Ecological Management Recommendations
Carver Preserve

February 2023

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

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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 Carver Preserve. The 27-acre property, owned and managed by the City of Maplewood, is in the far southern part of Maplewood, just west of Highway 494 at the northwest corner of Carver and Sterling. Fish Creek Natural Area is just south of the preserve, Carver Lake Park in Woodbury is to the east and there are other large natural areas in proximity, with the Mississippi River about 1.25 miles 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 would 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. About a third of the site is grassland, dominated by non-native grass, and the rest of the site is mostly wooded, with a dense understory of invasive common buckthorn. There has not been any significant ecological management of the site in recent years.

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

Carver Preserve is located within the Metro Conservation Corridors - a regional land protection plan – and is located within proximity to several other natural areas and the Mississippi River. While no rare plant or animal species have been recorded on the property, it is within the high potential zone for rusty patched bumblebee habitat. 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.

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 about 12 acres open grassland (dominated by non-native grasses), 11 acres wooded with dense buckthorn, 3 acres grassland with patchy trees, and half an acre of wetland.

The primary ecological concerns at the property are non-native invasive woody and herbaceous species, and depauperate native species diversity. 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 management, this property will inevitably be overtaken by invasive plants, and gradually lose structural and species 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. 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 Mesic Savanna, Southern Dry-Mesic Oak Woodland, Southern Terrace Forest, 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 and to continue to monitor and control them in the future. Controlling non-native herbaceous plants in the woodland, such as garlic mustard and burdock, and re-establishing native species is a secondary priority. Conducting annual monitoring and assessment is also a high priority to address emerging issues and to evaluate the success of management efforts.

The second main priority that warrants timely intervention is restoration of the grassland areas to eradicate the non-native grasses and establish a diverse cover of native prairie species, with an emphasis on species beneficial for pollinators.

Given the strong city support at the site, these ecological restoration activities can be completed by a combination of the city, other conservation-minded 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 $181,500. The grant funding obtained by FMR will cover the first year of project. An additional state grant has been applied for that will cover most of the remaining tasks.

SITE INFORMATION

LOCATION

Owner: City of Maplewood

Address: 2413 Carver Ave E, Maplewood, MN 55119-5917. (**Figure 1**)

Owner: City of Maplewood

Acres: 26.57

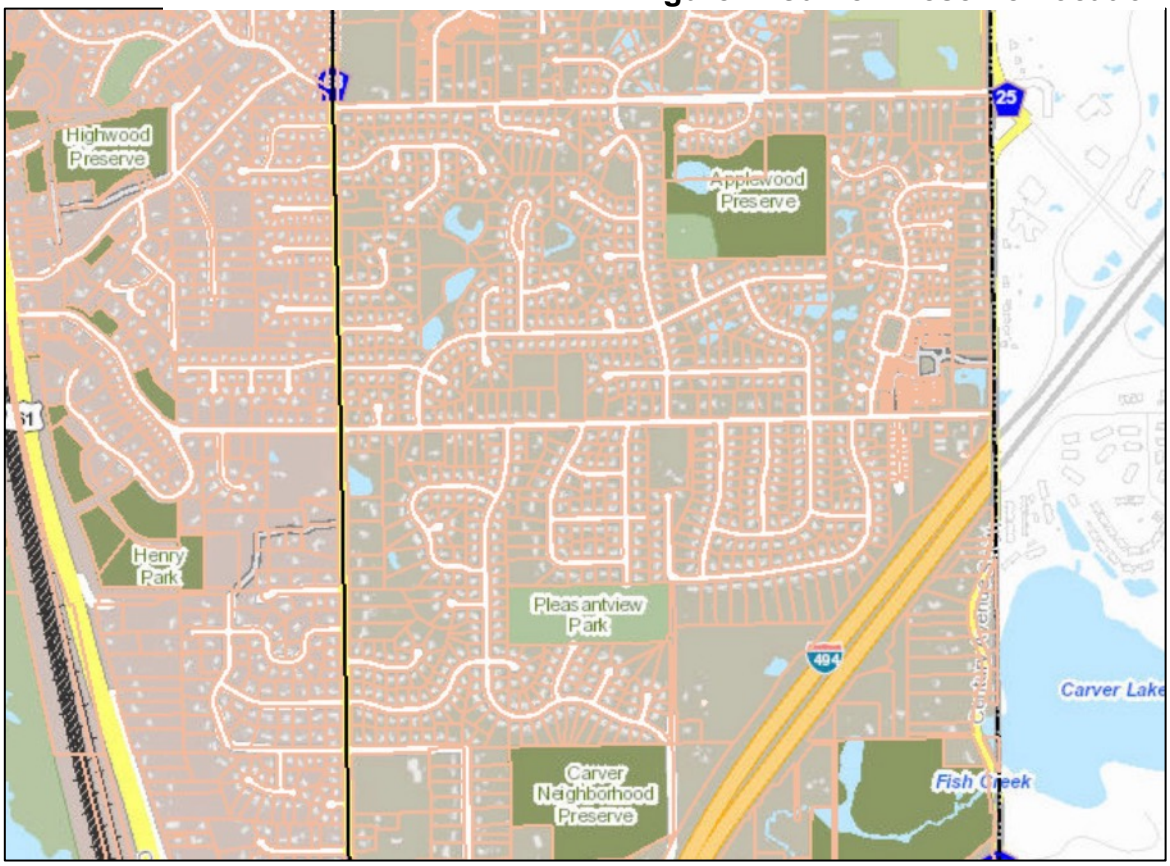
Parcel ID: 242822210013

Legal Description: Township 28, Range 22 (Dir 2), Section 24

Watershed: Mississippi River, Fish Creek

Watershed Organization: Ramsey-Washington Metro Watershed District

Figure 1. Carver Preserve Location



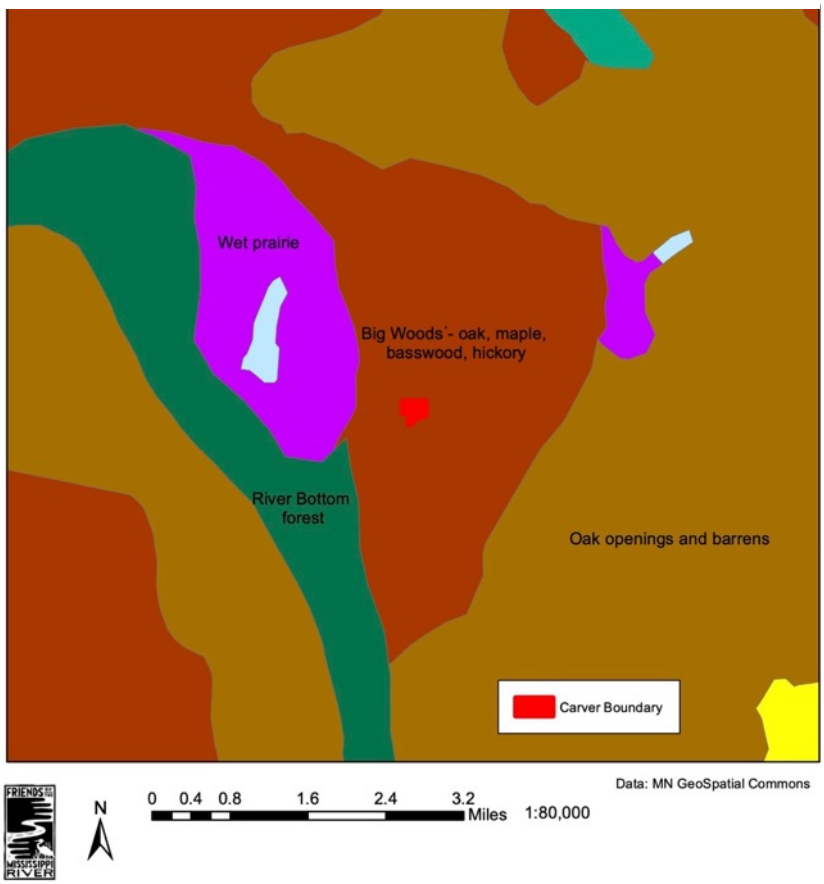
HISTORICAL VEGETATION AND LAND USE

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 p lant community at Carver 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, and the trees closest to them. The bearing trees near Carver 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.

FIGURE 2. Pre-Colonization Vegetation



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

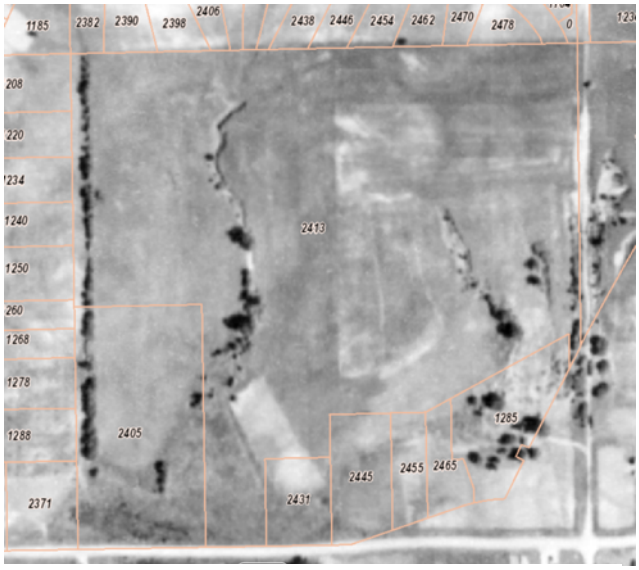
In 1940 the site was mostly grassland and cropland, nearly devoid of trees except for along the ravines. If the site had been wooded, the trees had been cleared from the land and it was converted to agricultural uses. The primarily use appears to have been pasture or hayfield, with a few acres that may have been cultivated.

In 1953 it appeared to be in very similar use, with a small grove of trees established in the far southeast and increased trees in the ravines. By 1974 these patches of trees had expanded somewhat, and the land usage was not apparent although there may have been some pasture use. From 1974 to 2003 the land changed dramatically, with increased trees and shrubs covering over 75% of the western half of the property. The eastern half was clearly delineated with a north-south demarcation of trees. The eastern half remained largely open grassland, with a grove of trees in the southeast accounting for roughly 20% coverage of the east half.

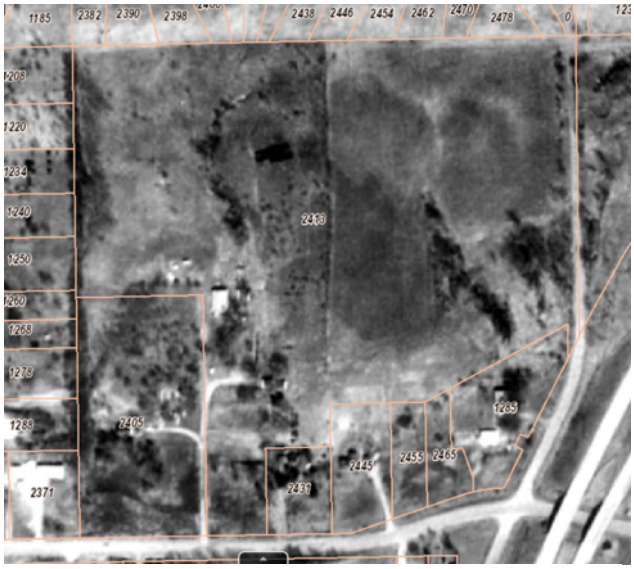
The 2022 aerial shows a further increase in woody cover. The western half of the site is 95% wooded with a few small grassland pockets and a small wetland, while the eastern half is about 30% wooded, 15% shrubland, and 55% grassland. Non-native species dominate throughout, with smooth brome grass in the grassland, and common buckthorn in the wooded area. While the site

provides wildlife habitat, especially for common habitat generalist species (e.g., deer, turkeys, rabbits, fox), the abundant non-native species do not provide the resources needed by many native wildlife, especially certain bird and pollinator species.

Figure 3. Historical Aerial Photographs



1940



1974

2003

2022

ECOLOGICAL ASSESSMENT

METHODS

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

Each of the land cover types was then assigned a Quality rank from 1 to 4, high to low (**Table 1 and Figure 5**), based primarily on species composition and restoration potential. Specific criteria were the abundance of invasive, non-native plants and the abundance and diversity of native plant species. The rankings were subjective and entirely relative for this site; they do not relate to state Quality rankings or to other sites. The highest-ranking units, therefore, do not necessarily denote what would be considered a high-quality unit by MN DNR standards, but were units that had the least abundance of non-native invasive species, and greatest cover and diversity of native species.

The highest quality rankings of 1, were given to the large grassland in the central and north-eastern part of the park and to the oak woodland area (7.4 acres total). Although dominated by non-native brome grass and abundant buckthorn in the woods, the rationale for these rankings is based primarily on the ease of restoration and potential ecological value of these cover types.

A quality rank of 2 was assigned to the shrubby grassland north of the large grassland, the aspen woodland on the western park boundary, the mixed conifer patch along the southern boundary, the lowland forest in the easternmost ravine and the mapped wetland (5.6 acres total). These areas have either native trees in the canopy and/or offer unique wildlife value such as native evergreen cover or wetland habitat.

Cover types with high invasive species cover, few native species and that will require significant resources to restore were ranked as 3 (5.1 acres) or 4 (0.3 acres).

Based on existing cover, relative habitat quality rankings and ecological factors, management units were delineated to guide restoration efforts. Sixteen ecological management units were created (**Table 2 and Figure 6**). For each unit 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. The three Pond units, including their associated wetland, were not evaluated other than to note if there were any invasive species present.

FIGURE 4. Existing Land Cover

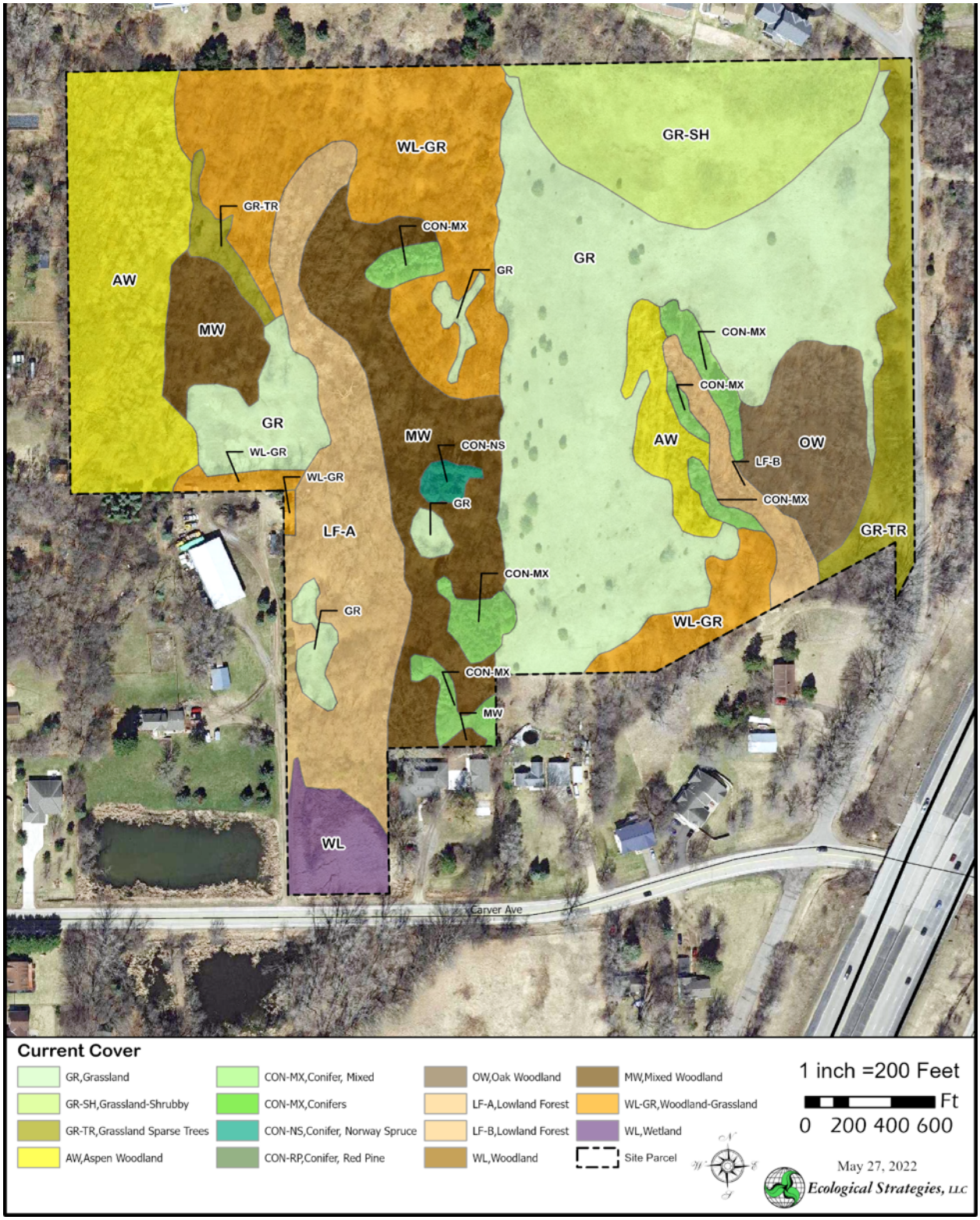


Table 1. Existing Land Cover and Relative Habitat Quality

	Cover Type Code	Cover Type Description	Acres	Relative Habitat Quality
GRASSLAND				
	GR	Grassland – large eastern patch	6.3	1
	GR	Grassland – smaller patches	1.1	3
	GR-SH	Grassland – shrubby	2.4	2
	GR-TR	Grassland – sparse trees	1.2	3
WOODLAND				
	WO-GR	Woodland-Grassland	3.5	3
	WO-GR	Woodland-Grassland	0.1	4
	AW	Aspen Woodland	3.1	2
	CON-MX	Conifer, Mixed	0.2	2
	CON-MX	Conifer, Mixed	0.2	3
	CON-NS	Conifer, Norway Spruce	0.1	4
	CON-RP	Conifer, Red Pine	0.2	3
	LF-A	Lowland Forest	2.6	3
	LF-B	Lowland Forest	0.5	2
	MW	Mixed Woodland	0.1	4
	OW	Oak Woodland	1.1	1
WETLAND				
	WL	Wetland	0.5	2

FIGURE 5. Relative Habitat Quality Ranking

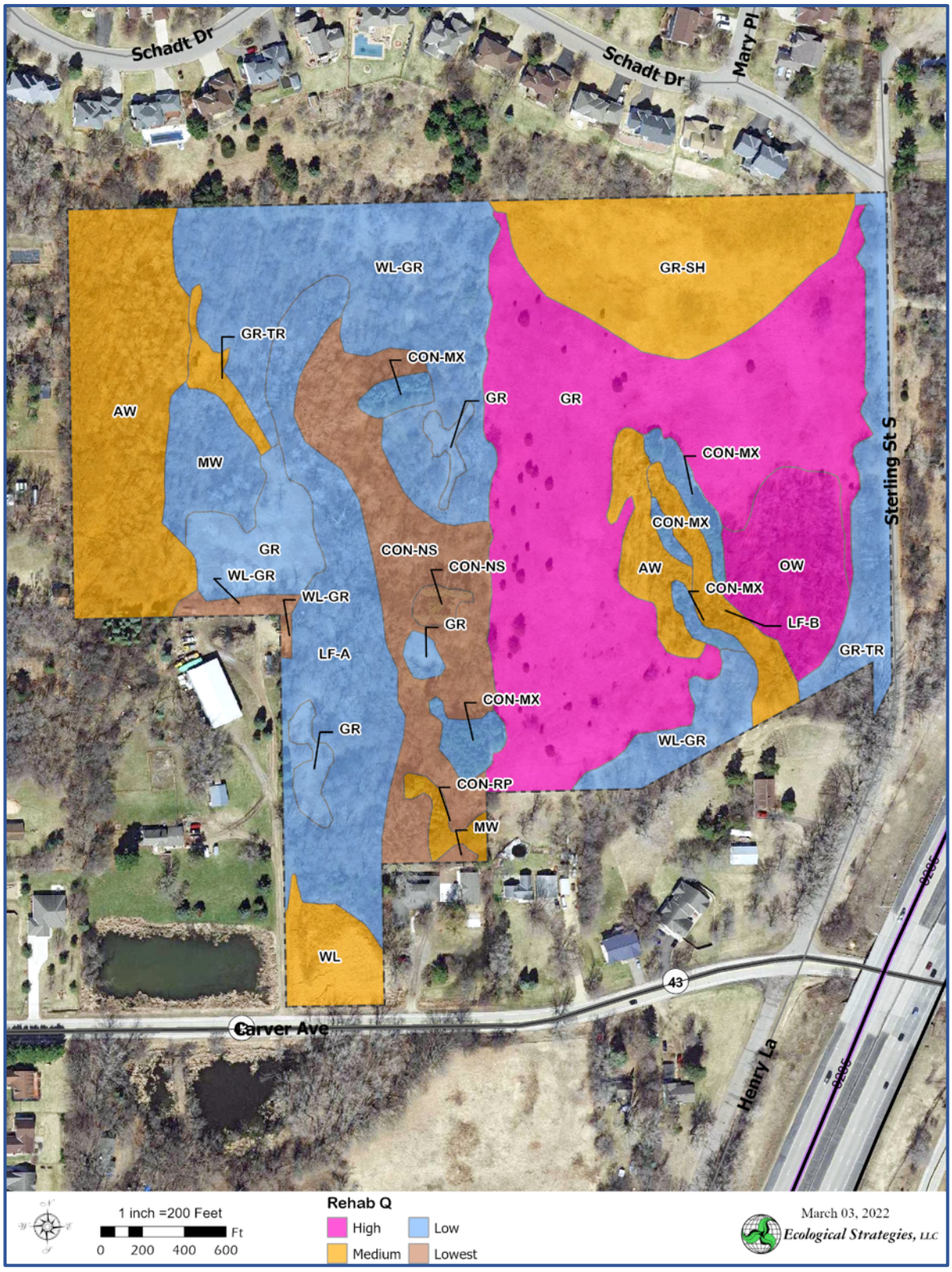


FIGURE 6. Management Units

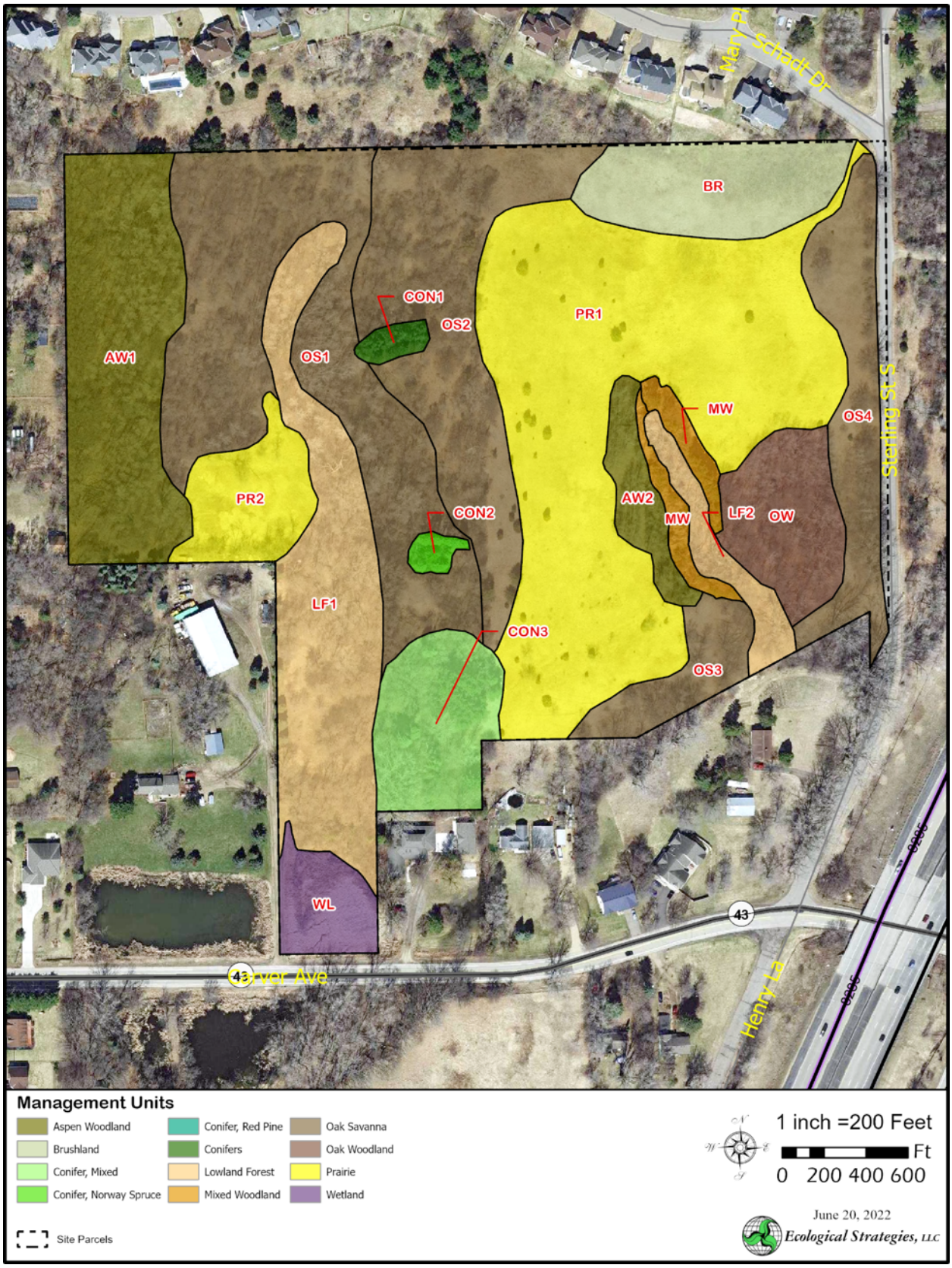


Table 2. Management Units and Target Plant Communities

GRASSLAND

MU Code	Management Unit Type	Acres	Target Plant Community
PR1	Prairie	6.3	Southern Mesic Prairie (UPs23)
PR2	Prairie	0.8	Southern Mesic Oak Savanna (UPs24)

BRUSHLAND

MU Code	Management Unit Type	Acres	Target Plant Community
BR	Brushland	1.3	Brushland

SAVANNA

MU Code	Management Unit Type	Acres	Target Plant Community
OS1	Oak Savanna	3.0	Southern Mesic Oak Savanna (UPs24)
OS2	Oak Savanna	3.0	
OS3	Oak Savanna	0.6	
OS4	Oak Savanna	1.3	

WOODLAND

MU Code	Management Unit Type	Acres	Target Plant Community
Deciduous Woodland			
AW1	Aspen Woodland	2.6	Aspen Woodland
AW2	Aspen Woodland	0.5	
OW	Oak Woodland	1.0	Southern Dry-Mesic Oak (Maple) Woodland (FDs37)
LF1	Lowland Forest	2.8	Southern Terrace Forest (FFs59)
LF2	Lowland Forest	0.5	
Conifer Groves			
CON1	Conifer Stand	0.12	Conifer Stand
CON2	Conifer Stand	0.10	
CON3	Conifer Woodland	0.20	Conifer Woodland
Mixed Woodland			
MW	Mixed Woodland	4.2	Mixed Woodland

WETLAND

MU Code	Management Unit Type	Acres	Target Plant Community
WL	Wetland	0.5	MRn83 Northern Mixed Cattail Marsh

SOILS AND GROUNDWATER

Site Soils

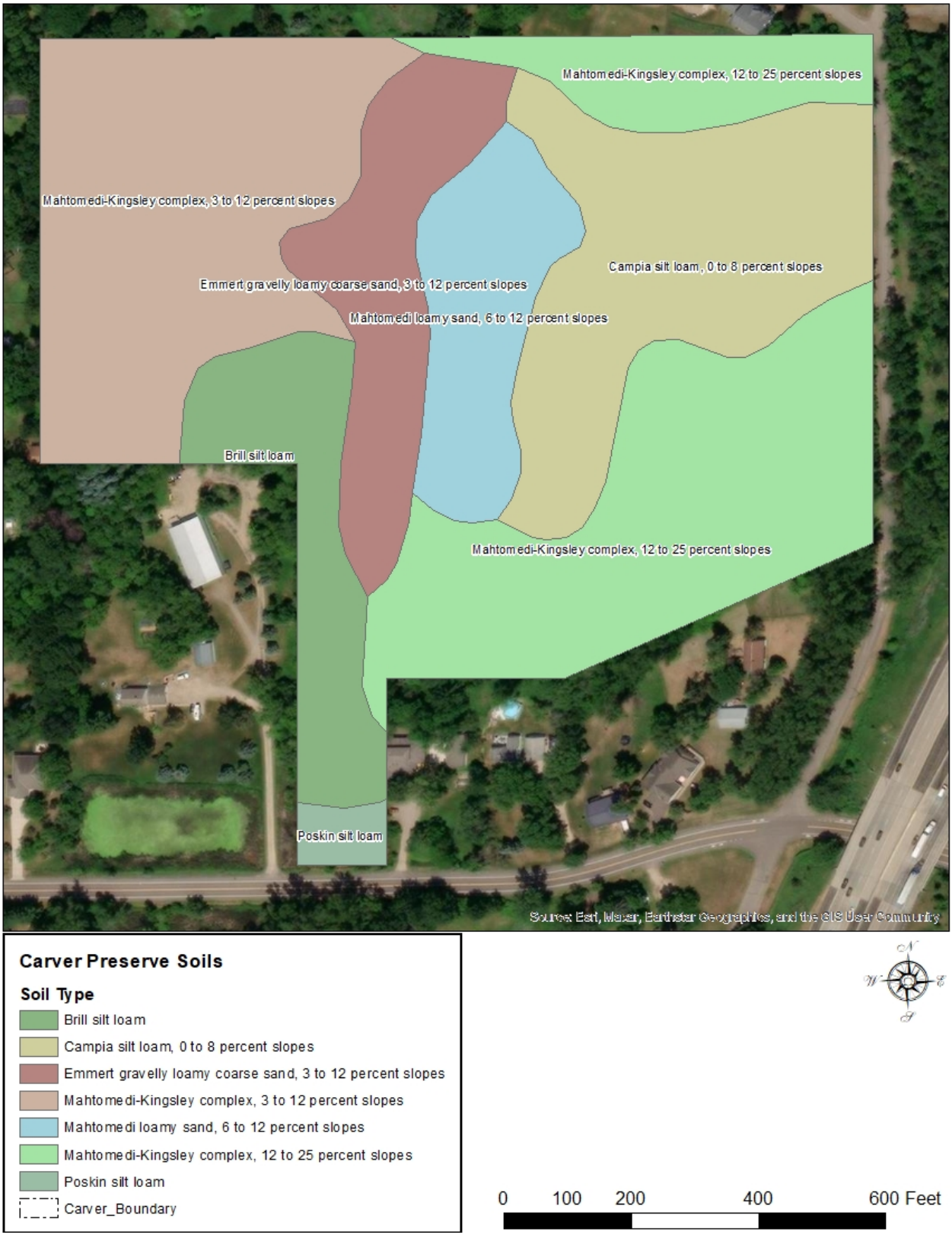
Soils within the park are somewhat homogenous, with Mahtomedi-Kingsley complex and Mahtomedi loamy sand on varying slopes across 16 acres of the 27-acre site. Mahtomedi loamy sand soils are excessively drained, rapidly permeable, and occur on broad flats, side slopes, and slightly convex crests of glacial moraines. Kingsley sandy loams that combine to form the complexes are well-drained and moderately slowly permeable. These soil types are moderately erodible, but Mahtomedi loamy sands contain less than 1% organic matter. By contrast, the Kingsley sandy loams contain 2-4% organic matter which are rated as "fair" to "poor" for establishment of herbaceous plants and coniferous and deciduous shrubs and trees associated with restoration. Complexes containing both soil types have moderated conditions of drainage and permeability.

Making up approximately 8 acres of the site are three different silt loams: Brill, Campia, and Poskin silt loams. Brill silt loam is a moderately well-drained soil in slightly concave positions in drainageways and depressions and has moderate permeability and organic matter content. Campia silt loam is a well-drained soil in level and convex areas on glacial lake plains and has moderate permeability with high available water capacity. Poskin silt loam is a somewhat poorly drained soil occurring on drainageways and depressions outwash plains and valley trains and has moderate organic matter content. Permeability is moderate in the silty mantle and very rapid in the underlying sand and gravel. Poskin silt loam has moderate available water capacity and low organic matter content. All three of these silt loams are rated as "good" for establishment of herbaceous plants and coniferous and deciduous shrubs and trees.

An approximately 3-acre area of Emmert gravelly loamy coarse sand is present at the southern tip of the park. This soil is excessively drained and occurs on convex knolls and side slopes on pitted outwash plains. Emmert soil has very rapid permeability and low available water capacity, so the hazards of drought, erosion, and nutrient loss through leaching are severe. These soils contain less than 1% of organic material, and as a result, are rated as "poor" for establishment of herbaceous plants and coniferous and deciduous shrubs and trees associated with restoration.

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

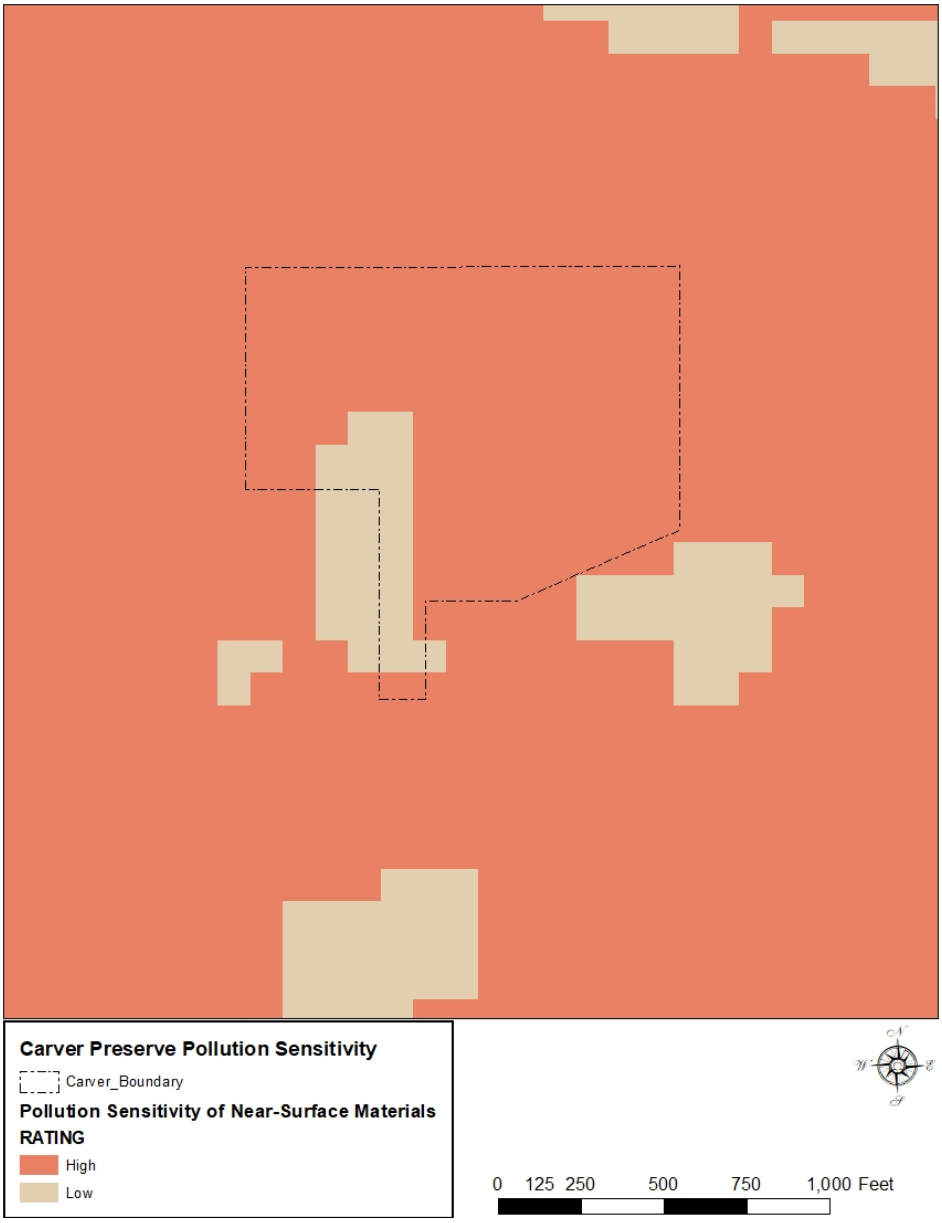
FIGURE 7: Carver Preserve Soils



Groundwater Pollution Sensitivity

Tied to soil types are the site's near surface materials and depth to bedrock and how these factors tie into sensitivity to groundwater pollution. Pollution sensitivity across the site is primarily high given the high permeability of the loamy sands. Specific care should be taken in the selection of herbicides and use of chemicals and gas-powered equipment. The areas of silty loam by contrast are considered to have low sensitivity with finer soil particles slowing pollutant transport to coarser grained material at depth. Figure 8 below delineates the degree of pollution sensitivity.

FIGURE 8: Carver Preserve Groundwater Pollution Sensitivity



GRASSLAND MANAGEMENT UNITS

Unit PR1 – Prairie

The PR1 Prairie management unit is a 6.3-acre grassland located in the central and eastern parts of the park.

Currently, the grassland is dominated by non-native invasive species such as smooth brome, Kentucky blue grass, crown vetch and leafy spurge. Overall species diversity is low, but there are scattered native plants including stiff and showy goldenrod, heath aster, and round-headed bush clover. There are occasional trees, especially near forested edges, including red cedar, Siberian elm and jack pine.

Red cedar is a native tree, but can form dense stands in absence of fire or mowing and crowd out prairie grasses and forbs. However, the evergreen foliage offers wildlife nesting and cover, and the fleshy cones are eaten by birds and mammals.

Leafy Spurge

The soil types are somewhat poorly drained Crystal Lake silt loam near the core of the grassland and well drained Mahtomedi-Kingsley complex on the northern and southern areas of the current grassland.

Restoration of this large grassland to a diverse native prairie community would significantly increase habitat value for beneficial insects and wildlife, improve the aesthetic value for park users and reduce invasive species populations that are a

seed source for neighboring yards and natural areas. The target native plant community for this grassland is UPs23 Southern Mesic Prairie.

Management Task Overview

- Utilize fire, mowing and/or herbicide applications to reduce abundance of non-native species and convert to diverse mix of native prairie grasses and forbs.
- Eliminate Siberian elm and maintain cover of cedar at the current abundance.
- Re-establish fire as an ecosystem process on the landscape.
- In the longer-term, utilize mowing and cutting as needed to prevent woody trees and shrubs from overtaking prairie grasses and forbs.
- Re-shape the boundaries with adjacent oak savanna to break up linear forms and create more natural looking and wildlife friendly edges.

Unit PR2 – Prairie

Unit PR2 – Prairie is a small 0.8-acre grassland in the southwestern part of the park. The area is dominated by non-native grassland species such as smooth brome, reed canary grass, barnyard grass, and Kentucky blue grass. The cover of the invasive forbs is also high including Canada goldenrod, crown vetch and Queen Anne's lace. Native forb species diversity is low, but beebalm, calico aster, and poke milkweed were observed. Around the edges there are a few scattered boxelder, Siberian elm and apple trees.

The soil type is a Brill silt loam.

While smaller than the PR1 prairie area, the restoration of this field also has the potential to offer important habitat for pollinators and other wildlife. The lower slope and heavier soils that occur here could support prairie species associated with mesic conditions. The target native plant

community for this area is UPs24 Mesic Oak Savanna – although restoring a community less diverse than the full complement of an oak savanna is a more realistic goal.

Management Task Overview

- Eliminate Siberian elm and other non-native woody invasive species in the grassland and on the perimeter.
- Options for restoration:
    - A - Reduce the abundance of non-native species and convert to diverse mix of native prairie grasses and forbs. Use mowing and fire to maintain a grassland condition. This Unit has the potential to provide important pollinator habitat.
    - B – Establish a matrix of native grasses and easy to establish, competitive forbs, then plant bur oaks and maintain with occasional mowing. This option will provide some pollinator habitat, cost less for seed, and present an opportunity to establish oaks.

BRUSHLAND MANAGEMENT UNIT

Unit BL – Brushland

This Management Unit is a 1.3-acre area on the northern edge of the large grassland.

The ground-layer vegetative cover is similar to the large grassland to the south (PR1), except that there are large patches of smooth sumac.

Brushlands were once common in the prairie-woodland interface of Minnesota, but are now rare. Preserving and restoring brushland in this area will improve views for park visitors and provide important wildlife food and cover.

Management Task Overview

- Manage to maintain and create a native brushland.

- Treat to control non-native species and convert openings to a mix of competitive native prairie grasses and forbs.
- Plant additional native shrub species to increase wildlife value.

SAVANNA MANAGEMENT UNIT

Four oak savanna management units were identified to provide opportunities for oak tree regeneration, offer visual screening on the south and east park boundaries, and to address the highly degraded and invasive species infested areas in some of the wooded portions of the park.

Unit OS 1 & 2 Oak Savanna

The canopy in OS1 – Oak Savanna unit (3 acres), is scattered green ash, boxelder, American elm and aspen. Occasional cottonwood and apple cultivars also occur. The understory is dominated by buckthorn, honeysuckle, garlic mustard, crown vetch, creeping Charlie and other weedy species. Because of the density of invasive species, the ground layer has few native species other than tenacious species such as white snakeroot, wild grape, Virginia creeper and goldenrod species.

Given that most ash trees are likely to die from emerald ash borer (EAB) infestations and with the high cover of invasive species, the most cost effective and likely to succeed method for restoration will be an almost complete removal of current vegetation. The understory could be cut with a forestry mower or similar equipment, along with the removal of ash and short-lived elm and boxelder. This would open the canopy enough to establish a native grass cover. Native grasses will help out-compete invasive species and will also facilitate the use of fire as a management tool.

The OS2 – Oak Savanna (3 acres) unit is adjacent to the open grassland unit and has more canopy openings and bur oak present than OS1. The same restoration approach of removing all understory vegetation and short-lived trees, followed by establishing native grass and forb species is recommended for this area. The target community for all the oak savanna units is UPs24 Mesic Oak Savanna.

Units OS 3 & 4 Oak Savanna

The OS3 and OS4 – Oak Savanna units 0.6 and 1.3 acres) occur along the southern and eastern borders of the large PR1 – Prairie unit. The grass and forb cover are similar to other grassy areas with non-native species dominant. Scattered trees occur including native northern pin oak, boxelder, and the occasional green ash, red cedar and American elm. Invasive species such as Autumn olive, Siberian elm, honeysuckle and buckthorn also occur in these units.

On the west side of OS4 is a utility ROW. The cover in the ROW is weedy with smooth brome, Kentucky blue grass and honeysuckle. It will be important to determine what management, if any is planned by the utility company for this area and modify management methods as needed to be compatible with planned maintenance.

The lower slope portions of OS3 and OS4 have moister conditions which should be considered when designing seed mixes and tree planting plans.

The primary benefits of restoring oak savanna to these two areas are to increase oak tree abundance – important for many beneficial insects and wildlife species, improve visitors park

experience by screening views of surrounding buildings and increase privacy for neighboring residences.

Management Task Overview

- Improve planting sites for oak trees by removing non-native trees and shrubs including Siberian elm and Autumn Olive and reducing the cover of native, but short-lived species including green ash, boxelder and aspen.
- Sow understory openings to prairie grasses and forbs.
- Plant northern pin and bur and protect from browse.
- Re-establish surface fires where feasible.

WOODLAND MANAGEMENT UNITS

Unit AW1 – Aspen Woodland

The largest block of aspen woodland, 2.6 acres, is located along the western boundary of the park.

The dominant canopy tree is aspen. However, many aspen trees are mature and showing signs of decline. Other common canopy trees are American and Siberian elm, green ash, with the occasional catalpa. The higher ridge on the southwest corner of the polygon has a few red cedar and bur oak. There are occasional black cherry, green ash and red oak seedlings.

Spotted Dead Nettle *(Lamium maculatum)*

The understory species diversity is low, but includes white snakeroot, fragrant bedstraw, sky blue aster. The lack of tree seedlings and diverse understory vegetation is likely due to the high density and cover of common buckthorn which dominates the shrub layer. In addition, invasive forb species, such as crown vetch, garlic mustard and Queen Anne's lace are present in the ground layer. There is also at least one patch of the invasive spotted dead nettle in the understory.

Areas with bare soil occur throughout the woodland and likely indicate the presence of non-native earthworms.

Ground layer vegetation

Bare soil patches on ground layer

There is no official native plant community for aspen woodland, but the goal for this community will be to maintain an aspen-dominated canopy and to restore an understory of native species. Given the history of high invasive species cover, establishing competitive native species will be a more realistic goal than attempting to restore diverse native ground and shrub layers.

Management Task Overview

- Control buckthorn and herbaceous invasive species.
- Once invasive species have been reduced in abundance, add seed or plants or native shrubs, grasses and forbs to restore the site to native species dominance.
- Create canopy openings to promote aspen regeneration.

Unit AW2 – Aspen Woodland

Along the edge prairie and eastern-most ravine is a second aspen woodland 0.5 acres in size. Aspen is the primary canopy tree, with a grassy understory of smooth brome and Kentucky blue grass.

Management Task Overview

- Remove woody invasives
- Conduct ground fire when burning adjacent grassland.
- Broadcast competitive native grasses into understory.

Unit OW - Oak Woodland

The OW – Oak Woodland unit (1.0 acres) is in the south eastern portion of the park. While the current tree canopy is a of northern pin oak, aspen, cottonwood and paper birch, the presence of oaks offers an opportunity to restore oak woodland.

The understory is dominated by buckthorn, with some larger diameter plants present. There are occasional honeysuckle and garlic mustard present as well. The target plant community for this unit would be Southern Dry-Mesic Oak Woodland (FDs37).

Management Task Overview

- Remove dead or dying trees and mature aspen to create canopy openings and encourage oak regeneration.
- Conduct prescribed burns to help control non-native woody species and stimulate oak woodland understory species.
- Plant oaks in canopy openings and protect from mammalian browse.

Unit CON-1,2,3 Conifers

Conifers occur in three primary patches of the park as rows of planted trees. The units total 1.3 acres, with Con3 the largest at 1.1 acres. Because of the dense canopy cover, the ground layer typically has just a few sparse plants.

Norway Spruce Plantation and White Cedar

Conifers are also found as scattered among the deciduous tree units. Along the western edge of the prairie are occasional jack pine and red cedar. In the short term, we do not suggest restoring these units to a native plant community but to manage them for invasive species and to create better growing conditions for a diversity of species.

Recommendations for management of the jack pine and red cedar associated with oak savanna and prairie management units will be provided in those sections.

Management Task Overview

- Thin 1/3 to 1/2 of the trees from the stand to create growing space for the remaining trees.
- Control invasive species after the thinning occurs and light levels in the understory increase.

- Leave trees standing at maturity to provide nesting and other habitat for wildlife.
- In the long-term, convert the conifer stands into oak savanna by including these areas in prescribed burns. An alternative long-term goal for CO3 is to manage the stand for the continued presence of conifers by thinning trees, removal of short-lived deciduous trees and planting white pine.

Unit LF 1 - Lowland Forest

The eastern most lowland forest (2.8 acres) occurs in the lower part of a ravine that runs through the park. The northern-most end of the ravine has been used for dumping (see image below).

Typical of drainage areas, the dominant tree species are boxelder and cottonwood. There is a high cover of buckthorn and the understory is sparse with creeping Charlie, white snakeroot, violet species, and enchanters nightshade.

Also in the bottom of the ravine is a significant pile of trash, such as old tires, concrete rubble and plastic junk.

While the LF units are not likely to be restored to a true native plant community, the most similar target community is Southern Terrace Forest (FFs59). As invasive species are managed, native species (**Appendix B**) can be added to regain some of the ecological functions of that community.

Mature cottonwood and river grape

Management Task Overview

- Control buckthorn, honeysuckle, garlic mustard and other invasive species.
- Replanting with native species will likely be needed.
- Remove dumped materials and install bioengineering controls to reduce runoff during storm events.
- Regenerate cottonwood trees.

Dump in LF1 ravine

Unit LF 2 - Lowland Forest

The other larger ravine in the park has similar lowland forest species with large diameter cottonwood, boxelder and silver maple. Again, buckthorn density is high and weedy species such as garlic mustard and creeping Charlie common in the ground layer.

Preventing excessive soil erosion due to more severe storm events and promoting cottonwood regeneration are management challenges for this unit.

Management Task Overview

- Control woody invasive species including buckthorn.
- Replant sapling cottonwood to ensure the species remains present in the community.
- Monitor for erosion from storm events and employ bio-engineering as needed to slow water flow and increase infiltration.

Unit MW - Mixed Woodland

Along both sides of the eastern-most ravine is a mixed woods of deciduous and coniferous trees including aspen, birch, northern pin oak, bur oak, red pine and jack pine. As shown in the photo above, the sunlit forest edges are dense with invasive shrub species including buckthorn and honeysuckle. Garlic mustard occurs in the ground layer. Native ground layer plants also occur such as green ash seedlings, sweet scented bedstraw, enchanters nightshade and hairy Solomon's seal.

Management Task Overview

- Reduce or eliminate invasive species cover.
- Plant seedlings of canopy trees and understory shrubs and protect from mammalian browse.

WETLAND MANAGEMENT UNIT

Unit WL - Wetland

The wetland is primarily non-native cattail species (0.5 acres) and reed canary grass. Along the edges there are occasional blue joint grass, wool grass, lake sedge and native forbs such as water smartweed and marsh horsetail.

Conversion back to native cattail species and increasing species diversity is challenging; however, the site is easily accessible for restoration activities and wetland provide important wildlife habitat.

Management Task Overview

- Conduct a prescribed fire to reduce cattail cover.
- Further reduce cattail as needed with herbicide, or by soil removal, to create opportunities for other species to establish.
- Seed with native wetland graminoids (grasses and sedges) and forbs.

ECOLOGICAL MANAGEMENT RECOMMENDATIONS

RESTORATION GOALS

The main goals for this site will be to create 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 several 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 <10% in treated units by the end of the second year.

2) Restore grassland units to prairie and obtain 90% coverage of native, non-woody species by the fifth year.

3) Improve pollinator habitat in the prairie restorations by including an abundance of milkweed species, with pollinator plants having at least 30% coverage in the prairie.

4) Increase native plant diversity in the forest areas: successfully establish native grass and sedge species and increase overall floral abudance while simultaneously including tree species adapted for a changing climate.

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
- monitor annually for potential erosion, as well as for non-native invasive woody and herbaceous species
- add 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 process. It takes time to restore ecosystems to their former functionality and diversity. Sometimes this 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 skill 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 (both the Railroad to the south and other city properties to the north, east, and west) 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 the Carver Park 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 is describe 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**.

MANAGEMENT PRIORITIES

On this site removal of woody invasive plants throughout the property is the highest priority, with a focus on restoration of the forest units. 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 sorely 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 this section. 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

GRASSLAND MANAGEMENT UNITS

Unit PR1 - Prairie

The initial stage of restoration will be to eliminate as much of the non-native plant species as feasible. Once these objectives have been attained, the next step will be to establish a diverse native prairie community and manage over the long-term with mowing and/or fire.

Overview of restoration tasks

Year 1

- Conduct a prescribed fire in early spring or fall. The timing of the fire should be selected to have the greatest impact on cool season non-native species.
- Implement at least one season of invasive species control including:
    - Mow site to stimulate growth and reduce woody cover.

- Use a broad-spectrum herbicide such as glyphosate to spray the site starting in spring or fall and following with subsequent treatments as dictated by regrowth. Spray when any new growth is 6" or less and before any seed development. Spot spray as needed with Milestone to target hard to control species, including crown vetch, tansy, burdock, mugwort, and leafy spurge.
- An alternative site preparation method for portions of the prairie would be to grow a soybean crop for two years on the site using no-till, which includes controlling weeds with herbicide. This method would likely only be feasible if a farmer is within a close distance and willing to crop the area.

Year 2

- Monitor the effectiveness of treatments and repeat as needed.
- Once sufficient invasive species control has been achieved, conduct a prescribed burn to further impact cool season vegetation (time the burn to be most effective) and remove dead vegetation in preparation for seeding.
- Lightly harrow to prepare the site for seeding. Or if the site is cropped, use no till seeding equipment.
- Broadcast, or drill, native seed with in accepted spring or fall windows. If drill seeding, harrowing is not likely necessary, which would reduce weed germination.

Year 3

- Mow to 6-8" tall in order keep competing vegetation less than 12-15 inches tall, typically about 2-3 times the first growing season and once the second. Plan to burn in the third growing season.
- Spot treat for invasive species as needed.

Unit PR2 - Prairie

Two options are recommended for the PR2 Prairie. One option is to use the same methods presented for the PR1 Prairie with the goal of establishing a diverse native grassland. The second option is to establish a matrix of competitive grasses and eventually add oak trees. In addition to the methods described for PR1 Prairie, tree removal around the edge of the opening is recommended, both to remove non-native and short-live tree species and to reduce overall woody encroachment.

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 no more than one third of the entire grassland in any year and avoid burning adjacent units in consecutive years. Each unit can be burned approximately every three years, though frequency may vary depending on site conditions and objectives.

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 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.

BRUSHLAND MANAGEMENT UNIT

The main management tasks in the Brushland Unit will be controlling invasive ground layer species and increasing native woody shrub diversity. The goal will be to establish a dense shrub cover that can compete with ground layer invasive species.

Year 1

- Mow to simulate invasive species growth and to rejuvenate any dead patches of sumac.
- Apply grass and legume specific herbicides to non-native grasses and crown vetch. Spot spray other broadleaf weeds as needed. Coordinate treatments with restoration activities planned for the PR1 Prairie unit.

Year 2

- Monitor for invasive species and cut and/or spray as needed.

Year 3

- Plant native shrubs to increase diversity including, American hazelnut, gray dogwood, American plum, Saskatoon, smooth rose, prairie rose and wolfberry. Plant lower stature/less competitive shrub species on edges of trails or shrub canopy openings.
- Plant shrubs in masses of at least 10-20 plants and mulch with 6-8" of woodchip or bark mulch. Ideally wood mulch should be composted one year prior to use. However, if fresh chip is used, broadcast a slow-release fertilizer with nitrogen to the soil prior to installing wood chip.
- Mow or spot spray to control weeds in openings as needed.

Long-term management will include mowing edges adjacent to the PR1 Prairie to avoid woody encroachment. Spot spraying in the understory or edges may be needed to control invasive species.

OAK SAVANNA UNITS

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. To restore 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 as savanna and control invasive woody species. The initial priority for these units will be invasive woody removal. Removing the canopy trees from these units will be a larger undertaking and would be part of a future restoration phase.

Unit OS1 and OS2 Oak Savanna

Year 1

- Use a forestry mulcher to removal all woody material including buckthorn and honeysuckle, as well as short-lived native trees such as boxelder, ash, elm, up to the limits of the mulcher (typically 6-8"). Forestry mowing should be done on frozen soils to minimize soil compaction.
- Assess tree canopy opening after this initial treatment and identify any additional trees to needed to be removed to create sufficient light conditions for oak and prairie plant establishment. Cut and remove large diameter trunks, stack smaller brush into piles for burning in winter. A local firewood producer may be an option for cost-effective removal of larger material.
- Treat resprouting tree and shrubs with glyphosate or triclopyr (depending on target species).

Year 2

- Treat seedling and resprouting trees and shrubs. If sufficient fuels are present, conduct a prescribed burn. If there are oak seedlings/saplings less than 2" diameter, protect from fire by precutting and removing vegetation near the trunks, for example with a weed whip and leaf blower, and watering down a 10' diameter ring around each tree. Time the burn to help control any remaining invasive woody species.
- Design seed mixes for partially shaded, open sun, moist and dry microhabitats. Note that the upper slope of OS2 is drier, while the lower slopes of OS1 and 2 have moister conditions.
- If woodchip is sufficiently decomposed, do a light harrowing (if needed) and broadcast seed. Otherwise wait to seed.

Year 3

- Mow as needed, typically 2-3 times per season, to control weeds and establish desirable native prairie species.

Year 4

- Once a ground layer of grasses and forbs is established, plant bur and northern pin oak in canopy openings. Protect seedlings with wire fencing from mammalian browse.

Unit OS3 and OS4 Oak Savanna

The same general methods of restoration used for OS1 and OS2 Savanna are recommended for these units. The primary difference between the units is the amount of woody material that needs to be removed and accessibility.

Year 1

- Use a forestry mulcher or hand cut all woody material including buckthorn and honeysuckle, as well as short-lived native trees such as boxelder, ash, elm, up to the limits of the mulcher (typically 6-8").
- Assess tree canopy opening after this initial treatment and identify any additional trees to needed to be removed to create sufficient light conditions for oak and prairie plant establishment. Remove cut material from the units by hauling larger trunks and chipping smaller material. A local firewood producer may be an option for cost-effective removal of material suitable for firewood.
- Treat any resprouting tree and shrubs with glyphosate or triclopyr (depending on target species).

Year 2

- If sufficient fuels are present, conduct a prescribed burn. Protect oaks from fire by precutting and removing vegetation near the trunk, for example with a weed whip and leaf blower, and watering down a 10' diameter ring around each tree. Time the burn to help control any remaining invasive woody species.
- Design seed mixes for partially shaded, open sun, moist and dry microhabitats. Note the that lower slopes of both units have more moist conditions. Consider planting white oak as in the south-eastern portion of the park, along with wet prairie species.
- Do a light harrowing and broadcast seed.

Year 3

- Mow as needed, typically 2-3 times per season, to control weeds and establish desirable native prairie species.

Year 4

- Once a ground layer of grasses and forbs is established, plant bur and northern pin oak in canopy openings. Protect seedlings with wire fencing from mammalian browse.

Long-term maintenance for savanna units will require occasional mowing or prescribed fire to reduce woody and inhibit non-native species. Regular monitoring to spot treat invasive species is also critical to maintaining species diversity.

WOODLAND UNITS

AF1 – Aspen 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 B**) 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.

- To regenerate canopy trees, create canopy openings approximately ¼ acre in size by cutting and removing trees to increase light conditions. Opportunities to create canopy openings could include removal of dead green ash (as a result of 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 may require replanting openings with desirable native species. If large canopy openings can be created, use these areas to establish oak seedlings.

AF2 – Aspen Forest

- Control invasive species, especially buckthorn and honeysuckle.
- Use a grass selective herbicide to reduce cool season non-native species. Conduct a prescribed fire through the trees if feasible. This work could be completed in conjunction with efforts to restore the adjacent PR1 Prairie.
- Broadcast native grass and shade tolerant forb seed under the aspen and on sunny edges.

OW – Oak Woodland

- Control invasives species including buckthorn, honeysuckle, garlic mustard.
- If feasible, conduct ground fires through the woodland when adjacent oak savanna areas are burned.
- Once buckthorn and honeysuckle are significantly reduced or eliminated, plant native shrub species to restore the understory. It may be advantageous to plant shrubs in groves that can be heavily mulched to control weeds and retain moisture during establishment.
- Seed or plugs for native grass, sedge and forb ground layer species could be sown between shrub patches following shrub establishment.

LF1 and LF2 – Lowland 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 saplings and protect from mammalian browse.
- Monitor for any issues with storm water runoff and address with bioengineering methods as needed.

MW – Mixed Woodland

- Monitor for and control invasive species.
- Allow conifers to grow to maturity and remaining standing to provide wildlife habitat as snags, and later coarse woody debris. Because the overall goal for the site is a mix of mostly prairie, savanna, and oak woodland, it is recommended to run fire through this community as well.
- Plant oaks in areas with good sunlight, such as along the edges between prairie and mixed wood 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 thinning to promote tree health and removal of invasive species. In the long-term, the trees can be allowed to mature and left standing to provide wildlife habitat

- Thin trees in the conifer groves to promote the heath of remaining trees. Select the trees with the poorest form and heath and remove about one-third to one-half of the trees in the stands.
- Prune lower limbs on white pine to help prevent or mitigate damage from white pine blister rust.

WETLAND UNIT

WL – Wetland

- Protect from impacts due to chemical pollutants or soil siltation. Educate and encourage neighboring property owners to eliminate or reduce landscape related chemical use, and to follow best management practices for any chemicals used.
- Conduct a prescribed fire at a time when impacts to cattails will be greatest. Evidence suggests that a summer burn when soils are dry and plant resources have been committed to the leaves will be most effective.
- Follow the burn with herbicide treatments to further reduce cattail cover.
- Seed with native grasses, sedges and forbs.

MANAGEMENT TASK SCHEDULE AND COSTS

Date	Season	Unit	Activity	Ac	$/ac	Cost est
Year 1						
	Fall/winter	Wooded. Level areas of AW1, OS1, OS2, LF1	Forestry desired mow where feasible. Before mow, cut/treat any invasive woody >2" dbh. Hand-cut/treat where no mow. Stack/burn or forestry mow brush piles. Disperse wood chip to 3" thick.	6.4	$1,029	$6,586
	Fall/winter	Grassland: PR1, PR2, BR	Cut and treat non-native woody brush and trees. Stack and burn. Garlon, Daubers only. Girdle and treat trees >5" dbh. Do not girdle trees that could fall on a powerline or neighbor property.	10.3	$505	$5,202
			Ecologicial and Project Management			$4,800
						$16,587
Year 2						
	Aug	Grassland: PR1, PR2, BR	Site prep: Broadcast herbicide	10.3	$500	$5,150
	Sept	Grassland: PR1, PR2, BR	Site prep: Rx burn	10.3	$500	$5,150
	Fall/winter	Wooded: Steep areas of all units.	Hand cut and treat non-native woody brush and trees. Garlon. Daubers only. Forestry mow piles or stack and burn.	9	$2,800	$25,200
	Fall	Wooded - level areas	Foliar treat invasive re-sprouts and seedlings	6.4	$510	$3,232
	Fall	Wooded-mowed areas	Spot treat/mow herbaceous invasive species. 1 visits	6.4	$500	$3,200
			Ecologicial and Project Management			$4,800
						$46,732
Year 3						
	Jan	Grassland: PR1, PR2, BR	Purchase seed	10.3	$900	$9,270
	Apr/May	Grassland: PR1, PR2, BR	Site prep: Broadcast herbicide	10.3	$500	$5,150
	Jun	Grassland: PR1, PR2, BR	Seeding (drill larger seed, broadcast small seed)	10.3	$500	$5,150
	Jul, Aug	Grassland: PR1, PR2, BR	Establishment mow 2x	10.3	$500	$5,150
	Spring-Fall	Wooded	Spot treat/mow herbaceous invasive species. All wooded. Min 2 visits.	15.4	$900	$13,860
	Sept	Wooded	Spot treat invasive re-sprouts and seedlings	15.4	$500	$7,700
	Summer	Wooded	Purchase woodland seed mixes for new units.	9.0	$500	$4,480
	Fall	Wooded	Broadcast woodland mix.	9	$300	$2,700
			Ecologicial and Project Management			$4,800
						$58,260

Date	Season	Unit	Activity	Ac	$/ac	Cost est
Year 4						
	May/June	Grassland: PR1, PR2, BR	Establishment mow 1x	10.3	$300	$3,090
	Jul-Sept	Grassland: PR1, PR2, BR	Spot mow/treat invasive herbaceous plants	10.3	$400	$4,120
	Spring-Fall	All Wooded	Spot treat/mow herbaceous invasive species. All wooded. Min 2 visits.	15.4	$800	$12,320
	Fall	All Wooded	Spot treat invasive woody re-sprouts and seedlings	15.4	$400	$6,160
			Ecologicial and Project Management			$4,800
						$30,490
Year 5						
	Apr/May	Grassland: PR1, PR2, BR	Rx burn	10.3	$670	$6,901
	Jul-Sept	Grassland	Spot mow/treat invasive herbaceous plants	10.3	$600	$6,180
	Spring-Fall	All Wooded	Spot treat/mow herbaceous invasive species. All wooded.	15.4	$400	$6,160
	Fall	All Wooded	Spot treat invasive woody re-sprouts and seedlings	15.4	$350	$5,390
			Ecologicial and Project Management			$4,800
						$29,431
Total Project						$181,500

Appendix A. Plant species recorded

GRASSLAND AND BRUSHLAND Native Species

Scientific name	Common name	PR1	PR2	BR
Forbs				
Achillea millefolium	common yarrow	0.5		0.5
Ageratina rugosum	white snakeroot	1		
Agrimonys sp.	agrimony	0.5		
Anemone cylindrica	thimbleweed	0.5		
Antennaria sp.	pussytoes	0.5		
Ambrosia artemisiifolia	common ragweed	0.5		
Amorpha canescens	lead plant	0.5		
Artemisia ludoviciana	white sage	0.5		
Asclepias exaltata	poke milkweed	0.5		
Asclepias syriaca	common milkweed	0.5		
Asclepias verticilata	whorled milkweed	0.5		
Cirsium discolor	field thistle	0.5		
Dalea purpurea	purple prairie clover	0.5		
Galium triflorum	sweet-scented bedstraw	0.5		
Lespedeza capitata	round-headed bush clover	0.5		
Monarda fistulosa	beebalm	0.5		
Potentilla recta	sulphur cinquefoil	0.5		
Pseudognaphalium obtusifolium	sweet everlasting	0.5		
Solidago altissima	tall goldernrod	3		0.5
Solidago canadensis	canada goldenrod	1	3	0.5
Solidago gigantea	late goldenrod		1	
Solidago nemoralis	gray goldenrod	0.5		
Solidago rigida	stiff goldenrod			0.5
Solidago speciosa	showy goldenrod	1		
Symphiyotrichum ericoides	heath aster	0.5		
Symphyotrichum lateriflorum	calico aster	0.5		
Symphyotrichum oolentangiense	sky-blue aster	0.5		
Verbena stricta	hoary vervain	0.5		
Verbena urticifolia	white vervain	0.5		
Viola sp.	violet	0.5		

Scientific name	Common name	PR1	PR2	BR
Graminoids				
Andropogon gerardii	big bluestem	0.5		
Eragrostis spectabilis	purple love grass	0.5		
Panicum virgatum	switchgrass	0.5		
Woody (0-0.5m)				
Acer negundo	boxelder	0.5		
Cornus racemosa	gray dogwood	0.5		
Parthenocissus quinquefolia	Virginia creeper	0.5		
Prunus virginiana	chokecherry	0.5		
Rhus glabra	smooth sumac			3
Rubus ideaus	red raspberry	0.5		
Vitis riparia	wild grape vine	0.5		
Woody (0.5-2m)				
Cornus racemosa	gray dogwood	0.5		
Cornus sericea	red osier dogwood	0.5		
Rhus glabra	smooth sumac			3
Canopy Trees >2m				
Acer negundo	boxelder	0.5	1	
Fraxinus pennsylvanica	green ash	0.5		
Juniperus virginiana	red cedar	0.5		
Populus tremuloides	aspen	0.5		

GRASSLAND AND BRUSHLAND non-native species

Scientific name	Common name	PR1	PR2	BR
Forbs				
Achillea millefolium	yarrow	1	0.5	
Arctium minus	common burdock		1	
Asparagus officinalis	garden asparagus	0.5		
Centaurea stoebe	spotted knapweed	0.5		
Cirsium arvense	Canada thistle	1		
Cirsium vulgare	bull thistle	0.5		
Daucus carota	Queen Anne's Lace	1	1	1
Erigeron sp.	fleabane	0.5		
Euphorbia cyparissias	cypress spurge	1		

Euphorbia virgata	leafy spurge	0.5		
Lotus corniculatus	birdsfoot trefoil	0.5		
Plantago major	common plantain	0.5		
Potentilla recta	sulfur cinquefoil	1	1	
Rumex acetosella	common sheep sorel	0.5		
Securigera varia	crown vetch	3	1	3
Taraxacum officionalis	dandelion	0.5	0.5	1
Tanacetum vulgare	Common tansy	0.5		
Verbascum thaspsus	common mullein	0.5	1	

Graminoids

Bromus inermis	smooth brome	5	3	5
Echinochloa crus-galli	barnyard grass	2	0.5	0.5
Phalaris arundinaceae	reed canary grass	2	3	
Poa pretensis	Kentucky bluegrass	3	3	4
Setaria pumila	yellow foxtail	0.5	0.5	

Woody (0-0.5m)

Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	1	1	
Rhamnus cathartica	common buckthorn	0.5		

Woody (0.5-2m)

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

Woody (>2m)

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

SAVANNA Native Species

Scientific name	Common name	OS1	OS2	OS3	OS4
Forbs					
Achillea millefolium	common yarrow	0.5	0.5		
Ageratina rugosum	white snakeroot	2	2	0.5	0.5
Ambrosia artemisiifolia	common ragweed		0.5		0.5
Amphicarpa bracteata	hog peanut	1	0.5		
Antennaria sp.	pussytoes species		0.5		
Arisaema triphyllum	Jack-in-the-pulpit	0.5			
Circium altisimum	tall thistle	0.5			
Cirsium discolor	field thistle	0.5	0.5		
Equisetum hymenale	tall scouring rush		0.5		
Fragaria virginiana	wild strawberry	0.5	1		
Galium aparine	sticky-willy		0.5		
Galium concinnum	shinning bedstraw	0.5			
Galium triflorum	sweet-scented bedstraw	1	1		
Geum macrophyllum	large leaf avens	0.5	0.5		
Monarda fistulosa	beebalm	1			
Pyrola sp.	Pyrola species	1			
Polygonatum pubescens	hairy Solomon's seal				
Potentialla recta	sulphur cinquefoil	0.5	0.5		
Ranunculus abortivus	little-leaf buttercup	0.5	0.5		
Scrophularia sp.	figwort species		0.5		
Solidago canadensis	Canada goldenrod	1			2
Solidago speciosa	showy goldenrod		1		
symphyotrichum ericoides	heath aster		0.5		
Symphyotrichum lanceolatum	panicled aster		0.5		
Urtica dioica	stinging nettle	1	0.5		
Verbena urticifolia	white vervain	0.5	0.5		
Graminoids					
Andropogon gerardii	big blue stem		0.5		
Carex pensylvanica	Pennsylvania sedge	2	1	0.5	
Oryzopsis asperifolia	Rough-leaved rice grass		0.5		
Woody (0-0.5m)					
Acer negundo	boxelder	0.5			
Cornus racemosa	gray dogwood	0.5	0.5		
Cornus sericea	red osier dogwood	0.5			

Scientific name	Common name	OS1	OS2	OS3	OS4
Fraxinus pensylvanica	green ash	1	1	0.5	0.5
Parthenocissus quinquefolia	Virginia creeper	1	0.5	0.5	
Vitis riparia	wild grape vine	0.5	0.5		

Woody (0.5-2m)

Amelanchier laevis	smooth serviceberry		0.5		
Acer negundo	boxelder	0.5	0.5	0.5	
Cornus racemosa	gray dogwood	0.5	0.5		
Cornus sericea	red osier dogwood	0.5			
Fraxinus pensylvanica	green ash		0.5		2
Parthenocissus quinquefolia	Virginia creeper		0.5		
Populus tremuloides	aspen				2
Prunus serotina	black cherry	0.5			
Quercus alba	white oak	1			
Rubus ideaus	red raspberry				1
Ulmus americana	American elm	0.5	0.5		0.5
Vitis riparia	wild grape vine	1	0.5	0.5	0.5

Woody (>2m)

Acer negundo	boxelder	3	2	0.5	
Catalpa speciosa	northern catalpa	0.5			
Celtis occidentalis	hackberry	0.5	0.5		
Cornus racemosa	gray dogwood		0.5		
Cornus sericea	red osier dogwood	0.5			
Fraxinus nigra	black ash	0.5			
Fraxinus pensylvanica	green ash	3	2	0.5	1
Juniperus virginiana	red cedar	0.5	1		1
Parthenocissus quinquefolia	Virginia creeper	1	1		
Pinus banksiana	Jack pine		0.5		
Populus deltoides	cottonwood	1	2		
Populus tremuloides	aspen	1	2		
Prunus serotina	black cherry	1	1		
Quercus alba	white oak	1			1
Quercus ellipsoidalis	northern pin oak		3		3
Quercus macrocarpa	bur oak		2		
Ulmus americana	American elm		1		
Vitis riparia	wild grape vine	0.5			1

SAVANNA Non-Native Species

Scientific name	Common name	OS1	OS2	OS3	OS4
Alliaria petiolata	garlic mustard	2	1	0.5	
Arctium minus	common burdock	1	0.5		
Cirsium arvense	Canada thistle		1		
Daucus carota	Queen Anne's Lace	2	2		
Euphorbia cyparissius	Cyperus spurge	1	1		
Glechoma hederacea	ground ivy	3	3	0.5	0.5
Leonurus cardiaca	mother wort	0.5	0.5		
Leucanthemum vulgare	ox-eye daisy	0.5			
Melilotus officinalis	yellow sweet clover		0.5		
Nepeta cataria	catnip	0.5			
Plantago major	common plantain		0.5	0.5	
Securigera varia	crown vetch		0.5		
Taraxacum officionale		0.5	0.5		
Trifolium repens	white clover	0.5	0.5	0.5	
Verbascum thaspsus	common mullein	0.5	0.5	0.5	
Graminoids					
Bromus inermis	smooth brome	0.5	3	2	2
Echinochloa crus-galli	barnyard grass		0.5	0.5	
Elymus repens	quackgrass		0.5		0.5
Phalaris arundinaceae	reed canary grass	0.5		0.5	
Poa pratensis	Kentucky bluegrass	1	2	1	4
Setaria sp.	Foxtail	0.5			
Woody (0-0.5m)					
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	1	1		2
Rhamnus cathartica	common buckthorn	1			1
Woody (0.5-2m)					
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	2	2		3
Rhamnus cathartica	common buckthorn	4			2
Ulmus pumila	Siberian elm				0.5
Woody (>2m)					
Elaeagnus angustifolia	Russian olive				0.5
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	4	1		
Malus sp.	Apple		0.5		
Morus alba	White mulberry	0.5	0.5		
Rhamnus cathartica	common buckthorn	3	3		

WOODLAND Native Species

Scientific name	Common name	AW1	AW2	OW	LF1	LF2	MW
Achillea millefolium	common yarrow				0.5		
Ageratina rugosum	white snakeroot	2			2		
Circaea lutetiana	enchanter's nightshade	0.5			1		1
Fragaria virginica	strawberry	1					
Galium aparine					0.5		0.5
Galium triflorum	sweet-scented bedstraw	1		1	1		1
Geum canadense	white avens				2		
Geum macrophyllum	large leaf avens				0.5		
Geranium maculatum	wild geranium				0.5		
Hackelia virginiana	Virginia stickseed	0.5		0.5			
Laportea canadense	Canada wood nettle				0.5		
Leonarus cardiaca	mother wort		0.5				
Phryma leptostachya	American lopseed	1					
Polygonatum pubescens	hairy Solomon's seal	0.5					0.5
Ranunculus abortivus	little-leaf buttercup				1		
Urtica dioica	stinging nettle	0.5					

Graminoids

Carex sp.	sedge species	0.5					
Carex blanda	common wood sedge		0.5				
Carex pensylvanica	Pennsylvania sedge				0.5		
Oryzopsis asperifolia	Rough-leaved rice grass	0.5	0.5				
Poa pratensis	Kentucky blue grass			2			

Woody (0-0.5m)

Acer negundo	boxelder	0.5	0.5				
Cornus sericea	red osier dogwood		0.5				
Fraxinus pensylvanica	green ash	1		1			0.5
Parthenocissus quinquefolia	Virginia creeper	1		1	1		
Parthenocissus vitacea		0.5	0.5				
Populus tremuloides	Trembling aspen	0.5	0.5				0.5
Prunus serotina	Black cherry		0.5	0.5	0.5		
Prunus virginiana	chokecherry		0.5				
Vitis riparia	wild grape vine	1					

Scientific name	Common name	AW1	AW2	OW	LF1	LF2	MW
Woody (0.5-2m)							
Fraxinus pensylvanica	green ash	1		1			1
Parthenocissus quinquefolia	Virginia creeper			1			
Populus tremuloides	Aspen		3				1
Prunus virginiana	chokecherry	0.5	0.5				
Prunus serotina	Black cherry	0.5					
Quercus macrocarpa	bur oak			0.5			0.5
Quercus rubrum	red oak	0.5					
Rubus ideaus	red raspberry				0.5	0.5	
Vitis riparia	wild grape vine				0.5	0.5	
Woody (2m0.5)							
Acer negundo	boxelder	2		0.5		0.5	1
Betula papyrifera	Paper birch						2
Catalpa speciosa	Catalpa	0.5					
Fraxinus pensylvanica	green ash	2				2	2
Juglans nigra	black walnut					0.5	
Parthenocissus quinquefolia	Virginia creeper				0.5		
Pinus banksiana	Jack pine						0.5
Pinus resinosa	red pine						2
Populus deltoides	cottonwood			2		3	1
Populus tremuloides	aspen	5	4	4		2	3
Prunus serotina	black cherry	0.5					
Quercus ellipsoidalis	northern pin oak			2		2	2
Quercus macrocarpa	bur oak					0.5	
Quercus rubrum	red oak	0.5					
Ulmus americana	American elm	0.5					1
Vitis riparia	wild grape vine				0.5		

WOODLAND Non-Native Species

Scientific name	Common name	AW1	AW2	OW	LF1	LF2	MW
Forbs							
Alliaria petiolata	garlic mustard	2	1	2	2	2	2
Arctium minus	common burdock	0.5	0.5	2	0.5	0.5	0.5
Centaurea stoebe	spotted knapweed	0.5					
Cirsium arvense	Canada thistle	0.5					
Daucus carota	Queen Anne's Lace	0.5	0.5		0.5		0.5
Glechoma hederacea	Ground ivy	2	2	0.5	0.5	0.5	
Leonurus cardiaca	Mother wort	0.5		1			
Plantago major	common plantain	0.5	0.5	0.5			
Securigera varia	crown vetch	1					
Taraxacum officionale		0.5	1	0.5	0.5	0.5	
Trifolium repens	white clover					0.5	
Graminoids							
Bromus inermis	smooth brome	0.5	4	4			
Echinochloa crus-galli	barnyard grass	1			0.5	0.5	
Elymus repens	quackgrass					0.5	
Poa pratensis	Kentucky bluegrass	0.5	3	2	0.5	0.5	10.5
Woody (0-0.5m)							
Acer ginnala	ginnala maple		0.5				
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	2	2	1	1	0.5	0.5
Morus alba	white mulberry	0.5					
Rhamnus cathartica	common buckthorn	3	2	1	3	0.5	0.5
Woody (0.5-2m)							
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	2	1	2	2	2	1
Rhamnus cathartica	common buckthorn	4	3	4	4	3	4
Ulmus pumila	Siberian elm	0.5					
Woody (>2)							
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	1	0.5	1	1	1	2
Malus sp.	Apple		1				
Morus alba	White mulberry				0.5		
Rhamnus cathartica	common buckthorn	1	1	4	3	2	2

CONIFER GROVE Native Species

Scientific name	Common name	CON1	CON2	CON3
Actaea rubra	red baneberry			0.5
Aralia nudicaulis	wild sarsaparilla	0.5		
Galium triflorum	Sweet scented bedstraw			0.5
Arisaema triphyllum	Jack-in-the-pulpit			0.5
Athyrium felix-femina	lady fern	0.5		
Phryma leptostachya				0.5
Pyrola sp.				0.5
Sanicula sp.				0.5
Thalictrum thalictroides	rue anemone	0.5		
Graminoids				
Carex pensylvanica	Pennsylvania sedge			3
Woody (0-0.5m)				
Acer negundo	boxelder	0.5		
Prunus virginiana	chokecherry		0.5	
Ribes sp.	gooseberry species			1
Woody (0.5-2m)				
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	3	2
Pinus resinosa	red pine			3
Pinus strobus	White pine			4
Populus tremuloides	Aspen			1
Prunus virginiana	chokecherry			2
Thuja occidentalis	White cedar	3		
Ulmus americana	American elm			1

CONIFER GROVE Non-Native Species

Scientific name	Common name	CON1	CON2	CON3
Graminoids				
Alliaria petiolata	garlic mustard			0.5
Taraxacum officionale	dandelion		0.5	0.5
Graminoids				
Setaria viridus				0.5
Woody (0-0.5m)				
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle			1
Rhamnus cathartica	common buckthorn			3
Woody (0.5-2m)				
Lonicera tatarica and/or L. X bella	Tatarian or showy honeysuckle	0.5		2
Rhamnus cathartica	common buckthorn		0.5	1
Woody (>2m)				
Lonicera tatarica	Tatarian honeysuckle	0.5		
Rhamnus cathartica	common buckthorn			0.5

WETLAND Native Species

Scientific name	Common name	WL
Epiliobium sp.	willow herb	0.5
Impatiens capensis	spotted touch-me-not	0.5
Nymphaea odorata	white water lily	1
Graminoids		
Calamagrostis canadensis	blue joint	0.5
Carex lacustris	lake sedge	0.5
Woody (0-0.5m)		
Vitis riparia		

WETLAND Non-Native Species

Scientific name	Common name	WL
Typha angustifolia	narrow-leaf cattail	5
Phalaris arundinacea	reed canary grass	2

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	Pincherry
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	Sideoats 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

Shrubs For Replacing Common Buckthorn (e.g. Aspen Woodland)

Dry-Mesic Upland Areas					
Common Name	**Scientific Name**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
Allegheny serviceberry	*Amelanchier laevis*	15 to 25	Sun/part shade	high	
Pagoda dogwood	*Cornus alternifolia*	15 to 20	Sun/shade		Beautiful growth form.
Round-leaved dogwood	*Cornus rugosa*	8 to 12	Part sun/shade		Butterflies use flowers; birds eat berries
Eastern wahoo	*Euonymus atropurpurea*	6 to 20	Sun/shade		Spreads
Common ninebark	*Physocarpus opulifolius*	8 to 10	Full sun	Bird food	Dense growth habit
American plum	*Prunus americana*	20 to 35	Sun	high	
Choke cherry	*Prunus virginiana*	20 to 30	Sun/part shade	Excellent	
Sambucus racemosa	*Red-berried elder*	10 to12	Sun/part shade	High value: bird food	Cluster of white flowers; red berries in early summer.
Smooth rose	*Rosa blanda*	4 to 6	Sun/part shade	high	
Red-berried elder	*Sambucus pubens*	6 to 12	Shade	Very high	Excellent massing, fast growing.
Bladdernut	*Staphylea trifolia*	8 to 15	Shade		Tolerates many soil conditions, disease resistant
Arrowwood viburnum	*Viburnum rafinesquianum*	5 to 8	Part shade, shade	high	Pretty foliage
Highbush cranberry	*Viburnum trilobum*	6 to 12	Sun to shade	High -Birds eat fruits.	Foliage open form in shade, dense in sun.
Wafer ash	*Ptelea trifoliata*	10 to15	Sun to shade	Larval host for swallowtail butterfly	Foliage open form in shade, dense in sun.

Southern Mesic Prairie species (Ups23)

	Scientific name	Common name
	Forbs	
1	*Agastache foeniculum*	Anise hyssop
2	*Amorpha canescens*	leadplant
3	*Artemisia ludoviciana*	prairie sage
4	*Asclepias incarnata*	Swamp milkweed
5	*Asclepias syriaca*	Common milkweed
6	*Asclepias tuberosa*	Butterflyweed
7	*Astragalus canadensis*	Canada milk vetch
8	*Chamaecrista fasciculata*	partridge pea
9	*Coreopsis palmata*	Coreopsis
10	*Dalea candida*	White prairie clover
11	*Dalea purpurea*	Purple prairie clover
12	*Desmodium canadense*	Showy tick-trefoil
13	*Euphorbia corollata*	Flowering spurge
14	*Galium boreale*	Northern bedstraw
15	*Gentiana flavida*	Cream gentian
16	*Heliopsis helianthoides*	early sunflower
17	*Liatris ligulostylis*	Meadow blazing star
18	*Liatris pycnostachya*	Great blazing star
19	*Monarda fistulosa*	Wild bergamot
20	*Pycnanthemum virginianum*	Mountain mint
21	*Ratibida pinnata*	gray-headed coneflower
22	*Rudbeckia hirta*	black-eyed susan
23	*Solidago speciosa*	showy goldenrod
24	*Symphyotrichum oolentangiensis*	Sky blue aster
25	*Symphyotricum laeve*	Smooth blue aster
26	*Symphyotricum novae-angliae*	New England aster
27	*Thalictrum dasycarpum*	Tall meadowrue
28	*Verbena hastata*	blue vervain
29	*Veronicastrum virginicum*	Culver's root
30	*Zizia aptera (or aurea)*	Heart-leaved Alexanders
	Graminoids	
1	*Andropogon gerardii*	big bluestem - small amt
2	*Bouteloua curtipendula*	Sideoats grama
3	*Bromus kalmii*	Kalm's brome
4	*Carex bicknellii*	Bicknell's sedge
5	*Elymus canadensis*	Canada wild rye
6	*Schizachyrium scoparium*	Little bluestem
7	*Sorghastrum nutans*	Indian grass
8	*Sporobolus heterolepis*	Prairie dropseed

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
Solidago 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

Southern Mesic Savanna (UPs24

Genus	Species	Common Name
Trees		
Quercus	*macrocarpa*	Bur oak
Shrubs		
Amorpha	*canescens*	Lead-plant
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*	Long-leaved panic grass
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-mifolium*	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*	Canada 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 bush-clover
Liatris	*aspera*	Rough blazing star
Liatris	*ligulistylis*	Northern plains blazing star
Liatris	*pycnostachya*	Gayfeather
Lilium	*Philadel-phicum*	Wood lily
Lobelia	*spicata*	Rough-spiked Lobelia
Maian-themum	*racemosum*	False Solomon's-seal
Maian-themum	*stellatum*	Starry false Solomon's-seal
Mirabilis	*hirsuta*	Hairy four-o'clock
Monarda	*fistulosa*	Wild bergamot
Oenothera	*biennis*	Common evening-primrose
Pedicularis	*canadensis*	Wood-betony
Phlox	*pilosa*	Prairie phlox
Physalis	*heterophylla*	Clammy ground-cherry
Potentilla	*arguta*	Tall cinquefoil
Pycnan-themum	*virginianum*	Virginia mountain-mint
Ratibida	*pinnata*	Gray-headed coneflower
Rudbeckia	*hirta*	Black-eyed Susan
Sisyrinchium	*campestre*	Field blue-eyed grass
Solidago	*missouriensis*	Missouri goldenrod
Solidago	*nemoralis*	Gray goldenrod
Solidago	*ptarmicoides*	Upland white goldenrod
Solidago	*speciosa*	Showy goldenrod
Thalictrum	*dasycarpum*	Tall meadow-rue
Tradescantia	*bracteata*	Bracted spiderwort
Veroni-castrum	*virginicum*	Culver's root
Viola	*pedatifida*	Prairie bird-foot violet
Zizia	*aurea*	Golden alexanders
Ferns and Fern Allies		
Equisetum	*arvense*	Field horsetail
Equisetum	*hyemale*	Tall scouring-rush
Equisetum	*laevigatum*	Smooth scouring-rush

Southern Terrace Forest (FFs59)

The following is not an exhaustive list of the species that occur in this plant community, but species more likely to be available at a native plant nursery.

Genus	Species	Common Name
Trees		
Acer	*saccharinum*	Silver maple
Acer	*saccharum*	Sugar maple
Carya	*cordiformis*	Bitternut hickory
Celtis	*occidentalis*	Hackberry
Ostrya	*virginiana*	Ironwood
Populus	*deltoides*	Cottonwood
Salix	*nigra*	Black willow
Tilia	*americana*	Basswood
Shrubs		
Cornus	*amomum*	Silky dogwood
Euonymus	*atropurpureus*	Wahoo
Prunus	*virginiana*	Chokecherry
Ribes	*missouriense*	Missouri gooseberry
Ribes	*americanum*	Wild black currant
Ribes	*cynosbati*	Prickly gooseberry
Sambucus	*canadensis*	Common elder
Sambucus	*racemosa*	Red-berried elder
Viburnum	*lentago*	Nannyberry
Forbs, ferns and fern allies		
Allium	*tricoccum*	Wild leek
Anemone	*quinquefolia*	Wood-anemone
Arisaema	*triphyllum*	Jack-in-the-pulpit
Campanula	*americana*	Tall bellflower
Caulophyllum	*thalictroides*	Blue cohosh
Dicentra	*cucullaria*	Dutchman's-breeches
Doellingeria	*umbellata*	Flat-topped aster
Enemion	*biternatum*	False rue-anemone
Erythronium	*albidum*	White trout-lily
Geranium	*maculatum*	Wild geranium
Hydrophyllum	*virginianum*	Virginia waterleaf
Impatiens	spp.	Touch-me-not
Lilium	*michiganense*	Michigan lily
Maianthemum	*canadense*	Canada mayflower
Matteuccia	*struthiopteris*	Ostrich-fern
Mianthemum	*racemosa*	Racemose false Solomon's-seal
Osmorhiza	*claytonii*	Clayton's sweet cicely
Phlox	*divaricata*	Blue phlox
Polygonatum	*biflorum*	Giant Solomon's-seal
Rudbeckia	*laciniata*	Goldenglow
Sanguinaria	*canadensis*	Bloodroot
Symphyotricum	*cordifolius*	Heart-leaved aster
Thalictrum	*dasycarpum*	Tall meadow-rue
Thalictrum	*dioicum*	Early meadow-rue
Trillium	*cernuum*	Nodding trillium
Uvularia	*grandiflora*	Yellow bellwort
Viola	spp	Violet
Grasses, Rushes and Sedges		
Calamagrostis	*canadensis*	Bluejoint
Carex	*sprengelii*	Sprengel's sedge
Carex	*radiata*	Stellate sedge
Cinna	*arundinacea*	Stout woodreed
Elymus	*hystrix*	Bottlebrush grass
Elymus	*virginicus*	Virginia wild rye
Elymus	*wiegandii*	Canada wild rye
Glyceria	*striata*	Fowl manna-grass

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 a 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 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 fairly 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, exotics 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 1pound 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.

Sweet clover *(Melilotus species)*

White and yellow sweet clover are very aggressive biennial species that *increase* with fire. Where sweet clover is found, it should be controlled in conjunction with treatment that attempts to eliminate smooth brome, if prairie restoration occurs. Sweet clovers are common plants in agricultural areas, so if restoration is implemented, the project area should be surveyed for this species on an annual basis. Often, following initial brush removal and/or burning, a flush of weedy annuals and biennials such as sweet clover can occur. Well-timed mows and burnings are usually adequate to control these species. Mowing the site, as is typically prescribed for prairie restoration maintenance, should occur when all plants on the site (including sweet clovers) are approximately 12 inches in height. Sweet clover can bloom even at a height of 6 inches, but if it is burned or mowed in the following year in the late spring, it should be controlled. On steep sites, brush cutting can be substituted for mowing. Individual plants or small populations can be removed by hand-pulling. If seed production occurs, prodigious amounts of seed can be produced and spread, so pull before seeds appear or bag seed producing plants. Competition from native species also helps control sweet clovers and other weedy annuals and biennials. To some extent, **common burdock** and **common mullein** can be treated similarly to sweet clover, since they are both exotic, biennial forbs that are typically found in disturbed areas or restoration projects.

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 an 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.

Probably the best way to control garlic mustard 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 hrs 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

A. 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.

B. Disease

1. 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 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 downside 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 number 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.

2. 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.

3. 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.

C. Non-native and over-populated native animals

1. 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.

2. 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.

3. 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.

D. 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.

E. Misuse by visitors

As described in earlier sections, misuse of the site's natural areas by visitors and occupants has contributed to their current degraded state. Dumping of trash and yard waste and overuse of erosion-sensitive areas continues to cause issues on the site. Some of these activities are both taking away from the natural beauty and decreasing the habitat value of the units and can exacerbate erosion in the long term by preventing native plant establishment.

The woodlands on the north side of the site are plagued by the greatest number of examples of this behavior. Besides being heavily bisected by several spur trails, the units are full of trash, and erosion caused by foot traffic is damaging the sandstone bluff, especially in Unit P.

Curbing these behaviors will be difficult but will go a long way towards helping to restore the natural communities on site. Visitors should understand the benefits of natural areas, both for their own enjoyment and for the habitat and ecosystem services they provide. Beyond that, an understanding of how human uses can affect and degrade these areas will be important. Ultimately, education toward encouraging behavior changes will be necessary to lessen or halt these behaviors. Leveraging the expertise of local partner organizations can help accomplish this goal. For example, LCPC, FMR, and other organizations host workshops and educational events to educate community members on good land use practices that will benefit water quality and ecosystem health. Signage, site ambassadors, and continuing restoration and educational events on site are just a few strategies to help change visitor behavior.