Nicollet Island East
Natural Resource Management Plan

Prepared for:

MWMO and MPRB

Prepared by:

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December 2017

This Natural Area Management Plan and Work Plan has been reviewed and approved by MWMO and MPRB staff.

This document can be changed only by written agreement by the Mississippi Watershed Management Organization, the Minneapolis Park and Recreation Board, and Friends of the Mississippi River.

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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 the natural areas on Nicollet Island. Specifically, this plan encompasses roughly 5.8 acres of land on the northeast side of the island. The island itself is a 48-acre landmass located in the Mississippi River in Minneapolis. The acres in question are all owned by the Minneapolis Park and Recreation Board.

Prior to European settlement, the island was a mix of habitat types. The site is located in the southernmost lobe of the Anoka Sandplain ecological subsection, and pre-settlement vegetation was identified as 'oak openings and barrens' or oak savanna. However, firsthand records of vegetation on the island include dense oak-maple forests and open grassland areas. While this is different from the predominant surrounding vegetation, the island's position in the Mississippi River would have shielded it from the historical fire regime, allowing areas of denser forest to develop. Much of the natural area on the island has since been lost to development, and today the island itself and the areas directly around the island now make up portions of downtown and Northeast Minneapolis, highlighting the historical conversion of natural areas for the rapidly expanding Minneapolis metro area.

The northern tip and eastern side of the island (project area) is largely undeveloped, save for the residences along East Island Ave. While natural vegetation has recovered since the height of industrial development in the late 1800s, other threats to these natural areas remain. The open spaces within the project area have experienced continual woody encroachment in recent decades, both by native and non-native shrubs and trees. Runoff from increased impervious surfaces has caused gully formation at points along the slope. Existing conditions show evidence of much disturbance to the site, including earth moving, trails, yard waste, encroachment, and a proliferation and dominance of non-native vegetation.

Driven by a lack of natural ecosystems in the urban matrix, and by degradation from invasive species and other land use practices, this plan recommends restoring native plant communities on the upland areas of the site. This plan focuses on restoration of forest and prairie communities, which are targeted by the MN DNR as being among the most in need of restoration in this ecological subsection (Anoka Sand Plain). Vegetation and breeding bird surveys are recommended by this plan to monitor the site for plant and bird diversity, the measure of which would show trends that would indicate whether the site's habitat is improving for wildlife.

Natural Resource Inventory and Assessment

A natural resource inventory and assessment was conducted by staff from Friends of the Mississippi River in the summer and fall of 2017. The property consists of three primary

areas: altered deciduous woodlands, a degraded grassland, and turfgrass. The forested areas are dominated by box elder, hackberry, and green ash. American elm, cottonwood, and Siberian elm are prevalent as well. Buckthorn dominates much of the shrub layer, though few uninvaded pockets remain. White mulberry, a non-native tree, is becoming dominant in some patches. Garlic mustard, burdock, motherwort, and other herbaceous invaders are patchy but present. Groundcover in the forested areas ranges from thin to fairly dense, with species like white snakeroot, Enchanter's nightshade, Virginia stickseed. The shortgrass unit is severely degraded; smooth brome and Kentucky bluegrass dominate, while few native grasses or forbs are present. Patches of reed canary grass, birdsfoot trefoil and spotted knapweed are present throughout. Woody species are also invading this area, which will transition to a non-native dominated woodland if left unchecked.

There have been no notable restoration efforts within the project area, and in fact, the property has many areas that have been clearly impacted by human uses, including the 'not-a-lot' area most recently used as a parking lot. Use of the property by island residents has also degraded the landscape, with the remaining forest areas serving as a historical source of firewood for residents and now an area to dump yard waste. However, restoration of the grassland area just north of the high school (not included in the project area) occurred in the early 2000s. Unfortunately, without maintenance, this area has become degraded and overgrown with native and non-native trees. The rest of the property is highly degraded, both in terms of species composition and in the presence of non-native, invasive species. A lack of fire has allowed woody species – both native and non-native – to become overabundant and has allowed herbaceous invaders to proliferate.

Invasive plant species are the largest threat to the health of the natural areas on the island. Woody invaders in particular have degraded the plant communities in the units. Other non-native herbaceous species are present in both the forests and grasslands. Another potential management issue is erosion in the forested areas. Natural overland flow has increased due to nearby development and impervious surfaces, and combined with a lack of deep-rooted vegetation, has led to areas of serious erosion. While this will be somewhat mitigated by the addition of native vegetation, it should be given extra consideration if time and budget allows. Finally, future issues should be considered as well. For example, the large contingent of ash trees on the property is at risk from the emerald ash borer. Understanding these risks and their likelihoods can help in the design and preparation of future management strategies.

Natural Resource Management Recommendations

Based on the natural resource inventory and assessment, the lack of past management activities, the property's connection with nearby natural areas, as well as general goals by the Minnesota Department of Natural Resources for this landscape, this plan recommends removing invasive species and restoring native forest and prairie plant communities on the site.

Restoration is divided into three phases. The first phase focuses on removal of non-native woody shrubs and trees from all units, concentrating first on the forested units. Diversity should be added to forested areas as invaders are removed through both seeding and planting in all vegetative strata. Inclusion of climate-adapted tree species will be a priority for revegetation. As time and budget allows, overabundant native woody species should be thinned in the forested units, including but not limited to green ash and sumac. Removal should be conducted in the fall and winter, and may be done through a combination of cutting and treating and brush mowing in certain less sensitive areas. Follow-up treatment in subsequent years will focus on treating re-sprouts and newly emerged seedlings.

The second phase focuses on the restoration of prairie habitat on the grassland and not-a-lot units. This will consist of removing native and non-native shrubs and trees that are encroaching on the units, preparing the units for seeding through a combination of herbaceous vegetation removal, soil tilling, and prescribed fire, and broadcast seeding with a diverse mix of native prairie species. Follow-up maintenance will include spot spraying and hand pulling problem invasive species, regular mows, and eventual prescribed burns on the not-a-lot unit. The shortgrass unit on the north tip of the island will eventually be transitioned to a maple-dominated forest reminiscent of historical communities, and will include a mix of climate adapted tree species.

The third phase focuses on erosion control in the forested units. Seeding and planting the woodland units with appropriate native shrubs and understory plants will help to stymie erosion and add structural diversity to the site. Other recommended erosion control methods include installation of natural erosion bars, installation of grass strips and erosion mats, and soil work to prevent and remediate gully formation.

The estimated cost to restore the vegetative communities on site (Phase I and II) is $46,540. Expanding this restoration to include erosion control in the forested units would cost an additional $6,500. Full restoration and enhancement on site would cost an estimated $53,040 over the first three years with additional costs for ongoing maintenance. Future maintenance of the site will occur in irregular intervals, and could costs as much as $11,200 recurring. The landowner is not required to implement the restoration tasks presented in this plan. However, FMR can continue to assist with obtaining grant funding for restoration and enhancement, as well as with the coordination and management of restoration activities.

INTRODUCTION

This Natural Resource Management Plan presents the site analysis and recommended management and land use activities for 5.8-acres of natural area on Nicollet Island in Minneapolis, Minnesota (Figure 1). This document can be changed only by written agreement by the Mississippi Watershed Management Organization, the Minneapolis Park and Recreation Board, and Friends of the Mississippi River.

Nicollet Island is located in the Mississippi River, just north of the St. Anthony Falls and between downtown and Northeast Minneapolis. Hennepin Avenue, one of the city's main thoroughfares, runs across the island, connecting it to both the east and west banks of the river. The island itself is highly developed, and has supported a diverse history of land use, from industrial to commercial and residential. The island also contains a number of undeveloped natural areas, and serves as a connection to other parkland, including Boom Island Park to the north, B.F. Nelson park to the east, and Father Hennepin Bluff park to the south.

Apart from Hennepin Ave, the island has a number of smaller roads, including Island Ave, which runs along the island's perimeter, and a number of cross streets that form the island's paved street network. The BNSF rail line also runs east-west across the island, paralleling Hennepin Ave to the north.

The natural areas in question can be divided into three areas: the current 1.8-acre turf 'not-a-lot' on the eastern side, the deciduous forest that straddles the bike path on the eastern edge, and the woodlot and adjacent 1.1-acre the grassland on the north side. The site's overall topography is relatively flat, with the highest points occurring in the middle and the only real steep grades occurring on the banks of the river. Soils are classified as Urban Land – Hubbard complex, with bedrock substratum, and range from 0 to 8 percent slopes.

No rare species occur on the property, though two records of the black sandshell mussel (*Ligumia recta*) were recorded nearby, including in the eastern channel at the southern tip of the island and in the main channel just north of the island. Tricolored bats (*Pipistrellus subflavus*) were also recorded at Chute's Cave, just southeast of the island. Restoration of the natural areas at the site are unlikely to affect populations of either of these species.

The site is located in the southernmost lobe of the *Anoka Sandplains* ecological subsection, sandwiched between the *Big Woods* and *St. Paul Baldwin Plains* subsections, as designated by the Minnesota DNR (Figure 2). The *Anoka Sanplain* lies within the *Minnesota and Northeast Iowa Morainal* section in the *Eastern Broadleaf Forest* province of the state. Besides being located along the Mississippi River, one of the nation's most important wildlife corridors, the property is also situated within an arm of the Metro Conservation Corridors system (Figure 3), identified as an important habitat network for both sedentary and migratory plant and animal life in and around the Twin Cities. The property is also located northwest of riverside natural areas identified by the Minnesota County Biological Survey (MCBS) as areas of moderate biological

significance (Figure 3). Restoration of the natural areas on the island could effectively extend this stretch of quality natural habitat.

Due to its more urban nature and disturbed history, there may not be many Species of Greatest Conservation Need (SGCN) that currently utilize the site. However, restoring wildlife habitat is still a priority for this plan, and has the potential to attract SGCNs back to the site. Habitat loss and degradation have been the primary causes of problems for SGCN species in the Anoka Sandplain subsection, and restoration of prairie and forest at the site has the potential to benefit many SGCN species. The majority of the property is not in a natural state, and the natural communities that remain are relatively degraded. Improving the health of these ecosystems will benefit many species, some of which are currently experiencing population declines due to habitat loss and other factors. The property's location near the Mississippi and adjacent to other natural areas also makes it an important potential habitat for myriad plant and animal species, including migratory bird species.

The DNR recommends stabilizing and increasing SGCN populations in forest, savanna, and prairie areas by managing invasive species, using prescribed fire and other practices to maintain savanna and prairie, encouraging restoration efforts, and providing technical assistance and protection opportunities to interested individuals and organizations. The pre-settlement vegetation for this site was largely "oak openings and barrens" or oak savanna grading into both forest and prairie. In its current state the site has been greatly altered throughout its history. Restoring and enhancing forest and prairie will be the top priority of this management plan. Other priorities include providing improved wildlife habitat and mitigating erosion throughout the site.

The purpose of this management plan is to:

- Identify the existing ecological conditions on the property
- Identify best management practices to maximize habitat values, improve water quality, and increase community diversity
- Document allowable uses and activities of the property

Specific ecological and cultural goals for this property are to:

- Increase coverage and diversity of native plant species and reduce non-native species
- Provide connectivity with other natural areas in the landscape and along the river corridor
- Maintain and manage the property for water quality by recommending erosion control methods and controlling runoff and nutrient loading
- Create a model for responsible public land stewardship
- Utilize this property to guide surface water management activities on adjacent land in a manner that protects and fosters natural community establishment
- Utilize this property to enhance and expand the ecological functions of the area

SUMMARY OF EXISTING PLANS

Two recent planning documents exist for the natural areas on Nicollet Island. Both the Minneapolis Park and Recreation Board (MPRB) and the Mississippi Watershed Management Organization (MWMO) have produced plans for the island, with the MPRB plan focusing on broader long-term restoration and use goals and the MWMO plan focusing on erosion control on the north and west side of the island.

MPRB approved its Central Mississippi Riverfront Regional Park Master Plan in 2016, with a stated goal of the plan being to "restore and enhance natural resources, improve wildlife habitat, and water quality." It noted that throughout the park (including on Nicollet Island) "vegetation, habitat, and shoreline edges are degraded around the island despite its importance to birds within the Mississippi River flyway."

The restoration targets and activities proposed in this NRMP are in line with the recommendations of the MPRB's master plan. For example, abundant invasive species and a lack of native vegetation are noted as issues in the plan, and our NRMP provides a detailed evaluation of these issues on a unit-by-unit basis. Invasive removal and native seeding and planting are priority recommendations of this NRMP. Moreover, this NRMP recommends that the short-grass unit on the north tip of the island be transitioned to native prairie and eventually a maple-basswood forest, which reflects both recent community input and the goals of the master plan: "The patches of prairie on North Nicollet Island were historically wooded and the community has a desire to see them reforested. These patches of prairie are recommended to be maintained for invasive species and be transitioned over time to native woodlands, such as a Maple-Basswood forest." In response to more recent community input, and to the master plan's overall goal of expansion of native prairie in the larger park, this NRMP also includes a target prairie pocket within the overall larger woodland ecotype, with the goal of providing much needed pollinator habitat along the river. The NRMP provides additional detail to the master plan, including thorough evaluations of historical and current environmental conditions, ecological threats, restoration schedules, timelines and cost estimates.

The MWMO's Nicollet Island Feasibility Study was completed in 2015 and investigates erosion and bank stability on the island's west side. As is relates to natural areas restoration, the study comments on upland restoration activities that will ultimately benefit erosion control. This NRMP is in line with the recommendations of the study, and expounds on the methodologies, timetables, and costs of upland natural area restoration. While MWMO is continuing its investigation of erosion on the island, restoration of the upland natural areas in the meantime will provide myriad benefits, including erosion control, habitat provision, and community engagement.

SITE INFORMATION

Owner name, address, city/township, county and phone:
Minneapolis Park and Recreation Board
2117 West River Rd.
Minneapolis, MN 55401
Hennepin County

Property township, range, section:
T29N, R24W, Section 23, Northwest 1/4

Watershed:
Mississippi River Watershed

Watershed District:
Mississippi Watershed Management Organization

Parcel Identification Numbers:
2302924220016
2302924220017
2302924220011
2302924220010
2302924220009
2302924220008
2302924220003
2302924220002
2302924220001
2302924210003
2302924210004
2302924210007

Rare Features:
No occurrences on the property.

FIGURE 1. NRMP FOCAL AREA

LANDSCAPE CONTEXT

Proximity to established greenways
This property is located within the Metro Conservation Corridors (Figure 3), a regional land protection plan of the DNR. It is also adjacent to three other Minneapolis Parks and within Hennepin County's priority natural resource corridors. Finally, the property is located within the Mississippi River, arguably one of the nation's most important natural corridors for plant and wildlife species. The site is also located just upstream from St. Anthony Falls, a site with great historical and cultural significance.

Ecological significance and wildlife value
The property, although not ranked by the Minnesota County Biological Survey as biologically significant, is situated roughly two miles upstream of areas ranked as having moderate ecological significance by the MCBS. Due to its location along the Mississippi river, this property has inherent wildlife significance and plays an important role as a natural area in the river corridor. Birds use the Mississippi river corridor as an important migratory flyway, and all forms of wildlife depend on the river and surrounding natural areas for food and shelter. Many species utilize upland areas for breeding and foraging sites, making the property a potentially important site for many wildlife species.

FIGURE 2. ECOLOGICAL SUBSECTIONS

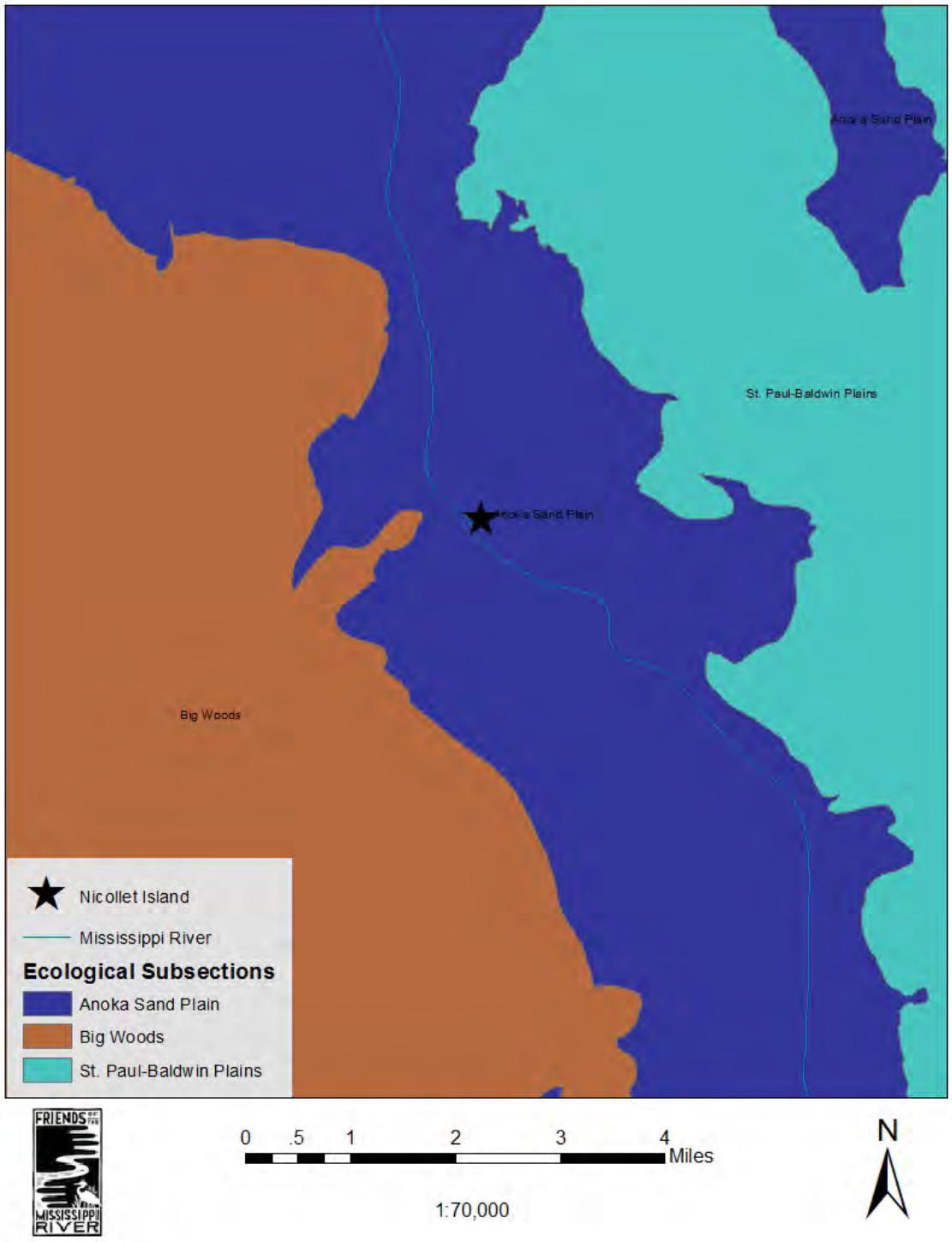
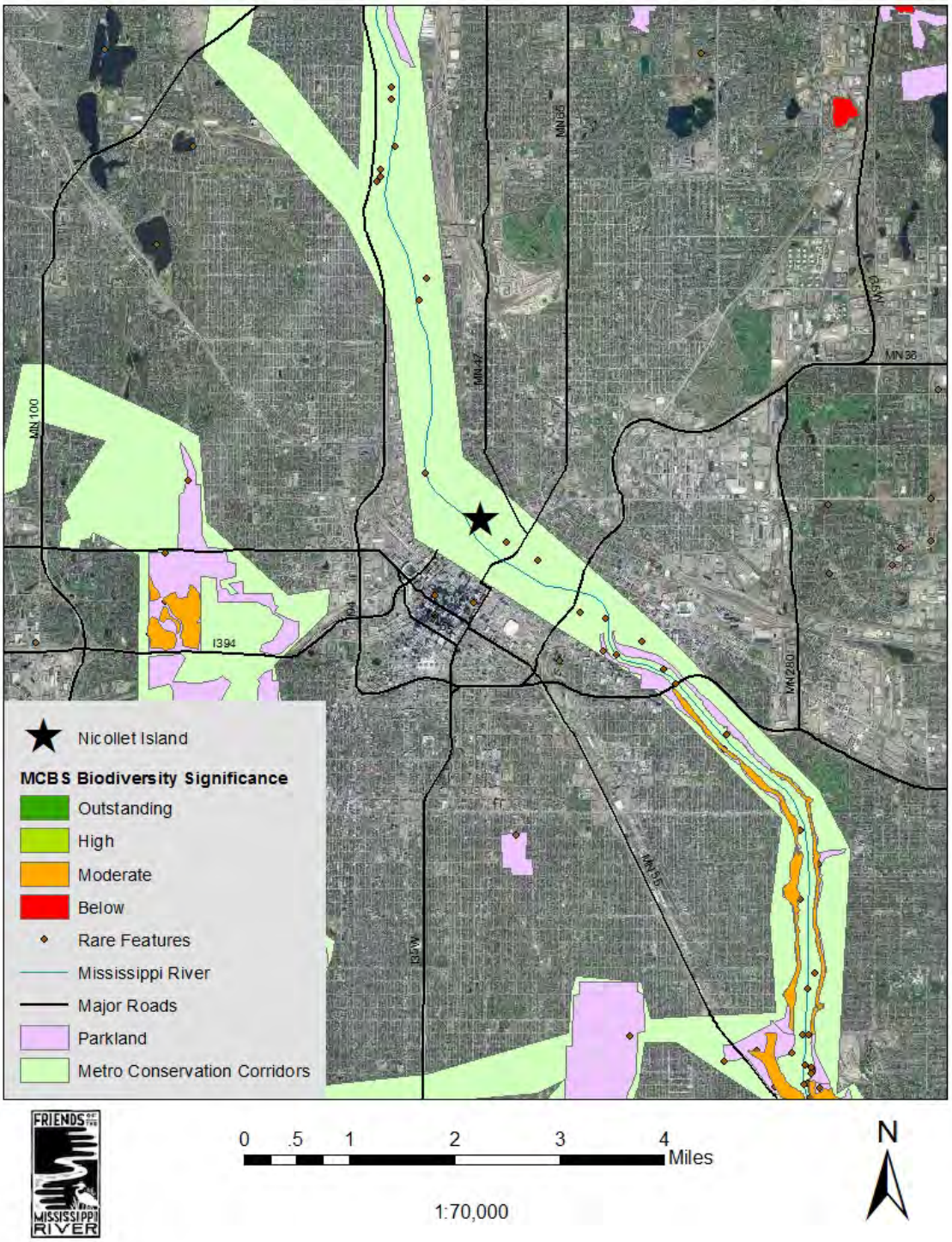


FIGURE 3. LANDSCAPE CONTEXT



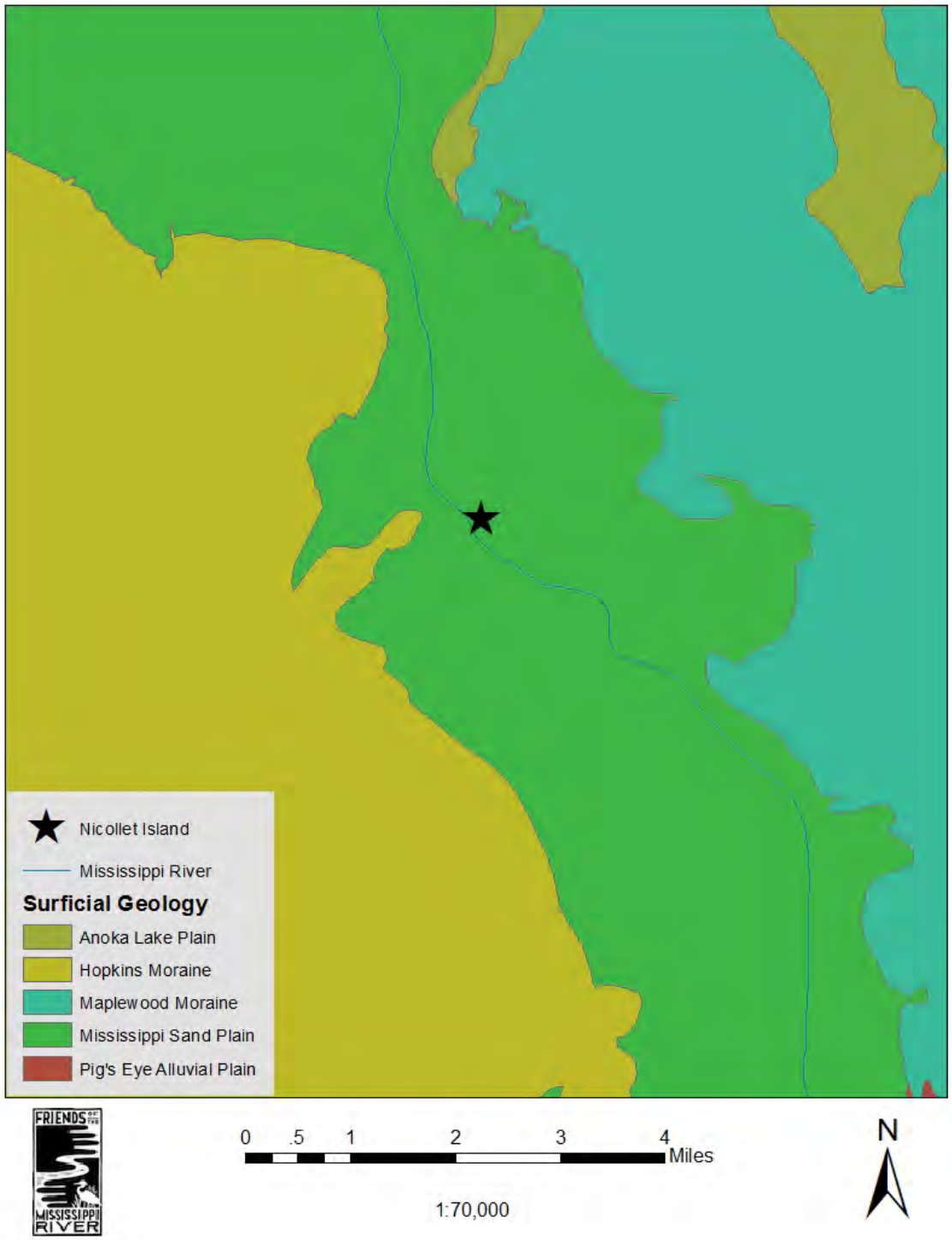
SITE GEOLOGY AND GROUNDWATER

The site lies within the Anoka Sandplain Ecological subsection and within the Mississippi Sandplain land type association. The surficial geology consists primarily of sandy terrace deposits from the Pleistocene era. Deposits range from sand to loamy sand and are often covered with layers of loam and silt. These occur above current floodplain areas but below nearby moraine or outwash areas.

The bedrock geology is largely Platteville limestone overlaying St. Peter Sandstone. The Platteville limestone is fine grained and contains thin shale partings. The St. Peter Sandstone includes fine to medium grain quartz sandstone. For the entirety of the site, the depth from surface to bedrock is less than 50 feet.

Throughout the site, the sensitivity of groundwater to pollution is very high, as the depth to the water table mirrors that of the surface of the river. The susceptibility of the Prairie Du Chien aquifer to pollution is low-medium, as the finer grained material of the Platteville limestone and St. Peter Sandstone has a lower porosity.

FIGURE 4. SURFICIAL GEOLOGY



TOPOGRAPHY AND SOILS

TOPOGRAPHY

As an island, the site has a relatively predictable topography, and is generally highest in the central portion, with the largest relief occurring on the edges as the site slopes downward toward the Mississippi. The island does have a small raised hill just north of the railroad tracks; at 850 ft above sea level, this is the highest point on the island and is roughly 20 ft higher than the majority of the surrounding area. The rest of the island is largely flat or gently sloping, with steep banks dropping roughly 30 ft to the water's edge. Overall, elevation at the site ranges from a low of 798 ft above sea level along the banks to a high of 850 ft in the central portion of the site (Figure 5).

SOILS

Soil formation is the result of the interaction of five soil-forming factors: parent material, climate, organisms, topographic position or slope, and time (Foth, 1990). Taken collectively, these factors can help determine the dominant floral and faunal communities that helped form the soils.

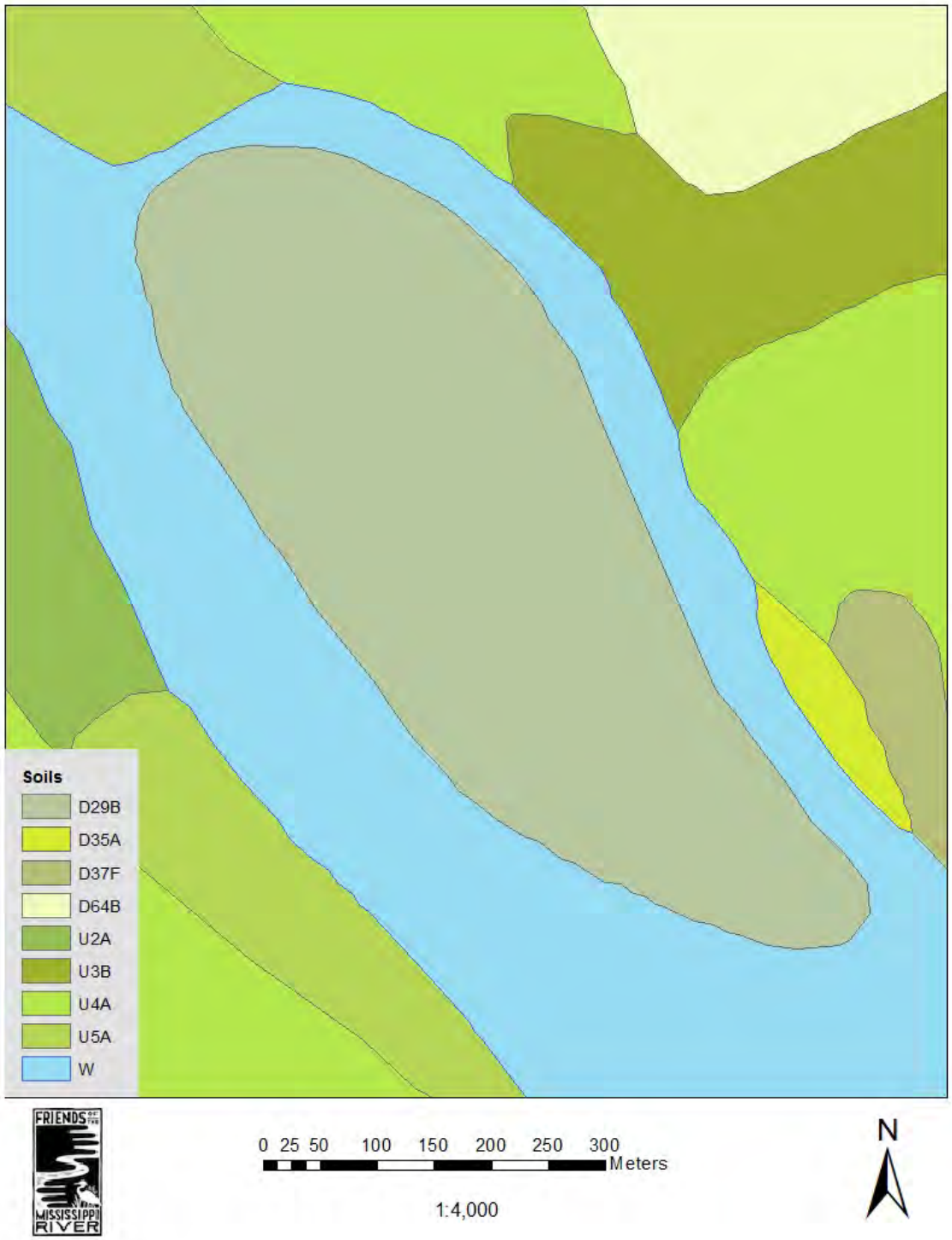
Soils vary relatively little in character across the site and are heavily influenced by the historical river features. The soils on the site are loamy sand, meaning that they are a mix of sand and silt, with clay composing a very small fraction of the mix. The soils contain a large percentage of fine sand deposited by historical river flows, and are excessively drained. The parent material is largely outwash over limestone bedrock (Platteville limestone), with a shallow depth to bedrock (40 to 80 inches) and a base of St. Peter sandstone. The upper portion of the site experiences little to no flooding. However, overland water flow combined with the steep bank slopes make the slopes prone to erosion. A summary of soils and their associated characteristics is listed in Table 1, and can be visualized in Figure 6.

FIGURE 5. TOPOGRAPHY

TABLE 1. SOILS

Soil Code*	Soil Name	Percent Slope	Soil Family	Hydric (yes or no)	Drainage	Erodibility (Susceptibility to water & wind)
D29B	Urban land – Hubbard, bedrock substratum	0 to 8	Loamy sand	N	Excessively drained	Water – Low Wind – High

FIGURE 6. SOILS



RARE SPECIES

According to the DNR natural heritage database, there are no rare species recorded on the island. However, there were two elements recorded within a mile of the site. The closest element of occurrence was found at the southern tip of the island in the east channel. There, surveys found *Ligumia recta*, or the black sandshell mussel, a species of special concern in Minnesota. To the southeast of that, surveys recorded the tricolored bat (*Pipistrellus subflavus*), another special concern species. This occurrence, in Chute's cave on the east bank of the river, is the largest concentration of the species in any hibernacula in the state.

Although the black sandshell is not likely to occur at the site, a restored upland vegetative community would likely benefit its populations. A healthy vegetative community will help stabilize soils and decrease erosion into the channel, decreasing sedimentation and improving local water quality, though this is largely influenced by the larger river system as a whole. A restored upland community will also support a variety of insects and could provide roosting habitat for the tricolored bat. Restoration of the island could also support a number of Species of Greatest Conservation Need (SGCN). SGCNs are species designated by the DNR and presented in *Tomorrow's Habitat for the Wild and Rare* (DNR 2006) as those in need of conservation, or species whose populations have experienced large declines in their respective ecological subsections. Thus, restoring wildlife habitat is still a priority for this plan. Habitat loss and degradation have been the primary causes of problems for SGCN species in the subsection, with the greatest number of species dependent on prairie/grassland, oak savanna, and forest. The property's location along the Mississippi also makes it an important potential habitat for myriad plant and animal species. The DNR recommends stabilizing and increasing SGCN populations in oak savanna, prairie and forest areas by managing invasive species, using prescribed fire and other practices to maintain savanna and prairie, encouraging restoration efforts, and providing technical assistance and protection opportunities to interested individuals and organizations.

EXISTING WILDLIFE POPULATIONS

Also, although no longer a rare species, bald eagles remain on the DNR watch list and were frequently seen flying above the property. Other wildlife seen in regularity at the site include gray and red squirrels, chipmunks, groundhogs, rabbits, a fox, garter snakes, red-tailed hawks, downy woodpeckers, great blue herons, and numerous insects, including honeybees, bumblebees, dragonflies, damselflies, carrion beetles, and monarch butterflies. A beaver lodge is also present on the bank of the not-a-lot unit and shows evidence of recent activity, including a few felled buckthorn shrubs.

As stated in previous sections, there are no rare species occurrences recorded on the property. However, it is possible that these and others species are present throughout the site, though no evidence of this was found during site surveys.

HISTORICAL VEGETATION

Based on interpretation of the 1850s public land survey (PLS), in which the dominant tree (bearing tree) and other vegetation was recorded at every one-mile interval, the boundaries of the island lie within what would have been oak openings and barrens in pre-European settlement times (Figure 7). The island is sandwiched between bands of prairie to the east and big woods forest to the west. The land cover type in this region was a mosaic of different habitats ranging from oak openings and floodplain forests, to prairie, big woods forests, and aspen-oak woodlands. The most common land cover type of the region was oak openings and barrens, which we today would call savanna. Savanna is an area of scattered trees, primarily bur oak, with areas of open prairie between them. Prairie was an area dominated by mixed height grasses and forbs (wild flowers), with patches of shrubs and very few to no trees. The difference between prairie and savanna is created by frequency and intensity of fire. Generally, frequent fire (every 2 to 5 years) will result in prairie, while slightly less frequent fire (3 to 8 years) will result in savanna.

Bearing trees were noted by the 1850s PLS surveyors to help identify each section of land. If no trees were in the section, that was also noted. Bearing trees were recorded east and west of the island. Trees were identified as either “bur oak” or “black oak (pin)” providing further evidence that this area was likely a mix of vegetation types within the overarching oak openings. However, its location as an island in the Mississippi River likely shielded it from the historical disturbances that shaped much of the surrounding landscape, and it was likely more of a forested habitat, with variation throughout.

Today, the north, south, and west sides of the property are classified as forest. Because of their steep slopes, that is likely their historical state as well, though the species composition may be slightly different. Because of these steep slopes, fire was less frequent, allowing woody species to dominate. Other areas of the site may have been more open than they are today, with larger prairie pockets and fewer trees and shrubs.

Historical aerial photos can also help us reconstruct what the vegetation was like during the last 75 years. The oldest aerial photos for the area are from 1938, and the earliest and best photo of the entire site is from 1940 (Figure 8). By that time, the island was already largely developed, and while the nature of the development was slightly different, the locations are largely the same. The not-a-lot area was still open, though it had more tree cover on top and less tree cover along the banks. Likewise, the upper path unit was quite open, likely because the areas to the east of the current path were kept clear to easily service the rail line that fed the railyard at what is now Boom Island. Large trees still dominated the narrow strip between the current path and East Island Ave, though this forest seems to have had a slightly more open nature similar in structure to vegetation found in a savanna-type landscape. Finally, a few buildings occurred on what is now the grassland and forest units at the north tip of the island, though the majority of the area was open and very little woodland remained.

A progression of historical photos helps us to understand how the vegetative structure has changed over time (Figure 8; Figure 9; Figure 10; Figure 11; Figure 12). By 1965ß, tree cover had increased along the banks, though much of the not-a-lot area had become used for parking and industrial uses. At the north tip, buildings had shifted into the grassland unit, while the forest unit was now open grassland. By 1988, tree cover and uses of the not-a-lot had been largely removed, as had the buildings on the north tip of the island. Many other developed areas of the island were removed and had become open or recreational space. Use of the railyard at Boom Island had ceased, and vegetation along the railway/path continued to increase. By 2002, woody encroachment along the banks of the not-a-lot and in the woodland unit at the northern tip had increased, becoming similar to what they are today. In the intervening period, vegetation in the woodlot continued to increase.

Historical communications also paint a detailed picture of the vegetative character of the island. Multiple people describe the forests on the island. For example, Caleb Door, in 1847, noted that he and others used to tap the maples trees "in the forest on Nicollet Island." He also noted that they had to guard these areas from the Chippewa, "else they would steal the sap." Presumably, the Chippewa would have also tapped these trees before European settlement. A quote from Dr. Lysander P. Foster in 1849 also notes that black walnut grew on the island. In 1851, Rebecca Cathcart noted that the island was "heavily wooded, and in its wild state very beautiful." In 1858, Jane Swisshelm wrote that Nicollet Island was "crowned with a dense forest." Thoreau's field notes from his visit in 1861 also note a number of forest plants, including Virginia waterleaf (*Hydrophyllum virginicum*), Woodland phlox (*Phlox divaricuta*), and others. He also describes the canopy trees: "What oaks and maples. I see sugar & a little white. What Juglandaceae – butternut and hickory. Celtis." Charles Loring, in his history of the parks of Minneapolis, even notes that the island "was covered with a fine growth of forest trees, mostly hard maple…" While singular descriptions or observations about specific species can be untrustworthy, taken together (and especially given Thoreau's botanical prowess) these observations point to a more forested island in the past.

FIGURE 7. PRESETTLEMENT VEGETATION

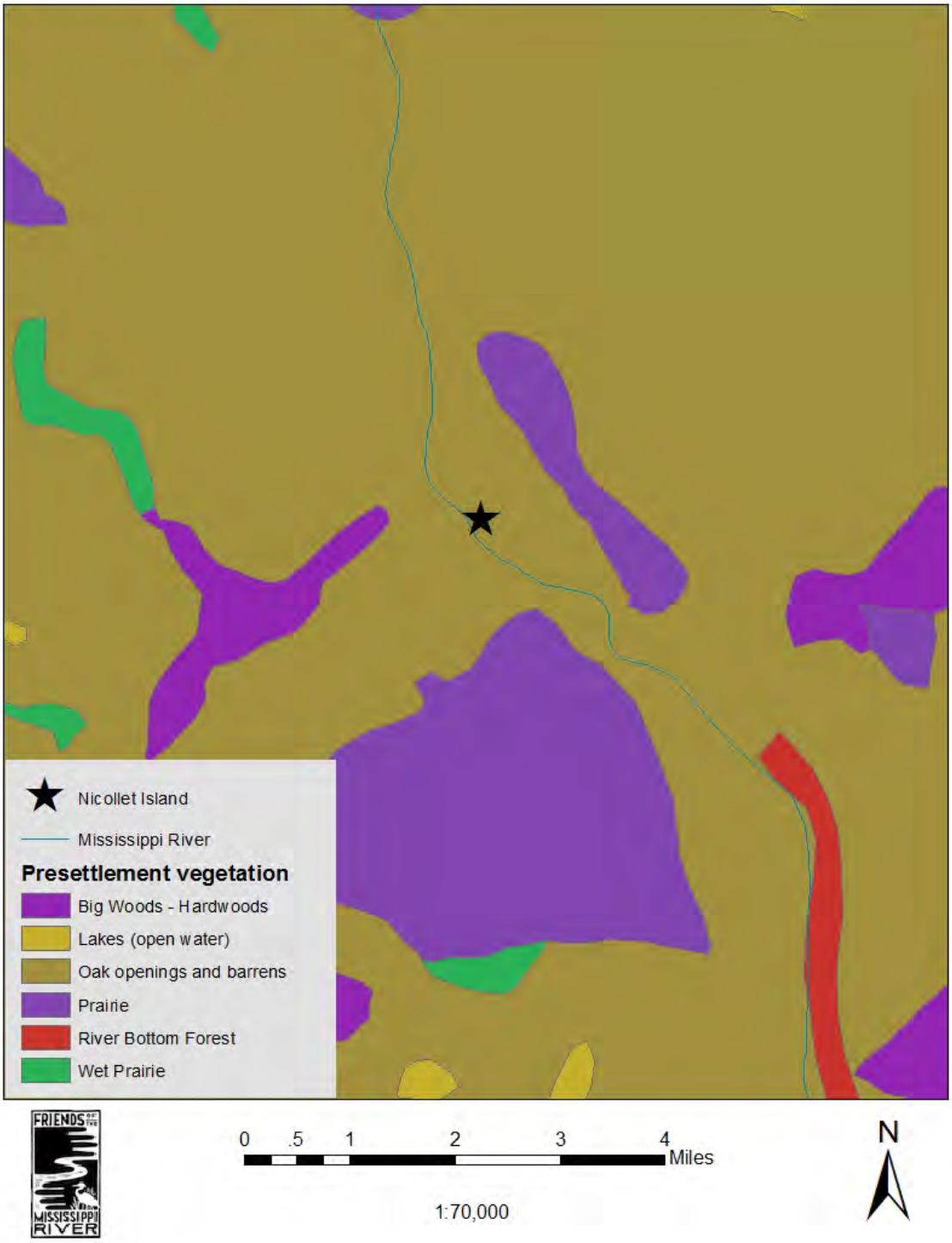


FIGURE 8. 1940 AERIAL PHOTO WITH CURRENT PROJECT AREAS

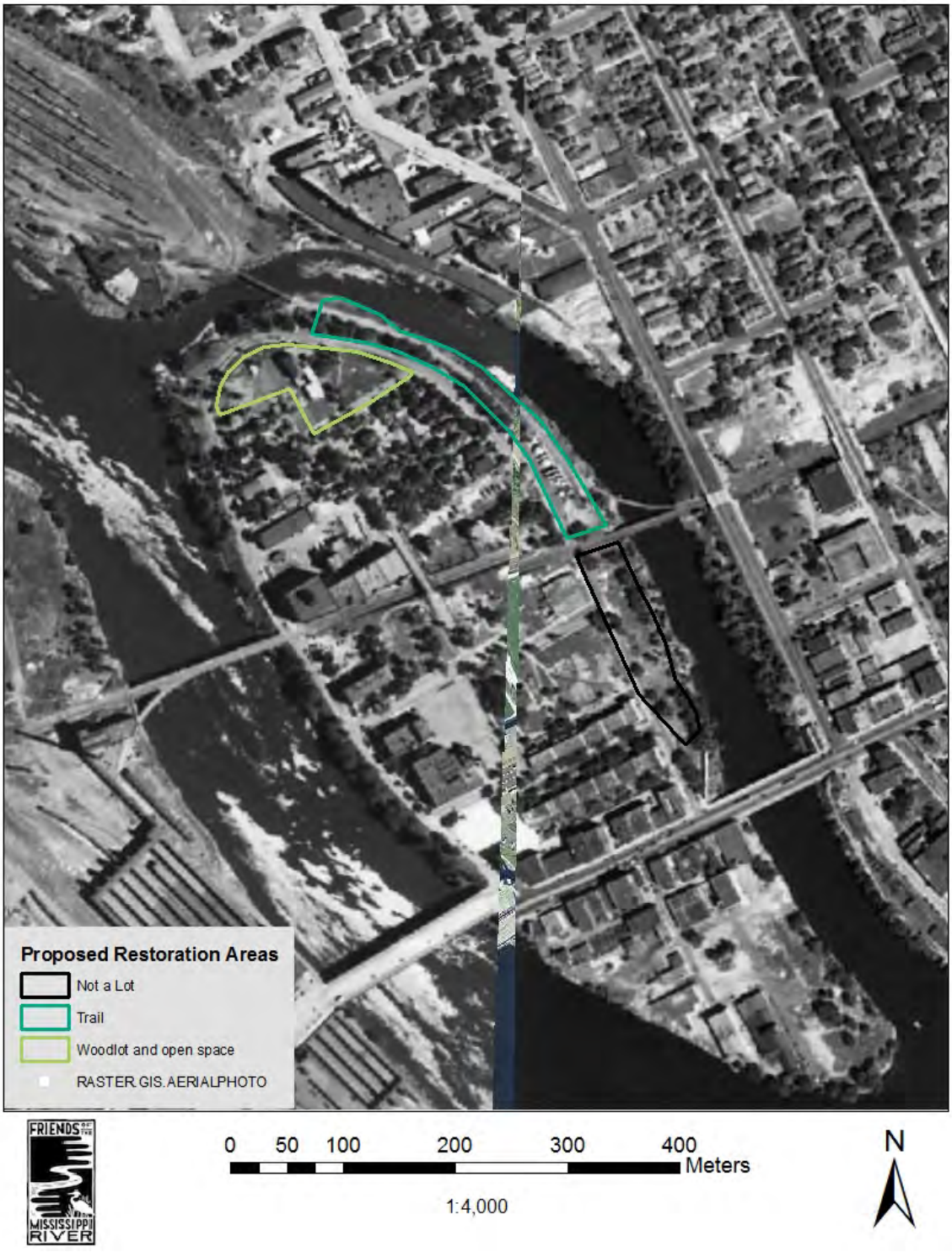


FIGURE 9. 1965 AERIAL PHOTO WITH CURRENT PROJECT AREAS

FIGURE 10. 1988 AERIAL PHOTO WITH CURRENT PROJECT AREAS

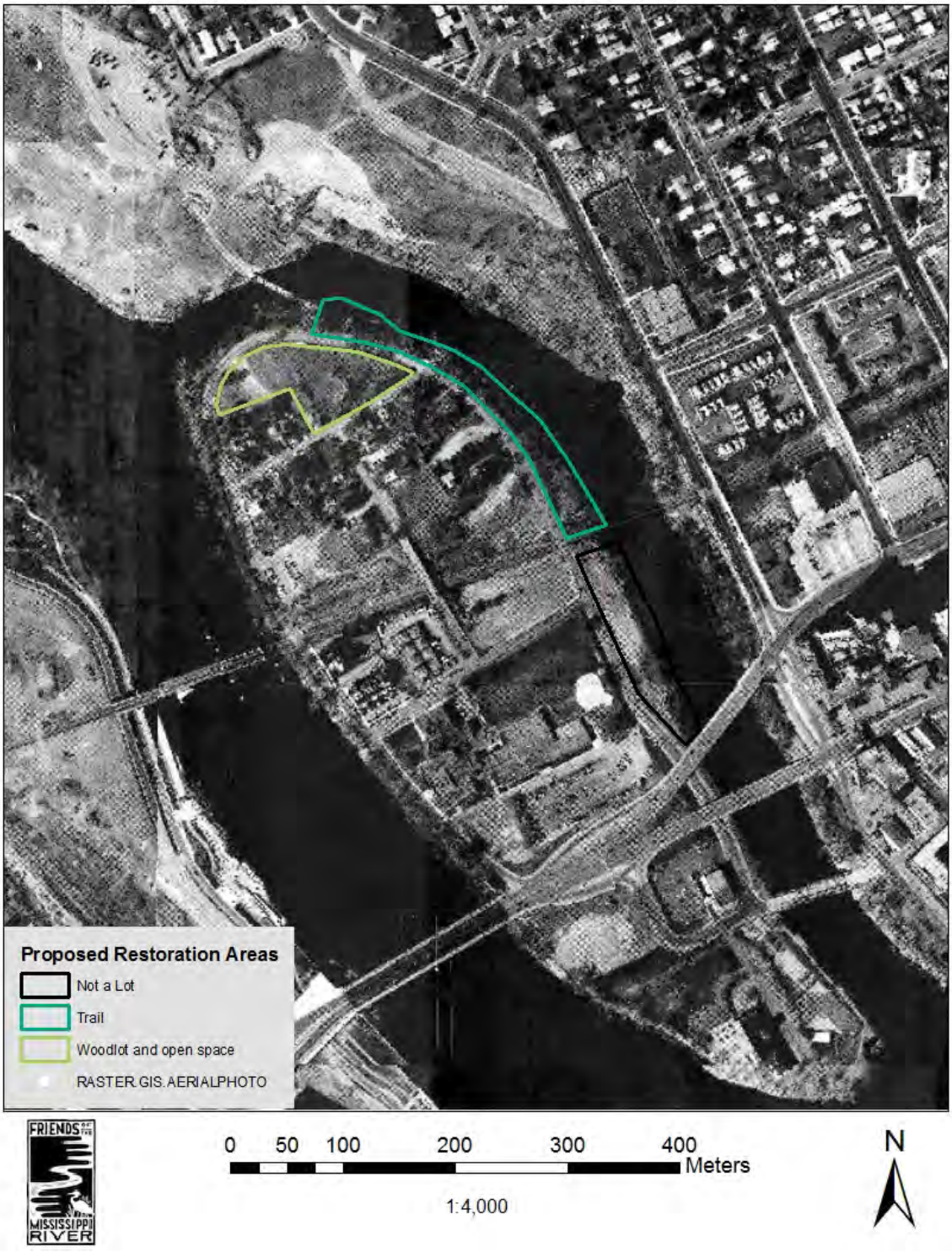


FIGURE 11. 2002 AERIAL PHOTO WITH CURRENT PROJECT AREAS

FIGURE 12. 2015 AERIAL PHOTO WITH CURRENT PROJECT AREAS

HISTORICAL AND EXISTING LAND USE

Detailed records of land use before European settlement are lacking, but evidence exists that areas surrounding the site may have been used in pre-European settlement days. Evidence of Native Americans' presence in Hennepin County extends back over 12,000 years, with various flakes and projectile points (arrowheads, spearheads etc.) being excavated from sites around the county. Preferred settlement locations occurred near streams, lakes, and rivers, and the habitat along the Mississippi was especially good for hunting and gathering. Hennepin Avenue itself was built on a Native American footpath that ran from the Mississippi River southwest through the Minneapolis Chain of Lakes and eventually south to Iowa (http://hclib.tumblr.com/post/13979163752/genesis-of-hennepin-avenue-photo-from-1869-did). However, due in part to the urban and industrial development along the river, historical evidence of Native American use of the area is not abundant. In the area around the island, a single burial was found in 1870, as were various other artifacts, including a copper spear point, a Clovis point, and a potsherd (Anfinson 1989). However, accounts of the Native American use of the area are more plentiful, including a camp along the river at Bassett's Creek (Foster 1849) and even camps on the island itself for maple sugaring (Anfinson 1989b). The Dakota even called the island "Wita waste," meaning "beautiful island." While there have been no archaeological finds on the island itself, studies conclude that due to its known use by Native Americans, there is a high likelihood that the island contains archaeological resources (DLS High School report).

Detailed records exist of the post-European settlement uses of the island. The island may have been first visited by Zebulon Pike in 1805. The surrounding areas soon became home to Sawmills that milled timber floating down from the north. By 1839, Joseph Nicollet had mapped the island and surrounding areas, and by 1849, the island's first residents moved into a log cabin there. Early residents had to reach the island by crossing the floating mats of timber that backed up in the channels. By the early 1850s, the island had many visitors and admirers, who remarked upon its natural beauty. Dense forests, open meadows, and abundant wildflowers offered an oasis. Even in 1861, when Thoreau visited, he noted not only abundant plant life (including white oaks, sugar maples, and walnut), but wood peewees, phoebe, red-headed woodpeckers, and deer.

However, the 1850s also brought considerable development to the island. Houses began popping up north of present-day Grove Street. A limestone quarry and plant nursery operated on the southern end of the island. When a bridge was finally constructed to the island in 1854, that opened the way for the eventual erection of the Island Power building in 1879 and a wave of industrial development followed. In the intervening period, residential development continued on the north end of the island, with many shopkeepers and tradesmen setting up residence. The Grove Street Flats, erected in 1877, are still standing today, and are on the National Register of Historical Places. Once the power building was complete, a furniture factory, box manufacturer, boiler works, grist mills, an ice house, and various other industries flooded the island. In 1893, a large fire destroyed many of these buildings and left over 1,500 people homeless in northeast Minneapolis. The Island Sash and Door company, now the Nicollet Island Inn, was just begin built that

year. By 1921, the last sawmill in the area closed, and much of the industry had already left. The next few decades saw the demolition of much of the row housing and the rise of rental and rooming houses in the remaining buildings. DeLaSalle high school expanded in the 1920s and again in 1959. In 1961, Hertz operated a truck storage garage on the island. The current "not-a-lot" is indicative of the many historical uses of properties on the island, most recently serving as a stone storage location for Twin City Tile and Marble, a garage building with a concrete slab, and an overflow parking area for DeLaSalle. The smaller rail line connecting the railyard at Boom Island remained active until 1970, when the Wisconsin Central railyard closed. The island has also been proposed as a park on various occasions, including in 1866, 1906, 1917, and 1957. The City of Minneapolis rejected the 1866 proposal, only to have future plans and proposals reach the same conclusions.

The human uses of the island are intertwined with its natural features. Native Americans and European settlers alike tapped the maple trees for maple syruping. Captain John Tapper, a ferry operator, pastured a small number of sheep and pigs in the open areas of the island. Brewers used the natural caves at the north tip of the island for beer storage and mushroom growers later used those same limestone and sandstone caves. However, it wasn't until residential and industrial of the island took off that the vegetative structure of the property changed.

WATER RESOURCES

Surface Waters – Streams

The Mississippi river is the obvious surface water resource in this area, and west and slower moving east channel surrounds the island on both sides. However, the river does not affect any of the surface water on the property, given that the island is set well above even the 100 year floodplain. The property has no surface water resources (streams, ponds etc), though overland flow has cut cut small gullies down the banks in a number of locations. Following large rain events, especially in the spring, flows can be quite high, and erosion is common.

Stormwater Management Issues

There is significant erosion potential throughout the site, due both to highly erodible soils and the steep slopes. Because of this, the property is highly affected by overland runoff. The nearby roads, residences and buildings all contribute runoff water to the natural areas, and combined with erodible soils, slopes, and the lack of deep-rooted native vegetation, erosion is common. According to a 2014 MWMO study, root depth and root density are major contributors bank stabilization and factor highly into Bank Erosion Hazard Index (BEHI) scores (MWMO 2014). Estimates from the west side of the island showed that steep areas with little to no native groundcover (and thus low rooting depth and density) resulted in up to 11.7 tons of sediment loss per year over just 141 feet of bank. Moreover, this sediment can transfer up to 1.5 pounds of phosphorus per ton of soil into the river (though actual values were likely lower), contributing to water quality issues. Re-vegetating the forest areas with native vegetation, which has larger and deeper root systems, will help to retain water and prevent runoff from rapidly eroding the slopes.

ADJACENT LAND USE

Land use around the natural areas of the island is dominated by residential use (Figure 1). Island Avenue rings the island, and smaller streets connect East and West Island Ave. Many residences, including houses and some townhomes, line the streets, and DeLaSalle High School is located at the southern end of the project area. Just north of DeLaSalle, a strip of parkland occurs between East and West Island Aves, though the park is severely degraded by non-native species. South of Hennepin Ave - the southern project area boundary – land use is a mix of parkland and commercial uses, with the Nicollet Island Inn and pavilion occupying much of the site.

The island itself is surrounded by the city of Minneapolis on either side of the river. Dense urban development dominates the landscape, with a ribbon of parkland on either bank of the river. As was discussed at the beginning of this document, the potential to link the property with conservation corridors is a vital strategy for promoting the health of wildlife populations here. Since it is virtually surrounded by urban land uses, this is difficult to accomplish, but its location in the river and its proximity to the riverside parkland provide important natural linkages. Connecting the property to habitat along the Mississippi river will enhance the overall usability of this riverside habitat corridor.

Adjacent landuse can also cause a variety of ecological issues. Residents have long dumped yard waste throughout the property. This has led to the proliferation of lilies and other garden plants in the natural areas, and many piles of lawn clippings and potted plant soils. This should eventually be cleaned up and the practice discouraged.

A possible problem for the surrounding landowners could be smoke drifting from the property during controlled burns. Proper planning and notification or residents should avert conflicts, however. In fact, all adjacent residents should be notified prior to any controlled burning events at any time, and smoke management should always be part of any burn plan. Burning the prairie areas may ultimately be problematic and the prairies could be maintained through repeated mows. Nevertheless, wind direction from the south would be advisable when burning.

ECOLOGICAL THREATS

There are a number of ecological threats to the natural areas on the island. Invasive species, erosion, and human uses are all contributing to the degradation of these units. Invasive plants are present in all vegetative strata in the units, including in the herbaceous, shrub, subcanopy, and canopy layers. Invasive shrubs like buckthorn and bush honeysuckle are the most prevalent species, and have a host of documented negative effects on soils, vegetation and wildlife. The herbaceous invaders on site are patchy, but are becoming dense enough to crowd out native understory vegetation. Finally, the invasive tree species on the island, while not creating dense monocultures, are providing a continual seed source for future colonization of these species.

A general dominance by non-native vegetation further exacerbates erosion on site. Native vegetation, especially native prairie grasses and woodland graminoids, are both fine- and deep-rooted. It is well known that the fine rooted herbaceous vegetation is one of the primary factors that holds fine soil particles in place, especially on steep slopes. As invasive plants outcompete the native vegetation, a lack of graminoids and forbs will lead to increased erosion and sedimentation in the forested units. While not as visible, the lack of native graminoids in the grassland areas compounds the problem, as the non-native species with shallower root systems are less able to absorb and hold water, creating more overland flow into the forest units. The sooner restoration of these area occurs, the better.

Combined with erosion caused by invasive shrubs and lack of native vegetation, the general topography of the site exacerbates erosion, since steep slopes and erodible soils occur on two of the four work units. Throughout the site, at the bases of some of the steeper slopes, there were areas of sediment accumulation and on portions of the steeper slopes there were areas of surface erosion as evidenced by exposed root crowns of trees. This is a chronic phenomenon that can be again attributed to the simple fact that there is a lack of fine-rooted vegetation on these slopes. A denser vegetation layer would act to break the impact of raindrops and dissipate the energy of stormwater running on these slopes. Proactive thinning of the canopy and shrub layers may be necessary to establish native understory vegetation in some areas.

The forest floor throughout the property does not have a duff layer, and instead has much bare soil, with only one year's leaf litter accumulation present each spring. This is primarily due to European earthworm invasion. 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, epigeic (litter dwelling), endogeic (soil dwelling), and anecic (deep burrowing) species of earthworms 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 (*Lumbricus terrestris)*, invading and establishing. 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. The result of their activities is a net soil compaction and a marked increase in the litter and duff layer turnover rate (the time it takes for the litter layer to be decomposed). Thus, where there used to be several inches of thick duff layer in our native forests, now there is only a trace or often none at all, with compacted, bare soil prevalent. This situation can then lead to detrimental impacts on surface water, as increased erosion, nutrient leaching and runoff from affected areas flows directly into the river.

The lack of duff layer and soil compaction also has negative ramifications for native forb and tree populations, especially spring ephemerals, which have evolved to germinate and thrive in thick duff layers. Not only do these species germinate poorly on bare soil, but common buckthorn seeds and other non-native species such as garlic mustard have evolved to readily germinate in these conditions. Once buckthorn is introduced to an area that has been "wormed", it can easily take over, which spells yet greater degradation to the ecosystem. Once a few large seed-producing trees take hold in an area, a virtual carpet of buckthorn seedlings will radiate outward from each "mother plant", displacing or preventing native plants from re-establishing in these areas. The berries of buckthorn (and many other non-native shrubs) are dispersed by birds throughout the woodlands; trees that offer perches for birds are typically choked with buckthorn plants growing under their crowns. Hence, buckthorn can rapidly come to dominate a vulnerable woodland or forest in a matter of 30 to 50 years.

Another factor degrading these units is over-browsing by deer. Deer populations have greatly increased over the last century due to both direct and indirect causes. Vast amounts of agricultural land have been created at the expense of native forest, woodland, savanna, and prairie, concentrating deer in fewer natural areas. Moreover, deer have come to thrive in human-dominated landscapes where hunting pressure is low. It is well known that deer prefer "edge" habitat: areas of land with large amounts of long, linear forest/woodland edge, so they can use both the open areas to feed and the wooded areas for cover. Fragmentation of forests and managing for large gaps and lots with linear woodlands have greatly increased the "edge effect" in Minnesota. This, plus the destruction of wolf populations, has resulted in an explosion in the deer population within the last 75 years. Deer rarely eat invasive plants like buckthorn or garlic mustard (relative newcomers on the landscape) —if given the choice they prefer many of the native forbs,

shrubs, and tree seedlings. This greatly increases the browsing pressure on the few natives that can survive earthworm and buckthorn invasions. While deer pressure on the island isn't as high as in many urban natural areas, over browsing has likely resulted in lower diversity and a lack of tree regeneration in the units.

The lack of fire due to fire suppression over the course of the last century and a half also negatively impacts grasslands and woodlands. Fire acts to kill small woody seedlings that might otherwise grow into mature trees and shrubs, keeping the understory of woodlands and the ground layer of grasslands open. Because of this, wildflowers, grasses, sedges, and ferns can thrive. When fires were allowed (and encouraged, by native Americans), a very diverse and varied herbaceous ground layer flourished in forests and grasslands, with hundreds of species occurring. While fire was likely infrequent on the island, it would have occurred in patches and played a part in maintaining the open areas of the site.

Human uses of the natural areas of the island continue to threaten their ecological health. Historical dumping has been replaced by the disposal of yard waste in the units, and escaped (and planted) ornamental garden plants have come to dominate some of the natural areas. Areas of yard waste, especially on slopes, can contribute to erosion by preventing the growth of native plants. Ornamental plants have outcompeted native in some areas, and continue to prevent the establishment of native species. Finally, encroachment by neighboring properties has even resulted in the loss of natural areas.

Lastly, emerald ash borer (EAB) - present in much of the metro area - is a threat to the ash trees on the island. Predicted to wipe out the majority of Minnesota's ash canopy, EAB warrants proactive forest management strategies. While green ash is a relatively small component of the tree canopy in the island's natural areas, proactive removal of some of these trees will not only prevent future hazard trees, but also presents an opportunity for understory restoration. Removal of areas of dense ash will improve understory restoration success by allowing light to penetrate to the forest floor and increase seeding success.

Due to several factors over the last 150 years, our forests in Minnesota have undergone a transformation of vulnerability, degradation, and decline. Coupled with future threats including climate change and tree pests and disease, the future of these forests are in jeopardy. The forested areas on the island are typical of this situation. Some areas are worse than others, but there is still time to manage this site before it is fully dominated by buckthorn and other non-native invasive plants, and before erosion becomes too severe to remedy. With proper, well-timed management, restoration of the property's natural areas is possible and likely (see Management Recommendations section below).

EXISTING LAND COVER & ECOLOGICAL MANAGEMENT RECOMMENDATIONS

The Department of Natural Resources (DNR) developed a system called the Minnesota Land Cover Classification System (MLCCS), which integrates cultural and vegetation features of the landscape into one comprehensive land classification system. This information was used as a basis for the site evaluation, which was conducted by FMR's ecologist in the summer of 2017.

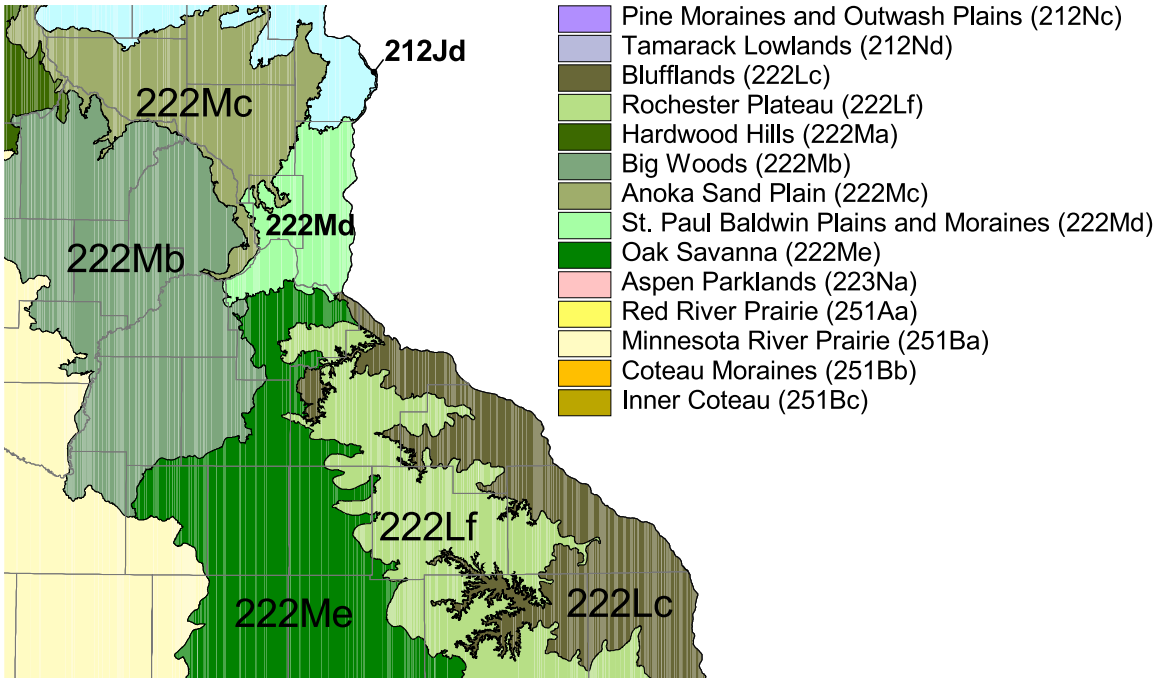
For determining target plant communities for restoration (Table 3), we considered the following: 1) historical conditions, 2) existing conditions, and 3) relative effort vs. benefits. Relative effort vs. benefit simply means that if the amount of energy and work that will go into restoring a particular community is too great, in terms of the benefits received, then restoration would not be recommended. This helps us determine the optimal and most suitable goals for restoration. Target communities are in accordance with the DNR field guides and are described below.

As a guideline for the target plant community goals, we used the *Field Guide to the Native Plant Communities of Minnesota: the Eastern Broadleaf Forest Province* (DNR, 2005). This book describes the system developed by the Minnesota Department of Natural Resources for identifying ecological systems and native plant community types in the state, based on multiple ecological features such as major climate zones, origin of glacial deposit, plant composition, and so on.

There are four ecological provinces in Minnesota (prairie parkland, eastern broadleaf forest, Laurentian mixed forest, and tallgrass aspen parkland), ten sections within the provinces, and 26 subsections. The property is classified as follows (Figure 13):

Ecological Province: *Eastern Broadleaf Forest*
Section: *Minnesota and Northeast Iowa Morainal*
Subsection: *Anoka Sand Plain*

FIGURE 13. ECOLOGICAL SUBSECTIONS OF SOUHEAST MINNESOTA



As stated earlier in the Historical Vegetation section, the pre-settlement vegetation at the site was most likely a mix of forest and grassland pockets. This is still appropriate for most of the site, although there has been intense woody encroachment into any recently open areas. Some areas that had likely been open have succeeded to overgrown woodland, meaning that restoration to grassland would likely be prohibitively expensive and not worth the effort. For the majority of the site, forest is the most appropriate restoration goal.

PLANT COMMUNITY ASSESSMENT

Land Cover

The following are descriptions of the various cover types found on the property. The cover types were described and designated by Minnesota Land Cover Classification System (MLCCS). Cover types may be represented by multiple units of the same cover type (e.g. Altered Woodland represented by AW-1, AW-2, AW-3, etc.). Please refer to Figure 14 (MLCCS Landcover), Figure 15 (Landcover Units), Figure 17 and Table 2 (Features of Interest), and Figure 18 (Target Plant Communities and Work Units) throughout this section. Detailed plant lists surveyed from certain units are provided in Appendix A.

FIGURE 14. MLCCS LANDCOVER

FIGURE 15. LANDCOVER UNITS

Altered/Non-native Deciduous Woodland (3.7 acres) (AW1,2,3)

This is the largest unit on the property and is divided into three subunits. Two of the subunits are connected along the eastern side of the island, running north-south along the shoreline, and are separated by the railroad bridge. The third subunit is located west of Island Ave toward the northern end of the island. Restoration of the AW subunits will depend in part on limiting their use by neighboring residents. Continual soil and vegetative disturbance allows for colonization by non-native species, a cycle that is difficult to break. The three subunits, labeled AW or Altered Woodland (AW-1 south, AW-2 north, and AW-3) are approximate, and serve to better aid the discussion of the vegetation types on the property. They are roughly delineated on the maps (Figure 15, 18).

AW-1

The first subunit is AW-1, a narrow unit of forest along the southern half of the focus area. This unit was historically largely forested, but also experienced development and degradation due to human land uses. Today, the unit contains multiple large cottonwoods – relics from the pre-settlement forest – as well as younger trees that have filled in post-development. Other natural features include a large beaver lodge along the shore midway through the unit, and a number of groundhog and other ground-nesting mammal burrows. The unit shows little evidence of current human use, but has many areas of concrete and other building materials that had been historically dumped there. There is also a concrete retaining wall at the top of the slope, which separates the unit from the flat, "not-a-lot" unit.

Currently, the unit has a relatively uniform vegetative character, and is dominated by large trees, particularly the few towering cottonwoods (Photo 1). Box elder is the most abundant tree species, followed by cottonwoods, hackberry, and American elm. The subcanopy is made up of a few smaller box elders. The canopy is dense, with some tree regeneration, mostly from box elder, but overall there is relatively low regeneration. One Siberian elm is present on the southern border of the unit.

A common measure of tree size and size distribution is a tree's diameter at breast height, or dbh. The cottonwoods in this subunit ranged in size from 68.6-114.4 cm dbh, indicative of their status as a supercanopy tree. Box elder individuals were smaller, with the largest recorded at 64.8 cm dbh, and many in the 40-50cm range. The few hackberry individuals were between 35.7 and 52.9 cm dbh. The largest individuals of other species included one American elm (44.3) and a Siberian elm (42.1).

The shrub layer ranges from conspicuously absent in some areas, to small pockets where buckthorn, gray dogwood, or elderberry dominate. Some small hackberries are interspersed throughout, while buckthorn and honeysuckle are present along the upper edge of the slope. Vines like wild grape and woodbine are common throughout the unit. The understory has the least diversity of any unit in the focal area, though diversity is somewhat bolstered by the upper forest edge that borders the not-a-lot. Common forest species such as stickseed, lopseed, white snakeroot, and enchanter's nightshade were

found throughout. Woody seedlings included hackberry, box elder, Siberian elm and one northern catalpa; no cottonwood seedlings were encountered. Buckthorn seedlings were present but not overly abundant, while herbaceous invaders included motherwort and small patches of garlic mustard in the forest, and spotted knapweed and leafy spurge along the not-a-lot border. Using LCCMR's statewide restoration monitoring evaluation tool, we can use the community's percent native vegetation and invasive species abundance to rank the overall vegetative community heath. In this case, AW-1 ranked highest out of the units in this plan, but still scored in the low quality category (Figure 16). Overall, this was one of the least diverse units, but scored well in terms of its percent native vegetation (43%) and its invasive species cover was moderate.

Besides invasive species, erosion was the most prominent issue in this unit (Photo 3). The lack of vegetative cover has led to sloughing of the steep slopes, and overland flow has cause small erosion gullies, especially at the north end of the unit. The erosion is also due in part to the loss of native species cover, both due to competition from buckthorn and the role of invasive European earthworms. Here, native graminoids and forbs could help prevent further erosion, as grasses and sedges could greatly stabilize soils. If time and money allow, other erosion control measures such as erosion bars can be considered. Another notable feature was the smattering of old, rusted equipment in the unit. This occurred just downslope of the concrete retaining wall at the edge of the not-a-lot, and was likely deposited there decades ago. In most cases, this debris is firmly set into the soil; removal is not necessary, except where debris may hamper restoration efforts.

Overall, removing invasive species and re-vegetating this unit can provide important benefits, especially erosion control and water retention and filtration. The remaining woody invasive species should be removed and native trees and shrubs should be added in some places. The low light conditions may make establishment of native species difficult, but woodland sedges, grasses and wildflowers could be added, starting with canopy gap and open areas created by invasive removal. Thinning of native canopy and shrub-layer species will be necessary to establish native groundcover in some areas.

Photo 1. Active beaver lodge along the water in AW1. The beavers had even recently felled a few buckthorn shrubs.

Photo 2. Sheet and rill erosion in AW-1 where a lack of vegetation and compacted soils in the upslope SG-NAL lead to high overland flow.

Photo 3. One of a few open areas in AW1. These are candidate areas for revegetation to control erosion.

Photo 4. A concrete wall separates AW1 from the adjacent SG-NAL unit.

AW-2

AW-2 is a wider unit running north-south between East Island Ave and the eastern river channel. The unit is separated from AW-1 by the railroad tracks to the south, and the unit also straddles the walking/biking path that leads to Boom Island. Here, the vegetative community is more diverse, though the canopy is still dominated by similar species – with box elder, hackberry, and cottonwoods the dominant species and American elm, green ash, Siberian elm and basswood subdominant. These trees are, on average, similar in size to those in AW-1, but include more varied smaller size classes. Numerous smaller elms, hackberries, ash, and white mulberries make up the youngest regenerative classes, and the abundant edge habitat, due to the road and trail, provide plentiful space for regeneration.

Though the canopy is quite dense, more shrublayer and understory vegetation is present than in AW-1. The shrublayer contains abundant native species, including chokecherry, elderberry, pagoda dogwood, and wild black currant, though buckthorn and honeysuckle are abundant as well. Moonseed and wild yam are abundant in places, as are wild grape and woodbine. The understory is made up of a mix of shade and edge species such as common blue violet, columbine, white snakeroot, zig-zag goldenrod and stickseed, as well as more sun-loving species like Canada goldenrod, common milkweed, and yarrow. Abundant tree and shrub seedlings are present as well. While quite diverse (see species list in Appendix A), the unit also contains many non-native and invasive herbaceous species, including garlic mustard, motherwort, burdock, Canada thistle, bouncing bet, curly dock, and Asiatic dayflower. AW-2 is the most diverse unit in this plan, but scored low in terms of its percent native vegetation (23%) and moderately high in its invasive species cover. AW-2 ranked scored in the low quality category in terms of its overall vegetative health (Figure 16).

This unit is the more gently sloping than AW-1, owing to the flat trail that used to be a railroad route connecting boom island south and across the east channel. This path provides easy access for the management of both sides of the unit, and management will be easier than in AW-1. Buckthorn is abundant along the path as well as in the upslope section of the unit; however, the diversity retained in the shrub and ground layer makes this a priority area when beginning restoration (Photo 5). Moreover, the presence of green ash in the unit allows for proactive removal to create canopy gaps and help jumpstart understory restoration. Thinning of chokecherry is a secondary option to create open gaps for groundcover establishment.

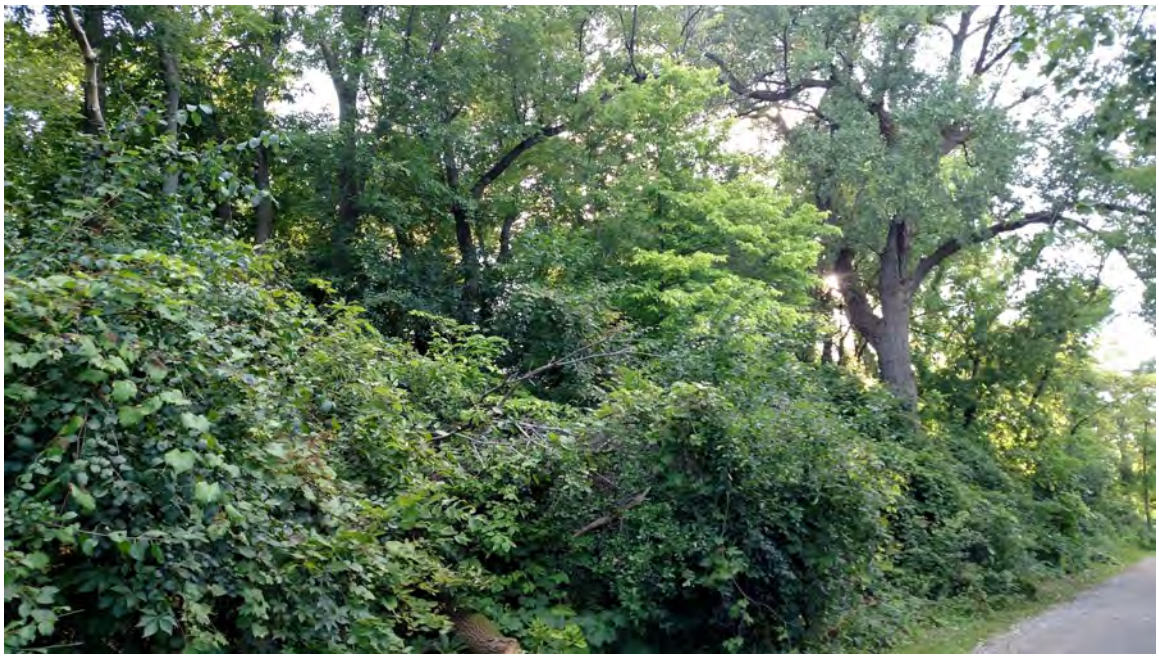


Photo 5. AW-2 vegetative strata along walking path to boom island. Invasive buckthorn is interspersed with native shrubs and vines in the foreground.

Photo 6. Old rock wall along the path in AW-2. A dense carpet of first year garlic mustard seedlings covers the area.

Photo 7. A pile of cut branches from a neighbor's yard was dumped into an opening in AW-2. This and other human uses of the unit hamper native regeneration and exacerbate erosion and other issues.

Photo 8. Excel has forestry mowed under the powerline right of way at the south end of AW2. Planting with shorter statured natives will be necessary to revegetate the area.

AW-3

The third subunit encompasses the upland forest adjacent to the degraded grassland. This unit was historically open, with few trees, and served as open pasture space for the homestead and later buildings on the neighboring degraded grassland unit. Roughly triangular in shape, this unit is bordered on two sides by streets and by a private residence on the third, and has a network of trails throughout. This is the most altered forest unit of the three, with abundant evidence of current human use. The species composition and distribution is slightly different, with an overall younger character evident of more recent succession from open habitat. There is also a stand of younger cottonwoods, a pioneer species that was likely among the first to colonize the area once it was abandoned. One towering cottonwood (139.3 cm DBH) rises about the others (40-50cm DBH), and the next largest and most abundant trees include box elder (up to 30.7cm DBH), hackberry (up to 29.6cm DBH), and Siberian elm (26.8cm DBH). The subcanopy and shrub layer is made up of young hackberry, green ash, white mulberry, buckthorn, and honeysuckle (all roughly 10cm DBH or smaller). On the north side of the unit, a large patch of sumac serves as a transition between the forested area and the grassland. The occasional lilac is present, evidence of the unit's proximity to residences and their hedgerows, and the presence of gooseberry is evidence of previous grazing of the unit. Vines like wild grape and woodbine indicate the forest's young, disturbed nature.

The understory is made up of mostly non-native or introduced plants, though natives like Virginia waterleaf, zig-zag goldenrod and common blue violet are still present. However, much of the understory is dominated by creeping Charlie, creeping bellflower, motherwort, and garden plants like day lilies, irises, bouncing bet, and ornamental mayapple. Garlic mustard, honeysuckle and buckthorn are also all present in patches. AW-3 had moderate score in terms of its percent native vegetation (39%) and scored moderately high in its invasive species cover. AW-3 ranked in the low quality category in terms of its overall vegetative health, but higher than AW-2 (Figure 16).

Overall, this unit suffers from much human intervention. Piles of leaves and garden materials are scattered throughout and provide evidence of the introduction pathway by which many of the garden plants have established in the unit. The neighbors to the west have also constructed a treehouse in and extended their yard past the likely unit boundary. There is also a large area within the unit that is fenced off, complete with a bench and tended planting areas. This area faces Maple Place just east of Nicollet Street. Removing this area and dissuading neighbors from dumping their yard waste will help stop the spread of ornamental plants throughout the natural areas on the island, and removing the non-native trees and shrubs will allow for understory restoration through a combination of seeding and planting.

Photo 9. Young tree and shrub species surround a large cottonwood in the AW-3 unit. While groundcover is present, it is largely composed of non-native and disturbance tolerant species.

Photo 10. A manicured garden area sits within AW-3. This fenced and maintained section is planted with ornamental garden plants which have spread and come to dominate much of the unit.

Photo 11. A patch of lilies dominates the understory in a section of AW-3. These were either intentionally planted or spread from nearby plantings.

Photo 12. A treehouse sites squarely within the AW-3 boundary – a clear example of the common property boundary issues on the island.

Short grass on upland soils (0.9 acres) (SG)

This small degraded grassland unit sits to the west and adjacent to AW-3, and is largely bounded by the northern curve of Island Ave. Once occupied by a homestead and open pasture area in the 1940s, the area saw development followed by abandonment in the 1970s, and by the mid-1980s all buildings had been removed. Currently, a mowed trail winds through the middle of the unit, providing a short walking path from east to west. This unit should likely be reclassified to "grassland with sparse trees - non-native dominated" as its MLCCS category.

The historical degradation and a lack of fire in this unit has now paved the way for the dominance of non-native vegetation. Smooth brome is the dominant groundcover, and species like honeysuckle, spotted knapweed, and birdsfoot trefoil are abundant as well. Native species like black-eyed Susan, hoary vervain, wild bergamot and big bluestem provide evidence of a prairie-like character, but are hardly abundant. Canada goldenrod is the most abundant forb, and species like white snakeroot, wild grape, and wild mint demonstrate the rate at which the unit is transitioning away from grassland toward shrubland and woodland. A few large trees are present, including a hackberry (63.8 cm DBH), birch (33.2 cm, DBH) and a variety of younger cottonwoods, elms (Siberian and American), box elders, and green ash are beginning to shade out pockets of grassland. Mulberry is becoming abundant in the unit, and shrubs like chokecherry, black raspberry, and currant are present too. As shrub cover increases, the site becomes more mesic, and the cover of any remaining native prairie species will continue to decrease. SG had very low percent native vegetation (12%) and the highest cover of invasive species. As a result, it ranked in the low quality category in terms of its overall vegetative health, and was far and away the lowest quality community (Figure 16).

On the southwest corner of the unit, there is evidence of planted species, including rhubarb, some shrubs, and even native wildflowers. However, the list of non-native plants in the unit is long, and includes troublesome species like birdsfoot trefoil, yellow sweet clover, Canda thistle, spotted knapweed and reed canary grass. Management of the unit will be key to prevent it from succeeding to a non-native dominated shrubland and can provide a unique opportunity for the improvement of grassland habitat on the island. Community input has also identified the desire to re-create some of the historical maple-dominated communities on the island. Planting maples and other species into this grassland will allow for their establishment over time while still providing grassland and pollinator habitat in the short term.

Photo 13. SG unit dominated by smooth brome (foreground) and Canada goldenrod (back right). Notice the woody vegetation encroaching in the background and on the left side of the photo.

Photo 14. Debris, trash, and yard waste abound between the SG unit and neighboring residential properties.

Short grasses on upland soils (1.1 acres) (SG-NAL)

This unit, affectionately named the "not-a-lot" is a linear stretch of upland that parallels AW-1 and is bounded by East Island Ave to the west, AW-1 to the east, and the railroad tracks to the north. The unit was once the site of a garage and building, but has since been left vacant and used for various purposes, including a staging area and a parking lot. In the last few years, curbs were added to prevent people from parking on the unit, and it is kept mowed and used by the DeLaSalle track team, among other groups. The unit has little to no native vegetation, except along its border with the woodland unit. However, many invaders occur along the border and in the mowed turfgrass, including glossy and common buckthorn, bull thistle, spotted knapweed, leafy spurge, birdsfoot trefoil, white sweetclover, and others. Native grassland species such as common milkweed, big bluestem, stiff and Canada goldenrod, and native woodland species such as white snakeroot, lopseed, stickseed, and wild grape both occupy the transition zone between the unit and AW-1. Box elder and native shrubs like gray dogwood and elderberry are present along the unit's border as well, and a number of planted ornamental trees are present along the edge of the road. Because the bulk of the unit was turfgrass, we did not rank the vegetative quality of the unit.

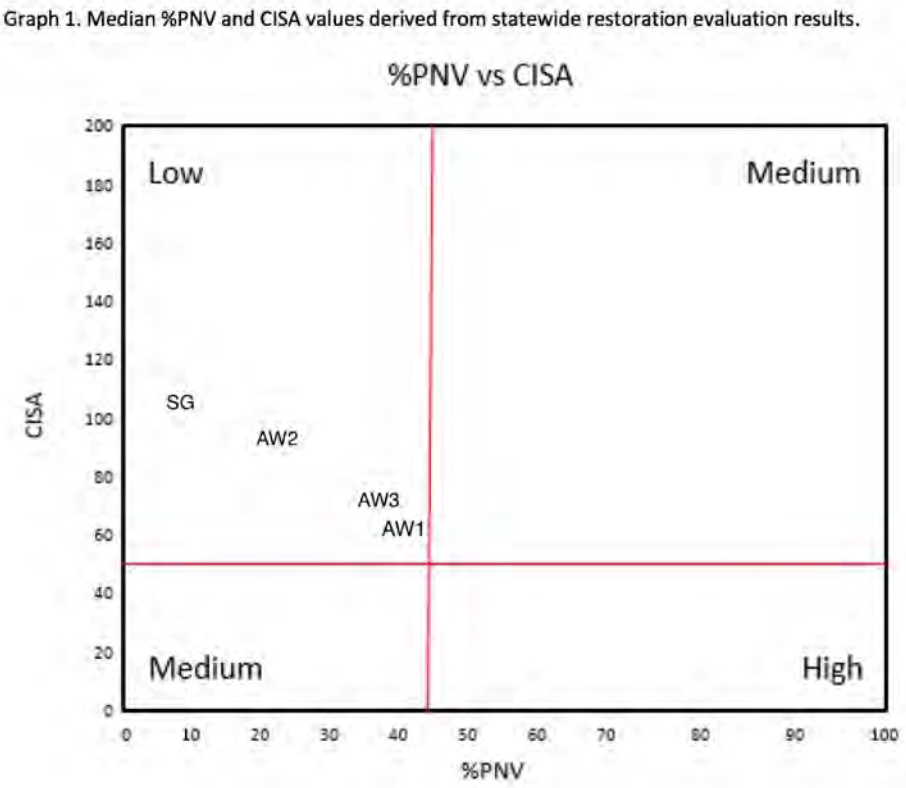
Owing to its degraded state and location along the edge of the property, restoration of this unit will be difficult. However, the opportunity exists to create over an acre of habitat where there was essentially none.

Photo 15. The turfgrass dominated SG-NAL unit. Notice the transition to forest vegetation (AW-1) to the right in the photo and the powerlines overhead.

Photo 16. Chunks of asphalt and patches of rock are present throughout the SG-NAL unit and will need to be removed in order to restore prairie. Photo by Marcia Holmberg.

Photo 17. The south end of the SG-NAL unit was temporarily used as a staging area for the pumping station rebuild.

FIGURE 16. COMMUNITY RANKINGS



*Rankings calculated using the LCCMR's Restoration Evaluation Project Vegetation Monitoring Tool:

(https://www.lccmr.leg.mn/pm_info/restoration_evaluations/Restoration_Evaluation_Project_Vegetation_Monitoring_Tool.pdf)

FIGURE 17. FEATURES OF INTEREST

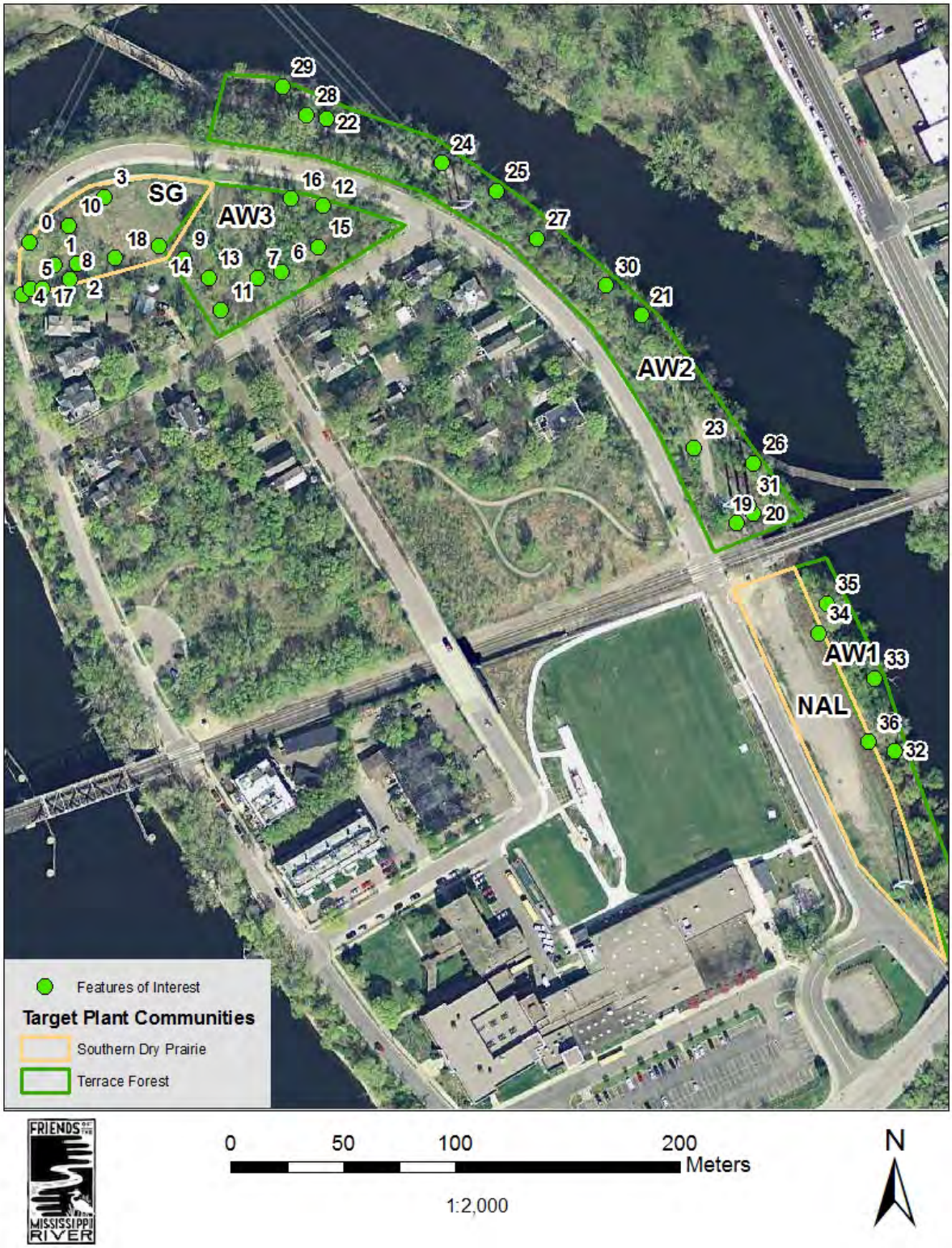


TABLE 2. FEATURES OF INTEREST

ID	Title	Description
1	Paper birch	Multi-stemmed large paper birch
2	Planted area	Rhubarb, dogwood, maple, and other caged shrubs and trees
3	Goldenrod	Dense stand of Canada goldenrod
4	Siberian elm	Large Siberian elm – should be removed
5	Patch of native forbs	Wild bergamot, common milkweed, and others
6	Leaf piles	Neighbors have dumped leaf piles into the unit
7	Yard waste dumping area	Leaves and plant material. Near large cottonwood. Lilies throughout
8	Patch of reed canary grass	Garlic mustard also present
9	Treehouse	Treehouse built by neighbors well across unit border
10	Woody species encroaching	Two cottonwoods, two Siberian elms, boxelder, and honeysuckle
11	Lilies and campanula	Area dominated by planted and non-native species
12	Hackberry	Large old hackberry on edge of grassland
13	Lilac	Clump of lilac on edge of unit
14	Woody species in forest	Dominated by boxelder, buckthorn, honeysuckle and green ash
15	Blue spruce	Blue spruce planted on corned of property (in unit)
16	Fenced area	Garden area with ornamental mayapple, lilies, and other species
17	Sumac	Staghorn sumac clump on woodland edge
18	Glossy buckthorn	Large shrub and seedlings
19	Trash piles	Trash, yard waste, downed trees and invasive species
20	Violet	Likely common violet but odd growth – potentially Birdsfoot. Monitor.
21	Debris pile	Old equipment, rock, and other material in gully next to railroad tracks
22	Erosion work	Old wood designed to slow erosion in small gullies. Work needed.
23	Small gully erosion	Area should be planted and erosion bars installed.
24	Power line ROW	Area was forestry mowed. RBC/FMR planning event added native forbs.
25	Large cottonwoods	Leaning into river somewhat. Potential shoreline stabilization area
26	Red cedar	Lone small red cedar
27	Dogwood	Pagoda dogwood
28	Rock wall	Old rock wall covered in garlic mustard seedlings
29	Small erosion gullies	Places for trees, erosion bars, and native plantings
30	Small sand beach	Opportunities for live staking or other habitat creation
31	Sumac	Stand of staghorn sumac along trail
32	Storm drain gully	Area had also been forestry mowed on either side.
33	Beaver lodge	Active beaver lodge with felled buckthorn
34	Bare soil area	Candidate slope for revegetation
35	Erosion gully	Earth work and native plantings needed
36	Debris	Examples of human uses of the unit. Old equipment
37	Reinforced wall	Separates NAL unit from AW1

RESTORATION

This section describes the restoration process for the property. This includes information on the target plant communities and community descriptions, taken from the DNR, for the proposed restoration on site. It also includes a description of the restoration process and the goals for the restoration, both broad and specific.

Target Plant Communities

Table 3. Restoration Target Plant Communities for Existing Landcover

MLCCS Unit	Acres	Target Plant Community
AW-1	0.6	Southern Terrace Forest (FFs59c)
AW-2	2.1	Southern Terrace Forest (FFs59c)
AW-3	1	Southern Terrace Forest (FFs59c)
SG	1	Southern Dry Prairie (Ups13), transitioning to a maple dominated forest (akin to MHs39a)
SG (NAL)	1.1	Southern Dry Prairie (Ups13)

FIGURE 18. TARGET PLANT COMMUNITIES AND WORK UNITS

Southern Dry Prairie – UPs13

This community type will occur in what is currently the small non-native dominated short grassland and the not-a-lot. In total, UPs13 will occur on roughly 2 acres, though this will decline over time as planted trees establish in the SG unit. Restoration could commence in the first winter with woody removal (if funding allows), and should continue with soil prep, herbicide treatments, and broadcast seeding. Mows and spot spraying will occur in the first and second years, with a prescribed burn in the third. Once these prairie areas are established, long term maintenance will include spot treatment of herbaceous invaders, rotating prescribed burn and mows, and interseeding.

According to the DNR:

> "Southern mesic prairies are grass-dominated herbaceous communities on level to steeply sloping sites with droughty soils. Moderate growing-season moisture deficits occur most years, and severe moisture deficits are frequent, especially during periodic regional droughts. Historically, fires probably occurred every few years.
>
> Trees are absent except where fire suppression has allowed invasion by woody species. Kentucky bluegrass (Poa pratensis), an introduced species, is invariably present; it increases in the prolonged absence of fire but becomes dominant only with heavy grazing pressure. Smooth brome (Bromus inermis), another exotic, is a very troublesome invasive species favored by disturbance, including natural disturbance by pocket gophers."

Southern Terrace Forest – FFs59

This community type will occur on all AW units. FFs59 would make up roughly 3.8 acres on the restored property. Because removing the invasive seed source is a priority for this plan, initial invasive removal on these units should be a priority. Invasive shrub removal should occur as part of Phase 1, and will ideally be followed by native seeding and planting to maximize effectiveness.

According to the DNR, southern terrace forests are:

> "Wet-mesic deciduous forests on silty or sandy alluvium on level, occasionally flooded sites along small streams to large rivers in the southern half of Minnesota. Canopy is interrupted to continuous (50–100% cover). Species composition is variable, but American elm, green ash, hackberry, basswood, box elder, silver maple, black ash, and cottonwood are often common."

Maple Basswood Forest – MHs39a

This community type will eventually occur on the SG unit. MHs39a would make up roughly 0.9 acres on the restored property. Because community input identified both pollinator habitat and an eventual return of the maple syruping that was a part of the island's history as goals, the SG unit provides an opportunity to transition to a maple dominated forest in the long term while maintaining a diverse native prairie in the short term. This unorthodox restoration method marries both habitat benefits and community goals without hampering the restoration success. Initial woody removal on these units will be the first priority, and restoration will follow that of the Ups13 units, with trees planted into the prairie once it has established. Over time, the prairie will be maintained by mowing instead of prescribed fire, and future shrub and wildflower planting should be considered to restore a forest understory community once the canopy has closed.

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 ultimate 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 also 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 on the island.

Given the narrow units and overall layout of the property, restoration of the site will be difficult. Access to all 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 above the flood line and away from direct sources of propagules (seeds of invasive species) means that restoration may be less hampered by the cycle of continual reinvasion that plagues many riverine sites. Engaging neighbors (both the MPRB and private residences) 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 on Nicollet Island 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.

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. The final priority will be to undertake erosion control efforts in the forest units. All priorities will help to accomplish the main goal of increasing wildlife and pollinator habitat throughout the property.

RESTORATION GOALS

This site has both areas that are used for recreation and those that serve as a natural area. Thus, the main goal of this restoration 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. Healthy ecosystems will support a variety of wildlife, and will provide a number of ecosystem services, including water retention and filtration. Toward achieving this goal, 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 at the time of European settlement. This includes the improvement of habitat (prairie and forest) that has been historically decimated throughout the state, but does not mean that the restoration will go out of its way to convert current natural communities to what may have been present in the past. However, adding new habitat and restoring degraded areas will improve the ecological functions that both historic native plant communities and current healthy communities provide, 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.

Though degraded by past uses, the existing plant cover retains a good variety of native species and could 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.

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) All units: Reduce invasive woody stems over ½ inch diameter to <10% in treated units by the end of the second year.

2) SG + SG-NAL: Restore prairie by adding at least 25 species and obtain 90% coverage of native prairie species by the fifth year.

2b) SG: Establish 50 maple, hickory, and other climate adapted species in the northernmost grassland unit.

3) SG + SG-NAL:Improve pollinator habitat; include three milkweed species and at least three other pollinator species blooming in spring, summer, and fall.

4) AW1,2,3: Increase forest plant diversity; establish at least 10 native grass and forb species and include five tree species adapted for a changing climate.

5) AW1, 2: Reduce erosion; install mitigation techniques at all obvious erosion locations.

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 opportunities to create focused water quality additions to the project, including small infiltration basins in the prairie units;
- explore other opportunities to create wildlife habitat, including but not limited to snake hibernaculums, osprey towers, turle nesting habitat etc.

MANAGEMENT PRIORITIES

PRIORITY 1: Invasive woody removal

Woody Plant Removal

Given the size of the property, clearing the non-native, invasive brush is less daunting than at other sites. However, the layout, orientation, and topography of the units will present challenges. If funding is an issue, removal should be prioritized based on the ecological quality and topography of the units. Removal should first focus on the areas with highest native diversity and those that are easily treated. In AW-2, understory diversity remains high and removal will be important to prevent further species loss. AW-3 is less diverse, but removal will be relatively simple, and post-removal seeding and planting can help ensure that the area stays free of woody invasives. Removal in the AW-1 and grassland units should follow the forest units. If removal will take place over a number of years, crews could initially remove especially prolific seed-producing individuals from these units.

During the removal process, the site can be assessed for further woody removal, including native shrub and tree species. Primary non-native species to remove are common buckthorn, glossy buckthorn, Tartarian honeysuckle, black locust, Siberian elm, and white mulberry. Native species such as box elder, prickly ash, sumac, and green ash could be thinned as well, especially in areas where they have become very dense. Some flatter areas of the site may lend themselves to brush mowing, including areas in AW-3 and SG. Cut stumps should be treated with a triclopyr- or glyphosate-based herbicide, though aquatic formulas should be used within 100 feet of the river. Glyphosate can be applied to stumps on a calm day during the growing season when temperatures are above freezing but not above 85 degrees. Triclopyr can be applied even when temperatures are below freezing, and is the best choice for fall and winter application, though application earlier than late fall is not recommended due to potential non-target effects on native vegetation. Less toxic formulations, including Vastlan and Trycera, should be considered. Use of chemicals should be done with extreme care on this site given the proximity to water and potential for groundwater contamination. Glyphosate binds to soil particles and is generally not mobile, so may be a better choice than other herbicides that are more mobile, especially near the water. However, triclopry-based herbicides like Garlon are generally more effective at preventing resprouting. Due to the sensitivity of the site, Garlon 3A is preferred over Garlon 4. See Appendix C for more information on controlling both native and non-native species.

Hand cutting (with brush saws and chainsaws) will be the most-used method given the varied topography. Hand cutting can be done at various times of the year, though the fall is recommended, as native plants will have senesced and buckthorn and other invaders that hold their leaves longer will be easier to identify. For hand-cutting, brush pile locations will need to be determined in order to burn piles safely.

Brush disposal includes several different options that will be determined as the project progresses, and will depend on the volume as well as site access. Cut brush may be stacked and burned, chipped and blown back on the site, or even removed for biofuels. The biofuels option requires a large amount of material (18 semi-trailer loads of chipped brush, for example), which is unlikely given size of the property. The paths around the grassland and woodland provide easy access for large equipment and vehicles to reach the units. In some areas, chipping the material on site could provide mulch that would suppress buckthorn regeneration from the seedbank and protect against erosion. Access along trails and unit edges provides many possible areas to utilize a chipper.

Once the first phase of removal is complete, yearly follow-up treatments will be necessary. If done correctly, stump-sprouting should only occur in small numbers (if at all), though these sprouts will need to be treated by cut and paint herbicide application or foliar spray. The seedbank will be more problematic, as buckthorn seeds can remain viable for at least five years. Treating germinating seedlings will be a difficult and repetitive process, but can be accomplished through foliar herbicide application. Prescribed fire is a seedling management option in drier areas, but will be difficult in many of the forest areas. Prescribed burns should occur in the spring if possible, when buckthorn is actively growing and its carbohydrate stores are low. Light surface fires should burn these woodlands on a rotation of about once every 10-20 years once initial management is complete. In the more open areas of the forests, seeding will be necessary after buckthorn removal. Cover of native plants will help to fill unoccupied niches and compete with and suppress germinating buckthorn seedlings. Forb, shrub and tree planting events could also help restore shrub and sapling-layer diversity. Tree planting should focus on important habitat trees like cottonwoods as well as climate adapted species like sycamore, hickory, Kentucky coffee tree, and others. See Appendix B for a list of native plant species for restoration of the forest units.

PRIORITY 2: Prairie restoration

For one of the smallest potential habitat types on the property, the prairie restoration could result in some of the biggest habitat and water quality benefits. Because of the rarity of this habitat in the state, and its provision of important pollinator and wildlife habitat, restoration prairie to the grassland and not-a-lot units is an important priority.

First, almost all trees and shrubs (woody brush) should be removed from the grassland and unit. The NAL unit is mostly free of woody species. Detailed woody species removal information is provided in Appendix D, though it bears repeating that any use of chemicals should be done with extreme care due to the sensitivity to groundwater pollution and proximity to the river.

In the SG unit, grasses like smooth brome dominate, while turf grass and various weeds dominate the NAL. The first step in site preparation of these areas will be to broadcast an herbicide to remove current cover. Once top-killed, both units should be burned to remove dead vegetation. SG can then be lightly disced or harrowed to help flush the weed

seedbank. However, completely turning over the soil is not recommended. The NAL will need compaction alleviation, including deep ripping and the addition of soil amendments. Herbicide should then be applied at least one more time for both units, likely twice to kill the regrowth.

The areas can then be broadcast seeded with a mixed height prairie species mix; the mix will contain an abundance of pollinator species, including milkweeds and other nectar plants. See Appendix B for a list of plant species for prairie restoration. Small forb seeds should be hand-broadcast rather than drilled to avoid burying them too deeply. Seeding in the fall or winter, referred to as dormant seeding, benefits forb species, as many require cold, wet stratification prior to germination. The seed will get worked into the soil by the freeze-thaw cycles of winter and will germinate in the spring. The melting snow will provide the necessary moisture to fuel the seed's germination. However, because the soils have medium erosion potential, a cover crop should be considered for inclusion in the fall seeding to help prevent erosion. Winter wheat is commonly used for this purpose.

Maintenance: Mowing and burning

In the summer following the seeding, the prairies will need to be mowed 2-3 times. These establishment mows help to stimulate vegetative growth and to keep weed species from flowering and dispersing seed throughout the site. This also allows light to reach the new seedlings, which are mostly very small the first year. Mowing should occur when the vegetation reaches roughly 12 in, though it is difficult and unnecessary to be exact in this measurement. Because mowing is used to prevent annual weeds from seeding into the restoration, mowing should also be timed to prevent weeds from setting seed, with height often being a proxy for these events. Monitoring will determine the ultimate timing of the mows. Vegetation should be mowed to a height of 4-6 in, and the process repeated two or more times depending on the rate of growth throughout the season. During this time, weed species on unit edges and surrounding units can be treated by spot-spraying in order to prevent them from encroaching into the establishing prairies. In the second growing season, mowing is generally needed just once in the spring or early summer. However, spot-mowing and/or spot-spraying of problematic areas may be needed.

Eventually, the newly established NAL prairie will need to be burned. Depending on the condition of the unit, this will likely occur in spring of the third growing season. Burning will help stimulate root production and aboveground growth, and will help to control woody and herbaceous species establishing in the unit. Burning can be done in the spring or fall, depending on weather conditions and goals of the burn (controlling non-native grasses, etc.). After the burn, native seed can be added to the unit to supplement cover and diversity in areas that have not taken well. In the long term, a burn rotation will need to be established so that the units are burned at repeated intervals. Burning every 2-3 years is a common interval for prairies. Burning frequently will help to keep woody species from taking hold, though frequent burns may favor more common and less conservative species. Ultimately, the interval length will depend on the desired balance of native shrubs and herbaceous plants, and can also be timed to respond to outbreaks of non-native woody or herbaceous species. If burning is not part of the management, the

prairie will likely succeed to forest, since there are many woody seedlings (both native and non-native) encroaching from the surrounding units. The prairie should be divided into multiple burn units that would be burned in different seasons or years to ensure the availability of unburned refugia for species. The current unit edges and proposed trail will serve as useful fire breaks. See the Prescribed Burning section below for more information.

Eventually, seed collections can be used to provide additional seed for the site. Collecting seed in the summer and fall following a burn is recommended since fecundity and fertility of plants from burned areas improves. If not enough seed is available from on site, then purchase seed of local genetic origin (local ecotype origin) that is appropriate to the community. Origin within 100 miles is desirable.

SG canopy restoration

Once the prairie in the SG unit has begun to establish, introduction of woody species, including maple, hickory, and Kentucky coffee tree can be considered. Establishing the canopy will consist of planting sizeable potted or burlap trees throughout the unit and will primarily include species historically present on the island. A focus on sugar maple will provide a historical tie-in to the past maple syruping done on the site, while the addition of more southerly species will improve the climate resiliency of the unit. While creating a forest within a prairie is an unusual restoration method, the interim benefits of prairie plants will better serve the site as the canopy establishes.

Spot spraying and mowing will take the place of prescribed fire in the SG unit, as fire will inhibit the establishment of the desired trees. Trees will need to be protected from deer browse and should be watered frequently the first few years after installation.

PRIORITY 3: Erosion control

Erosion on the east side of the island is not nearly as severe as the west side, but nonetheless deserves attention in order to prevent conditions from worsening. Erosion is worst in AW-1, but is present in AW-2 as well. The NAL, SG, and AW-3 units occur on largely flat ground and are not at risk for severe erosion.

Due to the abundance of bare soil resulting from the effects of invasive plants and earthworms, splash erosion is frequent but does not result in much sediment transport in the units. In both AW-1 and AW-2, there is some sheet erosion, evidenced by sediment accumulation behind trees or at the base of portions of the steeper slopes. This is a chronic phenomenon that can be again attributed to the simple fact that there is a lack of fine-rooted vegetation on these slopes. In AW-1, there is both sheet and rill erosion, as water from the compacted NAL unit flows into and down the slopes of AW-1, moving larger amounts of sediment where there is not vegetation to hold the soil in place. Some preferential flow pathways have formed, and have even begun to create gullies in some areas. A few small gullies occur east of the path in AW-2, and evidence of past attempts

to shore these up is still visible. A denser vegetation layer throughout these units would act to break the impact of raindrops and dissipate the energy of stormwater running on these slopes, but in some cases larger interventions will be required.

All units will be seeded with native forb and graminoid mixes once removal of non-native shrubs is complete. In AW-1 and AW-2, installing natural wood erosion bars in areas where sheet and rill erosion are progressing is recommended. Finally, some small-scale soil work will be necessary to create diversion pathways to prevent gullies from increasing. Grass strips, erosion mats, and other means may be necessary to further control gully erosion.

These interventions are important, but should be undertaken only if funding is available, and only after invasive removal has occurred.

Prescribed Burns—More Information

Once prairie is established on the property, it is recommended to split the unit into burn units – both for ease of operation and for ecological reasons. It is important to leave some areas unburned (refugia) to allow insect and animal populations to recover and repopulate burned areas. To do this, it is recommended to rotate the burn units from year to year, and try not to burn adjacent units in consecutive years. Prior to a prescribed burn, a burn plan must be devised. The burn contractor can help with the burn plan. Permits must be obtained from the DNR, MPRB and local fire officials. Initially, burning should be rotated every one to two years, so that each year a different burn unit would be burned. Long-term, burns can occur every 3-5 years in prairies, though longer intervals could allow for the establishment of more woody shrubs if desired.

Prior to burning, burn breaks must be created to contain the fire. Burn breaks consist of a mowed swath in grassland areas, typically at least 8 feet wide. There should be burn breaks between restoration units and within the prairie restoration. A gravel walking trail is proposed through the NAL unit, which would essentially create a de-facto burn break. Utilizing this path and more discrete unit edges will be useful and easier than making breaks from scratch. In woodland areas, break lines are created by clearing the leaf litter and any other debris down to the mineral soil. The burn contractor can also help with the placement and installation of burn breaks. Allowing fire to run into adjacent land covers is another good practice. For example, breaklines in a prairie unit that is adjacent to woodland should be placed a short distance into the woodland, where feasible. This makes for a more natural looking and functioning landscape and helps to prevent the woodland from encroaching into the prairie.

Smoke management is a concern for burning on the island, since there are nearby residences, buildings, and roads. Care must be taken to select a burn date where smoke will not reduce visibility on Island Ave or become a nuisance for the neighbors, DeLaSalle, or other local businesses.

Long-Term Monitoring and Maintenance

Monitoring is very important to restoration success. Monitoring, evaluation and assessment should be done at least annually by an ecologist or a restoration professional. More frequent monitoring will be needed in the initial phases of restoration to evaluate the success of the methodologies and to inform adaptive management strategies. Adapting to issues or factors observed during monitoring and assessment is vital to the restoration process.

Once the primary restoration tasks are completed, the restoration process will convert to a monitoring and adaptive management phase. Long-term maintenance for the forest areas will consist of managing for invasive species and monitoring every year for potential new issues. For the prairie, burning should occur every 2 to 5 years to prevent woody encroachment and maintain the health of the unit.

Restored areas must be regularly monitored to identify ecological issues such as erosion and sedimentation, invasive species, and disease. Monitoring is also important for detecting human-related issues such as waste disposal, planting, tree harvesting, hunting etc. Early detection of concerns enables quick responses to address them before they become significant problems.

Finally, monitoring animal as well as plant communities is also helpful for evaluating results of the restoration. A comparison of bird populations before and after restoration, for example, would be a valuable tool for quantifying positive impacts on the land. Trail cameras can also provide information on wildlife using the property. This is another area where citizens should be involved in the process, and tie-ins with programs like Monitoring Avian Productivity and Survivorship (MAPS) and eMammal would provide great citizen science opportunities. Moreover, the DeLaSalle Green Team and various science classes have expressed interest in conducting some restoration monitoring, most notably around pollinators in the restored prairie. This would coincide well with their proposal to build beehives on the roof of the school and would provide a living laboratory for students to study pollinator populations.

WORKPLAN

The landowner is not required to implement any or all of the restoration tasks presented in this plan. Costs could potentially be decreased by, for example, reducing the diversity of prairie seed costs, contracting for the entire project with one contractor, or using volunteers or STS (Sentence to Serve) crews for portions of the labor. Some activities may be carried out by the landowner if they wish, and have the time and equipment to do so.

RESTORATION SCHEDULE AND COST ESTIMATES

A general time frame is shown in Table 4, but note that the year for any given task may shift, depending on when the project starts. Note also that that the costs shown are estimates, based on similar work at other sites, but actual costs may be higher or lower.

The work units are referred to by their unit name. Undertaking the recommended restoration in this plan will be a significant task, and assistance is available to help landowners with the process. Friends of the Mississippi River will continue to work closely with the landowners, if desired, to secure funding and implement all or parts of the management plan. FMR can hire and oversee contractors such as a professional firm listed in **Appendix D**.

Table 4. Restoration Schedule and Cost Estimates

These tables are rough schedules and approximate costs for restoration and management tasks for Nicollet Island. Both the project tasks and costs are likely to change as the project progresses - these tables should be used only as rough guides. Tasks were phased, with 1 being the highest priority. Work units correspond with those shown in Figure 18.

Year	Season	Units	Activity	Acres	Cost/ Ac	Cost Est.
PHASE 1. FOREST RESTORATION						
2018	Winter	AW 1-3	Cut and treat non-native woody brush and non-native and undesirable native trees. Chip and blow back or remove from site Thin areas of dense ash and box elder saplings to create native regen areas	3.7 0.5	1,500	$5,550
2018	Fall	AW 1-3	Spot/broadcast spray invasive resprouts and seedlings	3.7	500	$1,850
2018	Fall	AW 1, 2	Volunteer event to plant 50 shrubs and trees, and 500+ woodland grasses and wildflowers. Include deer protection for shrubs and trees.	2.7	-	$3,000
2019	Summer/ Fall	AW 1-3	Spot/broadcast spray invasive resprouts and seedlings	3.7	400	$1,480
2019	Fall/winter	AW 1-3	Seed open areas after removal: in areas where invasive removal creates open understories, broadcast seed with wild rye and an appropriate native graminoid seed mix.	1.5	900	$1,350

2019	Fall	AW 3	Volunteer event to plant 50 shrubs and trees, and 500+ woodland grasses and wildflowers.	1	-	$3,000
2020	Summer/ Fall	AW 1-3	Spot treat invasive re-sprouts and seedlings	3.7	300	$1,110
Subtotal				3.7		$17,340
PHASE 2. GRASSLAND AND NOT-A-LOT RESTORATION						
2018	Winter	SG	Cut and treat non-native woody brush and non-native and undesirable native trees. Pile and burn or remove from site. Grind stumps.	1	4,000	$4,000
2018	Summer	SG+NAL	Prep grassland areas by controlling non-native grasses and forbs with broadcast sprays. TWO APPLICATIONS	2	400	$800
2018	Summer	NAL	Rip soil to 18in. Add soil amendments and till/disc to mix and smooth. Install silt fence along unit if necessary.	1	5,000	$5,000
2018	Fall	SG	Conduct a prescribed burn (spring) in open grassland area. Goal is to reduce thatch and prepare seed bed.	1	1,000	$1,000
2018	***Spring***	***NAL***	***8ft wide by 6" deep crushed limestone trail installation along 500 linear feet of NAL***	**-**	**-**	***$6,000****
2018	Fall	SG	Prep the units following the burn for seeding (including, if needed one final herbicide application, harrowing and smoothing)	1	1,000	$1,000
2018	Fall	NAL	Conduct one final herbicide application if necessary	1	400	$400
2018	Fall	SG+NAL	Broadcast seed the SG and NAL units with diverse native seed mix (seed included in cost)	2	2,000	$4,000
2019	Spring	NAL	Volunteer event to install native plants in a small demonstration garden along trail area	-	-	$2,000
2019	Summer	SG+NAL	Mow 2-3x as needed. Mow when vegetation reaches 12in or to prevent flowering of weeds. Mow to 4-6in. Spot spray herbaceous weeds.	2	500 per	$2,000
2019	Fall	SG	Install ~50 sugar maple, hickory, and walnut saplings in grassland area	1	-	$10,000
2020	Summer	SG+NAL	Mow 1x and spot spray herbaceous weeds	2	1,000	$1,000
2021	Summer	SG+NAL	Mow 1x and spot spray herbaceous weeds	2	1,000	$1,000
2022	Spring	NAL	Prescribed burn on NAL. Broadcast seed after burn to supplement diversity.	1	-	$2,000
Subtotal				2		$34,200
PHASE 3. EROSION CONTROL						
2018	Winter/ Spring	AW 1, 2	Install natural wood erosion bars in gullies and on bare slopes to hold soil	2	-	$3,000

2018	Fall	AW 1, 2	Add additional seed (rye) to erosion prone areas	2		$500
2019	Spring	AW 1, 2	Create diversion pathways, Install erosion mats and plant grass strips to further control gully erosion if needed.	2	-	$3,000
Subtotal				2		$6,500
Total				**5.7**		**$58,040**

LONG TERM MANAGEMENT AND FUNDING

Once initial restoration tasks are completed, then long-term management ensues. Long-term management includes tasks that are required periodically to maintain healthy ecosystems. Table 5 lists these tasks with associated cost estimates.

Table 5. Long-Term Management Schedule and Cost Estimates

Season	Units	Activity	Acres	Cost/ Ac	Cost Est.
Spring or fall	NAL	Burn the prairie unit every 3-6 years. Allow burns to run into neighboring forest unit where possible. To provide refugia, do not burn more than 1/2 of the the unit in one year. Rotate burns from spring to fall if feasible.	1	1,000	$1,000
Summer	SG	Mow the SG unit at least every other year	1	-	$500
Spring of fall	AW 1-3	Burn the forest units every 15-20 years. Combine burns with other units when possible. Rotate burn units. To provide refugia, do not burn adjacent units in consecutive years. Rotate burns from spring to fall.	3.7	1,000	$3,700
Summer/Fall	AW 1-3	Monitor **and manage** for invasive herbaceous and woody species. Can also be done with yearly volunteer tending events.	3.7	-	$5,000
Fall, summer, spring	All	Evaluation and assessment by ecologist: Monitor for erosion, tree disease (ash for EAB, bur oaks for Oak Wilt disease (July-Aug) and for Bur Oak Blight (BOB) (July-Aug for leaf necrosis and winter for marcescent leaves)).	All	-	$1,000
					$ 11,200 (at intervals)

FMR has a long history of funding restoration projects. As a place-based organization, we remain engaged in our restoration sites long after the initial restoration work takes place. A variety of federal, state, and local funding sources exist and could be applied to for Nicollet Island restoration, including but not limited to the National Fish and Wildlife Foundation, the Environment and Natural Resources Trust Fund, the Lessard Sam's Outdoor Heritage Fund, the Conservation Partners Legacy Fund, MWMO's Action Grant, Hennepin County Good Stewards and Opportunity grants, and a multitude of private and foundation sources to support ongoing stewardship at the site.

PROJECT PARTNERS AND COMMUNITY ENGAGEMENT

Project Partners:

A variety of organizations have a stake in the management of Nicollet Island, either as direct partners or interested parties. The Mississippi Watershed Management Organization (MWMO), through their funding of this NRMP, has made possible the future restoration of the natural areas on the island. MWMO will be a valuable partner moving forward on the restoration of the island and has grant programs that could help to fund specific restoration tasks. Their ongoing erosion study on the west side of the island will also inform further upland restoration and future bank stabilization work. The Nicollet Island East Bank Neighborhood Association (NIEBNA) has also provided funding and support for the NRMP and future trail work through the restored areas of the island. NIEBNA provided a forum for obtaining public input on the NRMP, and will be a valuable partner moving forward, both in terms of being a direct connection to the residents of the island and a source of future funding.

The Minneapolis Park and Recreation Board is the landowner of the areas in question and will also be a partner in the restoration, providing long term goals and guidance, as well as volunteer event support. The Island also falls within the Mississippi National River and Recreation Area (MNRRA), and the National Park Service has an interest in restoration of natural areas within this 72-mile corridor. Other interested parties include the St. Anthony Falls Heritage Board and various environmental organizations who work on environmental issues along the river, including groups like Mississippi Park Connection and the Great River Coalition.

Community Engagement:

Restoration of natural areas is never done in a vacuum. At FMR, we recognize that humans are an integral part of the ecosystem, and that humans will continue to influence our natural habitat through both direct and indirect means. As such, it is tantamount to the success of restoration to engage and involve the local community. This should happen both before restoration starts, as well as throughout the restoration process. Community support prior for restoration is important for getting the project off the ground and for making sure that the project fulfills the goals and desires that the community has for the space. Providing opportunities for citizens to be involved in the restoration process builds a connection that teaches local residents the value of these lands and inspires their interest in their long-term stewardship. Building a community of volunteers from the surrounding area creates a sense of ownership and stewardship, and encourages citizens to take a larger role in protecting the resources that benefit their communities. Like restoration, developing an active and involved volunteer base takes time. However, FMR is well positioned in this area and has a robust volunteer program in Minneapolis. For example, in 2017 alone, 837 FMR volunteers contributed 1844 hours at FMR restoration projects on MPRB sites.

With these types of community engagement, we can create a strong support base that can become advocates for these natural areas and the benefits they provide. With all restoration projects, we not only hope to restore healthy ecosystems that provide habitat and a variety of ecosystem service, but also to create natural areas that engage and benefit the people that use them.

On Nicollet Island, we envision a variety of opportunities for community and volunteer engagement. Below are proposed activities and a tentative timeline for public engagement surrounding the Nicollet Island habitat restoration project.

2018:
Spring: DeLaSalle group volunteer event (confirmed)

Summer: Nicollet Island restoration update flyer

Fall: Nicollet Island public volunteer event (planting/tending)

Temporary habitat "restoration in progress" educational signage, especially for prairie areas
AND/OR
Periodic habitat improvement update flyer for residents

2019:
Spring: Group/public volunteer event (planting/tending)

Spring/Fall: DeLaSalle pollinator events (classroom/field)

Fall: Group/public volunteer event

Temporary habitat "restoration in progress" educational signage
AND/OR
Periodic habitat improvement update flyer

2020:
Spring: Group/public volunteer event

DeLaSalle pollinator events (classroom/field)

Fall: Group/public volunteer event

Temporary habitat "restoration in progress" educational signage
AND/OR
Periodic habitat improvement update flyer

Many opportunities exist to work with MWMO, MPRB, and NIEBNA, and any suggestions for specific partnerships or projects are encouraged. For example, MPRB or MWMO could install more permanent educational signage about the benefits of prairie plants to water quality, or how native and non-native species differ in their effects on water and other ecological processes. Moreover, FMR and MWMO could host education events around the restoration, including focusing on topics such as prairie plants, invasive species, and water quality.

OTHER CONSIDERATIONS

Deer

High deer densities are a problem for native vegetation, especially in forested areas. Deer browse native tree seedlings and saplings, preventing the regeneration of tree species. They also can put serious pressure on rare plants such as trillium, which they preferentially seek out and consume. Currently, deer densities are much higher than they were historically, and this presents a problem for both native plant communities and for restoration of the property. As controlled hunting (by urban sharpshooters hired by the landowner) is unlikely to be allowed, restoration will need to prioritize protection for any shrubs and trees planted into the restoration areas.

Powerline Right of Ways

Excel Energy maintains a powerline that runs roughly parallel to and through the site, traversing parts of AW-2 and the SG-NAL units. This will have different management implications for each unit. In AW-2, maintaining the powerline right of way involved trimming canopy trees away from the line and mowing down forest vegetation under the line. This means that when planting tree and shrub species around and underneath the lines, choosing specific species based on height will be important to avoid have those species damaged or killed by pruning or mowing. Choosing largely subcanopy, shrub, and understory species for these areas.

Tree Disease (Oak Wilt, BOB, DED, EAB, etc.)

Dutch Elm Disease and Emerald Ash Borer

There are both elm and green ash trees growing at the site. These trees are not only ecologically valuable but are also at high risk to attack from non-native tree pests. Elms are susceptible to Dutch Elm Disease and ash are susceptible to Emerald Ash Borer. These tree pests have caused widespread mortality of elms and ash throughout the eastern United States and in Minnesota.

Dutch Elm disease is a fungal infection caused by the fungus *Ceratocystis ulmi*, which is native to Asia, and is spread by both native and non-native bark beetles (family:

Curculionidae). Once the fungus is introduced onto a tree, the tree reacts by sealing its own xylem tissues (conduits of water and nutrients) to prevent further spread. This effectively prevents water and nutrients from reaching the upper branches, causing gradual die-off as more and more of the xylem is sealed. Symptoms include a yellowing and browning of leaves that spreads from the outer crown toward the trunk. Dutch elm disease was first recorded in Minnesota near Monticello in 1961, and has since spread throughout the state. Minnesota relied heavily on American Elms (*Ulmus americana*) as shade trees on streets, with about 140 million in the state at the time of the outbreak. The disease is now present in all Minnesota counties, though elms remain an important component of many Minnesota forests.

Emerald ash borer (EAB) is a non-native wood-boring beetle from Asia that was first identified in the United States in the summer of 2002. Likely transported from Asia to Michigan in ash wood used for pallets and other shipping materials, the beetle has now been confirmed in 15 states, including Minnesota. The beetle works by depositing larvae under the bark of the tree; these larvae then feed on the wood, eventually disrupting enough of the phloem to prevent the transport of nutrients throughout the tree. While Minnesota's cold weather can stymie the spread of the beetle, it continues to spread, with new outbreaks confirmed in and around the metro area. Quarantines are already in place around the metro counties, where infestations of the borer have been confirmed (including in Washington county). With risks such as human movement of firewood and climate change ever-present, the likelihood that EAB might reach the property is high, though the search for effective biological controls and other deterrents is ongoing.

Unless viable control or treatment options are developed, the elms and ash on the property are at risk of dying in the near future. When such large trees die, it will have a pronounced effect on the vegetation and the water in the river. These trees act to shade the water and provide habitat and improve water quality for fish and other species. When large trees die, they open up the canopy and create gaps, which in turn releases the understory that was formerly suppressed by the shade from such trees. If desirable species like native forbs, grasses, sedges, and shrubs exist in the understory, then this can be a good thing, since the result will probably be a net increase in bank stability and diversity. In the case of this property, these canopy gaps will likely be filled by buckthorn and Tatarian honeysuckle, which are poised to take advantage of such a situation. In order to avoid this undesirable scenario, active management is recommended. Removal of undesirable shrub species and replacing them with desirable native shrubs and herbaceous plant species is a recommended management strategy.

The principle of risk is highly applicable here; risk is often defined as the probability of a negative event weighted by its consequences. In the case of EAB, the consequences will be large and quite negative, as a loss of canopy on the property could have cascading consequences for invasive species, water quality, and wildlife. The probability that EAB arrives is high, though it is unclear when this will occur. While this plan calls for removal of invasive species prior to this occurring, which will reduce some of the negative consequences, another potential strategy is to proactively remove the ash from the property. This would be a large undertaking, as the ash would have to be removed and

replaced by other species, but this also presents a possible benefit for understory restoration. Ultimately, removal should occur once invasive species are removed, and could occur in specific dense stands or in stages (10-20% per year) to minimize disturbance to the community. The removal should be timed to minimize impacts on the restoration process and plant communities (winter), and should be timed with understory seeding and planting to achieve the greatest native species success.

Oak Wilt and Bur Oak Blight

Oak wilt is an increasingly common tree disease caused by the fungus *Ceratocystis fagacearum*. While the disease is present in many eastern US states, it is most prevalent in the Midwest US. Within Minnesota, it is an issue of serious concern in and around the seven-county metro area. Oak wilt affects all of Minnesota's most common oak species (red oak [*Quercus rubra*], pin oak [Q. *ellipsoidales*], bur oak [*Q. macrocarpa*], and white oak [*Q. alba*]), though it does not affect these species equally. Red and pin oak are the most susceptible species, with infected individuals wilting in six weeks or less. Bur and white oaks may take years to wilt completely and may only do so one branch at a time. The fungus can be transported from tree to tree by sap beetles, but most commonly spreads through root grafts. The beetles are attracted to the fungal mats created when mature oaks die from oak wilt, and also to wounds on uninfected oaks, providing a convenient pathway of spread for the fungus. Oaks commonly form root grafts between individuals, allowing direct transfer of the fungus from infected to healthy individuals.

There is small contingent of oaks on the property, though most occur outside of the identified restoration units. Monitoring will be necessary to identify and manage infected individuals. If infected individuals are found, root barriers may be installed around infected trees using a vibratory plow. Other options include soil sterilization and inoculation of high value individual trees. Care should also be taken to avoid injuring trees during the early growing season (April to July), when trees are most susceptible to the fungal spread. If a tree is injured during this time, covering the wounds is recommended. If pruning or other activities must be done, waiting for the winter is the safest option.

Bur oak blight (BOB) is another threat to the oaks on the property. BOB affects only bur oaks, and is most injurious to upland individuals in savanna remnants. Caused by a species of fungus in the *Tubaki* genus, BOB causes lesions and discoloration of the veins on the underside of the leaves, eventually causing large portions of the leaf to die. In many cases, severe infections will cause tree death, though individual susceptibility to the disease varies. The fungus can overwinter on leaf petioles that remain attached to trees and is primarily spread by rain droplets moving spores throughout the tree. Early results suggest that inoculation of trees with fungicide may help slow or stop the spread of the disease within individual trees. If oaks are planted in the future, it may be beneficial to avoid planting the variety *Q. macrocarpa var. oliviformis*, which has shown the most severe susceptibility to BOB.

Misuse by residents and visitors

As described in earlier sections, misuse of the island's natural areas by residents and visitors has contributed to their current degraded state. Dumping of trash and yard waste, the escape and deliberate planting of ornamental garden plants, encroaching land use by neighbors, and overuse of erosion-sensitive areas continues to cause issues on the island. Some of these activities, like encroaching land use and ornamental plantings, are both taking away from the natural beauty and decreasing the habitat value of the units. Other activities, like dumping yard waste, can exacerbate erosion in the long term by preventing native plant establishment.

AW-3 is plagued by the greatest number of examples of this behavior. Besides being heavily bisected by a number of walking paths, the unit is largely used as a place for residents to dump yard waste. Piles of leaves and potted plants abound, and many of these plants have rooted to create new escaped populations. Lilies, irises, tulips, and other ornamental flowers now form carpets in some areas of the unit. Moreover, a literal garden has been maintained within the unit; this area is fenced off and contains a bench as well as myriad ornamental plant species. This private use of a public natural area has negatively affected the ecological health of this and other units. Another example of encroaching land use is a treehouse that sits squarely within the unit boundaries. Other units have different issues, including trash and debris piles (SG, AW1), yard waste (AW1, AW2), and erosion caused by foot traffic (AW1, AW2).

Curbing these behaviors will be difficult, but will go a long way towards helping to restore the natural communities on the island. Residents 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, both FMR and MWMO host workshops and educational events to educate residents on good land use pratices that will benefit water quality and ecosystem health. Occasional events on Nicollet Island, whether standalone or paired with restoration activities, are one strategy to help change resident behavior.

INFORMATION SOURCES

Bur oak blight. (http://www.myminnesotawoods.umn.edu/2010/09/bur-oak-blight-bob-in-minnesota/).

Dutch elm disease. (http://www.extension.umn.edu/garden/yard-garden/trees-shrubs/dutch-elm-disease/).

Emerald ash borer. (http://www.mda.state.mn.us/emeraldashborer).

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of Northeastern United States and adjacent Canada. Second Edition. The New York Botanical Garden, Bronx, New York.

Johnson, G et al. 2009. Nicollet Island Brownfield Study. University of Minnesota Extension. http://www.myminnesotawoods.umn.edu/2009/01/nicollet-island-brownfield-study/

Marschner, F.J. 1974. The Original Vegetation of Minnesota (map, scale 1:500,000). USDA Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota (redraft of the original 1930 edition).

Minneapolis Park and Recreation Board. 2016. Central Mississippi Riverfront Regional Park Master Plan. MPRB. 143pp.

Minnesota Department of Natural Resources. 2001. MnDNR Natural Community Element Occurrence Ranking Guidelines. Minnesota Natural Heritage Program. St. Paul, Minnesota.

Minnesota Department of Natural Resources. 2004. Minnesota Land Cover Classification System User Manual, Version 5.4. DNR Central Region, St. Paul, Minnesota.

Minnesota Department of Natural Resources. 2005. Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. St. Paul, MN.

Minnesota Department of Natural Resources. 2006. *Tomorrow's Habitat for the Wild and Rare; An Action Plan for Minnesota Wildlife*. Comprehensive Wildlife Conservation Strategy. Division of Ecological Services, MNDNR.

Minnesota Department of Natural Resources. 2009. Conservation Status Ranks for Native Plant Community Types and Subtypes.

Minnesota Department of Natural Resources. 2013. Plant Checklist - November 2013. Spreadsheet. Minnesota Department of Natural Resources. 2016. Natural Heritage Information System (NHIS) data.

Mississippi Watershed Management Organization. 2015. Nicollet Island Feasibility Study. MWMO. 59pp.

Oak wilt. (http://www.extension.umn.edu/environment/trees-woodlands/oak-wilt-in-minnesota/).

Olsen and Mossler (1982) Geological map of Minnesota, depth to bedrock. Minnesota Geological Survey. University of Minnesota.

Soil Conservation Service. 1977. Soil Survey of Washington County. United States Department of Agriculture.

APPENDICES

APPENDIX A. Plant Species Recorded at Nicollet Island

The following plant species were identified at the site by Friends of the Mississippi River.

Date: Summer 2017	**Site: Nicollet Island**	**3 Surveys**
Map Unit name:	**AW-1**	
Scientific Name	**Common Name**	**Abund[1]**
Ground layer		
Acer negundo	Box elder	P
Ageratina altissima	White snakeroot	C
Alliaria petiolata	Garlic mustard	P
Arctium minus	Burdock	P
Artemesia absinthium	Wormwood	R
Celtis occidentalis	Hackberry	P
Circaea lutetiana	Enchanter's nightshade	C
Conyza canadensis	Horseweed	P
Euphorbia esula	Leafy spurge	P
Hackelia virginiana	Stickseed	C
Leonurus cardiaca	Motherwort	P
Lotus corniculatus	Birdsfoot trefoil	R
Mentha arvensis	Wild mint	P
Parthenocissus vitacea	Woodbine	C
Phryma leptostachya	Lopseed	P
Solanum ptycanthum	Black nightshade	P
Solidago canadensis	Canada goldenrod	P
Vitis riparia	Wild grape	C
Shrub Layer		
Celtis occidentalis	Hackberry	P
Cornus recemosa	Gray dogwood	R
Frangula alnus	Glossy buckthorn	R
Fraxinus pennsylvanica	Green ash	P
Lonicera tatarica	Tatarian honeysuckle	P
Rhamnus cathartica	Buckthorn	A
Sambucus racemosa	Elderberry	P
Canopy, Subcanopy		
Acer negundo	Box elder	D
Celtis occidentalis	Hackberry	P

Populus deltoides	Cottonwood	C
Ulmus americana	American elm	P
Ulmus pumila	Siberian elm	P

[1]D= Dominant, C= Common, P= Present, R= Rare

Date: Summer 2017	**Site: Nicollet Island**	**3 Surveys**
Map Unit name:	**AW-2**	
Scientific Name	**Common Name**	**Abund[1]**
Ground layer		
Acer negundo	Box elder	P
Achillea millefolium	Yarrow	R
Ageratina altissima	White snakeroot	A
Alliaria petiolata	Garlic mustard	C
Allium spp	Garden Chives	R
Ambrosia artemiisifolia	Ragweed	P
Apocynum cannabinum	Indian hemp	R
Aquilegia canadensis	Columbine	R
Arctium minus	Burdock	P
Artemesia absinthium	Wormwood	P
Asclepias syriaca	Common milkweed	R
Boehmeria cylindrica	False nettle	P
Bromus intermis	Smooth brome	R
Campanula rapunculoides	Creeping bellflower	C
Chenopodium album	Lambs quarters	P
Cirsium arvense	Canada thistle	R
Commelina communis	Asiatic dayflower	R
Conyza canadensis	Horsetail	C
Dioscorea villosa	Wild yam	C
Echinacea purpurea	Purple coneflower	R
Elymus virginius	Virginia wild rye	P
Frangula alnus	Glossy buckthorn	R
Glechoma hederacea	Creeping Charlie	A
Hackelia virginiana	Stickseed	C
Hemerocallis fulva	Day lily	P
Hordeum jubatum	Foxtail barley	R
Juniperus virginiana	Red cedar	R
Leonurus cardiaca	Motherwort	C
Lonicera tatarica	Tatarian honeysuckle	P
Lotus corniculatus	Birdsfoot trefoil	P

Mentha arvensis	Wild mint	P
Mirabilis nyctaginea	Wild four o'clock	P
Parthenocissus vitacea	Woodbine	A
Phalais arundinacea	Reed canary grass	R
Poa pratensis	Kentucky blue grass	P
Prunus virginiana	Chokecherry	C
Ranunculus abortivus	Little-leaf buttercup	P
Rhamnus cathartica	Buckthorn	A
Rumex crispus	Curly dock	R
Sambucus racemosa	Elderberry	P
Saponaria officinalis	Bouncing bet	P
Scrophularia lanceolata	Lance leaf figwort	P
Setaria viridis	Foxtail	R
Solanum ptycanthum	Black nightshade	P
Solidago canadensis	Canada goldenrod	P
Solidago flexicaulis	Zig zag goldenrod	C
Syringa vulgaris	Lilac	P
Taraxacum oficinale	Dandelion	R
Tilia americana	Basswood	R
Toxicodendron rydbergii	Poison ivy	P
Tragopogon dubius	Yellow goatsbeard	R
Tulipa spp	Tulips	P
Urtica dioica	Stinging nettle	P
Viola sororia	Common blue violet	P
Vitis riparia	Wild grape	A
Shrub Layer		
Acer negundo	Box elder	P
Celtis occidentalis	Hackberry	P
Cornus alternifolia	Pagoda dogwood	P
Diervilla lonicera	Bush honeysuckle	P
Fraxinus pennsylvanica	Green ash	P
Juniperus virginiana	Red cedar	R
Lonicera tatarica	Tatarian honeysuckle	P
Menispermum canadense	Moonseed	C
Morus alba	White mulberry	P
Prunus americana	Plum	P
Prunus virginiana	Chokecherry	C
Rhamnus cathartica	Buckthorn	A
Rhus typhina	Staghorn sumac	P

Ribes americanum	Currant	C
Ribes cynosbati	Gooseberry	P
Sambucus racemosa	Elderberry	P
Syringa vulgaris	Lilac	P
Tilia americana	Basswood	R
Vitis riparia	Wild grape	C
Canopy, Subcanopy		
Acer negundo	Box elder	A
Celtis occidentalis	Hackberry	A
Fraxinus pennsylvanica	Green ash	C
Populus deltoides	Cottonwood	C
Tilia americana	Basswood	P
Ulmus americana	American elm	C
Ulmus pumila	Siberian elm	P

[1]D= Dominant, C= Common, P= Present, R= Rare

Date: Summer 2017	**Site: Nicollet Island**	**3 Surveys**
Map Unit name:	**AW-3**	
Scientific Name	**Common Name**	**Abund[1]**
Ground layer		
Acer negundo	Box elder	P
Aesculus glabra	Buckeye	R
Alliaria petiolata	Garlic mustard	C
Allium spp	Garden Chives	R
Campanula americana	American bellflower	P
Campanula rapunculoides	Creeping bellflower	C
Glechoma hederacea	Creeping Charlie	C
Hackelia virginiana	Stickseed	C
Hemerocallis fulva	Day lily	C
Hydrophyllum virginianum	Virginia waterleaf	P
Iris spp	Irises	P
Leonurus cardiaca	Motherwort	C
Lonicera tatarica	Tatarian honeysuckle	P
Podophyllum spp	Ornamental mayapple	P
Rhamnus cathartica	Buckthorn	C
Ribes cynosbati	Gooseberry	C
Saponaria officinalis	Bouncing bet	P
Solidago flexicaulis	Zig zag goldenrod	P

Syringa vulgaris	Lilac	P
Taraxicum oficinale	Dandelion	R
Tulipa spp	Tulips	P
Viola sororia	Common blue violet	P
Shrub Layer		
Acer negundo	Box elder	P
Celtis occidentalis	Hackberry	C
Fraxinus pennsylvanica	Green ash	P
Lonicera tatarica	Tatarian honeysuckle	P
Morus alba	White mulberry	A
Parthenocissus vitacea	Woodbine	P
Prunus virginiana	Chokecherry	P
Rhamnus cathartica	Buckthorn	A
Rhus typhina	Staghorn sumac	C
Syringa vulgaris	Lilac	C
Ulmus americana	American elm	P
Ulmus pumila	Siberian elm	P
Vitis riparia	Wild grape	C
Canopy, Subcanopy		
Acer negundo	Box elder	P
Celtis occidentalis	Hackberry	C
Fraxinus pennsylvanica	Green ash	P
Malus spp	Apple	R
Populus deltoides	Cottonwood	C
Ulmus americana	American elm	P
Ulmus pumila	Siberian elm	P

[1]D= Dominant, C= Common, P= Present, R= Rare

Date: Summer 2017	**Site: Nicollet Island**	**3 Surveys**
Map Unit name:	**SG**	
Scientific Name	**Common Name**	**Abund[1]**
Ground Layer		
Acer negundo	Box elder	P
Ageratina altissima	White snakeroot	P
Andropogon gerardii	Big bluestem	R
Arctium minus	Burdock	R
Asclepias syriaca	Common milkweed	R

Bergamot	Wild bergamot	R
Berteroa incana	Hoary alyssum	R
Bromus intermis	Smooth brome	D
Centaurea stoebe	Spotted knapweed	R
Cirsium arvense	Canada thistle	P
Fraxinus pennsylvanica	Green ash	P
Glechoma hederacea	Creeping Charlie	P
Leonurus cardiaca	Motherwort	P
Lotus corniculatus	Birdsfoot trefoil	C
Melilotus officinalis	Yellow sweet clover	P
Mentha arvense	Wild mint	P
Morus alba	White mulberry	P
Parthenocissus vitacea	Woodbine	P
Phalaris arundinacea	Reed canary grass	P
Poa pratensis	Kentucky bluegrass	A
Prunus virginiana	Chokecherry	P
Rosa arkansana	Prairie rose	P
Rubus ideaus	Red raspberry	P
Rubus occidentalis	Black raspberry	R
Rudbeckia hirta	Black eyed susan	P
Rumex crispus	Curly dock	R
Silene latifolia	White campion	P
Solidago canadensis	Canada goldenrod	A
Toxicodendron rydbergii	Poison ivy	R
Tragopogon dubius	Yellow goatsbeard	R
Ulmus pumila	Siberian elm	P
Verbascum thapsis	Mullein	R
Verbena stricta	Hoary vervain	R
Vitis riparia	Wild grape	P
Shrub Layer		
Acer negundo	Box elder	C
Frangula alnus	Glossy buckthorn	R
Fraxinus pennsylvanica	Green ash	P
Morus alba	White mulberry	P
Ribes americanum	Currant	P
Canopy Layer		
Acer negundo	Box elder	P

Betula paperyfera	Paper birch	P
Celtis occidentalis	Hackberry	P
Picea pungens	Blue spruce	R
Populus deltoides	Cottonwood	P
Ulmus americana	American elm	P
Ulmus pumila	Siberian elm	P

[1]D= Dominant, C= Common, P= Present, R= Rare

Date: 6/24/15	**Site: Nicollet Island**	
Map Unit name:	**NAL**	
Scientific Name	**Common Name**	**Abund[1]**
Ground layer		
Acer negundo	Box elder	P
Ageratina altissima	White snakeroot	A
Alliaria petiolata	Garlic mustard	P
Andropogon gerardii	Big bluestem	R
Arctium minus	Burdock	P
Artemesia absinthium	Wormwood	P
Asclepias syriaca	Common milkweed	R
Berteroa incana	Hoary alyssum	C
Catalpa speciosa	Catalpa	R
Celtis occidentalis	Hackberry	R
Centaurea stoebe	Spotted knapweed	P
Circaea lutetiana	Enchanter's nightshade	C
Cirsium spp	Thistle	P
Cirsium vulgare	Bull thistle	R
Conyza canadensis	Horseweed	A
Euphorbia esula	Leafy spurge	A
Hackelia virginiana	Stickseed	P
Leonurus cardiaca	Motherwort	P
Lotus corniculatus	Birdsfoot trefoil	C
Mellilotus alba	White sweetclover	P
Mentha arvensis	Wild mint	P
Parthenocissus vitacea	Woodbine	C
Phryma leptostachya	Lopseed	R
Populus deltoides	Cottonwood	R
Rumex crispus	Curly dock	R
Setaria viridis	Foxtail	P
Solanum ptycanthum	Black nightshade	P

Solidago canadensis	Canada goldenrod	A
Solidago rigida	Stiff goldenrod	P
Ulmus pumila	Siberian elm	P
Verbascum thapsis	Mullein	P
Vitis riparia	Wild grape	A

[1]D= Dominant, C= Common, P= Present, R= Rare

APPENDIX B. Plant Species for Restoration on Nicollet Island

Southern Dry Prairie (UPs13)

Genus	Species	Common Name
Shrubs		
Rosa	*blanda*	Smooth wild rose
Amorpha	*canescens*	Lead-plant
Forbs		
Anemone	*cylindrica*	Long-headed thimbleweed
Antennaria	*spp.*	Pussytoes
Aquilegia	*canadensis*	Columbine
Asclepias	*verticillata*	Whorled milkweed
Asclepias	*tuberosa*	Butterfly-weed
Asclepias	*viridiflora*	Green milkweed
Asclepias	*syriaca*	Common milkweed
Aster	*sericeus*	Silky aster
Aster	*Oolentan-giensis*	Sky-blue aster
Aster	*ericoides*	Heath aster
Aster	*laevis*	Smooth aster
Astragalus	*Crassi-carpus*	Buffalo-bean
Calylophus	*serrulata*	Toothed evening primrose
Campanula	*rotundifolia*	Harebell
Coreopsis	*palmata*	Stiff tickseed
Dalea	*purpurea*	Purple prairie-clover
Dalea	*candida*	White prairie-clover
Delphinium	*carolini-anum*	Prairie larkspur
Desmodium	*illinoense*	Illinois tick-trefoil
Euphorbia	*corollata*	Flowering spurge
Gnaphalium	*Obtuse-folium*	Sweet everlasting
Helianthem um	*bicknellii*	Hoary frostweed
Helianthus	*pauciflorus*	Stiff sunflower
Heuchera	*richardsonii*	Alum-root
Hypericum	*perforatum*	Common St. John's-wort
Kuhnia	*eupato-roides*	False boneset
Lespedeza	*capitata*	Round-headed bush-clover
Liatris	*aspera*	Rough blazing star
Liatris	*punctata*	Dotted blazing star
Liatris	*cylindracea*	Cylindric blazing star
Linum	*sulcatum*	Grooved yellow flax
Lobelia	*spicata*	Rough-spiked Lobelia
Lysimachia	*ciliata*	Fringed loosestrife
Mirabilis	*hirsuta*	Hairy four-o'clock
Monarda	*fistulosa*	Wild bergamot
Another	*biennia*	Common evening-primrose
Oenothera	*clelandii*	Cleland's evening-primrose
Oxalis	*violacea*	Violet wood-sorrel
Pediomelum	*esculentum*	Prairie-turnip
Pediomelum	*argophyllum*	Silvery scurf-pea
Penstemon	*grandiflorus*	Large-flowered beard-tongue
Physalis	*virginiana*	Ground-cherry
Potentilla	*arguta*	Tall cinquefoil
Pycnan-themum	*virginianum*	Virginia mountain-mint
Scutellaria	*leonardi*	Leonard's skullcap
Senecio	*plattensis*	Prairie ragwort
Silene	*antirrhina*	Sleepy catchfly
Sisyrinchium	*campestre*	Field blue-eyed grass
Solidago	*nemoralis*	Gray goldenrod
Solidago	*rigida*	Stiff goldenrod
Solidago	*speciosa*	Showy goldenrod
Tradescantia	*occidentalis*	Western spiderwort
Viola	*pedatifida*	Prairie bird-foot violet
Viola	*pedata*	Bird-foot violet
Zizia	*aptera*	Heart-leaved alexanders

Southern Terrace Forest (FFs59)

Genus	Species	Common Name
Canopy Trees (>10 m)		
Acer	*saccharinum*	Silver maple
Celtis	*occidentalis*	Hackberry
Fraxinus	*pennsylvanica*	Green ash
Populus	*deltoids*	Cottonwood
Salix	*Ingra*	Black willow
Tilia	*americana*	Basswood
Ulmus	*rubra*	Slippery elm
*Ulmus**	*americana**	American elm*
Understory Trees		
Acer	*saccharinum*	Silver maple
Carya	*cordiformis*	Bitternut hickory
Celtis	*occidentalis*	Hackberry
Fraxinus	*pennsylvanica*	Green ash
Ostrya	*virginiana*	Ironwood
Tilia	*americana*	Basswood
*Ulmus**	*americana**	American elm*
*Ulmus**	*rubra**	Slippery elm*
Shrubs		
Cornus	*amour*	Silky dogwood
Euonymus	*atropurpureus*	Wahoo
Prunus	*virginiana*	Chokecherry
Ribes	*americanum*	Wild black currant
Ribes	*cynosbati*	Prickly gooseberry
Ribes	*missouriense*	Missouri gooseberry
Sambucus	*canadensis*	Common elder
Sambucus	*racemosa*	Red-berried elder
Viburnum	*lentago*	Nannyberry
Vines		
Menispermum	*canadense*	Canada moonseed
Parthenocissus	spp.	Virginia creeper
Forbs		
Allium	*tricoccum*	Wild leek
Anemone	*quinquefolia*	Wood-anemone
Arisaema	*triphyllum*	Jack-in-the-pulpit
Aster	*cordifolius*	Heart-leaved aster
Aster	*ontarionis*	Ontario aster
Aster	*pubentior*	Flat-topped aster
Campanula	*americana*	Tall bellflower
Caulophyllum	*thalictroides*	Blue cohosh
Circaea	*alpina*	Small enchanter's nightshade
Circaea	*lutetiana*	Canada enchanter's nightshade
Cryptotaenia	*canadensis*	Honewort
Dicentra	*cucullaria*	Dutchman's-breeches
Enemion	*biternatum*	False rue-anemone
Erythronium	*albidum*	White trout-lily
Galium	*aparine*	Cleavers
Galium	*triflorum*	Three-flowered bedstraw
Geranium	*maculatum*	Wild geranium
Geum	*canadense*	White avens
Hydrophyllum	*virginianum*	Virginia waterleaf
Impatiens	*capensis*	Touch-me-not
Lilium	*michiganense*	Michigan lily
Maianthemum	*canadense*	Canada mayflower
Osmorhiza	*claytonii*	Clayton's sweet cicely
Phlox	*divaricata*	Blue phlox
Polygonatum	*biflorum*	Giant Solomon's-seal
Ranunculus	*abortivus*	Kidney-leaf buttercup
Rudbeckia	*laciniata*	Goldenglow
Sanguinaria	*canadensis*	Bloodroot
Sanicula	*gregaria*	Gregarious black snakeroot
Smilacina	*racemosa*	Racemose false Solomon's-seal
Smilacina	*stellata*	Starry false Solomon's-seal
Smilax	*lasioneura*	Carrion-flower
Stachys	*palustris*	Woundwort
Thalictrum	*dasycarpum*	Tall meadow-rue
Thalictrum	*dioicum*	Early meadow-rue
Trillium	*cernuum*	Nodding trillium
Trillium	*flexipes*	Drooping trillium
Uvularia	*grandiflora*	Yellow bellwort
Viola	spp.	Violet
Grasses, Rushes and Sedges		
Calamagrostis	*canadensis*	Bluejoint
Carex	*amphibola*	Ambiguous sedge
Carex	*pedunculata*	Long-stalked sedge
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
Ferns and Fern Allies		
Matteuccia	*struthiopteris*	Ostrich-fern

*Plant disease resistant varieties.

Climate Adapted Tree Species for Restoration on Nicollet Island

Five main tree species not currently present in the restoration units will be included in plantings, both to re-create historical plant communities valued by residents and to introduce climate adapted species to improve the resilience of these communities. These species will be included in both the AW and SG units.

Scientific name	Common name	Reasoning
Acer saccharum	Sugar Maple	Historical component, maple syruping
Acer rubrum	Red Maple	Maple syruping, better growth on site
Carya ovata	Shagbark Hickory	Climate adaptation, community resilience
Platanus occidentais	American Sycamore	Climate adaptation, community resilience
Gymnocladus dioicus	Kentucky Coffee tree	Climate adaptation, community resilience
Aesculus flavus	Yellow Buckeye	Climate adaptation, community resilience

A list of additional optional species can be found at the following living link. This list was compiled by the Mississippi Park Connection and the National Park Service with input from FMR and other organizations.

https://docs.google.com/spreadsheets/d/1Z8ngt6gAiiQEZOkpfn9hZ39AFak45_EbXhjMVZZUHDo/edit#gid=0

APPENDIX C. Methods for Controlling Exotic, Invasive Plant Species

Trees and Shrubs

Common Buckthorn, Glossy buckthorn, Tartarian Honeysuckle, Siberian Elm, and Black Locust are some of the most common non-native woody species likely to invade native forests, woodlands and prairies in Minnesota. Buckthorn and honeysuckle are European species that escaped and invaded woodlands in many parts of the country. They are exceedingly aggressive and, lacking natural diseases and predators, can out-compete native species. They remain photosynthetically active longer than most other native shrubs and trees, which gives them a competitive advantage. The seeds are disseminated by birds, which make them especially problematic in open woodlands, savannas, and overgrown prairies. They also benefit from the net actions of invasive earthworms, fire suppression, and high deer populations, forming a synergy that helps set the stage for their establishment and dominance. Invasions eventually result in dense, impenetrable brush thickets that greatly reduce ground-level light availability and can cause declines in native species abundance and diversity.

Siberian elm, native to eastern Asia, grows vigorously, especially in disturbed and low-nutrient soils with low moisture. Seed germination is high and seedlings establish quickly in sparse vegetation. It can invade and dominate disturbed areas in just a few years. Black locust is native to the southeastern United States and the very southeastern corner of Minnesota. It has been planted outside its natural range (it was promoted as an erosion control species and a soil stabilizer partly because it was falsely assumed to be a nitrogen fixer, and since it quickly colonizes bare slopes), and readily invades disturbed areas. It reproduces vigorously by root suckering and can form monotypic stands.

Biological Control

Currently there are no biological control agents for non-native woody plants in Minnesota. Recently, an 11-year study conducted by the DNR and University of MN resulted in the conclusion that there were no viable biological control agents for common or glossy buckthorn, based in part on the lack of damage to the host plants and a lack of host specificity (http://www.dnr.state.mn.us/invasives/terrestrialplants/woody/buckthorn/biocontrol.html)

Chemical Control

The most efficient way to remove woody plants that are 1/2 inch or more in diameter is to cut the stems close to the ground and treat the cut stumps with herbicide immediately after they are cut, when the stumps are fresh and the chemicals are most readily absorbed. Failure to treat the stumps will result in resprouting, creating the need for future management interventions.

In non-freezing temperatures, a glyphosate herbicide such as Roundup can be used for most woody species. It is important to obtain the concentrated formula and dilute it with water to achieve 10% glyphosate concentration. Adding a marker dye helps to make

treated stumps more visible, improving accuracy and overall efficiency. In winter months, an herbicide with the active ingredient triclopyr must be used. *Garlon 4* is a common brand name and it must be mixed with a penetrating oil, such as diluent blue. *Garlon* 4 will also work throughout the year. Do not use diesel fuel, as it is much more toxic in the environment and to humans.

Brush removal work can be done at any time of year except during spring sap flow, but late fall is often ideal because buckthorn retains its leaves longer than other species and is more readily identified. Moreover, once native plants have senesced, herbicide will have fewer non-target effects on native vegetation. Cutting can be accomplished with loppers or handsaws in many cases. Larger shrubs may require brush cutters and chainsaws, used only by properly trained professionals.

For plants in the pea family, such as black locust, an herbicide with the active ingredient clopyralid can be more effective than glyphosate. Common brand names for clopyralid herbicides are Transline, Stinger, and Reclaim.

In the year following initial cutting and stump treatment, there will be a flush of new seedlings as well as possible resprouting from some of the cut plants. Herbicide can be applied to the foliage of these plants. Fall is the best time to do this, when desirable native plants are dormant and when the plant is pulling resources from the leaves down into the roots. Glyphosate, triclopyr and Krenite (active ingredient – fosamine ammonium) are the most commonly used herbicides for foliar application. Krenite prevents bud formation so the plants do not grow in the spring. This herbicide can be effective, but results are highly variable. Glyphosate or a triclopyr herbicide such as Garlon can also be used. Glyphosate is non-specific and will kill anything green, while triclopyr targets broadleaf plants and does not harm graminoids. All herbicides should be applied by licensed applicators and should not be applied on windy days. Care should be taken to avoid application to other plants. “Weed Wands” or other devices that allow dabbing of the product can be used rather than spraying, especially for stump treatment.

Basal bark herbicide treatment is another effective control method. A triclopyr herbicide such as Garlon 4, mixed with a penetrating oil, is applied all around the lower 6-12 inches of the tree or shrub, taking care so that it does not run off. If the herbicide runs off it can kill other plants nearby. More herbicide is needed for effective treatment of plants that are four inches or more in diameter.

Undesirable trees and shrubs can also be destroyed without cutting them down. Girdling is a method suitable for small numbers of large trees. Bark is removed in a band around the tree, just to the outside of the wood. If girdled too deeply, the tree will respond by resprouting from the roots. Girdled trees die slowly over the course of one to two years. Girdling should be done in late spring to mid-summer when sap is flowing and the bark easily peels away from the sapwood. Herbicide can also be used in combination with girdling for a more effective treatment. Girdling has the added benefit of creating snags for wildlife habitat. While girdling a large number of trees is not feasible, girdling the

occasional large tree will provide a matrix of habitat for species that depend on standing dead trees for food or nesting opportunities.

Mechanical Control

Three mechanical methods for woody plant removal are hand pulling (only useful on small seedlings and only if few in number), weed wrenching (using a weed wrench tool to pull stems of one to two inches diameter), and repeated or "critical" cutting. Pulling and weed wrenching can be done any time when the soil is moist and not frozen. The disadvantage to both methods is that they are somewhat time-consuming, as the soil from each stem should be shaken off. Weed wrenching also creates a great deal of soil disturbance and should not be used on steep slopes or anywhere that desirable native forbs are growing. The soil disturbance also creates opportunities for colonization by other non-native plants. This method is the least preferable and is probably best used in areas that have hardly any desirable native plant cover.

Repeated cutting consists of cutting the plants (by hand or with a brush cutter) at critical stages in its growth cycle, typically twice per growing season. Cutting in mid spring (late May) intercepts the flow of nutrients from the roots to the leaves and cutting in fall (about mid-October) intercepts the flow of nutrients from the leaves to the roots. Depending on the size of the stem, the plants typically die within three years, with two cuttings per year.

Prescribed Fire

Prescribed burning is the most efficient, cost effective, and least harmful way to control very small stems, seedlings, and resprouts of all woody plants. It also restores an important natural process to fire-dependant natural communities (oak forests, for example). Burning can only be accomplished if adequate fuel (leaf litter) is present and can be done in late fall or early spring, depending on site conditions.

Native Shrubs

Prickly Ash

A common native shrub, prickly ash can become excessively abundant, especially in areas that have been disturbed or grazed. Complete eradication may not be necessary, but management may target reducing the extent of a population. Removal is most easily accomplished in the same manner as for buckthorn – cutting shrubs and treating cut stumps with glyphosate herbicide. Cutting can be completed at any time of the year.

Sumac

Like prickly ash, smooth sumac can become excessively abundant, especially in areas where fire has been suppressed for long periods of time. It can form dense, clonal stands that dominate other vegetation. Unlike prickly ash or buckthorn, however, controlling smooth sumac does not require herbicide applications, since that would require a tremendous amount of herbicide, be quite labor intensive, and probably cause heavy damage to surrounding plants. Control of smooth sumac can be easily accomplished by

cutting and burning, or a combination of these two methods. To be effective, the sumac must be burned or cut twice a year: the first time in the late spring, just after it has fully leafed out (expended maximum energy), and the second time in late summer, after it has re-sprouted. Repeat this method annually for two to five years to deplete the clone of its energy, working back at the edges of the clone and reducing cover from the outside of the area towards the center. If cutting or burning is performed only once a season, the clone will persist, since this will not be enough to drain the root system of stored energy. Cutting twice a year without burning will be effective, but burning is doubly so, since fire tends to benefit herbaceous plants and suppress woody ones.

Disposal

The easiest and most cost-effective method to handle large amounts of woody brush is usually to stack it and burn it. This is most typically done during winter to lessen the impacts to soil (compaction, erosion, rutting, etc.), though often brush will be piled soon after the removal and burned during the winter. In areas where brush is not dense, it can be cut up into smaller pieces, scattered, and left on the ground where it will decompose in one to three years (this method is especially useful on slopes to reduce erosion potential). Small brush piles can also be left in the woods as wildlife cover. Where there is an abundance of larger trees, cut trees may be hauled and chipped and used for mulch or as a biofuel. Alternatively, the wood can be cut and used for firewood, if a recipient can be found, or perhaps saved to be used later as waterbars for slope stabilization.

FORBS

Spotted knapweed

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 actually 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 fairly 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 bio-control (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 bio-control.

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.

Canada thistle

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. Where native grasses and sedges are present, use of a broadleaf herbicide such as 2,4-D is recommended, since 2,4-D only affects dicots. 2,4-D is most effective when applied 10-14 days before the flowering stems bolt. It is applied at a rate of 2-4 lb/acre using a backpack or tractor-mounted sprayer or in granular form. Dicamba could also be used, with the advantages that it can be applied earlier in the spring at a rate of 1 lb/acre. Another chemical that has been used for thistles is aminopyralid ("Milestone"), which can be applied at bud stage. Aminopyralid will affect other species and it has longer residual activity than some other chemicals, so use with caution—typically use it on large patches/clones of thistles and avoid areas of higher diversity. 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 their 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 strong, rather than in an old field, where competition is likely to be weaker.

Sweet clover

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 times, 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.

Garlic mustard

Garlic mustard is an exotic 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 out-competed by garlic mustard. The flavinoid persists in the soil years after garlic mustard plants are removed, which can hamper restoration efforts.

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 foliar 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 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 bio-control 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.

GRASSES

Smooth brome

Smooth brome is a cool season grass —active early in the growing season in southern Minnesota (April-May-June) and then going semi-dormant in July-September. It reproduces by means of underground stems (stolons and rhizomes) called "tillers". The most effective treatment is timed to occur at the same time as the brome is "tillering"—mid to late May in southern Minnesota. Burning two years in a row (late-season burns in June) followed by seeding has been shown to be effective in controlling smooth brome. Consider that this timing may be a week or two earlier on steep south-facing slopes or in very sandy or sand-gravel soils. Following this method will usually be sufficient to control smooth brome. Seeding following burns, preferably with native seed collected on-site, or purchased from a seller that provides local ecotypes, is important for restoring cover at the site. Evaluation can occur each year, and especially after two years. If this is not working, perhaps try a cool-season overspray of a grass-specific herbicide either in the spring (April) or in the fall (October). Using glyphosate as a cool-season overspray herbicide application is a last resort, since it is non-specific and can kill everything.

Kentucky bluegrass and *creeping fescue* can be treated similarly to smooth brome, since like smooth brome, they are both exotic, stoloniferous, cool-season grasses. Spring burns are the most effective tool against all of these species.

Reed canary grass

This species is extremely difficult to eradicate and requires repeated treatment over a period of up to three years. A combination of burning, chemical treatment and mowing can be used in accessible areas, or chemical treatment alone in inaccessible areas. First, burn in late spring to remove dead vegetation and to stimulate new growth. When new sprouts have reached a height of 4 to 6 inches, the site can be sprayed with a 5% solution of a glyphosate herbicide appropriate for wetland habitat (e.g. Rodeo). The site is then mowed in late summer, followed by chemical application after re-growth. This treatment will stimulate new growth and germination to deplete the seed bank. The sequence is repeated for at least a second season, and possibly a third until the grass is completely eradicated. Then native grass and forb seed can be broadcast or drilled.

If reed canary grass is eradicated from an area, future management of the grassland, namely burning, will likely keep the reed canary in check. Monitoring and mapping new individuals or clumps should continue, however, and those individuals should be treated if burning is not adequately controlling them. If the plants are small they can be removed by digging out the entire root. Generally though, chemical treatment is more feasible. If plants are clumped, they can be treated by tying them together, cutting the blades, and treating the cut surface with herbicide. Otherwise, herbicide should only be applied in native planted areas on very calm days to avoid drift to non-target plants.

APPENDIX D. Ecological Contractors

Following is a list of contractors to consider for implementing the management plans. While this is not an exhaustive list, it does include firms with ecologists who are very knowledgeable with natural resource management. Unless otherwise noted, all firms do prescribed burning. Many other brush removal companies are listed in the yellow pages (under tree care), but most do not have knowledge or understanding of native plant communities. We recommend hiring firms that can provide ecological expertise. Additional firm listings can be found on the DNR website: http://www.dnr.state.mn.us/gardens/nativeplants/index.html

Friends of the Mississippi River (FMR) has extensive experience working with landowners to implement natural resource management plans. FMR can assist landowners with obtaining funding for restoration and management projects and providing project management, including contractor negotiations, coordinating restoration and management work, and site monitoring and evaluation.

Applied Ecological Services, Inc.
21938 Mushtown Rd
Prior Lake, MN 55372
952-447-1919
www.appliedeco.com

Conservation Corps Minnesota
2715 Upper Afton Road, Suite 100
Maplewood, MN 55119
(651) 209-9900

Great River Greening
35 West Water St, Suite 201
St. Paul, MN 55107
651-665-9500
www.greatrivergreening.org

Minnesota Native Landscapes, L.L.C.
14088 Highway 95 N.E.
Foley, MN 56329
(320) 968-4222
www.mnnativelandscapes.com

Prairie Restorations, Inc.
PO Box 305
Cannon Falls, MN 55009
507-663-1091
www.prairieresto.com

Stantec
2335 West Highway 36
St. Paul, MN 55113
651-604-4812
www.stantec.com

Wetland Habitats Restoration, LLC.
1397 Chelmsford St.
St. Paul, MN 55108
Cell: 612-385-9105
Fax: 636-333-8834
www.whr.mn

Native Resource Preservation
2325 290th St.
Madison, MN 55625
320-752-4338
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Natural Resources Restoration, Inc.
2013 Walnut Ave.
New Brighton, MN 55112
651-636-3462