Ecological Management Recommendations

Applewood Preserve

February 2023

Submitted to:
City of Maplewood
Parks and Natural Resources
2659 East 7th Street
Maplewood, MN 55119

Prepared by
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EXECUTIVE SUMMARY

Background

This document was assembled by Friends of the Mississippi River (FMR) to guide the restoration and management of Applewood Preserve. The 29-acre property, owned and managed by the City of Maplewood, is in the southern part of Maplewood, west of Century Avenue between Linwood Avenue and Highwood Avenue. Although surrounded by residential housing, there are numerous natural areas nearby, including Battle Creek Park about a mile to the north, Carver Park in Woodbury less than a mile southeast, and Highwood Preserve and Pig's Eye Lake about a mile to the west.

According to the 1850's public land survey, at the time of European colonization the site was referred to as Big Woods forest. The proximity to oak savanna as well as soil types and other features of the site tend to indicate the site was more intermediate between savanna and woodland.

Although the specific human land uses prior to colonization are not known, the site was in an area occupied by the Dakota people for hundreds of years. After colonization in approximately the mid-1800's, the site was in agricultural use, primarily for pasture and hay, but some cultivation as well.

The site was obtained by the City of Maplewood and has been managed as a neighborhood preserve. Approximately two thirds of the site is wooded, with a dense understory of invasive common buckthorn. The other third is overgrown grassland, dominated by non-native sumac and dogwood, with some relics of native prairie species. Many very large apple trees remain from at least the early 1970's but are crowded by native and non-native shrubs. The site has not had much ecological management in recent years and invasive woody plants have taken over.

Friends of the Mississippi River obtained a grant from the Environment and Natural Resources Trust Fund, as approved by the Legislative and Citizens Commission on Minnesota Resources, to prepare this document and to begin to improve the habitat for native pollinators and other wildlife, in partnership with the city.

The over-arching goal for the property is to restore ecological functions so that the property approximates conditions and functions that native plant communities provide. The plant communities present at the time of European colonization are used as a general guide, but not strictly adhered to as site conditions have been so drastically altered.

Specific ecological and cultural goals for the preserve are to:

- Restore a complement of native plant communities

- Improve wildlife habitat
- Provide connectivity with other natural areas in the landscape,
- Maintain and manage the property for water quality by:
    - avoiding or controlling any erosion that may develop, and
    - retaining continuous ground cover throughout the site
- Increase biological diversity
- Create a model for responsible stewardship
- Honor the site's former stewards, the Dakota people, by adding culturally important plant species in both the prairie and forest units.
- Utilize this property to enhance and expand the ecological functions of the property and of the larger Metro Conservation Corridor and Mississippi River Greenway.

Natural Resource Inventory and Assessment

Applewood Preserve is not located within the Metro Conservation Corridors - a regional land protection plan – but it is less than half a mile away and is part of that ecological landscape, providing adjacent habitat for plants and animals within the corridor. While no rare plant or animal species have been recorded on the property, the site is within the high potential zone for the rusty patched bumblebee. The site has the potential to provide important wildlife habitat for this and other species, and to provide habitat connectivity to the Mississippi River - a globally significant migratory flyway. Improving the habitat quality at this property may provide habitat for dozens of species that use the flyway.

Through the assessment of the property for these ecological management recommendations, the site was divided into Land Cover Management Units based on existing land cover, realistic restoration goals, and proposed restoration tasks. Current conditions were compared to historical conditions to develop target plant communities and prioritize activities to progress toward those targets. The existing land cover is primarily oak woodlands with an understory dominated by non-native shrubs, and degraded grasslands overgrown with woody plants. The site also contains a pond and emergent wetland vegetation.

The primary ecological concerns at the property are non-native invasive woody and herbaceous species, depauperate native species diversity in some areas. Larger issues such as earthworms and climate change are factors that affect the plant communities and for which there may be no solution other than to mitigate effects as much as possible. Without on-going management, this property will inevitably be overtaken by invasive plants, and gradually lose diversity.

As non-native invasive species increase, they displace native species and decrease habitat for pollinators and wildlife. In the woodlands, the dense shade and competitiveness of buckthorn has displaced most native species in the ground layer and shrub layer. As ground cover species decline, erosion will increase, negatively affecting water quality. These issues are further exacerbated by the rapid consumption of leaf litter and organic material by earthworms.

Migratory birds and other wildlife primarily depend on the cover and food provided by native trees and shrubs and would be less likely to find the resources they need in a buckthorn dominated woods.

Natural Resource Management Plan Recommendations

This document outlines recommendations for ecological management tasks on all units of the property. The target plant communities for the site include Southern Mesic Prairie, Southern Dry-Mesic Oak Woodland, Brushland-Oak Woodland, Aspen Forest and Conifer Grove.

The first restoration priority is to eradicate the non-native woody species throughout the site, especially common buckthorn, and Tatarian honeysuckle, which are most prevalent in the wooded areas. After initial removal, it will be important to continue to monitor and control non-native woody species in the future. Controlling non-native herbaceous plants such as garlic mustard and burdock is a secondary priority in the woodlands, and issues with these species may increase with increased sunlight reaching the forest floor after woody removal. Conducting annual monitoring and assessment is also a high priority to address emerging issues and to evaluate the success of management efforts.

The second priority that warrants timely intervention is the rapidly degrading grassland areas. Woody invaders have crowded out native prairie species, and non-native and invasive grass and forb species are common. Removal of both woody and herbaceous plants should be a first step, with overall restoration of the degraded grassland to prairie to be taken on as funding allows.

Given the strong city support at the site, these ecological restoration activities can be completed by a combination of city staff, conservation non-profit organizations, private contractors that specialize in ecological restoration, and volunteers. The estimated cost for implementing all recommendations, including project management and ecological surveys over a 5-year period is roughly $145,000. The grant funding obtained by Friends of the Mississippi River will cover the first three years of project. An application has been made for additional state grant to cover most of the remaining tasks.

SITE INFORMATION

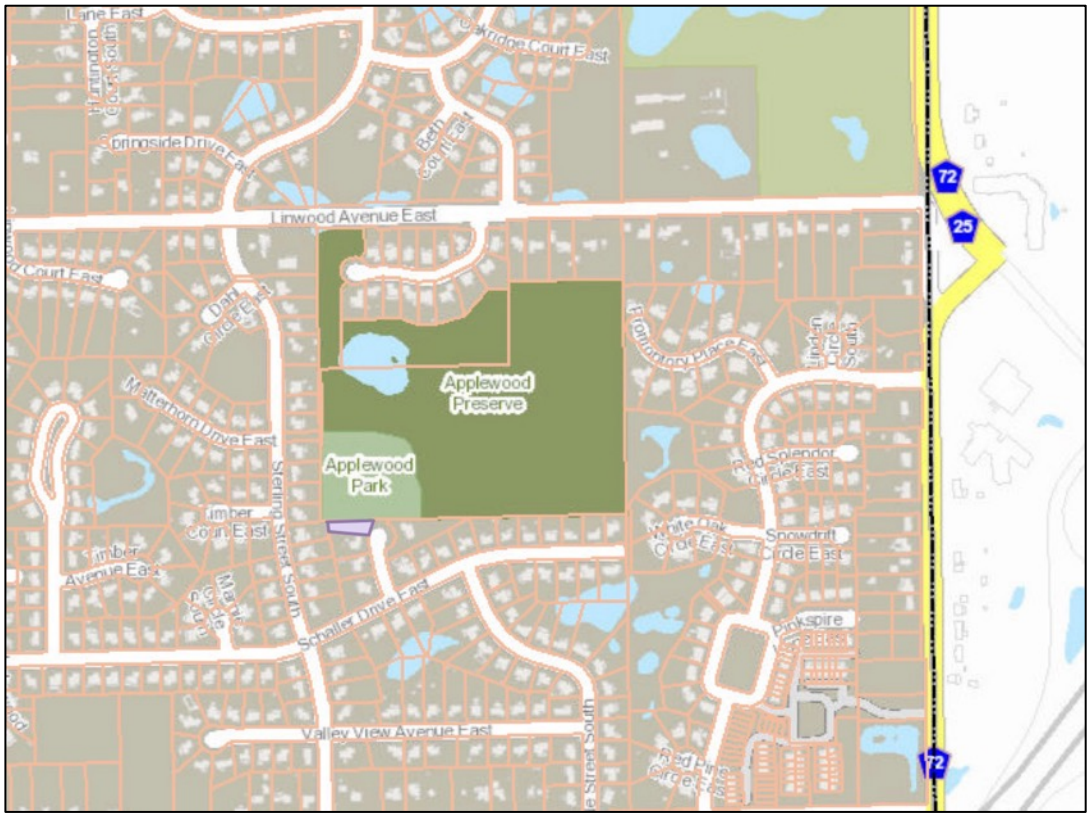
LOCATION

Owner: City of Maplewood
Address: 822 Sterling St S, Maplewood, MN 55119
Acres: 29.42
Parcel Information: There are four parcels (**Figure 1**).
Parcel Identification Numbers:
132822120029 (23.80 acres)
132822120028 (3.69 acres)

132822120027 (1.71 acres)
132822130086 (0.22 acres)

Legal Description: Township 28, Range 22 (Dir 2), Section 13
Watershed: Mississippi River, Fish Creek
Watershed Organization: Ramsey-Washington Metro Watershed District

Figure 1. Applewood Preserve Location



HISTORICAL VEGETATION AND LAND USE

One important consideration for developing a natural resources management plan is to understand the types of vegetation found at a property or in the local area prior to European colonization. This information can be a helpful indicator of what plants may thrive on the property. Fortunately, field notes on vegetation were taken during original territorial surveys in the 1840s and compiled by Francis Marschner into a map of the state entitled "The Original Vegetation of Minnesota", published in 1974.

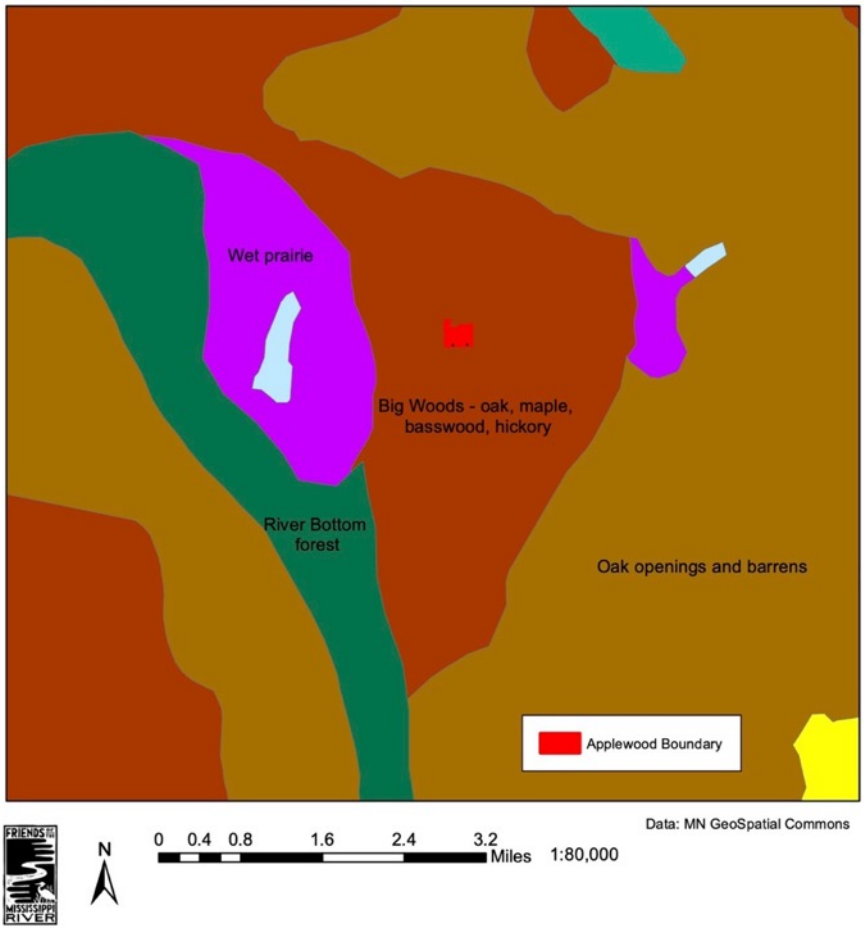
According to Marschner's map, the predominant plant community at Applewood Preserve in the 1840s was Big Woods, or what might be referred to today as maple-basswood forest (**Figure 2**). The plant community assignment is based on data from bearing trees, which were recorded every mile. The bearing trees near Applewood were mostly bur oak, with some white oak and black oak. The abundance of bur oak seems to indicate the area may have been a transition area between Big Woods and Oak Savanna. Oak savanna is mapped just a mile to the east, so it is very likely the Applewood site was intermediary between the two plant community types.

Indicators of the historical forest can be seen in forested areas near the pond, where some very large-diameter trees persist, such as a 35-inch white oak.

A series of historical aerial photographs (**Figure 3**), show the changes in vegetation since 1940, and associated land uses.

In 1940 the site was nearly devoid of trees, except for a small cluster of scattered trees around the pond. It is likely the trees had been cleared from the land, which was converted to

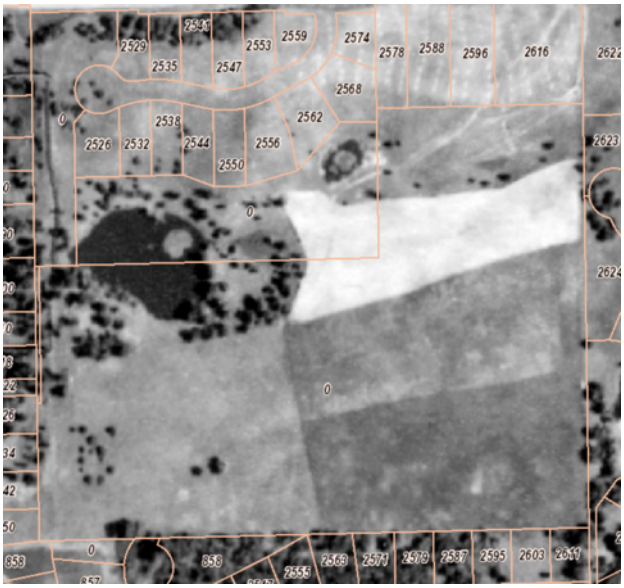
FIGURE 2. Pre-Colonization Vegetation



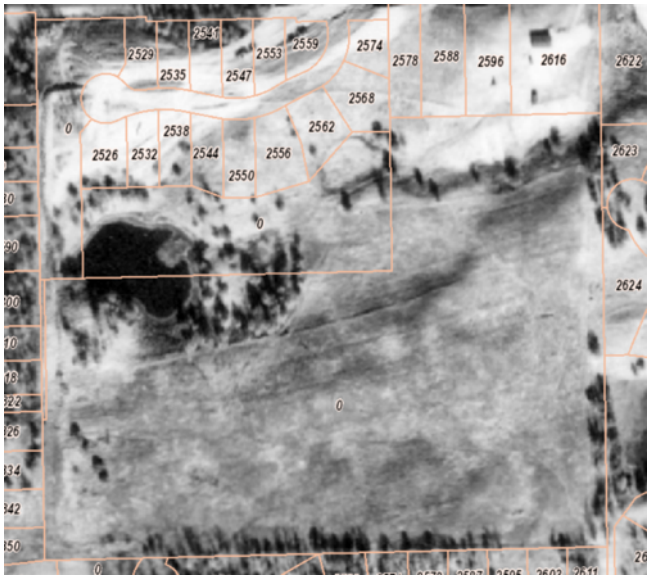
agricultural uses. The primary use appears to have been pasture or hayfield, with a cultivated area east of the pond.

In 1953 the site appeared to be hayed or possibly pastured. By 1974 the present-day apple trees can be seen on the land and the small, wooded patches have expanded slightly. By 1985 the tree cover has significantly increased, especially around the pond and the northern side of the park. By 2003 the park has about 75% woody cover, likely including oak woodland as well as brushland. By 2022 the park is almost entirely covered with woody vegetation, of which about 25% is shrubby.

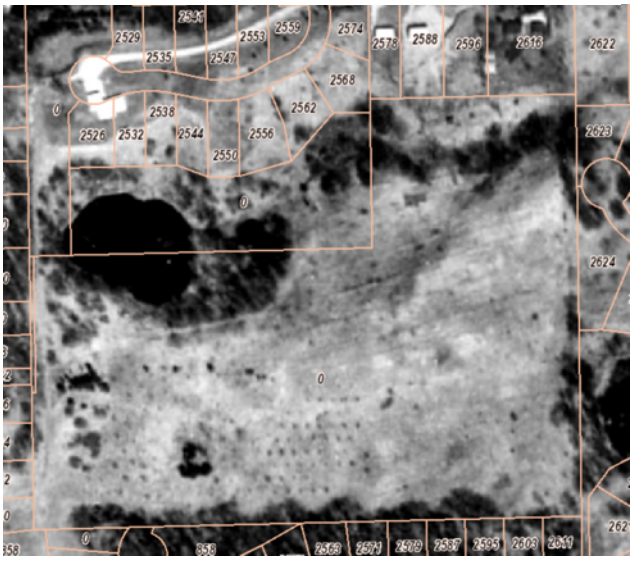
Figure 3. Historical Aerial Photographs



1940



1953



1974

2003

ECOLOGICAL ASSESSMENT

METHODS

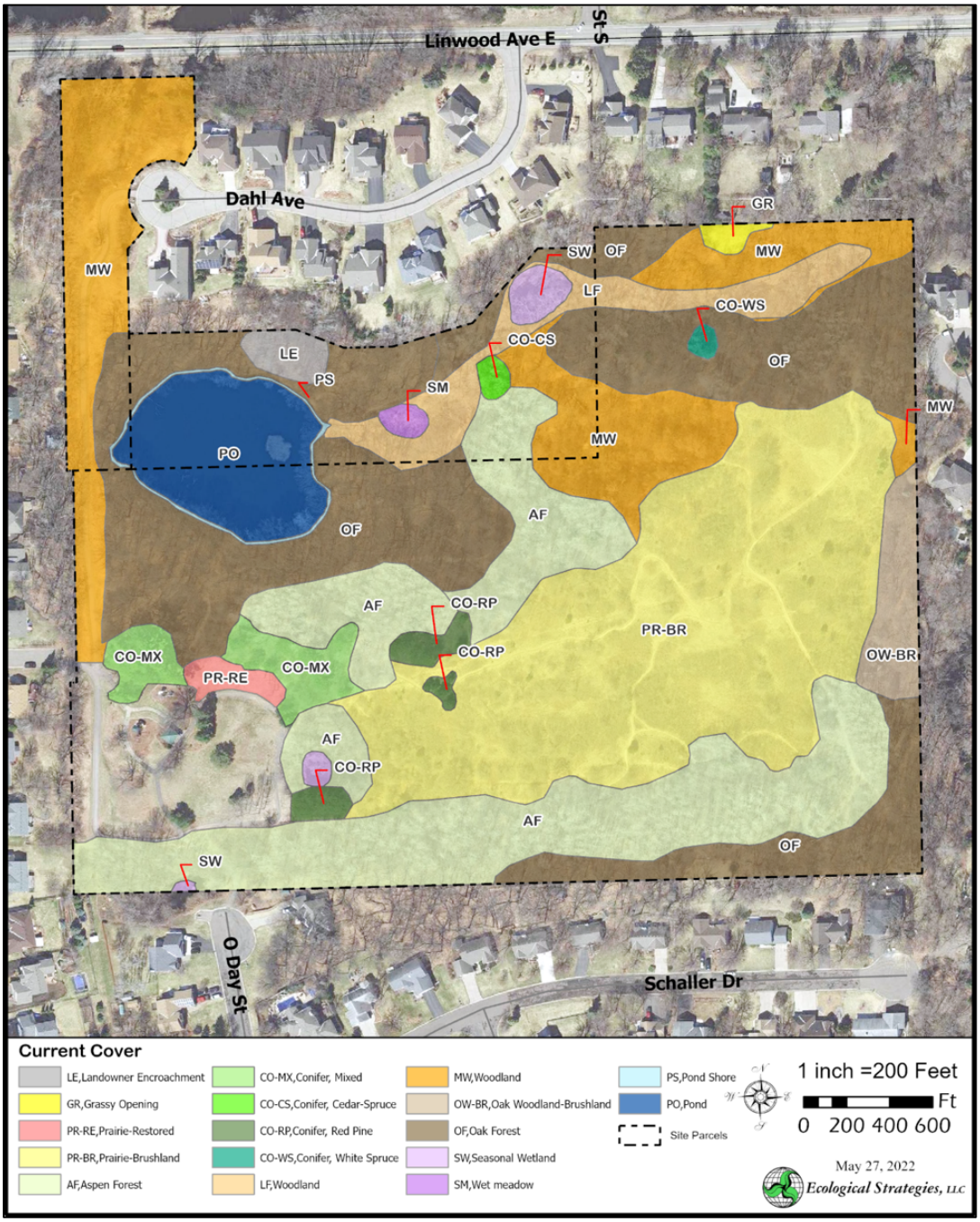
Ecologists from Ecological Strategies, LLC and Friends of the Mississippi River conducted site assessments in fall of 2021 and spring of 2022 to evaluate the existing conditions of Applewood Park and to develop recommendations for improving and managing the plant communities. We began by defining the existing land cover types at the site (**Table 1, Figure 4**). These cover types are similar to the Minnesota Land Cover Classifications (MLCCS), but the names are simplified, for the purposes of this document.

Table 1. Existing Land Cover and Relative Quality Rank

Map Code	Existing vegetation	MLCCS Cover Type	Acres	Quality Rank *
AF3,4	Aspen Forest	Aspen Forest	4.0	3
AF1,2	Aspen Forest	Aspen Forest	2.2	2
CO-CS	Conifer - Cedar, Spruce	Other Coniferous Trees	0.1	3
CO-MX	Conifer-Mixed	Other Coniferous Trees	0.6	4
CO-RP	Conifer- Red Pine	Red Pine	0.3	4
CO-WS	Conifer-White Spruce	Other Coniferous Trees	0.04	4
GR	Grassy Opening	Planted or Maintained Grasses	0.1	4
LE	Landowner Encroachment		0.2	3
LF	Lowland Forest	Altered/Non-native Deciduous Forest Seasonally Flooded	1.0	3
MW	Mixed Woodland	Altered/Non-native Deciduous Woodland	3.7	4
OF	Oak Forest	Oak Forest	4.1	2
OF	Oak Forest	Oak Forest	1.9	4
OW-BR	Oak Woodland-Brushland	Oak Woodland-Brushland	0.5	2
PO	Pond	Palustrine Open Water	1.4	1
PR-BR	Prairie-Brushland	Non-native dominated grasses and forbs	6.7	1
PS	Pond Shore	Seasonally Flooded Annual Forb Vegetation	0.1	1
PR-RE	Prairie-Restored		0.2	2
SM	Sedge Meadow	Wet Meadow	0.1	1
SW	Seasonal Wetland	Seasonally Flooded Annual Forb Vegetation	0.2	3

* 1 is highest quality, 4 is lowest

FIGURE 4. Existing Land Cover



A relative quality rank from 1 to 4, high to low (**Table 1, Figure 5**) was assigned to each land cover type, based primarily on the species composition. Specific criteria were the abundance of invasive, non-native plants contrasted with the abundance and diversity of native plant species and the relative difficulty to restore these areas to native plant communities. The rankings were subjective and entirely relative for this site; they do not relate to MN DNR quality rankings or to other sites. The highest-ranking units, therefore, do not necessarily denote what would be

considered high quality by DNR standards (i.e., intact native plant community with high biodiversity), but were units that had the least abundance of non-native invasive species, and greatest cover and diversity of native species.

Four areas (PR-BR, PO, PS, PM), totaling 8.3 acres, were ranked Quality-1. These Quality-1 areas were the prairie-brushland area and the wetland units. These units were well vegetated with the highest abundance of native plants in the park. Invasive non-native plants were still present, and there are opportunities to improve plant species diversity. Restoring the prairie-brushland unit to prairie is needed in the very near future to potentially recover the prairie species that have been suppressed by the shrubs.

Three woodland areas including aspen forest, oak forest, mixed woodland (7.6 ac) and the restored prairie (PR-BR, 0.16 ac), were ranked Quality-2, indicating somewhat higher amounts of non-native, invasive plant species than Quality-1 and greater management needs.

Areas ranked as level three included the landowner encroachment area in the oak forest, the aspen forest on the southern boundary of the park, lowland forest, and seasonal wetlands (CO-MX, CO-RP, CO-WS, GR, MW, and OF, totaling 5 acres). There areas have native species present, but the high levels of invasive species and challenges with canopy tree regeneration will require significantly more management effort.

At the bottom of the ranking, Quality-4 units (6.6 ac) were those places with such a high coverage of non-native, invasive plants and so few desirable native plant species that we considered these areas to be candidates for a complete re-restoration or reconstruction. Many of these areas are planted groves of conifers or forest that has been significantly impacted by invasive species.

Each of the land cover types was evaluated to assess the management needs and target plant community. This process resulted in defining different management strategies for different areas. Using that information and incorporating the trail systems and other natural dividing lines, we defined 25 ecological management units at the site (**Figure 6, Table 2**). For each plant community type we compiled a plant species list, including relative coverages of each species (**Appendix A**). The species lists are not comprehensive but intended to identify the most common species at a unit.

FIGURE 5. Relative Habitat Quality Ranks

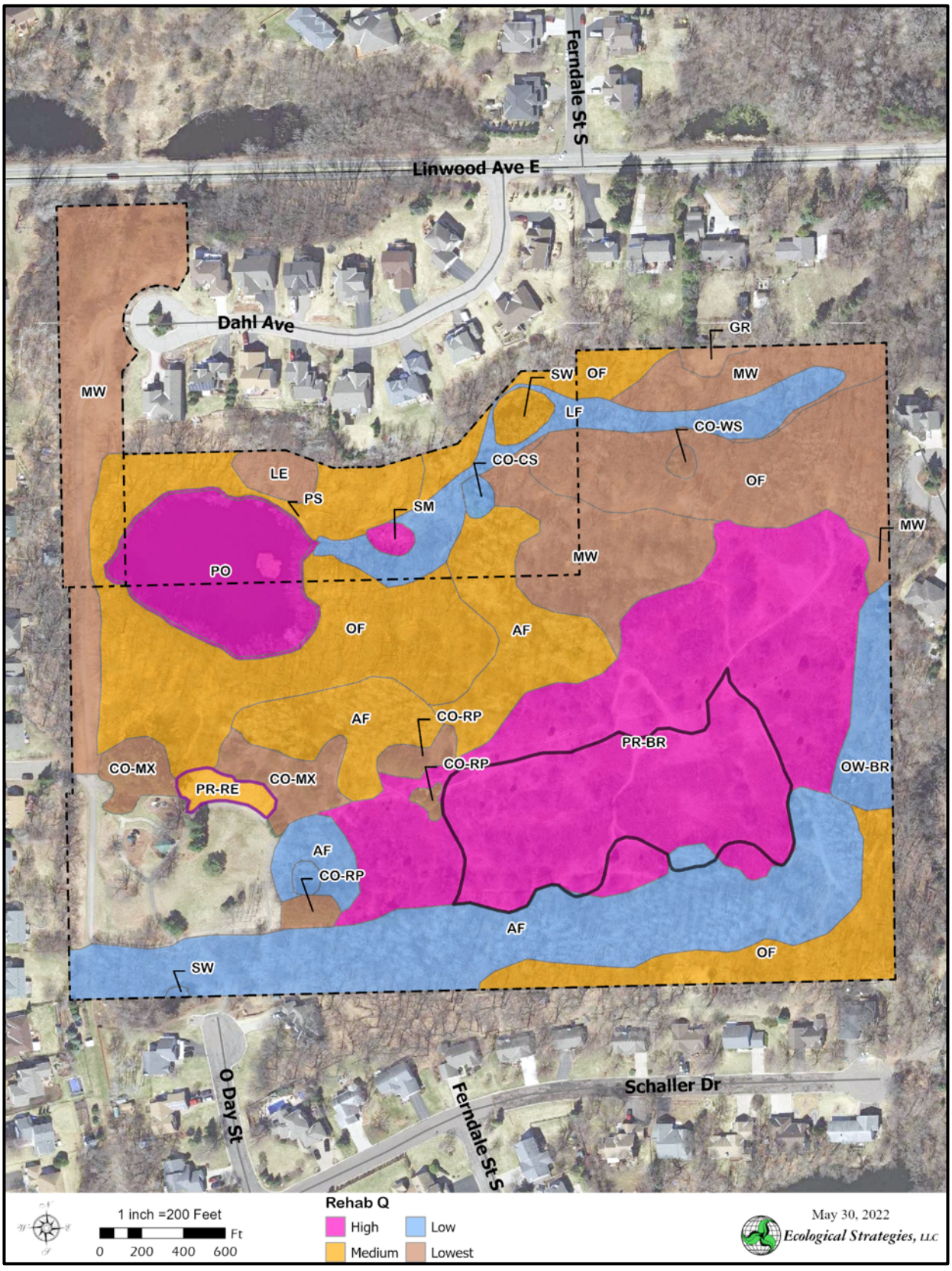


FIGURE 6. Management Units and Target Plant Communities

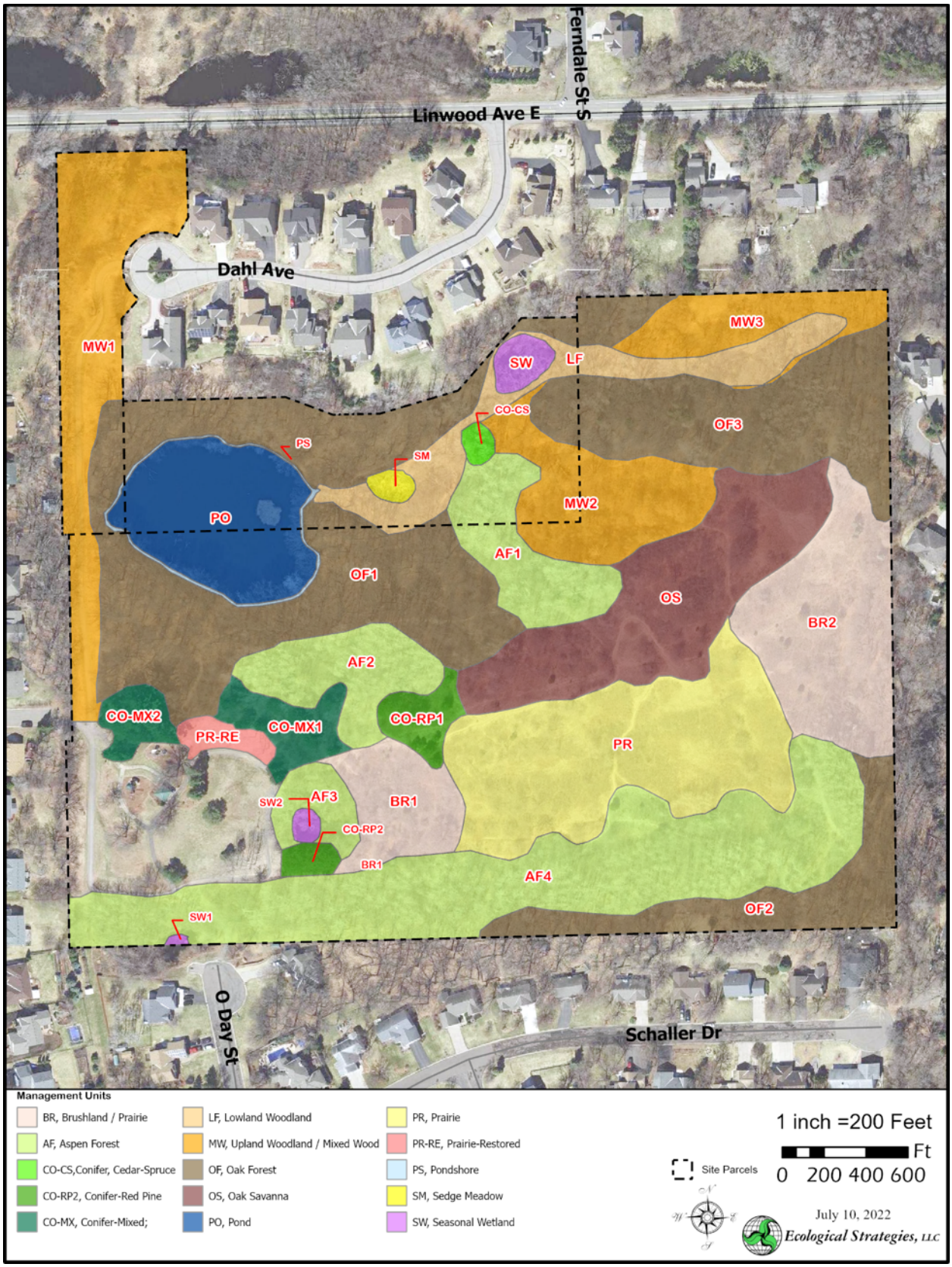


Table 2. Management Units and Target Plant Communities

GRASSLAND

MU Code	Management Unit (MU) Type	Acres	Target Plant Community
PR	Prairie	2.6	UPs23 Southern Mesic Prairie
PR-RE	Prairie-Restored	0.2	UPs23 Southern Mesic Prairie

BRUSHLAND

MU Code	Management Unit Type	Acres	Target Plant Community
BR1	Brushland-Oak Woodland	0.7	Brushland-Oak Woodland
BR2	Brushland	1.7	Brushland

SAVANNA

MU Code	Management Unit Type	Acres	Target Plant Community
OS	Oak Savanna	2.1	UPs24 Southern Mesic Savanna

WOODLAND

MU Code	Management Unit Type	Acres	Target Plant Community
Deciduous Woodland			
OF1	Oak Forest	4.1	FDs37 Southern Dry-Mesic Oak (Maple) Woodland or Mesic Hardwood Forest
OF2	Oak Forest	1.1	
OF3	Oak Forest	1.9	
AF1	Aspen Forest	0.8	Aspen Forest
AF2	Aspen Forest	0.8	
AF3	Aspen Forest	0.3	
AF4	Aspen Forest	3.7	
LF	Lowland Forest	1.0	Lowland Forest/ Southern Terrace Forest (FFs59)
MW1	Mixed Woodland	1.8	Mixed Woodland
MW2	Mixed Woodland	1.2	
MW3	Mixed Woodland	0.7	
Conifer Groves			
CO-CS	Conifer	0.1	Conifer Grove
CO-RP1	Conifer	0.3	Conifer Savanna
CO-RP2	Conifer	0.1	Conifer Grove
CO-MX1	Conifer	0.4	
CO-MX2	Conifer	0.2	

WETLAND

MU Code	Management Unit Type	Acres	Target Plant Community
PO	Pond	1.4	Palustrine Open Water
PS	Pond Shore	0.1	Pond Shore
SM	Sedge Meadow	0.1	Sedge Meadow
SW1	Seasonal Wetland	0.02	Seasonal Wetland
SW2	Seasonal Wetland	0.01	
SW3	Seasonal Wetland	0.01	

OTHER

MU Code	Management Unit Type	Acres	Target Cover Type
TR	Trails	-	Trails

SOILS AND GROUNDWATER

Site Soils

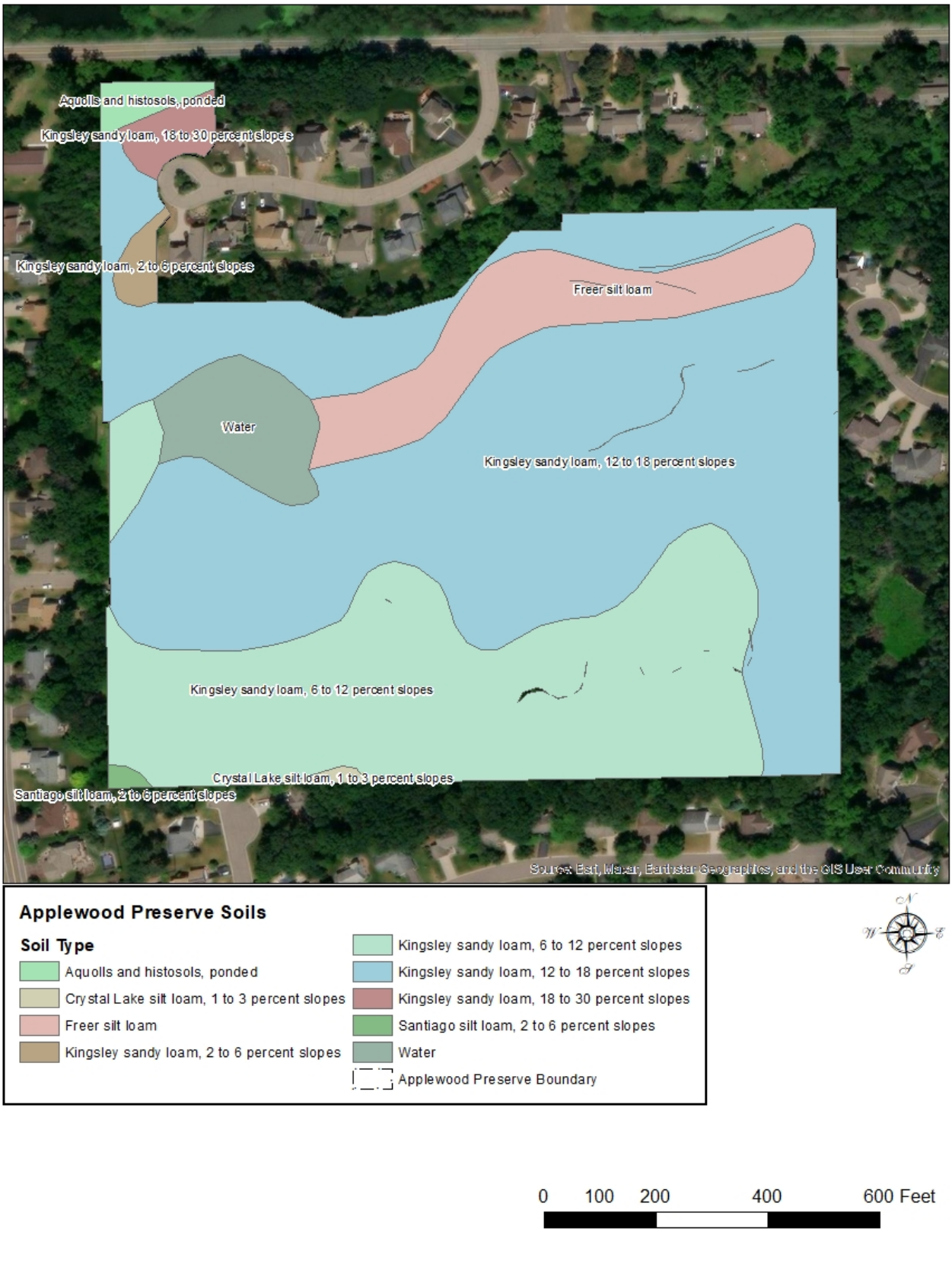
Soils within the park are largely homogenous, with Kingsley sandy loam across 25 acres of the 29-acre site. These soils are well-drained and moderately slowly permeable and present on end moraines. Kingsley sandy loams are also moderately erodible and contain 2-4% organic matter which are rated as "good" for establishment of herbaceous plants and coniferous and deciduous shrubs and trees associated with restoration.

The site's other soil types include other sandy and silty loams including Santiago silt loam, Freer silt loam, Crystal Lake silt loam. Santiago silt loam and Crystal Lake silt loam have similar characteristics to Kingsley sandy loam in that they are both well-drained and moderately slowly permeable. Crystal Lake silt loam occurs on glacial lake plains, and Santiago silt loam occurs on loess-mantled glacial uplands. Freer silt loam is somewhat poorly drained, forming in silty sediments and underlying loamy glacial till. All three of these silt loams are rated as "good" for establishment of herbaceous plants and coniferous and deciduous shrubs and trees associated with restoration.

A 0.25-acre area of ponded Aquolls and histosols are present at the northwest tip of the park. These soils consist of level, very poorly drained mineral and organic soils around waterbodies. Because the water table is high in areas of these soils, the soils support vegetation for wetland wildlife habitat.

Figure 7 below indicates the location of these soil types within the preserve.

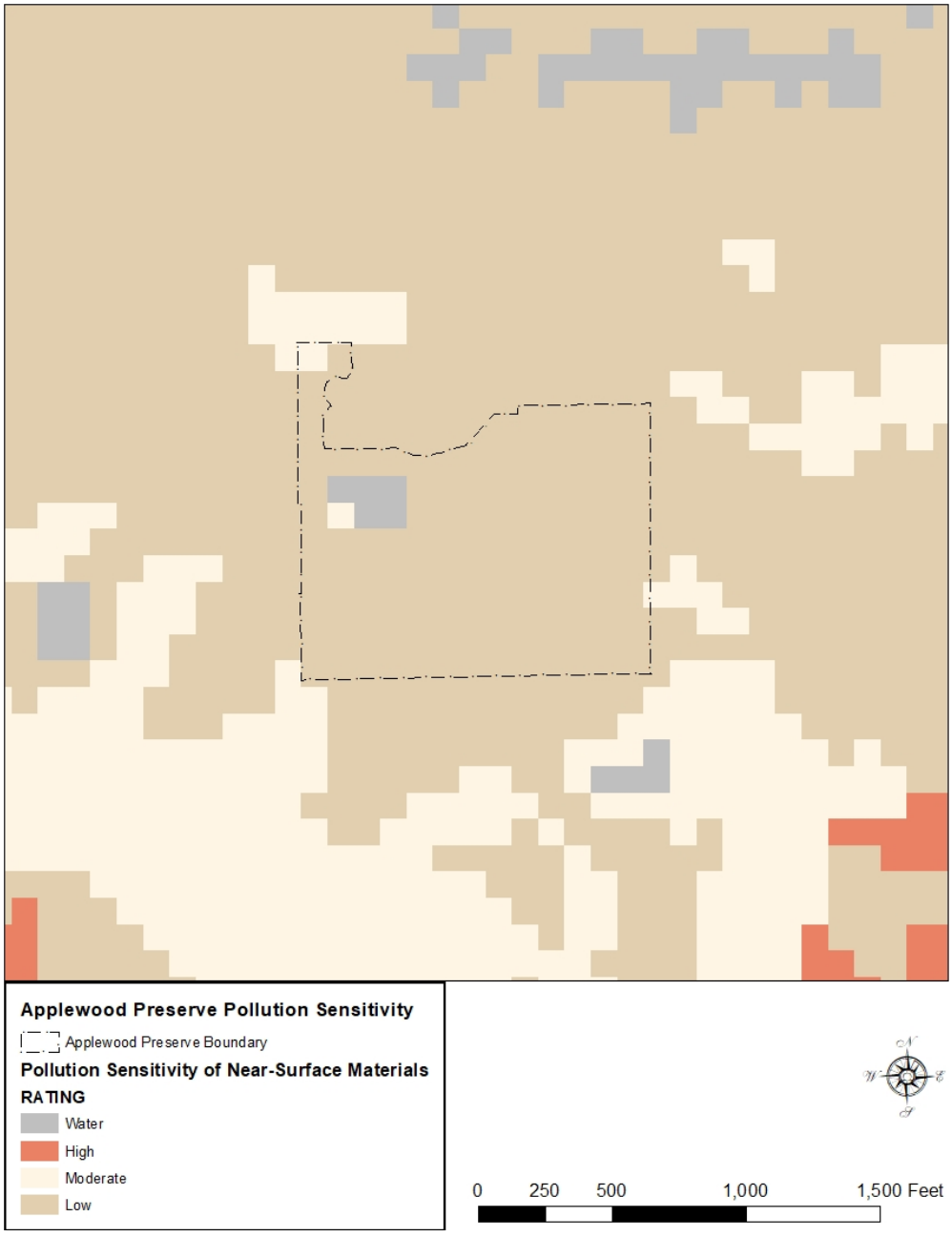
Figure 7: Applewood Preserve Soils



Groundwater Pollution Sensitivity

Tied to soil types are the site's near surface materials and depth to bedrock and how these factors affect sensitivity to groundwater pollution. Pollution sensitivity across the site is primarily low with some small areas of moderate sensitivity where silty loam soils are present and where groundwater is nearer the surface. Figure 8 below delineates the degree of pollution sensitivity.

Figure 8: Groundwater Pollution Sensitivity



GRASSLAND MANAGEMENT UNITS

Unit PR - Prairie

The Prairie management unit is a large opening in the central portion of the park and presents an excellent opportunity to restore pollinator and other important wildlife habitat. In the absence of fire, grazing, and other disturbances, woody species have proliferated, and the vegetation is now mostly patches of shrubs and scattered tree saplings. However, native grasses and forbs are hanging on within small openings between shrubs and along trail edges. This management unit is ranked as a relative quality of 1 based on the presence of these native prairie plants and because restoration to a diverse prairie is achievable.

Gray dogwood and smooth sumac are the two most common native shrub species in this unit. Non-native invasive species also occur, including common buckthorn, honeysuckle, and small Siberian peashrub. Tree species include, northern pin oak, black cherry, quaking aspen, and scattered red cedar.

Native herbaceous species that occur in openings are grasses such as big bluestem, little bluestem, and Indian grass, as well as prairie forb species such as pussytoes, showy goldenrod, and round-headed bush clover. Some species described in the 1999 Maplewood Open Space Evaluations report were not seen in the 2021-2022 site survey including leadplant, prairie cordgrass and whorled milkweed. This may indicate that increasing shrub cover has suppressed these

species. Several herbaceous invasive plants also occur in the openings between shrubs or along trail edges including crown vetch and spotted knapweed.

Restoring this prairie would offer much needed grassland bird species and pollinator habitat. Native prairie, for example, is used by 20 specialist bird species (DNR 2006). Recent research has shown that native plants also provide better habitat for native insects (Tallamy) whose populations have plummeted by up to 30 percent in the past 50 years. Many native bees, which play a critical role in pollination, have had more precipitous declines, up to 90 percent in the past 20 years

The plant community goal for this unit is to foster a species diverse UPs23 Southern Mesic Prairie with patches of native shrubs.

Management Task Overview

- Reduce tree and shrub cover by mowing and implementing prescribed fire. Leave scattered patches of native shrubs along the southern boundary, such as gray dogwood and sumac, to provide wildlife habitat connectivity between the brushland management units
- If burning and/or mowing/cutting brush in summer has not reduced woody cover sufficiently, or there is a lot of stump sprouting, use herbicide as needed to diminish woody cover.
- Use herbicide applications as needed to control invasive species such as buckthorn, honeysuckle, spotted knapweed, Canada thistle, etc.
- Inventory plant presence and abundance following woody removal and prescribed fire.
- Based on the vegetation inventory, design a seed mix that will increase overall species diversity, in particular pollinator plant abundance and diversity, and offer flowering throughout the growing season.
- Maintain grassland cover in the future by mowing and conducting prescribed fire.

Unit RP - Restored Prairie

A small prairie occurs on the slope near the park playground and picnic shelter. It may be a remnant, although overseeding was done to increase diversity at some time (personal communication with Carole Gernes). This prairie slope is in a high use area, and if forb diversity is increased, the prairie will offer wildflower and insect viewing opportunities for park visitors as well as habitat for beneficial insects. Given the presence of native species, a quality ranking of 2 was given to this area. The target plant community is UPs23 Southern Mesic Prairie.

Several species of native prairie grasses are present including little bluestem, switchgrass, and Indian grass. Scattered native forbs are also present in the prairie such as gray-headed

coneflower. Invasive species are also present such as the shrub Tatarian honeysuckle and Scots pine seedlings/saplings. Spotted knapweed also occurs on site and could quickly proliferate.

Management Task Overview

- Cut and stump treat honeysuckle and Scots pine. Thin out the woody vegetation on the edge of the prairie to facilitate future prescribed fire.
- Treat to control spotted knapweed or explore the release of knapweed biocontrol.
- Conduct prescribed burn followed by species inventory to confirm which native species are present.
- Overseed to increase overall species diversity and in particular pollinator plant abundance and diversity.
- Maintain grassland cover by mowing and conducting prescribed fire.

BRUSHLAND/SAVANNA MANAGEMENT UNITS

Unit BL1 - Brushland

Unit BL1-Brushland is located on the western end of the PR unit. Based on the historic aerial photos and information on the ecology of the region, most of what is shrubland now was likely a prairie-savanna complex at some point. The current cover is dominated by mostly native shrubs with occasional trees and non-native invasive species. The eastern side of the unit is mostly dense gray dogwood. Most understory vegetation has been shaded out and the main ground cover is moss.

On the western side of the unit there are large, old sprawling Tatarian honeysuckle shrubs and scattered buckthorn. Scattered trees are present and include apple, red cedar, box elder, green ash, and Northern pin oak.
The goal for this management unit is to develop a native species-dominated brushland cover type. Woody shrubs provide important wildlife food and cover, and while brushland was once abundant in the Midwest as part of the prairie/brushland/savanna complex, this cover type is now

extremely rare. In addition, a dense shrub cover will block residential views and noise for park visitors seeking a natural environment experience.

Management Task Overview

- Selectively remove trees from the brushland. In particular, remove trees such as green ash and boxelder or other species that are likely to be short-lived due to insect-related mortality or life-characteristics.
- Control invasive species including buckthorn and honeysuckle.
- Leave scattered red cedar for wildlife habitat, unless proliferation becomes an issue.
- Leave northern pin oak as scattered trees.
- Mow brush as needed to control tree growth. Mow in years when the adjacent prairie is not being burned. Ideally, mow on a different yearly schedule as the Brushland BR2 unit.
- Increase native species diversity by planting additional native shrub species.

Unit BL2 – Brushland

Unit BL2 is along the eastern side of the Prairie Restoration management unit. This unit is primarily covered by woody shrub species with occasional red cedar on the western side and transitioning to woodland on the eastern park boundary.

The brushland portion of the unit has similar species composition as the Prairie and Brushland management units (see sections above). At the eastern and lower slopes where brushland transitions to oak forest, there are scattered trees such as northern pin oak, quaking aspen, boxelder, white spruce and the occasional apple tree.

Management Task Overview

- Selectively remove non-native trees from the brushland. In particular, remove trees such as American elm, green ash, boxelder, or other species that are likely to be short-lived due to insect-related mortality or life-characteristics.
- Control invasive species including buckthorn and honeysuckle.
- Leave scattered red cedar for wildlife habitat, unless proliferation becomes an issue.
- Mow brush as needed to control tree growth. Mow in years when the adjacent prairie is not being burned. Ideally mow on a different yearly schedule as the Brushland BR1 unit.

Unit OS – Oak Savanna

The Oak Savanna management unit occurs as a transition area between the area targeted for prairie restoration and the large woodland blocks to the north. Several individual and clustered northern pin oak occur in this area.

The shrub, grass and forb composition in the area targeted for oak savanna restoration is similar to that in the A1 and B1 units.

Oaks provide food and habitat for many beneficial insects, birds, mammals and other wildlife. However, the high light and low competition conditions required for oak trees to successfully regenerate from seedlings are currently limited by dense shrub cover – threatening the long-term presence of shade-intolerant oak species on the landscape. Clearing to increase light levels, reducing competition from other plants, and protection from mammalian herbivores is needed to promote oak regeneration.

Given the importance of oaks and the rarity of oak savanna communities across the Midwest, the goal for this management unit will be to restore the structure and composition of mesic oak savanna (UPs24 Southern Mesic Savanna). The primary approach to restoration will be to remove woody shrubs and trees, except northern pin oaks, followed by prescribed fire and then the protection of oak seedlings from mammals. If few oak seedlings are present after clearing, seedling planting is recommended.

<u>Management Task Overview</u>

- Reduce shrub cover and any tree species other than northern pin oak or bur oak with mowing and/or forestry mulcher. Follow up with repeated mowing or herbicide as needed to control shrub sprouting.
- Target control of invasive species including buckthorn, Siberian peashrub, honeysuckle, crown vetch, as needed.
- Conduct prescribed fire in summer when it will be most damaging to woody shrubs, protect oaks from fire by weed-whipping and removing vegetation near trunks and wetting down soil and vegetation under the tree canopy.
- Inventory ground layer vegetation following shrub removal and prescribed fire
- Seed to increase overall species diversity and in particular pollinator plant abundance and diversity.

- Conduct prescribed burns when sufficient fuel has built up to control shrub encroachment.

WOODLAND MANAGEMENT UNITS

Unit OF1 - Oak Forest

The oak forest in D1 is located on the uplands surrounding the pond and along the upper slope on the north boundary of the park. Historic aerial photos show scattered large trees in this area, which are most likely some of the older, open grown oaks in the current woodland. One of the largest white oaks is 35 inches in diameter.

Canopy trees include red oak, white oak, black walnut, American elm, quaking aspen, white pine, green ash and occasional northern pin oak.

Common buckthorn is the dominant understory shrub, followed by honeysuckle species. Occasional black cherry, juneberry, green ash and paper birch were observed in the seedling and sapling layers. Very few oak seedlings or saplings are present – indicating little regeneration of oak species is occurring.

While, ground layer vegetation is not as diverse as historic oak forests, several native species are present including white snakeroot, sweet-scented bedstraw, sweet cicely, early meadow rue, spinulose wood fern, and river grape. Garlic mustard, an invasive non-native species, is also present.

The two pressing management needs in this unit are to reduce invasive species abundance and foster oak regeneration. Common buckthorn and Tatarian honeysuckle are the primary threats, although garlic mustard may proliferate in response to removal of these invasive shrub species. The other issue, which will eventually lead to the loss of oaks in the forest, is the lack of oak regeneration. Several factors could be contributing to poor regeneration including, high rates of acorn herbivory, lack of light to seedlings resulting from dense buckthorn cover and/or seedling mortality from mammalian browse.

Given the challenges with creating conditions suitable for oak regeneration, a more feasible option for the lower slope area with silt loam may be to allow the forest to transition to more shade tolerant species such as maples. Removal of invasive species and initial planting with maples will be needed as a minimum.

Management Task Overview

- Manage to maintain an oak forest plant community and increase ground layer and understory diversity.
- Control invasive species, in particular buckthorn, honeysuckle and garlic mustard.
- Create canopy openings to foster oak regeneration by cutting and removing selected trees in patches.
- Conduct ground layer fires.
- Plant oaks and native shrubs and protect from browse and maintain canopy openings until established.

Unit OF2 - Oak Forest

The oak forest in D2 is located in the southeastern portion of the park along the park boundary.

Canopy trees include red oak, white oak, American elm, quaking aspen, green ash, northern pin oak, and black cherry. No oak seedlings or saplings were observed.

Common buckthorn is dominant in the understory, with scattered Tatarian honeysuckle, and occasional gray dogwood. Scattered black cherry and quaking aspen saplings are also present.

The ground layer vegetation is sparse and includes native species such as white snakeroot, pointed-leaf tick-trefoil, Canada goldenrod, western poison ivy and Pennsylvania sedge. Several non-native understory species are also present including garlic mustard, common dandelion, and burdock.

Similar to the OF1 management unit, the primary threats to maintaining this oak forest are invasive species and oak regeneration. Given the relatively small size and narrow shape of this unit, and that the forest borders residential properties where landowner's sight lines will be

impacted by any significant canopy removal, managing the site to allow a shift to shade tolerant species is the most realistic goal.

Management Task Overview

- Reduce invasive species abundance
- Allow oak trees to die out over time and be replaced by native, shade tolerant trees or create canopy openings necessary to regenerate oak.
- Monitor for oak wilt and treat/control spread as needed.

Unit OF3 - Oak Forest

Just south of the deep ravine in the northeastern portion of the park is the third oak forest management unit. The forest occurs on the flatter ridge tops and continues down much of the slope to the ravine. While this part of the forest also has patches of quaking aspen and other hardwoods, the target communities and management will focus on oak regeneration or conversion to mesic hardwoods. The management is similar to the other two oak forest units.

Canopy trees include red oak, white oak, American elm, quaking aspen, green ash and northern pin oak, and black cherry. Paper birch is common in the northeastern portion of the unit. No oak seedlings or saplings were observed.

Common buckthorn is dominant in the understory with scattered honeysuckle and occasional black cherry, green ash, and aspen saplings also present.

On the moist, shaded north slope, the ground layer vegetation includes early meadow rue, sweet cicely, bunchberry, and dwarf raspberry. On the drier, upper slopes, common understory plants are white snakeroot, fragrant bedstraw, downy agrimony, and Pennsylvania sedge. Garlic mustard occurs in the understory, as well.

Similar to the other oak forest management units, the primary threats to maintaining this forest are invasive species and lack of canopy tree regeneration. Where possible, the priority for management should be to foster oak regeneration. This could be accomplished by including areas adjacent to the oak savanna management unit in prescribed fire management, creating canopy

openings by removing patches of trees or short-lived trees around selected oak seedlings and saplings. Allowing the forest along the north slope to shift to shade tolerant species will likely be the most feasible management alternative.

Management Task Overview

- Reduce invasive species abundance
- Remove declining and short-lived trees, such as mature quaking aspen and boxelder, dying green ash, etc. to create openings around existing or planted oak seedlings/saplings.
- Monitor for oak wilt and treat/control spread as needed.
- Conduct prescribed fire as feasible, especially through upper-slope areas adjacent to oak savanna.

Units AF1-4 - Aspen Forest

Four areas in the park have a high cover of aspen and are targeted to be managed as aspen forest. The composition of the aspen forests is similar throughout the site. Quaking aspen is the dominant tree, with occasional northern pin, red, white and/or bur oaks, black cherry, and green ash.

Similar to other woodlands in the park, the understory has a high cover of invasive woody shrubs including buckthorn, both as seedlings and saplings, and honeysuckle.

The primary threats to the aspen forest are invasive species and canopy tree regeneration. Aspen trees require open, sunny areas for seedlings and saplings to grow. Therefore, the elimination of the dense invasive cover of woody plants and creating canopy openings will be needed. Canopy openings could be created by cutting patches of aspen and removing most of the cut material.

Most stumps will resprout with new stems. These resprouts provide important winter food for browsing mammals in winter.

The target community is an aspen forest with native understory and ground layer. Given the level of invasive species infestation, the goal will be to establish competitive native species versus attempting to restore high diversity.

Management Task Overview

- Removal and herbicide treatment to reduce invasive woody and herbaceous species.
- Cut and remove aspen boles and/or use forestry mulcher to regenerate aspen in selected management units. Create openings to create canopy openings needed for aspen to thrive.
- Seed or plant native understory shrubs and forbs once invasive species have been reduced.

Unit LF – Lowland Forest

Lowland forest (LF) occurs in the ravine that runs from the northeastern part of the park to the pond. The somewhat poorly drained and wetter soils here provide habitat for cottonwood, and several large trees are growing near the seasonal wetland (SW). Boxelder is common, with the occasional black walnut. Native plants in the understory include enchanter's nightshade, wood nettle, white avens, sweet-scented bedstraw and lady fern.

Similar to other forested areas in the park, the understory is dominated by buckthorn and honeysuckle, and garlic mustard dominates the ground layer.

The target community type for restoration is a FFs59 Southern Terrace Forest.

The main threats to this community are invasive species, lack of canopy regeneration, and subsequent erosion from severe rain storm events.

Management Task Overview

- Control invasive species
- Increase understory diversity by planting native species.
- Evaluate any stormwater runoff issues. As needed, protect against storm water erosion with bioengineering methods to stabilize slopes and slow water runoff.

Unit MW1 -3– Mixed Woodland

Three areas within the park have vegetation composition that is disturbed to the extent that it is not possible to apply a native plant classification. These are near the north park entrance and access trail (MW1), in a steep sloped area near the core or the northern forest area (MW2), and along the slope in the north-east part of the park. The invasive shrub cover in the MW – Mixed Woodland units is some of the densest in the park. For this reason, these areas are ranked as a low priority for management because of the significant resources required to restore native plant composition and structure.

The MW1 management unit, which includes the north park entrance and runs along the access trail on the west side of the park, has both wooded and open areas. The wooded portion is a mix of quaking aspen, red pine, black walnut, cottonwood, and Norway spruce. The understory is weedy with honeysuckle and buckthorn in the wooded shrub layer areas, and garlic mustard, thistle species, and mugwort in the ground layer and/or canopy openings.

MW1 area – park entrance and trail head

Dumping of yard waste is occurring near the entrance (MW2) and may contain weed seed or other propagules.

Dumping near the north park entrance.

MW2 area – northern forest core

In the MW2 area, tree and understory layers are sparse – likely because of the dense patches of invasive buckthorn, honeysuckle and Siberian peashrub. Occasional boxelder, paper birch, quaking aspen and black cherry trees also occur. Occasional native shrubs are present including red osier dogwood and gooseberry. Similarly, some native ground layer plants occur, mostly as individuals or small patches such as lady fern and Jack-in-the-pulpit. Garlic mustard is also present in the understory and is a high priority for control to prevent further spread even if comprehensive management of the unit is deprioritized.

The vegetation is sparser in the MW3 area, which is on the northern boundary of the park, along a south facing slope. In addition, there is a small grassy clearing that appears to have been created by adjacent landowners. The clearing offers a sunlit location to establish a few oak trees.

<u>Management Task Overview</u>

- Control invasive species including buckthorn, honeysuckle, garlic mustard, non-native thistles, mugwort, and other invasive species that might appear.
- Once invasive species are under control, increase understory native shrub diversity by planting native shrubs and native grasses and forbs that are good competitors.
- Establish dense native grass cover along the trail edges to help control weeds.

- Larger canopy openings created by invasive species removal could also be good sites to establish oaks.
- Encourage residents and others to stop dumping over the slope.

CO and CS – Conifer Grove Units

Five small conifer groves occur in the park, and the presence of large white cedar and Norway spruce suggest that the groves may have been planted at a former homesite or other human use feature.

There are two patches of predominantly red pines, CO-RP1 and CO-RP2. The other two areas with conifers (CO-MX1, CO-MX2) have mixed evergreen species, including white and Scots pine.

Understory vegetation is generally sparse, likely due to heavy shade from the tree canopy. Species observed under conifers include rue anemone, lady fern, Virginia creeper and a *Pyrola* species.

The cedar-spruce grove (CO-CS) occurs in the north-central part of the park on Freer silt loam soil which is somewhat poorly drained. The grove is primarily one large Norway spruce and white cedar clump that may have been planted at some point.

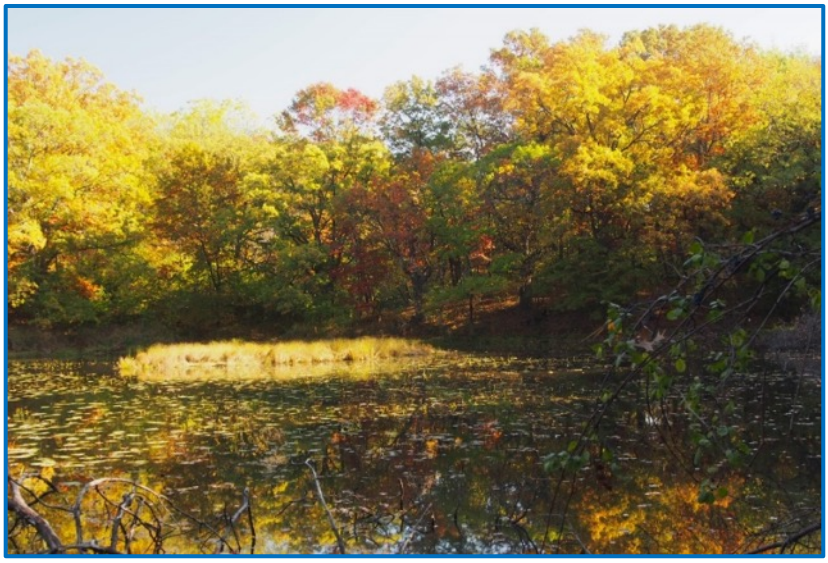
The primary management activity recommended for the conifer groves is to allow them to grow to maturity and after death, provide snags for wildlife habitat. Where resources permit, management to reduce the impacts from insect pests and diseases is recommended. To provide varied habitat and facilitate prescribed fire management, the red pine grove adjacent to the prairie and oak savanna, CO-RP1, could be managed as a pine savanna.

Management Task Overview

- Allow trees to mature and remain standing after senescence to provide wildlife habitat.
- Control invasive species.
- Manage to reduce incidence of insects and disease, such as pruning to reduce incidence and severity of white pine blister rust or pine bark beetle.
- Remove any Scots pine seedlings or saplings.
- Manage CO-RP1, adjacent to the prairie, as a pine savanna.
    - Thin conifers and reduce understory woody vegetation. Limb up lower branches and thin pines as needed to create canopy openings.
    - Manage with prescribed fire to create pine savanna-like patch
    - Encourage ground layer prairie species from adjacent cover types to colonize under in openings between the pines.

WETLAND MANAGEMENT UNITS

Unit PO –Pond



A large, shallow pond is located in the northwestern portion of the park within the oak forest. It is classified as a palustrine open water wetland. There is a small grassy island on the east side and white water lily and other emergent or submergent aquatic plants are common.

Maintaining water quality is essential for the health of the wetland. Potential impacts to water quality come from yard waste dumping, pet waste, lawn chemicals, car washing and other upslope activities by adjacent landowners. In addition, any construction or activities that expose soil upslope and where heavy rains could wash soil into the wetland are also a threat to the health of the pond.

Management Task Overview

- Encourage landowners upslope from the pond to avoid the use of fertilizers, clean up pet waste, and compost yard waste rather than dumping it.

- Employ practices to eliminate soil runoff during any construction activities.
- Close any unofficial trails or pond access areas that could result in soil erosion into the pond.

Unit PS – Pond Shore

The perimeter of the pond is habitat for specialized plant species and important wildlife. Plants adapted to fluctuating water levels, mud flats and shallow water occur in this zone.

Nodding bur-marigold, marsh skullcap, stinging nettle, and clearweed are examples of forb species found in this zone. Grass plants include rice cutgrass, blue joint, and sedge (*Carex*) species.

Threats to this habitat are siltation from soil erosion upslope, invasive species, and trampling or erosion from park users.

Management Task Overview

- Close any unofficial trails or pond access areas that could result in trampling of the sensitive shoreline.
- Monitor for invasive species that may be introduced by stormwater.
- Educate and encourage property owners upslope to avoid soil runoff.

Unit SW1 and 2 – Seasonal Wetlands

SW1 seasonal wetland, located east of the playground, serves as a stormwater pond. It has mostly weedy species such as motherwort, burdock, and reed canary grass, but with native plants such as silver maple and *Carex* species. The presence of sand suggests that snow from the nearby road is plowed onto the bank above the pond.

A small, seasonal wetland, SW2, occurs in a low spot within the Lowland Forest area. There was no surface water in the fall of 2021 when the site survey was conducted. However, rainfall in 2021was below normal, and the wetland may have standing water later into the season in a wetter year.

The vegetation was sparse at the time of the survey and included patches of greater bladder sedge, mad-dog skullcap, tall thistle, and smartweed species. The area was filled with water in the spring of 2022 so efforts to characterize the vegetation further would need to happen after water levels drop.

<u>Management Task Overview</u>

- Control reed canary grass and other invasive species in the seasonal wetland near the Lowland Forest management unit.
- Robust native species could be added to the edges of the pond to increase plant diversity.
- Avoid plowing or dumping snow with salt near or into the stormwater basin.

Unit SM – Sedge Meadow

Unit K is a low wet area dominated by wide-leaved sedges – hence the classification as a sedge meadow. The most common sedge is lake sedge. Forbs such as clearweed, willow herb and sensitive fern occur mostly on the edges of the meadow.

Threats to this wetland include invasion by reed canary grass, and around the perimeter of the wetland on drier soils is a dense wall of buckthorn. While buckthorn is unlikely to invade the meadow area, it has reduced the diversity of plants that would typically occur along wetland edges.

Management Task Overview

- Control invasive species including reed canary grass, especially when infestations are small.
- Cut and treat perimeter shrubs as needed to create habitat for wetland perimeter plant species.
- Use prescribed fire as feasible to control woody encroachment and reduce RCG.

OTHER MANAGEMENT UNITS

Unit TR – Trails

Designated trails loop throughout the park to allow visitor access. Trails have been re-routed and water bars installed to reduce soil erosion. The disturbance on the edges of the trails creates conditions that allow invasive species to colonize, proliferate and be transported throughout the park.

The disturbance associated with trail edges often results in conditions conducive to weed invasion. Invasive or weedy species observed along trail edges include crown vetch, Canada thistle, birds-foot trefoil, dandelion, and Queen Anne's lace.

The trail running down slope along the eastern part of the park (image to right) is eroding. With heavy rain events this erosion could become more severe.

Management Task Overview

- Educate local landowners about the importance of cleaning shoes and boots before hiking in the park.
- Control invasive species and weeds on the edges of trails.
- Monitor for new weed infestations.
- Plant trail edges with prairie grass and other competitive native species to reduce erosion and protect against invasive species colonization.
- Address erosion issues early to prevent more damage.
- Consider changing the trail alignment on the eastern park side to include curves and other features to slow runoff or add water bars to direct the flow.
- Close any informal trails, especially in sensitive areas such as along the pond shore or through the prairies.

ECOLOGICAL MANAGEMENT RECOMMENDATIONS

RESTORATION GOALS

The main goals for this site will be to create more diverse, healthy habitats that support wildlife and overall ecosystem health. The second goal will be to improve the units for human visitors, including by providing aesthetic beauty and the ability to passively recreate in the units, as well as incorporating species that recognize and honor the Dakota people, who stewarded this region in the past. Healthy ecosystems will support a variety of wildlife and will provide a number of ecosystem services including water retention and filtration.

Toward achieving these goals, restoration will aim to improve the diversity, composition, and structure of the plant communities throughout the property, which will also better reflect what would have been present prior to colonization. This includes improving habitats (prairie and forest) that have been historically decimated throughout the state. It does not, however, mean the clock will be turned back to 1840. Some plant communities have progressed too far past that historical condition. Rather, existing conditions will be enhanced to the greatest extent possible to improve the ecological functions, including:

- habitat for a diversity of wildlife species
- nutrient and water cycling
- carbon storage
- moderation of water-table levels
- erosion control
- filtration of nutrients, sediments, and pollutants
- development and enrichment of soils
- local temperature moderation
- food and healing resources for both people and wildlife

Though degraded by past uses, the existing plant cover retains many native species and can be readily improved. A healthy and diverse plant community can provide much greater wildlife value than a degraded one and tends to be much more stable and less susceptible to disease, invasive species, and other disturbances. Moreover, a diverse, healthy plant community will contain more species that are culturally important and provide resources that support and nurture human life.

Management recommendations were developed for each land cover area, with the overall objectives for the property focused on protecting and restoring high quality habitat by removing invasive plant species, restoring prairie, and providing pollinator and wildlife habitat. Specific goals include the following, and should be attained by the fifth year of the restoration process:

1) Reduce invasive woody stems over ½ inch diameter to <5% in treated units.

2) Restore grassland units to prairie and obtain 80% coverage of native, non-woody species.

3) Improve pollinator habitat in the prairie restorations by including a diversity of forb species, with pollinator plants having at least 40% coverage in the prairie.

4) Increase native plant diversity in the forest areas by successfully establishing native herbaceous and woody plants.

Overall management practices to achieve those goals are:

- remove non-native, invasive, woody species
- control non-native, invasive herbaceous species
- remove or thin out native woody species encroaching on restoration areas
- restore ground layer and shrub layer diversity in prairie and woodland areas
- conduct periodic prescribed burning to maintain prairie and woodland vegetation and reduce invasive shrubs and overabundant tree seedlings
- foster the regeneration of key canopy trees, especially oak species
- monitor annually for potential erosion, as well as for non-native invasive woody and herbaceous species
- consider adding climate adapted tree species to improve the overall resiliency of the forested unit
- institute a monitoring plan to track effectiveness of management and restoration activities
- explore other opportunities to create wildlife habitat, including but not limited to snake hibernaculums, osprey towers, turle nesting habitat etc.

In the above priorities, attention should be paid to incorporating native plant species that honor the cultural significance of the site. Many native prairie and forest plants that will be important for their ecological benefits also have cultural importance for the Dakota and larger Indigenous communities. In Dakota and other Native cultures, many prairie and forest plant species are used for medicinal and ceremonial purposes, while others are harvested for food or revered for their cultural and spiritual significance. Intentionally including these species will honor the site's native history and help the restoration better reflect pre-colonization vegetation while simultaneously highlighting that Dakota culture and traditions are still a part of our community. Including these species at the site may also allow for Native communities to participate in foraging and harvesting for a variety of uses and is an opportunity for the City of Maplewood to encourage and educate parkgoers on these practices and the cultural history of the area.

RESTORATION PROCESS

Restoration is a long-term process. It takes time to restore ecosystems to their former functionality and diversity. Sometimes these systems can only be approximated. It took many decades to degrade the ecosystem and biological communities on site, so it will not be restored overnight. Many steps are typically involved in a successful restoration; even deciding when a restoration is complete/successful can be very difficult. Restoration should be viewed as a process not a state of being. The goal is to achieve and maintain a diverse natural community at the site, though this will not always proceed in a linear fashion. Using the concept of *adaptive management* will be key to continual progress at the site. Adaptive management is a strategy commonly used by land managers and integrates thought and action into the restoration process. It can be described as a strategy that uses evaluation, reflection, communication, and incorporates learning into planning and management. It is set up like a feedback loop and looks like this: Assess Problem → Design → Implement → Monitor → Evaluate → Adjust → Assess Problem → and so forth. Thus, moving forward with restoration, each round of adaptive management refines and hones the process to better fit the conditions of the site. This strategy should be emphasized at the sanctuary.

Given the many small units and the overall layout of the property, restoration of the site will be difficult. Access to some of the units is challenging, and the varied topography will necessitate care and patience. Restoring and maintaining any site takes dedicated time and effort. However, the location of these units away from direct sources of propagules means that restoration may be less hampered by the cycle of continual reinvasion that plagues many sites. Engaging neighbors in the importance of restoration on their lands will not only help the restoration on the property be more successful - as it will reduce the potential seed source of non-native invasive plants - but will also increase the size of natural communities being protected and managed in the area.

The restoration of the biological communities at Applewood Preserve will be broken into phases. Each phase will address the restoration of a given target plant community. Restoration tasks will also be prioritized, with the most important resources or vital areas taking precedence. However, restoration will ultimately be conducted based on available funds and resources and may not occur sequentially or as prioritized.

Recommended methods for controlling specific invasive and herbaceous plants are described in **Appendix C.** Specific methods for protecting pollinators and minimizing negative impacts of restoration and management practices are described in **Appendix D.** Considerations for current and future ecological concerns are described in **Appendix E**.

RESTORATION AND MANAGEMENT PRIORITIES

Priorities for restoration and management are based on the current quality of the site, ease, and cost effectiveness of conducting tasks and potential for achieving goals.

On this site, removal of woody invasive plants throughout the property is the highest priority. Without this crucial step, the forests will continue to lose diversity and the future prairie restorations will be consistently plagued by re-invasion. Prioritizing invasive removal will lead to better results in subsequent restoration tasks. The second priority is restoring and improving prairie habitat in the current grassland areas of the property. Prairie is a rare and vulnerable plant community and increasing its presence on the landscape is an important goal which will provide much needed pollinator habitat. All priorities will help to accomplish the main goal of increasing wildlife and pollinator habitat throughout the property.

Management Recommendations for each Management Unit, based on the priority for restoration, are described in the following sections. Restoration priorities were assigned to each Management Unit based on:

- Relative quality of the existing vegetation
- Feasibility and cost effectiveness of restoration
- Potential wildlife benefits from restoration

PRIORITY 1: Prairie restoration

- Grassland restoration will offer significant habitat and water quality benefits. Because of the rarity of this habitat in the state, and its provision of important pollinator and wildlife habitat, restoration of the grassland units is an important priority.

PRIORITY 2: Oak Forest

- Protect existing oaks by eliminating invasive species and potentially encouraging regeneration.
- Oak woodland/forest is threatened by oak insects and diseases including oak wilt and lack of regeneration. Priority is to keep acorn-producing oaks on the landscape. Understory and canopy tree regeneration is threatened by invasive species. Control invasive species to protect understory diversity and prevent further changes to soil.

PRIORITY 3: Sedge Meadow

- Minimal invasive species monitoring and control is needed to maintain current habitat quality.
- Opportunity to increase wetland plant diversity and animal habitat.

GRASSLAND MANAGEMENT UNITS

Unit PR – Prairie

Initially, the primary approach to restoration of the Prairie unit will be the reduction of woody plant cover and invasive species control. Once these objectives have been attained, the next steps will be to conduct prescribed fire and augment native diversity as needed. Selected clumps of native shrubs, in particular gray dogwood and sumac should be left in patches for wildlife habitat along the southern border and adjacent to the aspen forest. If repeated mowing does not sufficiently reduce shrub cover, it may be necessary to treat with herbicide. Any herbicide use should be done with caution to prevent damage to nearby native prairie plants.

Overview of restoration tasks:
Year 1

- Use forestry mower to cut and mulch woody plants or cut with a brush mower. Cut mid-spring (late May) and again in the fall (around mid-October) during the first season to deplete reserves.
- Aim to reduce woody cover by 90%. Leave clumps of native shrubs, primarily along the southern area of the unit and scattered west to east to provide habitat connectivity between the two Brushland management unit patches.
- Spot spray or use wick applicator to treat invasive herbaceous species, including spotted knapweed and Canada thistle, especially in openings and along trails.

Year 2

- Treat any resprouting woody species with a foliar or basal bark application of herbicide with appropriate herbicide, e.g., Triclopyr (Garlon 4), Picloram (Tordon), and glyphosate (Roundup) depending on species to be controlled (see Appendix C). Treat when newly sprouting and low to the ground to help avoid overspray onto surrounding plants.
- Spot spray or use wick applicator to treat invasive herbaceous species, especially in openings and along trails. In all cases, a top priority will be to prevent seed production of the targeted plants. Spot-mowing, therefore, is an inherent step to be included as needed when other control methods are not effective or not feasible. Milestone or Transline can be applied to target the legumes and some of the other forbs (e.g., crown vetch, trefoil, butter and eggs, thistles, knapweed) and a broad-spectrum herbicide such as glyphosate can be used to target the grasses and some of the other forbs such as mugwort.
- If sufficient fuels are present, conduct a prescribed burn in the spring (first preference) or fall.

- If smooth brome and Kentucky bluegrass are at high abundances spray with a grass specific herbicide, such as sethoxydim, at a time of year when native warm season grasses are dormant (**Appendix C**).
- Inventory species diversity and develop a seed and/or planting mix to augment plant diversity. Plant as dormant seeding in fall if site preparation is completed. Wait at least a week after applying glyphosate before seeding, longer if feasible. Sow seed of dry prairie species at the top of the slopes and mesic prairie species on the lower slopes (**Appendix B**).

Year 3

- Mow to 6-8" tall in order keep competing vegetation less than 12-15" tall, typically about 2-3 times per growing season.

Unit RP- Restored Prairie

The management focus for the Restored Prairie will be to eliminate or reduce the abundance if invasive species, burn or mow to reduce thatch and increase native species diversity.

Year 1

- Cut, pull and/or spot spray invasive species such as Scots pine, honeysuckle, knapweed, crown vetch, birds-foot trefoil and burdock. Control when actively growing but before seeds form. If cut, treat honeysuckle stumps to prevent sprouting.
- Keep woody species from proliferating in the prairie by mowing in the spring and/or fall.
- Conduct a prescribed fire in the fall.

Year 2

- Inventory to see how native and non-native species responded to the prescribed burn.
- Use light harrowing to prepare site for seeding.
- Broadcast seed to augment species diversity in fall and/or plant plugs, especially forb species, as a volunteer activity. Plants should be installed in early fall when temperatures are lower and less stressful for transplants. Water plugs thoroughly at the time of planting, then mulch with grass (native grass straw is ideal) or clean straw (no weed seeds).

Year 3

- Mow 2-3 times during the growing season to prevent weed species from maturing and to reduce competition to first year prairie plants.

- Minimize other activities on the site and spraying for weeds year to prevent damage to new plants.

Unit BR1, BR2 - Brushland

The main management tasks in the Brushland Units will be removing all trees except northern pin or bur oak, controlling invasive species, in particular buckthorn and honeysuckle, and increasing native shrub diversity.

Year 1

- In spring (May), cut and stump treat invasive shrub species and any tree species except northern pin or bur oak. Reduce or totally remove all red cedar in Brushland Unit 1 (no stump treating necessary).
- Treat buckthorn and honeysuckle stumps to prevent resprouting.

Year 2

- Monitor for invasive species and cut and/or spray as needed. The canopy openings created by shrub removal may foster ground layer invasive species.

Year 3

- Plant native shrubs to increase diversity including chokecherry, American hazelnut, low juneberry, Saskatoon, prairie rose and wolfberry. Plant lower stature/less competitive shrub species on edges of trails or grassy openings.

Unit OS - Oak Savanna

Restoring oak savanna will help create sunny conditions conducive to oak regeneration and create habitat for grasses and forbs that thrive in partially shaded conditions. Restoration of savanna structure will require an initial investment of resources in woody shrub and tree removal. Once the savanna structure is restored, prescribed fire can be used to maintain the community. If species diversity is slow to recover, characteristic species of grasses and forbs could be sown from seed or planted using plugs.

Year 1

- In spring, cut and stump treat (as needed) invasive tree and shrub species, and any native tree species, except northern pin and bur oak. Mark oak seedlings and protect from mowing, fire, and browse.
- Avoid disturbing the soil to protect native plants present and reduce the likelihood of invasive plant proliferation.

Year 2

- If sufficient fuels are present conduct a prescribed burn. If there are patches of oak seedlings/saplings less than 2" diameter, protect from fire by precutting and removing vegetation with a weed whip and leaf blower, and watering down a 10' diameter ring around each tree.
- Burn in alternate years with Brushland management units if cost effective and logistically feasible.

Year 3

- Assess whether native grasses and forbs are present and proliferating in the ground layer. If not, augment by seeding. Prepare for seeding by harrowing, or similar method, and broadcast seed in spring.
- Mow as needed to control weeds and establish desirable native prairie species.

Long-term Maintenance

For all grassland units, long-term management will be needed to maintain the plant communities. Regular monitoring and spot-treating or spot-mowing will be needed. A rotating burn schedule should be set up to burn approximately every three years, though frequency may vary depending on site conditions and objectives. Typically, it is best to burn no more than half of the grassland in any year, to keep refugia for pollinators and other insects. However, at a site this small that may not be possible.

The timing of burns should be alternated for each unit between spring and fall as much as possible, to avoid always benefitting or harming the same species. Fall burns tend to favor forbs, spring burns tend to favor grasses.

Additionally, summer burns could be done occasionally, if possible. Summer burns are especially effective at reducing woody plants, much more so than at any other season.

Mowing can be used as an alternative to burning and is especially useful for reducing Canada goldenrod. For that purpose, the mowing should be done early to mid-August, when the goldenrod is about to flower. This should be repeated two consecutive years where the goldenrod is a problem.

Another alternative to burns and mowing would be grazing. Grazing animals were very important components of native prairies and are now virtually absent. To the extent possible, periodically bringing sheep or other grazing animals to the site could be very beneficial. Sheep are grass grazers whereas goats, for example, eat more forbs so the animal selected would depend on the objective for the unit.

Monitoring and Community Engagement

The entire park will require regular monitoring, at least monthly during the growing season, to address the weed issues and adjust strategies based on observed results, i.e., the adaptive management process. The frequency of monitoring may decrease over time as control is gained and as more knowledge is gathered on timing needs of management. It may be beneficial to set up vegetation survey plots (e.g., Relevé) or to use other quantitative vegetation survey methods to better track the progress of the site and the plant diversity. Keeping detailed records of management activities and results will also be extremely important to inform future steps.

In addition to monitoring plant communities, it would be beneficial to monitor wildlife species. Birds and pollinators are two groups of animals that are relatively easily seen and for which there are good monitoring protocols established. Both types of surveys could also be done by volunteers, with some training.
The restoration activities provide opportunities for community participation including installing and monitoring plantings, removal of invasive woody and herbaceous plants, photography, and surveying plants and animals. Some examples of community science opportunities that FMR has used with volunteers are the Xerces Society protocols for monitoring pollinators (*Upper Midwest Citizen Science Monitoring Guide-Native Bees*) and the monarch larva monitoring project with Monarch Joint Venture (https://monarchjointventure.org/mlmp).

WOODLAND UNITS

Unit OF1-3 – Oak Forest

- Control invasives species including buckthorn, honeysuckle, garlic mustard
- Cut and remove brush from site or spread woodchips to add organic matter. Breakdown of woodchips will tie up nitrogen during the decomposition process which may help offset effects of buckthorn impacts to soil chemistry.
- Conduct invasive species control when native ground-layer plants are actively growing to reduce damaging desirable plants.
- Stump treat after cutting or foliar treat later after resprouting.
- For smaller diameter woody invasive species, a basal bark treatment may be quicker and more cost effective.
- Install native shrubs and trees to add diversity and structure once invasive plants are well controlled. Plant shade tolerant tree and shrub species (Appendix A) unless canopy openings are available. Establish oaks in canopy openings and protect from browse.
- Native wildflowers, grasses, and sedges can be added by both seeding and planting.

- For areas where oak woodland/forest is the target community, conduct ground layer prescribed fires when and where feasible. One area to consider is where OF1 – oak forest is adjacent to oak savanna and where the trail can serve as one of the fire breaks.

Unit AF1-4 – Aspen Forest

- Control invasive species, especially buckthorn and honeysuckle.
- Create canopy openings approximately ¼ acre in size by cutting and removing trees to regenerate aspen. Opportunities to create canopy openings could include removal of dead green ash (resulting from emerald ash borer), or removal of dead and declining aspen. Removal of younger aspen will likely result in vegetative regeneration by resprouting. Old aspen removal my require replanting openings with desirable native species. For larger openings, replant with oak species.

Unit LH – Lowland Hardwood Forest

- Monitor for and control invasive species including buckthorn, honeysuckle, and garlic mustard.
- Increase species diversity by adding native shrubs such as chokecherry, nannyberry, and gooseberry species.
- Plant cottonwood trees, 5-6’ whips, and protect from mammalian browse.

Unit MW – Mixed Woodland

- Monitor for and control invasive species
- Plant desirable species in canopy openings. Native trees and shrubs. Try installing native shrubs in dense clusters with thick mulch and maintain with herbicide to foster establishment.
- Plant oaks in areas with good sunlight and where trees can be protected with fencing from mammalian browse.

Units CO – Conifer Groves

In the short-term, little management is recommended for the conifer groves other than pruning to protect tree health and removal of non-native conifer seedlings and saplings. The trees can be allowed to mature and left standing after senescence to provide wildlife habitat. Controlling invasive species in the understory is also a goal for these units.

- Thin trees in CO-RP1 and RP2. Select the trees with the poorest form and heath and remove about half of the trees in the stands. Prune lower limbs to allow better access into the groves and in the case of RP1, create a structure that will allow prescribe fire to be run through the understory.
- Eventual removal of all Scots pine and replacement with white pine seedlings in CO-MX2 would improve wildlife habitat quality. Thin Scots pine around the mature white pine and prune lower white pine branches to help prevent white pine blister rust.

WETLAND UNITS

Unit PO – Pond

- Protect from impacts due to chemical pollutants, soil siltation, and phosphorous inputs. Educate and encourage neighboring property owners to eliminate or reduce landscape related fertilizer use, to follow best management practices for any chemicals used, and to refrain from yard waste dumping within the site.
- Educate and encourage adjacent landowners to maintain buffer strips of native grasses and forbs to help filter water before entering the park.
- Educate and encourage adjacent landowners to avoid soil disturbance and/or prevent soil runoff during any construction activities.
- Include specifications for contractors to use the proper chemicals and methods of application to avoid impacts to wetlands during restoration activities.

Unit PS – Pond Shore

- Avoid walking and trampling of edge vegetation. Post signs, keep access trails, etc. limited.
- Install one access point as needed to reduce other access points.
- Monitor for invasives species and control as needed.

Unit SW – Seasonal Wetland

- Monitor for and control reed canary grass and other invasive native or non-native species

Unit SM – Sedge Meadow

- Monitor for and control reed canary grass and other invasive species.
- Increase graminoid and forb diversity with seed or plugs.
- Post educational signs.

TRAILS

- Close any rogue trails. Install boot brushes at trail entrances.
- Plant native grasses, such as Canada wild rye, along trail edge to outcompete weeds.
- Monitor edges for weeds and control prior to seeding/spreading.
- Monitor for soil erosion - especially given heavy rainfalls that occur more frequently due to climate change. Install erosion control measures and/or modify trail route as required.

MANAGEMENT TASK SCHEDULE AND COSTS

The tasks below were identified as the primary needs for the initial phase of restoration. Additional maintenance and restoration tasks can be developed for future years.

Date	Season	Unit	Activity	Ac	$/ac	Cost est
Year 1						
	Fall/winter	All Wooded except steep slope	Forestry mowing is permitted if feasible, but not required. Avoid mowing native woody spp. Before mow, cut/treat any invasive woody ≥2" dbh. Hand-cut/treat where no mow.	8	$ 1,850.00	$ 14,800.00
	Fall/winter	Wooded - perimieter & steep slopes.	Hand-cut, stump treat non-native, invasive shrubs and trees up to 6" dbh. Garlon 3a or 4, Dauber only. Stack & burn or mow. Do not cut apple trees.	10	$ 2,630.00	$ 26,300.00
	Fall/winter	BR1, BR2	Hand-cut, stump treat non-native, invasive shrubs and trees only. Keep all native woody. Garlon 3a or 4, Dauber only. Stack & burn or mow.	2	$ 1,935.00	$ 3,870.00
	April	PR	Brush mow (or clear with brush saws) grassland to remove all woody cover except large apple trees (seedling/saplings OK to mow). Light equipment.	5	$ 455.00	$ 2,275.00
			Ecologicial and Project Management			$ 4,800.00
						$ 52,045.00
Year 2						
	Early Spring	All Wooded	Spot-treat herbaceous invasive species	20	$ 220.00	$ 4,400.00
	June	PR	Re-mow or cut grassland to reduce woody species.	5	$ 390.00	$ 1,950.00
	Fall	All Wooded	Spot treat invasive woody re-sprouts and seedlings	20	$ 490.00	$ 9,800.00
	Fall	PR	Spot-treat invasive woody re-sprouts and seedlings. Must minimize	5	$ 425.00	$ 2,125.00

Year 3						
	Spring	PR, BR1, BR2, OS, AF4	Rx burn. Burn into adjacent edges of woods and brushland. Protect apple trees and conifers.	11	$ 341.00	$ 3,751.00
	Spring	PR, OS	Seed-supplemental (e.g. 40 seeds/sf)	5	$ 600.00	$ 3,000.00
	Spring	PR, OS	Broadcast seed post-burn	5	$ 300.00	$ 1,500.00
	Spring	All Wooded	Spot-treat herbaceous invasive species	20	$ 170.00	$ 3,400.00
	Fall	All Wooded	Spot-treat invasive woody re-sprouts and seedlings	20	$ 165.00	$ 3,300.00
	Fall	PR, BR1, BR2	Spot-treat invasive woody re-sprouts and seedlings	9	$ 490.00	$ 4,410.00
	Fall	All Wooded	Seed	15	$ 300.00	$ 4,500.00
	Fall	All Wooded	Broadcast seed open areas with woodland mix.	8	$ 325.00	$ 2,600.00
			Ecologicial and Project Management			$ 4,800.00
						$ 26,461.00

Date	Season	Unit	Activity	Ac	$/ac	Cost est
Year 4						
	Winter	All Wooded	Bareroot shrubs and trees	1	$ 800.00	$ 800.00
	Spring	All Wooded	Plant bareroot shrubs and trees into open forested areas to add diversity and wildlife habitat, esp for pollinators	2	$ -	$ 4,500.00
	Spring	All Wooded	Spot-treat herbaceous invasive species	20	$ 300.00	$ 6,000.00
	Fall	All Wooded	Spot-treat invasive woody re-sprouts and seedlings	20	$ 500.00	$ 10,000.00
	Spr-Fall	Grassland	Spot-treat invasive woody and weedy plants	5	$ 500.00	$ 2,500.00
			Ecologicial and Project Management			$ 4,800.00
						$ 28,600.00

Date	Season	Unit	Activity	Ac	$/ac	Cost est
Year 5						
	Spr-Fall	All Wooded	Spot-treat invasive woody and weedy plants	20	$ 500.00	$ 10,000.00
	Spr-Fall	PR	Spot-treat invasive woody and weedy plants	5	$ 500.00	$ 2,500.00
			Ecologicial and Project Management			$ 3,800.00
						$ 16,300.00
				TOTAL		**$ 145,481.00**

APPENDIX A. PLANT SPECIES RECORDED

Applewood Preserve 2021-2022

GRASSLAND, BRUSHLAND & SAVANNA - Native Species

Scientific name	Common name	PR	PR-RE	BR1	BR2	OS
Forbs						
Achillea millefolium	common yarrow		0.5		0.5	0.5
Ageratina rugosum	white snakeroot			0.5		0.5
Agrimonia sp.	agrimony	0.5		0.5		0.5
Anemone cylindrica	thimbleweed	0.5			0.5	0.5
Antennaria	pussytoes	0.5		1	2	
Ambrosia artemisiifolia	common ragweed	0.5		0.5		
Asclepias syriaca	common milkweed	0.5				
Baptisia lactea	white wild indigo	0.5				
Galium triflorum	sweet-scented bedstraw			1	1	
Geum canadense	white avens	0.5				
Geum macrophyllum	large leaf avens			1	1	
Monarda fistulosa	beebalm				2	0.5
Oenothera biennis	common evening primrose				0.5	
Potentilla recta	sulphur cinquefoil	0.5				0.5
Ratibida pinnata	yellow coneflower	0.5				
Solidago canadensis	Canada goldenrod	1		0.5		0.5
Solidago gigantea	late goldenrod	0.5			0.5	0.5
Solidago rigida	stiff goldenrod	0.5			0.5	
Solidago speciosa	showy goldenrod	0.5				
Symphyotrichum oolentangiense	Sky-blue aster	0.5				
Viola sp	violet			0.5	1	0.5
TOTAL		8	0.5	5.5	9.5	

Graminoids						
Andropogon gerardii	big bluestem	1	0.5			
Bouteloua curtipendula	sideoats grama					
Carex pensylvanica	Pennsylvania sedge	2				
Elymus canadensis	Canada wild rye					
Panicum virgatum	switchgrass	0.5	2			
Schizachrium scoparium	little bluestem	1	4		2	

Grassland, Brushland & Savanna (continued)

Scientific name	Common name	PR	PR-RE	BR1	BR2	OS
Woody - seedlings, saplings, vines						
Acer negundo	boxelder			1	1	
Cornus racemosa	gray dogwood	4		3	4	4
Cornus sericea	red twig dogwood				0.5	
Fraxinus pensylvanica	green ash	0.5		0.5		
Parthenocissus quinquefolia	Virginia creeper			0.5		
Prunus virginiana	chokecherry	0.5			0.5	1
Rhus glabra	smooth sumac	3		1	2	
Rubus ideaus	red raspberry	1				
Vitis riparia	wild grape vine			1		
Zanthoxylum americanum	prickly ash	1				
Canopy Trees						
Acer negundo	boxelder			1	1	
Fraxinus pennsylvanica	Green ash	1		1	2	
Juniperus virginiana	red cedar	1		0.5	1	1
Populus tremuloides	Quaking aspen	1		0.5	1	
Prunus serotina	black cherry			1	0.5	
Quercus ellipsoidalis	northern pin oak	1		1	0.5	2
Quercus macrocarpa	bur oak				0.5	
Quercus rubra	red oak				>	

Grassland, Brushland & Savanna - Non- Native Species

Scientific name	Common name	PR	PR-RE	BR1	BR2	OS
Forbs						
Arctium minus	common burdock	0.5		1		
Centaurea stoebe	spotted knapweed	1	1			
Cirsium arvense	Canada thistle		1		0.5	
Cirsium vulgare	bull thistle	0.5				
Daucus carota	Queen Anne's Lace					1
Erigeron sp.					1	
Lotus corniculatus	birdsfoot trefoil	0.5				
Plantago major	common plantain					0.5
Potentilla recta	sulfur cinquefoil	0.5		0.5		
Rumex acetosella	common sheep sorel		0.5		0.5	
Securigera varia	crown vetch				0.5	

Taraxacum officionalis	dandelion	0.5		0.5	0.5	
Verbascum thaspsus	common mullein	0.5				
Graminoids						
Bromus inermis	smooth brome		0.5			
Echinochloa crus-galli	barnyard grass	0.5		0.5		
Poa pretensis	Kentucky bluegrass	2	2	1	3	0.5
Setaria pumila	yellow foxtail	1	1		1	
Woody – trees, shrubs, seedlings						
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	2	0.5	3	2	1
Malus sp.	Apple			2		
Morus alba	white mulberry	0.5				
Pinus sylvestris	Scots pine		1			
Rhamnus catharticus	common buckthorn	1		2		
Robinia pseudoacacia	black locust		0.5			
Ulmus pumila	Siberian elm			1	2	

DECIDUOUS WOODLAND - Native Species

Scientific name	Common name	OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Achillea millefolium	common yarrow				0.5					0.5	1
Actaea rubra	red baneberry						0.5				
Ageratina rugosum	white snakeroot	1						2	3	2	1
Ambrosia artemisiifolia	common ragweed									0.5	0.5
Amphicarpa bracteata	Hog peanut								0.5	0.5	
Anemone quinquefolia	wood anemone	0.5									
Arisaema triphyllum	Jack-in-the-pulpit								0.5	0.5	
Aralia nudicaulis	wild Sarsaparilla										0.5
Athyrium Filix-femina	lady fern			0.5							0.5
Circaea lutetiana	enchanter's nightshade			0.5							
Cornus canadensis	bunch berry									0.5	
Cystopteris bulbifera	bulblet fern										0.5
Desmodium glutinosum	pointed-leaf tick-trefoil		0.5					0.5		0.5	
Dryopteris carthusiana	spinulose wood fern	0.5							0.5		
Galium triflorum	sweet-scented bedstraw	0.5		0.5					1	1	
Geum canadense	white avens	0.5			1	1	1	1	1		
Geum macrophyllum	large leaf avens	0.5		1					1		
Geranium maculatum	wild geranium	0.5			1						
Hackelia virginiana	Virginia stickseed		0.5	1							

Hydrophyllum virginianum	Virginia waterleaf	1								0.5	1
Laportea canadense	Canada wood nettle	0.5									
Leonarus cardiaca	mother wort								0.5		
Maianthemum canadense	Canada Mayflower	1			1						0.5
Matteuccia struthiopteris	ostrich fern	0.5							0.5	0.5	
Monarda fistulosa	beebalm										1
Osmunda claytonia	Interrupted fern	0.5						0.5	1	1	0.5
Osmorhiza claytonii	Sweet cicely	1							1		
Persicaria longiseta	Oriental lady's thumb								0.5		
Persicaria virginiana	jumpseed								0.5		
Pilea sp.	clearweed								1		
Pilea fontana	black fruited clearweed								0.5		
Pyrola sp.	Pyrola species				0.5						
Polygonatum pubescens	hairy Solomon's seal	0.5									
Ranunculus abortivus	little-leaf buttercup	0.5									
Smilax ecirrhata	upright carrion flower								0.5		
Solidago canadensis	Canada goldenrod									1	2
Solidago speciosa	showy goldenrod									0.5	
Thalictrum dioicum	early meadow rue	0.5								0.5	
Thalictrum thalictroides	Rue anemone	0.5	1								
Urtica dioica	stinging nettle							0.5	2	1	
Verbena urticifolia	white vervain		0.5								
Viola sororia	common blue violet			0.5			0.5				
Zizia aptera	Golden Alexander										2

Graminoids		OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Andropogon gerardii	big blue stem									0.5	
Beckmannia syzigachne	American slough grass									1	
Carex sp.	sedge species									1	
Carex blanda	common wood sedge	1	0.5	0.5		0.5			0.5		
Carex pensylvanica	Pennsylvania sedge	3-4	4		1	2	1	2	1	1	0.5

Woody (0-0.5m)											
Acer negundo	boxelder				1	0.5	0.5				

Cornus alternifolia	Pagoda dogwood		0.5								
Cornus racemosa	gray dogwood		1								
Cornus sericea	red osier dogwood									1	
Diervilla lonicera			0.5								
Fraxinus pensylvanica	green ash		0.5							1	
Juglans nigra	black walnut										
Parthenocissus quinquefolia	Virginia creeper										
Parthenocissus vitacea									1		0.5
Physocarpus opulifolius	ninebark										
Populus deltoides	cottonwood								0.5		
Prunus serotina	Black cherry	0.5	0.5	0.5	0.5	0.5	0.5	0.5		1	
Prunus virginiana	chokecherry	2									
Quercus macrocarpa	bur oak										
Quercus rubra	red oak										
Ribes sp.		1								1	
Rubus ideaus	red raspberry		1								
Rubus pubescens										0.5	
Salix exigua	sandbar willow										
Sambucus racemosa	elderberry										
Tilia americana	basswood										
Toxicodendron rydbergii			1								
Ulmus americana	American elm										
Viburnum lentago	nannyberry										
Viburnum trilobum	highbush cranberry						0.5	1			
Vitis riparia	wild grape vine	0.5						1	1	1	1

Shrub layer (0.5-2m)		OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Amelanchier laevis	Smooth serviceberry	0.5									
Acer negundo	boxelder				1	2	1	1	1	1	0.5
Celtis occidentalis	hackberry										
Cornus alternifolia	Pagoda dogwood		0.5								
Cornus racemosa	gray dogwood		1		1	1		1		2	1
Cornus sericea	red osier dogwood						0.5	0.5	0.5		0.5
Fraxinus pensylvanica	green ash	1	1					2	1	1	1
Juglans nigra	black walnut										
Malus spp	crabapple		1								
Parthenocissus quinquefolia	Virginia creeper				0.5				0.5	0.5	

Populus deltoides	cottonwood								0.5		
Populus tremuloides	Quaking aspen		1					0.5			
Prunus virginiana	chokecherry										0.5
Prunus serotina	Black cherry	2		1					0.5	1	
Quercus alba	white oak	0.5									
Quercus macrocarpa	bur oak										
Quercus rubra	red oak	0.5								0.5	
Rhus glabra			0.5					1			
Ribes missouriense	Gooseberry	1	1	1	0.5		1	0.5	1	1	0.5
Rosa sp.										0.5	
Rubus ideaus	red raspberry	?							1	1	2
Salix petiolaris											1
Ulmus americana	American elm							1			
Vitis riparia	wild grape vine									0.5	
Canopy (2 – 15 m)		OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Acer negundo	boxelder		1	1			2	1	3	0.5	0.5
Acer saccharinum	silver maple										
Amelanchier		0.5									
Betula papyrifera	Paper birch	1		2				1	2	1	
Catalpa speciosa	Catalpa	0.5									
Celtis occidentalis	hackberry			1							
Cornus alternifolia	pagoda dogwood				0.5						
Cornus racemosa	gray dogwood			1							
Cornus sericea	red osier dogwood			0.5							
Fraxinus nigra	Black ash									1	
Fraxinus pensylvanica	green ash		2	1	2			1	2	2	2
Juglans nigra	black walnut	0.5							2		
Juniperus virginiana	red cedar			0.5	2					0.5	
Larix laricina	tamarack										
Malus sp.			1					1		0.5	
Parthenocissus quinquefolia	Virginia creeper			0.5							0.5
Pinus resinosa	red pine									0.5	
Pinus strobus	white pine	0.5									
Populus deltoides	cottonwood	1					2		3		
Populus grandidentata	big tooth aspen		0.5								
Populus tremuloides	quaking aspen	0.5	1	3	4		3	4	1	3	

Prunus virginiana	chokecherry		1	1					1		
Prunus serotina	black cherry	1	2	2	1			1		1	
Quercus alba	white oak	3	2	3							
Quercus ellipsoidalis	northern pin oak	2	3	0.5	2			1		4	
Quercus macrocarpa	bur oak	1	1	1				1		1	
Quercus rubrum	red oak	2	1	2				2			
Tilia americana	basswood	0.5								0.5	0.5
Ulmus americana	American elm	1			1					0.5	0.5
Vitis riparia	wild grape vine	1	0.5								0.5

DECIDUOUS WOODLAND Non-Native Species

Scientific name	Common name	OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Forbs											
Alliaria petiolata	garlic mustard	2	1	2	2	2		1	2/3	2	2
Arctium minus	common burdock		0.5	2	0.5	0.5	0.5		0.5	1	1
Artemisia vulgaris	mugwort									0.5	0.5
Berteroa incana	hoary alyssum									0.5	
Centaurea stoebe	spotted knapweed	0.5								0.5	
Cirsium arvense	Canada thistle										1
Cirsium vulgare	bull thistle									0.5	0.5
Daucus carota	Queen Anne's Lace	0.5	0.5		0.5		0.5		0.5		0.5
Glechoma hederacea	Ground ivy	0.5	0.5	0.5	0.5	0.5	0.5	1	2	2	1
Hemerocallis fulva	Daylily										1
Leonurus cardiaca	Mother wort			1				0.5	1		0.5
Leucanthemum vulgare	Ox-eye daisy										
Linaria vulgaris	butter and eggs									0.5	
Melilotus officinalis	yellow sweet clover									0.5	
Nepeta cataria	Catnip										0.5
Plantago major	common plantain	0.5	0.5	0.5						1	1
Securigera varia	crown vetch									0.5	
Taraxacum officionale		0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Trifolium repens	white clover					0.5				0.5	0.5
Verbascum thaspsus	common mullein									0.5	0.5

Graminoids

Scientific name	Common name	OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Bromus inermis	smooth brome							0.5	0.5	1	2
Echinochloa crus-galli	barnyard grass				0.5	0.5				0.5	0.5
Elymus repens	quackgrass					0.5					0.5
Phalaris arundinaceae	reed canary grass								0.5	1	1
Poa pratensis	Kentucky bluegrass	0.5	0.5		0.5	0.5	0.5	0.5		1	3

Woody (0-0.5m)

Scientific name	Common name	OF1	OF2	OF3	AF1	AF2	AF3	AF4	LF	MW1	MW2
Acer ginnala	ginnala maple		0.5							0.5	
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	2	2	1	1	0.5	0.5	1	1	2	2
Morus alba	white mulberry	0.5									
Rhamnus cathartica	common buckthorn	3	2	2	3	0.5	0.5	4	3	2	

Shrub Layer Woody (0.5-2m)

Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	2	1	2	2	2	2	2	2	2	2
Rhamnus cathartica	common buckthorn	4	3	4	4	3	3	2	4	3	2
Ulmus pumila	Siberian elm										0.5

Canopy (2-15m)

Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	1	0.5	0.5	1					1	
Malus sp.	Apple		1								
Morus alba	White mulberry				0.5						
Rhamnus cathartica	common buckthorn	1	1	2	3				1	4	2

CONIFEROUS WOODLAND - Native Species

Scientific name	Common name	CO-CS	CO-RP1	CO-RP2	CO-	CO-MX2
Actaea rubra	red baneberry			0.5		
Aralia nudicaulis	wild sarsaparilla	0.5				
Athyrium felix-femina	lady fern	0.5				
Pyrola sp.				0.5		
Thalictrum thalictroides	rue anemone	0.5				

Graminoids

Carex pensylvanica	Pennsylvania sedge			3		
Phalaris arundinacea	reed canary grass	1				

Woody (0-0.5m)-ground layer

Acer negundo	boxelder	0.5				
Prunus virginiana	chokecherry		0.5			
Ribes sp.	gooseberry species			1		

Woody (0.5-2m)- Shrub layer

Acer negundo	boxelder				0.5	
Amelanchier laevis	smooth serviceberry			1		
Fraxinus pensylvanica	green ash			1		
Prunus serotina	Black cherry			1		
Prunus virginiana	chokecherry			1		
Viburnum lentago	nannyberry			0.5		
Viburnum trilobum	highbush cranberry			0.5		

Woody (>2m)

Picea abies	Norway spruce	3				
Pinus resinosa	red pine			5	4	
Pinus strobus	White pine					4
Pinus sylvestris	Scots pine					2
Populus tremuloides	quaking aspen			1		
Prunus virginiana	chokecherry			2		
Thuja occidentalis	White cedar	3				
Ulmus americana	American elm			1		

CONIFEROUS WOODLAND - Non-Native Species

Scientific name	Common name	CO-CS	CO-	CO-RP2	CO-MX1	CO-
Alliaria petiolata	garlic mustard				0.5	
Arctium minus	common burdock		0.5	0.5		
Taraxacum officionale	dandelion			0.5		
Graminoids						
Bromus inermis	smooth brome					1
Woody (0-0.5m)						
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	0.5		0.5		
Morus alba	White mulberry					
Rhamnus cathartica	common buckthorn	1		3		
Robinia pseudoacacia	black locust					
Ulmus pumila	Siberian elm					
Woody (0.5-2m)-shrub layer						
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle			2		
Rhamnus cathartica	common buckthorn	2		4		
Woody (>2m)						
Lonicera tatarica	Tatarian			1		
Pinus sylvestris	Scots pine			2	2	
Rhamnus cathartica	common buckthorn			2		

WETLAND Native Species

Scientific name	Common name	PO	PS	SW	SM
Ageratina altissima	white snakeroot			0.5	
Barbarea orthoceras	American yellow		0.5	0.5	
Bidens cernua	Nodding bur-marigold		1		
Cicuta maculata	water hemlock				0.5
Cirsium muticum	swamp thistle			0.5	
Cuscuta sp.	dodder			0.5	
Epiliobium sp.	willow herb				0.5
Impatiens capensis	spotted touch-me-not			0.5	
Iris versicolor	wild iris			0.5	
Lycopus sp.	bugleweed				
Nymphaea odorata	white water lily	1			
Onoclea sensibilis	sensitive fern		0.5		0.5
Parietaria pensylvanica	Pennsylvania pellitory		0.5		0.5
Persicaria sp.	smartweed		0.5		1
Pilea sp.	clearweed		0.5	0.5	1
Scutellaria lateriflora	mad-dog skullcap		0.5	0.5	
Urtica dioica	stinging nettle		0.5	0.5	
Viola macloskeyi var. pallens	small white violet		0.5		
Graminoids					
Calamagrostis canadensis	blue joint		1		
Leerzia oryzoides	Rice cut grass		1		
Carex lacustris	lake sedge				4
Woody (0-0.5m)					
Vitis riparia			0.5		
Woody (0.5-2m) – shrub layer					
Vitis riparia			0.5	0.5	
Woody (>2m)					
Acer saccharinum	silver maple			0.5	
Ulmus americana	American elm			0.5	

WETLAND Non-Native Species

Scientific name	Common name	PO	PS	SW	SM
Alliaria petiolata	garlic mustard			0.5	
Glechoma hederacea	creeping Charlie			0.5	
Leonurus cardiaca	motherwort			0.5	
Stellaria media	common chickweed			0.5	
Graminoids					
Bromus inermis	smooth brome			0.5	
Carex lacustris	lake sedge			5	
Phalaris arundinacea	reed canary grass			1	

APPENDIX B. RECOMMENDED PLANTS SPECIES FOR RESTORATION

CULTURALLY IMPORTANT SPECIES

Listed here are some of the species that are culturally significant to the Dakota people, who stewarded this region prior to colonization. These can be incorporated in the planting plans wherever possible.

Dry Prairie	Woodland	Mesic Prairie
Aster species	Forbs	Aster sp.
Beardstongue/Penstemon	Blue cohosh	Compass Plant
Buffaloberry	Jack-in-the-pulpit	Dogbane
Four O'clock	Trillium (nodding)	Mountain mint
Leadplant	Wild ginger	Rattlesnake master
Prairie rose	Wild leeks	Sumac (R. glabra)
Prairie sage	Trees and shrubs	Yarrow
Prairie Smoke	Basswood	
Prairie turnip	Bitternut hickory	Savanna
Red cedar	Black cherry	Forbs
Sand cherry	Chokecherry	Sunchoke
Wild Lupine	Elderberry	Trees and shrubs
Wild strawberry	Gooseberry	Bur oak
	Hackberry	Hazelnut
Wetland	Juneberry	Pin cherry
Boneset	Nannyberry	Raspberry
Ironweed	Wild grape	Red osier dogwood
Sweetgrass		Wild plum

Important species identified that are already present

Arrowhead	Little bluestem
Bergamot	Milkweed
Big bluestem	Side oats grama
Blue flag iris	Stinging nettle
Cottonwood	Sunflower
Echinacea	Willows
Goldenrod	Wood nettle

Not suitable for site

Black ash	Needs bog/seepage swamp
Bog Labrador Tea	Needs bog
Cut-leaved toothwort	Needs mesic hardwood forest

Indian ricegrass	MN endangered sp, found only in far NW MN.
Paper birch	Needs mesic hardwood forest
Sugar maple	Needs mesic hardwood forest
white cedar	Needs mesic hardwood forest

MESIC PRAIRIE SPECIES (Ups23)

Scientific name	Common Name	Scientific name	Common Name
Forbs		*Sisyrinchium campestre*	Field blue-eyed grass
Allium canadense	Wild garlic	*Smilacina racemosa*	False Solomon's-seal
Allium stellatum	Prairie wild onion	*Smilacina stellata*	Starry false Solomon's-seal
Anemone canadensis	Canada anemone	*Solidago missouriensis*	Missouri goldenrod
Anemone cylindrica	Long-headed thimbleweed	*Solidago nemoralis*	Gray goldenrod
Anemone virginiana	Virginia thimbleweed	*Solidago ptarmicoides*	Upland white aster
Antennaria spp	Pussytoes	*Solidago rigida*	Stiff goldenrod
Apocynum androsaemifolium	Spreading dogbane	*Solidago speciosa*	Showy goldenrod
Artemisia campestris	Tall wormwood	*Symphyotricum ericoides*	Heath aster
Artemisia frigida	Prairie sagewort	*Symphyotricum laeve*	Smooth aster
Artemisia ludoviciana	Western mugwort	*Symphyotricum lanceolatum*	Panicled aster
Asclepias syriaca	Common milkweed	*Symphyotricum novae-angliae*	New England aster
Asclepias tuberosa	Butterfly-weed	*Symphyotricum oolentangiense*	Sky-blue aster
Astragalus canadensis	Canada milk-vetch	*Thalictrum dasycarpum*	Tall meadow-rue
Campanula rotundifolia	Harebell	*Tradescantia bracteata*	Bracted spiderwort
Chrysopsis villosa	Prairie golden aster	*Vernonia fasciculata*	Ironweed
Comandra umbellata	Bastard toad-flax	*Veronicastrum virginicum*	Culver's root
Coreopsis palmata	Stiff tickseed	*Vicia americana*	American vetch
Dalea candida	White prairie-clover	*Zizia aurea*	Golden alexanders
Dalea purpurea	Purple prairie-clover	**Shrubs**	
Desmodium canadense	Canadian tick-trefoil	*Amorpha canescens*	Lead-plant
Eryngium yuccifolium	Rattlesnake master	*Amorpha nana*	Fragrant false indigo
Euphorbia corollata	Flowering spurge	*Rosa arkansana*	Prairie rose
Euthamia graminifolia	Grass-leaved goldenrod	*Symphoricarpos cmx.*	Snowberry
Fragaria virginiana	Common strawberry	**Grasses, Rushes and Sedges**	
Galium boreale	Northern bedstraw	*Andropogon gerardii*	Big bluestem
Geum triflorum	Prairie smoke	*Bromus kalmii*	Kalm's brome
Helenium autumnale	Autumn sneezeweed	*Carex bicknellii*	Bicknell's sedge
Helianthus maximiliani	Maximilian's sunflower	*Carex muhlenbergii*	Muhlenberg's sedge
Helianthus pauciflorus	Stiff sunflower	*Carex meadii*	Mead's sedge
Heliopsis helianthoides	Ox-eye	*Carex tenera*	Marsh-straw sedge
Lathyrus venosus	Veiny pea	*Elymus canadensis*	Canada wild rye
Lespedeza capitata	Round-headed bush-clover	*Elymus trachycaulus*	Slender wheatgrass
Liatris ligulistylis	Northern plains blazing star	*Eragrostis spectabilis*	Purple lovegrass
Liatris pycnostachya	Gayfeather	*Muhlenbergia mexicana*	Mexican satin-grass
Mirabilis hirsuta	Hairy four-o'clock	*Panicum oligosanthes*	Few-flowered panic grass
Monarda fistulosa	Wild bergamot	*Panicum virgatum*	Switchgrass
Oenothera biennis	Common evening-primrose	*Panicum perlongum*	Long-leaved panic grass
Phlox pilosa	Prairie phlox	*Schizachyrium scoparium*	Little bluestem
Potentilla arguta	Tall cinquefoil	*Sorghastrum nutans*	Indian grass
Pycnanthemum virginianum	Virginia mountain-mint	*Sporobolus heterolepis*	Prairie dropseed
Ratibida pinnata	Gray-headed coneflower	*Stipa spartea*	Porcupine-grass
Rudbeckia hirta	Black-eyed Susan		

Southern Dry-Mesic Oak Woodland (FDs38)

Scientific name	Common name
Forbs	
Amphicarpaea bracteata	hog-peanut
Antenaria spp.	pussytoes
Anemone americana	round-lobed hepatica
Anemone quinquefolia	Wood anemone
Apocynum androsaemifolium	Spreading dogbane
Aquilegia Canadensis	columbine
Aralia nudicaulis	wild sarsaparilla
Aster cordifolius	heart-leaved aster
Aster macrophyllus	Large-leaved aster
Aster sagittifolius	Tail-leaved aster
Athyrium filix-femina	lady fern
Campanula rotundifolia	harebell
Carex pensylvanica	Pennsylvania sedge
Circaea lutetiana	enchanter's nightshade
Desmodium glutinosum	pointed-leaved tick-trefoil
Eupatorium rugosum	white snakeroot
Euphorbia corollata	flowering spurge
Fragaria virginiana	wild strawberry
Galium boreale	northern bedstraw
Galium triflorum	three-flowered bedstraw
Geranium maculatum	wild geranium
Geum canadense	white avens
Helianthus strumosus	woodland sunflower
Maianthemum canadense	Canada mayflower
Osmorhiza claytonii	sweet cicely
Osmunda claytoniana	Interrupted fern
Pteridium aquilinum	Bracken fern
Phryma leptostachya	lopseed
Polygonatum biflorum	Giant Solomon's seal
Pyrola elliptica	Elliptic shinleaf
Sanicula gregari	gregarious black snakeroot
Sanicula marilandica	Maryland black snakeroot
Smilacina racemosa	false Solomon's seal
Solidago ulmifolia	elm-leaved goldenrod
Thalictrum dioicum	Early meadow rue
Trientalis borealis	Starflower
Uvularia grandiflora	Large-flowered bellwort
Uvularia sessilifolia	Pale bellwort
Grasses and Sedges	
Oryzopsis asperifolia	Mountain rice gras
Festuca subverticillata	Nodding fescue
Elymus hystrix	Bottlebrush grass
Shrubs	
Amelanchier spp.	Juneberries
Cornus alternifolia	Pagoda dogwood
Cornus racemosa	Gray dogwood
Cornus rugosa	Round-leaved dog
Corylus americana	American hazelnu
Corylus cornuta	Beaked hazelnut
Diervilla lonicera	Bush honeysuckle
Prunus virginiana	Chokecherry
Prunus pennsylvanica	pin cherry
Ribes cynosbati	Prickly gooseberry
Sambucus racemosa	Red berried elder
Symphoricarpos albus or occidentalis	Snowberry/wolfbe
Viburnum lentago	Nannyberry
Viburnum rafenesquianum	Downy arrowwoo
Xanthoxylum americanum	Prickly ash
Trees	
Betula papyrifera	Paper birch
Carya cordiformes	Bitternut hickory
Celtis occidentalis	Hackberry
Ostrya virginiana	Ironwood
Prunus serotina	Black cherry
Quercus alba	White oak
Quercus ellipsoidalis	Northern pin oak
Quercus macrocarpa	Bur oak
Quercus rubra	Northern red oak

Southern Mesic Savanna (UPs24)

Genus	Species	Common Name
Trees		
Quercus	macrocarpa	Bur oak
Shrubs		
Amorpha	*canescens*	Leadplant
Prunus	*virginiana*	Chokecherry
Rosa	*arkansana*	Prairie rose
Salix	*humilis*	Prairie willow
Symphori-carpos	*abla*	Snowberry
Grasses, Rushes and Sedges		
Andropogon	*gerardii*	Big bluestem
Bromus	*kalmii*	Kalm's brome
Carex	*bicknellii*	Bicknell's sedge
Carex	*meadii*	Mead's sedge
Carex	*muhlenbergii*	Muhlenberg's sedge
Elymus	*canadensis*	Canada wild rye
Dicanthelium	*perlongum*	Slimleaf panicgrass
Panicum	*virgatum*	Switchgrass
Schizachyrium	*scoparium*	Little bluestem
Sorghastrum	*nutans*	Indian grass
Sporobolus	*heterolepis*	Prairie dropseed
Stipa	*spartea*	Porcupine-grass
Forbs		
Allium	*canadense*	Wild garlic
Allium	*stellatum*	Prairie wild onion
Anemone	*canadensis*	Canada anemone
Anemone	*cylindrica*	Long-headed thimbleweed
Anemone	*virginiana*	Virginia thimbleweed
Antennaria	*species*	Pussytoes
Apocynum	*Androsae-*	Spreading dogbane
Artemisia	*campestris*	Tall wormwood
Artemisia	*frigida*	Prairie sagewort
Asclepias	*syriaca*	Common milkweed
Asclepias	*tuberosa*	Butterfly-weed
Aster	*ericoides*	Heath aster
Aster	*laevis*	Smooth aster
Aster	*lanceolatus*	Panicled aster
Aster	*novae-angliae*	New England aster
Aster	*oolentangiensis*	Sky-blue aster
Astragalus	*canadensis*	Canada milk-vetch
Campanula	*rotundifolia*	Harebell
Comandra	*umbellata*	Bastard toad-flax
Coreopsis	*palmata*	Stiff tickseed
Dalea	*candida*	White prairie-clover
Dalea	*purpurea*	Purple prairie-clover
Desmodium	*canadense*	Canadian tick-trefoil
Euphorbia	*corollata*	Flowering spurge
Euthamia	*graminifolia*	Grass-lvd goldenrod

Forbs (cont'd)

Fragaria	*virginiana*	Common strawberry
Galium	*boreale*	Northern bedstraw
Gentiana x	*billingtonii*	Closed gentian
Geum	*triflorum*	Prairie smoke
Helianthus	*maximiliani*	Maximilian's sunflower
Helianthus	*pauciflorus*	Stiff sunflower
Heliopsis	*helianthoides*	Ox-eye
Heterotheca	*villosa*	Prairie golden aster
Heuchera	*richardsonii*	Alum-root
Lathyrus	*venosus*	Veiny pea
Lespedeza	*capitata*	Round-headed
Liatris	*aspera*	Rough blazing star
Liatris	*ligulistylis*	Northern plains
Liatris	*pycnostachya*	Gayfeather
Lilium	*Philadel-*	Wood lily
Lobelia	*spicata*	Rough-spiked Lobelia
Maian-	*racemosum*	False Solomon's-seal
Maian-	*stellatum*	Starry false
Mirabilis	*hirsuta*	Hairy four-o'clock
Monarda	*fistulosa*	Wild bergamot
Oenothera	*biennis*	Common evening-
Pedicularis	*canadensis*	Wood-betony
Phlox	*pilosa*	Prairie phlox
Physalis	*heterophylla*	Clammy ground-cherry
Potentilla	*arguta*	Tall cinquefoil
Pycnan-	*virginianum*	Virginia mountain-mint
Ratibida	*pinnata*	Gray-headed
Rudbeckia	*hirta*	Black-eyed Susan
Sisyrinchium	*campestre*	Field blue-eyed grass
Solidago	*missouriensis*	Missouri goldenrod
Solidago	*nemoralis*	Gray goldenrod
Solidago	*ptarmicoides*	Upland white
Solidago	*speciosa*	Showy goldenrod
Thalictrum	*dasycarpum*	Tall meadow-rue
Tradescantia	*bracteata*	Bracted spiderwort
Veroni-	*virginicum*	Culver's root
Viola	*pedatifida*	Prairie bird-foot violet
Zizia	*aurea*	Golden alexanders
Equisetum	*arvense*	Field horsetail
Equisetum	*hyemale*	Tall scouring-rush
Equisetum	*laevigatum*	Smooth scouring-rush

SOUTHERN DRY-MESIC OAK WOODLAND (FDs37)

Scientific name	Common Name
Forbs, ferns	
Amphicarpaea bracteata	hog-peanut
Anemone quinquefolia	wood anemone
Apocynum androsaemifolium	spreading dogbane
Aquilegia canadensis	columbine
Aralia nudicaulis	wild sarsaparilla
Arisaema trifolium	Jack in the pulpit
Athyrium filix-femina	lady-fern
Circaea lutetiana	enchanter's nightshade
Desmodium glutinosum	pointed-leaved tick-trefoil
Eurybia macrophylla	large-leaved aster
Galium triflorum	three-flowered bedstraw
Geranium maculatum	wild geranium
Maianthemum canadense	Canada mayflower
Miangthemum racemosum	false Solomon's-seal
Osmorhiza claytonii	Clayton's sweet cicely
Osmunda claytoniana	interrupted fern
Phryma leptostachya	lopseed
Polygonatum biflorum	giant Solomon's-seal
Pyrola elliptica	shinleaf
Sanicula marilandica	Mariland black snakeroot
Sollidago flexicaulis	zigzag goldenrod
Thalictrum dioicum	early meadow-rue
Uvularia sessilifolia	pale bellwort
Uvularia grandiflora	large-flowered bellwort
Graminioids	
Carex blanda	eastern woodland sedge
Carex pensylvanica	Pennsylvania sedge
Carex rosea	rosy sedge
Elymus canadensis	Canada wild rye
Elymus hystrix	bottlebrush grass
Elymus virginicus	Virginia wild rye
Festuca subverticillata	nodding fescue
Leersia virginica	white grass
Oryzopsis asperifolia	mountain rice grass

Shrubs	
Amelanchier spp	Juneberry
Cornus racemosa	gray dogwood
Cornus rugosa	round-leaved dogwood
Corylus americana	American hazelnut
Corylus cornuta	beaked hazelnut
Diervilla lonicera	bush honeysuckle
Prunus virginiana	chokecherry
Ribes cynosbati	gooseberry
Ribes missouriense	Missouri gooseberry
Sambucus racemosa	red-berried elder
Symphoricarpos	snowberry
Viburnum rafinesquianum	downy arrowwood
Viburnum lentago	nannyberry
Canopy Trees	
Ostrya virginiana	Ironwood
Quercus alba	white oak
Quercus macrocarpa	bur oak

APPENDIX C. METHODS FOR CONTROLLING NON-NATIVE INVASIVE PLANT SPECIES

Crown vetch (*Securigera varia)*
Mechanical control can be done by pulling the plant by hand or with equipment such as a shovel. Plants can resprout from root fragments, so try to remove as much of the plant as possible. Additional control methods may be necessary. Follow Minnesota Department of Agriculture noxious weed disposal (link is external) guidance. Mowing several times each year can reduce the population but will likely not eliminate it. Mow repeatedly from May to October to prevent flowering. Do not mow if the plants have produced seeds as mowing will spread the seeds. In areas with native grasses, prescribed burning in late spring for several successive years can encourage the native grasses and increase their ability to compete with crown vetch. Crown vetch can resprout after burns so continue to monitor the population.
Herbicide control can be done using systemic herbicides which are taken up by plants and move within the plant, which can kill leaves, stems, and roots. Spot spray with aminopyralid before the plant begins to flower. Spot spray with clopyralid (Transline) from May to October while the plant is actively growing. Spot spraying during the growing season with herbicides containing 2,4-D, glyphosate, or triclopyr can also be effective.
https://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/crownvetch.html

Milestone applied at either bud or fall growth stage provided excellent control one year after treatment. However, only the fall herbicide application continued to provide good crown vetch control two growing seasons following treatment. Milestone applied at either 5 or 7 fl oz/A will provide good to excellent control when applied late summer or fall. Establishing a competitive plant community is critical to maintain long-term control of the weed. Follow-up herbicide applications may be necessary to control seedlings emerging from the soil seed bank or mature plants that survive treatment. https://www.techlinenews.com/articles/2015/long-term-control-of-crown-vetch-at-a-wisconsin-wildlife-refuge?rq=crown

Mugwort (*Artemisia vulgaris*)
Mugwort is a perennial with an extensive rhizome system. Shoots emerge during the spring, and flowering occurs from July to late September. A single plant can, depending on its environment, produce up to 200,000 seeds. The small seeds (~1mm in diameter) are largely wind dispersed. Seed production does not seem to be a major factor in the spread of mugwort populations, however, and some biotypes do not produce viable seed. Instead, mugwort spreads largely through vegetative expansion and the anthropogenic dispersal of root propagules.
Pulling is ineffective and may even promote growth by leaving residual rhizome fragments in the soil. Mugwort tolerates mowing, and even sustained mowing over two years will not fully eradicate mugwort stands but can significantly reduce it.

Glyphosate applied in late summer or early fall will suppress mugwort the following year but generally not eradicate it. **Triclopyr** and **clopyralid** are more selective herbicides that effectively control mugwort.
Mowing in combination with spot-spraying may provide the best control, whereby plants are mowed before they flower, then spot-sprayed in late summer.

http://nyis.info/invasive_species/mugwort-draft/

Birdsfoot trefoil (*Lotus corniculatus*)
Birdsfoot trefoil forms dense mats that choke out most other vegetation. It is especially problematic in prairies and disturbed open areas. Prescribed burns increase seed germination making it difficult to manage in native prairies.

Mechanical control alone is effective at reducing this species but will also eliminate desirable plants. More effective is a combination of mowing or burning and chemical application The most effective herbicide is aminopyralid (e.g., Milestone), and clopyralid (e.g., Transline at 0.4 - 0.75%) is also effective. Note that both herbicides will also kill native plants in the pea family and may affect some other species. Do not apply either herbicide directly to water or to areas where surface water is present. Both remain in soil for up to one year depending on application rate. Overspray or drift to desirable plants should be avoided.

Dr. Mark Renz, University of Wisconsin found that Milestone at 7 fluid ounces per acre provided good to excellent control in either June or October and was significantly better than Transline® herbicide at 1 pint per acre applied in June (TechlineNews). Milestone applied at 5 fluid ounces per acre was more effective when applied in October compared to June and provided similar control as Milestone at 7 fluid ounces per acre at this application timing.

Glyphosate at a 1-2% solution is effective but will kill everything it touches so should be used judiciously.

Trefoil species can also be reduced by grazing.

References: http://mipncontroldatabase.wisc.edu/Default.aspx,
http://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/birdsfoottrefoil.html
https://www.techlinenews.com/articles/2013/managing-birdsfoot-trefoil-lotus-corniculatus?rq=trefoil

Canada thistle (*Cirsium arvense*)
While native thistles are not generally problematic, non-native thistles such as Canada thistle are clone-forming perennials that can greatly reduce species diversity in old fields and restoration areas (Hoffman and Kearns 1997). A combination of chemical and mechanical control methods may be needed. Chemical control is most effective when the plants are in the rosette stage and least effective when the plants are flowering. A broadleaf herbicide such as 2,4-D can be used if

native grasses are present. It is most effective when applied 10-14 days before the flowering stems bolt. It is applied at rate of 2-4 pounds per acre using a backpack or tractor-mounted sprayer or in granular form. Dicamba could also be used, with the advantages that it can be applied earlier in the spring at a rate of 1 pound per acre. Plants that do not respond to treatment or that are more widely dispersed could be controlled mechanically.

Mechanical control, involving several cuttings per year for three or four years, can reduce an infestation, if timed correctly. The best time to cut is when the plants are just beginning to bud because food reserves are at their lowest. If plants are cut after flowers have opened, the cut plants should be removed because the seed may be viable. Plants should be cut at least three times throughout the season. Late spring burns can also discourage this species, but early spring burns can encourage it. Burning may be more effective in an established prairie, where competition from other species is good, than in an old field, where vegetation may not be as dense.

Common Burdock (*Arctium minus*)
Burdock is very aggressive biennial species that can be very invasive in both woodland and grassland habitats. It spreads readily and suppresses other species. The seed pods are a hazard to small birds that can become fatally entrapped in the sticky barbs. Burdock can be controlled mechanically controlled by cutting it in the summer before the seeds have formed. A second cutting may be necessary as new seed pods often develop. Timing is important - if cut too early the plant will come back the following year. If cut too late the seeds will create new plants. Burdock can also be treated in late fall, when most native plants are dormant. Herbicide is easily applied to the basal leaves. Common mullein (*Verbascum thapsus*), which can become invasive in grasslands and prairie restorations, can be treated similarly.

Spotted knapweed (*Centaurea stoebe*)
Knapweed is a perennial species that has become a troublesome prairie invader. Of all the typical prairie weeds, spotted knapweed is probably the most difficult to manage. It cannot be controlled with burning—like sweet clover it increases with fire. Hand-pulling individuals or small groups of individuals can be effective for small infestations and is often a good volunteer group task. However, knapweed has a large tap root and can be difficult to pull. Pulling is typically more difficult when soil is hard (dry), clayey, or compacted, but easier when soil is wet (following a rain), sandy, and friable.

If knapweed populations are large, a biocontrol (knapweed beetles--weevils) is recommended. Knapweed beetles (weevils) are released during the summer. Weevils can be purchased online, and they are sent via the mail. Knapweed populations should be monitored each year to keep a record of the effectiveness of the biocontrol. Weevils are effective for long-term control, but not a good short-term control option. Spot treatment with a systemic herbicide such as Milestone or Transline can be effective for short-term control.

Applying herbicide to prairie restoration areas should be done with care. Remnants with high diversity should be spot treated, not broadcast-treated. It is recommended to treat first with the least impactful chemical, monitor to see if that works, and then try another if it does not work. Degraded and highly disturbed areas can be treated a little less gently, perhaps using broadcast applications. Always follow the product label when using any chemical for weed control. Treatment should be done before the target plants form seed, so late spring and early summer are best. Professional pesticide applicators are required for herbicide treatment.

Garlic mustard (*Alliaria petiolata*)
Garlic mustard is a non-native biennial forb of woodlands and woodland edges that is very invasive and aggressive. Following the introduction of just a few plants, populations can rapidly increase, and a dramatic "explosion" of garlic mustard plants can occur. In some areas it can form monotypic stands that crowd out other species, while recent studies have shown that in other locations it may simply occupy open ecological niches. Nevertheless, garlic mustard can be very invasive in woodlands, and it is recommended to monitor and remove it as soon as it is detected (early detection and rapid response). Garlic mustard also produces a flavonoid (root exudate) that suppresses myccorhizal inoculation. Thus, species that are myccorhizae dependent, like oaks, will become stunted and easily outcompeted by garlic mustard. The flavinoid persists in the soil years after garlic mustard plants are removed, which is a good reason to keep woodlands garlic mustard-free.

The best way to prevent garlic mustard infestations is to closely monitor your site, and if garlic mustard is found, hand pull it before it spreads. Hand-pulling should occur before siliques (seed pods) form. Once siliques form, removed plants should be bagged and transported from the site, since the plant may have enough energy in the stem and root to make viable seeds, even though it is not growing in the ground. If bagging and transporting are not an option, making weed piles is an option, but prepare to deal with garlic mustard plants in the future at each pile. Garlic mustard plants produce hundreds of seeds per plant—they are very prolific. When pulling garlic mustard plants, take care to remove the entire root, since they may re-sprout if part of the root is left in the ground. This can be difficult since roots are "S-shaped" and tend to break off at ground level.

Chemical control is not recommended except in cases where garlic mustard is growing in large monocultural patches. In such cases, a systemic herbicide may be appropriate. Glyphosate is non-specific and will kill any actively growing plant. One technique that has been effective is applying a water-soluble herbicide during warm days in the winter, when no snow cover or only a thin snow cover exists. Garlic mustard rosettes (first year plants) remain green mostly all year round and can be killed during the winter when nearly all other plants are dormant. Another successful technique is to use an herbicide specific to broadleaved plants, like triclopyr ("Garlon"), but one that is water soluble, which can be dispensed with a backpack sprayer or the like; this will not kill grasses or sedges.

There are studies underway by the Minnesota DNR and University of Minnesota that show good potential for biocontrol of garlic mustard via an exotic weevil (http://www.legacy.leg.mn/projects/biological-control-european-buckthorn-and-garlic-mustard). The testing phase is complete, but the approval process still needs to be performed. If approved, this method could revolutionize garlic mustard control. However, whether it will be effective or not on a landscape scale is yet to be determined.

Non-native cool season grasses

Non-native cool season grasses include smooth brome, Kentucky bluegrass and reed canary grass. They emerge early in the growing season in southern Minnesota before most native plants are up, go dormant during the hot summer months, and are then actively growing again in the cool fall weather. By getting a head-start on the growing season over native species they can spread and outcompete them. They reproduce by both seeds and underground stems (stolons and rhizomes). Late spring burning (e.g., late May), followed by seeding with native species, can reduce the cool season grasses, especially if burns are done in consecutive years. Late spring burns can be a good tool for on-going maintenance but will be only partially effective and can be very hard on native forbs.

Where cool season grasses are more abundant, more aggressive control methods with herbicides will be needed. The grass would be mowed in late spring, before seeds are produced, and again as needed to prevent seed production, but not past mid-August. The goal is to have vigorous short growth in the fall. After native plants are dormant, e.g., mid-October, the cool-season grasses can be safely treated with glyphosate. The grass can similarly be treated in early spring (April) before natives are up. A grass-specific herbicide, especially clethodim, can be used if there is a concern for native forbs. That herbicide may be less effective than glyphosate so more treatments may be needed.

Reed canary grass is extremely difficult to eradicate and requires repeated treatment over a period of one to three years. It is important to monitor and manage small patches as they occur. Wick-application is a method that can be used for small patches. It is done in early June is a very effective means of control that does not harm adjacent species.

APPENDIX D. RECOMMENDED WORK SPECIFICATIONS FOR RESTORATION ACTIVITIES

1. For all tasks, follow best management practices to minimize negative impacts including but not limited to soil compaction, rutting, and other soil disturbances; herbicide drift and non-target impacts; disturbance to nesting birds and other wildlife.
2. Follow best management practices to avoid bringing weed-seed onto the site. ***All equipment coming from another site should be cleaned prior to entering this site.*** Personal gear, especially boots and laces, must be cleaned off before arriving at the project site. Material cleaned from equipment and clothing should be properly transported in sealed containers and disposed of offsite.

Herbicide and Applicators

1. Contract herbicide applicators must have a current Minnesota Commercial Applicators License issued by the Minnesota Department of Agriculture. All weather guidelines specified in the product label will be followed for pesticide applications. Application supervisor and applicators are responsible for pesticide coverage, placement, and efficacy.
2. Aquatic formula is required when applying within 100 feet of a wetland or water body.
3. The least persistent effective pesticides available will be used. Pesticides must be registered for the specified use by the Environmental Protection Agency (EPA) and the Minnesota Department of Agriculture (MDA). The safety of employees, the public, non-target organisms, and the environment will be given full consideration in the selection and use of any pesticide.
4. Neonicotinoid pesticides are not permitted.
5. Use, storage, handling, or disposal of a pesticide, rinsate, pesticide container, or pesticide application equipment must be done in a manner (M.S. 18B.07 subd.21):

a) consistent with labeling

b) that doesn't endanger humans, and damage agricultural products, food, livestock, fish, wildlife or beneficial insects

c) that will not cause unreasonable adverse effects on the environment.

6. All treatment sites will be posted as specified by the pesticide label, and as required by state guidelines.
7. Records of pesticide application must be completed for each use and records maintained according to state guidelines. Records must be submitted at the time of invoicing.
8. Conduct spot treatments rather than broadcast applications whenever possible.
9. Choose biocontrol over pesticides when available.
10. Spray in **early morning or evening** when bees and other pollinators are less active.
11. Avoid windy days (wind speeds less than 10 mph) and ensure a rain-free period of at least 3 hours after application.
12. Monitor pesticides for dispersal by drift, erosion, or runoff.

13. Prevent herbicide drift to non-target plants. Use wick application or physical barriers where needed.
14. Follow DNR Operational Order 59 (Pesticides and Pest Control) and other appropriate state guidelines.

Tree & Shrub Control

1. Species to control include buckthorn, Tartarian honeysuckle, Siberian elm, black locust, mulberry, Amur maple, peashrub, Scotch pine, and any other species not native to Minnesota that are considered invasive.
2. Cutting method: Cut stems as close to the ground as possible. Person cutting must also treat stumps. To minimize misses, cut no more stems than can be easily remembered. Then stop and treat.
3. Use dye with herbicide so contractor and FMR can see what was treated.
4. Herbicide application: Use **dauber** applicator for stump treating. **Foam applicator** is desired for foliar application.
5. Approved herbicides include Garlon 3a and other triclopyr-based herbicides or glyphosate unless otherwise approved. Oil-based herbicide is not permitted unless prior approved.
6. Brush burning: Where brush burning occurs. stack brush in openings where heat will not damage standing tree trunks or branches. Avoid making brush piles where native woodland or prairie vegetation is well established. Seek disturbed areas, non-native vegetation, or stumps of cut brush/trees. To minimize burn piles, brush can be stacked and burned at same time as cutting if conditions for burning are suitable. Otherwise burn piles in winter.

Forest management practices to protect pollinators & control erosion

1. Contractors must follow MN State BMPs for pollinators https://files.dnr.state.mn.us/natural_resources/npc/bmp_contract_language.pdf
2. Avoid broadcast spraying of pesticides when other effective means of control are available; encourage the use of spot treatments
3. When managing for legacy elements (patches within a treatment area that retain native plant community representation), select areas to include as many plants as possible that produce pollen and nectar
4. Minimize impact to spring ephemerals
5. Retain standing dead and downed logs where possible to serve as nesting habitat for bees, as well as feeding habitat for beetle and hoverfly pollinators whose larvae are saproxylic.
6. When clearing brush on a slope, use trunks of larger brush or small trees (e.g., 4 to 6-inch diameter), laid horizontally across the slope to help reduce erosion. Logs should be minimum length of 4 feet, longer is better.

APPENDIX E. FUTURE CONSIDERATIONS AND ECOLOGICAL IMPACTS

Fire Suppression

The application or withdrawal of ecosystem functions, processes, and components will have varying affects. Sometimes these affects are subtle and sometimes they are overt. They can be acute or chronic. As is so oftentimes the case, there are complex interactions between species and amongst abiotic features that result in changes to or even shifts in ecosystems. For example, periodic fires were very important parts of natural processes prior to settlement. Fire kills small woody seedlings that might otherwise grow into mature trees and shrubs, thus keeping the understory of woodland and the ground layer of savannas open. The resulting open areas allow wildflowers, grasses, sedges, and ferns to thrive. When fires occurred historically, a very diverse and varied herbaceous ground layer flourished under woodlands and savannas, with hundreds of species occurring. The lack of fire over the last 150 years has negatively impacted native woodlands and savannas. In broad terms, woodlands have succeeded and are currently succeeding to forests, with savannas and prairies succeeding to woodlands.

Disease

Oak Wilt

Oak wilt is a very serious fungal disease affecting oak trees that results in tree mortality. Once oak wilt fungus becomes established in one tree, it can move through common root systems to adjacent trees of the same species – red oaks to other red oaks, and white oaks to other white oaks – forming of an "infection center." Infection centers spread rapidly through red oaks and slowly through white oaks. Bur oaks are intermediate in spread rate. Oak wilt can be controlled primarily through reducing and preventing the wounding of trees.

Overland spread of oak wilt by insects can be prevented by following these guidelines on when to prune and when to paint.

High Risk Period: Don't wound or prune during April, May and June. If trees are accidentally wounded, or pruning is unavoidable, cover the wounds immediately or within minutes using one of the preferred materials such as water-based paint or shellac.

Low Risk Period: July through October. The tree's vascular system begins shutting down during this period and appears to be better able to prevent fungal growth. However, infections may rarely occur due to weather conditions and insect populations. Covering wounds is optional.

Safe Period: November through March. This is the preferred time for pruning since the fungal pathogen and insect vectors are inactive.

Tree climbing irons should never be used on living oak trees, even during the "safe period."

Control

Wounded oak trees (e.g., storm damage) are more susceptible to oak wilt, since beetles carrying fungal spores on their bodies are attracted to the scent of fresh wounds and become disease vectors.

To slow the underground spread of the fungus, root barriers are required. The most cost-effective method of creating root barriers is with a vibratory plow – a large, modified backhoe that pulls a

vibrating blade through the ground. The blade typically extends five-feet deep into the soil, cutting roots as it moves. This procedure can be more or less disturbing to the soil and plant community, so deciding whether or not to root-cut should include an analysis of the costs and benefits. Also, vibratory plows will not operate on slopes that are too steep or soils that are too wet or too hard. It is not recommended on the steep slopes of a site, but rather on relatively broad, flat areas. Access for a vibratory plow must be considered and a 10-foot wide lane must be available for machine use.

An alternative method is chemical injections into individual trees, which is used in situations where trees are of high value and/or vibratory plowing is not an option. The downsides of using chemicals is that they are more expensive, they only treat individual trees, not groups of trees, and injections must be repeated every two years to be effective.

Most of the time, oak wilt will affect red or pin oaks, and not affect bur and white oaks. This situation is usually tolerable, since red and pin oaks are somewhat invasive in woodlands and savannas and reducing tree density helps to restore woodlands and savannas. However, if the bur and white oaks become infected, control measures should be assessed as soon as possible. Sometimes there will be no good control options, due to steepness of slopes and presence of outcropping bedrock, etc. Removing wilting red and pin oaks (after control lines are in place, if feasible) is recommended, and properly disposing of the wood, since it can produce spore mats that can spread the disease to any nearby oaks. If there is a high amount of spores in an area, the likelihood of overland infection goes up, even for bur oaks and white oaks.

In some circumstances, monitoring and replanting, with a different tree species or a diversity of tree species is the only solution. See Appendix B for a list of appropriate tree species for the Protected Property.

Bur Oak Blight

Bur Oak Blight (BOB) is a relatively new fungal disease recently discovered in Minnesota, and confirmed in several counties, including Ramsey and Hennepin; so it could potentially occur in Dakota County. This disease kills trees but moves much more slowly than Oak Wilt. It only affects bur oaks, which is a concern in areas containing valuable bur oaks. BOB seems to be influenced by the frequency of rainfall, with more rainfall resulting in conditions more suitable for the disease. Symptoms occur on leaves during July and August, with large, brown, wedge-shaped necrotic lesions forming. Sometimes leaf veins also turn brown. One of the best ways to diagnose the presence of this disease is by examining bur oaks during the winter. Normal bur oaks drop all of their leaves during the winter. If the leaves are retained (even a few), this may indicate that the tree is infected with BOB. The disease overwinters in leaf petioles and spreads throughout the crown of the tree and potentially into other nearby trees over the span of several years. Mortality can result, but often trees that die are located next to ones that are unaffected, so the rate of spread is relatively slow. Control of this disease cannot be attained through raking and burning of fallen leaves, since many leaves remain attached to the tree over winter. However, periodic site-wide burning would reduce the spore load, since many fallen leaves bear fungal

spores. Researchers are supporting the use of fungicide injections since the protection provided by a single injection seems to last for several years.

Dutch Elm Disease

Dutch Elm Disease (DED) is caused by a fungus, which like oak wilt, kills trees and is transmitted via root grafts from tree to tree. Even though it has been active in Minnesota for decades, it has not disappeared and continues to infect and kill many elm trees every year. This should not significantly affect site management, unless large trees die and create large canopy gaps. Gaps will induce a flush of understory plants, which may be dominated by buckthorn; so the sites should be monitored and managed appropriately. It may not be necessary to replace dead elms with new plantings, since native seedlings will sprout in the gaps. Researchers are searching for and propagating individual trees that are resistant to DED, which may restore lost American elms, as well as replace dying ash trees. Some DED-resistant elms are available now, but these are hybrids of Asian species, which may not be desirable, and are often difficult to obtain. It will be many years before native genotype, DED-resistant elms become commercially available.

Non-native and over-populated native animals

Earthworms

No species of earthworms were native to the northern part of the U.S. since the last glaciation over 10,000 years ago. During the last century, "litter dwelling," "soil dwelling," and "deep burrowing" species of have been introduced – primarily as cast-off bait from anglers. Since then, they have become established and are very invasive in our native woodlands and forests. These species move into new areas in waves, one species following another, with ultimately the largest worms, night-crawlers, invading and becoming established. Where soils/systems have evolved without them, these earthworm species, contrary to popular opinion, are not good for the soil – tunneling into the top layers of soil and consuming large amounts of leaf litter (duff). The result of their activities is a net soil compaction and a marked increase in the duff turnover rate (the time it takes for the litter layer to be decomposed and turn into humus). Where there used to be several inches of the light, fluffy duff layer in native forests and woodlands, there is now only a trace of duff or often none, with compacted, bare soil often prevalent. This situation can result in increased erosion and nutrient runoff and lead to detrimental impacts for nearby lakes and streams. The lack of duff layer and soil compaction have negative ramifications on native forb populations, especially spring ephemerals that evolved under conditions that required thick, fluffy duff layers.

White-tail Deer

Another factor of the woodland decline is over-browsing/over-grazing. Areas that were pastured by cattle or sheep received heavy grazing pressure that was previously unknown. Native grazers (primarily bison and antelope) would move around and not concentrate in one area for long periods of time. This allowed a very diverse forb layer to thrive. With the introduction of cattle

in the last century and a half, that grazing pattern changed. Cattle will concentrate their grazing much longer and their impacts are much greater. Many native forbs simply cannot survive this type of grazing pressure.

Today, deer browsing, not grazing, has a more significant negative impact on woodlands. Deer populations in the Metropolitan Area have significantly increased over the last century, due to direct and indirect causes. The conversion of native forest, woodland, savanna, and prairie, first to agricultural land and then to more "suburbanized landscapes," has favored deer. Forest fragmentation and managing for large gaps and residential lots, with linear woodlands, has greatly increased the suburban "edge effect." Deer prefer areas with large amounts of long, linear forest/woodland edge that can be used as open areas to feed and wooded areas for cover. Active vegetation management for deer hunting by wildlife managers has also increased deer abundance. Deer prefer to feed on many native forbs, shrubs, and tree seedlings. Although deer will eat buckthorn and honeysuckle, they do not prefer them if given the choice. This combination of factors greatly increases the browsing pressure on the few natives that can survive earthworm and buckthorn infestations. The lack of oak regeneration, typical of such woodlands, is one result of these conditions.

The synergistic effect of four factors: fire suppression, earthworm infestation, buckthorn/ honeysuckle invasion, and high deer browsing pressure, has resulted in oak woodland decline. Although difficult to remediate, this decline can be improved and possibly reversed by implementing appropriate management activities.

Emerald Ash Borer

Emerald Ash Borer (EAB) is a small beetle from Asia that was recently introduced to the United States, first showing up in Michigan and Maryland in the 1990s (via packing material), and now in Minnesota since 2009. EAB is a wood boring insect whose larvae feeds on the inner bark and phloem of ash trees and kills them. All native species of ash are susceptible, including black, green, red, and white, as well as many planted cultivars. Primary damage is caused by larvae as they feed and produce galleries within the phloem and outer sapwood. Tree mortality occurs within one to three years of initial attack. For more information on the life cycle, symptoms, and control of EAB, see the Minnesota Department of Agriculture website: www.mda.state.mn.us/en/plants/pestmanagement/eab.aspx.

EAB is now widely established in Minnesota, especially in the Twin Cities metro area. Though all properties with ash trees will be affected, one small bit of hope for a natural control of EAB is cold temperatures. According to Lee Frelich, Director of the University of Minnesota Center for Forest Ecology, "winter mortality of EAB is definitely temperature dependent." A recent study in Minnesota showed that five percent of insect larvae die at 0 degrees Fahrenheit (F), 34 percent at -10 degrees F, 7 percent at -20 degrees F, and 98 percent at -30 degrees F. However, since the larvae overwinter under the bark and are insulated, air temperatures need to be slightly colder to have the measured effect, and larvae need to be exposed for prolonged periods of time for mortality to occur.

Another potential method of biological control is with three species of Asian wasps. These wasps are tiny and stingless, about the size of a gnat. In their native China, they parasitize the larvae and eggs of emerald ash beetles, which reduce EAB populations over the long term. EAB will never be eradicated by wasps since there will always be a level of population that does not get parasitized, but the wasps have the potential to keep EAB in-check.

Proper sanitation is an important strategy for slowing the spread of EAB. Sanitation is the prompt removal and appropriate disposal of dead and dying ash trees that are symptomatic for EAB, when EAB is known to occur in the vicinity (within 15 miles). Unfortunately, this strategy does not usually eradicate the insect.

For more information on the life cycle, symptoms, and control of EAB, see the Minnesota Department of Agriculture website: www.mda.state.mn.us/en/plants/pestmanagement/eab.aspx.

Climate Change

With the advent of global climate change, conditions for plant communities are changing. By the end of the century, scientists believe that much of Minnesota will not be conducive for the growth of boreal pine or boreal mixed forests. The climate of the Twin Cities will be more like that surrounding Sioux Falls, South Dakota, or Oklahoma City, Oklahoma. Minnesota is expected to receive the same average amounts of precipitation or slightly more, but yearly distributions will be different. More rain is expected during the winter months and less rain during the summer months. The result will be a sort of "savannafication" of the region.

By facilitating the movement of plants from more southerly and westerly regions of Minnesota, degradation of natural areas may be mitigated or averted. By promoting healthy oak woodland, oak savanna, and prairie ecosystems, the potential negative shift from unsustainable land management expectations and serious loss of diversity to better outcomes can occur by focusing on strategies emphasizing resistance and resilience. Appropriate actions could mimic, assist, or enable ongoing natural adaptive processes, such as species dispersal and migration, population mortality and colonization, changes in species dominance and community composition, and changing disturbance regimes.