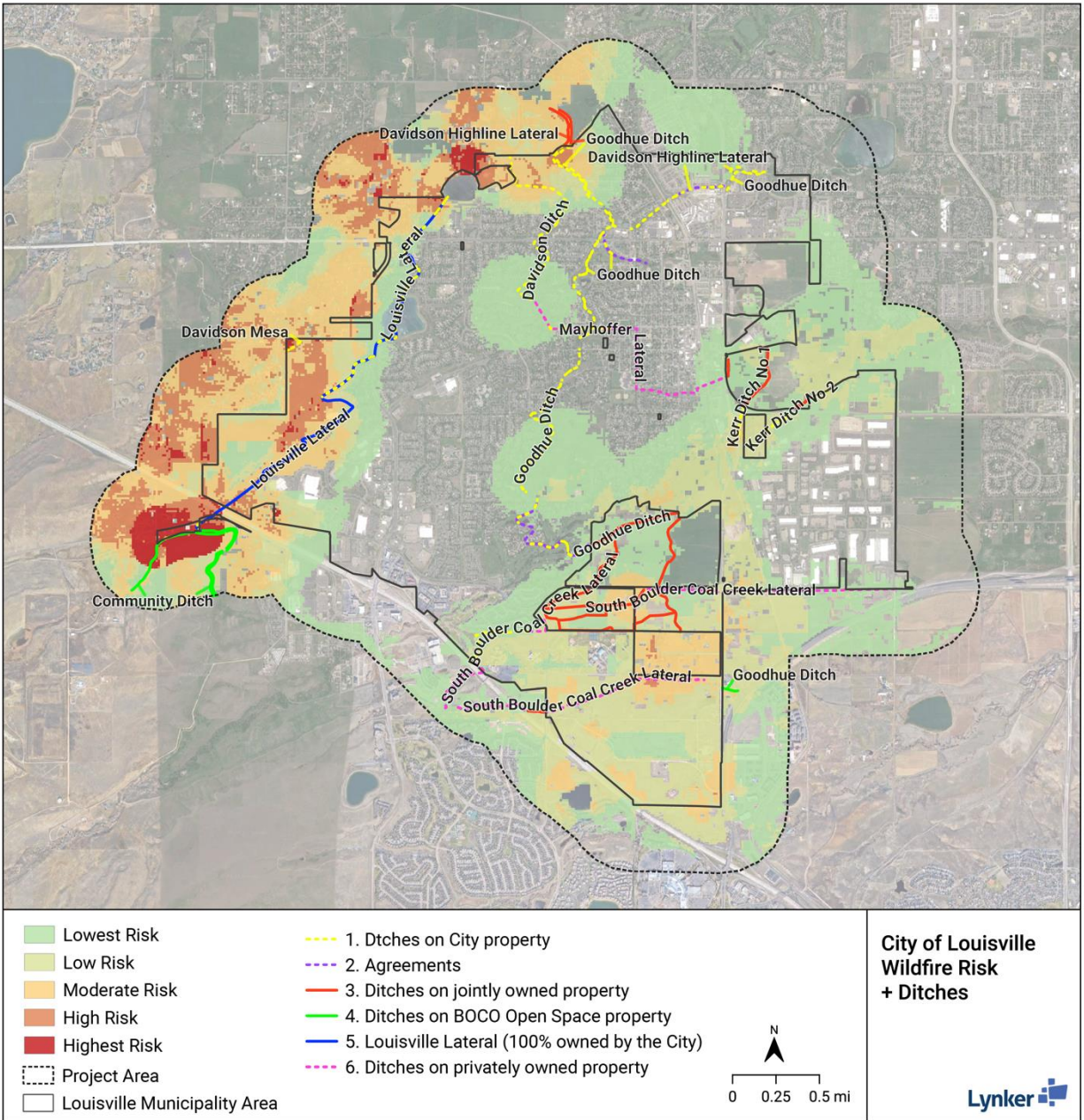


Figure 3-7. Wildfire risk to ditches in Louisville.



## 4. Mitigation Assessment

### 4.1. Introduction

There are benefits and tradeoffs to different actions to mitigate wildfire risk, and there are no management strategies that can optimize all values for public land and minimize wildfire risk at the same time. Reducing wildfire risk and restoring native grasslands often requires a variety of approaches including prescribed fire, grazing, and herbicide (Germino et al., 2016; Palit & DeKeyser, 2022). Social values, ecological impacts, feasibility, cost, and likelihood of success must be considered when deciding where to conduct different management options.

Given the range of benefits provided by public land and the uncertainty around wildfire occurrence and fuel treatment effectiveness, the best frameworks for enhancing wildfire resilience are those that have co-benefits in addition to wildfire risk reduction. For example, restoring native grasslands can create landscapes that burn with lower intensity than those invaded by non-native grasses while also creating wildlife habitat and increasing biodiversity. Hardening structures and creating defensible space around important infrastructure can increase the likelihood of structures surviving wildfire and reduce maintenance costs, reduce heating and cooling costs, and reduce landscaping water use.

#### Fuel Treatment Effectiveness

Fuel treatments are designed to reduce the intensity and spread of wildfires by decreasing the amount of fuel, altering the distribution of fuel, reducing the ignitability of fuel, and creating tactical opportunities for wildland firefighters to engage with wildland fires (Agee et al., 2000; Reinhardt et al., 2008). Fuels include natural vegetation, landscaping, and built structures. Fuel treatments can include mowing, grazing, prescribed burning, herbicide, and replacing flammable vegetation with more fire-resistant vegetation in strategic locations to minimize potential damages from wildfire. Fuel treatments include landscape-scale treatments, which can achieve ecological restoration objectives if intentionally designed to do so, defensible space creation around homes and other structures, linear fuel breaks, and linear fire breaks.

The effectiveness of fuel treatments is influenced by a variety of factors, including the intensity, quality, and extent of treatment, location of treatments, maintenance of treatments, weather conditions and fire behavior, and actions of firefighters (Figure 4-1) (Agee et al., 2000; Jain et al., 2021). The percentage of fuel breaks that have effectively stopped actual wildfires is between 22-47% in forests (Gannon et al., 2023; Syphard et al., 2011) and 46-71% in sagebrush ecosystems (Weise et al., 2023). A review of fuel treatment effectiveness found that, “A fuel treatment can only be as effective as the suppression that goes along with it”—less than 1% of wildfires are stopped by a fire break alone and in insolation of suppression activities (McDaniel, 2023; page 3). Fuel treatments are more effective under moderate fire weather conditions than extreme weather conditions, and most effective when firefighters are

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“Given the right conditions, wildlands will inevitably burn. It is a misconception to think that treating fuels can ‘fire-proof’ important areas... the primary goal of fuel treatment should be to create landscapes in which fire can occur without devastating consequences” (Reinhardt et al. 2008).

present to use the fuel treatment as a control feature (Gannon et al., 2023; Jain et al., 2021; Reinhardt et al., 2008; Syphard et al., 2011; Weise et al., 2023).

Mitigation efforts are unlikely to stop urban conflagrations driven by extreme windspeeds and producing prolific ember cast like the 2021 Marshall Fire. Fuel treatments cannot prevent embers from blowing into treatment areas or onto surrounding structures. During the Marshall Fire, embers blew across Highway 36—which is functionally a 180-ft fire break—and embers ignited tress in the middle of parking lots (Holstrom et al., 2023). Uncontrollable factors will always play a role in home loss during extreme wildfires. Minute-to-minute shifts in wind directions, unexpected wind gusts, and extreme fire behavior and growth that overwhelm suppression efforts can result in home loss not explained by mitigation efforts prior to the fire.

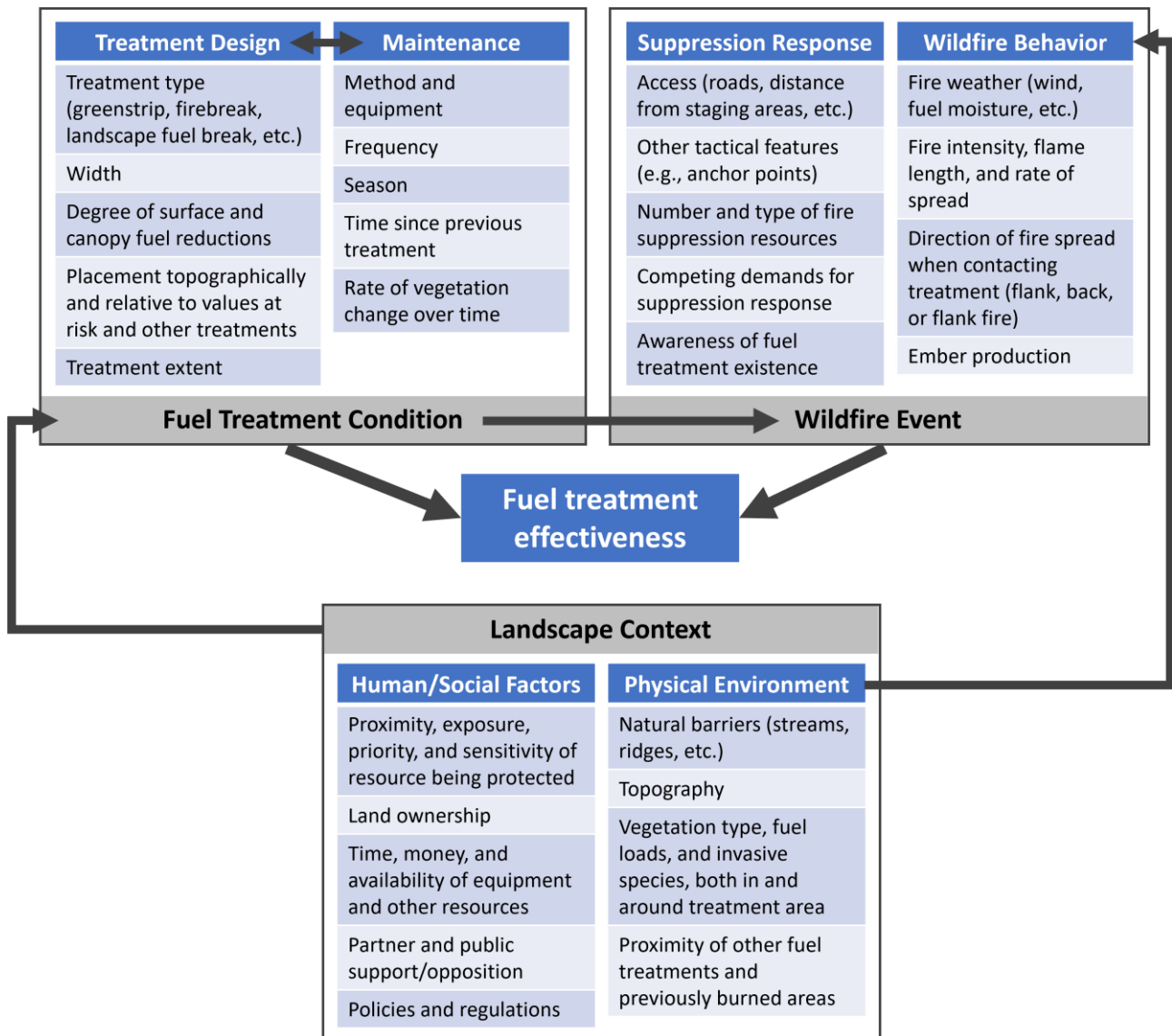


Figure 4-1. The effectiveness of fuel treatments at altering wildfire behavior is influenced by numerous factors related to landscape context, fuel treatment specifications, and conditions during a wildfire event. Figure modified by The Ember Alliance based on (Jain et al., 2021; Trauernicht & Kunz, 2019).

## Adaptive Management

Adaptive management and monitoring are crucial components of any management program. Knowledge about effective wildfire mitigation in the grassland-urban interface is lacking, but understanding will increase over time as more researchers are attracted to this line of inquiry and land managers experiment with different approaches and share their observations about treatment effects. Vegetation conditions change over time and year to year in response to weather, so the City needs to adapt their approach based on current conditions. For example, mowing will need to be repeated more frequently in years with greater precipitation resulting in increased vegetation growth. Monitoring is a part of any adaptive management program; therefore, monitoring to measure changes in fuel loads and vegetation conditions after implementing different strategies is recommended to understand their impact.

**There are no management strategies that can optimize all values for public land and minimize wildfire risk at the same time.** When approaching wildfire risk mitigation, fire and fuel managers, natural resource managers, and the public need to answer the following questions—questions that are as much of a social nature as a scientific one:

- What intensity of fire weather conditions are fuel treatments designed to be effective against?
- How much uncertainty is acceptable in terms of predicted effectiveness?
- What tradeoffs are acceptable? For example, wider fuel treatments with less remaining vegetation might be more effective at slowing the spread or reducing the intensity of wildfire, but they might degrade wildlife habitat, reduce privacy for adjacent property owners, and be more costly than narrower, less aggressive treatments.
- What marginal returns are acceptable? For example, is a treatment requiring two times the amount of work to increase potential success by 50% satisfactory? By 10%?

## Guiding Principles for Wildfire Risk Mitigation and Resilience

Ecological restoration of grassland communities is a useful framework to achieve wildfire resilience and enhance other values on public land in the City of Louisville, particularly on open space and non-irrigated parks. Defensible space creation and structure hardening is a useful framework for wildfire resilience on irrigated parks and public works facilities. Different mitigation tactics are available to achieve the objectives of grassland restoration, defensible space creation, and structure hardening, each with different advantages, disadvantages, and tradeoffs (see Section 4.2 Mitigation Alternatives and Recommendations).

## Grassland Restoration

Much of the area around Louisville was once covered in Western Great Plains foothill and piedmont grassland and Western Great Plains shortgrass prairie (K. Decker et al., 2020). Grazing by native ungulates (deer, elk, pronghorn, and bison), foraging and burrowing activity of prairie dogs, and fires started by lightning and Native Americans were important disturbances in these ecosystems. Regular grazing and fires occurring every 5 to 25 years maintained patchy fuels and high biodiversity in grasslands prior to Euro-American settlement (Milchunas et al., 2014; Schulz et al., 2014).

Western Great Plains foothill piedmont grasslands and Western Great Plains shortgrass prairie are some of the most severely degraded ecosystems in the state due to urban and suburban development, agricultural activities, fire exclusion, altered animal grazing, fragmentation, and invasion by non-native species (K. Decker et al., 2020). Grasslands invaded by cheatgrass and smooth brome have more abundant fine fuels, greater fuel continuity, and lower fuel moisture earlier in the summer than native grasslands, thereby creating conditions susceptible to fast-moving wildfires (Davies & Nafus, 2012; Fusco et al., 2019).

Objectives of shortgrass prairie restoration are to:

- Reduce the cover of non-native grasses, thereby reducing fuel load and continuity and creating opportunities for native plants to establish.
- Establish patchy vegetation dominated by native grasses, forbs, and shrubs, favoring species that have fire-resistant properties and stay green during hot summer months. Establishing native plants will also provide habitat for insects and wildlife.
- Utilize grazing and prescribed burning to increase the cover of bare mineral soil, consume dead plant litter, reduce the height of vegetation, and create heterogeneity in vegetation conditions—conditions that are less conducive to large, rapidly spreading wildfires.

Restoration can occur across entire properties or in vegetation buffers called greenstrips (Miller, 2006). Restoration of grasslands and prairie will take years of repeated treatment and maintenance. A combination of herbicide applications, grazing, reseeding, and prescribed burning are usually required to restore these ecosystems (Germino et al., 2016; Palit & DeKeyser, 2022).



*Western Great Plains foothill and piedmont grasslands were dominated by big bluestem, little bluestem, side-oats grama, green needlegrass, western wheatgrass, sand dropseed, needle-and-thread, and New Mexico feathergrass. Photo credit and source: (Decker et al., 2020).*



*Western Great Plains shortgrass prairies were dominated blue grama, buffalo grass, three-awn, side-oats grama, hairy grama, needle-and-thread, June grass, western wheatgrass, James' galleta, alkali sacaton, and sand dropseed. Photo credit and source: (Decker et al., 2020).*

## Defensible Space and Structure Hardening

The goal of defensible space and structure hardening is to increase the chance of homes and other structures surviving wildfires without relying on limited firefighter resources. The home ignition zone (HIZ) includes structures and three zones at various distances from the structure (Figure 4-2). Especially during windy conditions, embers can ignite structures even when the flaming front of a wildfire is several hundred feet, even miles, away. Structure hardening is particularly important in the WUI; 50 to 90% of homes ignite due to embers rather than radiant heat during wildfires (Babrauskas, 2018; Gropp, 2019; Holstrom et al., 2023). Firefighter intervention, adequate defensible space, and home hardening measures are common factors for homes that survive major wildfires (IIBHS, 2019; Maranghides et al., 2022).

Wildfire resources for Louisville residents and homeowners can be found in Section 5, including additional information on defensible space and low flammability landscaping, and wildfire adaptation.



Using ignition-resistant building materials and removing burnable fuel around primary structures, outbuilding such as sheds, is crucial for increasing the chance of structures surviving a wildfire and creating safe conditions for wildland firefighters. All combustible fuels should be removed from Zone 1 (0 to 5 feet of the structure) and fuels should be significantly reduced in Zone 2 (5 to 30 feet), including mowing grasses and removing some trees and shrubs to increase the spacing between them. Source: (CSFS, 2021).

*Figure 4-2. Home ignition zones recommended by the Colorado State Forest Service.*

There is never a 100% probability of fire break success due to uncertain factors such as sudden wind shifts, availability of suppression resources, small-scale variation in fuel loads and distribution, etc. Embers can travel from far away and ignite fuel on the other side of a fire break. Homeowners should never assume that a fire break will protect their home or other community values from wildfire. **Structure hardening, defensible space around structures, and emergency preparedness are vital for becoming a wildfire resilient community in conjunction with fuel treatments.**



## 4.2. Mitigation Alternatives and Recommendations

This section describes the advantages and disadvantages of different management strategies and proposes where these types of actions might be most appropriate and beneficial for the City of Louisville. Recommendations are based on research, best management practices, and experience with firefighting in the wildland-urban interface.

Table 4-1 compares impacts of mitigation strategies on potential fire behavior and fuel characteristic, and Table 4-2 outlines which mitigation strategies are appropriate on different types of public land—open space, unirrigated parks, irrigated parks, and public works facilities. This table is a generalization—within property types and in different parts of the same property, mitigation approaches can differ in their feasibility, desirability, and potential benefits. Ditches are included in the table, with the understanding that not all ditches are managed by the City of Louisville. Greater detail about where and how to apply treatments according to risk categories from the wildfire risk assessment are provided in Table 4-13 through Table 4-15 at the end of this section. Table 4-16 compares costs of different mitigation methods.

Some implementation recommendations are made for areas within 30-feet or 100-feet from structures or fence lines. According to the 2021 Home Ignition Zone Guide from the CSFS, Zone 2 is 5- to 30-feet from structures and Zone 3 is 30- to 100-feet from structures. Management of grasses is recommended in zone 2 but not in zone 3, and managing woody fuel is recommended in zone 2 and 3 to reduce the potential for passive and active crown fires. 100-feet is also considered a conservative estimate of the area that can experience short-range ember cast from burning vegetation, particularly burning shrubs and trees (Beverly et al., 2010).

Some actions will require coordination with other landowners or property managers. Most ditches or laterals in and around the City of Louisville are not owned by the City, so activities along ditches will require coordination with ditch companies (see Figure 3-4). Treatment impacts can be magnified if the City coordinates with managers of adjacent public- or neighborhood-owned land to conduct larger-scale treatments that cross property lines. Programs to encourage and enable mitigation in the home ignition zone of private property are also vital to protect structures from potential wildfires and reduce the chance for home-to-home ignitions (see Wildfire Resources in Section 5).

**Table 4-1. Impacts of different mitigation options on potential fire behavior and fuel characteristics.**

Mitigation option	Fire rate of spread	Flame length	Ember production	Fuel ignitability	Overall fuel load	Amount of dead fuel	Fuel height	Fuel continuity
Prescribed burning	↓	↓↓	0 / ↓ (by killing trees/shrubs)	0	↓↓	↓↓	↓	↓↓
Herbicide	↓	↓	0	0	↓ / 0	↑	↓ / 0	↓
Grazing	↓	↓↓	↓ (by killing shrubs)	0	↓↓	↓↓	↓↓	↓↓
Seeding with native plants	↓	↓	↓ (by using low-resin plants)	↓	↓	↓ / 0	↓ / 0	↓
Prairie dog activity	↓↓	↓↓	↓	0	↓↓	↓	↓	↓↓
Mowing	↓	↓↓	0 / ↑ (by leaving clippings)	↑ (by leaving clippings)	↓ / 0	↓ / 0	↓↓	0
Irrigating	↓↓	↓	↓ / 0	↓↓	↑↑	↓	↑	↑
Defensible space	↓	↓↓	↓ (by removing trees/shrubs/ mulch)	↓	↓↓	↓↓	↓↓	↓↓
Structure hardening	↓	↓↓	↓↓	↓↓	N/A	N/A	N/A	N/A

Notes: In this table an arrow pointing down (↓) indicates mitigation options that usually result in a decrease in that variable, two arrows pointing down (↓↓) indicates a larger decrease, one arrow pointing up (↑) indicates an increase, two arrows pointing up (↑↑) indicates a larger increase, and a zero (0) indicates no impact. The actual magnitude and sometimes the direction of impact can vary depending on factors such as the quality and placement treatments.

**Table 4-2. Potential wildfire mitigation approaches on different property types owned and managed by the City of Louisville.**

Wildfire mitigation approach	Open Space	Non-Irrigated Parks	Irrigated Parks	Public Works	Ditches
<b>Prescribed burning</b> under safe conditions and with adequate resources to reduce overall fuel buildup and facilitate shortgrass prairie restoration.	✓✓	✓	✗	✗	✓✓
Use of <b>herbicide</b> as part of integrated weed management to reduce overall fuel buildup and control non-native plants to facilitate shortgrass prairie restoration.	✓✓	✓✓	✓	✓	✓
<b>Grazing</b> with cows and/or goats to reduce fuel load, height, and connectivity.	✓✓	✓✓	✗	✓	✓✓
<b>Seeding with native plants</b> to help restore shortgrass prairie ecosystems.	✓✓	✓✓	✓	✓	✗
Conservation of existing <b>prairie dog colonies</b> and natural expansion of colonies (where feasible) to preserve natural fuel breaks created by animal activity.	✓✓	✓	✗	✗	✗
<b>Broadscale mechanical mowing</b> to reduce fuel height.	✗	✓	✓✓	✓✓	N/A
<b>Targeted mechanical mowing</b> along fence lines, trails, and ditches.	✓✓	✓✓	✓	✓	✓
Selective and strategic <b>pruning or removal of trees and shrubs</b> to moderate potential fire behavior and reduce potential ember production.	✓	✓	✓	✓	✓✓
Use ignition-resistant building material and create <b>defensible space</b> around City-owned buildings and other infrastructure.	(✗)	(✗)	✓	✓✓	N/A
<b>Irrigating</b> or spot-watering to increase fuel moisture.	(✗)	(✗)	✓	✓	N/A

Notes: Ditches are included in the table, with the understanding that not all ditches are managed by the City of Louisville. ✓✓ = highly recommended approach with greater risk-mitigation benefits. ✓ = recommended approach with moderate risk-mitigation benefits. ✗ = approach not recommended. (✗) = approach not recommended except under specific circumstances. N/A = approach not applicable.

### 4.2.1. Prescribed Burning

#### What is the treatment and why should it be implemented?

Prescribed burning under safe conditions and with adequate resources can reduce overall fuel buildup and facilitate shortgrass prairie restoration. Fire is a natural process in grassland ecosystems and impacts of fire on vegetation, soil, and habitat cannot be replicated by other management activities (e.g., grazing, mowing, or herbicide).

Prescribed burns have been safely conducted in the wildland-urban interface along the Colorado Front Range. The City of Longmont, City of Lafayette, City of Boulder, and Boulder County Parks and Open Space have prescribed burn programs, but the City of Louisville does not currently have plans for prescribed burning in 2024. Safe and effective prescribed burn programs in the wildland-urban interface require carefully crafted burn plans, efforts to minimize smoke impacts, adequate preparation to create control lines, ample staffing and equipment to safely conduct the burn and address public concerns, frequent and clear communication with the public before, during, and after a burn, prescribed burn training for firefighters, and strong partnerships with partner agencies that can add capacity and share best practices for prescribed burning in the area. Careful timing of prescribed burns and post-fire management are important for reducing the growth and spread of non-native species and favoring the recovery of native species.

Prescribed burning along ditches is a cost-effective way to reduce overall fuel buildup and reduce the ability of fire to spread. Controlled ditch burning is regulated like agricultural fire use and differently than prescribed burning in the state of Colorado (8 CCR 1507-32). The strengths and weaknesses of prescribed burning are summarized in Table 4-3.



Photo Credit: City of Louisville

*Figure 4-3. Prescribed burning in Aquarius Open Space.*

**Table 4-3. Pros and cons of prescribed burning under safe conditions and with adequate resources to reduce overall fuel buildup and facilitate shortgrass prairie restoration.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Natural process in shortgrass prairies.</li> <li>• Consumes dead plant material and reduces total fuel load.</li> <li>• Creates patches of bare soil.</li> <li>• Recycles nutrients into the soil.</li> <li>• Can reduce cover of non-native plants like smooth brome and cheatgrass (particularly early spring burns).</li> <li>• Can enhance wildlife habitat post-fire.</li> <li>• Increases grass palatability.</li> <li>• Can be conducted safely with proper planning and implementation (&lt;1-3% prescribed fires escape) (Weir et al., 2019).</li> <li>• Improves water conveyance in ditches.</li> </ul>	<ul style="list-style-type: none"> <li>• Infrequent opportunities to burn (weather, fuel conditions, air quality, and personnel availability must align).</li> <li>• Impacts of smoke on sensitive populations.</li> <li>• Slight potential for escape.</li> <li>• Can require post-burn weed control.</li> <li>• Can reduce cover for some wildlife species.</li> <li>• Requires new capacity within the City of Louisville for prescribed burn operations.</li> </ul>
<p><b>Sources:</b> (DiTomaso et al., 2006; Engle, 2009; Paysen et al., 2000; Schultz et al., 2019; Vermeire et al., 2020; Vogl, 1979; Weir et al., 2013)</p>	

**How is the treatment implemented?**

- Where appropriate, develop a patch burning system with grazing and regular prescribed burns to promote heterogeneity on grassland ecosystems (see recommendations in (Weir et al., 2013)).<sup>2</sup>
- Conduct burns in early- to mid-spring when tillers of cheatgrass and smooth brome are elongating, before seed production, and native perennial grasses are still mostly dormant, to more effectively control smooth brome and cheatgrass (DiTomaso et al., 2006; Germino et al., 2016; Palit & DeKeyser, 2022).
- Prepare and follow a burn plan in compliance with requirements of the Boulder County Sheriff’s Office and Colorado Division of Fire Prevention and Control. Work with members of the Boulder County Fireshed to gain insight into best practices for safely achieving burn objectives in the area. Coordinate treatment with local fire responsible parties.
- Conduct extensive public outreach to communicate purpose, actions, and status of the burn months ahead of ignitions, the week of ignitions, and daily after ignitions.
- Take steps to mitigate smoke impacts on sensitive populations, such as targeted outreach to at-risk individuals and burning on days with good smoke dispersal.
- Monitor impacts of prescribed burning and modify implementation practices to achieve objectives.
- Those conducting the prescribed burning should have proper training and certification to ensure correct safety protocols and best practices are being followed. For Louisville, contracting this

<sup>2</sup> Prescribed burning is most appropriate in parts of open spaces and unirrigated parks greater than 20 acres in size and that have adequate control features, such as trails and roads, a higher likelihood of successful prairie restoration (see section 4.2.4), and fewer homes along the boundary of the burn unit.



service out or coordinating with another local agency will be the most effective way to reinstate a program.

#### 4.2.2. Herbicide

##### **What is the treatment and why should it be implemented?**

Non-native grasses like smooth brome and cheatgrass create continuous fuel beds that dry out early in the summer, and reducing their cover can help slow fire intensity and rates of spread (Davies & Nafus, 2012; Fusco et al., 2019). Combating widespread, non-native grasses is a complex challenge that requires a variety of management approaches, including herbicide, prescribed burning, and grazing. Some efforts to restore native grasslands have failed without the use of herbicide to reduce the cover of non-native species and create opportunities for native species to establish. However, there are also negative ecological impacts of herbicide that must be weighed against potential benefits.<sup>3</sup>

Smooth brome and cheatgrass are abundant across many parks and open spaces in the City of Louisville due to the history of agriculture in the area and the inadvertent spread of grass seeds by humans, equipment, livestock, pets, and wildlife. The City of Louisville's [Integrated Weed Management Plan](#) includes the use of select herbicides to manage non-native species. Regulations in the city prohibit the use of Glyphosate and 2,4-D herbicides on City-maintained open space, and parks, except for Coal Creek Golf Course. For successful conversion of smooth brome and cheatgrass to native short grass prairie, leadership and City Council may need to remove the current herbicide restrictions such as the ban on glyphosate in these specific treatment areas. The strengths and weaknesses of herbicide use are summarized in Table 4-4.

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<sup>3</sup> Herbicide application is most appropriate in open space, non-irrigated parks, and ditches with a higher likelihood of successful short-grass prairie restoration (see section 4.2.4), areas where alternative methods of weed control are not feasible, and where concerns about water contamination are lower.

**Table 4-4. Pros and cons of herbicide use as part of integrated weed management to control non-native plants to facilitate short-grass prairie restoration and/or reduce overall fuel buildup.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Reduces continuous cover of non-native grasses like cheatgrass and smooth brome.</li> <li>• Creates opportunities for native species to establish.</li> <li>• Can be used in combination with other weed management strategies, such as grazing, biological control, mowing, and prescribed burning.</li> </ul>	<ul style="list-style-type: none"> <li>• May require multiple treatments over several years.</li> <li>• Logistically challenging to apply over large areas.</li> <li>• Can create bare-ground and opportunities for non-target, non-native species to establish.</li> <li>• Increases quantity of dead vegetation.</li> <li>• Can have negative impacts on non-target species and beneficial insects.</li> <li>• Can have negative impacts on water quality.</li> <li>• Can pose a human health hazard.</li> <li>• Can result in the development of herbicide resistance.</li> </ul>
<p><b>Sources:</b> (Bahm et al., 2011; Germino et al., 2016; Palit &amp; DeKeyser, 2022; Sebastian et al., 2017; U.S. Forest Service, 2014)</p>	

**How is the treatment implemented?**

- Follow City of Louisville regulations regarding herbicide application and use the lowest possible application rate to achieve intended outcomes.
- See the Field Guide for Managing Cheatgrass in the Southwest (U.S. Forest Service, 2014) and research by (Sebastian et al., 2017) for application rates of different herbicides for controlling cheatgrass, and research by (Bahm et al., 2011) for controlling smooth brome. Time herbicide application to kill cheatgrass and smooth brome during the boot stage and before seed production. Cheatgrass can also be controlled with a pre-emergent herbicide applied during plant dormancy.
- Monitor impacts of herbicide and modify application practices to achieve objectives.
- Set clear expectations about mitigation of non-native, cool-season grasses—smooth brome is ubiquitous on open space and parks lands and cannot be removed everywhere.

### 4.2.3. Grazing

#### What is the treatment and why should it be implemented?

Grazing by ungulates (i.e., hooved animals) is a natural process in grasslands and can promote biodiversity and heterogeneity in habitat conditions. Targeted grazing can reduce fuel load, height, and connectivity, resulting in reduced flame length and rates of spread. Fuel breaks created by targeted grazing in cheatgrass can lessen the intensity of wildfires and assist in wildfire suppression. Grazing must be carefully managed to avoid negative impacts to native vegetation, human-livestock conflicts, and damage to riparian areas.



Photo Credit: City of Louisville

*Figure 4-4. Goat grazing in City of Louisville Open Space. Photo credits: City of Louisville.*

The City of Louisville currently grazes cattle and goats on several properties for weed mitigation and wildfire risk reduction, most notably, grazing on Davidson Mesa and North Open Space, which has implemented both goats and cattle in the spring, summer, and fall of 2023. The strengths and weaknesses of grazing use are summarized in Table 4-5.

**Table 4-5. Pros and cons of grazing to create fuel breaks and reduce fuel loads.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Natural process in shortgrass prairies.</li> <li>• Decreases buildup of dead grasses.</li> <li>• Can reduce some non-native grasses and promote some native species.</li> <li>• Increase heterogeneity in grass height and cover of bare soil.</li> <li>• Can decrease shrub abundance if goats are used.</li> <li>• Trampling can increase the cover of bare soil and prepare soil for native seeds.</li> <li>• Important to the local economy.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires careful management to avoid overgrazing.</li> <li>• Requires fence construction and maintenance or management of temporary fencing.</li> <li>• Can introduce/promote non-native species and require additional weed control.</li> <li>• Potential human-livestock conflicts (including noise and smell).</li> <li>• Trampling can degrade riparian areas.</li> </ul>
<p><b>Sources:</b> (Clark et al., 2023; Davies et al., 2022; Diamond et al., 2009; Engle, 2009; Lovreglio et al., 2014; Marchetto et al., 2021; Nader et al., 2007)</p>	

#### How is the treatment implemented?

- Time grazing to reduce biomass and cover of cheatgrass and smooth brome during the boot stage and before seed production (Diamond et al., 2009).
- Conduct early spring or winter grazing to remove dead litter (Davies et al., 2015).

- Aim for moderate utilization rates (50-60%) to effectively reduce potential flame lengths and rates of spread without negatively impacting native vegetation and wildlife habitat (T. Decker, 2018; Schachtschneider, 2016). Monitor impacts of grazing and modify intensity and timing to achieve objectives. Too low of grazing intensity can fail to meet fuel mitigation objectives, but heavy grazing can decrease cover of native plants and encourage expansion of smooth brome and cheatgrass (Davies et al., 2022).
- Prioritize goat grazing over cattle grazing in areas where shrub removal is required, double fencing is less feasible, and/or where greater trampling by heavy cattle is undesirable (e.g., sensitive riparian areas).
- To magnify benefits of grazing, develop a patch burning system with grazing and regular prescribed burns to promote heterogeneity on grassland ecosystems, where prescribed burning is appropriate (see recommendations in (Weir et al., 2013).

#### 4.2.4. Seeding with Native Plants

##### **What is the treatment and why should it be implemented?**

Western Great Plains foothill piedmont grasslands and Western Great Plains shortgrass prairie are some of the most severely degraded ecosystems in the state of Colorado (K. Decker et al., 2020). Restoring grasslands and prairies with short-statured, low-flammability native species separated by patches of bare soil can reduce potential flame lengths and rates of spread relative to grasslands invaded by non-native species such as cheatgrass and smooth brome. Restoring grasslands often requires extensive site preparation with a combination of prescribed burning, grazing, herbicide application, and tilling to mitigate non-native species and create opportunities for native plants to establish (Germino et al., 2016; Palit & DeKeyser, 2022).

Although it might seem counterintuitive that planting vegetation can serve as a fuel break, if short-statured, low-flammability plants are used and plant density is low enough to reduce fuel continuity, greenbelts are as effective as firebreaks and mowed fuel breaks, particularly when the cover of shrubs and other woody fuel is low (Miller, 2006; Weise et al., 2023). Creating fuel breaks via restoration of prairie ecosystems is preferable to targeted mowing in certain locations because it balances wildfire mitigation objectives with other values for parks and open spaces, including biodiversity, wildlife habitat, and aesthetic beauty. Locations where prairie restoration is appropriate can include:

- Areas that already have a robust population of native, low-flammability plant material,
- Areas >60 feet wide, adjacent to neighborhoods, and bounded by trails or roads,
- Areas where prescribed fire and/or grazing can be used to maintain ecosystem health and reduce fuel loads,
- Areas where herbicide can be used to manage weedy species if other methods are ineffective,
- Areas where spot-watering is possible the first several years after seeding or planting to increase establishment success, and/or
- Highly visited parks where native gardens can be used as an educational tool to illustrate fire-resistant landscaping to residents.

The strengths and weaknesses of implementing seeding with native plants are summarized in Table 4-6.



**Table 4-6. Pros and cons of seeding with native plants to reduce potential flame lengths and rates of spread.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Results in patches of grass separated by bare mineral soil.</li> <li>• Reduces presence of cool season non-native grasses.</li> <li>• Increases biodiversity.</li> <li>• Creates habitat for wildlife and beneficial insects.</li> </ul>	<ul style="list-style-type: none"> <li>• Native plants are still a source of fuel, although some have more fire-resistant properties.</li> <li>• Requires irrigation/spot-watering the first couple years after seeding. If not watered, it may require reseeding in successive years and/or seedings timed with wet springs.</li> <li>• Requires site preparation, including herbicide, prescribed burning, and grazing.</li> <li>• Can require years of trial-and-error to identify the appropriate mix of species and revegetation techniques.</li> <li>• Difficult to prevent non-native plant invasion in high-recreation areas.</li> </ul>

**Sources:** (Colorado Natural Areas Program, 1998; Davies & Nafus, 2012; Fusco et al., 2019; Miller, 2006)

**How is the treatment implemented?**

- Reduce competition from non-native species with prescribed burning, herbicide, and/or grazing prior to seeding.
- Select native plants with low flammability, such as warm-season bunch grasses, penstemon, and succulents (Carter et al., 2023). Avoid highly flammable species like junipers.
- See the Native Plant Revegetation Guide for Colorado and Boulder County Revegetation Guide for recommended native plants and site preparation activities (Colorado Natural Areas Program, 1998).
- Irrigate or spot-water the first year or two following seeding if rainfall is low to increase establishment success.
- Consider a patch burning system with grazing and regular prescribed burns to help maintain prairie ecosystems and promote heterogeneity, where prescribed burning is appropriate (see recommendations in (Weir et al., 2013)).
- Utilize volunteers to encourage citizen involvement in short-grass prairie restoration and wildfire resilience.



Photo Credit: The Ember Alliance

*Figure 4-5. Flame lengths and rates of spread can be lower in areas with short-statured, low-flammability, native vegetation intermingled with bare soil.*

- Monitor seeding success and modify seed mix, watering, and soil preparation as necessary to achieve objectives.

#### 4.2.5. Conservation of Prairie Dog Colonies

##### What is the treatment and why should it be implemented?

Prairie dogs are a keystone species in grassland ecosystems that impact plant species composition, habitat and prey for other wildlife, nutrient cycling, and potential wildfire behavior by dramatically reduce grass cover, height, and fuel continuity over large areas (Kotliar et al., 1999). Prairie dog colonies are currently planned on Davidson Mesa, Aquarius, and Daughenbaugh Open Spaces in the City of Louisville, as well as on several adjacent open spaces managed by other cities or Boulder County. The strengths and weaknesses of using prairie dog colonies are summarized in Table 4-7.



Photo Credit: The Ember Alliance

Figure 4-6. Prairie dog habitat.

**Table 4-7. Pros and cons of conserving and promoting prairie dog colonies to create natural fuel breaks.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Native, keystone wildfire species in Colorado grasslands.</li> <li>• Dramatically reduce grass cover, height, and fuel continuity over large areas.</li> <li>• Create patches of bare mineral soil.</li> <li>• Prey for species like hawks, badgers, bobcats, and endangered black-footed ferrets (if relocated to ferret populated areas).</li> </ul>	<ul style="list-style-type: none"> <li>• Can promote non-native forbs and require additional weed control.</li> <li>• Increased cover of bare soil can detract from visual appeal of open space and parks.</li> <li>• Lack of vegetation can lead to wind and water erosion.</li> <li>• Cause damage to trails and private property.</li> <li>• Can transmit diseases.</li> <li>• Degrade rangelands used for cattle.</li> <li>• Can cause human-wildlife conflicts.</li> </ul>
<p><b>Sources:</b> (Kotliar et al., 1999; Seglund &amp; Schnurr, 2010)</p>	

##### How is the treatment implemented?

- Follow the City’s existing prairie dog management plan for open space properties (City of Louisville, 2004).
- Evaluate locations where natural expansion, or movement, of colonies is acceptable.
- Maintain healthy colonies by monitoring populations for disease.

- Follow conservation strategies for prairie dog populations outlined by Colorado Parks & Wildlife (Seglund & Schnurr, 2010) and Boulder County Parks and Open Space (BCPOS, 2022).
- Educate residents about the benefits of prairie dog colonies for creating effective, large-scale fuel breaks.

#### 4.2.6. Broadcast Mechanical Mowing

##### What is the treatment and why should it be implemented?

Broadcast mechanical mowing on Louisville’s public lands refers to using mechanical equipment to mow across large areas of grasslands. Mechanical mowing reduces fuel height which can decrease the potential flame length during a fire and rates of spread across a landscape (Cheney et al., 1993; Cruz et al., 2020). Mowing can reduce fuel loads if clippings are removed. The consequences of mowing large areas should be considered before being implemented across open space lands. For example, the City of Lafayette has noted that broadscale mowing has ecological consequences that may not be suited for their open space lands (City of Lafayette, Parks, Recreation & Open Space, 2023). The strengths and weaknesses of broadcast mechanical mowing are summarized in Table 4-8.

**Table 4-8. Pros and cons of broadcast mechanical mowing to reduce fuel height.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Reduces grass height and potential flame lengths by about 30-66% and rates of spread by about 5-50%.</li> <li>• Reduces fuel load if clippings are removed.</li> <li>• Can reduce cover of some non-native species (e.g., Russian thistle).</li> <li>• Creates better lawns for recreation in parks.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires repeated maintenance.</li> <li>• Clippings can serve as readily burnable fuel, seed source, and source of embers if not removed.</li> <li>• Can favor non-native over native species and require additional weed control.</li> <li>• Rarely kills weeds, just weakens them.</li> <li>• Can spread non-native species to other areas if mowers are not cleaned.</li> <li>• Can degrade habitat for wildlife, beneficial insects, and native plant species.</li> <li>• Can result in wildlife fatalities, especially for ground-dwelling mammals and birds.</li> <li>• Mowed grasslands can detract from visual appeal of open space and parks.</li> <li>• Unsafe for operators on steep slopes.</li> <li>• Equipment can spark fires.</li> <li>• Can encourage recreation access and create unplanned trails.</li> <li>• Can encourage the spread of prairie dog colonies to adjacent lands.</li> </ul>

**Sources:** (Baxter, 2007; Cheney et al., 1993; Cheney & Sullivan, 2008; Cruz et al., 2020; Vermeire et al., 2020)

## How is the treatment implemented?

- Maintain grass height <4-6" across the property or at least within 30 feet of infrastructure (buildings) following the Colorado State Forest Service Home Ignition Zone Guide (CSFS, 2021).<sup>4</sup>
- Frequency of mowing depends on the rate of grass growth. Mow a final time in the early fall before the grass fully cures.
- Mow all the way to the adjacent property or fence line.
- Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather, and at the end of the growing season, particularly on the highest-risk properties according to the wildfire risk analysis in Table 3-1 if the goal is to decrease rate of spread by an additional 10%<sup>5</sup>.
- Experiment with more frequent mows to create smaller clippings instead of removing clippings.
- Reduce the risk of sparking a wildfire by following recommendations from [CALFIRE](#) and the [National Fire Prevention Association](#): avoid mowing when it is excessively windy or dry. Use extra caution when mowing dry grass, particularly in rocky areas. Install a spark arrestor and carry a fire extinguisher on the mower, and make sure grass clippings have not clogged the mower.



Photo Credit: City of Louisville Open Space and Parks

*Figure 4-7. The City of Louisville has about 250 acres of grass turf to mow for recreational purposes.*

<sup>4</sup> Research demonstrates that fire rates of spread are slower in areas with lower grass height (Cruz et al., 2020), but there is not scientific evidence to suggest an ideal height for mowing to reduce wildfire risk, particularly since rates of spread in grassland fires are extremely dependent on wind speeds.

<sup>5</sup> Rates of fire spread can be slightly higher (about 10%) in areas where grass clippings are left in place (Cheney et al., 1993), and the risk of ember production is higher. However, removal of grass clippings can be costly and infeasible, and there is no scientific research measuring the importance of clipping removal for fuel break effectiveness.



#### 4.2.7. Targeted Mechanical Mowing to Create Fuel Breaks

##### What is the treatment and why should it be implemented?

Fuel breaks are linear features with reduced fuel loads that are designed to reduce the intensity and spread of wildfires and create tactical opportunities for firefighters to engage with wildland fires (Agee et al., 2000; Reinhardt et al., 2008). Strategic placement and maintenance of fuel breaks can be a useful mitigation strategy for the City of Louisville, but there is no guarantee a fuel break will stop fire spread, especially on days with extreme fire danger. Fuel treatments cannot prevent embers from blowing into treatment areas or onto surrounding structures. During the Marshall Fire, embers blew across Highway 36—which is functionally a 180-ft fire break—and embers ignited isolated trees in the middle of parking lots (Holstrom et al., 2023).

The width a fuel break needs to be, amount of woody material that needs to be removed, and height that grass needs to be mowed depends on a variety of factors, including slope, the type of wildfire event the fuel break encounters, and the presence or absence of firefighters (Figure 4-1). Although wider fuel breaks with less fuel might be more successful at supporting fire suppression, they are more expensive to create and maintain, and have a variety of negative ecological and aesthetic impacts. Fuel breaks can also create a false sense of security among residents regarding potential wildfire risk to their homes.

After the 2021 Marshall Fire, the City of Louisville began mowing along 15 miles of fence lines to create 12-foot-wide fuel breaks. The strengths and weaknesses of implementing fuel breaks are summarized in Table 4-9.



Photo Credit: Google Street View and Holstrom et al. (2023)

**Figure 4-8. Mowed vegetation adjacent to wooden fences likely protected some homes along McCaslin Blvd from the Marshall Fire.**

**Table 4-9. Pros and cons of targeted mechanical mowing to create fuel breaks along fence lines, trails, and ditches.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Reduces grass height and potential flame lengths by about 30-66% and rates of spread by about 5-50%.</li> <li>• Creates potential control lines for firefighters.</li> <li>• Mowing can be performed by residents within 10 feet of fence lines.</li> <li>• Can increase sight lines/visibility and enhance visitor safety on trails.</li> </ul>	<ul style="list-style-type: none"> <li>• Does not remove all vegetation and therefore not as effective as a fire break.</li> <li>• Uncertainty over effective fuel break width.</li> <li>• Usually requires the presence of firefighters along the fuel break to effectively control the spread of wildfires.</li> <li>• Can create a false sense of security regarding mitigated wildfire risk.</li> <li>• Clippings can serve as readily burnable fuel and seed source if not removed.</li> <li>• Can favor non-native over native species and require additional weed control.</li> <li>• Rarely kills weeds, just weakens them.</li> <li>• Can spread non-native species to other areas if mowers are not cleaned.</li> <li>• Can fragment habitat for wildlife.</li> <li>• Can result in wildlife fatalities, especially for ground-dwelling mammals and birds.</li> <li>• Can result in social trails, increased recreation, and reduce privacy along private property.</li> <li>• Unsafe for operators on steep slopes.</li> <li>• Can spark fires.</li> </ul>
<p><b>Sources:</b> (Baxter, 2007; Brou, 2022; Cheney &amp; Sullivan, 2008; Cruz et al., 2020; Dustin, 2002; Frangieh et al., 2021; Rossi et al., 2019; Shinneman et al., 2019; Vermeire et al., 2020; Weise et al., 2023; Wilson, 1988)</p>	

**How is the treatment implemented?**

- Position fuel breaks as close to roads, ridge tops, fence lines, and trails as possible. Fuel breaks interior to the property can help modify wildfire behavior and create tactical opportunities for firefighters. However, if the goal is to protect homes along the perimeter of a property from wildfire, fuel breaks should be located closer to the property line (ideally within 30 feet of the property line). If fuel breaks are farther away from properties, embers could ignite fuels on the other side of the fuel break and build up energy and speed before approaching a structure.
- Fuel break width can vary according to property wildfire risk, with 15-30 feet recommended for areas of high-risk properties and 12-15 feet for areas of moderate-risk properties.<sup>6</sup> See Table 3-2

<sup>6</sup> The general guidance for fuel breaks is that “wider is better and less fuel is better”. There is little scientific evidence about the best width of fuel breaks and the amount of fuel that should be removed (see Appendix 8.2). Research on fire breaks where all vegetation is removed suggests widths of 12-15 feet are adequate under high

for property wildfire risk and Table 4-15 for additional details about fuel break width and positioning.

- Maintain grass height <4-6" in the fuel break.<sup>7</sup>
- Frequency of mowing depends on the rate of grass growth. Mow a final time in the early fall before the grass fully cures. Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather, and at the end of the growing season, particularly on the highest-risk properties according to the wildfire risk analysis in Table 3-1 if the goal is to decrease rate of spread by an additional 10%<sup>8</sup>.
- Experiment with more frequent mows to create smaller clippings instead of removing clippings.
- Use leaf blowers to remove dead leaves and other debris that accumulate along fence lines at the end of the fall.
- Reduce the risk of sparking a wildfire by following recommendations from [CALFIRE](#) and the [National Fire Prevention Association](#): avoid mowing when it is excessively windy or dry. Use extra caution when mowing dry grass, particularly in rocky areas. Install a spark arrestor and carry a fire extinguisher on the mower, and make sure grass clippings have not clogged the mower.

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fire weather danger. Fuel breaks where vegetation is mowed should be wider than 15 feet in high-risk areas. The Colorado State Forest Service recommends mowing grass within 30-feet of structures, so 30 feet is a reasonable upper threshold for the width of mowed fuel breaks.

<sup>7</sup> Research demonstrates that fire rates of spread are slower in areas with lower grass height (Cruz et al., 2020), but there is not scientific evidence to suggest an ideal height for mowing to reduce wildfire risk, particularly since rates of spread in grassland fires are extremely dependent on wind speeds.

<sup>8</sup> Rates of fire spread can be slightly higher (about 10%) in areas where grass clippings are left in place (Cheney et al., 1993), and the risk of ember production is higher. However, removal of grass clippings can be costly and infeasible, and there is no scientific research measuring the importance of clipping removal for fuel break effectiveness.

#### 4.2.8. Selective and Strategic Management of Woody Vegetation

##### What is the treatment and why should it be implemented?

Burning trees and shrubs can emit more embers than burning grasses and produce higher flame lengths. Woody species with high content of resin or volatile oils, living branches growing close to the ground, fibrous bark, and high accumulations of dead branches and needles or leaves, such as junipers, are particularly flammable. The invasion of grasslands by juniper shrubs can greatly increase the potential for ember production and spot fires (Donovan et al., 2023). Deciduous tree species with higher moisture content in their leaves and fewer low branches are less flammable. Riparian ecosystems with cottonwood and willows can slow or stop fire spread due to cooler temperatures and higher live fuel moisture (Webb et al., 2019). However, willows can burn with high flame lengths and low rates of spread when they are dormant, especially if there is an accumulation of dead stems. Wildfire suppression has increased the accumulation of woody fuels in riparian ecosystems in addition to upland forests (Dwire et al., 2016; Webb et al., 2019).

Recently dead trees with fine branches and dry, dead needles are highly flammable, but older dead trees that have lost branches and needles are hard to ignite. Logs and dead branches can burn for a long time and emit extreme amounts of heat. Dead trees and logs are important habitat features for cavity-nesting birds and other animals and can create habitat for fish when they fall in rivers. Research is limited regarding best practices, effectiveness, and ecological impacts of fuels management in cottonwood stands and riparian ecosystems with willows. Low-impact management is recommended in riparian ecosystems and cottonwood stands due to the ecological importance of these habitats and the lower potential for severe wildfire (Dwire et al., 2016).

Selective and strategic management of woody vegetation for wildfire mitigation includes removal of trees to increase the spacing between trees, removal of highly flammable species, removal of low limbs and dead stems/branches, and removal of some dead logs and branches to reduce fuel loads. Woody vegetation can be managed with chainsaws, handsaws, herbicide, grazing by goats, and prescribed burning. The goal is to decrease the chance of fire spreading into treetops and producing embers that threaten homes, NOT to remove all woody vegetation from a property. After the 2021 Marshall Fire, the City of Louisville removed trees and low limbs on parks, open spaces, and city facilities that burned during the fire. The strengths and weaknesses of management of woody vegetation are summarized in Table 4-10.



Photo Credit: The Ember Alliance

**Figure 4-9. Removal of highly flammable shrubs such as juniper adjacent to wooden fences and homes can reduce the chance of flames and embers damaging property.**



**Table 4-10. Pros and cons of selective and strategic management of woody vegetation to moderate potential fire behavior and reduce potential ember production.**

Pros	Cons
<ul style="list-style-type: none"> <li>Decreases likelihood of fire transitioning into treetops.</li> <li>Decreases likelihood of fire spreading from treetop to treetop.</li> <li>Reduces the chance of ember production from burning trees or shrubs.</li> <li>Reduces the quantity of large, dead fuel that can burn for a long time and with high intensity.</li> <li>Increases the potential success of fuel breaks.</li> </ul>	<ul style="list-style-type: none"> <li>Can decrease the availability of wildlife habitat.</li> <li>Can decrease biodiversity on a site.</li> <li>Reduces shading and can result in lower soil and fuel moisture.</li> <li>Reduces surface friction and can result in higher surface wind speeds.</li> <li>Community attachment to specific trees.</li> <li>May reduce shading and privacy of adjacent private property.</li> </ul>
<p><b>Sources:</b> (Wilson, 1988; CSFS, 2021; Banerjee, 2020; CSFS, 2015; Dwire et al., 2016)</p>	

### How is the treatment implemented?

The following guidance for management of conifer forests and scattered trees around structures comes from the Colorado State Forest Service’s Home Ignition Zone Guide (CSFS, 2021):

- Remove trees and shrubs within 30 feet of structures or private fence lines to create at least 10-foot spacing between the outer branches of remaining trees. Small groups of two or three trees may be left, but at least 30-foot spacing should be created between the outer edge of tree groups and other trees or shrubs.
- Favor the retention of low-flammability shrubs and trees (see plant recommendations in (Carter et al., 2023) and (Colorado Natural Areas Program, 1998)).
- Remove junipers or dead trees with dry, red needles within 100-feet of structures.
- Prune limbs of trees within 100-feet of structures that hang 6-10 feet above the ground or a third of the total height of the tree.

Recommendations for fuels management in cottonwoods and riparian areas according to the Colorado State Forest Service’s Cottonwood Management Guide (CSFS, 2015) and other research on riparian ecosystems (Anjozian, 2008; Dwire et al., 2016) are as follows:

- Remove woody plants from underneath cottonwoods, particularly non-native plants such as Russian olive or highly flammable shrubs like juniper.
- Prune limbs that hang 6-10 feet above the ground or a third of the total height of the tree.
- Annually remove dead branches from shrubs and excess leaf litter buildup underneath trees as needed. Prescribed burning can be an effective management strategy for reducing dead fuel in willow-dominated areas. Move dead and downed woody debris in cottonwood groves to beyond the edge of tree branches, or to a minimum of 10 feet away from desirable trees. Reduce woody fuel loads to 5–30 tons/acre.
- Create a mosaic of habitat conditions, including open areas, areas with low tree density, and interspersed denser stands of trees, to simulate conditions historically created by floods. Small groups of trees may be left, but at least 30-foot spacing should be created between the outer edge of tree groups and other trees or shrubs.

- Leave enough young cottonwood growth for habitat and tree regeneration.
- Stage treatments over a period of years and in small patches to allow animals to adapt to habitat changes over time.
- Schedule treatments during the non-breeding season of birds, reptiles, and amphibians whenever possible.
- Plan restoration activities during the dry season to avoid compacting soils.
- Prior to treatment, conduct surveys for threatened and endangered bird, reptile, amphibian, and plant species.
- Develop a monitoring program to assess impacts of fuel treatments on riparian ecosystems (see recommendations in (Dwire et al., 2016)).

#### **4.2.9. Structure Hardening and Defensible Space**

##### **What is the treatment and why should it be implemented?**

The goal of defensible space and structure hardening is to increase the chance of homes and other structures surviving wildfires without relying on limited firefighter resources. Embers can ignite structures even when the flaming front of a wildfire is several hundred feet, even miles, away. Structure hardening is particularly important in the WUI; 50 to 90% of homes ignite due to embers rather than radiant heat during wildfires (Babrauskas, 2018; Gropp, 2019; Holstrom et al., 2023). Firefighter intervention, adequate defensible space, and home hardening measures are common factors for homes that survive major wildfires (IIBHS, 2019; Maranghides et al., 2022). The strengths and weaknesses of structure hardening and defensible space are summarized in Table 4-11.

**Table 4-11. Pros and cons of using ignition-resistant building material and creating defensible space.**

Pros	Cons
<ul style="list-style-type: none"> <li>• Reduces flammability of fuels around structures and the structure itself.</li> <li>• Reduces the ability of embers to penetrate structures, and these actions can also increase efficiency of heating and cooling buildings.</li> <li>• Removing trees or pruning lower branches decreases the likelihood of fire transitioning into treetops and reduces the chance of ember production.</li> <li>• Removal of mulch can decrease the chance of smoldering and ember production.</li> <li>• Fire-resistant plant species are often native, attract beneficial insects, and are drought tolerant conserving water.</li> <li>• Ignition-resistant building materials can be more weather resistant and have lower maintenance costs.</li> </ul>	<ul style="list-style-type: none"> <li>• Can require removal of existing vegetation.</li> <li>• Requires irrigation for the first several years after establishing new fire-resistant plants.</li> <li>• Xeriscaping and hardscaping are not visually appealing to everyone.</li> <li>• Removal of mulch can increase evaporation from soil.</li> <li>• Hardscaping requires weed control.</li> <li>• Changes visual appearance of buildings.</li> <li>• Sand in playgrounds is not ADA compliant or wheelchair accessible.</li> <li>• Silica in sand can cause inflammation of the lungs and trigger asthma.</li> </ul>
<p><b>Sources:</b> (Carter et al., 2023; CSFS, 2021; Hakes et al., 2017; IIBHS, 2019; Maranghides et al., 2022; Syphard et al., 2011)</p>	

**How is the treatment implemented?**

- Follow the 2021 Home Ignition Zone Guidelines from the Colorado State Forest Service (CSFS, 2021). This includes replacing flammable building materials with ignition-resistant materials, reducing the potential for ember penetration into buildings, removing all flammable material from within 5 feet of buildings and other infrastructure, mowing grasses to less than 4 inches within 30 feet of structures, removing flammable shrubs like juniper, and pruning tree branches to a height of 6-10 feet above the ground within 30 feet of structures.
- Start with easy-win actions, such as installing screens over vents and eaves to reduce the chance of ember penetration.



Photo Credit: The Ember Alliance

*Figure 4-10. The Louisville Recreation and Senior Center has exemplary structure hardening and defensible space and survived the Marshall Fire which burned across the center's campus.*

- More expensive actions like replacing roofs and siding with ignition-resistant material is a high priority for all critical infrastructure regardless of fire risk and for other structures in high-risk areas. The City should strongly consider using ignition-resistant materials for all renovations or new construction.
- Conduct annual maintenance activities around structures to mitigate risk of ignition.
- Select native plants with low flammability, such as warm-season bunch grasses, penstemon, and succulents (Carter et al., 2023). Avoid highly flammable species like junipers.
- Use the Recreation Center as an exemplary example of structure hardening and defensible space creation and maintenance.
- Replace mulch under trees with ignition-resistant materials such as gravel or non-flammable engineered wood fiber if there are homes, critical infrastructure, unirrigated grasslands, or dense woody fuel within 100-feet of the trees. This action is only recommended properties with high or highest risk according to the wildfire risk analysis in Table 3-1.

#### 4.2.10. Irrigation or Spot-Watering

##### **What is the treatment and why should it be implemented?**

Irrigating or spot-watering vegetation can reduce the ability of living and dead vegetation to ignite, but there are several reasons this is not the best option for mitigating wildfire risk. In Colorado, the occurrence of wet springs one or two years before hot, dry summers can exacerbate wildfire behavior by leading to abundant growth of grasses, which can fuel large, fast-moving wildfires when they dry out (Littell et al., 2009; Westerling et al., 2003).

Enormous quantities of water would be necessary to wet down vegetation on days with high fire danger because water evaporates quickly on hot, dry, windy days. Furthermore, if a fire were to ignite, the water system might be depleted in such a way that it hampers effective use of water resources by firefighters. Low water pressure in the system was a challenge for suppression of the Marshall Fire, and dedicated workers at three water treatment plants in the area made valiant efforts to maintain water pressure for firefighters (Holstrom et al., 2023). Widespread irrigation on days with high fire danger could exacerbate this situation.

The City of Louisville does not have enough water rights to irrigate all properties throughout the year, and irrigation systems cannot be used in cold months, when fires can ignite during prolonged winter drought and unusual heat. Water conservation is important in the arid and semi-arid Western US, so widespread irrigation is incompatible with sustainable growth and land management. Additionally, impacts from climate change project reductions in Colorado's future streamflow (Lynker and Wilson Water, 2019). Mowed fuel breaks or promoting native plants that require less water to stay healthy and green throughout the growing season is a more important, sustainable action, better use of limited resources, and provides co-benefits such as habitat for wildlife and pollinators and increased biodiversity.

The strengths and weaknesses of irrigation are summarized in Table 4-12Table 4-12.



**Table 4-12. Pros and cons of irrigation or spot-watering to increase fuel moisture.**

Pros	Cons
<ul style="list-style-type: none"> <li>Increases fuel moisture and decreases flammability.</li> <li>Can promote native seed establishment.</li> <li>Increases forage production for cattle.</li> </ul>	<ul style="list-style-type: none"> <li>Encourages grass production and increases fuel loads.</li> <li>Irrigation and water sources are not available on all properties. Would require extensive and expensive installation of irrigation systems.</li> <li>Antithetical to water conservation.</li> <li>Can favor some non-native species and require additional weed control. Winter watering in particular can favor cheatgrass.</li> <li>Irrigation lines must be blown out to prevent freezing in the winter, making it difficult to irrigate during prolonged drought in the winter.</li> <li>Frequent watering can damage wooden fences.</li> </ul>
<p><b>Sources:</b> (Littell et al., 2009; Prevey &amp; Seastedt, 2015; Westerling et al., 2003)</p>	

**How is the treatment implemented?**

- Utilize existing irrigation systems, cisterns, and other water sources where available. Use portable water sources in less accessible areas.
- Target watering during the heat of the summer and during periods of prolonged drought in the fall and winter.

**4.2.11. Mitigation Recommendations by Property Type**

This section provides specific recommendations on where treatments should be implemented (e.g., open space, irrigated parks, public works facilities) and how the treatments should be implemented, according to risk categories from the wildfire risk assessment.

Some actions will take several years to plan and create the enabling conditions for implementation, such as prescribed burning or agricultural burning in ditches. Implementing all recommendations outlined below would have significant budgetary and staffing implications for the City of Louisville (see cost estimates of treatment types in Table 4-16). Further conversations with City Council, City staff, and the public are important to determine exactly which of these priority recommendations will be implemented, where, and when in the coming years. Starting with high-priority actions on high-risk properties is recommended.

Fire risk predictions are provided in Table 3-1 and Table 3-2 for City-owned properties. Properties identified as low or moderate risk can be managed like properties identified as high to higher risk if there is a strong, compelling reason to treat the property as such (for example, an area that is predicted to have low to moderate risk but burned during the Marshall Fire). If budgets are limited and not all high-risk properties can be treated, highest priority for treatments are on the eastern side of high-risk properties or when neighborhoods or businesses occur upslope from continuous grassy fuels. Marshall

Fire Facilitated Learning Analysis found that many subdivisions impacted by the Marshall Fire have homes positioned north to south or form a southwest facing point into wildland fuels. The strongest winds in this area predominately blow from west to east, meaning properties to the east of a large open space have a higher potential exposure to wind-driven fires. Properties upslope from wildland vegetation also have elevated risk to intense wildfire.

In Table 4-13 through Table 4-15, a double green check (✓✓) indicates a high-priority action with a greater likelihood of meaningfully reducing wildfire risk; a single green check (✓) indicates a moderate-priority action with a lower likelihood of meaningfully reducing wildfire risk; and a single x (✖) indicates that an action is not recommended because of low risk and need.

**Table 4-13. Mitigation actions for irrigated parks.**

Method	Property Wildfire Risk	
	Moderate to Highest	Lowest to Low
<b>Broadcast mowing to create fuel breaks</b>		
Broadcast mow the entire property to 4-6" height throughout the growing season, with a final mowing at the end of the growing season. Mow all the way up to property / fence lines.	✓✓	✓
Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather and at the end of the growing season if the goal is to decrease rate of spread by an additional 10%.	✓	✗
<b>Woody vegetation management (where present)</b>		
Along ditches, use goats or hand tools to remove dead stems from willows and other shrubs, decrease the quantity of shrubs located under trees, and remove low branches that hang 6-10 feet above the ground or a third of the total height of the tree.	✓✓	✗
Remove trees and shrubs within 30 feet of private fence lines to create at least 10-foot spacing between the outer branches of remaining trees. Favor the retention of low-flammability shrubs and trees (see plant recommendations in (Carter et al., 2023) and (Colorado Natural Areas Program, 1998)).	✓	✗
Remove junipers or dead trees with dry, red needles within 100-feet of structures.	✓✓	✗
Prune limbs of trees within 100-feet of structures that hang 6-10 feet above the ground or a third of the total height of the tree.	✓✓	✗
Prohibit the creation of wooden forts.	✓✓	✗
<b>Mulch and debris removal</b>		
Remove mulch and pine needles from under trees within 100-feet of structures.	✓	✗
Use a leaf blower to remove leaves and other debris accumulated along fence lines at the end of the fall.	✓	✗
<b>Irrigation</b>		
Irrigate grass in the spring, summer, and early fall when there is no risk of frost damaging irrigation infrastructure.	✓✓	✓
<b>Structure hardening</b>		
Follow guidance from the 2021 <a href="#">Home Ignition Zone Guide</a> from the CSFS to harden City-owned structures, including gazebos, restrooms, and sheds, particularly those within 100-feet of homes, businesses, or other critical infrastructure.	✓✓	✓

**Table 4-14. Mitigation actions for City-owned facility (e.g., water treatment plant, fire station, police station, recreation center).**

Method	Property Wildfire Risk	
	Moderate to Highest	Lowest to Low
<b>Complete removal of vegetation removal to create fire breaks</b>		
Remove all vegetation to create a fire break within 10 feet of the property line where there are no roads that can serve as a fire break. Leave as bare soil or replace with gravel or other non-flammable material. Maintain fire breaks vegetation free with herbicide or manual removal every year.	✓✓ high-risk ✓ moderate-risk	✗
Remove all vegetation to create a fire break within 5 feet of critical infrastructure. Leave as bare soil or replace with gravel or other non-flammable material. Maintain fire breaks vegetation free with herbicide or manual removal every year.	✓✓	✓
<b>Broadcast mowing to create fuel breaks</b>		
Broadcast mow the entire property to 4-6" height throughout the growing season, with a final mowing at the end of the growing season. Mow all the way up to property / fence lines.	✓✓	✓
Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather and at the end of the growing season if the goal is to decrease rate of spread by an additional 10%.	✓	✗
<b>Woody vegetation management (where present)</b>		
Along ditches, use goats, prescribed burning, or hand tools to remove dead stems from willows and other shrubs, decrease the quantity of shrubs located under trees, and remove low branches that hang 6-10 feet above the ground or a third of the total height of the tree.	✓✓	✗
Remove trees and shrubs within 30 feet of private fence lines to create at least 10-foot spacing between the outer branches of remaining trees. Favor the retention of low-flammability shrubs and trees (see plant recommendations in (Carter et al., 2023) and (Colorado Natural Areas Program, 1998)).	✓✓	✗
Remove junipers or dead trees with dry, red needles within 100-feet of structures.	✓✓	✗
Prune limbs of trees within 100-feet of structures that hang 6-10 feet above the ground or a third of the total height of the tree.	✓✓	✗
<b>Mulch and debris removal</b>		
Remove mulch and pine needles from under trees within 100-feet of structures.	✓	✗
Use a leaf blower to remove leaves and other debris accumulated along fence lines at the end of the fall.	✓	✗
<b>Irrigation</b>		
Irrigate grass in the summer where irrigation infrastructure is present.	✓✓	✓
<b>Structure hardening</b>		
Follow guidance from the 2021 <a href="#">Home Ignition Zone Guide</a> from the CSFS to harden City-owned structures, including gazebos, restrooms, and sheds, particularly those within 100-feet of homes, businesses, or other critical infrastructure.	✓✓	✓



**Table 4-15. Mitigation actions for open spaces or unirrigated parks.**

Method	Property Wildfire Risk		
	High/ Highest	Moderate	Lowest/ Low
<b>Restoration of prairie ecosystems to create fuel breaks (aka, "greenstrip")</b>			
Restore prairie ecosystems in areas at least 30-feet wide (ideally >60-foot wide to create a larger buffer to resist invasion of non-native plants from adjacent areas). Restoration can require a combination of grazing, prescribed burning, herbicide, and seeding with native species, with specific methods depending on site-specific considerations. <sup>9</sup> Native species should be short-statured and have low-flammability (see plant recommendations in (Carter et al., 2023) and (Colorado Natural Areas Program, 1998)).	✓✓	✓✓	✗
<b>Conservation of prairie dog colonies where in alignment with City of Louisville Prairie Dog Management Plans to preserve natural fuel breaks created by animal activity</b>			
Follow the City's existing prairie dog management plan for open space properties (City of Louisville, 2004) and evaluate locations where natural expansion, or movement, of colonies are acceptable.	✓✓	✓✓	✗
<b>Targeted mowing to create fuel breaks if property is not suitable for prairie restoration, not suitable for prairie dog conservation, or if funding is not available to immediately begin restoration</b>			
Create fuel breaks along exterior trails or fence lines that are a total of "A" feet wide (width includes trails where present). Mow off fence lines where trails are not present within 30 to 100 feet of neighborhoods or businesses. Mow to 4-6" height throughout the growing season, with a final mowing at the end of the growing season. Mowing is not necessary along property lines when roads are present.	✓✓ A = 15-30 ft	✓✓ A = 12-15 ft	✗
Create fuel breaks along interior trails that are a total of 12-15 feet wide (width includes trails). Mowing interior trails is a higher priority if trails can be used as potential control lines for prescribed burning or if mowing is important for visibility or other trail considerations. Mow to 4-6" height throughout the growing season, with a final mowing at the end of the growing season.	✓	✓	✗
Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather and at the end of the growing season if the goal is to decrease rate of spread by an additional 10%.	✓	✓	✗

<sup>9</sup> Prescribed burning is most appropriate in parts of open spaces and unirrigated parks greater than 20 acres in size and that have adequate control features, such as trails and roads, a higher likelihood of successful prairie restoration (see section 4.2.4), and fewer homes along the boundary of the burn unit. Agricultural burning is most appropriate along segments of ditches that have high fuel loads connecting public land and neighborhoods or other highly valued resources or those that can serve as long, linear control features for firefighters.

Herbicide application is most appropriate in open space, non-irrigated parks, and ditches with a higher likelihood of successful short-grass prairie restoration, areas where alternative methods of weed control are not feasible, and where concerns about water contamination are lower.

Grazing is most appropriate in parts of open spaces, unirrigated parks, and ditches where managers can control animal movement and minimize human-wildlife conflicts. Prioritize goat grazing over cattle grazing in areas where shrub removal is required, double fencing is less feasible, and/or where greater trampling by heavy cattle is undesirable (e.g., sensitive riparian areas).

Method	Property Wildfire Risk		
	High/ Highest	Moderate	Low/ Lowest
<b>Woody vegetation management (where present)</b>			
Along ditches and in cottonwood stands, use goats, prescribed burning, or hand tools to remove dead stems from willows and other shrubs, decrease the quantity of shrubs located under trees, and remove low branches that hang 6-10 feet above the ground or a third of the total height of the tree.	✓✓	✓	✗
Remove trees and shrubs within 30 feet of private fence lines to create at least 10-foot spacing between the outer branches of remaining trees. Favor the retention of low-flammability shrubs and trees (see plant recommendations in (Carter et al., 2023) and (Colorado Natural Areas Program, 1998)).	✓✓	✓	✗
Remove junipers or dead trees with dry, red needles within 100-feet of structures.	✓✓	✓	✗
Prune limbs of trees within 100-feet of structures that hang 6-10 feet above the ground or a third of the total height of the tree.	✓✓	✓	✗
Prohibit the creation of wooden forts.	✓✓	✓	✗
Remove mulch and pine needles from under trees within 100-feet of structures.	✓	✗	✗
Use a leaf blower to remove leaves and other debris accumulated along fence lines at the end of the fall.	✓	✓	✗
<b>Structure hardening</b>			
Follow guidance from the 2021 <a href="#">Home Ignition Zone Guide</a> from the CSFS to harden City-owned structures, including gazebos, restrooms, and sheds, particularly those within 100-feet of homes, businesses, or other critical infrastructure.	✓✓	✓	✓
Remove mulch and pine needles from under trees within 100-feet of structures.	✓	✗	✗

**Table 4-16. Cost estimates for different mitigation approaches.**

Mitigation option	Cost <sup>1</sup>	Ease to Implement	Notes	Source
<b>Prescribed burning</b>	\$\$-\$\$\$	Hard	Cost includes staff time for site preparation with 2-3 FTEs, burning 20-40 acres of grasslands, ditches, and stream corridors over the course of 2-4 days with 8-10 FTEs, 2-4 pickup trucks with water tanks, and 2-4 ATVs/UTVs.	City of Longmont and <a href="#">Colorado Cooperator Resource Rates</a>
<b>Herbicide</b>	\$	Easy	Cost for a single broadcast application. Includes labor and cost of herbicide	City of Louisville
<b>Grazing with goats</b>	\$\$\$-\$\$\$\$	Easy to Moderate	Goats have the ability to cover ¼ to 1 acre per day. Additional fee for mobilization and hauling.	City of Louisville
<b>Grazing with cattle</b>	\$\$	Easy to Moderate	Cattle need water regularly	City of Louisville
<b>Seeding with native plants</b>	\$\$	Difficult due to site preparation	Note: Site preparation (e.g., prescribed burn, herbicide, grazing) needs to be conducted prior to seeding of native plants. Will also require ongoing maintenance. Cost estimate is for seeding only.	City of Louisville
<b>Mowing (without clipping removal)</b>	\$	Easy	String trimming is required on steep slopes or in forested areas inaccessible to mowers.	City of Louisville
<b>Tree or shrub removal</b>	\$\$-\$\$\$\$	Moderate	Costs vary based on tree size, access, location, and tree condition (i.e., dead, dangerous, or healthy)	City of Louisville
<b>Tree limbing</b>	\$\$-\$\$\$	Moderate	Costs vary based on tree size, access, location, and tree condition (i.e., dead, dangerous, or healthy).	City of Louisville
<b>Irrigating / spot watering</b>	\$\$-\$\$\$	Easy to Moderate	Assumes water supply is available for irrigation and water rights do not need to be purchased. Irrigation rates are 500,000 – 600,000 gallons / acre / year.	City of Louisville
<b>Structure hardening</b>	\$-\$\$\$\$	Easy to Difficult (based on work)	Examples: harden vents with coverings or ember resistant design, replace wood or shingle roof, install dual-paned windows, upgrade to ignition resistant siding, remove debris from gutters, install non-combustible fence material.	

<sup>1</sup>\$ = \$0-300/acre; \$\$ = \$300-1,000/acre; \$\$\$ = \$1,000-2,000/acre; \$\$\$\$ = \$2,000+/acre

Notes: Some costs do not scale directly with acres treated. For example, the costs of a small-sized prescribed burn (<20 acres) can be comparable to costs for a moderate-sized prescribed burn (20-100 acres) because high staffing and equipment levels will be used for burns of any size in the WUI. Overhead costs for staff time to plan mitigation projects don't scale proportionately with acres and can vary from \$250-1,500 per project.

### 4.3. Louisville Site Assessment and Mitigation Recommendations

In May 2023, The Ember Alliance conducted an on-the-ground assessment of conditions at City of Louisville open spaces, parks, and other sites to identify strategic opportunities to mitigate wildfire risk. The Ember Alliance’s certified wildfire mitigation specialist and PhD scientist / senior wildfire analyst visited 14 properties managed by the City of Louisville to look at fuel conditions, topography, potential wildfire exposure of structures on and adjacent to City properties, defensible space and hardening of structures on City properties, and features that could assist with or create challenges for wildfire suppression. Eight of the ten properties with the highest wildfire risk were included in this assessment (Table 3-1).



Photo Credit: The Ember Alliance

*Figure 4-11. In May 2023, The Ember Alliance staff assessed fuel conditions, topography, and structure exposure on properties managed by the City of Louisville.*

Recommendations are based on observations from the field assessment, research findings, best management practices, and experience with firefighting in the wildland-urban interface. Treatment priority (first, second, or third) is based on the relative wildfire risk on the property (Table 3-2) and potential benefits and effectiveness (Table 4-13 through Table 4-15). The timing of the treatments—ongoing efforts, near-term (can be implemented immediately or next year), or mid-term (requires multiple years for planning and implementation)—is also indicated for the sites. Properties in Sections 4.3.1 through 4.3.15 are ordered from highest to lowest risk according to Table 3-2.

The mitigation recommendations (first, second, or third priority) are separate from the overall wildfire risk ratings for the City of Louisville presented in Section 3.3 (highest risk, high risk, moderate risk, low risk, lowest risk). Treatment priorities serve as a tool to help the City understand how to prioritize treatments across properties with different levels of risk given limited resources. The City can conduct additional site assessments for properties not visited and strategize additional mitigation work using recommendations from Section 4.2 and the prioritization criteria for mitigation projects (Table 4-17).

**Table 4-17. Prioritization criteria for mitigation projects.**

		Likelihood of Meaningful Risk Reduction		
		High	Moderate	Low
Property Wildfire Risk	Moderate to highest and/or burned in Marshall Fire	First priority	Second priority	Third priority
	Low	Second priority	Third priority	Not prioritized
	Lowest	Third priority	Not prioritized	Not prioritized

See Table 3 2 for property wildfire risk and Table 4 13 through Table 4 15 for likelihood of meaningful risk reduction.



Although the wildfire model results are used as the first indicator of wildfire risk, the model is an imperfect representation of reality, and often researchers prefer using multiple lines of evidence when available to support conclusions from scientific endeavors. In this study, multiple lines of evidence were used to support recommendations around wildfire risk and mitigation treatments in the City of Louisville. While the wildfire risk assessment was the basis for determining wildfire risk, the Marshall Fire burned area and modeling from the 2022 CO-WRA were used to develop a better-informed understanding of risk in the City of Louisville. These results were synthesized along with the site assessments conducted for this study to present a holistic approach to delineating the relative wildfire risk on public lands.

4.3.1. Howard Berry Water Treatment Plant (WTP)

Site Description
<p>Howard Berry Water Treatment Plant sits on an 8-acre acre property and includes water treatment infrastructure, including several buildings, water tanks, and solar panels. The property share fence lines with Bush (Rodney Dean) and Bush (Donald) grazing areas (Boulder County Parks &amp; Open Space) to the south and east. Community Ditch runs along the eastern and southern edges of the property. Distribution lines are located outside the fence north of the property along Marshall Road.</p> <p>The property is flat and covered in short to medium-length grasses. The City removed six conifer trees that were burned by the Marshall Fire and limbed six others along Marshall Road. There are three live and one dead cottonwood tree on the south side of the property. Grazing areas adjacent to the water treatment plant are covered in moderate to tall grasses, and parts of these properties are irrigated croplands.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Highest risk, burned in Marshall Fire</p> <p>Grassy vegetation around Howard Berry Water Treatment Plant could support low to moderate flame lengths (1-8 feet) and low to very high rates of spread (2-&gt;60 chains/hour) according to the 2022 Colorado Forest Atlas. The properties south of the Water Treatment Plant could also support low to moderate flame lengths (1-8 feet) and high to very high rates of spread (12 - &gt;60 chains/hour). The potential for ember production is relatively low from this property due to low densities of trees and shrubs.</p>
Exposure of Values at Risk
<p>Predicted burn probability on and around the Howard Berry Water Treatment Plant is high. Fire burning adjacent grassy areas or along Community Ditch could spread onto the property and threaten infrastructure. Wooden power poles along the road could be burned by direct flame contact where they are surrounded by flammable vegetation. The potential for ember production is relatively low from this property due to the low density of trees and shrubs.</p> <p>Howard Berry Water Treatment Plant fell entirely within the boundary of the Marshall Fire, but infrastructure was defended and protected from the fire. Several trees on the property were burned by the fire and later removed by the City. The Marshall Fire destroyed ten homes and damaged three in the neighborhood north of the Water Treatment Plant.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>City-owned chain-link fences are ignition resistant. Buildings are ignition resistant as they are primarily brick and metal, but ember could still penetrate vents and enter the building. Solar panels survived the Marshall Fire and demonstrated low susceptibility to damage from wildfire. Wooden power poles are not ignition-resistant, and char marks from the Marshall Fire were evident along the base of several power poles.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Broadscale mowing across the entire property to create a large fuel break.</b>	Mow the entire property to a height of 4-6". Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather and at the end of the growing season. <b>Area:</b> 8 acres	Near-term
<b>Complete removal of vegetation to create a fire break around the property due to elevated wildfire risk.</b>	Remove all vegetation down to bare mineral soil to create a fire break within 10 feet of the property line on the east, south, and west side. Marshall Road can serve as an adequate fire break to the north. Install gravel or other non-burnable materials to prevent vegetation from recovering in the fire break. <b>Area:</b> 0.4 miles	Near- to mid-term
<b>Structure hardening and defensible space around critical infrastructure.</b>	Follow guidance from the CSFS Home Ignition Zone Guide, including removal of all vegetation within 5 feet of structures and installing screens to prevent ember penetration into vents.	Near- to mid-term
<b>Second Priority Treatments</b>		
<b>Ditch maintenance to reduce risk of high flame lengths, passive crown fire, and ember production.</b>	Use mowing, prescribed burning, or grazing to create a fuel break extending 15 feet to either side of the ditches. Louisville Lateral is owned by City of Louisville, but management of Community Ditch will require coordination with Boulder County Parks & Open Space. <b>Area:</b> Louisville Lateral and Community Ditch	Near- to mid-term
<b>Structure hardening around power poles.</b>	Retreat old, wooden power poles and fill in large cracks to reduce their flammability. Mow vegetation to <4-6" within 10-feet of each pole if vegetation is present. <b>Area:</b> 6 wooden power poles along Marshall Road	Near-term

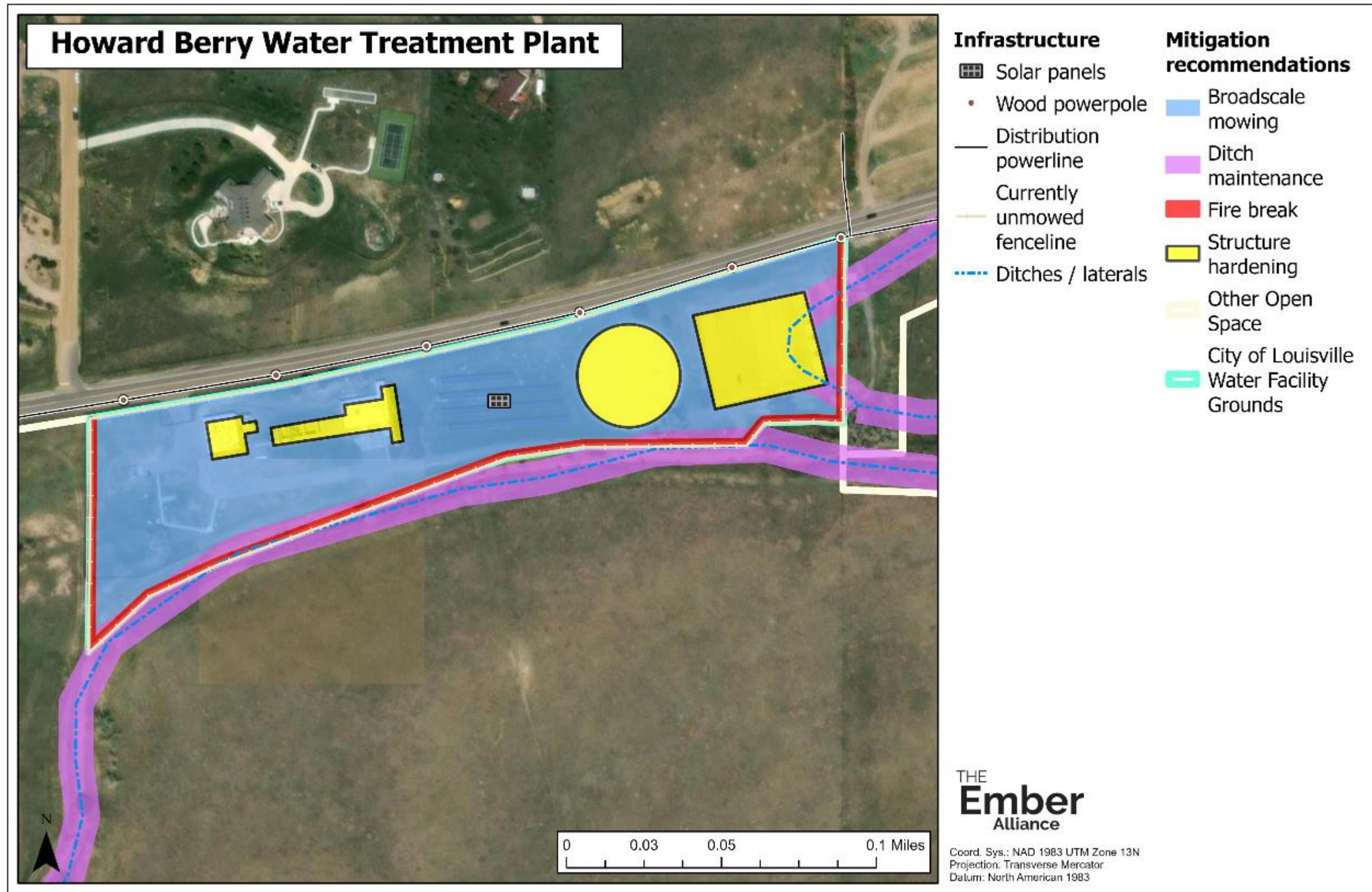


Figure 4-12. Howard Berry Water Treatment Plant Mitigation Treatments.



4.3.2. Keith Helart Park

Site Description
Keith Helart Park is a little over 1-acre in size and includes a playground, picnic tables under a gazebo, and access to paved trails. The property shares a fence line with Callahan Open Space (jointly owned by the City of Louisville and County of Boulder) to the west and North Open Space to the south. Davidson and Goodhue Ditches run along the western boundary of the property. The park is flat, and vegetation consists of an irrigated, mowed lawn.
Potential Fire Behavior
<b>Wildfire Risk Rating:</b> High risk Short grass on Keith Helart Park could support low flame lengths (1-4 feet) and low rates of spread (2-4 chains/hour) according to the 2022 Colorado Forest Atlas. However, the portion of the property along Davidson and Goodhue Ditches and the adjacent Callahan Open Space and North Open Space could experience moderate to extreme flame lengths (4->25 feet) and very high rates of spread (>60 chains/hour). There is a potential for ember production from trees and shrubs on the property.
Exposure of Values at Risk
Predicted burn probability on and around Keith Helart Park is moderate, and areas to the west have high burn probability according to the 2022 Colorado Forest Atlas. Fire could spread through areas of dense vegetation in Davidson and Goodhue Ditches into adjacent neighborhoods where continuous grassy vegetation abuts wooden fences and flammable vegetation on private properties. There is an accumulation of dried leaves and dead branches along portions of the ditches, particularly where they get trapped against the chain-link fence along the property line. It is possible that paved trails and Monarch Court could interrupt fire spread depending on fire weather conditions and direction of spread. There is a potential for ember production from the property, and several homes are within short-range spotting distance (about 33 yards). Keith Helart Park was not affected by the Marshall Fire.
Susceptibility of City-owned Infrastructure to Wildfire
City-owned chain-link fences are non-flammable. The metal playground and picnic tables are non-flammable. Weathered, exposed wood on the gazebos could ignite from embers but they are protected from direct flame impingement by concrete barriers. Engineered wood fiber used on the playground is certified as non-flammable, and the playground is surrounded by a concrete barrier

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Broadscale mowing across the irrigated portion of the property to maintain recreational fields and serve as a fuel break.</b>	Mow the irrigated portion of the property to a height of 4-6". Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather and at the end of the growing season. <b>Area:</b> 1 acre	Ongoing
<b>Ditch maintenance to create a fuel break.</b>	Coordinate with ditch companies to manage vegetation within ditches and at least 15-feet along each side. Use goats, prescribed burning, and/or hand tools to remove shrubs and dead stems, prune tree branches, and reduce the quantity of dead litter. Vegetation management along these two ditches could create strategic fuel breaks for wildland firefighters engaging fires spreading from the west towards neighborhoods in north Louisville. <b>Area:</b> At least 1.0 miles of Davidson Highline Lateral and Goodhue Ditch within and adjacent to the property	Near to mid-term
<b>Second Priority Treatments</b>		
<b>Debris removal along the property fence line.</b>	At the end of the fall, use a leaf blower to remove dead leaves, pine needles, and other debris that has accumulated along the fence line between Keith Helart Park and Callahan Open Space. <b>Area:</b> 650 feet of chain-link fence between Keith Helart Park and Callahan Open Space	Near-term
<b>Structure hardening of gazebos.</b>	Retreat exposed wood and fill in large cracks to reduce their ignitability. <b>Area:</b> Two wooden gazebos	Near-term



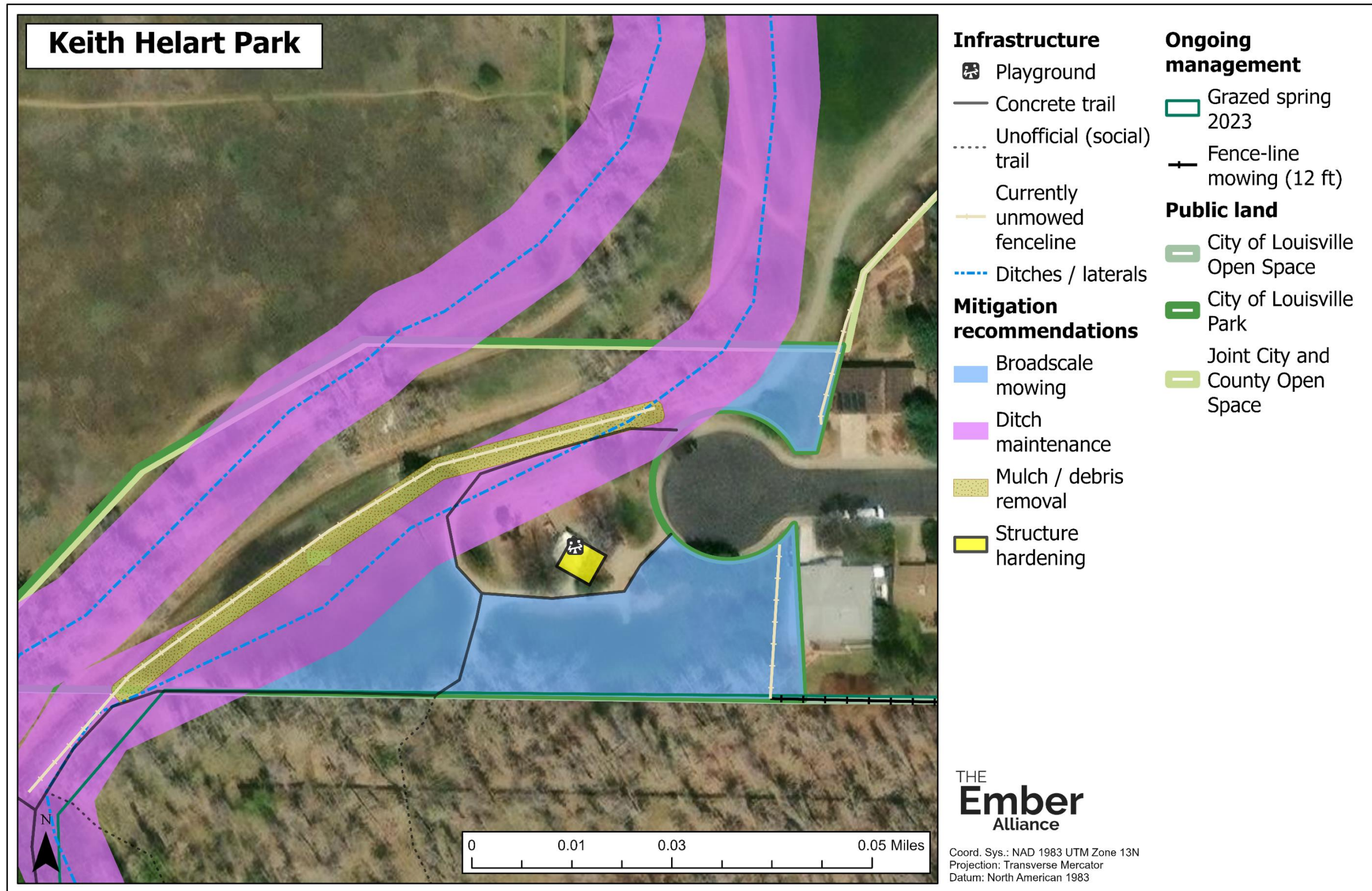


Figure 4-13. Keith Helart Park Mitigation Treatments.

### 4.3.3. Annette Brand Park

Site Description
<p>Annette Brand Park is a 7.4-acre park that includes about 1/3 of a mile of paved trails, a port-o-let bathroom, playground, picnic areas, basketball court, sand volleyball pit, and a multi-purpose field. The park shares a fence line with Steinbach Open Space (City of Boulder Open Space and Mountain Parks) to the north and North Louisville Water Treatment Plant to northeast. Community Ditch runs through the center of the park, and electric transmission lines follow the northern and eastern edges of the property.</p> <p>Most of the park's vegetation is mowed and irrigated lawns. There is a small area with riparian vegetation in the northern part of the property with thick willows, ash, other deciduous trees, and an accumulation of dead litter. Several pine trees with low branches are scattered across the property. There is a high accumulation of pine needles under pine trees adjacent to the fence along the North Water Treatment Plant property.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> High risk</p> <p>Fire spreading in short, mowed and irrigated grass on Annette Brand Park would likely have low flame lengths (1 to 4 feet) and low rates of spread (&lt;4 chains/hour) according to the 2022 Colorado Forest Atlas. Moderate to high-intensity fire behavior could be possible in an isolated area with overgrown litter and abundant dead litter in the northeastern part of the property. Several trees on the property have low branches that could ignite and emit embers, but mowed vegetation reduces the likelihood that trees would be exposed to enough radiant heat to ignite. Steinbach Open Space to the north of the park could experience high to very high rates of spread (40-&gt;60 chains/hour).</p>
Exposure of Values at Risk
<p>Predicted burn probability is low to moderate on and around Annette Brand Park according to the 2022 Colorado Forest Atlas, and exposure of homes and other structures immediately adjacent to the property is relatively low. Under extreme fire weather conditions, fire could spread along the irrigation ditch on the eastern edge of the property and ignite wooden fences and flammable vegetation on private properties. There is an accumulation of pine needles and dried leaves along portions of the ditch, particularly where they get trapped against the chain-link fence along the property line shared with North Louisville Water Treatment Plant. Electric transmission lines in this area have very little exposure to wildfire due to the substantial distance between the powerlines and vegetation.</p> <p>Annette Brand Park was not affected by the Marshall Fire.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>Chain-link and wire fences with t-posts/wooden posts are ignition resistant. The wooden sign for the park has weathered wood, but it is surrounded by a large area of bare soil and is unlikely to experience contact from flames. Metal gazebos and metal picnic tables on concrete pads are non-flammable. Engineered wood fiber used on the playground is certified as non-flammable, and the playground is surrounded by a concrete barrier</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Broadscale mowing across the entire property to maintain recreational fields and serve as a large fuel break.</b>	Mow the entire property to a height of 4-6". Remove clippings within 30 feet of private fence lines during extended periods of hot, dry weather and at the end of the growing season. <b>Area:</b> 7.4 acres	Ongoing
<b>Ditch maintenance to reduce risk of high flame lengths, passive crown fire, and ember production.</b>	Use mowing or grazing to create a fuel break extending 15 feet to either side of the ditch. <b>Area:</b> 2.5 miles of Louisville Lateral	Near- to mid-term
<b>Second Priority Treatments</b>		
<b>Debris removal along the property fence line.</b>	At the end of the fall use a leaf blower to remove pine needles and other dead vegetation that has accumulated along the fence line between Water Treatment Plant and Annette Brand Park. <b>Area:</b> 700 feet of chain-link fence between the Water Treatment Plant and Annette Brand Park.	Near-term
<b>Woody vegetation management to reduce the potential for passive crown fire and ember production from riparian area.</b>	Use grazing or hand tools to remove dead shrubs and prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. <b>Area:</b> 0.5 acres in a small riparian area along the boundary between the Water Treatment Plant and Annette Brand Park	Near- to mid-term
<b>Woody vegetation management to reduce the potential for passive crown fire and ember production from scattered trees across park.</b>	Use hand tools to prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. Remove leaves, pine needles, and mulch from around the base of trees and replace with bare soil or gravel. <b>Area:</b> Scattered trees within the park boundary	Near-term



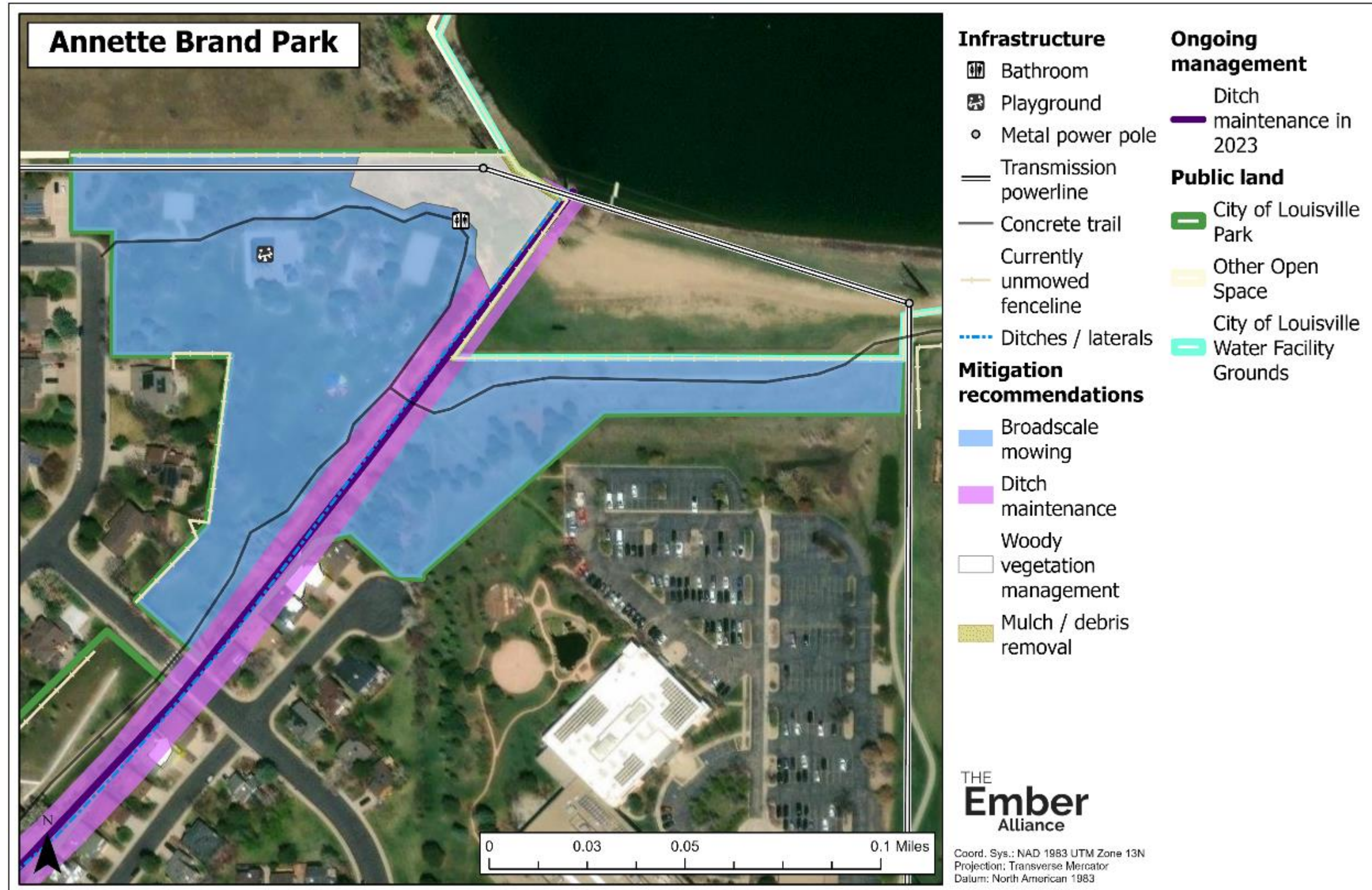


Figure 4-14. Annette Brand Park Mitigation Treatments.



4.3.4. North Open Space

Site Description
<p>North Open Space is a relatively large property (70 acres) managed for trails and habitat. The property has 1.5 miles of paved trails and 1.3 miles of unofficial social trails. Davidson and Goodhue Ditches run through the property.</p> <p>Vegetation is primarily continuous expanses of non-native grasses (smooth brome, wheatgrass species, sheep fescue, and other species) with scattered forbs. Ditches throughout the property have dense vegetation of willows, cottonwoods, ash, and other woody species and an abundance of dead litter. Dead branches and logs are present in several places along the ditches. The riparian plant community in the center of North Open Space is dominated by cottonwood with patches of deciduous shrubs and very few, isolated junipers. There is a low to moderate load of dead, downed trees in the cottonwood stand and a couple forts built of dead logs and branches.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Moderate risk</p> <p>Predicted fire behavior is highly variable across North Open Space according to the 2022 Colorado Forest Atlas, ranging from low to extreme flame lengths (1 to &gt;25 feet) and low to very high rates of spread (2 to &gt;60 chains/hour). Higher rates of spread could occur on steeper slopes, particularly when wind direction aligns with slopes during a wildfire. Higher flame lengths are possible in woody vegetation along ditches and in the cottonwood stand on the property. Passive or active crown fire could develop in the cottonwood stand if fire were to transition from the ground into treetops, but an on-the-ground assessment suggests that the actual likelihood of crown fire is relatively low because of higher fuel moisture in deciduous trees and the low abundance of ladder fuels.</p>
Exposure of Values at Risk
<p>Predicted burn probability on and around North Open Space transitions from high to low moving towards the adjacent neighborhoods according to the 2022 Colorado Forest Atlas. Fire could spread from North Open Space or along Davidson or Goodhue Ditches into adjacent neighborhoods where continuous grassy vegetation abuts wooden fences and flammable vegetation on private properties. It is possible that trails across North Open Space could interrupt fire spread depending on fire weather conditions and direction of spread. Homes on the eastern edge of the property have higher exposure due to the prevailing strong winds blowing out of the west, as are homes at the top of the steep north-facing slope on the property, particularly if wind gusts were to blow out of the north. Several homes are within short-range spotting distance of trees on the property (about 33 yards) and could be exposed to embers were passive or active crown fires to develop. Electric transmission lines in this area have very little exposure to wildfire due to the substantial distance between the powerlines and vegetation.</p> <p>North Open Space was not affected by the Marshall Fire.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>There is no City-owned infrastructure on North Open Space.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Restoration of prairie ecosystem to reduce potential flame lengths and rates of spread.</b>	Use a combination of prescribed burning, grazing, herbicide, and seeding to restore prairie ecosystems with short-statured, low-flammability native species separated by patches of bare soil. Some of the treatment area is already actively grazed by goats and cattle, and trails around the area can be used as potential control lines for prescribed burns. <b>Area:</b> 30 acres	Ongoing to mid-term
<b>Mowing around property perimeter and exterior trails to create a fuel break.</b>	Mow to create fuel breaks that are a total of 12-15 feet wide along exterior trails (width includes trails). If trails are not present within 30 to 100 feet of homes, mow 12-15 feet off the fence line in addition to the trail. <b>Area:</b> 1.5 miles. The city currently mows 12-foot fuel breaks along 2 miles of the perimeter in North Open Space.	Near-term
<b>Woody vegetation management to reduce potential of passive crown fire and ember production in cottonwood stand.</b>	Use goats, prescribed burning, and/or hand tools to remove shrubs and dead stems and to prune tree branches. Dismantle wooden forts and remove logs or scatter them around the property so they can serve as wildlife habitat. <b>Area:</b> 8 acres of cottonwood stands	Ongoing to near-term
<b>Ditch maintenance to reduce risk of high flame lengths, passive crown fire, and ember production.</b>	Coordinate with ditch companies to manage vegetation within ditches and at least 15-feet along each side. Use goats, prescribed burning, and/or hand tools to remove shrubs and dead stems, prune tree branches, and reduce the quantity of dead litter. <b>Area:</b> At least 0.7 miles of Davidson Ditch and at least 1.0 miles of Davidson Highline Lateral and Goodhue Ditch within and adjacent to the property.	Near- to mid-term
<b>Second Priority Treatments</b>		
<b>Mowing along interior trails to create a fuel break and potential control lines for prescribed burns.</b>	Mow to create fuel breaks along interior trails that are 12-15 feet wide (width includes trails). <b>Area:</b> 0.5 miles	Near-term

**Additional guidance:**

- Recommended fuel break widths include the width of the existing trail. If trails are not present within 30 to 100 feet of homes, mowing off the fence line as well as along trails can provide additional protection to homes.
- Woody management primarily entails removing dead stems and low branches to decrease the chance of fire spreading into treetops and producing embers, not the removal of all trees from a property. See Section 4.2.8.
- If budgets are limited and not all high-risk properties can be treated, highest priority for treatments are on the eastern side of high-risk properties or when neighborhoods or businesses occur upslope from continuous grassy fuels.



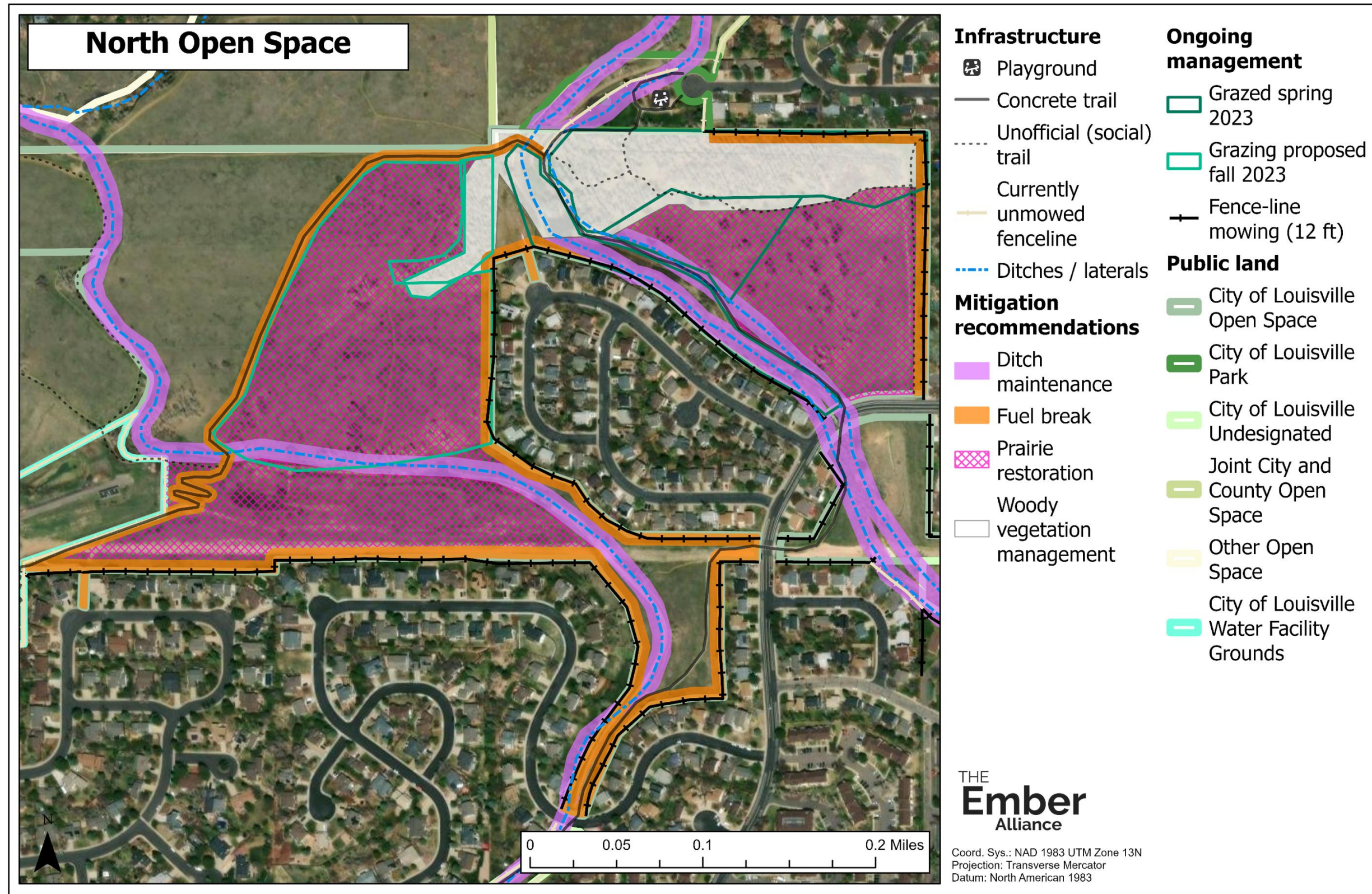


Figure 4-15. North Open Space Mitigation Treatments.



4.3.5. Davidson Mesa Open Space

Site Description
Davidson Mesa is the largest open space property owned solely by the City of Louisville at 246 acres. The property includes a dog park, dogs off-leash area, and about 4.1 miles of soft-surface trails. Davidson Ditch crosses the northwestern corner of the property and Louisville Lateral follows the eastern boundary. Vegetation conditions and wildlife habitat are highly varied across Davidson Mesa, with ten distinct vegetation communities in the northwest part of the property and six in the southeastern part (Cedar Creek Associates, Inc, 2022). Non-native forbs and grasses are abundant across the property. Diverse grassland conditions are partially created and maintained by the presence of prairie dog colonies, cattle grazing in several different pastures, integrated weed management by the City of Louisville (including mowing and herbicide), impacts of the Marshall Fire, and historical land use. Large narrowleaf cottonwood and plains cottonwood occur along Davidson Ditch in the northwest corner of the property.
Potential Fire Behavior
<b>Wildfire Risk Rating:</b> Moderate risk, burned in Marshall Fire Grassy vegetation on Davidson Mesa Open Space support low flame lengths (1 to 4 feet) and moderate to very high rates of spread (12 to >60 chains/hour) according to the 2022 Colorado Forest Atlas. The contiguous expanse of grassy vegetation could allow for fire to rapidly grow in size and intensity on hot, dry, and windy days. Trails throughout the property could interrupt fire spread, especially if firefighters are able to use trails to support suppression tactics. Cottonwoods in the northeastern part of the property are unlikely to burn due to higher soil and fuel moisture along Davidson Ditch. The potential for ember production is relatively low from this property due to the low cover of trees and shrubs. The Marshall Fire burned across most of Davidson Mesa Open Space (92%) and resulted in dramatic reductions in vegetation cover (average reduction of 40%, and upwards of 80% reduction in vegetation cover) (Cedar Creek Associates, Inc, 2022).
Exposure of Values at Risk
Predicted burn probability is high on and around Davidson Mesa according to the 2022 Colorado Forest Atlas. Fire could spread from Davidson Mesa Open Space into adjacent neighborhoods where continuous grassy vegetation abuts wooden fences and flammable vegetation on private properties. It is possible that trails across Davidson Mesa Open Space could interrupt fire spread depending on fire weather conditions and direction of spread. Homes on the eastern edge of the property are particularly at risk due to the prevailing strong winds blowing out of the west. Electric transmission lines in this area have very little exposure to wildfire due to the substantial distance between the powerlines and vegetation. The Marshall Fire destroyed 65 homes and damaged seven in the neighborhood west of Davidson Mesa and destroyed 86 homes and damaged four in the neighborhood to the east.
Susceptibility of City-owned Infrastructure to Wildfire
Two or three-rail design fences owned by the City are fairly ignition resistant. Metal power poles along the transmission line are non-flammable.

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Restoration of prairie ecosystem to reduce potential flame lengths and rates of spread.</b>	Use a combination of prescribed burning, grazing, herbicide, and seeding to restore prairie ecosystems with short-statured, low-flammability native species separated by patches of bare soil. Much of the area is already actively grazed by cattle and surrounded by trails, which can be used as potential control lines for prescribed burns. <b>Area:</b> 50 acres	Ongoing to mid-term
<b>Prairie dog conservation to maintain a natural fuel break in the center of the property.</b>	Follow the City's prairie dog management plan to keep the colony healthy. Explore the potential to permit natural expansion of the colony on the property.	Ongoing to mid-term
<b>Mowing around property perimeter and exterior trails to create a fuel break.</b>	Mow to create fuel breaks that are a total of 15-30 feet wide along exterior trails (width includes trails). If trails are not present within 30 to 100 feet of homes, mow 15-30 feet off the fence line in addition to the trail. <b>Area:</b> 3.4 miles. The city currently mows 12-foot fuel breaks along 2.4 miles of the perimeter in Davidson Mesa Open Space.	Ongoing to near-term
<b>Second Priority Treatments</b>		
<b>Mowing along interior trails to create a fuel break and potential control lines for prescribed burns.</b>	Mow to create fuel breaks along interior trails that are 12-15 feet wide (width includes trails). <b>Area:</b> 1.7 miles	Ongoing to near-term
<b>Woody vegetation management to reduce potential of passive crown fire and ember production.</b>	Use hand tools to remove dead stems and low branches hanging 6-10 feet above the ground or a third of the total height of the tree. Mow or leaf-blow litter that has accumulated in the bottom of the ditch. <b>Area:</b> 3.5 acres along Davidson Ditch	Ongoing
<b>Third Priority Treatments</b>		
<b>Promote short-statured, low-flammability plant material adjacent to underpasses.</b>	Use short-statured, low-flammability plants or hardscaping around the McCaslin underpass. At the end of the fall, remove accumulated litter with a leaf blower. <b>Area:</b> <0.1 acres	Near-term

- Additional guidance:**
- Recommended fuel break widths include the width of the existing trail. If trails are not present within 30 to 100 feet of homes, mowing off the fence line as well as along trails can provide additional protection to homes.
  - Woody management primarily entails removing dead stems and low branches to decrease the chance of fire spreading into treetops and producing embers, not the removal of all trees from a property. See Section 4.2.8.
  - If budgets are limited and not all high-risk properties can be treated, highest priority for treatments are on the eastern side of high-risk properties or when neighborhoods or businesses occur upslope from continuous grassy fuels.



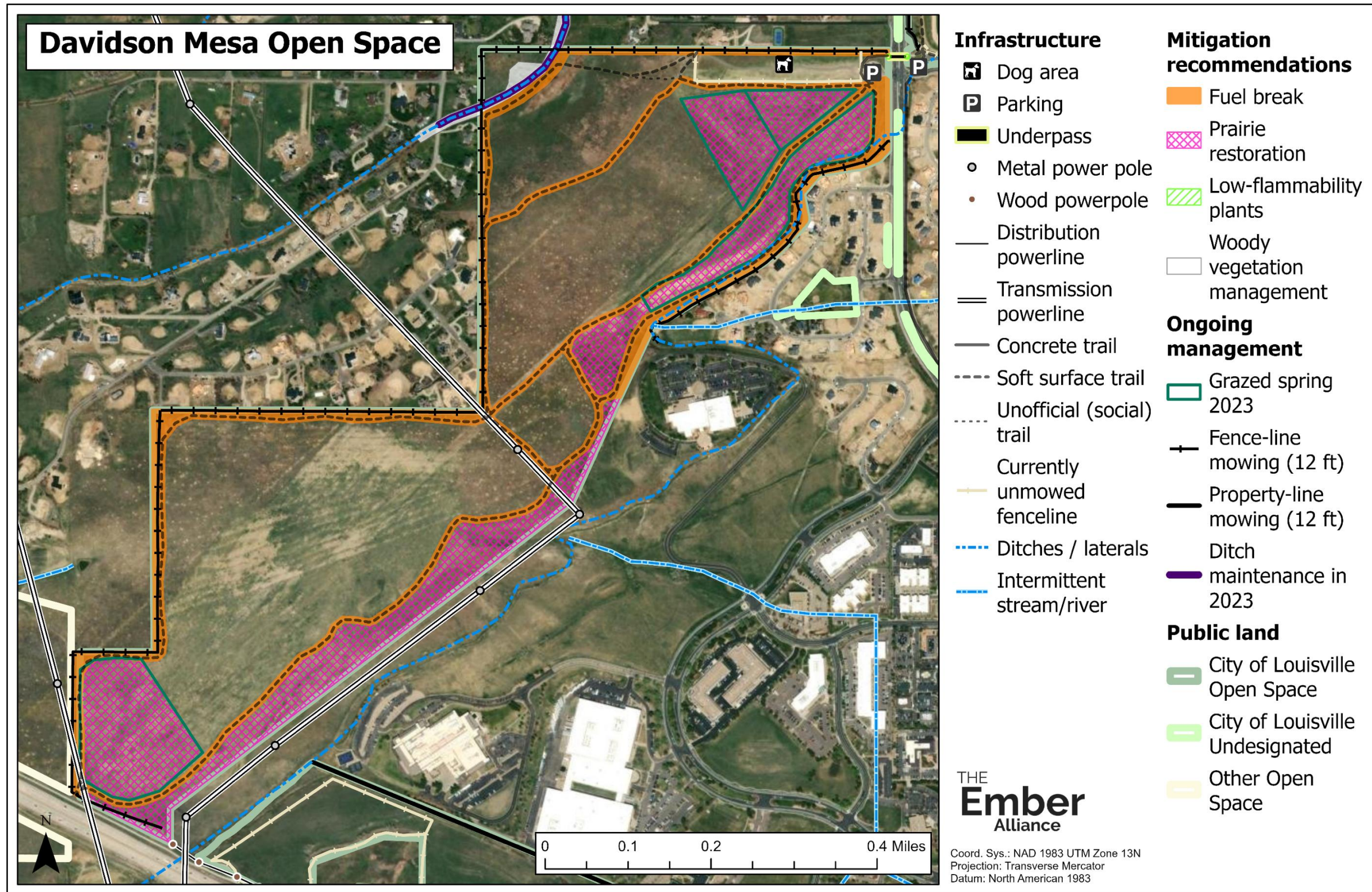


Figure 4-16: Davidson Mesa Mitigation Treatments



4.3.6. Damyanovich Open Space

Site Description
<p>Damyanovich Open Space is a 43-acre property north of Highway 36 and southeast of Davidson Mesa Open Space. Dryer Road runs through the two portions of this property, which contains no trails or other amenities. Community Ditch runs along the western edge of the property, and electric distribution lines run along Dryer Road.</p> <p>The property is flat and covered in short to medium-height, continuous grasses, primarily smooth brome with intermittent clumps of other species such as fescue. The property is not irrigated.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Moderate risk, burned in Marshall Fire</p> <p>Moderate to tall, continuous grasses on Damyanovich Open Space could support low to moderate flame lengths (1-8 feet) and high to very high rates of spread (12-&gt;60 chains/hour) according to the 2022 Colorado Forest Atlas. Some passive crown fire could occur in trees located on the property and result in ember production.</p>
Exposure of Values at Risk
<p>Predicted burn probability on and around Damyanovich Open Space is moderate to high according to the 2022 Colorado Forest Atlas. Fire could spread from Damyanovich Open Space into adjacent neighborhoods where continuous grassy vegetation abuts wooden fences and flammable vegetation on private properties. It is possible that Dyer Road could interrupt fire spread depending on fire weather conditions and direction of spread. Electric distribution lines in this area are exposed to wildfire because many wooden power poles are surrounded by flammable vegetation, and there are two trees directly under the powerlines on the property.</p> <p>The Marshall Fire burned over 75% of Damyanovich Open Space and destroyed one home within the property, destroyed eight homes east of the property, and damaged one home north of the property.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>City-owned fences are ignition-resistant wire with t-posts/wooden posts. Wooden power poles are not ignition-resistant, and char marks from the Marshall Fire were evident along the base of several power poles.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<p><b>Restoration of prairie ecosystem to reduce potential flame lengths and rates of spread.</b></p>	<p>Use a combination of prescribed burning, grazing, herbicide, and seeding to restore prairie ecosystems with short-statured, low-flammability native species separated by patches of bare soil. The isolation of the property from dense neighborhoods makes it a strong candidate for prescribed burning and adaptive management to learn effective restoration practices that can be applied on other properties. Currently, this property is hayed.</p> <p><b>Area:</b> 37 acres</p>	Mid-term
<p><b>Mowing around property perimeter to create a fuel break and potential control lines for prescribed burns.</b></p>	<p>Mow to create fuel breaks along property and fence lines that are 15-30 feet wide.</p> <p><b>Area:</b> 1.0 miles. The city currently mows 12-foot fuel breaks along 0.5 miles of the perimeter in Damyanovich Open Space.</p>	Ongoing to near-term
<p><b>Structure hardening and defensible space around power poles and under powerlines.</b></p>	<p>Retreat old, wooden power poles and fill in large cracks to reduce their flammability. Mow vegetation to &lt;4-6" within 10-feet of each pole. Remove the two dead conifer trees located under the overhead distribution line.</p> <p><b>Area:</b> 15 wooden power poles on and around the property</p>	Near-term
<b>Second Priority Treatments</b>		
<p><b>Ditch maintenance to create a fuel break.</b></p>	<p>Use mowing or prescribed burning to create a fuel break extending 15 feet to either side of the Louisville Lateral to allow firefighters to engage wildfires spreading out of the west.</p> <p><b>Area:</b> 3.7 miles along the Louisville Lateral</p>	Near to mid-term



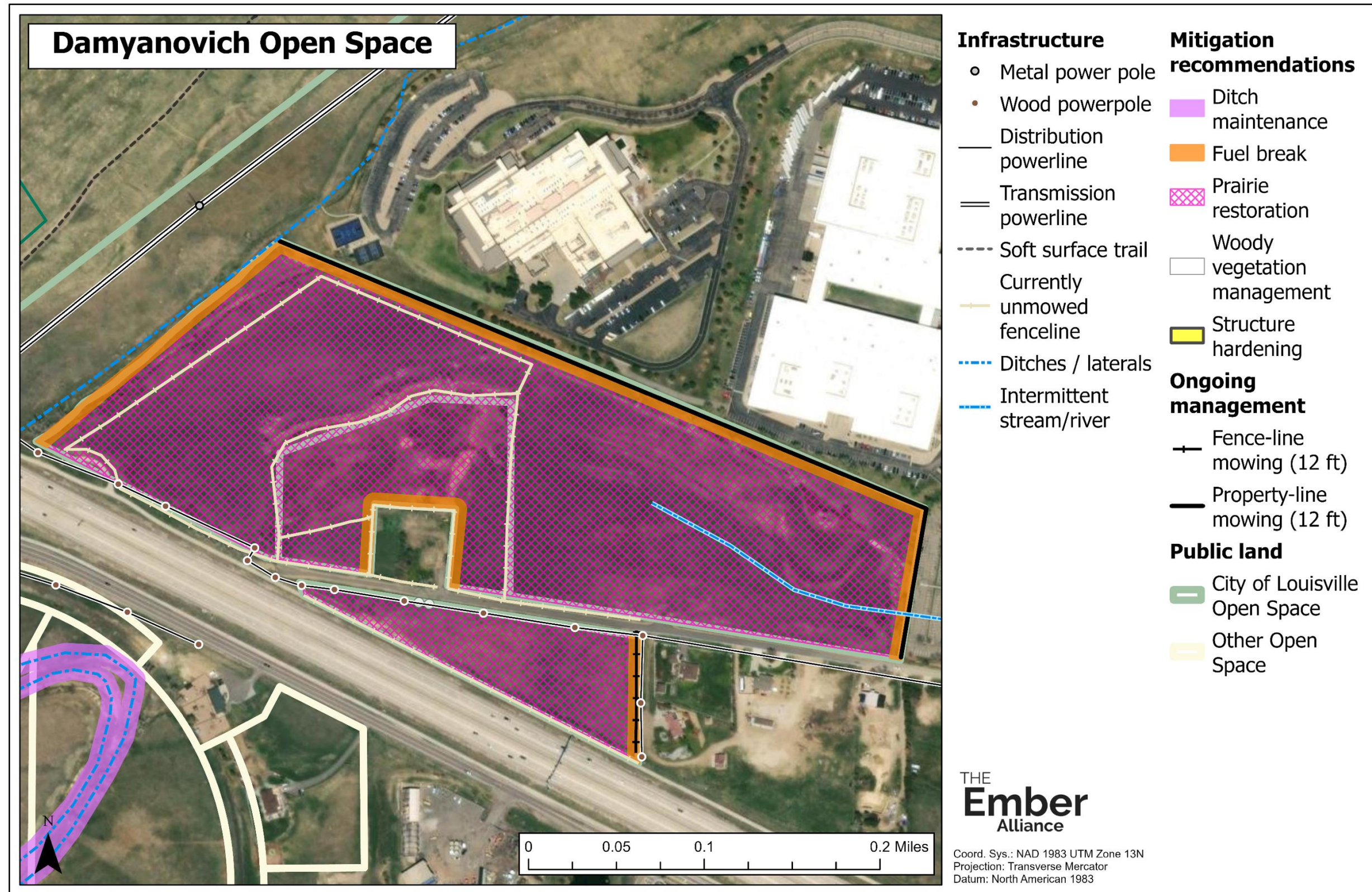


Figure 4-17. Damyanovich Open Space Mitigation Treatments.



#### 4.3.7. North Water Treatment Plant (WTP)

Site Description
<p>North Louisville Water Treatment Plant is a 35-acre property that encompasses 16 acres of the Louisville Reservoir, water tanks, solar panels, and other water treatment infrastructure. Community Ditch enters the reservoir from the south, and Davidson Ditch runs along the eastern edge of the property. Transmission lines are located along the southern portion of the property. The property is closed to the public.</p> <p>Most of the property is covered in mowed or medium-height grass and large patches of bare soil. Several widely-spaced conifer and deciduous trees are scattered across the property. A row of about 25 juniper and pine trees line the fence line in the southeastern portion of the property to create a visual barrier for the adjacent neighborhood.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Moderate risk</p> <p>Short grass around the North Water Treatment Plant could support low flame lengths (&lt;4 feet) and low rates of spread (&lt;4 chains/hour) according to the 2022 Colorado Forest Atlas. Moderate to high flame lengths (4-12 feet) and moderate to very high rates of spread (12 - &gt;60 chains/hour) are possible north of the reservoir on the steep north-facing slope located in O'Connor-Hagman Open Space. Rows of junipers along the fence line of this property could ignite and produce prolific embers.</p>
Exposure of values at risk
<p>Predicted burn probability on and around North Water Treatment Plant transitions from high to low moving towards the adjacent neighborhoods according to the 2022 Colorado Forest Atlas. The reservoir, roads, and trails could interrupt fire spread towards neighborhoods depending on fire weather conditions and direction of spread. Embers from junipers and conifers lining the fence line could spread fire into adjacent neighborhoods.</p> <p>North Water Treatment Plant was not affected by the Marshall Fire.</p>
Susceptibility of city-owned infrastructure to wildfire
<p>City-owned chain-link fences are non-flammable. Buildings are ignition resistant as they are primarily brick and metal, but ember could still penetrate vents and enter the building. Solar panels on Howard Berry Water Treatment Plant survived the Marshall Fire, so it is likely solar panels on the North Water Treatment Plant could also survive wildfire.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Broadscale mowing across the entire property to create a large fuel break.</b>	Mow the entire property to a height of 4-6". Area: 19 acres	Near-term
<b>Removal of flammable juniper and pine trees along fence line to reduce the potential for passive crown fire and ember production.</b>	Remove enough of the juniper and pine trees along the southeastern fence line to result in at least 10-foot crown spacing. Prune branches hanging 6-10 feet above the ground on remaining trees. If possible, remove all junipers and replace with fewer, more widely spaced, flame-resistant species.	Near- to mid-term
<b>Structure hardening and defensible space around critical infrastructure</b>	Follow guidance from the CSFS Home Ignition Zone Guide, including removal of all vegetation within 5 feet of structures and installing screens to prevent ember penetration into vents.	Near- to mid-term
<b>Second Priority Treatments</b>		
<b>Ditch maintenance to reduce risk of high flame lengths, passive crown fire, and ember production.</b>	Coordinate with ditch companies to use mowing, prescribed burning, or grazing to create a fuel break extending 15 feet to either side of the ditches. Treatments along Davidson Ditch could allow firefighters to engage wildfires spreading from expansive grasslands to the north of the Water Treatment Plant. <b>Area:</b> At least 0.7 miles of Davidson Ditch north of the property and 2.5 miles of Louisville Lateral to the south.	Near- to mid-term
<b>Debris removal along the property fence line.</b>	At the end of the fall, use a leaf blower to remove pine needles and other dead vegetation that has accumulated along the fence line between Water Treatment Plant and Annette Brand Park. <b>Area:</b> 700 feet of chain-link fence between the Water Treatment Plant and Annette Brand Park.	Near-term
<b>Woody vegetation management to reduce the potential for passive crown fire and ember production.</b>	Remove dead shrubs and prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. <b>Area:</b> Trees along the boundary between the Water Treatment Plant and Annette Brand Park.	Near- to mid-term



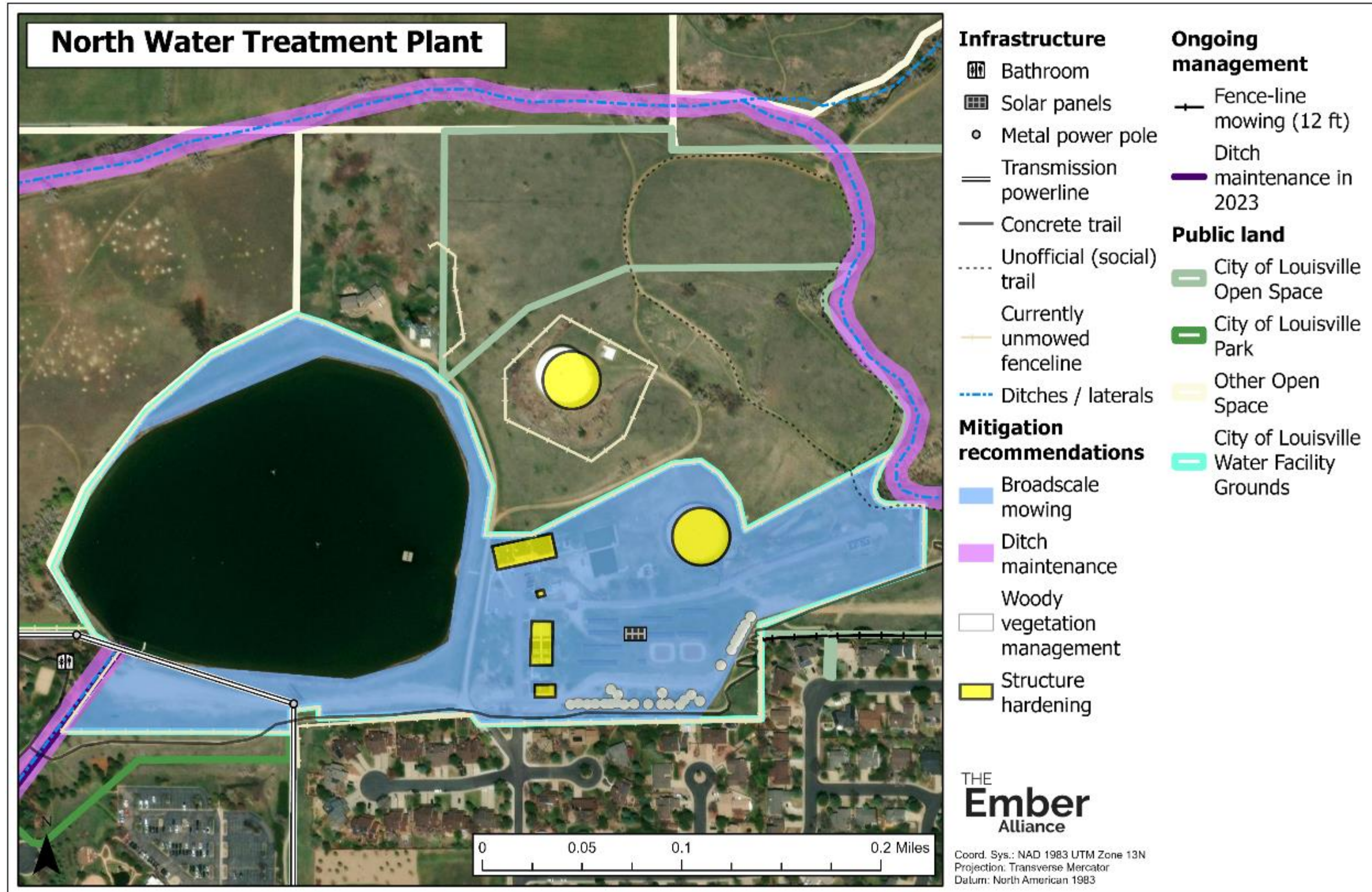


Figure 4-18. North Louisville Water Treatment Plant Mitigation Treatments.



4.3.8. Dutch Creek Open Space including Coal Creek Riparian Trail/Corridor

Site Description
<p>Dutch Creek Open Space is a 26-acre property that includes a portion of the Coal Creek Riparian/Trail Corridor. The property is managed primarily for trail and habitat improvement and includes about 1.4 miles of paved and unpaved trails.</p> <p>The western part of the property is flat and continuously covered in short to medium-height grasses, primarily smooth brome but also some native bunch grasses. There is a "pocket prairie" with native plants between several trails in the western part of the property. The Coal Creek Riparian Corridor is dominated by cottonwood trees and willows, with cheatgrass and smooth brome occurring alongside the trail. Some willows are overgrown and have an abundance of dead stems. There is a moderate accumulation of dead branches and logs in the riparian area.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Low risk</p> <p>Grassy vegetation on Dutch Creek Open Space could support very low to moderate flame lengths (0-8 feet) and riparian forests along the Coal Creek Corridor could support moderate to extreme flame lengths (4-25 feet) according to the 2022 Colorado Forest Atlas. Extreme flame lengths are possible if fire were to transition from surface fuels into treetops and become passive or active crown fire. Willow in the riparian area could ignite and carry slow-moving wildfire during their dormant season, particularly overgrown willow with an abundance of dead stems, but there is a relatively low chance for overhead cottonwoods to ignite due to their higher fuel moisture and lack of leaves during the dormant season. and there are very few ladder fuels under trees. Moderate to very high rates of spread (4 to &gt;60 chains/hour) are predicted for the property.</p>
Exposure of Values at Risk
<p>Predicted burn probability on and around Dutch Creek Open Space is moderately low according to the 2022 Colorado Forest Atlas, and exposure of homes and other structures immediately adjacent to the property is relatively low. If a fire were to ignite and carry through grassy vegetation or the riparian corridor in this area, it is possible that trails on the property could interrupt fire spread towards neighborhoods to the north depending on fire weather conditions and direction of spread. There is a potential for ember production were fire to transition into treetops, and several homes are within short-range spotting distance of the property.</p> <p>Dutch Creek Open Space was not affected by the Marshall Fire.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>City-owned fences are wire with t-posts/wooden posts and ignition resistant.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>Second Priority Treatments</b>		
<p><b>Mowing around property perimeter and exterior trails to create a fuel break.</b></p>	<p>Mow to create fuel breaks that are a total of 12-15 feet wide along exterior trails (width includes trails). If trails are not present within 30 to 100 feet of homes, mow 12-15 feet off the fence line in addition to the trail. Mow to maintain grass height &lt;4-6" height.</p> <p><b>Area:</b> 0.7 miles. The city currently mows 12-foot fuel breaks along 0.5 miles of the perimeter in Dutch Creek Open Space.</p>	<p>Ongoing to near-term</p>
<p><b>Riparian management along Coal Creek Corridor to reduce potential of long flame lengths, passive crown fire, and ember production.</b></p>	<p>Use goats, prescribed burning, and/or hand tools to remove shrubs and dead stems and to prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree.</p> <p><b>Area:</b> 5.3 acres</p>	<p>Near-term</p>
<b>Third Priority Treatments</b>		
<p><b>Restoration of prairie ecosystem to reduce potential flame lengths and rates of spread.</b></p>	<p>Use a combination of grazing, herbicide, and seeding to restore prairie ecosystems with short-statured, low-flammability native species separated by patches of bare soil.</p> <p><b>Area:</b> 13.5 acres</p>	<p>Mid-term</p>
<p><b>Mowing along interior trails to create a fuel break and potential control lines for prescribed burns.</b></p>	<p>Mow fuel breaks along interior trails that are a total of 12-15 feet wide (width includes trails). Mow to 4-6" height.</p> <p><b>Area:</b> 0.7 miles</p>	<p>Near-term</p>
<p><b>Promote short-statured, low-flammability plant material adjacent to underpasses.</b></p>	<p>Use short-statured, low-flammability plants or hardscaping around the W. Cherry Street underpass. At the end of the fall, remove accumulated litter with a leaf blower.</p> <p><b>Area:</b> &lt;0.1 acres</p>	<p>Near-term</p>



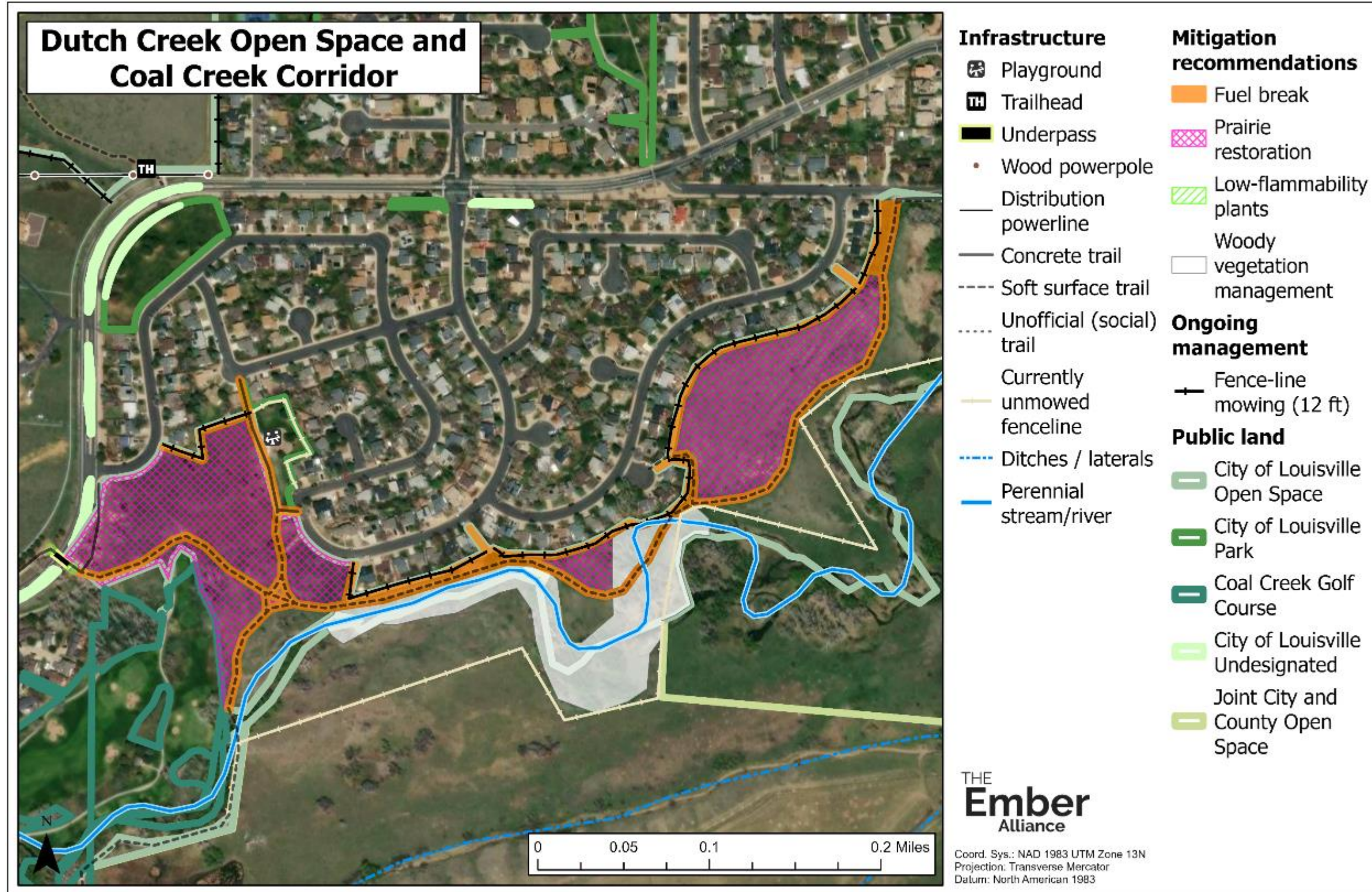


Figure 4-19. Dutch Creek Open Space Mitigation Treatments.



### 4.3.9. Elephant Park

Site Description
Elephant Park is a small 1-acre part with a playground, picnic table, and access to paved trails in the adjacent Dutch Creek Open Space. The property is flat, and vegetation consists of an irrigated, mowed lawn.
Potential Fire Behavior
<b>Wildfire Risk Rating:</b> Low risk Fire spreading in short, mowed and irrigated grass in Elephant Park could support low flame lengths (1-4 feet) and low rates of spread (2-4 chains/hour) according to the 2022 Colorado Forest Atlas. Several trees with low branches adjacent to the park could ignite and emit embers.
Exposure of Values at Risk
Predicted burn probability around the park is moderately low according to the 2022 Colorado Forest Atlas, and homes adjacent to the property have low exposure to wildfire. Elephant Park was not affected by the Marshall Fire.
Susceptibility of City-owned Infrastructure to Wildfire
The metal playground equipment is non-flammable. Engineered wood fiber used on the playground is certified as non-flammable, and the playground is surrounded by a concrete barrier.

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>Second Priority Treatments</b>		
<b>Broadscale mowing across the entire property to maintain recreational fields and serve as a fuel break.</b>	Mow the entire property to a height of 4-6". <b>Area:</b> 1 acre	Ongoing
<b>Third Priority Treatments</b>		
<b>Pruning of lower limbs and removal of litter from under trees to reduce the potential for passive crown fire and ember production.</b>	Use hand tools to prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. <b>Area:</b> Four trees within the park boundary	Near-term

**Additional guidance:**

- Woody management primarily entails removing dead stems and low branches to decrease the chance of fire spreading into treetops and producing embers, not the removal of all trees from a property. See Section 4.2.8.





Figure 4-20. Elephant Park Mitigation Treatments.

4.3.10. Avista Open Space

Site Description
<p>Avista Open Space is about a 9-acre property abutting the Coal Creek Golf Course, Avista Hospital, and St. Andrews Lane subdivision. There are no trails or other amenities on the property. South Boulder Coal Creek Lateral runs through the center of the park, and electric transmission lines follow the northern and eastern edges of the property.</p> <p>The property is on a moderately steep north-facing slope and covered in short to medium-height, continuous grass—a mixture of smooth brome and various bunch grasses. The property is not irrigated. Grass on the hospital property north of the open space is mowed close to the hospital, and there is a drainage feature in the property with tall rushes and several small deciduous trees and shrubs.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Lowest risk, but property burned in Marshall Fire</p> <p>Grassy vegetation on Avista Open Space could support low to moderate flame lengths (1 to 8 feet) and high to very high rates of spread (12-&gt;60 chains/hour). Higher flame lengths and rates of spread are possible on parts of the property with steeper slopes. The potential for ember production is relatively low from this property due to the absence of trees and shrubs. Very low to low flame lengths and rates of spread are predicted for properties surrounding Avista Open Space.</p>
Exposure of Values at Risk
<p>Predicted burn probability on and around Avista Open Space is low to moderate according to the 2022 Colorado Forest Atlas, but as the Marshall Fire demonstrated, homes and other structures in this part of Louisville can burn, particularly when exposed to embers. Rapidly moving grass fire on the property could spread into adjacent neighborhoods where continuous grassy vegetation abuts wooden fences and flammable vegetation on private properties. Electric transmission lines in this area have very little exposure to wildfire due to the substantial distance between the powerlines and vegetation.</p> <p>The Marshall Fire burned across all of Avista Open Space and destroyed 138 homes and damaged two homes north of the property.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>There is no City-owned infrastructure on Avista Open Space.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<p><b>Mowing along northern property perimeter to create a fuel break.</b></p>	<p>Mow to create fuel breaks along fence lines that are 15-30 feet wide.</p> <p>Mowing in the middle of the slope on the property line with Avista Hospital is unlikely to function as an effective fuel break. Working with Avista Hospital to ensure lawns are mowed and irrigated adjacent to the hospital is more important.</p> <p><b>Area:</b> 0.4 miles. The city currently mows 12-foot fuel breaks along 0.4 miles of the perimeter in Avista Open Space.</p>	<p>Ongoing to near-term</p>
<b>Second Priority Treatments</b>		
<p><b>Restoration of prairie ecosystem to reduce potential flame lengths and rates of spread.</b></p>	<p>Use a combination of prescribed burning (if there is public acceptance), grazing, herbicide, and seeding to restore prairie ecosystems with short-statured, low-flammability native species separated by patches of bare soil. This small property could be a good opportunity for adaptive management to learn effective restoration practices that can be applied on other properties.</p> <p><b>Area:</b> 9 acres</p>	<p>Mid-term</p>



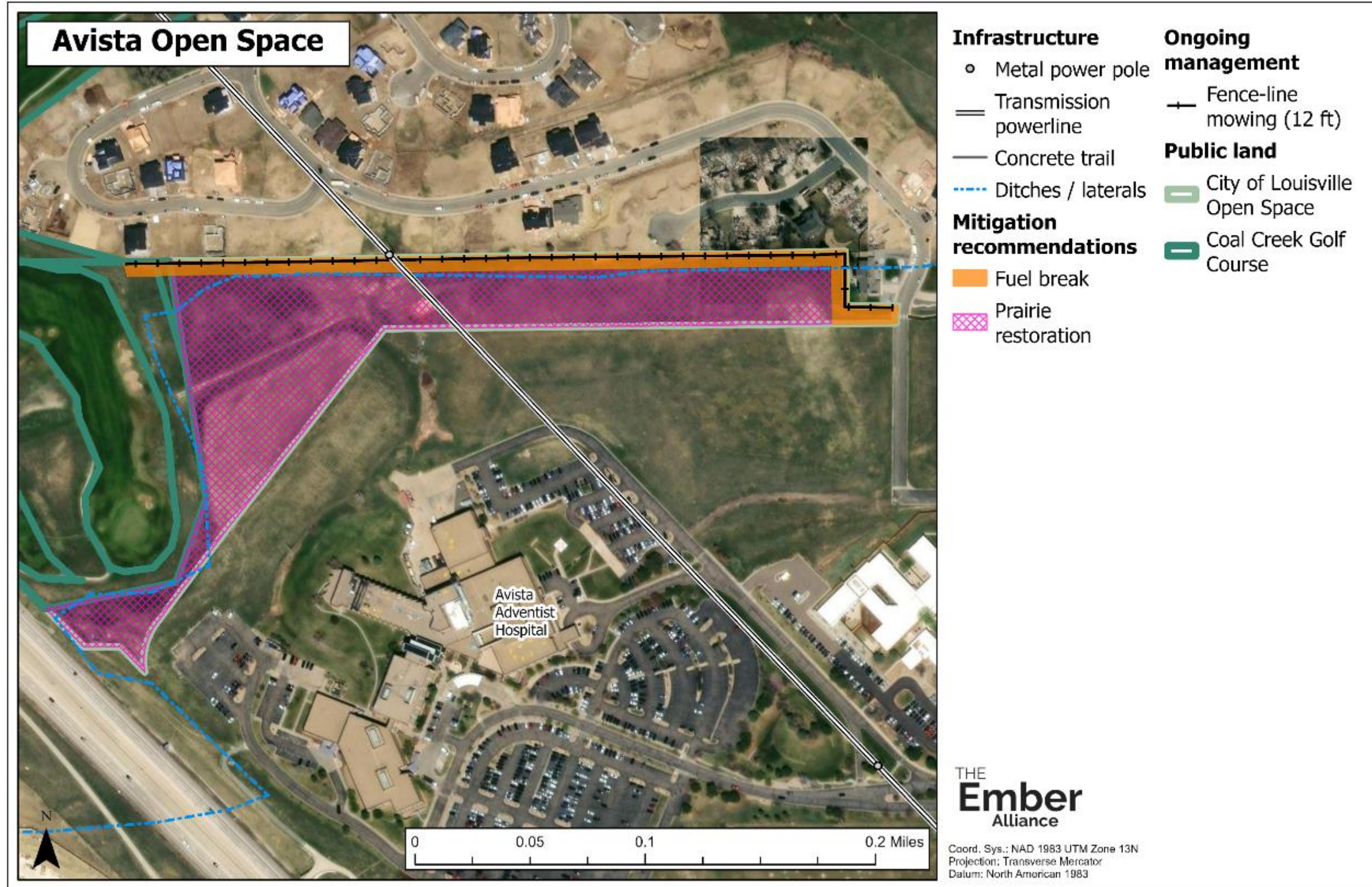


Figure 4-21. Avista Open Space Mitigation Treatments.



4.3.11. Daughenbaugh Open Space

Site Description
<p>Daughenbaugh Open Space is a 20-acre open space managed for trails and habitat. The property shares a boundary with Heritage Park to the west and connects to Warembourg Open Space to the north. There is a parking area, wooden shed owned by the City, and about 0.8 miles of paved and unpaved trails. Goodhue Ditch runs along the western boundary of the park.</p> <p>The property is flat and primarily occupied by a prairie dog colony, which significantly shapes vegetation on the property. According to 2021 vegetation surveys by the City of Louisville, the average cover of dry plant litter is 40%, bare soil/rock is 33%, non-native forbs is 11%, native forbs is 17%. Non-native forbs include field bindweed, Canada thistle, and dock. Grasses are sparse on the property, mostly occurring along the side of trails. A small clump of cottonwood and deciduous shrubs are present in the center of the property.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Lowest risk</p> <p>Vegetation on the site would likely support very low flame lengths and low to moderate rates of spread due to the short stature of forbs and high cover of bare soil. This assessment aligns with predictions from the 2012 wildfire hazard and risk assessment for the City of Louisville Open Spaces. The 2022 Colorado Forest Atlas differs and predicts low to moderate flame lengths (1-8 feet) but high to very high rates of spread (12 - &gt;60 chains/hour), potentially due to limitations with assigning fuel models to properties using satellite imagery instead of on-the-ground observations. The patchy vegetation from prairie dog activity would likely interrupt and slow forward rates of spread on the property. The potential for ember production is relatively low from this property due to low densities of trees and shrubs.</p>
Exposure of Values at Risk
<p>Predicted burn probability on and around Daughenbaugh Open Space is low to moderately low according to the 2022 Colorado Forest Atlas, and exposure of homes and other structures immediately adjacent to the property is relatively low. Fire could spread along parts of Goodhue Ditch with dense vegetation and potentially ignite continuous grassy vegetation that abuts wooden fences and flammable vegetation on private properties. It is possible that trails around Daughenbaugh Open Space could interrupt fire spread depending on fire weather conditions and direction of spread. The potential for ember production is relatively low from this property due to the low density of trees and shrubs.</p> <p>Daughenbaugh Open Space was not affected by the Marshall Fire.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>The City-owned wooden structure is highly susceptible to fire due to its construction and lack of defensible space.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>Third Priority Treatments</b>		
<b>Prairie dog conservation to maintain a natural fuel break in the center of the property.</b>	Follow the City's prairie dog management plan to keep the colony healthy. Explore the potential to permit natural expansion of the colony on the property.	Ongoing to mid-term
<b>Ditch maintenance to reduce risk of high flame lengths, passive crown fire, and ember production.</b>	Coordinate with ditch companies to use goats, mowing, and/or hand tools to remove shrubs and dead stems, prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree, and reduce grass height to <4-6" within 15-feet of either side of the ditch. Some of this work is already ongoing.  <b>Area:</b> At least 0.5 miles of Goodhue Ditch along the western edge of Daughenbaugh and Warembourg Open Spaces.	Ongoing to near-term
<b>Mowing around exterior trail to create a fuel break.</b>	Mow to create fuel breaks that are a total of 12-15 feet wide along exterior trails (width includes trails).  <b>Area:</b> 0.3 miles	Ongoing to near-term
<b>Structure hardening and defensible space around wooden shed on property.</b>	Remove all flammable vegetation within 5 feet of the structure, treat wood siding with fire-resistant stain, fill large tracks between boards, and place screens over vents, eaves, and around doors to reduce the potential for ember penetration.	Near-term



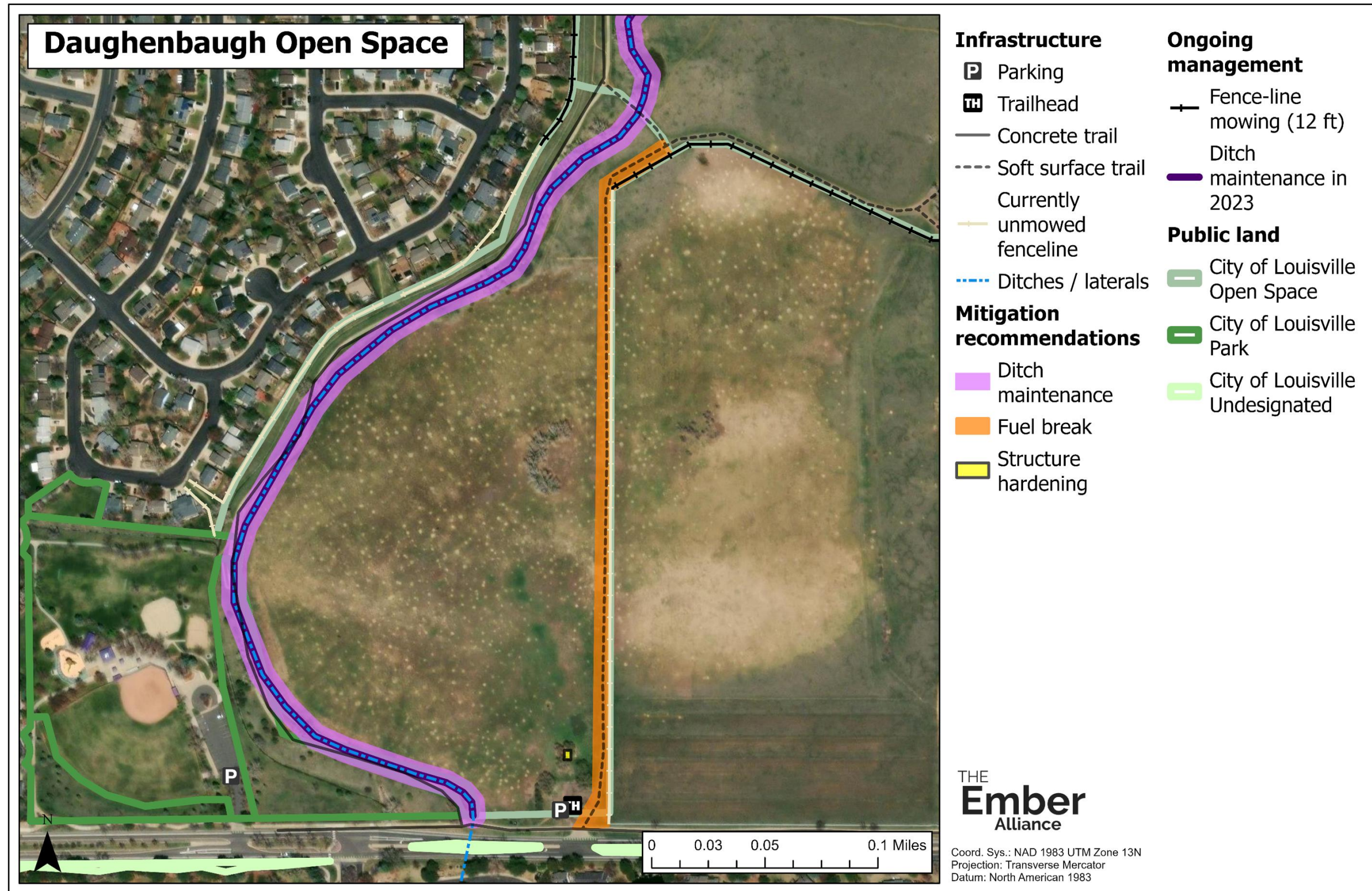


Figure 4-22. Daughenbaugh Open Space Mitigation Treatments.



4.3.12. Harper Lake Open Space and western corridor of Coyote Open Space

Site Description
<p>Harper Lake Open Space, also the Leon A. Wurl Wildlife Sanctuary, is a 49-acre property that includes 30 acres of Harper Lake. The open space is designated for wildlife habitat, fishing in the lake, and recreation on the surrounding trails. Amenities include a parking area, bathroom, 1.0 mile of unpaved trails, and access to fishing opportunities in Harper Lake. Community Ditch runs through the middle of the property, entering and exiting Harper Lake.</p> <p>The property is flat, and over half of the area is occupied by Harper Lake. Vegetated portions of the property are covered in native and non-native grasses and forbs with scattered shrubs and cottonwood trees. The property is not irrigated.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> Lowest risk, but property burned in Marshall Fire</p> <p>Grassy vegetation around Harper Lake Open Space could support low flame lengths (1 to 4 feet) and low rates of spread (&lt;4 chains/hour) according to the 2022 Colorado Forest Atlas. Juniper shrubs scattered throughout the property could ignite and produce embers, which is primarily a concern for the junipers closer to private fence lines.</p>
Exposure of Values at Risk
<p>Predicted burn probability is low to moderately on and around Harper Lake Open Space according to the 2022 Colorado Forest Atlas, but as the Marshall Fire demonstrated, homes and other structures in this part of Louisville can burn, particularly when exposed to embers. Fire could spread from Harper Lake Open Space into adjacent neighborhoods where continuous grassy vegetation abuts wooden fences and flammable vegetation on private properties. Embers from junipers near fence lines could spread fire into adjacent neighborhoods. Fire could also spread from Harper Lake Open Space through the narrow corridor connecting to Coyote Open Space—an area covered in grass and lined with private, wooden privacy fences. It is possible that McCaslin Blvd could interrupt fire spread towards Harper Lake Open Space depending on fire weather conditions and direction of spread.</p> <p>About 25% of the non-water area of Harper Lake Open Space was burned by the Marshall Fire. The Marshall Fire destroyed 236 homes and damaged 23 in the neighborhood south of the property.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>Two or three-rail design fences owned by the City are fairly ignition resistant.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>First Priority Treatments</b>		
<b>Mowing around property perimeter to create a fuel break.</b>	Mow 12-15-ft off fence line adjacent to homes and 30-feet along property line adjacent to HOA-maintained lawns. Coordinate with HOAs to expand perimeter mowing along fence lines adjacent to green belts. <b>Area:</b> 1.5 miles. The city currently mows 12-foot fuel breaks along 1.3 miles of the perimeter in the area of Harper Lake Open Space and the western corridor of Coyote Open Space.	Ongoing to near-term
<b>Restoration of prairie to reduce potential flame lengths and rates of spread.</b>	Use a combination of grazing, herbicide, and seeding to restore grasslands and prairies with short-statured, low-flammability native species separated by patches of bare soil. Successful restoration could eliminate the need to mow along fence lines in this area. <b>Area:</b> 3.0 acres in the western corridor of Coyote Open Space	Mid-term
<b>Second Priority Treatments</b>		
<b>Woody vegetation management to reduce the potential for passive crown fire and ember production.</b>	Remove junipers within 100 feet of fence lines and replace with low-flammability shrubs. Remove dead trees that do not serve as habitat trees and prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree.	Ongoing to near-term
<b>Third Priority Treatments</b>		
<b>Promote short-statured, low-flammability plant material adjacent to underpasses.</b>	Use short-statured, low-flammability plants or hardscaping around the McCaslin underpass. At the end of the fall, remove accumulated litter with a leaf blower. <b>Area:</b> <0.1 acres	Near-term

**Additional guidance:**

- Woody management primarily entails removing dead stems and low branches to decrease the chance of fire spreading into treetops and producing embers, not the removal of all trees from a property. See Section 4.2.8.
- If budgets are limited and not all high-risk properties can be treated, highest priority for treatments are on the eastern side of high-risk properties or when neighborhoods or businesses occur upslope from continuous grassy fuels.



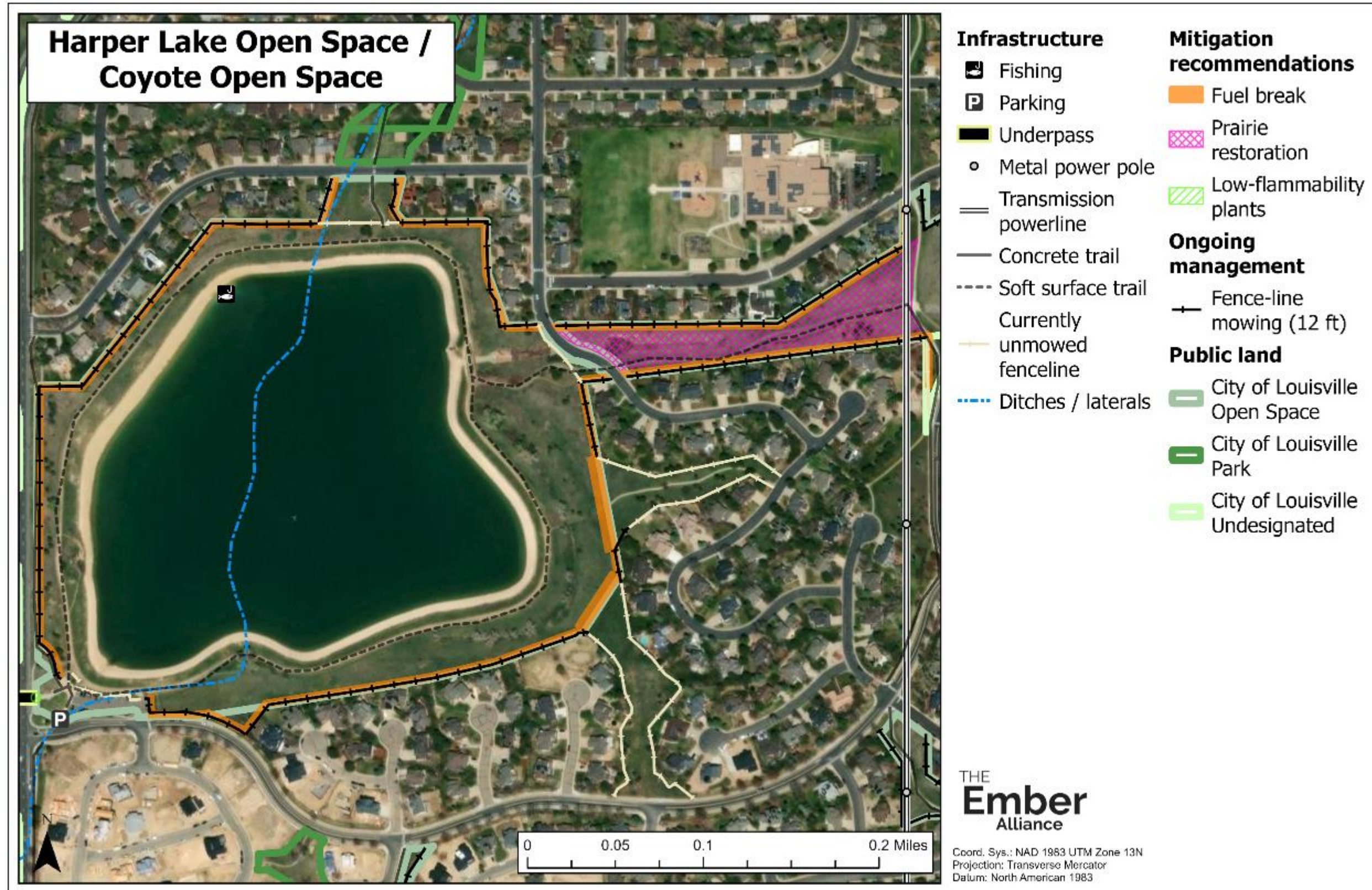


Figure 4-23. Harper Lake Open Space Mitigation Treatments.



4.3.13. Warembourg Open Space

Site Description
<p>Warembourg Open Space is a 50-acre property linked to a 40-acre conservation easement. The property is primarily managed for the Klubert Warembourg Fishing Pond and 1.5 miles of paved and unpaved trails. About 0.5 miles of unofficial social trails cross the property. Goodhue Ditch runs along the western boundary of the property, and an electric distribution line with four wooden power poles runs through a small segment of the property.</p> <p>The property is primarily flat with only a very small hillock in the middle. A majority of the property is covered in short- to medium-height smooth brome, but there are pockets of native grasses. Native shrubs have been planted along the trail to the fishing pond. A small riparian area in the northwestern part of the property has cottonwoods, willows, and a few scattered junipers and deciduous shrubs. Parts of Goodhue Ditch are lined by dense willow and other shrubs with an abundance of dead stems and an accumulation of dead litter.</p>
Potential fire behavior
<p><b>Wildfire Risk Rating:</b> Lowest risk</p> <p>Grassy vegetation could support low flame lengths (1-4 feet) and low rates of spread (2-4 chains/hour) according to the 2022 Colorado Forest Atlas. The potential for ember production is relatively low from this property due to the low density of trees and shrubs. Higher rates of spread are predicted for the adjacent Daughenbaugh Open Space, but an on-the-ground assessment of the properties in 2023 and the 2012 Wildfire Hazard and Risk Assessment for the City of Louisville disagree with these predictions due to the patchier nature of vegetation in the prairie dog colonies on Daughenbaugh Open Space.</p>
Exposure of values at risk
<p>Predicted burn probability is low to moderately low on and around Warembourg Open Space according to the 2022 Colorado Forest Atlas, and the exposure of homes and other structures immediately adjacent to the property is relatively low. Fire could spread along parts of Goodhue Ditch with dense vegetation and potentially ignite continuous grassy vegetation that abuts wooden fences and flammable vegetation on private properties. It is possible that trails around and through Warembourg Open Space could interrupt fire spread depending on fire weather conditions and direction of spread.</p> <p>Warembourg Open Space was not affected by the Marshall Fire.</p>
Susceptibility of city-owned infrastructure to wildfire
<p>There is no City-owned infrastructure on Warembourg Open Space.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>Third Priority Treatments</b>		
<p><b>Restoration of prairie ecosystem to reduce potential flame lengths and rates of spread.</b></p>	<p>Use a combination of prescribed burning (if there is public acceptance), grazing, herbicide, and seeding to restore prairie ecosystems with short-statured, low-flammability native species separated by patches of bare soil. Fire mitigation treatments are lower priority on this property, but this site could be a good opportunity for adaptive management to learn effective restoration practices that can be applied on other properties.</p> <p><b>Area:</b> 17.5 acres of land to the east of the fishing pond where efforts are already underway to establish native shrubs.</p>	<p>Mid-term</p>
<p><b>Ditch maintenance to reduce risk of high flame lengths, passive crown fire, and ember production.</b></p>	<p>Coordinate with ditch companies to use goats, mowing, and/or hand tools to remove shrubs and dead stems, prune tree branches, and reduce grass height to &lt;4-6" within 15-feet of either side of the ditch. Some of this work is already ongoing.</p> <p><b>Area:</b> At least 0.5 miles of Goodhue Ditch along the western edge of Daughenbaugh and Warembourg Open Spaces.</p>	<p>Ongoing to near-term</p>
<p><b>Mowing along exterior trails to create a fuel break.</b></p>	<p>Mow to create fuel breaks that are a total of 12-15 feet wide along exterior trails (width includes trails). If trails are not present within 30 to 100 feet of homes, mow 12-15 feet off the fence line in addition to the trail. <b>Area:</b> 1.3 miles. The city currently mows 12-foot fuel breaks along 1.2 miles of the perimeter of Warembourg Open Space.</p>	<p>Ongoing to near-term</p>

**Additional guidance:**

- Recommended fuel break widths include the width of the existing trail. If trails are not present within 30 to 100 feet of homes, mowing off the fence line as well as along trails can provide additional protection to homes.
- If budgets are limited and not all high-risk properties can be treated, highest priority for treatments are on the eastern side of high-risk properties or when neighborhoods or businesses occur upslope from continuous grassy fuels.



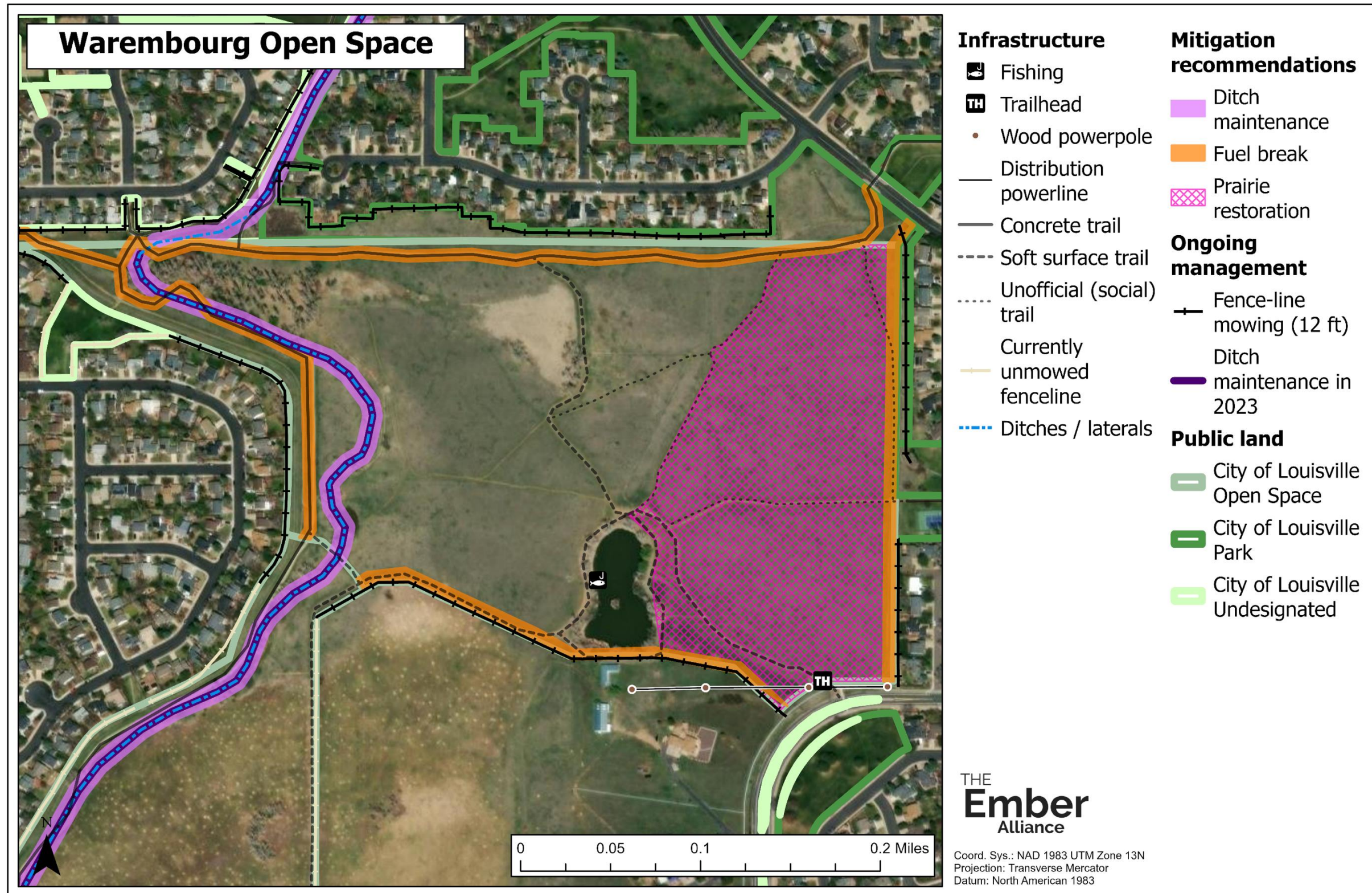


Figure 4-24. Warembourg Open Space Mitigation Treatments.



4.3.14. Tyler Canyon

Site Description
Tyler Canyon is an unclassified property owned by the City of Louisville that consists of two greenbelts running along Tyler Road and covering approximately 6 acres. Paved sidewalks like Tyler Road, and private, wooden privacy fences along the property. There are no ditches or powerlines on the property. The property is on a moderately steep (about 30%) southeast-facing slope with un-mowed, unirrigated grasses and scattered shrubs and trees.
Potential Fire Behavior
<b>Wildfire Risk Rating:</b> Lowest risk Grassy vegetation along Tyler Canyon could support low flame lengths (1 to 4 feet) and low rates of spread (<4 chains/hour) according to the 2022 Colorado Forest Atlas. However, much longer flame lengths and rates of spread are possible if winds were to blow directly along Tyler Road, pushing fire through continuous grasses up the moderately steep slope. Conifer trees and shrubs on the Tyler Canyon property could ignite and emit embers.
Exposure of Values at Risk
Predicted burn probability is low along Tyler Road according to the 2022 Colorado Forest Atlas, but properties aligning this area could be exposed to wildfire, particularly were an ignition to occur at the bottom of the road and wind direction to align with slope. Grassy vegetation abuts continuous rows of wooden privacy fences and flammable vegetation on private property, and embers from shrubs and trees could threaten homes within short-range spotting distance (about 33 yards). Tyler Canyon was not affected by the Marshall Fire.
Susceptibility of City-owned Infrastructure to Wildfire
There is no City-owned infrastructure on Tyler Canyon.

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>Third Priority Treatments</b>		
<b>Mowing around property perimeter to create a fuel break.</b>	Mow 12-15-ft off fence line adjacent to homes and 30-feet along property line adjacent to HOA-maintained lawns. Coordinate with HOAs to expand perimeter mowing along fence lines adjacent to green belts. <b>Area:</b> 0.7 miles	Near-term
<b>Woody vegetation management to reduce the potential for passive crown fire and ember production.</b>	Remove junipers within 100 feet of fence lines. Remove dead trees that do not serve as habitat trees, and prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. <b>Area:</b> Trees and shrubs scattered across the property	Ongoing to near-term

**Additional guidance:**

- Woody management primarily entails removing dead stems and low branches to decrease the chance of fire spreading into treetops and producing embers, not the removal of all trees from a property. See Section 4.2.8.



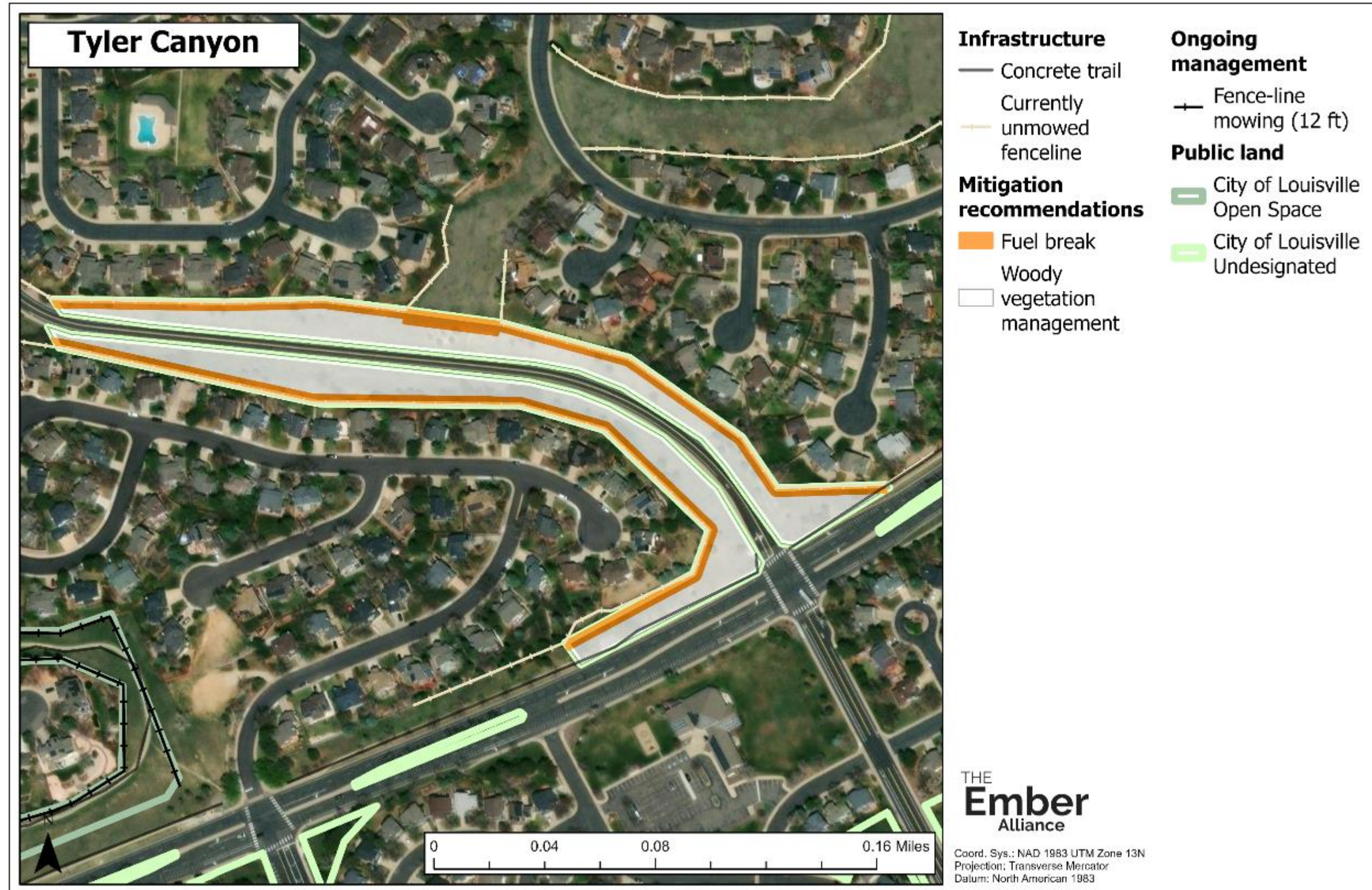


Figure 4-25. Tyler Canyon Mitigation Treatments.



4.3.15. Louisville Recreation Center Campus and Arboretum

Site Description
<p>The Louisville Recreation and Senior Center and Arboretum sits on a 30-acre campus east of the Louisville Police Department and south of the Louisville Fire Station #2 on Via Appia Way. The property includes an arboretum, skatepark, tennis courts, gazebo, restroom facility, and about 1 mile of concrete and soft-surface trails.</p> <p>The campus sits on a rolling hill covered in short, mowed grass with a mixture of smooth brome, Kentucky blue grass, and fescue. A small drainage area with willows and cottonwood trees runs east to west through the middle of the campus. The property is not irrigated except for small strips of grass along the sidewalk facing Via Appia Way. Widely spaced deciduous and conifer trees are present in the Arboretum in the western portion of the property.</p>
Potential Fire Behavior
<p><b>Wildfire Risk Rating:</b> No modeled risk, but property burned in Marshall Fire</p> <p>Fire spreading in short grass on the campus of the Louisville Recreation and Senior Center and Arboretum would likely have low flame lengths (1 to 4 feet) and low rates of spread (&lt;4 chains/hour) according to the 2022 Colorado Forest Atlas. There is no potential for active crown fire on this property. Several conifer trees in the arboretum could experience torching and emit embers if flames transition into their lower branches. Riparian vegetation in the drainage feature is unlikely to carry fire during the growing season but could support flame lengths over 8 feet during drought or when vegetation is cured.</p>
Exposure of Values at Risk
<p>Predicted burn probability is low on and around the Louisville Recreation and Senior Center and Arboretum according to the 2022 Colorado Forest Atlas, but as the Marshall Fire demonstrated, homes and other structures in this part of Louisville can burn, particularly when exposed to embers. Under extreme fire weather conditions, fire could spread from grasses on the campus into greenbelts or spread up to wooden fences and flammable vegetation on private properties. Electric transmission lines in this area have very little exposure to wildfire due to the substantial distance between the powerlines and vegetation.</p> <p>The Marshall Fire burned about 33% of the campus and destroyed 54 homes and damaged ten homes south of the property. The Recreation and Senior Center survived the fire. Scorch marks are visible on the stems of several trees in the Arboretum, and the City is in the process of removing trees killed by the fire.</p>
Susceptibility of City-owned Infrastructure to Wildfire
<p>The Louisville Recreation and Senior Center has exemplary defensible space and structure hardening. The building was remodeled in 2017-2018 with non-burnable construction material and is surrounded by sidewalks, parking lots, and mowed grass. Landscaping abutting the building includes widely spaced bunch grasses with cobblestones. Metal power poles along the transmission line are ignition resistant.</p> <p>The gazebo and restroom facility near the arboretum have metal roofs and non-burnable material (stone or concrete) at their bases to about 2 feet above the ground. Wood on these structures were treated to be fire-resistant, but some of the wood is worn and cracked and therefore more flammable.</p>

Mitigation Recommendations		
Mitigation Description	Methods	Timing
<b>Second Priority Treatments</b>		
<b>Woody vegetation management to reduce potential for passive crown fire and ember production.</b>	Remove dead trees and prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. <b>Area:</b> Trees within the 3-acre Arboretum	Ongoing
<b>Mowing around property perimeter to create a fuel break.</b>	Mow 12-15 ft along the south and eastern perimeters of the property to create opportunities for firefighters to protect structures during wildfires. Mow to 4-6" height. <b>Area:</b> 0.5 miles	Near-term
<b>Promote short-statured, low-flammability plant material to create a fuel break.</b>	Remove lawn and replace with short-statured, low-flammability plants to create a fuel break, increase biodiversity, and then eliminate the need to mow around the Arboretum. <b>Area:</b> Within the 3-acre Arboretum	Mid-term
<b>Third Priority Treatments</b>		
<b>Mowing along trails and around the Arboretum to create a fuel break.</b>	Mow 10-ft along either side of trails along the perimeter of the property and surrounding the Arboretum. Mow to 4-6" height. <b>Area:</b> 0.8 miles	Near-term
<b>Mulch removal around trees and spot watering.</b>	Remove leaves, pine needles, and mulch from around the base of trees in the Arboretum and replace with bare soil or gravel. Spot water to maintain high foliar moisture content. <b>Area:</b> Trees within the 3-acre Arboretum	Near-term
<b>Structure hardening of gazebo and restroom.</b>	Retreat exposed wood and fill in large cracks to reduce their ignitability.	Near-term
<b>Woody vegetation management in riparian area to reduce potential for high flame lengths, passive crown fire, and ember production.</b>	Remove dead willow stems. Prune tree branches hanging 6-10 feet above the ground or a third of the total height of the tree. <b>Area:</b> 1 acre in small riparian corridor north of the Arboretum.	Mid-term

**Additional guidance:**

- Recommended fuel break widths include the width of the existing trail. If trails are not present within 30 to 100 feet of homes, mowing off the fence line as well as along trails can provide additional protection to homes.
- Woody management primarily entails removing dead stems and low branches to decrease the chance of fire spreading into treetops and producing embers, not the removal of all trees from a property. See Section 4.2.8.
- If budgets are limited and not all high-risk properties can be treated, highest priority for treatments are on the eastern side of high-risk properties or when neighborhoods or businesses occur upslope from continuous grassy fuels.



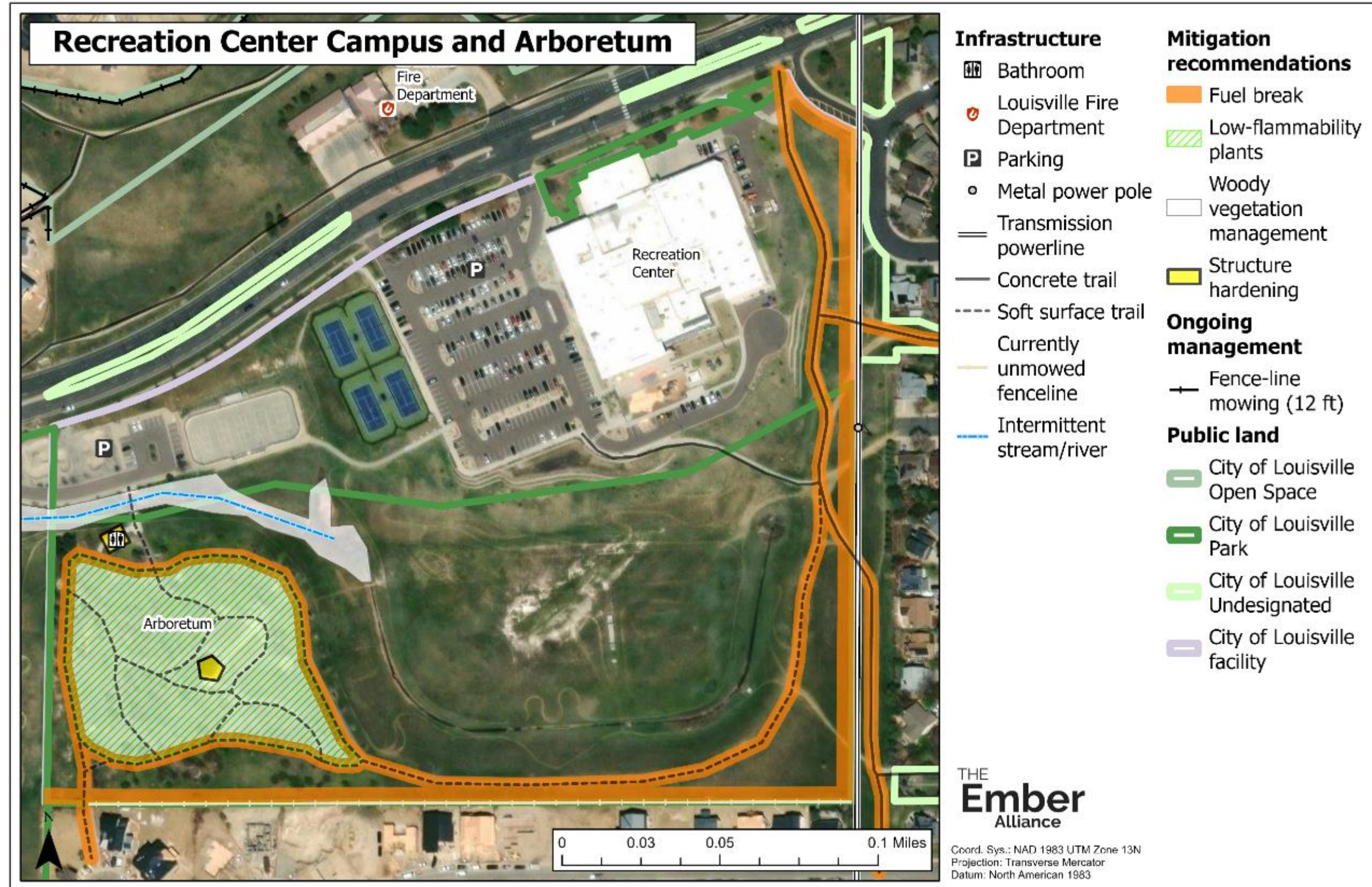
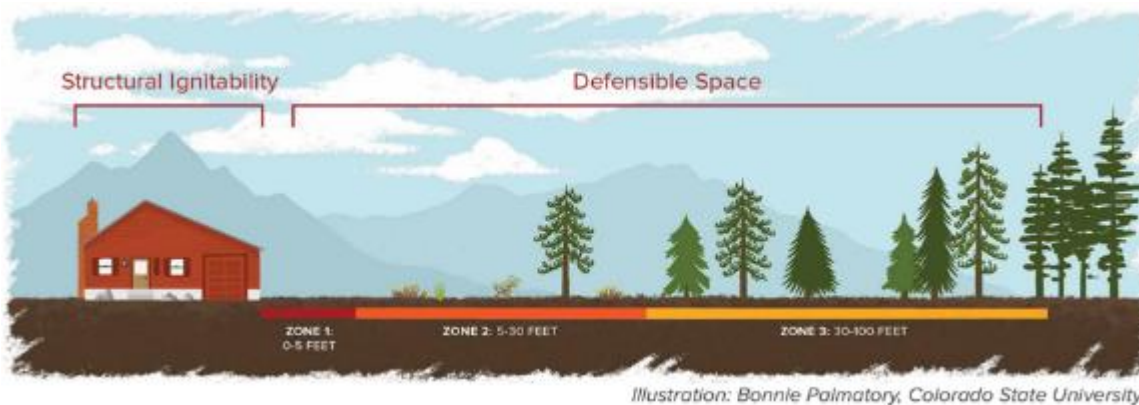


Figure 4-26. Recreation Center and Arboretum Mitigation Treatments



## 5. Wildfire Resources

There are many great resources for Coloradans looking to adapt to changing wildfire conditions and improve their resilience. While wildfires are a natural phenomenon, especially in Colorado's ecosystems, the intensity, timing, and impact of these wildfires are evolving with climate change and landscape modifications. According to the CSFS WUI Risk Assessment (2017), "more than half of Colorado residents live in the wildland-urban interface and are at some risk of being affected by wildfire." Because of this, communities must be 'wildfire prepared' year-round. In light of the increasing threat of wildfire in Colorado, Colorado State University (CSU Extension) and the Colorado State Forest Service have developed resources for community members concerned about their wildfire risk. This section introduces the concepts of defensible space for homes and structures, firewise and low flammability landscaping, and strategies for community adaptation to wildfire.



*Figure 5-1. Illustration of the defensible space around a home.*

### Defensible Space

Creating a defensible space around homes and infrastructure is an important element in reducing wildfire risk (Figure 5-1). The Colorado State Forest Service (CSFS) defines three zones for creating and maintaining defensible space for structures:

- Zone 1 is from 0-5 feet from the structure
- Zone 2 is 5-30 feet from the structure
- Zone 3 is 30-100 feet from the structure

Within each zone (Table 5-1) there are specified goals for reducing or eliminating fuels or highly flammable vegetation, which can begin with planting fire-resistant vegetation (known as Firewise vegetation) and routine landscaping (e.g., grass mowing and tree pruning). Resources and for defensible space and Firewise plant materials are summarized at the end of this section in Table 5-2 and Table 5-4.

**Table 5-1. Defensible space zones and goals**

Zone	Distance from Home	Goals
1	0-5 feet	Zone 1 seeks to prevent flames from coming in direct contact with the structure by using nonflammable, hard surface materials such as rock, gravel, sand, cement, bare earth or stone/concrete pavers.
2	5-30 feet	Zone 2 is designed to limit the fuels of an approaching fire by using lower flammability plants and increasing vegetation spacing, which will help reduce the fire intensity as it gets closer to a home or structure.
3	30-100 feet	Zone 3 focuses on mitigation that keeps fire on the ground and out of the tree canopy. Mitigation measures can improve forest health by including trees of multiple ages, sizes, and species, with adequate room for growth over time.  If Zone 3 (100 ft.) stretches beyond property lines, residents should work with adjoining property owners to complete an appropriate defensible space. If a home or structure is on steep slopes or has certain topographic considerations, this zone may be larger.

Source: CSFS, 2021

**Low Flammability Landscaping**

Low flammability landscaping, also referred to as firewise landscaping, focuses on using the correct grasses, plants, trees, and shrubs to limit combustible materials near homes to promote a defensible space. While there are no true “fireproof” species (CSFS, 2012, Fact Sheet 6.305), firewise plants typically have one or more common characteristics summarized in the blue call-out box to the right. Although these species are helpful in promoting defensible space by potentially reducing wildfire intensity and spread, plant choice, spacing, and proper maintenance are important to maximize these benefits. An example of a poorly maintained landscape that provides poor defensible space is shown in the upper left half of Figure 5-3 where overgrown shrubs and trees are immediately adjacent to the home in zone 1 (0-5 ft from the structure), which should be free of flammable materials. An example of a well maintained landscape promoting defensible space is shown in the lower right half of Figure 5-2, which is free of flammable materials in zone 1, increases the spacing between plants and uses smaller and lower plants to reduce flammability. Other preparations include home maintenance like cleaning gutters and roofs and keeping certain storage items (e.g., firewood, propane tanks) away from the home.

**Firewise Plant Characteristics**

- Low moisture vegetation
- Low on flammable compounds like volatile oils
- Less fuel from smaller size or less litter
- Shorter in height to limit fuel development

Source: Kuhns, 2019



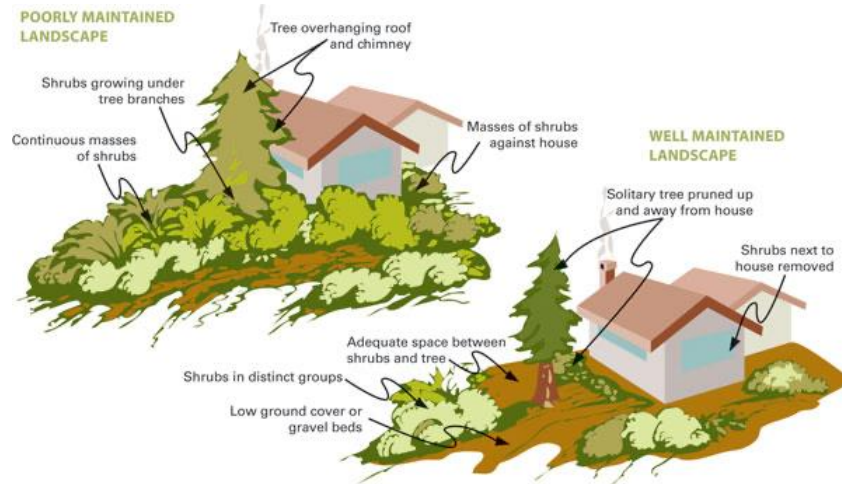


Figure 5-2. Firewise landscaping to promote defensible space (Source: [Kuhns, n.d.](#)).

### Community Adaptation to Wildfire

Fire Adapted Communities (FAC; <https://fireadapted.org/>) encourages communities to increase their wildfire resilience by adapting to wildfire, with the understanding that adaptation can be improved before, during, and after a fire. Fire adapted communities use a comprehensive approach to wildfire adaptation including elements such as implementing fuel treatments, wildfire prevention campaigns, policy, safety measures, and resident mitigation (among other methods) to increase resilience (Figure 5-3). Wildfire adaptation should involve collaboration among all parts of a community including but not limited to community members, fire agencies, utilities, government officials, and land managers.

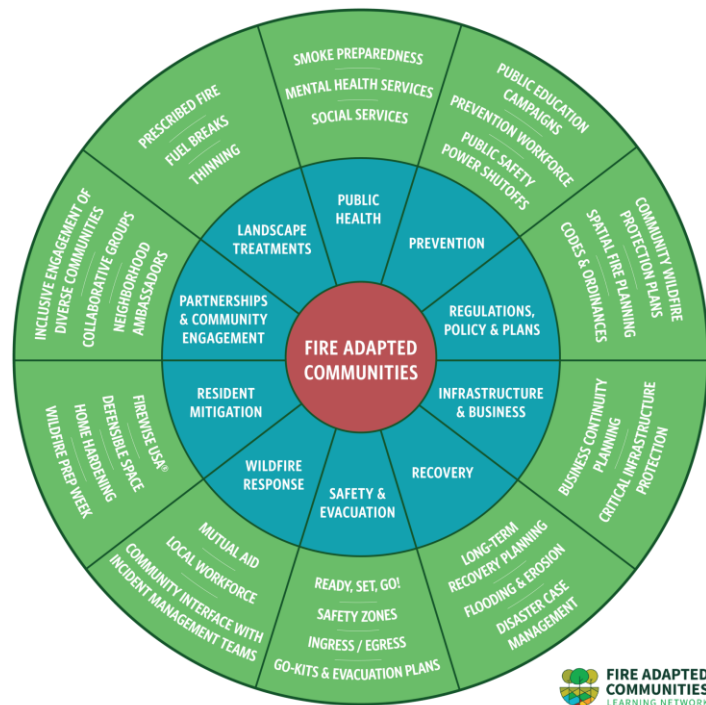


Figure 5-3: The Fire Adapted Communities provides specific programs and activities that communities can take to reduce their wildfire risk and increase their resilience.

With a similar mission, The National Fire Protection Association (NFPA) developed an education campaign called Firewise USA® to equip residents in protecting homes in the communities. A community is “Firewise” when they “have taken appropriate measures to become more resistant to wildfire structural damage” (NFPA, 2023). This program offers recognition to communities around the nation that have taken steps to be Firewise ([Firewise USA Sites of Excellence](#)), and the webpage provides tools such like trainings to assess a property’s ignition potential and other research-based recommendations on how to prepare and protect property.

## Wildfire Resources

The resources compiled here are organized by pre-wildfire preparations for improving defensible space (Table 5-2), recommendations for implementing Firewise and low flammability plant materials (Table 5-3), and post-wildfire recovery resources (Table 5-4). While this information is not inclusive of all the available wildfire resources, the following links provide the pertinent materials to begin improving wildfire resilience.

**Table 5-2: Wildfire Preparation Resources**

Resource	Description	Link
Live Wildfire Ready	The new CSFS <a href="#">Live Wildfire Ready</a> website serves as a one-stop-shop to prepare your home for wildfire. Among its resources, the webpage provides a ' <a href="#">checklist of practical and low-cost actions</a> ' that residents can do to decrease the impacts of wildfire on their home.	<a href="#">CSFS</a> (Webpage)
Home Ignition Zone Guide (CSFS)	This comprehensive guide to 'home hardening' provides a structural ignitability best practice checklist (page 7) and a thorough home maintenance checklist (page 10). The guide also provides information on wildfire behavior and surface fuels. Additional maintenance tips are provided based on surrounding forest types.	<a href="#">CSFS</a> (PDF)
Wildfire Mitigation (CSFS)	The Wildfire Mitigation webpage provides links to great resources including private property protection, CWPPs, Fire Adapted Communities, and the FireWise USA program.	<a href="#">CSFS Wildfire Mitigation</a> (Webpage)
Fire Adapted Communities	The Fire Adapted Communities Learning Network provides resources that promote community resilience and adaptation to wildfire.	<a href="#">Fire Adapted</a> (Webpage)
Defensible Space (Colorado Springs Fire Department)	The website provides a shortened summary (9 items) to 'help protect your family and home'. It includes the <a href="#">Colorado Springs Fire Department Wildfire Mitigation guide</a> that provides tips for reducing risk in and around a home.	<a href="#">COSFD</a> (Webpage)

**Table 5-3: Landscaping Resources**

Resource	Description	Link
Low Flammability Landscape Plants (CSU Extension)	The Low-Flammability Landscape Plants fact sheet (2023) introduces the WUI, defensible space and the flammability of plants. It provides an in-depth summary into managing defensible space with low flammability plants particularly useful in home defense zones 1 and 2. The table in the document (page 4) provides information about the water needs, sun/shade preference, mature height, elevation, bloom month, and low flammability rating for each recommended plant and grass.	<a href="#">2023 Fact Sheet 6.305</a> (PDF)
FireWise Plant Material (CSU Extension)	The FireWise Plant Materials fact sheet (2012) provides a list of flowers, ground cover, shrubs, and trees that meet FireWise specifications (page 3). It includes information on each vegetation's water needs, sun/shade preference, mature height, elevation, and bloom month, as well as general guidelines and tips on landscaping.	<a href="#">2012 Fact Sheet 6.305</a> (PDF)
Fire Resistant Landscaping Fact Sheet (CSU Extension)	The fire resistant landscaping webpage and fact sheet (2012) explores how to develop and maintain a home's defensible space. The document further expands on the types of grasses, ground cover plants, wildflowers, shrubs, and trees that can be used when landscaping for defensible space.	<a href="#">Fire Resistant Landscaping (Webpage)</a> <a href="#">Fact Sheet 6.303</a> (PDF)
Fire Resistant Landscaping (Rotary Wildfire Ready)	This webpage recommends vegetation types based on the ignition zones around a home or structure. For example, the non-combustible zone (0-5 feet within a home) should be modified to remove all flammable materials (e.g., mulch, shrubs, pine needles).	<a href="#">Fire-resistant Landscaping</a> (Webpage)

**Table 5-4: Post-Fire Recovery Resources**

Resource	Description	Link
Firewise Landscape Design (CSU Extension)	A webinar about how to learn from previous impacts from wildfire to harden a home against future wildfires. The webinar is led by a senior landscape designer (start time = 1:09:16) and goes through the design process with the lens of maintaining a defensible space and Firewise landscaping principles. This is part of the larger Post-Fire Recovery of the Home Landscape webinar hosted by CSU Extension.	<a href="#">Landscape Design Webinar</a> (YouTube Video)
Wildfire Recovery (Colorado Resiliency Office)	This is the Wildfire Recovery home page for the 'most up-to-date information, resources and contact information related to wildfire recovery and resilience planning from the Colorado Resiliency Office. The webpage categorizes resources for use by local government, businesses, or individuals. The website also hosts additional wildfire resources and documents, a few of which have been summarized below: <ol style="list-style-type: none"> <li>1. <a href="#">Colorado Disaster Recovery (lessons learned)</a></li> <li>2. <a href="#">Colorado Post-Fire Recovery Playbook</a></li> <li>3. <a href="#">Local Government Guide to Recovery</a></li> <li>4. <a href="#">Colorado Post-Wildfire Guide</a></li> </ol>	<a href="#">CO DOLA</a> (Webpage)




## 6. Recommendations and Conclusions

This report summarizes the findings of the wildfire risk assessment for the City of Louisville public lands and identifies mitigation treatment alternatives and recommendations to help the City increase its wildfire resilience and prepare for future fire hazards.

### 6.1. Summary of Findings

A wildfire risk assessment was developed using updated wildfire behavior modeling from the Colorado State Forest Service combined with a geospatial analysis of City public lands and facilities to quantify wildfire risk throughout the City of Louisville. The wildfire risk assessment indicates that the regions of the City of Louisville with the highest wildfire risk are located along the western and northern municipal boundary, from the Howard Berry Water Treatment Plant (WTP) on Marshall Road to the North WTP and North Open Space, including Davidson Mesa and adjacent public and private land. The City of Louisville properties with the highest wildfire risk are summarized in Table 6-1. The wildfire risk scores are grouped into five risk categories: lowest risk, low risk, moderate risk, high risk, and highest risk. Most properties affected by the Marshall Fire were categorized as moderate, high, or highest risk. However, some properties like Avista Open Space, Coal Creek Golf Course, and Harper Lake were categorized as lowest risk. The wildfire risk assessment will serve as a tool to help decision-makers allocate limited resources across the City of Louisville properties.

**Table 6-1. Highest wildfire risk at City of Louisville properties.**

Location	Average Risk	Relative Risk
<b>Howard Berry Water Treatment Plant</b>	Highest Risk	
Keith Helart Park	High Risk	
Annette Brand Park	High Risk	
North Open Space	Moderate Risk	
<b>Davidson Mesa Open Space</b>	Moderate Risk	
<b>Damyanovich Open Space</b>	Moderate Risk	
Pressure release valve (PRV) - 9182 W Dillon Rd	Moderate Risk	
Gateway Open Space	Moderate Risk	
City of Louisville Water Treatment Plant	Moderate Risk	
Coal Creek Regional Trail Corridor	Low Risk	

Note: **bolded text** indicates properties that were burned during the Marshall Fire.

This report includes a comprehensive summary of mitigation alternatives and recommendations for implementing the proposed treatments on City of Louisville properties. Treatment alternatives include prescribed burning, herbicide use, grazing, seeding with native plants, prairie dog activity, mowing, woody vegetation management, structure hardening and defensible space, and irrigation.

In Section 4.2, the treatment alternatives are summarized by property type (i.e., irrigated park, open space, city facility), with recommendations on how to implement the mitigation measures based on the associated wildfire risk for the property (high, moderate, low). Section 1.1 presents the findings and recommendations from the site assessments conducted by The Ember Alliance after visiting 14

properties managed by the City of Louisville. The site assessments analyzed fuel conditions, topography, potential wildfire exposure of structures on and adjacent to City properties, defensible space and hardening of structures on City properties, and features that could assist with or create challenges for wildfire suppression. The site assessments leverage the wildfire risk modeling to propose first priority, second priority, and third priority treatments for each site.

### **Balancing Community Values**

There are benefits and tradeoffs to different actions to mitigate wildfire risk, and there are no mitigation strategies that can optimize all values for public land and minimize wildfire risk at the same time. Social values, ecological impacts, feasibility, cost, and likelihood of success should be considered when deciding where to conduct different mitigation options. Reducing wildfire risk is a balance between these social and ecological considerations with economic costs. This report is not a land management plan, and the recommendations acknowledge that these public lands are managed by the City for multiple uses—tiers of treatment options and pathways are provided consistent with the City’s Open Space mission. Becoming a fire adapted community requires a comprehensive approach and coordinated action to address shared risk. Fuel treatments on properties managed by the City of Louisville are just one piece of fire resilience and treatments on adjacent private property may be more cost-effective in some instances. Partnerships between agencies, landowners, and homeowners are necessary for meaningful progress towards fire resiliency. This includes outreach, education, and incentive programs.

## **6.2. Additional Recommendations**

In addition to the mitigation treatment recommendations identified in Section 4, this report summarizes additional actionable recommendations across multiple categories—including public policy and city plans, education and training, and detection and prevention—to help the City of Louisville improve wildfire resilience.

### **Land Use Management Plan**

In many instances, mitigation treatments improve natural habitat or native ecosystems by providing co-benefits beyond wildfire mitigation. In these instances, it would be helpful to coordinate mitigation treatments as a part of a larger management plan documenting the City’s medium and long-term vision for each property controlled by the Parks, Recreation, and Open Space Department. In this more general land use management plan, wildfire is one of many considerations in determining the future of open space lands. This plan would be an essential tool that would help guide more complex mitigation strategies, such as native grass/habitat restoration, that require a larger investment and long-term maintenance by the City to ensure proper results.

- Update the Open Space Management Plan from 2004 in light of changing conditions following the Marshall Fire and potential future conditions with climate change. As part of this planning process:
  - Re-evaluate herbicide regulations in the City of Louisville to determine if City Council would approve the use of glyphosate for reducing widespread cover of non-native grasses like smooth brome and cheatgrass.
  - Re-evaluate prairie dog management on open spaces where prairie dog activity could help restore the ecosystem and reduce wildfire risk in new or existing areas.

## Policies and Programs

Consider revising or implementing policies and programs that can help reduce wildfire risk and improve resilience.

- Work with the Planning Department to explore the feasibility and benefits of municipal code changes or an incentive program to encourage residents adjacent to parks and open spaces and private grassland or forested areas to replace flammable privacy fences with ignition-resistant materials.
- Consider a program to allow citizens to create greenstrips within at least 10 feet of their fence line—in specific city designated locations where non-native grasses are removed and replaced with approved, native, low-flammability plants.

## Adaptive Management

Adaptive management is an iterative process that implements an action (in this case mitigation treatments), monitors and evaluates the results of the strategies, and adjusts the initial action based on the desired outcome.

- Develop a robust monitoring program to measure changes in fuel loads and vegetation conditions after implementing different strategies on property managed by the City.
- Actively participate in the Boulder Fireshed Grasslands Working Group to glean lessons learned and best practices from other land managers and researchers in the area.
- Facilitate citizen science and formal research on property managed by the City to evaluate impacts of mitigation measures. Consider developing a small grant program for research such as those offered by [Boulder County Parks & Open Space](#) and the [City of Boulder Open Space and Mountain Parks](#). These grant programs have resulted in invaluable place-based knowledge about the impacts of prescribed fire, grazing, and herbicide on ecosystem conditions and function.

## Wildfire Detection and Prevention

Reducing the potential for fire ignitions is a powerful tool in wildfire mitigation.

- Coordinate with the Louisville Fire Department and Boulder Sheriff's Office Fire Management to ensure the placement of new wildfire rapid detection technology provides visuals on high-risk parks and open spaces.
- Conduct fire prevention campaigns to share information about reducing the possibility of unplanned ignitions from recreation on parks and open space properties or activities on private land adjacent to public land. This includes informing residents about the risk of dry plant clippings, leaves, and even cotton fluff from cottonwood trees igniting from heat and sparks from grills, chainsaws, or mowers. Additionally, encouraging residents to avoid using a grill, chainsaw, or mower when there is a Red Flag Warning.
- Explore the feasibility and benefits of prohibiting mowing and grilling on Red Flag Days.

## Community Wildfire Resources, Education, and Training

The community expressed interest in comprehensive wildfire resources for the community that were consolidated and centrally located for the community to access. Community resources have been provided as a part of this report in Section 50, and they are included in the accompanying project StoryMap, but the City should consider structuring these materials (and others) on the government website along with existing post-Marshall Fire resources ([Louisville Rebuilds](#)).



- Example URL: <https://www.louisvilleco.gov/living-in-louisville/residents/wildfire-resources/>

In addition to educational materials, the City should consider offering training or conducting campaigns that connect with the community on strategies they can contribute to wildfire mitigation. Examples of these include:

- Training events on firewise landscaping, defensible space, and structure hardening for both community citizens as well as professional contractors and landscapers. Field visits to the Louisville Recreation Center, which has exemplary defensible space and structure hardening.
- Communicate with the public regarding mitigation treatments implemented on public lands.
- Information campaigns about the ability of citizens to mow within 10 feet of their fence line. Share information about best practices for mowing to reduce the chance of sparks from [CAL FIRE](#) and the [National Fire Prevention Association](#).

### **Citizen Engagement**

Engage with members of the Louisville community interested in engaging on reducing wildfire risk.

- Organize a Fire Adapted Communities Alliance comprised of concerned citizens who can assist with on-the-ground mitigation efforts, monitoring treatment effectiveness, and education campaigns. Follow the model of the City of Superior's Open Space Ambassador Program that identifies and trains volunteers.
- Conduct a public survey as part of the process for developing the City of Louisville Parks & Open Space Management Plan to determine general acceptability of different mitigation measures and willingness to accept different tradeoffs (e.g., concern about smoke from prescribed burns vs. concerns about high fuel loads).

### **Partnerships and Collaboration**

Wildfire risk is not limited to the municipal boundary, therefore partnering with neighboring agencies will help to achieve regional goals.

- Continue developing relationships with ditch companies, Boulder County Parks & Open Space, City of Boulder Open Space & Mountain Parks, City of Superior, City of Lafayette, Boulder County Fireshed Grasslands Working Group, and other partners to pursue cross-boundary mitigation efforts. Examples include developing Memorandums of Understanding with ditch companies to facilitate prescribed burning along ditch banks.
- Actively participate in the development of the new Boulder County Community Wildfire Protection Plan to ensure concerns and needs for wildfire risk mitigation and resilience on parks and open space are incorporated into the plan.

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## 8. Appendix A

### 8.1. Wildfire Modeling Methods

#### 8.1.1. Sub-HVRA Resources

**Table 8-1. City of Louisville Open Space properties included in HVRA #1 (sub-HVRA = Open Space).**

HVRA #1 – Open Space	
Aquarius Open Space	Hecla Lake Open Space
Avista Adventist Hospital Open Space	Hillside Open Space
Bullhead Gulch Open Space	North Open Space
Coyote Run Open Space	Walnut Open Space
CTC Open Space	Warembourg Open Space
Damyanovich Open Space	Centennial Drive Corridor
Daughenbaugh Open Space	Coal Creek Regional Trail Corridor
Davidson Mesa Open Space	Garfield Utility Corridor
Dutch Creek Open Space	Harper Lake / Leon A. Wurl Wildlife Sanctuary
Gateway Open Space	

**Table 8-2. City of Louisville Parks properties included in HVRA #1 (sub-HVRA = Parks).**

HVRA #1 – Parks	
Annette Brand Park	Louisville Sports Complex
Centennial Park	McKinley Park
Chunkinson Park	Meadows Park
City of Louisville Branch Recycling Site	Memory Square Park
Cleo Mudrcok Park	Miner's Field
Cottonwood Park	Mission Greens Park
Cowboy Park	Owl Park
Dutch Creek Path	Pallino Park
Elephant Park	Pine Street Park
Hackberry Park	Pirates Park
Hammer Run Park	Recreation Center Campus & Arboretum
Heritage Park	Saratoga Park
Hutchinson Park	Steel Ranch Park
Joe Carnival Park	Sundance Park
Keith Helart Park	Sunflower Park
Kennedy Park	Swankinson Park

HVRA #1 – Parks	
Lake Park	Tyler Avenue
Lawrence D Enrietto Park	Tyler Park
Louisville Cemetery	Washington Park
Louisville Community Park / Dog Park	<i>Church property</i>
Louisville Police Department and Municipal Court	

**Table 8-3. City of Louisville City Building Grounds (HVRA #2).**

HVRA #2 – City Building Grounds	
City Services	Louisville Historical Museum
Golf Clubhouse	Louisville Public Library
Golf Maintenance	Police Department and Municipal Court
Louisville Center for the Arts	Recreation & Senior Center
Louisville City Hall	Steinbaugh Pavilion

**Table 8-4. City of Louisville Water Facility Grounds (HVRA #3).**

HVRA #3 – Water Facility Grounds	
City of Louisville Water Treatment Plant	Steel Ranch Lift Station
Louisville Wastewater Treatment Plant	North End Lift Station
Howard Berry Water Treatment Plant	PRV - 9182 W Dillon Rd
Harper Lake & Pump Station	PRV - Pine & Hoover
Northern Pump Station	PRV - 800 Nighthawk Cir
CTC Lift Station	PRV - 373 Centennial Pkwy

### 8.1.2. Relative Importance

A sensitivity assessment was conducted on the relative importance scores of open space lands, where the value was modified from 60 to 100. The results were insensitive to this change with wildfire risk providing similar output for both values, therefore a final relative importance of 80 was used for City of Louisville open space.



**Table 8-5. Relative importance values for each HVRA and sub-HVRA.**

HVRA	Abs. Impor.	Categorical RI*	Sub-HVRA	Abs. Impor.	Sub-HVRA RI**	Combined RI***	
<b>#1: Public Lands</b>	50	14%	City Open Space	80	25%	3.5%	
			Golf course	Irrigated	100	31%	4.4%
				Non-irrigated	20	6%	0.9%
			City parks	Irrigated	90	28%	3.9%
				Non-irrigated	20	6%	0.9%
City undesignated land	10	3%	0.4%				
<b>#2: City facility grounds<sup>◇</sup></b>	90	25%	City Services Facility	80	12%	3.0%	
			Police Station	100	15%	3.8%	
			Recreation Center	100	15%	3.8%	
			Golf Clubhouse	50	8%	1.9%	
			Golf Maintenance Building	40	6%	1.5%	
			Louisville Historical Museum	50	8%	1.9%	
			Louisville Public Library	70	11%	2.7%	
			Louisville City Hall	70	11%	2.7%	
			Louisville Center for the Arts	70	11%	2.7%	
			Steinbaugh Pavilion	30	5%	1.1%	
<b>#3: Water facility grounds<sup>◇</sup></b>	100	27%	WWTF	100	13%	3.6%	
			WTP South	100	13%	3.6%	
			WTP North	100	13%	3.6%	
			Harper Lake & Pump Station	90	12%	3.2%	
			Northern Pump Station	90	12%	3.2%	
			North End Lift Station	70	9%	2.5%	
			CTC Lift Station	80	11%	2.9%	
			Steel Ranch Lift Station	70	9%	2.5%	
			PRVs	50	7%	1.8%	
<b>#4: WUI</b>	100	27%	LT 1 hs/40 ac	100	14%	3.9%	
			1 hs/20-40 ac	100	14%	3.9%	
			1 hs/10-20 ac	100	14%	3.9%	
			1 hs/5-10 ac	100	14%	3.9%	
			1 hs/2-5 ac	100	14%	3.9%	
			1-3 hs/1 ac	100	14%	3.9%	
			GT 3 hs/1 ac	100	14%	3.9%	
<b>#5: Other private and public lands</b>	25	7%	Adjacent Public Lands	100	50%	3.5%	
			Adjacent Private Lands (open space)	100	50%	3.5%	

\* Categorical RI is calculated by taking the primary HVRA RI and dividing by the sum of RI values for all the primary HVRA's

e.g.) #1 Public Lands:  $\frac{50}{(50+90+100+100+25)} * 100\% = 14\%$

\*\* Sub-HVRA RI is calculated by taking the RI for sub-HVRA and dividing by the sum RI values for the primary HVRA category

e.g.) City Open Space:  $\frac{80}{(80+100+20+90+20+10)} * 100\% = 25\%$

\*\*\* Combined RI is calculated by multiplying the categorical RI (%) and the sub-HVRA RI (%)

<sup>◇</sup> Lands that are buffered 300-meters to capture the area around.

### 8.1.3. Response Functions

**Table 8-6. Response functions for each HVRA and sub-HVRA.**

HVRA	Sub-HVRA	0-2ft	2-4ft	4-6ft	6-8ft	8-12ft	12+ft	
<b>#1: Public Lands</b>	City Open Space	0	0	-20	-45	-75	-75	
	Golf course	Irrigated	-10	-20	-30	-50	-75	-75
		Non-irrigated	0	-10	-20	-30	-40	-50
	City parks	Irrigated	-10	-20	-30	-50	-75	-75
		Non-irrigated	0	-10	-20	-30	-40	-50
<b>#2: City facility grounds</b>	City undesignated land	0	-10	-20	-30	-40	-50	
	City Services Facility	-20	-40	-80	-100	-100	-100	
	Police Station	-20	-40	-80	-100	-100	-100	
	Recreation Center	-20	-40	-80	-100	-100	-100	
	Golf Clubhouse	-20	-40	-80	-100	-100	-100	
	Golf Maintenance Building	-20	-40	-80	-100	-100	-100	
	Louisville Historical Museum	-20	-40	-80	-100	-100	-100	
	Louisville Public Library	-20	-40	-80	-100	-100	-100	
	Louisville City Hall	-20	-40	-80	-100	-100	-100	
	Louisville Center for the Arts	-20	-40	-80	-100	-100	-100	
	Steinbaugh Pavilion	-20	-40	-80	-100	-100	-100	
<b>#3: Water facility grounds</b>	WWTF	-20	-40	-80	-100	-100	-100	
	WTP South	-20	-40	-80	-100	-100	-100	
	WTP North	-20	-40	-80	-100	-100	-100	
	Harper Lake & Pump Station	-20	-40	-80	-100	-100	-100	
	Northern Pump Station	-20	-40	-80	-100	-100	-100	
	North End Lift Station	-20	-40	-80	-100	-100	-100	
	CTC Lift Station	-20	-40	-80	-100	-100	-100	
	Steel Ranch Lift Station	-20	-40	-80	-100	-100	-100	
4 PRVs	-20	-40	-80	-100	-100	-100		
<b>#4: WUI</b>	<1 hs/40 ac	-4	-7	-11	-16	-20	-20	
	1 hs/20-40 ac	-9	-13	-22	-31	-40	-40	
	1 hs/10-20 ac	-13	-20	-33	-47	-60	-60	
	1 hs/5-10 ac	-17	-25	-42	-58	-79	-79	
	1 hs/2-5 ac	-21	-32	-53	-74	-88	-95	
	1-3 hs/1 ac	-22	-33	-56	-79	-100	-100	
	>3 hs/1 ac	-22	-56	-78	-89	-100	-100	
<b>#5: Other private and public lands</b>	Adjacent Public Lands	0	0	-20	-45	-75	-75	
	Adjacent Private Lands (open space)	-13	-20	-33	-47	-60	-60	

### 8.1.4. Wildfire Risk Mapping Categories

**Table 8-7. Wildfire risk mapping categories based on raster values from the model output.**

Percentile Range	Map Color	Lower end		Higher end	
		Percentile	Raster value	Percentile	Raster value
0-41%	Lowest Risk	0	0	41	-0.070
41.1-68.7%	Low Risk	41.1	-0.070	68.7	-0.358
68.8-89.4%	Moderate Risk	68.8	-0.359	89.4	-1.005
89.5-97.6%	High Risk	89.5	-1.010	97.6	-1.981
97.7%-100%	Highest Risk	97.7	-2.037	100	-6.887

Note: The percentile categories were based on the binning methods used in the 2022 wildfire risk modeling by the CSFS and Technosylva (Technosylva, 2023).



## 8.2. Fuel Breaks

### How wide should a fuel break be?

The general guidance for fuel breaks is that “wider is better and less fuel is better”. Guidance on fuel breaks widths vary widely, and there is little scientific evidence behind these specific guidelines for grassland, shrubland, or forest ecosystems (Rossi et al., 2019). Anecdotal guidance for fuel break width vary from three times the vegetation height (Trauernicht & Kunz, 2019), 30 feet around structures (CSFS, 2021), 15-100 feet in grasslands without trees (Miller, 2006; Trauernicht & Kunz, 2019; Wilson, 1988), 200-300 feet in shrublands (Maestas et al., 2016; Miller, 2006), and 200-1,300 feet in forests (Agee et al., 2000; Rossi et al., 2019).

The following limited research is available on the effectiveness of fire breaks (linear features devoid of vegetation) of different widths in grasslands based on experimental fires and fire modeling simulations. There was not comparable research on the effectiveness of different widths of fuel breaks (linear features with some vegetation left intact, such as a mow line). (Weise et al., 2023) found that the probability of success was comparable for fire breaks, mowed fuel breaks, and fuel breaks with low flammability plants in sagebrush ecosystems, so the following findings for fire breaks might also be translatable to fuel breaks in non-forested ecosystems:

- In experimental grassland fires in Australia, fire breaks over 15-feet wide were not breached by fire where trees were not present, but embers could travel across the fire breaks. When trees were within 65 feet of the line, fire breaks even as wide as 50-feet were breached. The probability of fire break success was lower for narrower fire breaks and decreased with the presence of trees within 65 feet of the fire line (Wilson, 1988). **Figure 2** shows predicted probability of fire break success for grass fuel models common on Louisville public land based on the equation developed by (Wilson, 1988).
- In experimental grassland fires in continuous cheatgrass in Utah, fire breaks of 13-feet wide and 500-feet wide in three staggered rows 50, 100, or 200-feet apart reduced rates of spread and flame lengths low enough for safe and effective fire suppression with direct attack. Fire behavior in control treatments and with staggered fire breaks 500-feet apart was not conducive to safe and effective direct attack (Dustin, 2002). This experiment only included rows of staggered fire breaks, not individual fire breaks.
- Fire modeling simulations suggest fire breaks must be between 1 to 10 times flame length or 10 to 80 times the fuel height to allow firefighters to suppress the fire safely and effectively, with greater widths required for more extreme fire behavior under hotter, drier, and windier conditions (Frangieh et al., 2021).
- Fire modeling simulations suggest fire breaks must be about 2 times the flame length to have at least an 80% chance of preventing fire from igniting fuels across the fire break. Fire breaks  $\geq 26$  feet were effective for most flame lengths (Brou, 2022).

**NOTE:** The above four studies looked at fire breaks, not fuel breaks. Areas where vegetation is not completely removed (fuel break) need to be larger than a fire break to reduce flame lengths and create opportunities for firefighters.

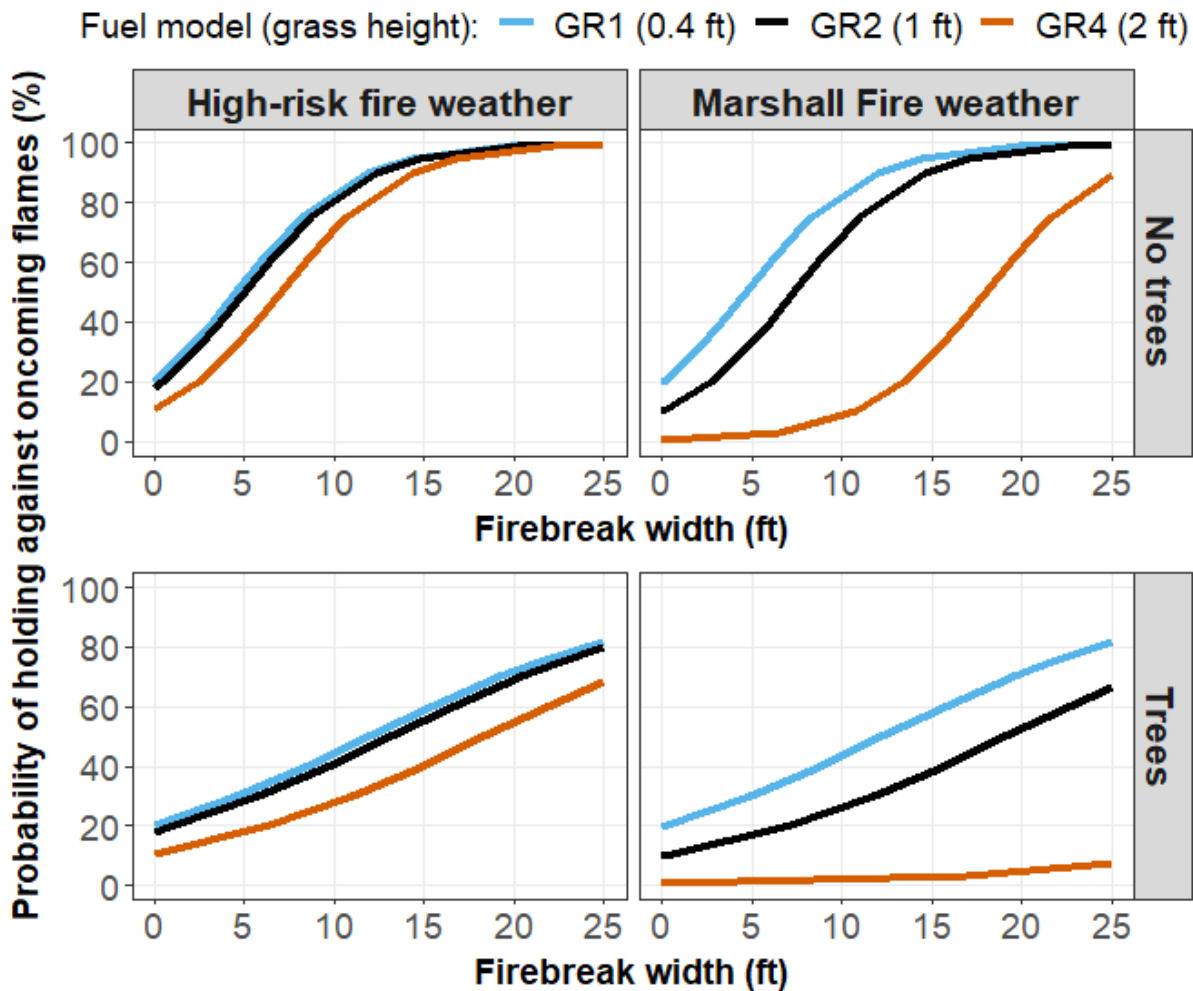


Figure 8-1. Predicted probability of fire break success for three grass fuel models (Scott & Burgan, 2005) common on Louisville public land under high fire weather conditions and extreme conditions and on flat ground (see Table 8-8 for fuel moisture and wind conditions used for the simulations). Flame lengths for these fuel types were predicted using the fire behavior model BEHAVE, and probability of success was predicted using the equation developed by (Wilson, 1988) for fire breaks without trees (top two figures) and with trees within 65 feet of the fire break (bottom two figures).

**IMPORTANT:** There is never a 100% probability of fire break success due to uncertain factors such as sudden wind shifts, availability of suppression resources, small-scale variation in fuel loads and distribution, etc. Embers can travel from far away and ignite fuel on the other side of a fire break. Homeowners should never assume that a fire break will protect their home or other community values from wildfire. **Structure hardening, defensible space around structures, and emergency preparedness are vital for becoming a wildfire resilient community in conjunction with fuel treatments.**

**Table 8-8. Fire weather conditions used for predicting flame length using the fire behavior model BEHAVE for three grassland fuel types common in the City of Louisville.**

Description	High fire weather conditions	2021 Marshall Fire weather conditions
<b>20-ft wind speed (mph)</b>	12	24
<b>Fuel moisture (%)</b>		
1-hr fuels	6	3
10-hr fuels	7	4
100-hr fuels	8	5
Live herbaceous plants	60	30
Live woody plants	90	60

Notes: Wind speeds and fuel moistures for the high fire weather scenario are consistent with those used by Anchor Point in a 2012 wildfire hazard and risk assessment for the City of Louisville Open Space (Anchor Point, 2012) and those for the Marshall Fire weather scenario are consistent with those used by the Marshall Fire Facilitated Learning Analysis (Holstrom et al., 2023).