Natural Resource Management Plan

for the

River to River Greenway

prepared by

Dakota County

Adopted October 20, 2020

Table of Contents

List of Tables

List of Figures

I. Executive Summary

Background

The River to River Greenway encompasses 7.6 miles of paved trail from Kaposia Landing along the Mississippi River in the east, to the northwest at Lilydale where the Mississippi flows downstream of the confluence of the Minnesota River. The Greenway is adjacent to 830 acres of publicly accessible lands owned by cities of Mendota Heights, West Saint Paul and South Saint Paul, Dodge Nature Center, and Independent School District 197. Originally named the North Urban Regional Trail, this Greenway was made contiguous in 2015 when many pre-existing trails through city parks were linked with a continuous paved path, but adjustments will occur in the next few years with additional trailhead parking, grade separated crossings, and new alignment opportunities.

Prior to European settlement, the area was covered by hardwood forest, oak savanna and prairies, with wetlands occupying small depressions on the landscape. Farming practices and subsequent development eliminated any native prairie that once occupied open areas. The steep slopes of ravines leading to floodplain forest along the River encompassed maple basswood hardwood forest. With the onset of post-WWII development, many wetland depressions became ponds or small lakes with increased runoff from upland impervious surfaces. Subsequently, many of these were altered (excavated) for increased stormwater-holding capacity as development expanded.

Within the current urban and suburban landscape, many of the lands remaining with native plant cover are highly degraded due to the introgression of invasive species, the expansion of impervious cover from surrounding development, and the disruption of corridors conducive to the movement of wildlife. Current opportunities to ameliorate these challenges include the removal of invasive vegetation, enhancement of forests with native forbs and shrubs, addressing ravine erosion issues, and conversion of underutilized turf lawns to prairies and native plantings with high pollinator value. Some existing prairie restorations and native plantings within the Greenway Corridor contribute to its natural resource quality. These plantings could be expanded and enhanced with additional funding. Future long-term projects could address degraded wetlands to facilitate the return of native wet meadow and pond shoreline plantings to bring in more diversity and facilitate improvements in water quality for hydrologically connected systems within the Greenway.

This Natural Resource Management Plan aims to provide a foundation for future natural resource restoration and enhancement projects on the public lands outlined along this greenway. Additionally, this document aims to provide structure and precedent with guiding principles governing future partnerships for natural resource projects and management on non-County owned lands adjacent to County Greenways that involve public lands owned by municipalities, non-profits, and school districts. Recommendations for structuring future collaborations around cost share for obtaining extramural funding are presented.

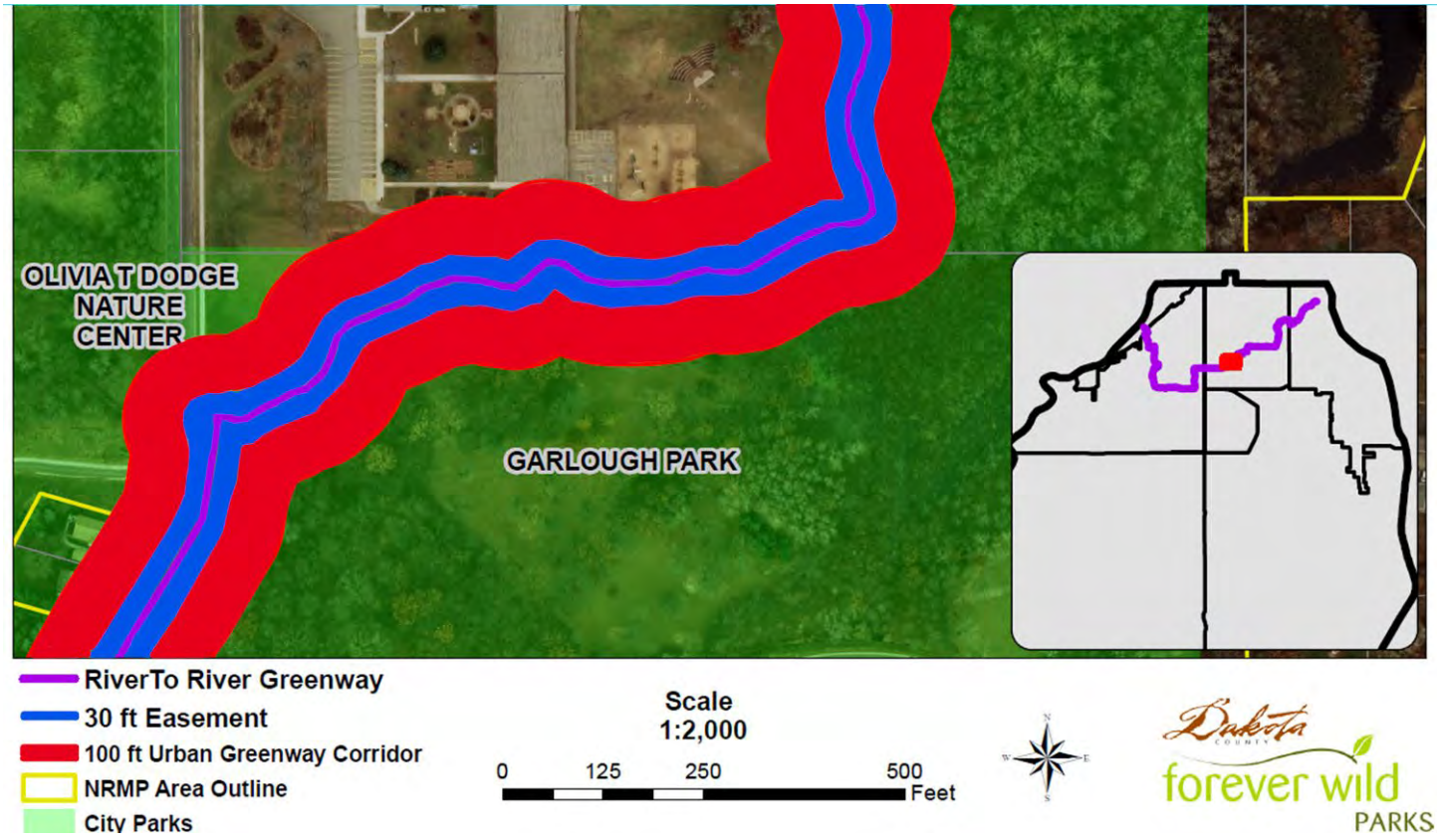
Natural Resource Management Plan Recommendations

Restoration projects within public lands along the River to River Greenway Corridor amount to approximately **$1.9 million** in project costs. **Table 7** (**pg. 93**) illustrates the Restoration Priorities and site-specific restoration

sequencing of all major sites within the Greenway Corridor. Briefly, the biggest priority for all woodlands and forests along the River to River Greenway is to remove invasive shrubs such as buckthorn and honeysuckle. Secondarily, additional native trees and shrubs could be removed from oak woodlands and former grasslands currently experiencing woody encroachment. The highest priority for grasslands is to restore prairie in currently unrestored areas and determine the best underutilized turf areas for smaller prairie restorations and pollinator plantings. Finally, the highest wetland priorities are those that will have the greatest impact on water quality or public visibility, such as stormwater pond shoreline restorations (concurrent with buckthorn removal, but challenges exist with establishing emergent vegetation due to fluctuating water levels) and isolated wetlands proximal to trails (Marthaler Park). Next priority wetlands include those with the ability to control hydrology via water control structures (Valley Park), while the larger tracts of wetlands on Dodge's Lilly Property are a longer-term management consideration.

The implementation of natural resource projects outlined in **Table 7** of the Plan is subject to external grant funding. In the case of restorations occurring on non-County Lands, the County would seek to establish Joint Powers Agreements and Supplemental Maintenance Agreements with project Partners to define roles in restoration, enhancement and maintenance activities. State grant opportunities for funding natural resources related work require initial financial investment in the form of grant match. As a typical scenario, Dakota County would seek partnership contributions amounting to half the grant cash match associated with restoration on non-County lands. Thus, for a hypothetical $100,000 restoration project funded by a state grant, a 20% cash match contribution ($20,000) would be shared 50/50 between the County and project Partners ($10,000 each). Partner contributions could deviate from this default scenario and would depend on the site's position relative to the Greenway (see **Executive Figure 1** and **Executive Table 1 below**). Greenway Corridors of 100-300 feet are defined based upon Greenway Guidebook (County Board Resolution No. 10-487), and Natural Lands are defined as public lands immediately outside this Greenway Corridor that form continuity with respect to natural vegetation and wildlife habitat. Ongoing maintenance of the native plantings on non-County lands would be the responsibility of the County within the Greenway Corridor, and the responsibility of the Landowner outside the Corridor.

Executive Figure 1: River to River Greenway Corridor Terms Defined



Executive Table 1: Greenway Roles and Responsibilities

Greenway Roles / Location	30-foot Easement	100 – 300-foot Corridor	Natural Lands Beyond Corridor
Grant Match Cost Share	County	County and Landowner have equal cost share (50/50).	County/Landowner cost share to be determined by Land Conservation Plan.
Restoration Project Management	County	County/Landowner Partnership.	Landowner. County may assist as determined by Land Conservation Plan.
Maintenance	County	County. Landowner may assist.	County/Landowner cost share to be determined by Land Conservation Plan.

Given the above Greenway Roles and Responsibilities, **Executive Table 2** (below) exhibits Funding Scenarios for natural resource restoration activities based upon the cost estimates presented in **Table 7** and were constructed with the following assumptions:

- Dakota County assumes 100% of the costs associated with Easements (~3% of total Greenway Study Area of 830 acres) and with restoration in Thompson County Park (either internally or grant funded, depending on the scenario);
- The County assists in 50% cost share for grant match within 100 ft Urban Greenway Corridor (11% of total Greenway Study Area), or 50% of total costs if no grant is obtained;
- Funding for restoration in Natural Lands Beyond the Greenway Corridor is to be determined by the County Land Conservation Plan and individual Joint Powers Agreements, but one potential scenario illustrated here indicates that the County assists with 25% cost share for grant match outside the 100 ft Urban Greenway Corridor (~86% of the Greenway Study Area), or 25% of total costs if no grant is obtained;
- A Subwatershed Assessment is included within the cost estimate for the County
- All other restoration costs not described above are the responsibility of the respective Landowner and are summed as an Implementation Cost Estimate for Partners.

The following Table outlines potential cost scenarios for initial restoration implementation within the total Scoping area (Easement, Greenway Corridor and non-County Natural Lands (**Table 7**), assuming the roles and responsibilities above:

Executive Table 2: Restoration Implementation Funding Scenarios

Grant Funding Scenario	Implementation Cost Estimate for County	Implementation Cost Estimate for Partners	Grant Funds	Total Cost Estimate
No Grant Funding	$1,000,000	$920,000	$ -	$1,910,000
50% Grant Funded	$620,000	$550,000	$750,000	$1,910,000
100% Grant Funded	$240,000	$180,000	$1,500,000	$1,910,000

This initial Greenway NRMP seeks to establish general parameters for cost share roles and responsibilities between Dakota County and landowner partnership organizations. The guiding principles determining County contributions for initializing implementation of natural resource restoration projects on non-County owned land within established Greenway Corridors will establish a preferred policy approach, directed by the County Board's approval of the Plan and future Joint Powers Agreements during implementation of the Plan's activities.

II. Purpose of the Natural Resource Management Plan

The purpose of the Natural Resource Management Plan (NRMP) is to describe the current and preferred natural resource conditions, goals, and activities for the protected portion of the landowner's property included in the permanent natural area conservation corridor (Greenway Corridor or Study Area) held by Dakota County and other municipal and public lands. The NRMP includes information on the Corridor's location; historic, existing, and adjacent land use; bedrock and surficial geology; soils; topography; hydrology, including groundwater and surface water; historic and existing vegetation cover, noxious and invasive plants, and land cover; ecological impacts, past and present, from fire suppression, diseases, wildlife, and climate

change; plant community assessment; wildlife; target vegetation communities, including management priorities, methods, five year workplan, and long-term workplan. The NRMP also includes plant restoration goals and recommendations, a restoration process, schedule, and cost estimates.

Natural Resource Management Agreements (Management Agreements) are developed in conjunction with the NRMP and each include: a workplan for implementing jointly agreed on natural resource activities and priorities, the respective roles and responsibilities of the landowners (the County or Partners), project schedules, cost estimates and funding/in-kind sources.

The status of any approved activity under any Management Agreement will be monitored and assessed as part of routine ecological monitoring of the restored or enhanced areas by County staff, as allowed by the Management Agreement. The NRMP will be reviewed and updated every five years, or as needed to maintain its relevancy.

Contacts

Dakota County Parks Department

14955 Galaxie Avenue, Apple Valley, MN 55124

Project Lead: Christian Klatt

952-891-7947

christian.klatt@co.dakota.mn.us

River to River Greenway

PARTNERS:

City of South Saint Paul

City of West Saint Paul

City of Mendota Heights

Dodge Nature Center

Independent School District 197

III. Introduction

Most of Dakota County's 429,000 residents live in the highly urbanized northern one-third of the County, a rolling landscape bordered by major rivers to the north and east, and dotted with lakes, forests, wetlands and other natural areas. The southern two-thirds of the County are generally level and open where agriculture is the predominant land use. This portion of the County is dissected by many streams and tributaries, and includes the largest tracts of natural areas.

As a result of the County's rich soils and close proximity and easy transportation access to St. Paul and Minneapolis, the combination of agricultural use and suburban development has resulted in the loss of most pre-settlement wetlands, prairies, savannas, and upland forests. Many of the remaining natural areas are degraded and fragmented, which make it increasingly difficult for these areas to function as healthy ecosystems. Moreover, many of the remaining natural areas are the most attractive undeveloped areas for future residential development. Despite being relatively few in number and extent, some of these natural areas include important plant and animal communities and are prime candidates for conservation. Residential surveys consistently indicate that the majority of County citizens think it is important that the County has an active role in protecting these areas.

To address citizen's concerns over the loss of open space and natural areas throughout the County, and to determine how to protect these areas using incentive-based tools, the County Board adopted the "Dakota County Farmland and Natural Area Protection Plan" (Plan) in 2002. The Plan identified 36,000 acres of high quality natural areas as a priority for protection which overlapped with the nearly 60,000 acres of land eligible for farmland protection. The Plan identified the following public purposes for protecting natural areas:

- Increase property values and enhance neighborhood appeal
- Provide close-to-home opportunities for people to enjoy and interact with nature
- Provide critical habitat for plants and animals and preserve critical ecological connections between habitat areas
- Provide environmental services, including filtering pollutants from soil and water, reducing soil erosion, and absorbing air pollutants and carbon dioxide
- Provide natural flood control for area streams and rivers by retaining wetlands and vegetated corridors to absorb flood waters.

Citizen input was used to identify the desired characteristics for natural areas:

- Lands of biological significance
- Lands adjacent to lakes, rivers, and streams to improve water quality
- Lands that provide wildlife habitat
- Lands that provide some level of public access

The Plan found that there were high quality natural areas worth protecting and identified three primary strategies to protect these areas:

Strategy 1: Protect priority natural areas in eligible areas and corridors using conservation easements and fee title acquisition from willing sellers and donors.

Strategy 2: Work with other agencies through their programs to protect County priority natural areas.

Strategy 3: Work with owners of large land tracts and agencies to protect natural areas on their properties with conservation easements and Natural Resource Management Plans (NRMPs).

IV. Vision and Goals

A. Vision

Dakota County approaches conserving Natural Resources within the County with the following Vision Statement in mind: "The water, vegetation, and wildlife of Dakota County Parks [and Greenways] will be managed to conserve biodiversity, restore native habitats, improve public benefits, and achieve resilience and regionally outstanding quality, now and for future generations (Natural Resources Management System Plan, 2017)." Towards this end, the County has an interest towards improving the ecological value of the public lands outside but adjacent to the County's land-holdings and easements.

B. Maximize Biodiversity and Increase Community Resilience

A major goal of ecological restoration is to establish native plantings that support high biodiversity, including the highest numbers of species adapted to the physical conditions of each site. This high biodiversity ensures that multiple species are able to have some degree of overlap in their respective ecological roles, such that if some species were removed from the system, there is enough redundancy to ensure that the ecosystem continues to provide food, habitat, and perform the necessary ecological functions that keep the system healthy. This redundancy results in greater resilience to change due to climate or the influx of exotic species.

C. Conserve and Promote Species of Greatest Conservation Need

The conservation of species adversely impacted by human activity is a priority goal in Natural Resource management. Species of Greatest Conservation Need (SGCNs) are identified in the State's Wildlife Action Plan for 2015-2025 and include species listed under Federal and State Endangered, Threatened, and Special Concern Species Lists. Additionally, this Plan identified rare or declining species and stewardship species whose populations are stable within the State but declining elsewhere, or migratory species whose congregations within the State represent significant proportions of total populations in North America.

D. Enhance Water Quality

Native plantings offer an advantage over turf grasses in that their roots penetrate into soils much more deeply (up to tens of feet), facilitating the infiltration of surface water into the soil. This not only

reduces overland surface water runoff, thus reducing the turbidity and nutrient loading of receiving water bodies, but it also assists with groundwater recharge.

E. Restore Degraded Landscapes to Native Plant Communities

Many of the landscapes identified in this Plan have low vegetative quality due to lack of continued maintenance in the form of prescribed fire or invasive species removal. Bringing back native plant communities to the landscape will significantly improve the habitat quality of these lands but will also work towards conserving disappearing plants and animals in an altered, urbanized landscape.

F. Remove Invasive Species

Invasive species can more be considered symptoms of a greater problem- lack of land management activities in general- as their removal from these landscapes are temporary without continued effort. However, by removing these species, we can take the most significant and impactful step to returning these landscapes to healthy, functioning natural communities.

V. Natural History and Current Conditions

A. Landscape Context

i. Location

The River to River Greenway is a 7.6 mile trail that is proximal to 830 acres of public land within northern Dakota County (**Figure 1**). The Greenway connects regions designated as Metro Conservation Corridors (MeCC, a regional land protection plan of the DNR), highlighting the importance these greenspaces play in facilitating movement and providing contiguous habitat for pollinators and other wildlife (**Figures 2** and **3**). These lands comprise a corridor that connects with the Big Rivers Regional Trail along the Minnesota River in Lilydale on the west end and the Mississippi River Greenway in South Saint Paul on the east side. The Mendota to Lebanon Greenway connects with the River to River Greenway corridor near where Dodd Road crosses Highway 62 in Mendota Heights, whereupon it forms a north-south directed greenway adjoining the Dodge Nature Preserve and will eventually create a contiguous trail to Lebanon Hills Regional Park in Eagan.

The parks and greenspaces connected by the River to River Greenway vary in size from 5 acre stormwater ponds and 30 acre city parks to 190 acre preserves. Taken together, they form semi-contiguous linear corridors of natural land that range from 60 feet to over 4,000 feet in width. Some of these city park lands accommodate recreational uses such as picnic areas, disc golf, athletic fields and winter sledding hills. Dodge Nature Center is the largest landowner of natural spaces along the corridor, encompassing over 350 acres. These lands are managed to serve outdoor educational programs, including a working farm, and preserve natural landscapes from development.

In addition to city parks and public spaces, both Henry Sibley High School and Garlough Elementary Magnet School lie within the River to River Greenway corridor and are managed by Independent School District 197.

Both schools currently have native plantings on their property, and discussions with School District staff indicate there are opportunities to expand such plantings on their properties along the Greenway.

There are linear tracts of the River to River Greenway that pass through contiguous habitat up to a mile long, however, much of these greenspaces are dissected by roads and highways. In particular, US Highway 52 and Robert Street (State Highway 3) have the heaviest traffic, thus creating barriers to the movement of wildlife. Other prominent road crossings include Marie Ave, Wentworth Ave, Delaware Ave, Dodd Rd (State Highway 149), and Oakdale Ave. These roads fragment areas that have native plant cover or have the potential to be restored, and this fragmentation affects the movement of wildlife and impacts hydrological conditions in these natural areas.

FIGURE 1: Location of Greenway and Biodiversity Corridors

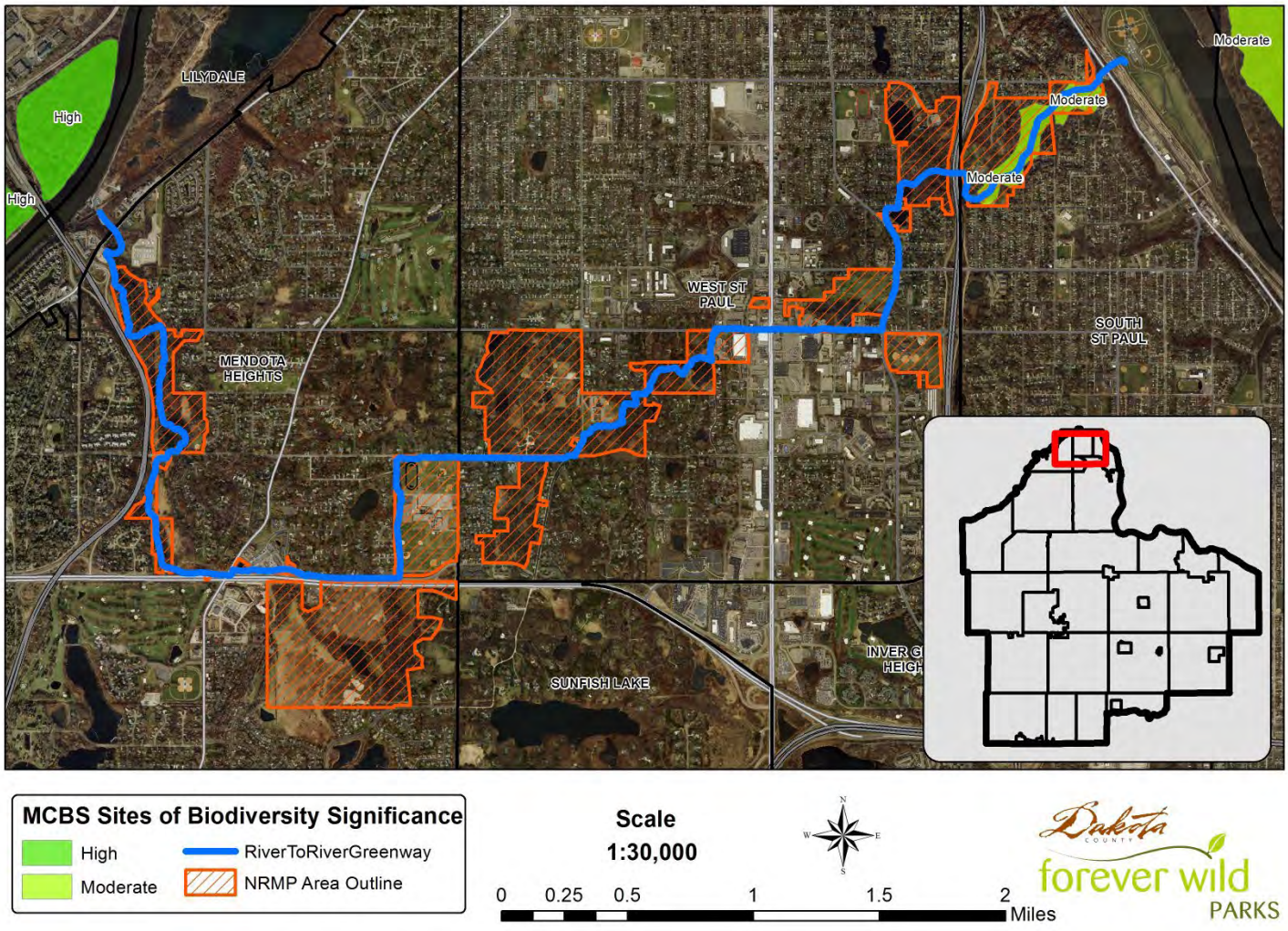


FIGURE 2: Sub-Regional Landscape Context

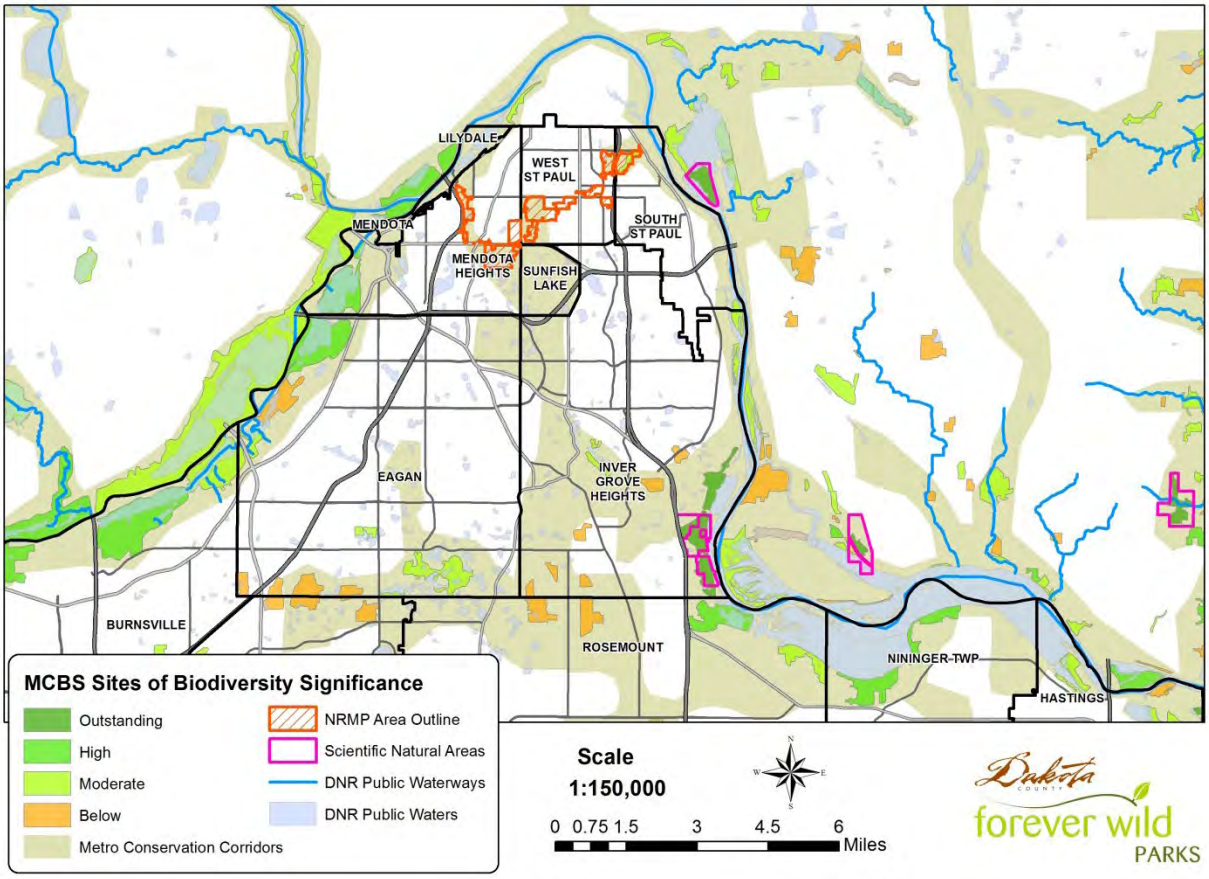
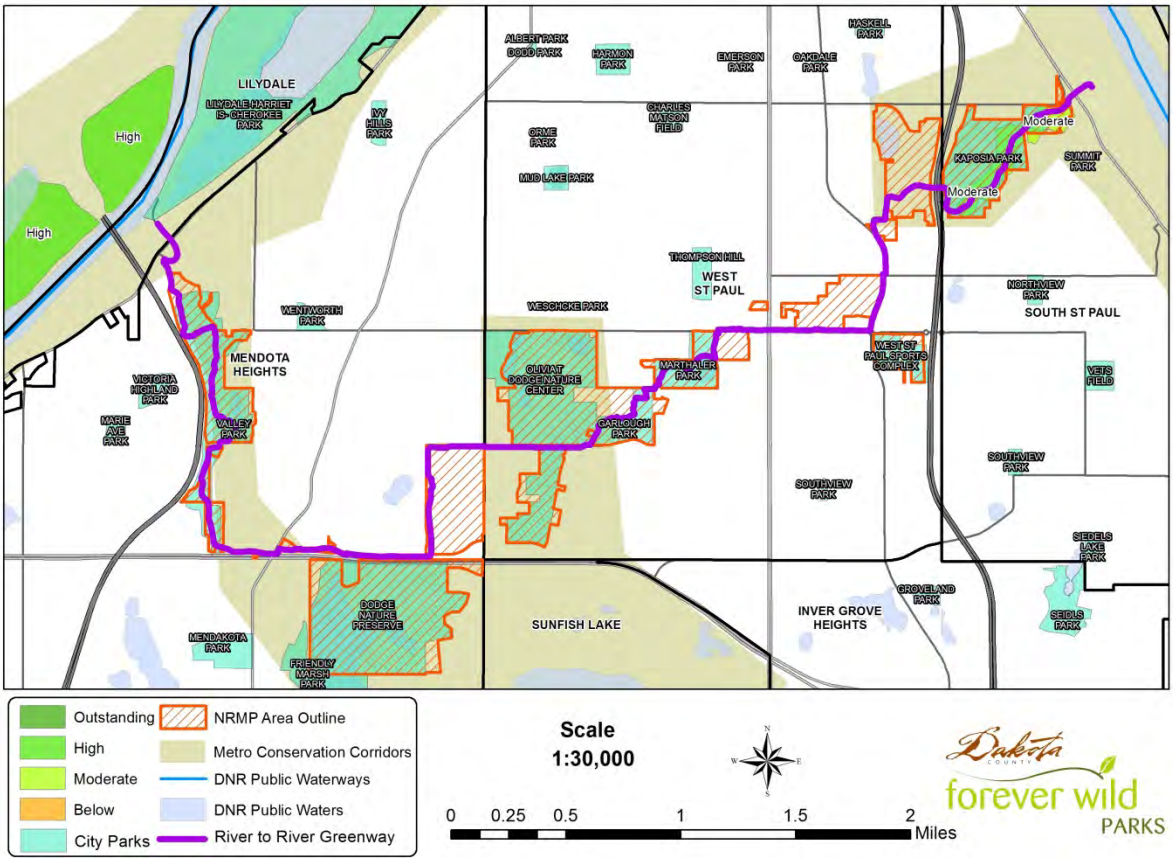


FIGURE 3: Local Landscape Context



ii. Historic and Existing Land Use

European settlement significantly changed the County landscape. Native prairies were plowed, forests and woodlands cut, wetlands drained, fires suppressed, and intense agricultural practices introduced, including row cropping and livestock grazing.

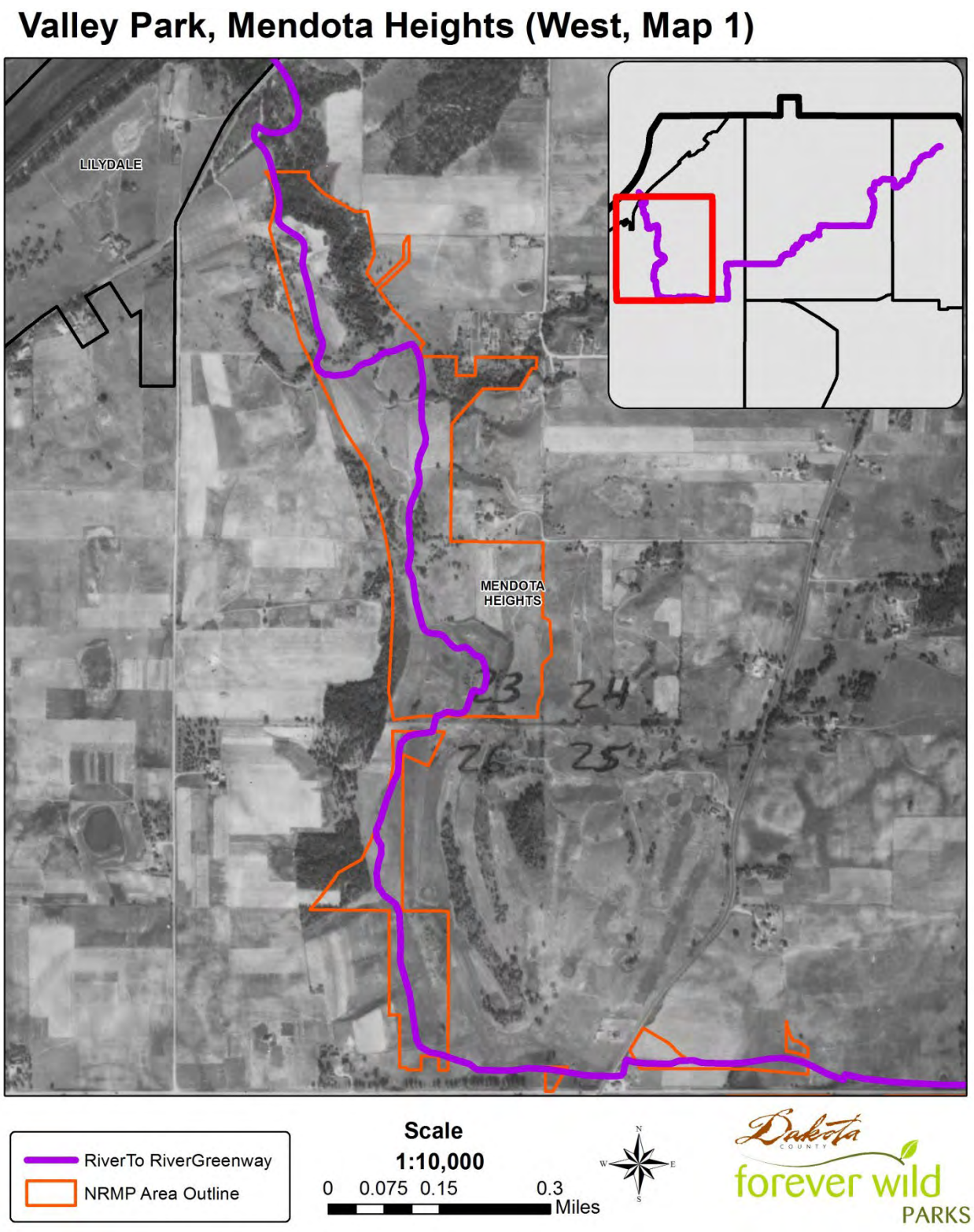
Some of the best evidence of past land use is depicted in historic aerial photographs. **Figures 4** and **5A-D** are historic aerial photos for natural segments of the River to River Greenway and surrounding area from 1937 to 2017. The photos show extensive urbanization and development of farm fields into predominantly single family homes and commercial spaces. In areas where development did not occur, the cessation of farming resulted in extensive afforestation such that they consist largely of secondary growth forest predominated by fast-growing tree species such as boxelder and cottonwood. Protected pockets of forest or savanna are depicted in the earliest (1937) aerial photographs, and some of these forested areas persisted to the present day

The following comments address these issues in more detail:

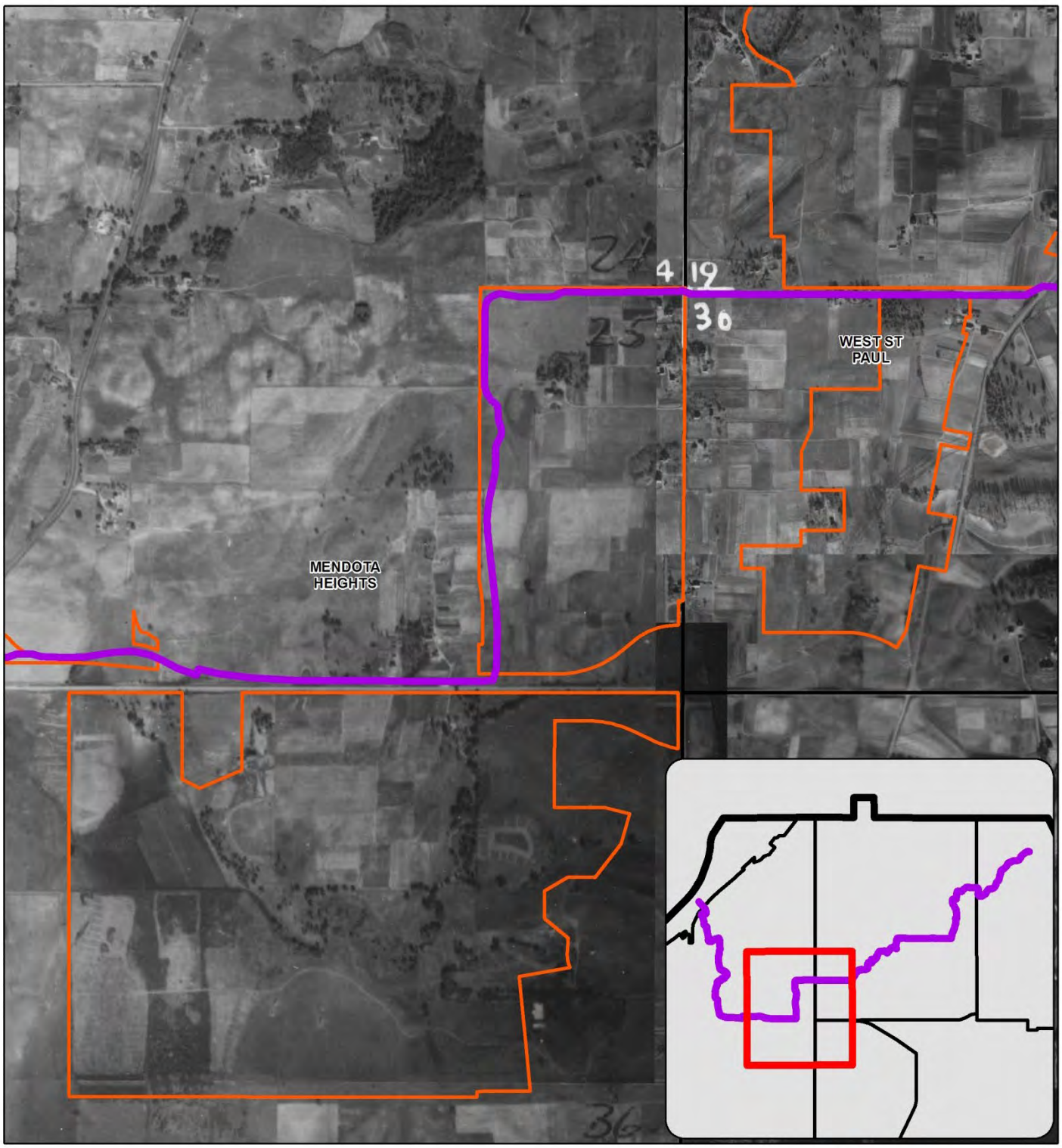
1. Forested areas within ravines leading to the Mississippi River in Lillydale/Mendota Heights and Simon's Ravine in South Saint Paul up to Kaposia Park and the southern portion of Thompson County Park were largely left intact due to the inability to farm steep slopes.

2. Low-lying wetlands along Valley Creek in what is currently Valley Park showed some evidence of cultivation or haying in the 1937 photos, but the lack of ditching and subsequent cultivation allowed for wetland communities to persist until extensive afforestation occurred beginning in the 1980s.
3. A copse of white and bur oak trees near the present location of Wentworth Library was evident in 1937, and many of these trees are still standing.
4. Oak savanna was also present within the undulating hills of Garlough and Marthaler Parks in West Saint Paul in 1937, and over time these areas became more densely forested.
5. While neighborhood developments existed to the north of Kaposia Park and Thompson County Park by 1937, large-scale developments of single-family homes were constructed to the south of these parks between 1962 and 1964.
6. Shallow wetland basins within the Main Dodge Nature Center property began to exhibit surface water year-round in the 1970s, concomitant with an increase in impervious surfaces associated with development of the surrounding area.
7. Areas of what is now the Lilly Property of Dodge Nature Preserve had trees, especially along streams and some surrounding hillslopes. These areas have since become much more densely forested.
8. The large wetland complex on the west side of Dodge Nature Preserve showed evidence of being ditched and farmed in 1937, but farming activity ceased in subsequent aerial photos, allowing wetland vegetation to reestablish. Historic ditches still remain and potentially contribute to an altered hydrologic state.

FIGURE 4: Earliest Historical Aerial Photographs



Dodge, Mendota Heights / West St. Paul (Map 2)

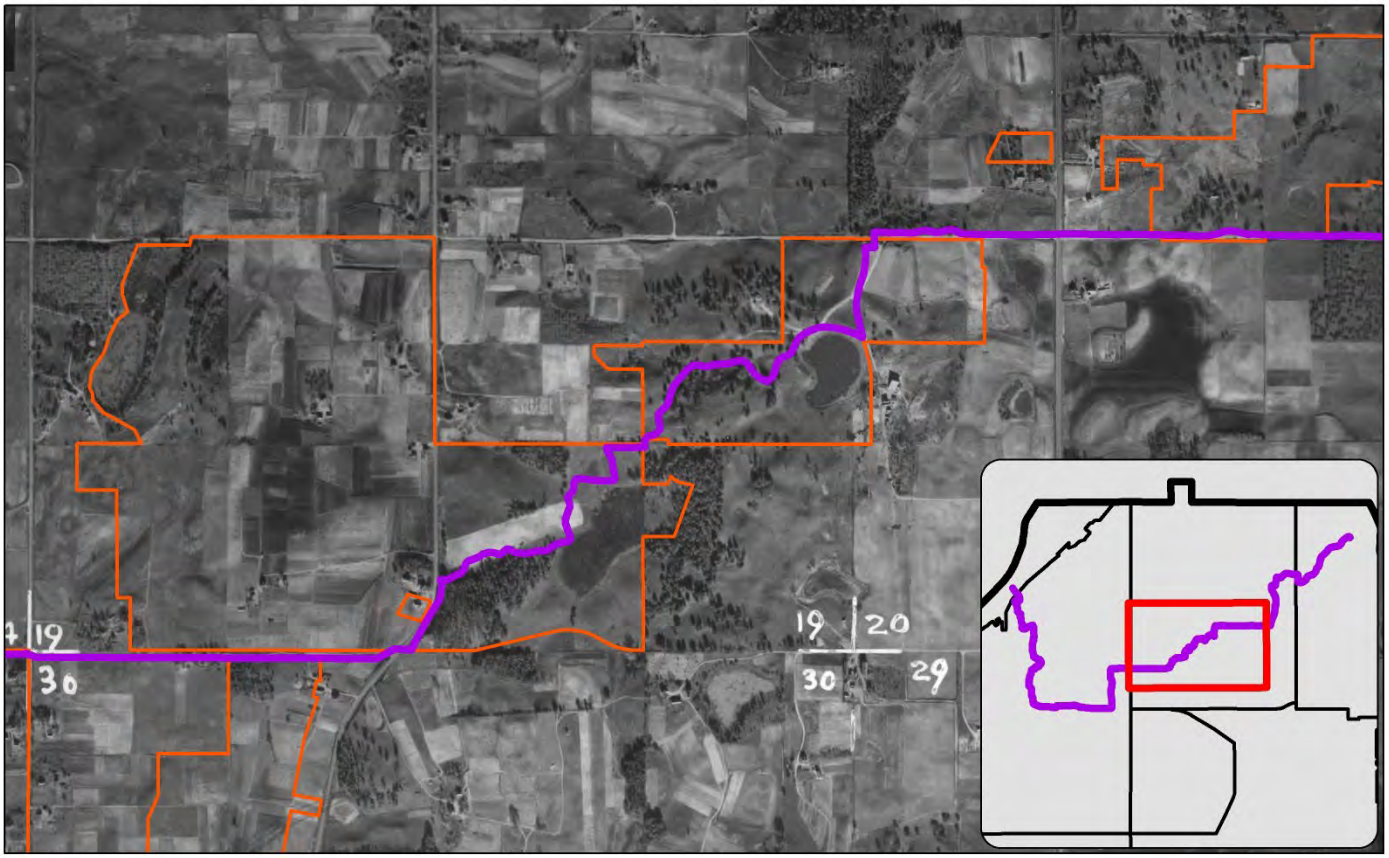


RiverTo RiverGreenway
NRMP Area Outline

Scale
1:10,000
0 0.075 0.15 0.3
Miles

Dakota County
forever wild
PARKS

Dodge, Garlough & Marthaler Parks, West Saint Paul (Map 3)



RiverTo River Greenway
NRMP Area Outline

Scale
1:10,000
0 625 1,250 2,500 Feet

Dakota County forever wild PARKS

Thompson County Park, Kaposia Park, West and South Saint Paul (Map 4)

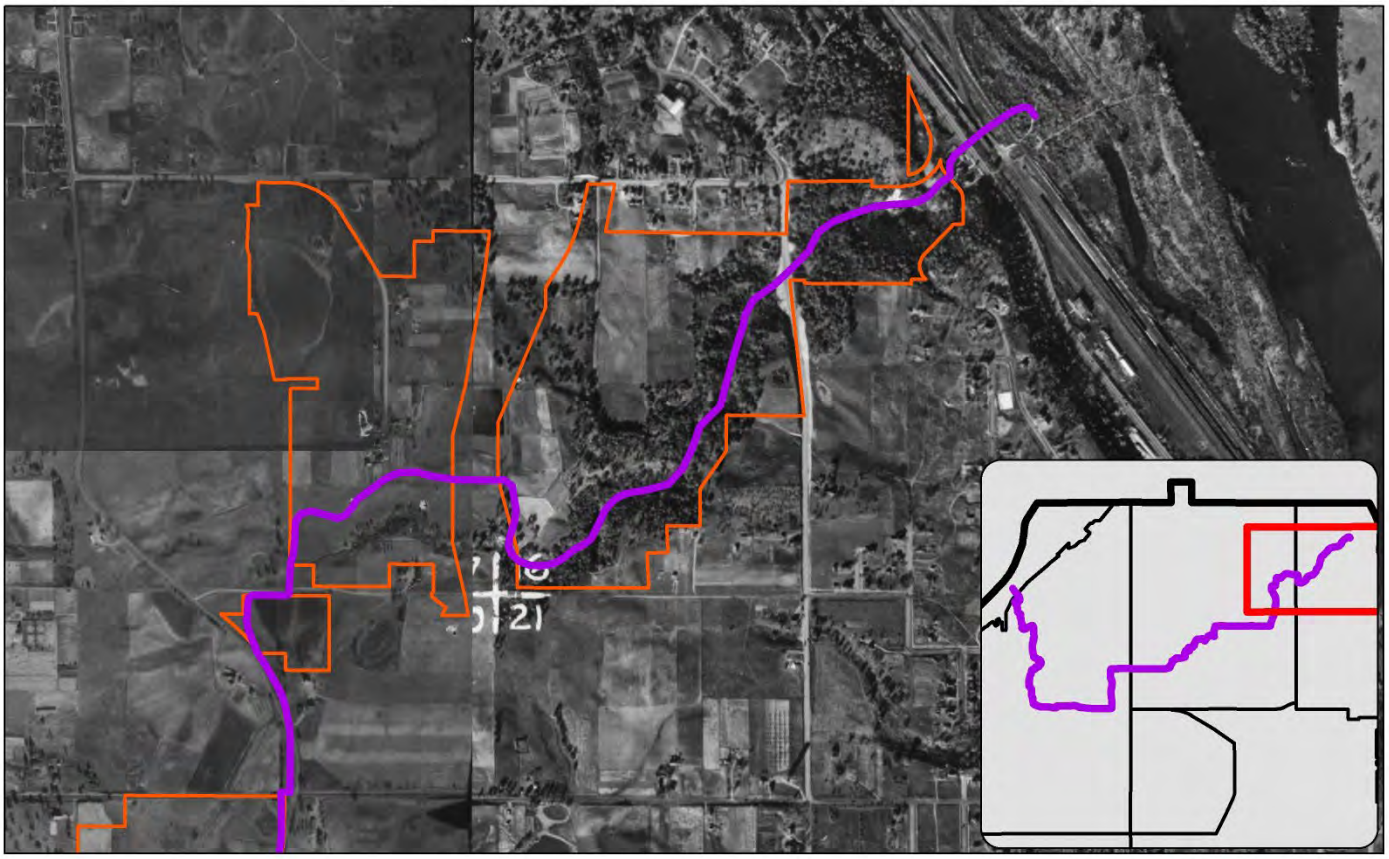


FIGURE 5A: Historic Aerial Composite, Valley Park

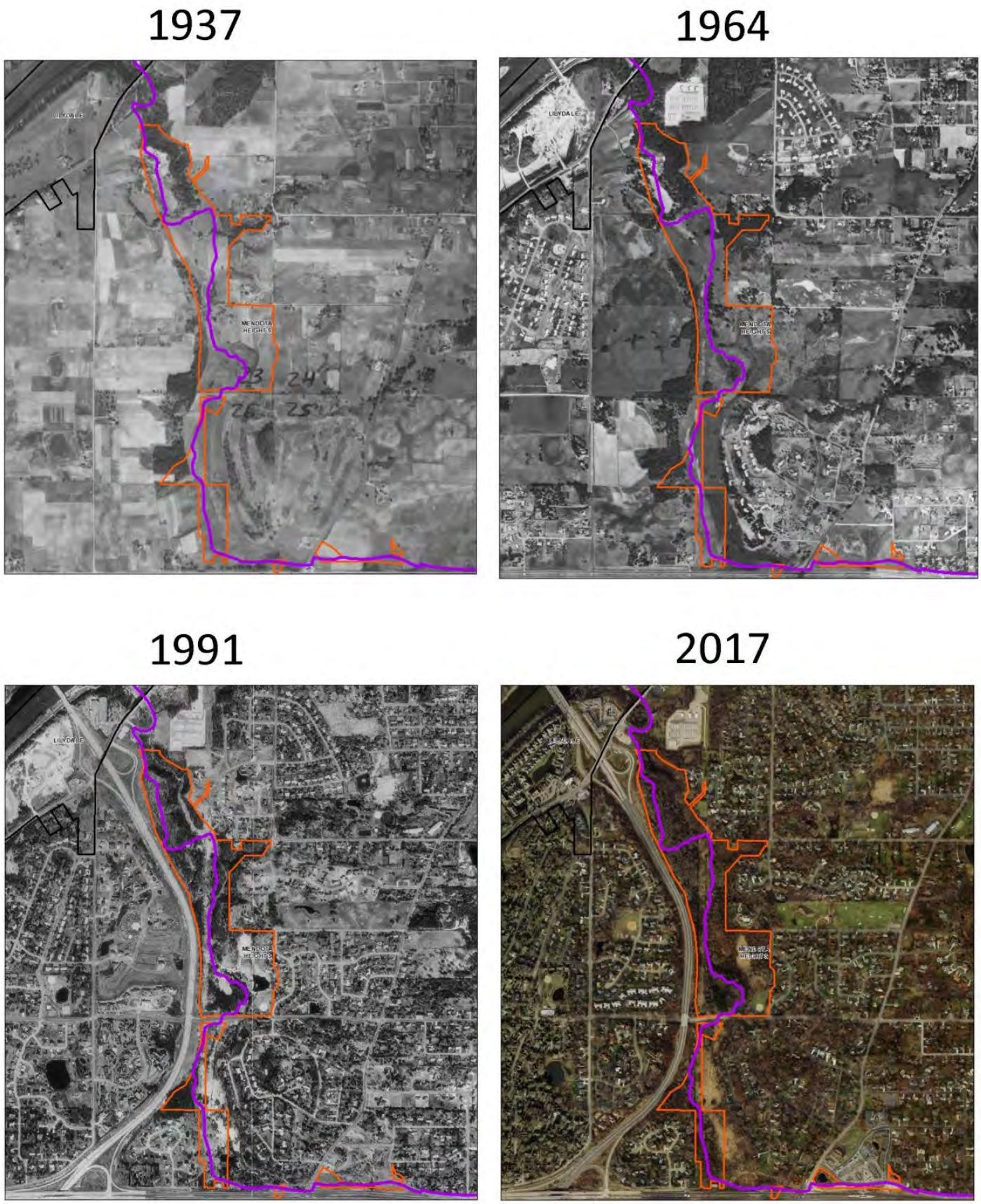


FIGURE 5B: Historic Aerial Composite, Dodge Nature Center, Lilly and Marie Properties

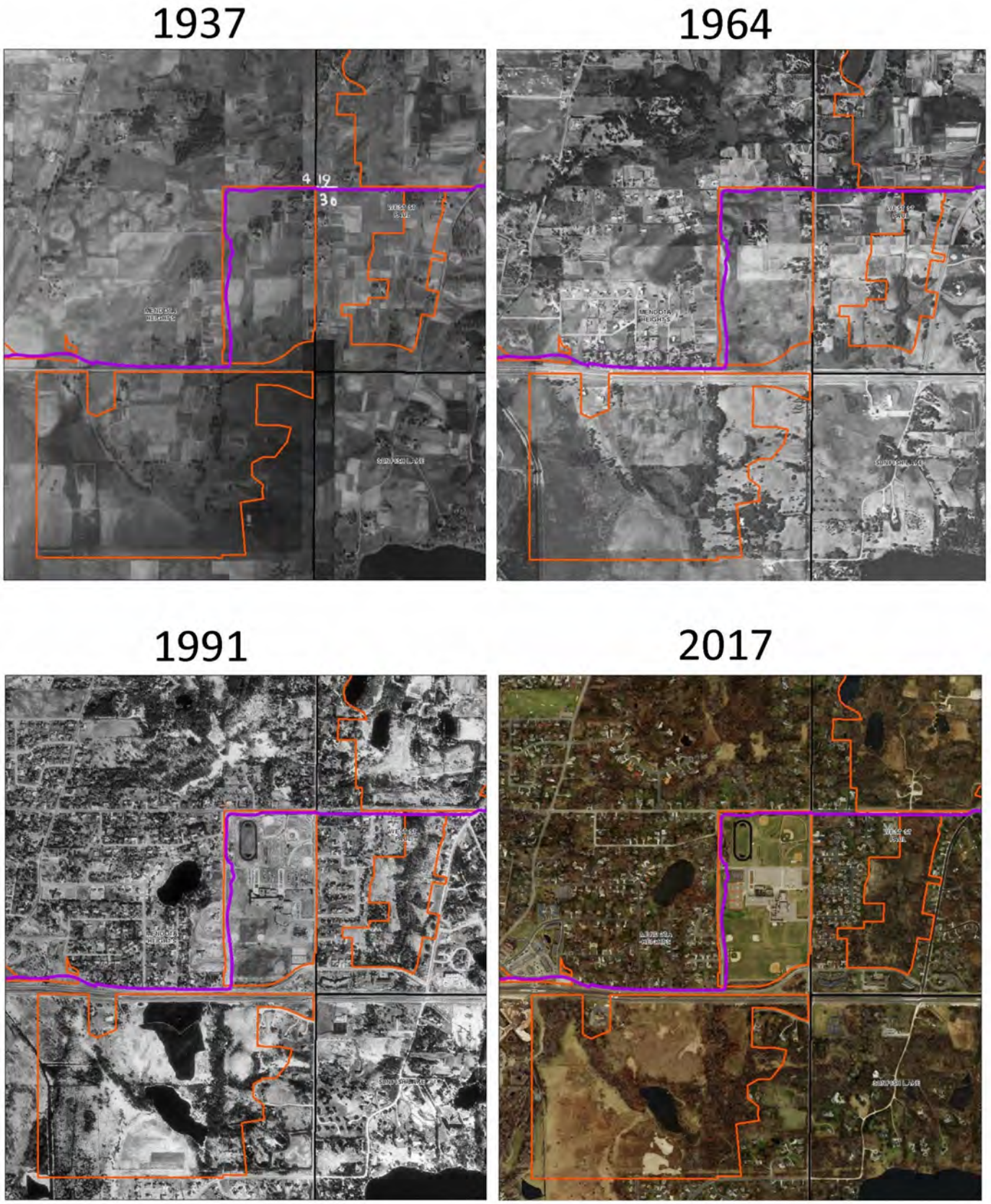


FIGURE 5C: Historic Aerial Composite, Dodge Nature Center Main Property, West Saint Paul

1937

1964

1991

2017

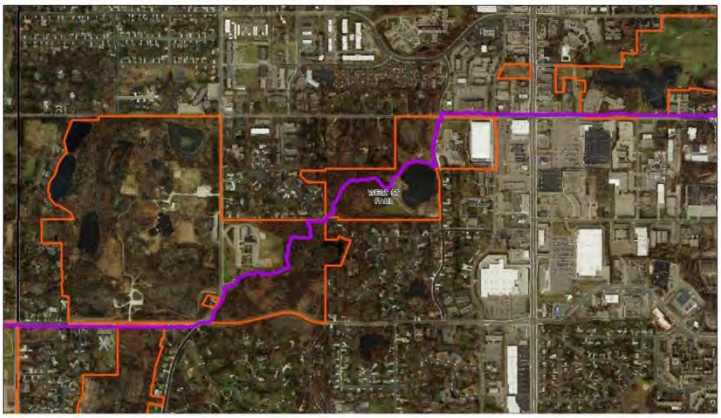


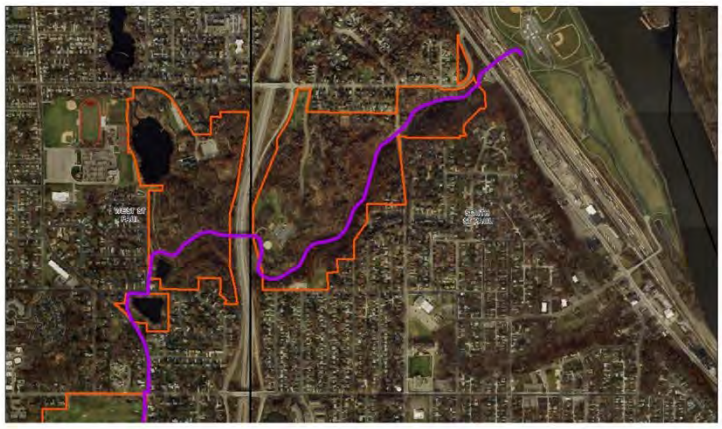
FIGURE 5D: Historic Aerial Composite, Thompson County Park and Kaposia

1937

1964

1991

2017



iii. Adjacent Land Use

The adjacency of parkland, cultivated land, open areas, and residential sub-divisions can affect vegetation and wildlife management options, and may present opportunities to enlarge existing habitat areas, create corridors for wildlife movement, and determine the characteristics of local surface water hydrology.

Lands surrounding the Mississippi River and on the northern regions of the River to River Greenway Corridor were developed earlier than regions more distant from the River and regions further south. Subsequently, many of the impacts on natural features that come with development, i.e., fragmented habitat, altered hydrology, etc., affected different regions of this trail Corridor at different times. Today, the relatively high percentage of impervious surfaces surrounding this corridor significantly increases stormwater runoff and changes hydrological conditions of wetlands, streams and ponds within the Corridor (**Figure 14**).

Natural areas along this urbanized Greenway Corridor are subject to higher densities of invasive species due to their urban context. Many introduced species that are invading natural areas were once utilized in the nursery trade. Thus, surrounding residential areas could be the source of European buckthorn (*Rhamnus cathartica*), asiatic honeysuckle (*Lonicera* spp.), Amur maple (*Acer ginnala*) winged burning bush (*Euonymus alatus*), and other species that are impacting the ecological integrity of the Greenway Corridor.

FIGURE 6A: CURRENT AERIAL PHOTO – Valley Park

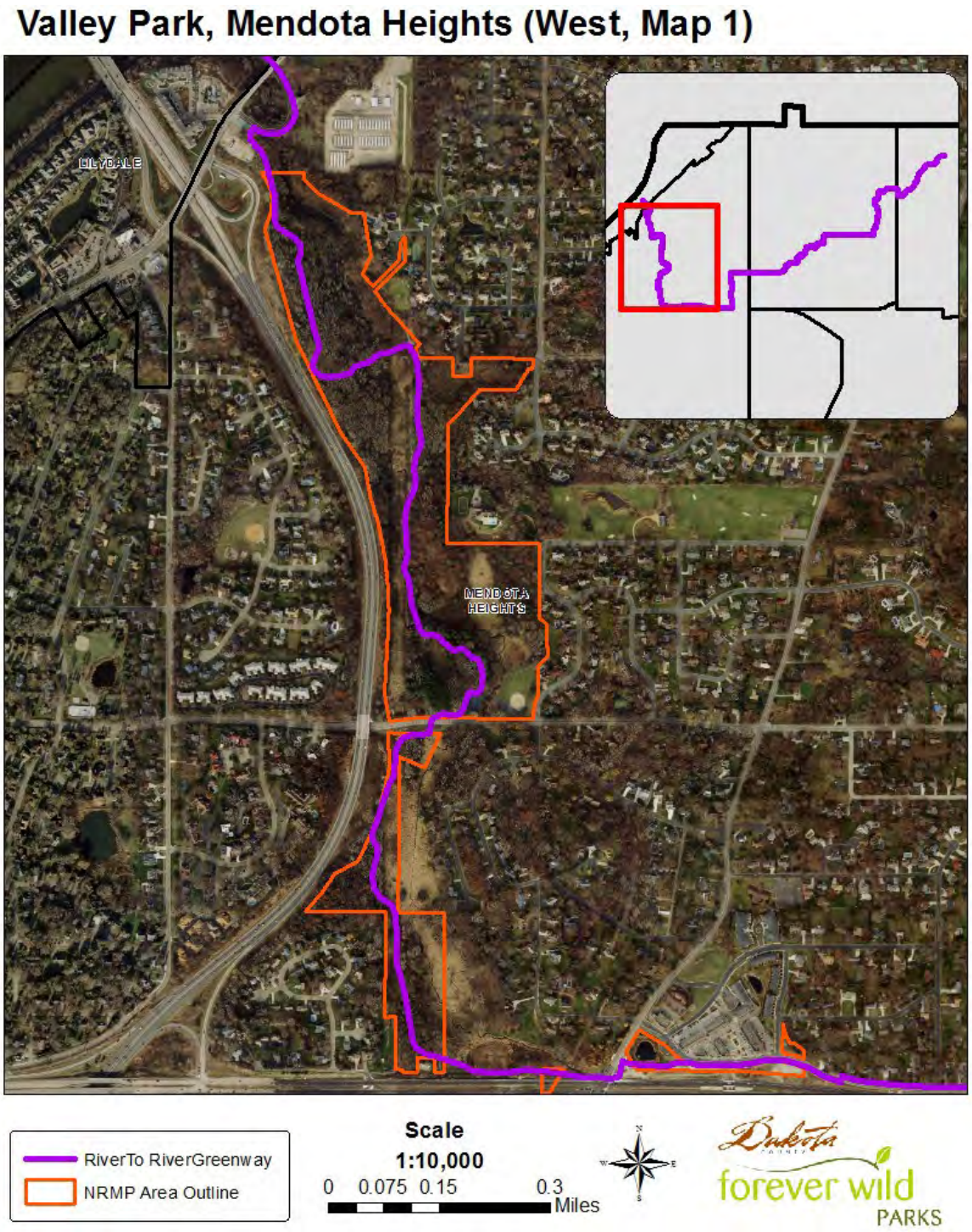


FIGURE 6B: CURRENT AERIAL PHOTO – Dodge Nature Center, Lilly and Marie Properties

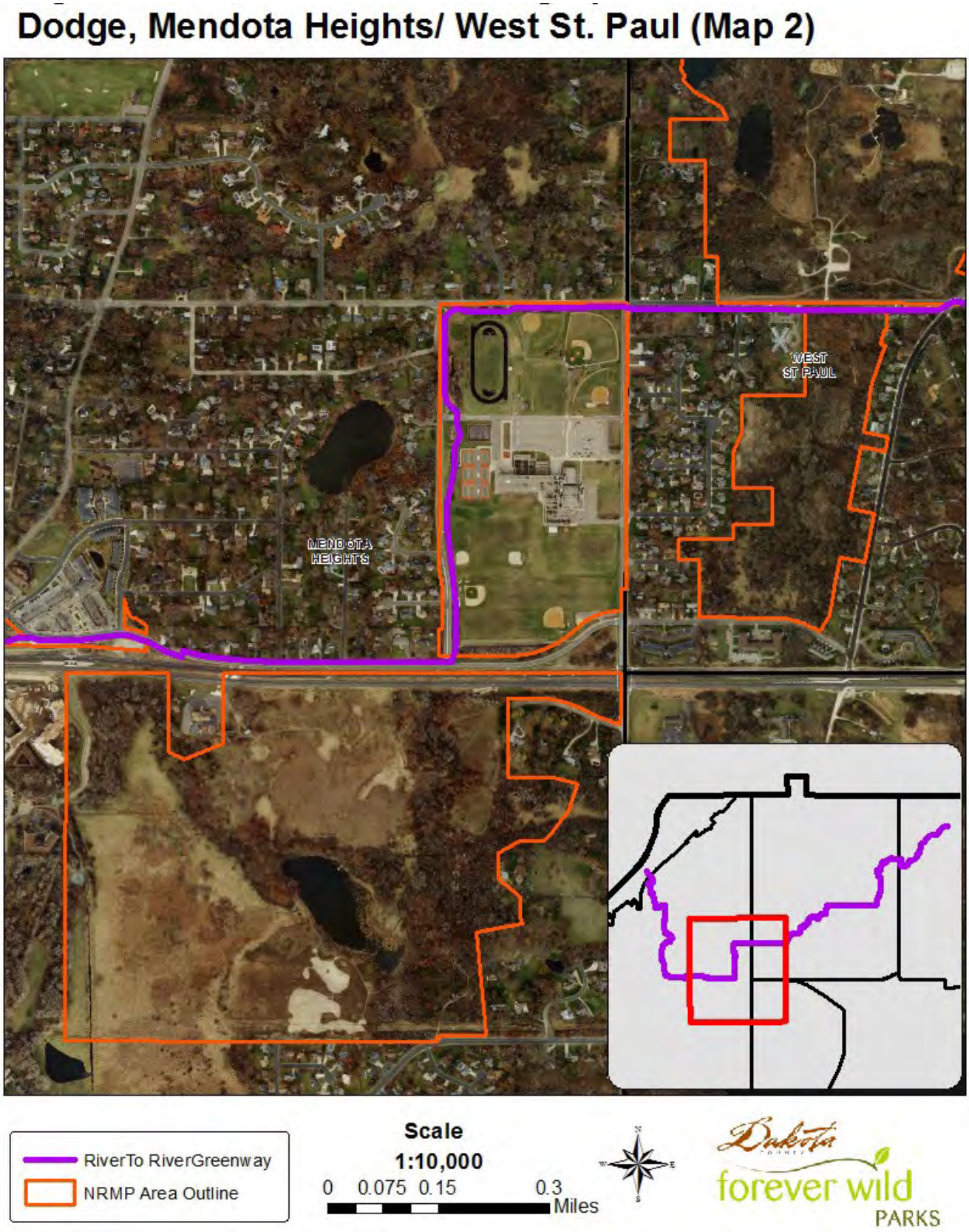


FIGURE 6C: CURRENT AERIAL PHOTO – Dodge Nature Center, Main Property and West Saint Paul Parks

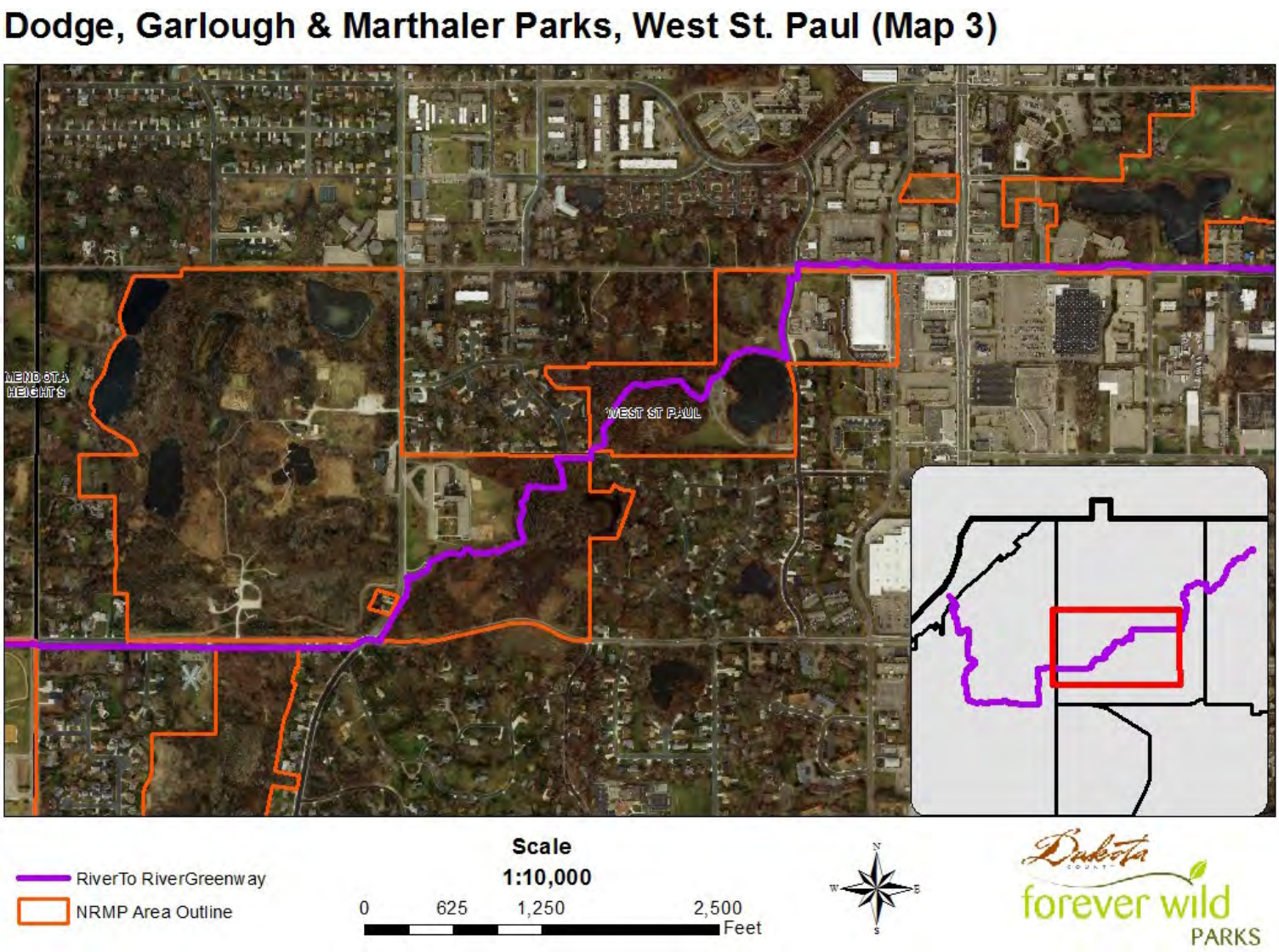
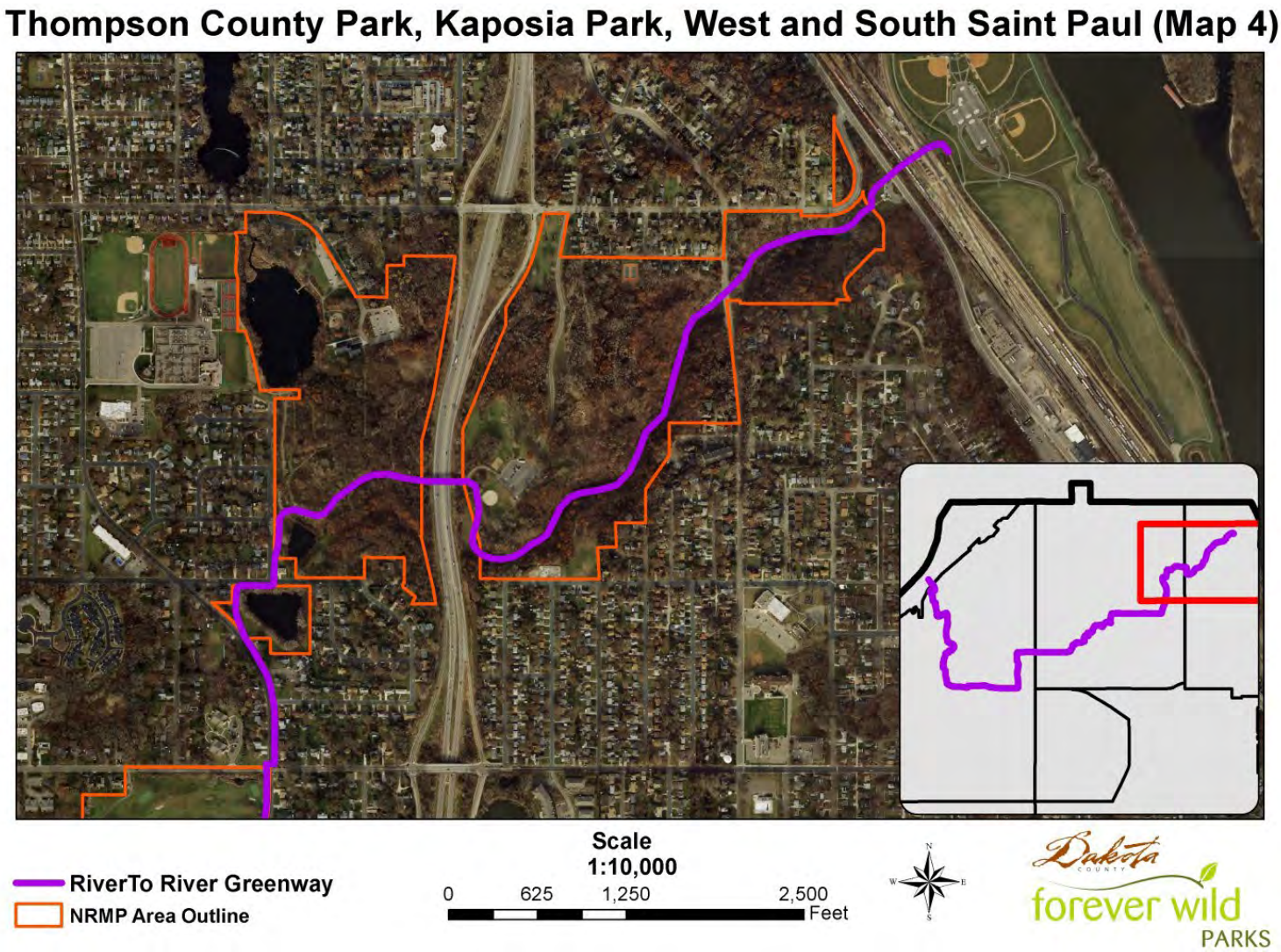


FIGURE 6D: CURRENT AERIAL PHOTO – Thompson County Park and Kaposia



iv. Rare Features

The Minnesota DNR has three statuses for rare species, classified as: endangered, threatened, and special concern. Endangered refers to species threatened with extinction throughout all or a significant portion of its range within Minnesota; threatened refers to species likely to become endangered within the foreseeable future throughout all or a significant portion of its range within Minnesota; and special concern refers to species not endangered or threatened, but that are extremely uncommon in Minnesota, or have unique or highly specific habitat requirements and deserve careful status monitoring. Species on the periphery of their range that are not listed as threatened may be included in this category, along with species that were once threatened or endangered, but now have increasing or protected, stable populations.

A search was conducted on a DNR database within one mile of the boundaries of the River to River Greenway Corridor study area that revealed rare features. The following features were observed within the study area boundaries:

Table 1: Rare Features

Taxon	Scientific Name	Common Name	State Status	Federal Status	Last Observed
Amphibian	*Necturus maculosus*	Mudpuppy	SPC		2016
Fish	*Cycleptus elongatus*	Blue Sucker	SPC		2012
Fish	*Ictiobus niger*	Black Buffalo	THR		2010
Fish	*Notropis anogenus*	Pugnose Shiner	THR		1890
Fish	*Polyodon spathula*	Paddlefish	THR		2012
Insect	*Bombus affinis*	Rusty-patched Bumble Bee		END	2018
Mussel	*Actinonaias ligamentina*	Mucket	THR		1905
Mussel	*Arcidens confragosus*	Rock Pocketbook	END		2005
Mussel	*Cyclonaias tuberculata*	Purple Wartyback	END		2001
Mussel	*Ellipsaria lineolata*	Butterfly	THR		2005
Mussel	*Elliptio crassidens*	Elephant-ear	END		2007
Mussel	*Eurynia dilatata*	Spike	THR		2000
Mussel	*Leptodea leptodon*	Scaleshell	extirpated		1820
Mussel	*Ligumia recta*	Black Sandshell	SPC		2007
Mussel	*Obovaria olivaria*	Hickorynut	delisted 2013		2004
Mussel	*Plethobasus cyphyus*	Sheepnose	END	END	2001
Mussel	*Pleurobema sintoxia*	Round Pigtoe	SPC		2001
Mussel	*Quadrula fragosa*	Winged Mapleleaf	END	END	2001
Mussel	*Quadrula nodulata*	Wartyback	THR		2011
Mussel	*Reginaia ebenus*	Ebonyshell	END		2001
Mussel	*Theliderma metanevra*	Monkeyface	THR		2001
Mussel	*Tritogonia verrucosa*	Pistolgrip	END		2003
Mussel	*Truncilla donaciformis*	Fawnsfoot	THR		2010
Plant	*Juglans cinera*	Butternut	END		1884
Reptile	*Emydoidea blandingii*	Blanding's Turtle	THR		2000
Reptile	*Pantherophis ramspotti*	Western Foxsnake			1993
Reptile	*Lampropeltis triangulum*	Milk Snake			2015

- Oak-Basswood Forest, Southeast Mesic Subtype (MHs38c) in Kaposia Park (Morley, 1995)
- Three occurrences of Rusty-patched bumblebee (*Bombus affinis*) in 2017-2018
- Two occurrences of Blanding's turtles (*Emydoidea blandingii*) in 1987 & 1992

Many other records of rare features were found to occur within one mile of the trail (Table 1). The fish and mussel species listed were found in the Mississippi River, and some of these records are early historical anecdotes.

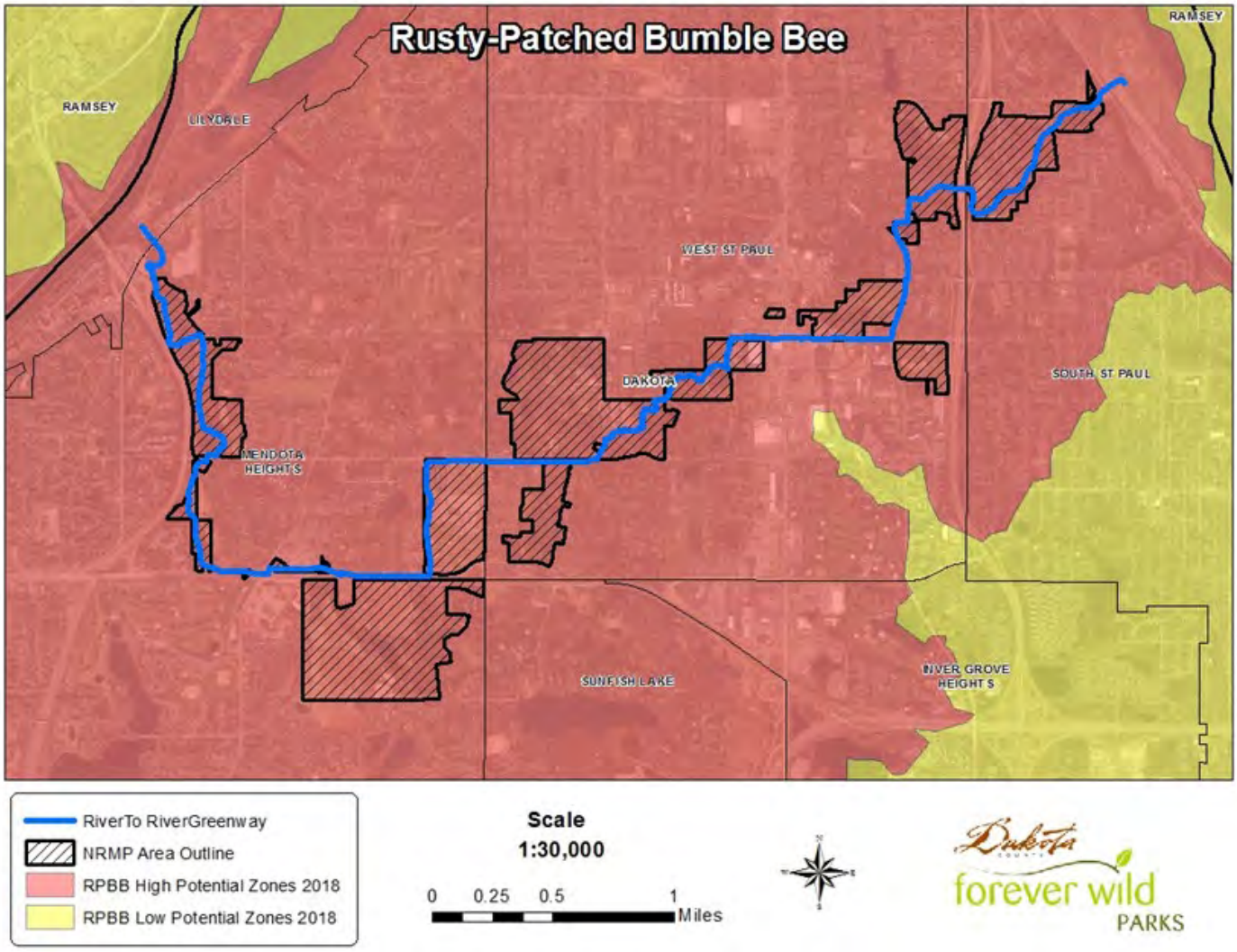
<u>Oak-Basswood Forest, Southeast Mesic Subtype (MHs38c)</u>

The Southern Mesic Oak-Basswood Forest plant community MHs38c is defined by the DNR's Native Plant Communities of Minnesota (MN DNR 2005) as being a mesic hardwood forest that has interrupted canopy cover to continuous cover (50-100%) of basswood, northern red oak and sugar maple, with bur oak, green ash, and white oak as subdominant species. This particular subtype 'c' is deemed a 'Red Oak – Sugar Maple – Basswood – (Bitternut Hickory) Forest' and has northern red oak and sugar maple as the most dominant canopy members, while ironwood and sugar maple are most abundant in the subcanopy and shrub layers of the forest. This forest type is found on steep, north facing slopes on thin silt over bedrock, and the most prominent example within the study area has persisted in Simon's Ravine. Disturbance due to catastrophic fire was rare in these forests, with light surface fires occurring approximately every 35 years, and catastrophic windthrow would happen on intervals of ~360 years. This community subtype faces structural changes due to invasion of the shrub layer by exotic species such as buckthorn and asiatic honeysuckles, forest floor invasion by garlic mustard, soil alteration due to the presence of exotic earthworms, and forest compositional changes in the face of present and emerging forest pests and diseases such as emerald ash borer, oak wilt, bur oak blight, oak decline, and Dutch elm disease.

Rusty Patched Bumblebee

The Rusty Patched Bumblebee (*Bombus affinis*) was the first bee in the continental United States to be listed on the Federal Endangered Species List after long-term declines were observed within its range in the Midwest and Eastern U.S. Its decline is attributed to widespread loss of habitat due to conversion of native prairie and open grasslands with nectar sources into commercial agriculture, and increased use of pesticides are also thought to contribute to its disappearance. This species of bumble bee is dependent upon reliable nectar resources throughout much of the growing season (April-September), and adequate nesting sites such as abandoned rodent cavities or bunch grasses. The bee has been observed within Thompson County Park as recently as 2020, and the Greenway Corridor lies entirely within the High-Potential Zone as demarcated by the US Fish and Wildlife Service (**Figure 7**).

FIGURE 7: Rusty Patched Bumblebee Zones of Occurrence



Blanding's Turtle

Blanding's turtle (*Emydoidea blandingii*) sightings occurred over 25 years ago and have occurred within Dodge Nature Center and a West Saint Paul wetland. It is possible that these turtles occupy wetlands throughout the Greenway Corridor, especially those that are in closer proximity to undeveloped upland areas for nesting

Blanding's turtles face many threats to their populations, including habitat loss and fragmentation, predation, and road mortality. Blanding's turtles are long lived and don't reach sexual maturity until after 12 years. These turtles breed during spring and early summer in wetlands where there are abundant food sources of invertebrates and small amphibians (Oldfield and Moriarty 1994). Females choose nesting sites in sandy upland areas with sparse vegetation up to a mile away from their resident marshes (Piepgras and Lang 2000). Turtle nests are generally raided by predators to a high degree, and Blanding's turtles have been documented to experience nest predation rates as high as 93% (Congdon et al., 1983). For those nests that survive, the hatchlings that emerge in August and September must face hazards such as predation and road mortality as

they seek shelter in wetland habitats. Their low reproduction and high predation rates limit the degree to which their populations can rebound from disturbance. Priorities for assisting Blanding's turtle recovery include restorations of wetland habitats adjacent to suitable nesting sites, turtle nest protection, and transportation planning that allows for safe turtle crossings separated from vehicle traffic.

B. Physical Conditions

The natural resources within the Greenway Corridor are affected by a number of physical conditions that influence their origin, current status and future condition. These features include bedrock and surficial geology, soils, topography, and local and regional hydrology.

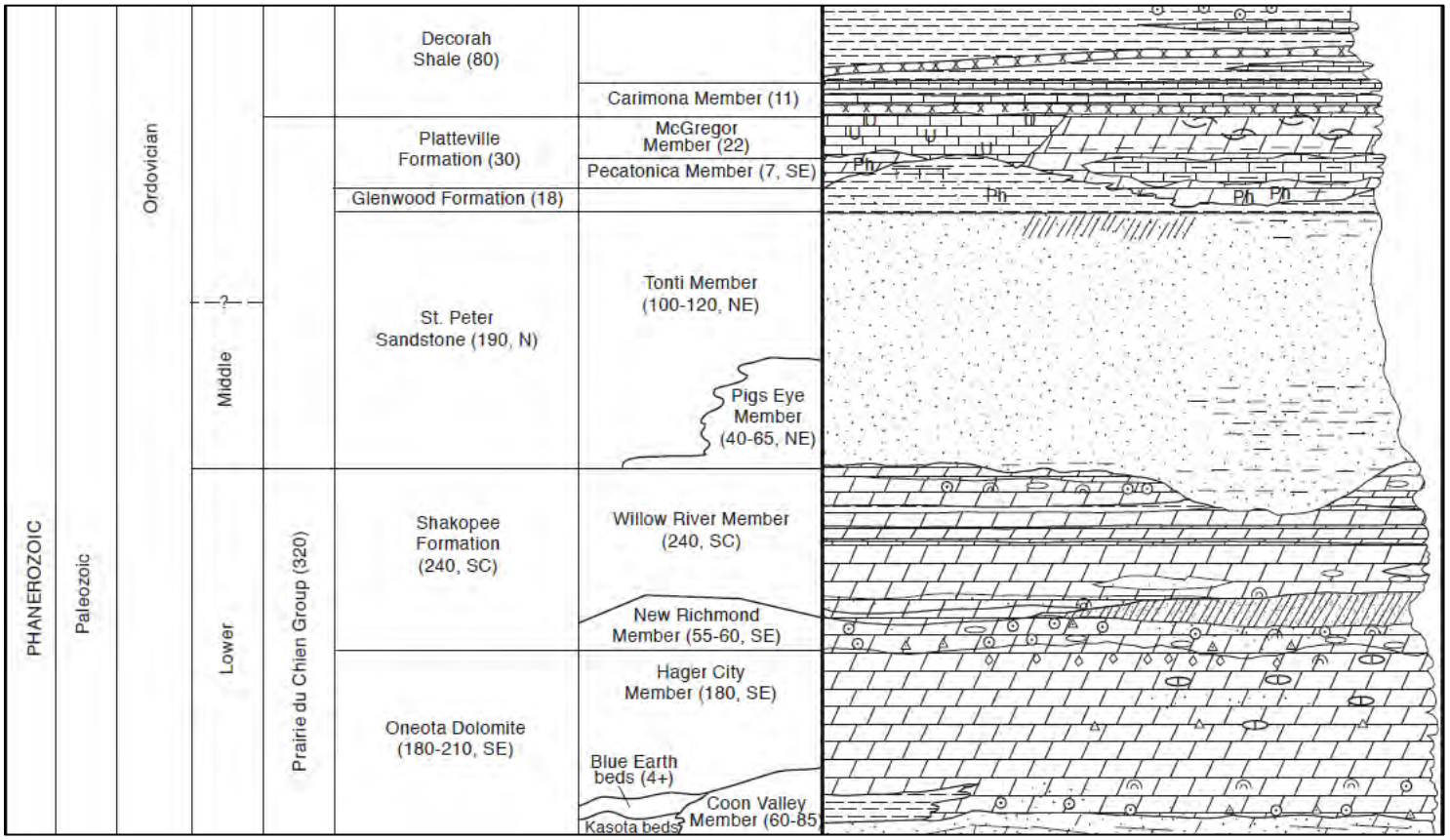
i. Geology

Bedrock formed as a result of ancient oceans, beaches, reefs or mudflats that once existed. Sand and clay and marine animals became compressed and formed a variety of sedimentary rock layers, with different depths and characteristics. The position and substrate types of underlying rock layers are important because these layers support underground aquifers where groundwater is stored. As the primary source of drinking water for County residents, it is critical that the quantity and quality of this water is managed and protected.

The major bedrock units found in the River to River Greenway Corridor include the Decorah, Platteville, Glenwood Sequence, underlain by St. Peter Sandstone and limestone and dolomite in the Prairie du Chien Group. These layers were formed from deposits within shallow ancient seas during the Ordovician period 480 to 440 MYA.

The Decorah Shale is the most recently formed (Upper Ordovician) and highest formation of bedrock within the River to River Greenway corridor (**Figure 8**), and it is up to 90 feet thick where uneroded. The Platteville and Glenwood Formations (Upper Ordovician) underlie much of the Study Area of the River to River Greenway (**Figure 9**). These layers together can be up to 34 feet thick in the Twin Cities Basin area and consist of limestone (Plateville) and shale (Glenwood). The Saint Peter Sandstone formation was deposited during the Middle to Upper Ordovician and consists primarily of fine to medium-sized quartz sand and has the capacity to act as an aquifer when submerged below the water table. The Saint Peter Sandstone forms the bedrock of the lower-elevation regions of the Corridor, including the lower portions of the Valley Park and Simon's Ravines. The Decorah, Platteville, Glenwood, and upper part of the Saint Peter formations are exposed in outcrops along the Mississippi and Minnesota Rivers in this region. The dolomite and limestone formations of the older Prairie du Chien Group formed during the Lower Ordovician Period make up the bedrock southwest of the study corridor. The fine- to very fine-grained Shakopee Dolomite that makes up the majority of the Prairie du Chien Group forms an aquifer due to its capacity for groundwater storage.

FIGURE 8: Bedrock Geological Strata - Excerpted from Mossler 2008.



Dakota County has very diverse surficial geology that created a scenic and ecologically diverse landscape. The most recent glaciers extended south into the northern portion of the County and the resulting terminal moraines are characterized by a typical “knoll and basin” topography. South of these moraines, the rock surface is quite irregular. In some places, the softer rock was worn down and is much lower than the more resistant rock layers. This has created areas with isolated, mesa-like uplands, 100 to 200 feet above the surrounding land. Glacial deposits have partially concealed these uplands and covered their surfaces with only a thin layer of glacial drift. In some areas, especially the Minnesota and Mississippi River valleys, level alluvium and terrace deposits were formed by glacial rivers and contemporary floods. More level outwash plains, south of the moraines and north of the uplands, formed from melting glaciers and characterize much of the central portions of the County.

The surficial geology of a site is important because it is a highly influential factor in determining site characteristics, such as topography, soil type, soil drainage, and floral structure and community composition.

This site has two distinct landscapes: Upland moraines comprised of glacial deposits from the Superior lobe, and dissected ravines resulting from streams cutting through glacial till, outwash, and river terraces deposited by the River Warren that now define the Mississippi and Minnesota River Valleys (**Figure 10**). These landscapes each contain features with topographical relief that, within the last 10,000 years since glacial

retreat, influenced the hydrology, vegetation types, and soil development that will be discussed in the next section.

The upland areas contain glacial terminal moraines, whereupon sand, gravel and unsorted till were deposited in small, undulating hills and ridges. The streams draining these upland areas travelled through a 300-foot elevation drop down to the surrounding river floodplains. This erosional force eventually dissected the material left behind by glaciers to form steep ravines.

FIGURE 9: Bedrock Geology

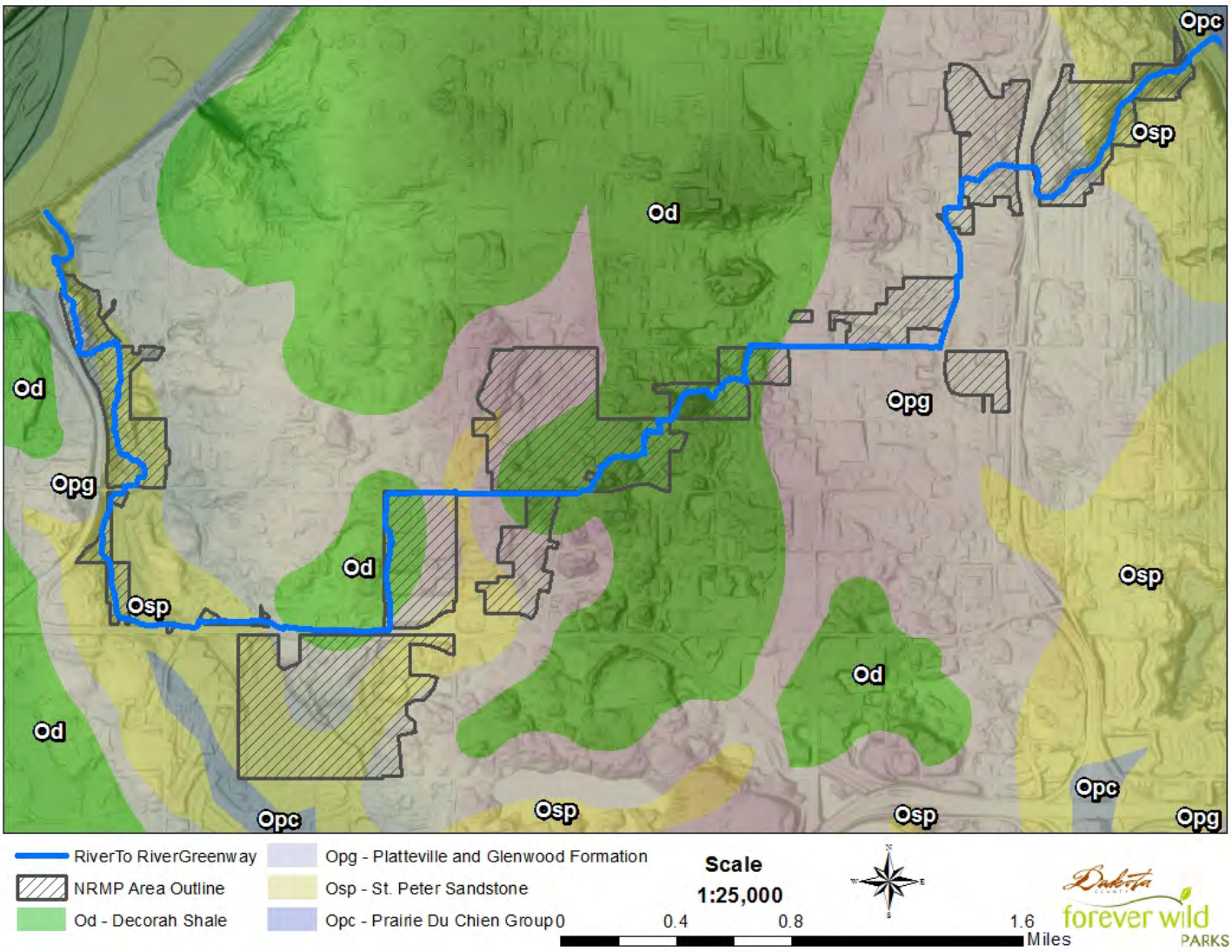
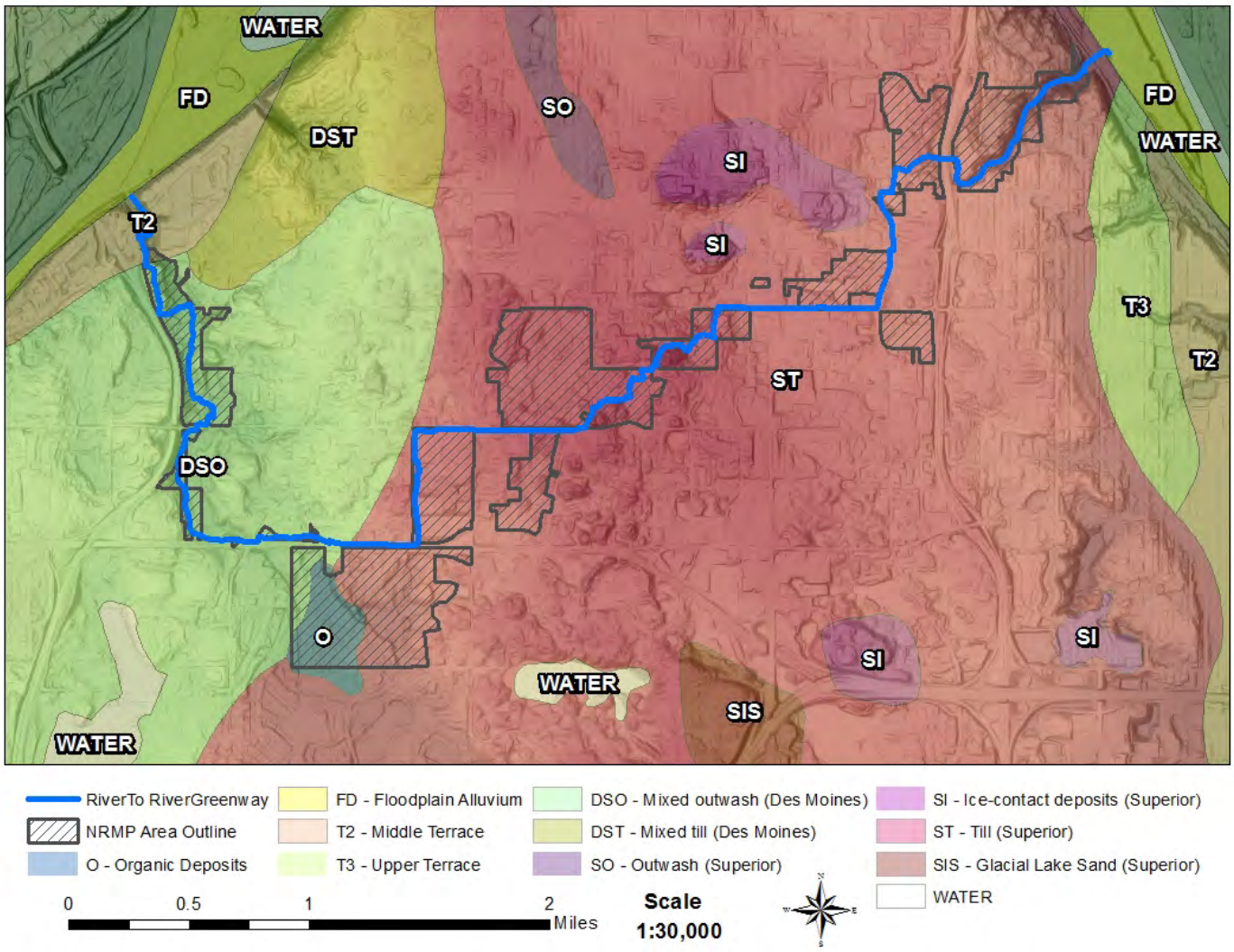


FIGURE 10: Surficial Geology



ii. Soil Descriptions

Extensive work in identifying and classifying soils has been undertaken because of its importance to management and restoration of the Greenway Corridor. The "Soil Survey of Dakota County Minnesota," issued April 1983 and updated in May 1994, provides a generalized depiction and description of soils in the County. 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 plant and animal communities that helped form soils. There are ten general soil units based on formation, relief, and drainage. Soil units/types are important, because they affect the vegetative and hydrologic features of the Greenway Corridor, and they suggest the most appropriate use and management of the land.

Table 2: Soil Type Descriptions

Soil Unit	Description	Percent Slope	Taxon	Drainage	Area (ac)
39C2	Wadena loam	6 to 12	Fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Hapludolls	Well drained	0.1
49B	Antigo silt loam	1 to 8	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, frigid Haplic Glossudalfs	Well drained	7.4
98	Colo silty clay loam	0 to 2	Fine-silty, mixed, superactive, mesic Cumulic Endoaquolls	Poorly drained	19.6
100A	Copaston sandy clay loam	0 to 2	Loamy, mixed, superactive, mesic Lithic Hapludolls	Somewhat excessively drained	0.8
150B	Spencer silt loam	2 to 6	Fine-silty, mixed, superactive, frigid Oxyaquic Glossudalfs	Moderately well drained	5.3
155B	Chetek sandy loam	3 to 8	Coarse-loamy, mixed, superactive, frigid Inceptic Hapludalfs	Somewhat excessively drained	4.3
155C	Chetek sandy loam	8 to 15	Coarse-loamy, mixed, superactive, frigid Inceptic Hapludalfs	Somewhat excessively drained	12.1
155E	Chetek sandy loam	15 to 25	Coarse-loamy, mixed, superactive, frigid Inceptic Hapludalfs	Somewhat excessively drained	16.5

189	Auburndale silt loam	< 1	Fine-silty, mixed, superactive, frigid Mollic Epiaqualfs	Poorly drained	52.5
250	Kennebec silt loam	< 1	Fine-silty, mixed, superactive, mesic Cumulic Hapludolls	Moderately well drained	4.2
313	Spillville loam, occasionally flooded	< 1	Fine-loamy, mixed, superactive, mesic Cumulic Hapludolls	Moderately well drained	13.9
342B	Kingsley sandy loam	3 to 8	Coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs	Well drained	49.9
342C	Kingsley sandy loam	8 to 15	Coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs	Well drained	108.3
342E	Kingsley sandy loam	15 to 25	Coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs	Well drained	42.2
344	Quam silt loam	< 1	Fine-silty, mixed, superactive, frigid Cumulic Endoaquolls	Poorly drained	30.5
411A	Waukegan silt loam	0 to 2	Fine-silty over sandy or sandy-skeletal, mixed, superactive, mesic Typic Hapludolls	Well drained	0.6
415C	Kanaranzi loam	6 to 12	Fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Hapludolls	Well drained	0.1
449B	Crystal Lake silt loam	1 to 8	Fine-silty, mixed, superactive, frigid Oxyaquic Glossudalfs	Moderately well drained	16.6
463	Minneiska loam, occasionally flooded		Coarse-loamy, mixed, superactive, calcareous, mesic Mollic Udifluvents	Moderately well drained	0.4
539	Palms muck	< 1	Loamy, mixed, euic, mesic Terric Haplosaprists	Very Poorly drained	77.1
540	Seelyeville muck	< 1	Euic, frigid Typic Haplosaprists	Very Poorly drained	7.3
611E	Hawick loamy sand	8 to 25	Sandy, mixed, mesic Entic Hapludolls	Excessively drained	9.7
857B	Urban land-Waukegan complex	1 to 8	Fine-silty over sandy or sandy-skeletal, mixed, superactive, mesic Typic Hapludolls	Well drained	8.0
861C	Urban land-Kingsley complex	3 to 15	Coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs	Well drained	104.1

861E	Urban land-Kingsley complex	15 to 25	Coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs	Well drained	2.9
895B	Kingsley-Mahtomedi-Spencer complex	3 to 8	Loamy, mixed Alfisols/Entisols	Well drained	11.6
895C	Kingsley-Mahtomedi-Spencer complex	8 to 15	Loamy, mixed Alfisols/Entisols	Well drained	49.8
896F	Kingsley-Mahtomedi complex	25 to 40	Loamy sand, Typic Udipsamments	Excessively drained	39.3
1027	Udorthents, wet	< 1		Poorly drained	44.2
1029	Pits, gravel				3.6
1055	Aquolls and Histosols, ponded	< 1		Poorly drained	12.6
1824	Quam silt loam, ponded	< 1	Fine-silty, mixed, superactive, frigid Cumulic Endoaquolls	Very Poorly drained	0.6
1898F	Etter-Brodale complex	25 to 60	Loamy mesic Hapludolls		4.1
1902B	Jewett silt loam	1 to 6	Fine-loamy, mixed, superactive, frigid Typic Hapludalfs	Well drained	41.7
W	Water	0			30.9
	Total				832.8

FIGURE 11A: Soils - Valley Park

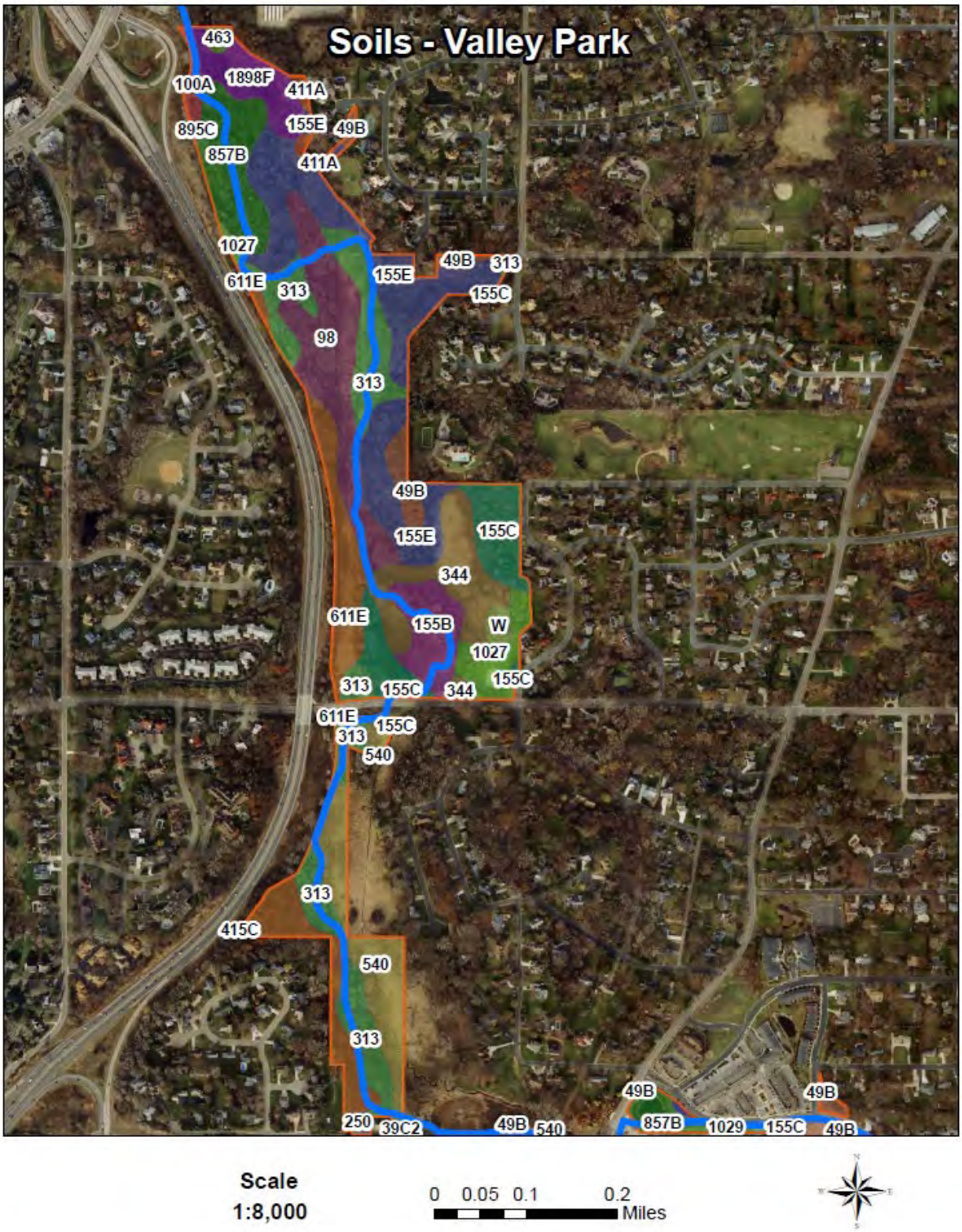


FIGURE 11B: Soils – Dodge Nature Center – Lilly Property

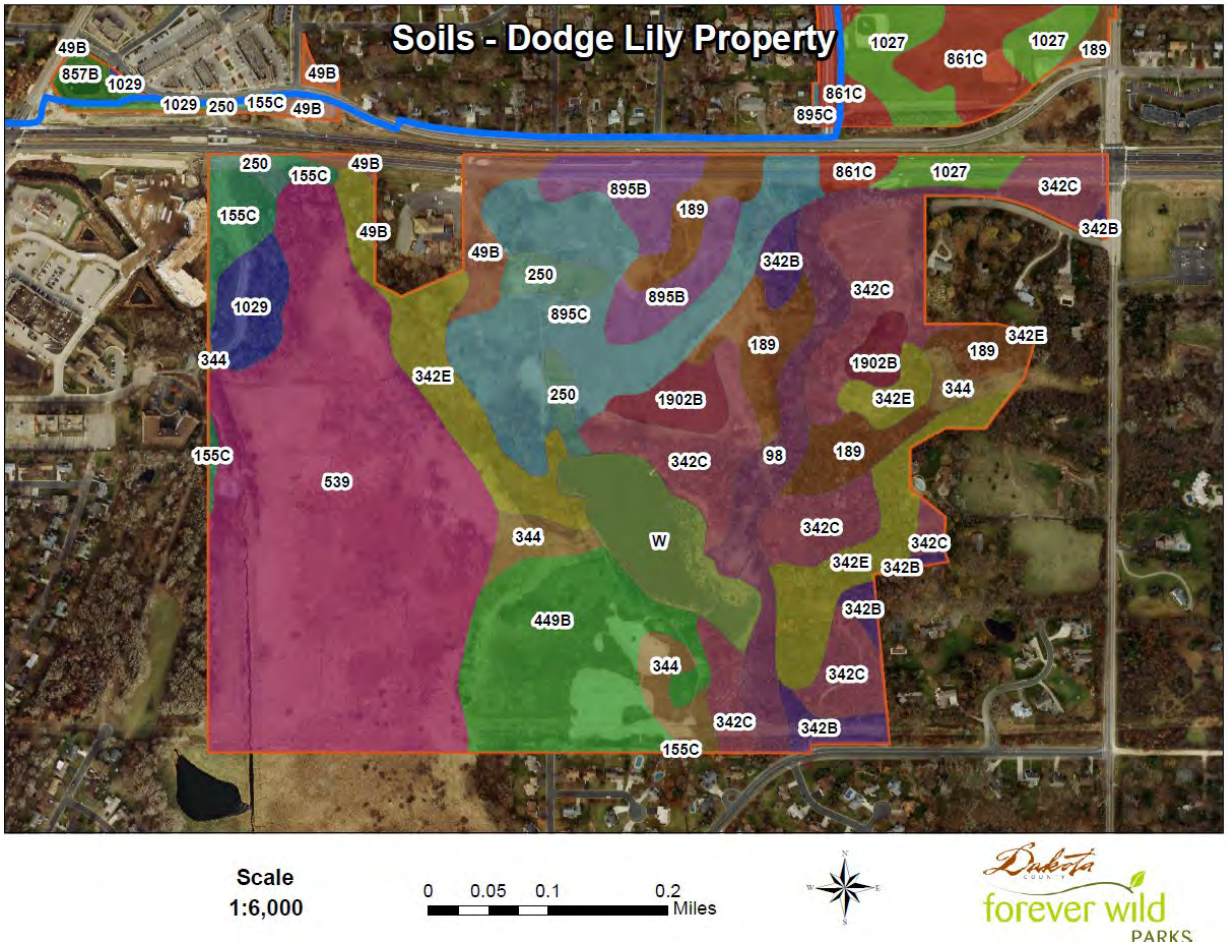


FIGURE 11C: Soils - Dodge Nature Center – Main/Marie

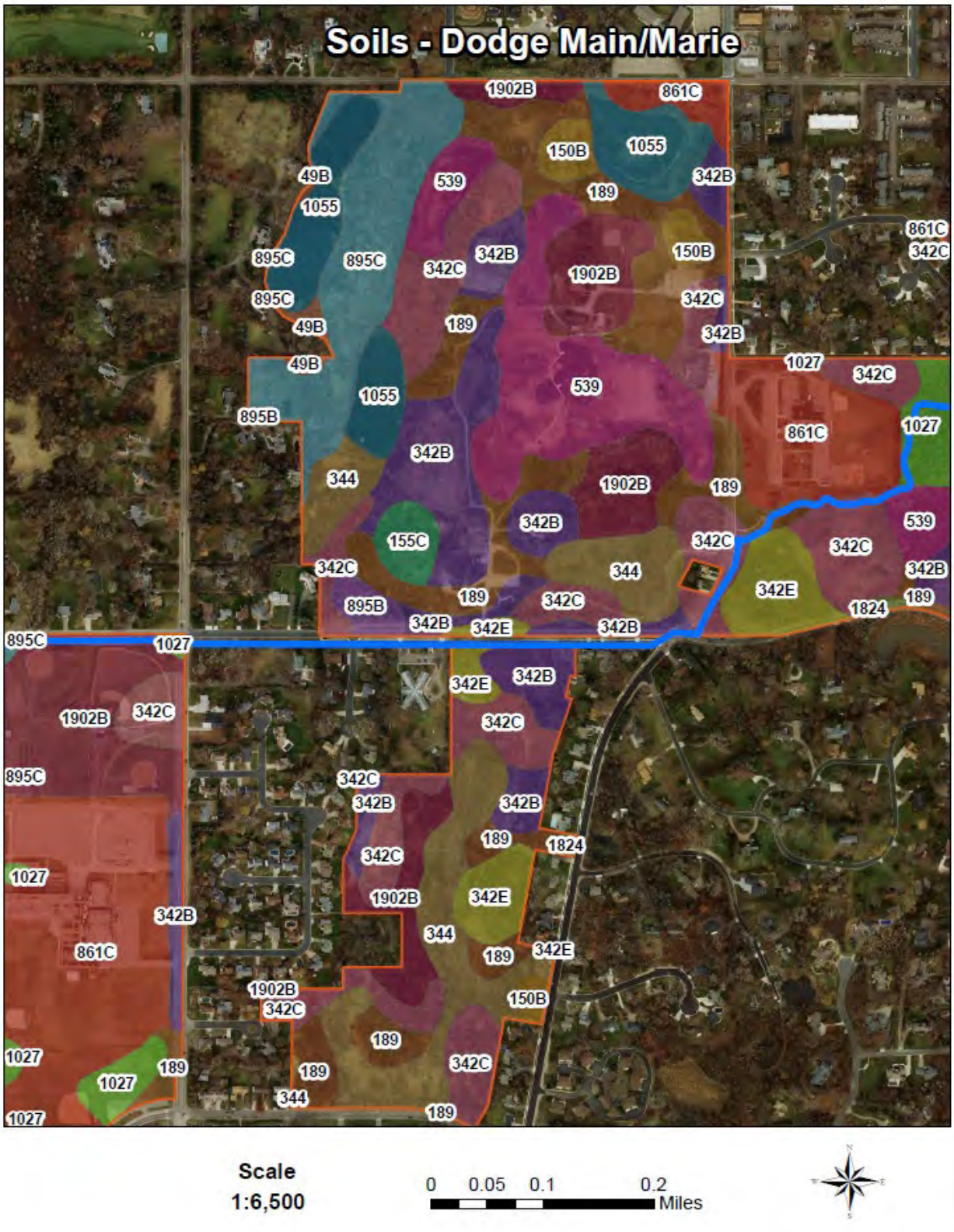


FIGURE 11D: Soils - West Saint Paul

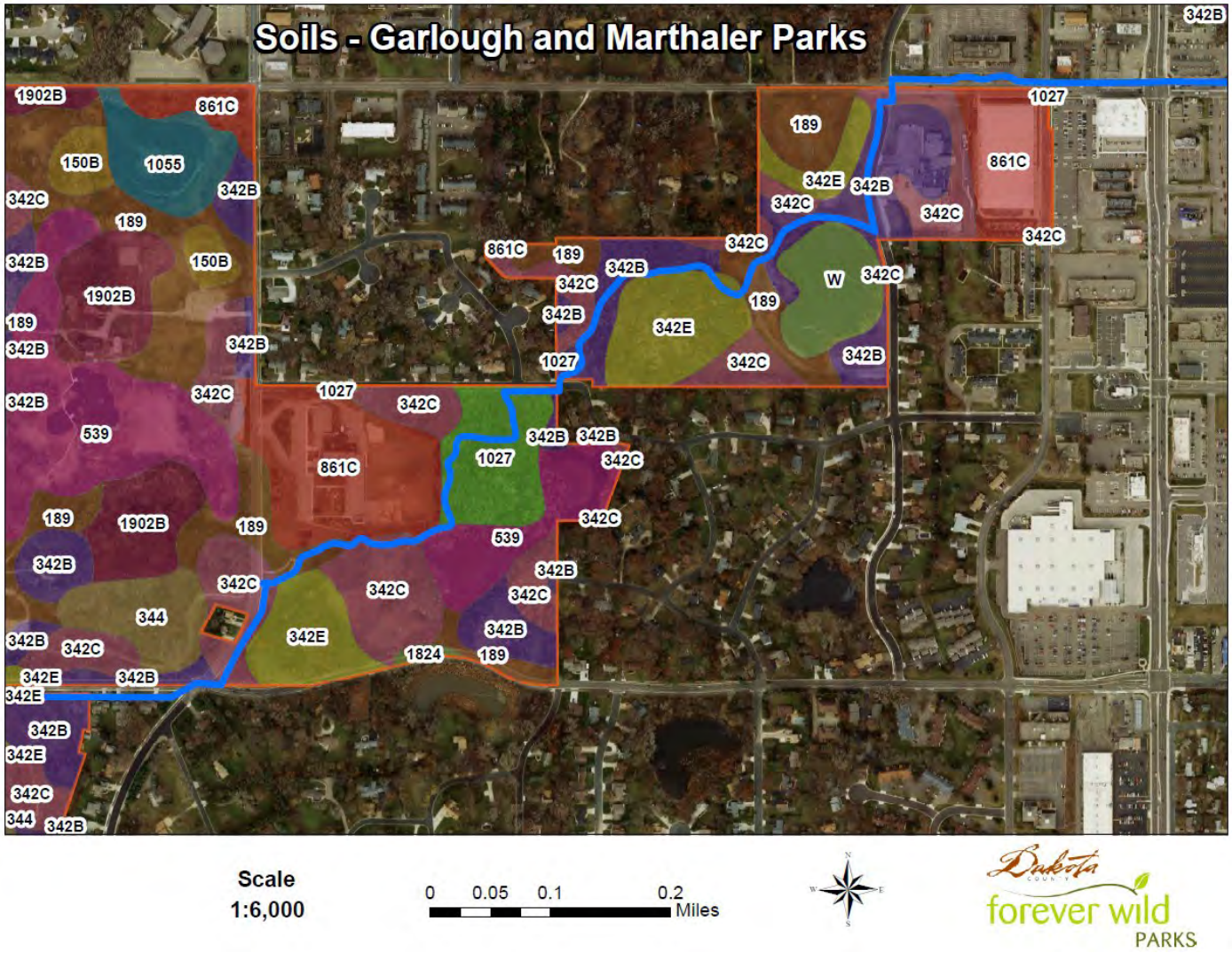
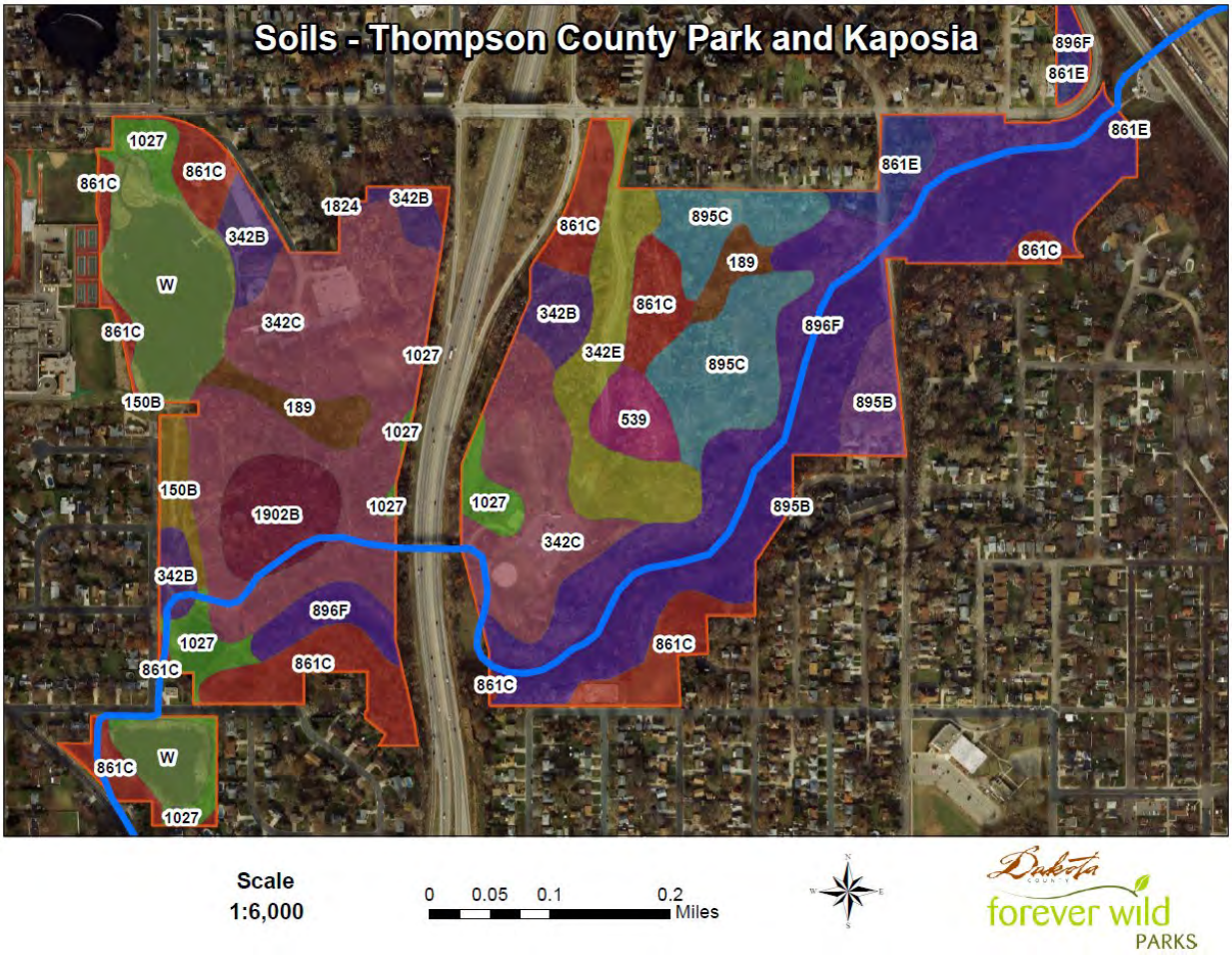


FIGURE 11E: Soils - Thompson County Park and Kaposia



Most of the soils within the River to River Greenway study corridor consist of two groups that are associated with each other due to their proximity and landscape relationship, such that the soils within each of these groups developed together as a complex.

A large proportion (72%) of the Study Area is comprised of soils associated with the Kinglsey-Mahtomedi complex that formed on loamy and sandy glacial till as well as sandy, pitted outwash plains associated with the Superior Lobe. Due to their generally sandy texture, the upland soils such as Kingsley and Chetek sandy loams and Mahtomedi loamy sand are typically well drained and historically supported hardwood forest vegetation (Alfisols) adapted to dried conditions, such as oak savannas and woodlands maintained by periodic fire. Most notably, the steepest (>15% slope) Kingsley soil units (Units 342E) correspond to areas that contain white and bur oaks that are present in the earliest (1937) historic aerials (**Figures 4A-D**). Precipitation typically drains to lower lying areas with less permeability, and many of these depressions contain natural lakes or wetlands with Quam, Palms, Kennebec or Auburndale silt loams that developed as floodplain alluvium. These soils range from being moderately well drained to poorly drained and supported wetland or forested vegetation.

A second important soil complex include the Wadena loam, Waukegan silt loam, and Hawick loamy sand soils that formed on level outwash plains and terraces. These soils are Mollisols that formed under tallgrass prairie vegetation. This soil complex occupies the uplands surrounding Valley Park within the outwash from the Des Moines glaciation.

Other soils of note are the Minnieska loam, Copaston sandy loam, and Etter-Brodale series loams that developed within the Mississippi and Minnesota River floodplains and terraces. These soils can be found within the Valley Park drainage and likely supported prairie openings where fire was frequent; low lying areas in this valley supported the development of Colo silty clay loam, which is poorly drained and likely supported wet meadow and wetland vegetation.

iii. Topography

Topography and the orientation of slopes (aspect) relative to north, south, east, and west, are an important factor in the development and formation of soil, potential for soil erosion, and the type and stability of vegetation that will grow in a given location. In general, more topographic variation will result in more complexity and diversity of vegetation communities and hydrologic features. Generally, south and southwest facing slopes will be drier and support less vegetation than north and north-east facing slopes.

Aspect can have a strong influence on soil temperature and moisture. In the northern hemisphere, north-facing slopes are often shaded, while south-facing slopes receive more solar radiation for a given surface area, because the slope is tilted toward the sun and is not shaded directly by the earth. The slope aspect can significantly influence its locational climate (microclimate). Soil temperatures and soil moisture on south-facing slopes are typically warmer and drier than those on north-facing slopes, due in part to the increased solar radiation and direction of the prevailing winds in the summer. Likewise, soils on north-facing slopes tend to be cooler and wetter, due to diminished solar energy.

Erosion on steep slopes was apparent in Simon's Ravine, where scouring and incising of the creek channel was observed. The amount of water flowing through this ravine has increased since development encompassed the surrounding upland areas, and stormwater conveyance was directed down the ravine towards the Mississippi River.

Together with soils, topography had significant impacts on the species distributions and community associations of vegetation on the landscape. Simon's Ravine in particular exhibits distinct directional slopes, such that more mesic-adapted species such as sugar maple were likely (and continue to be) in higher abundance on northerly and easterly aspects. Similarly, areas near wetland depressions or in uneven terrain had a higher likelihood of escaping exposure to fire, such that protected pockets of trees likely persisted within a patchy matrix of vegetation. Maps illustrating slope percentage and detailed elevation are illustrated in **Figures 12A-D**.

FIGURE 12A: Percent Slope and Topography – Valley Park

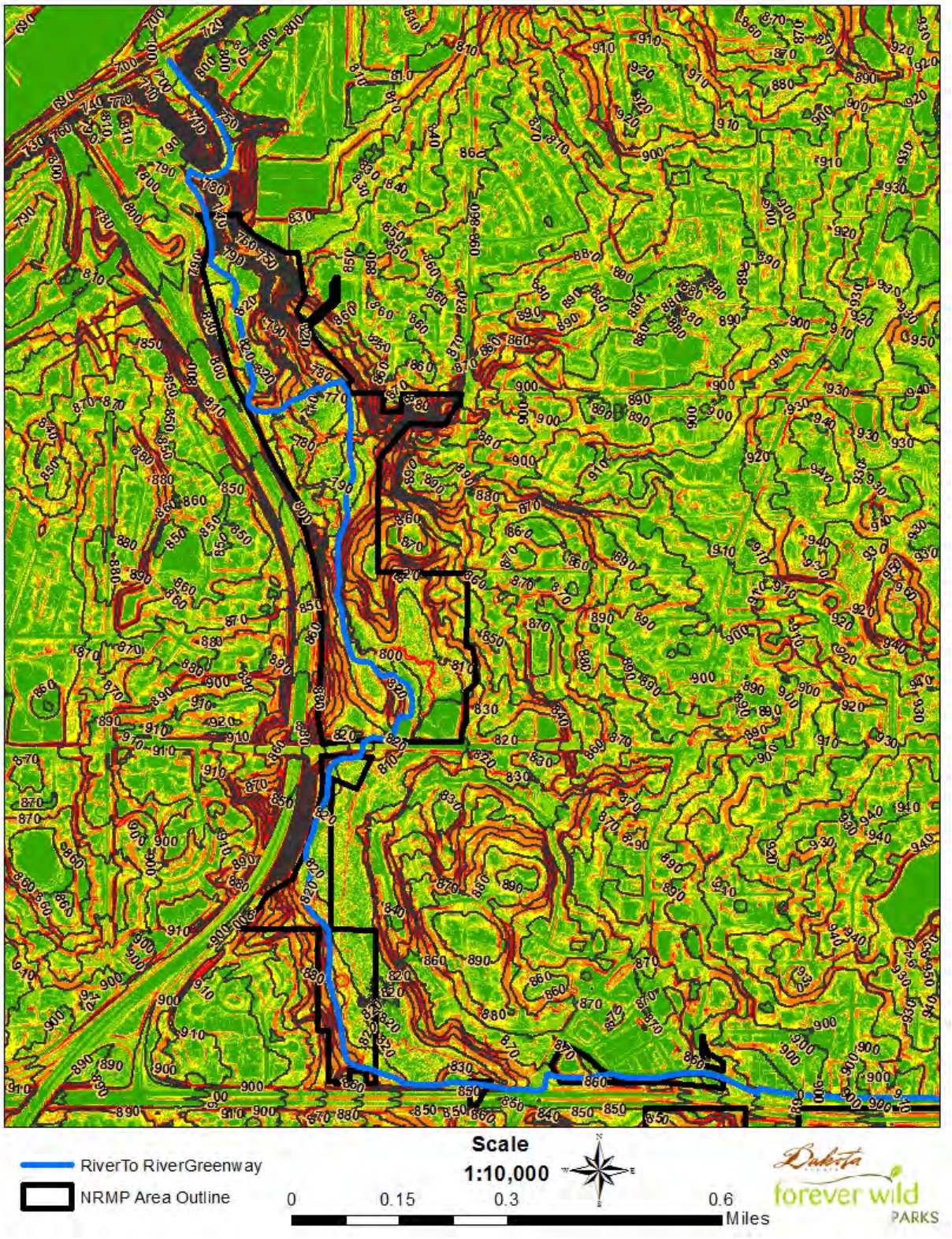


FIGURE 12B: Percent Slope and Topography – Dodge Nature Center

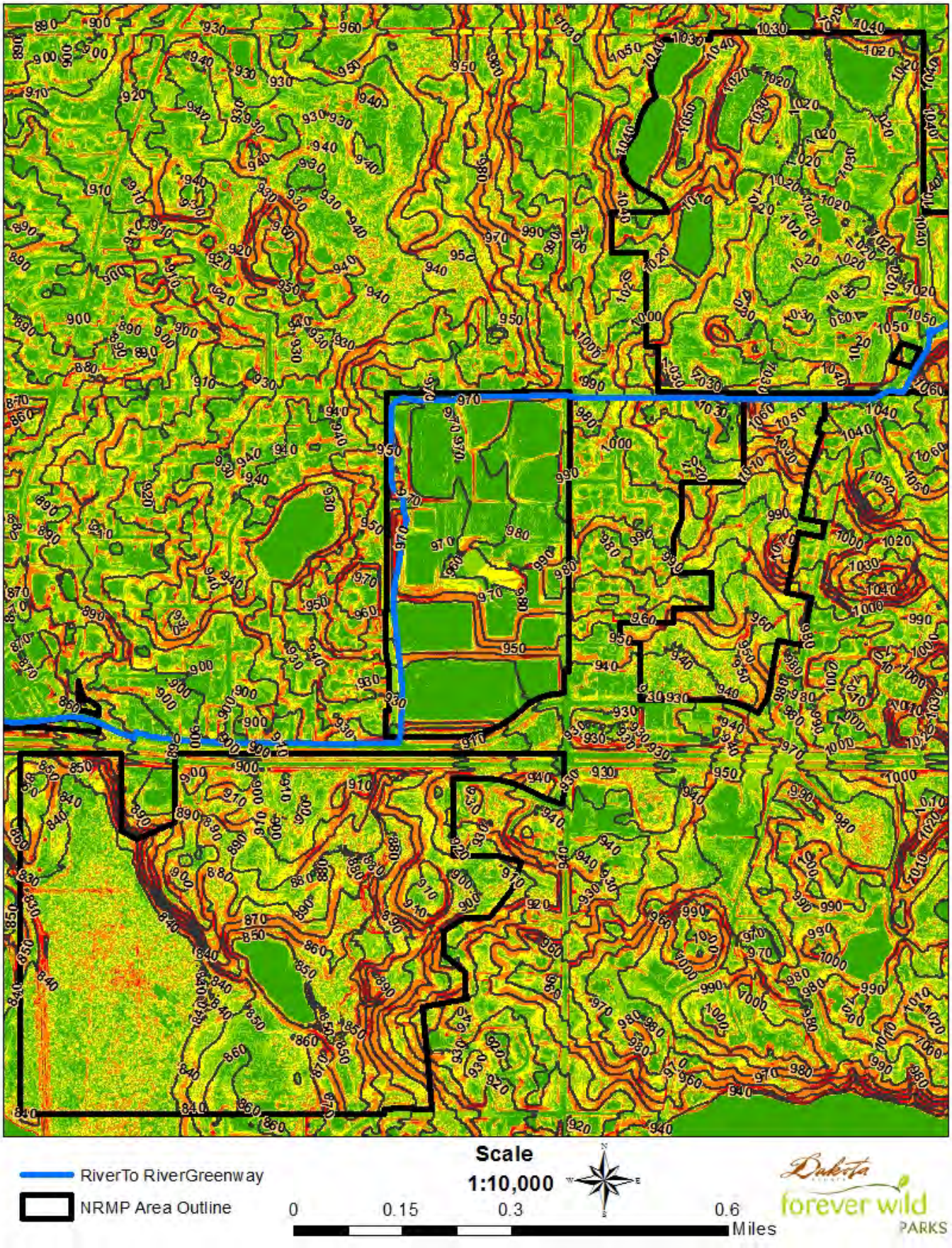


FIGURE 12C: Percent Slope and Topography - West Saint Paul

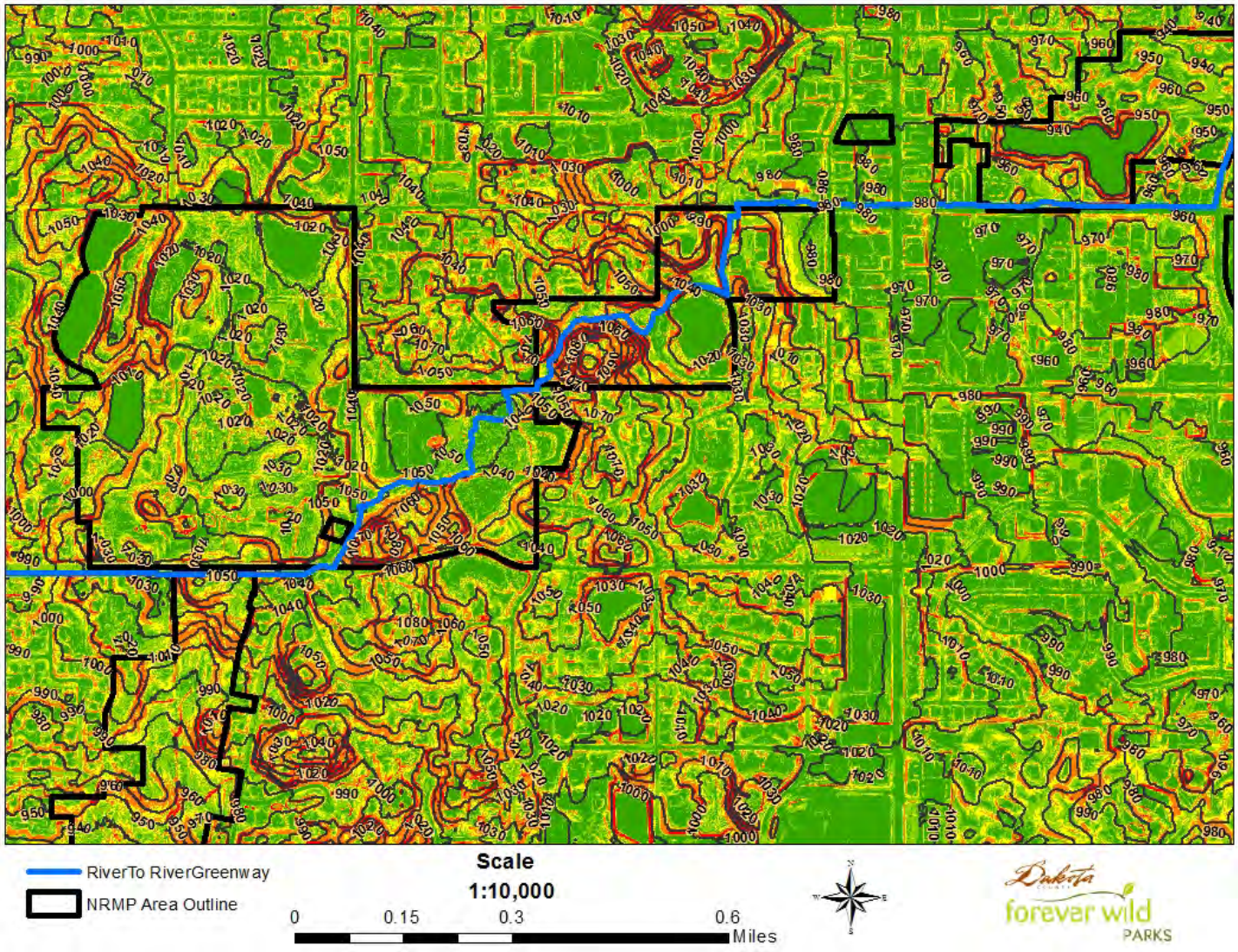
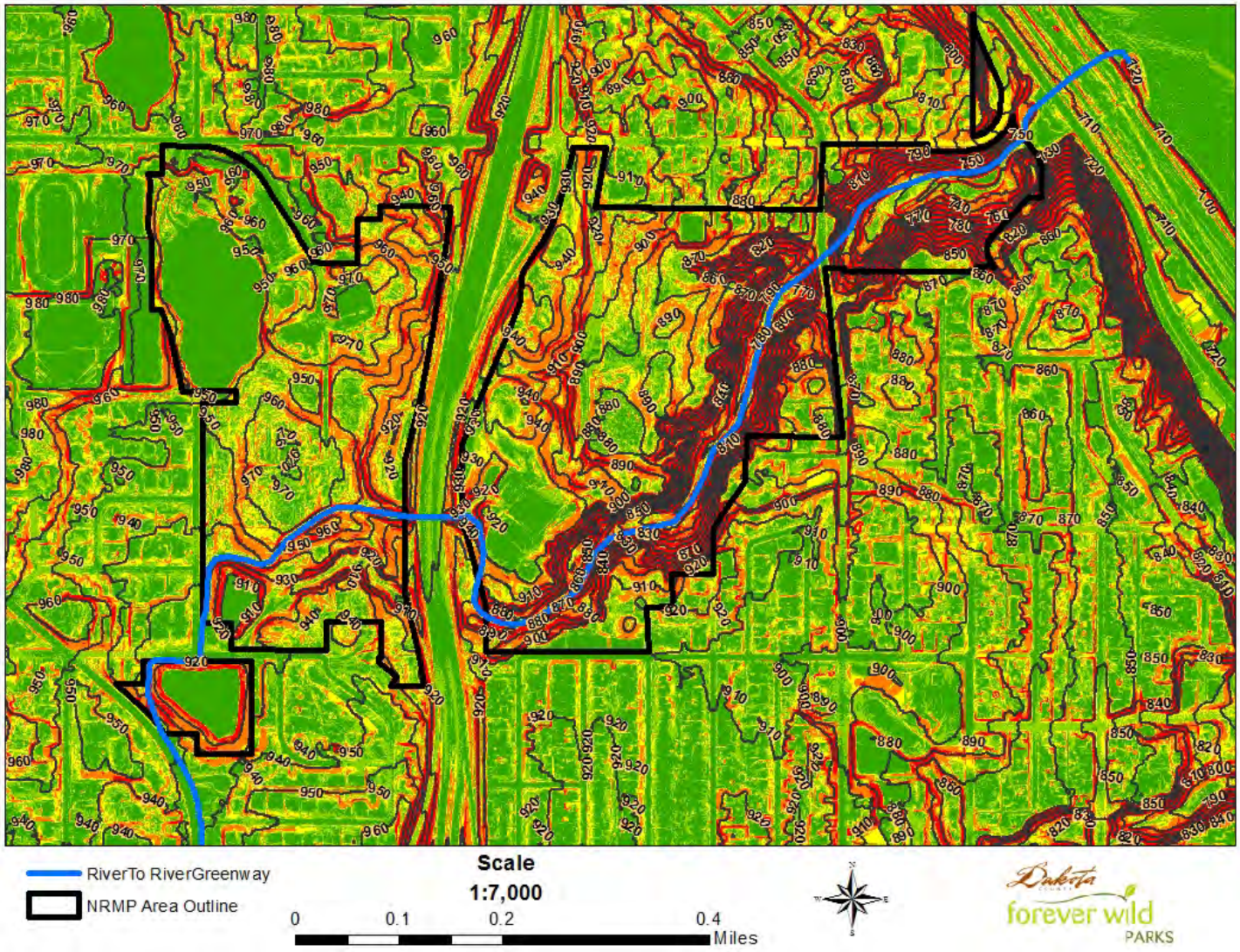


FIGURE 12D: Percent Slope and Topography – Thompson County Park and Kaposia



iv. Hydrology

The two, key, interrelated hydrologic components of the Greenway Corridor are groundwater and surface water.

1. Groundwater

Groundwater accumulates below the surface of the land and is stored in aquifers: complex, underground geologic layers of sand, gravel and porous rock. If groundwater exists in suitable quantity and quality, and can be delivered for human use, it is of great economic value. Private wells in Dakota County typically draw water from either the sand and gravel aquifer, the Prairie du Chien dolomite or the Jordan sandstone aquifer. Most public water supplies obtain water from the Jordan aquifer.

Due to its relative abundance, quality and reasonable access, groundwater provides drinking water for the majority of County citizens, irrigation water for agricultural crops (especially on the sandier soils in the eastern part of the County), and process and cooling water for industrial and manufacturing companies. There is concern about the long-term supply of groundwater, due to increased residential and agricultural irrigation, municipal water use, changing climate, and the need to protect groundwater-dependent ecological systems like trout streams. Furthermore, most of the County's groundwater is "highly sensitive" to surface contamination. Once an aquifer is polluted, it is very expensive or prohibitive to improve its quality to drinking water standards.

Given groundwater's importance and potential vulnerability, it is important to be aware of the potential for groundwater contamination from activities at the surface. In rural parts of Dakota County, the greatest risk to drinking water health is pesticide and nitrate as nitrogen contamination. Naturally occurring manganese and arsenic are a concern county-wide. Factors to consider during natural resource management activities are depth to groundwater and the ability of the overlying geologic materials to protect the groundwater aquifer.

The DNR defines groundwater sensitivity as an area where natural geologic factors create a significant risk of groundwater degradation through the migration of waterborne contaminants. Migration of contaminants dissolved in water through unsaturated and saturated sediments is affected by many things, including biological degradation, and contaminant type and density. General assumptions include:

- Contaminants move conservatively with water
- Flow paths are vertical
- Permeability of the sediment is the controlling factor

Infiltration rates are based on the soil type (**Figure 11**) and the texture of surficial geology (**Figure 10**). The travel time varies from hours to approximately a year. The pollution sensitivity of buried sand and gravel aquifers and of the first buried bedrock surface represents the approximate time it takes for water to move from land surface to the aquifer.

Five relative classes of geologic sensitivity are based on overlapping time of travel ranges (Very High, High, Medium, Low, and Very Low). The pollution sensitivity is inversely proportional to the time of travel.

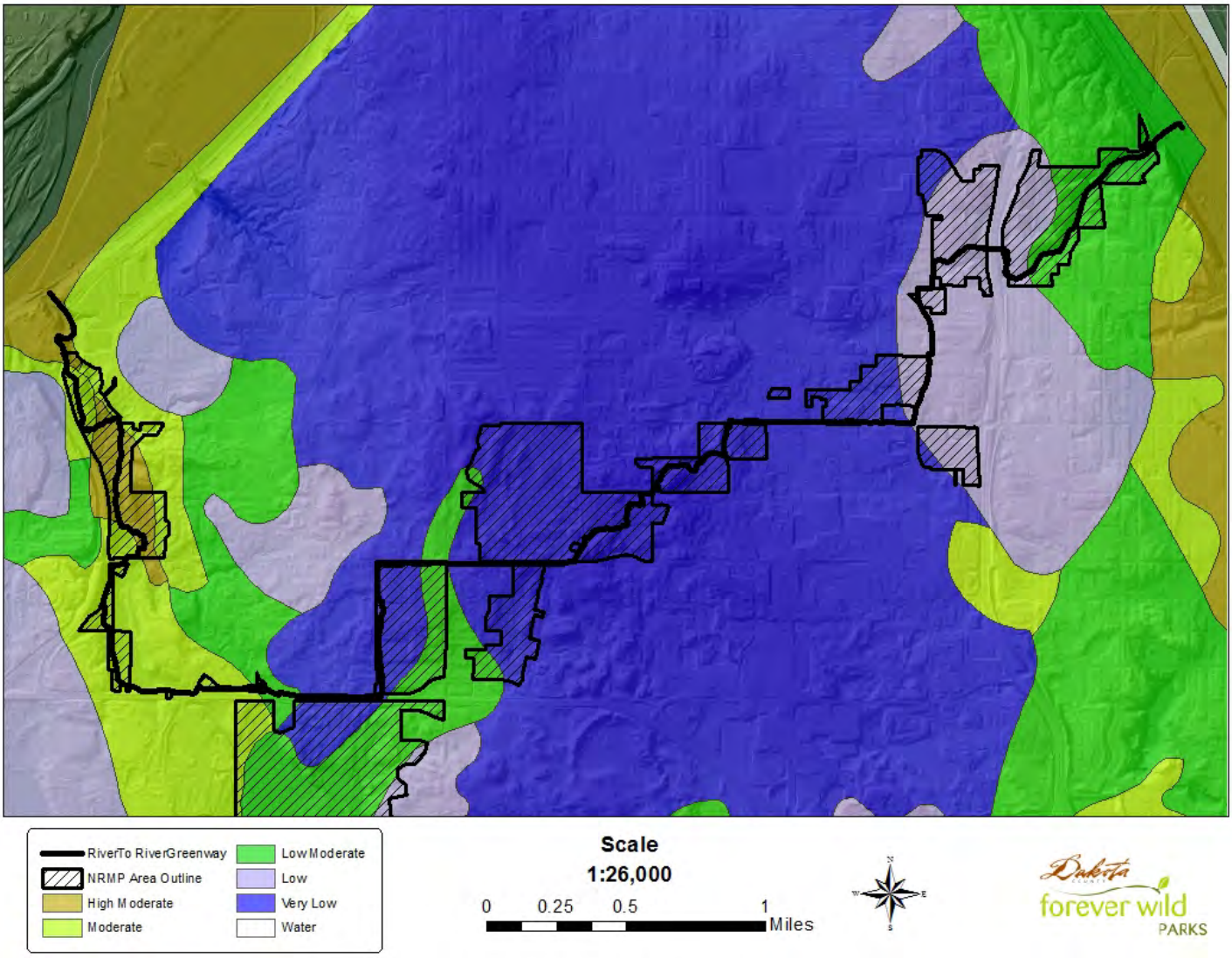
- In areas of higher sensitivity contaminants may reach the groundwater within hours to months.
- In areas of lower sensitivity there is time for a surface contamination source to be investigated, and possibly corrected, before serious groundwater pollution develops.

The Dakota County Geologic Atlas classifies uplands as “Moderately Sensitive,” because the Platteville Limestone is a locally unused aquifer, and the Glenwood Shale offers some protection to the St. Peter Sandstone aquifer. Hillslopes and lowlands are classified as either High or High-Moderate sensitivity due to the shallow depth to the St. Peter Sandstone aquifer, and because this appears to be a groundwater recharge area where infiltration reaching the water table will move deeper into the groundwater system.

Relatively high sensitivity does not mean that water quality has been or will be degraded. If there are no contaminant sources, pollution will not occur. Low sensitivity does not guarantee protection. Leakage from an unsealed well for example, may bypass the natural protection, allowing contamination to directly enter an aquifer.

In much of the area surrounding the Greenway Corridor, the Prairie du Chien limestone aquifer is protected by the overlying, less permeable Glenwood Shale formation. Residences in this area are connected to municipal water services such that domestic wells are not a consideration. Water tests from local wells in the Jordan Sandstone aquifer have very low levels of nitrate. There are older water tests from nearby wells that have nitrate levels as high as 10.0 ppm; they are likely from shallower wells, and verify the sensitivity of shallow aquifers to nitrate pollution. See Figure 13.

FIGURE 13: Sensitivity of Groundwater to Pollution



2. *Surface Water*

One of the unique and attractive features of Dakota County is the amount and diversity of its surface waters. Major riverine systems, including the Mississippi, Minnesota, Cannon, and Vermillion rivers demarcate the major watersheds within the County. Numerous small lakes are found in the northern and western portions of the County as a result of previous glaciation. Different types of wetlands are scattered throughout the County and several unique wetlands, known as fens, are found in the Minnesota River Valley.

Within the Greenway Corridor, the majority of wetlands existing in landscape depressions are classified by the National Wetland Inventory as being palustrine forested wetlands consisting of temporarily flooded areas with hardwood forest cover (PFO1A) or wetlands exhibiting persistent emergent vegetation consisting of reed canary grass or hybrid cattail (PEM1A), sometimes with intermittent shrub cover (scrub shrub, code PSS1A) (See **Figures 14A-D**). Another typical class of wetlands include small pods for use as retaining stormwater on the landscape (palustrine intermittently flooded basins with unconsolidated bottom substrates, PUBG), some of which have been excavated for the purpose of increased stormwater-holding capacity (PUBGx).

Over time, most of these surface waters have been significantly degraded, due to agricultural and municipal stormwater run-off. Entire wetland complexes have been lost that were important for filtering and retaining water, which was critical for recharging groundwater levels. Pollution often includes excess bacteria, sediment and nutrients (such as nitrogen and phosphorous from fertilizer), and lack of dissolved oxygen that affects the ability of fish and other aquatic organisms to live and reproduce. Although regulations and voluntary efforts have improved water conditions, protection and management of natural areas, especially those adjacent to water bodies, is an important strategy for achieving these water quality goals.

Due to the multifaceted challenges and complexity of interrelated factors contributing to poor surficial water quality within this area, it is recommended that a subsequent subwatershed analysis study be conducted in partnership with Dakota Soil and Water Conservation District and the Lower Mississippi Water Management Organization. This study would serve to identify restoration opportunities to ameliorate ravine and streambank erosion, wetland degredation, and prioritize stormwater best management practices.

FIGURE 14A: National Wetland Inventory Features – Valley Park

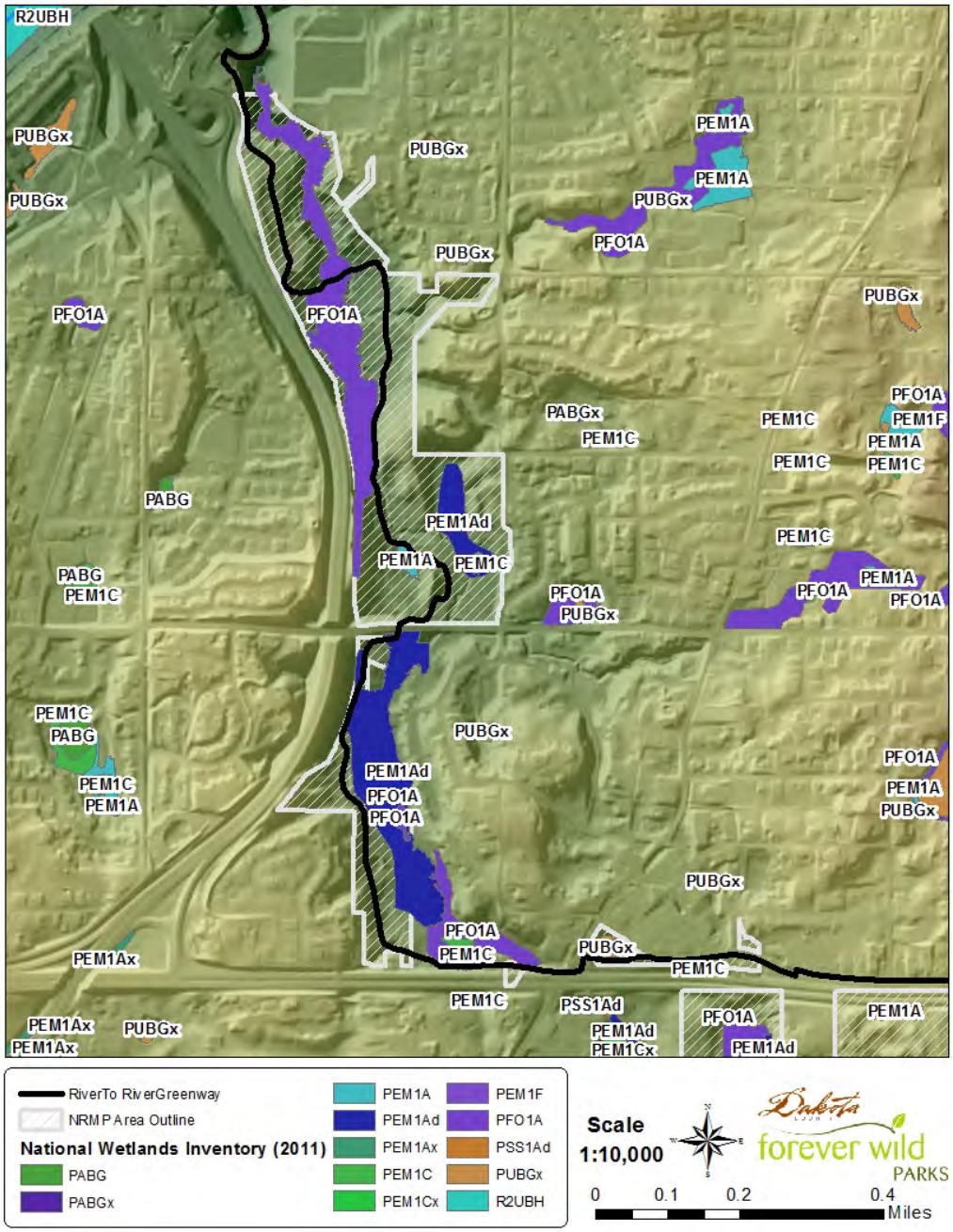


FIGURE 14B: National Wetland Inventory Features – Dodge Nature Center

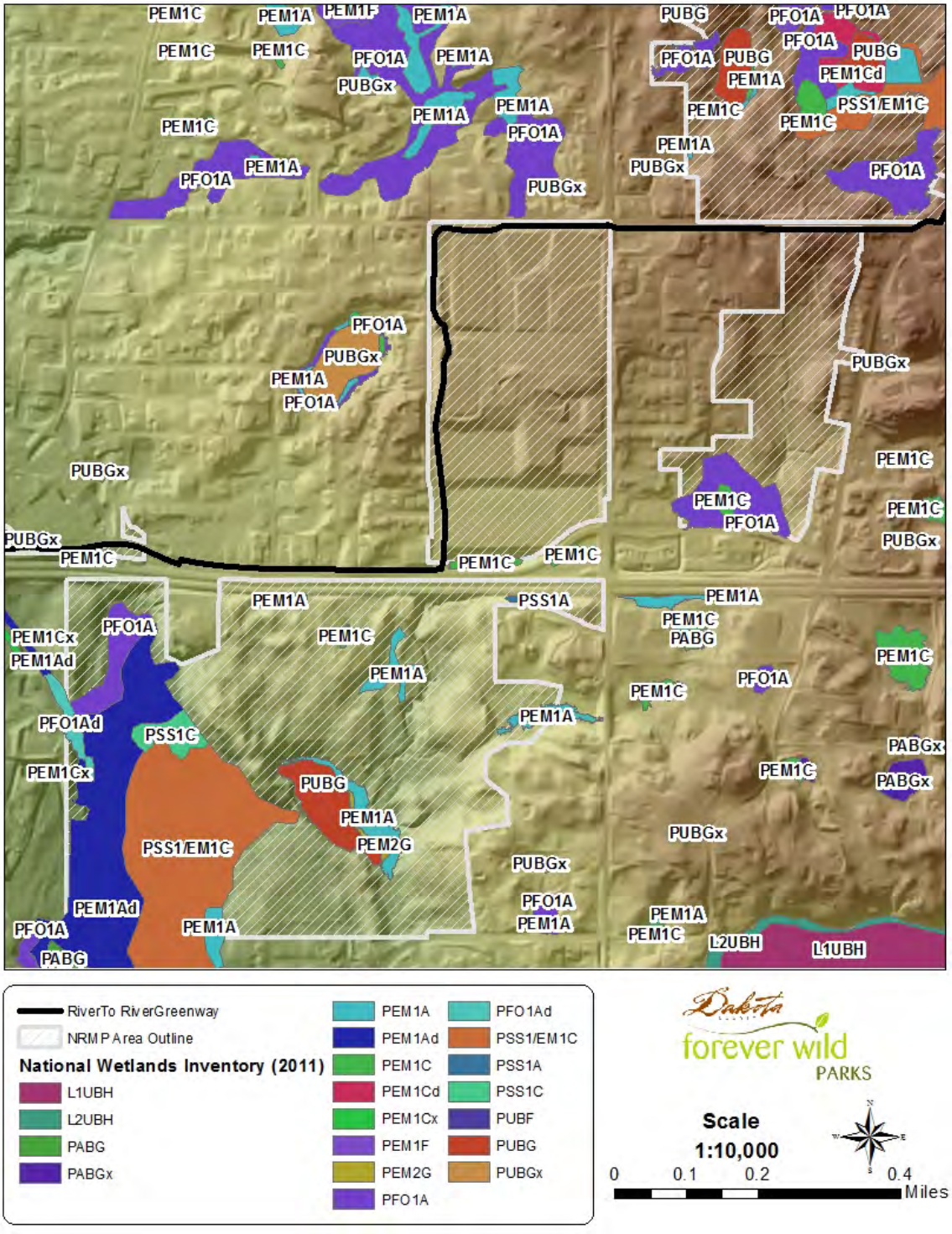


FIGURE 14C: National Wetland Inventory Features – West Saint Paul

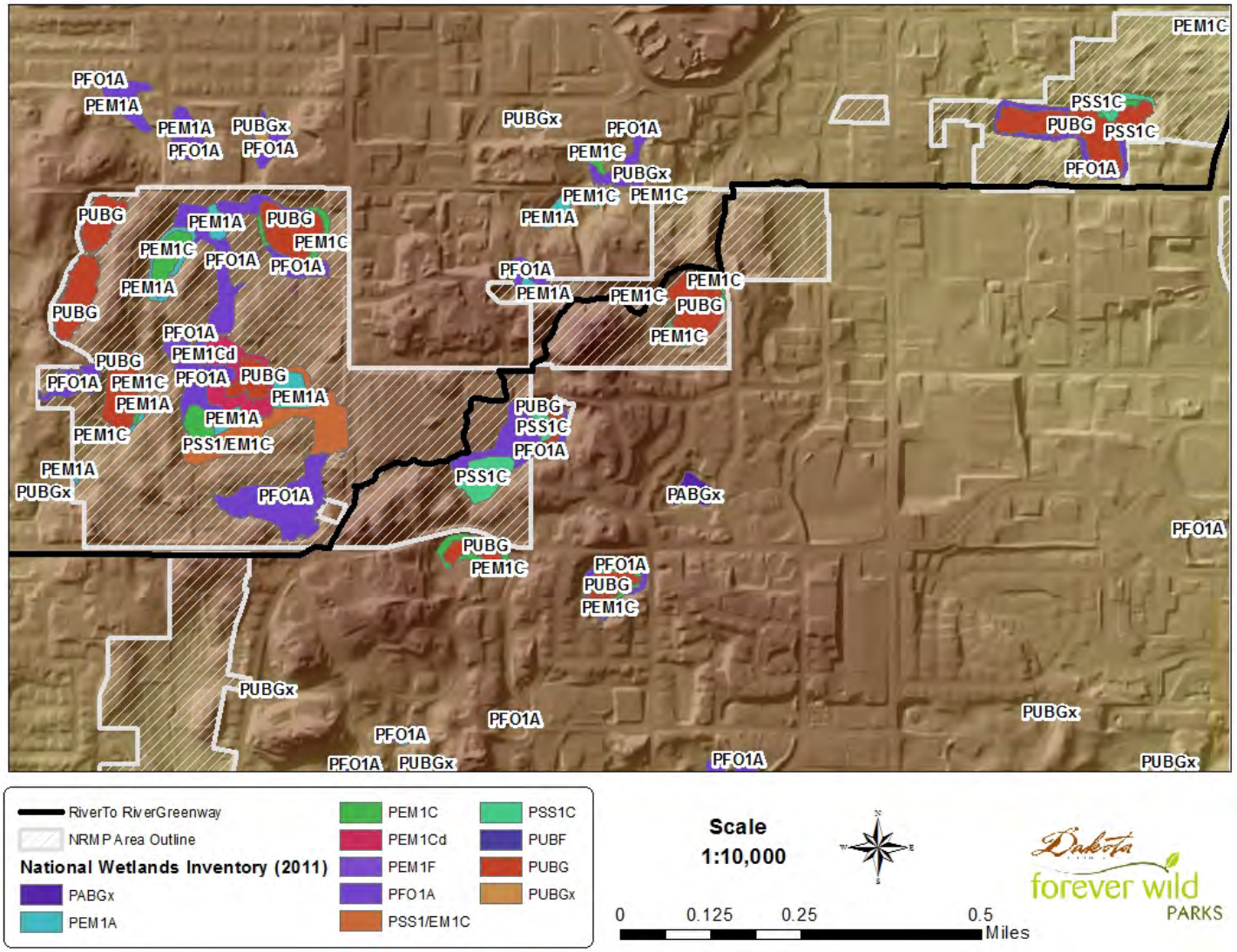
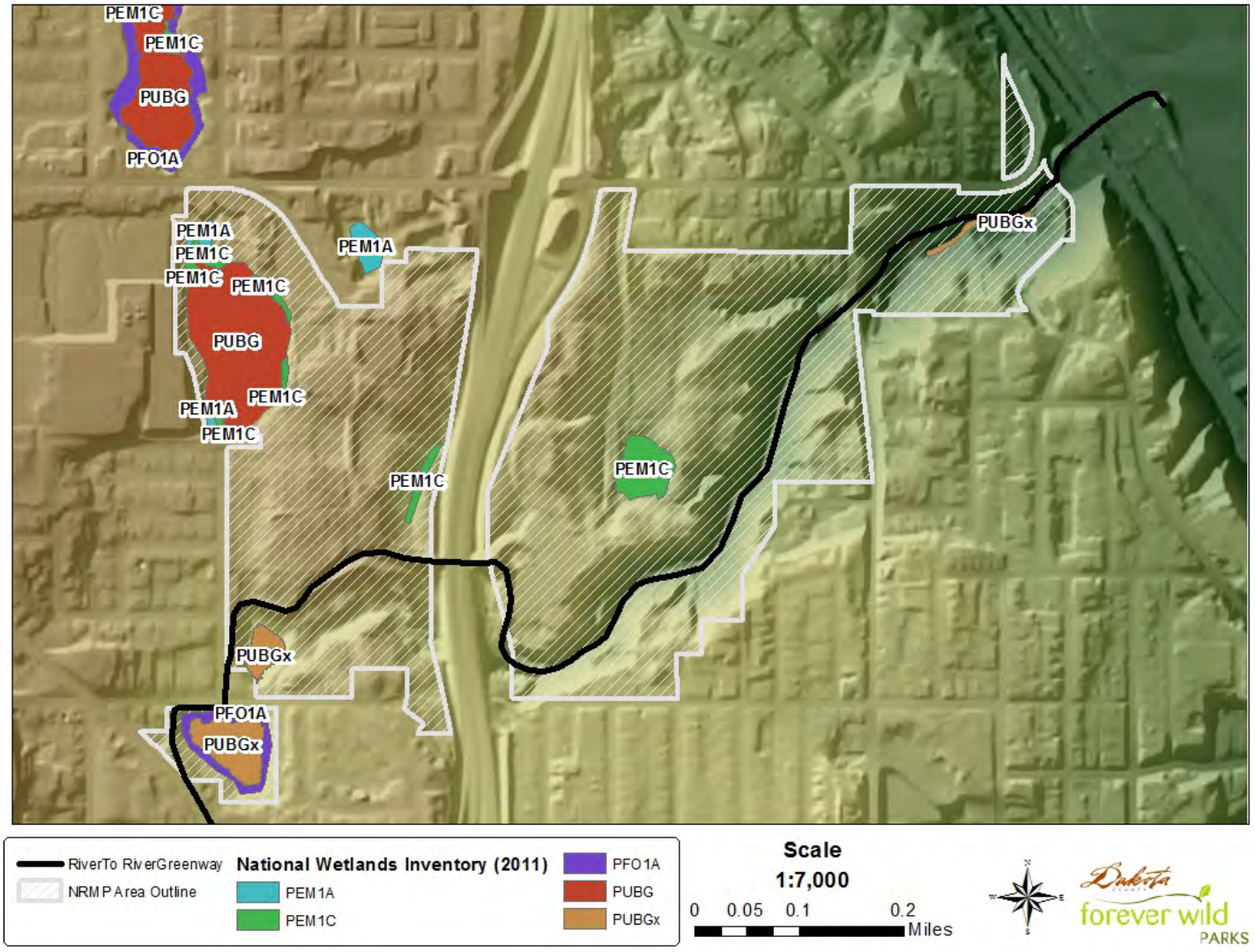


FIGURE 14D: National Wetland Inventory Features – Thompson County Park and Kaposia



C. Vegetation

The vegetation found within the Greenway Corridor is determined by a number of factors including, but not limited to: physical site conditions, such as topography; soils and hydrology; historic and current land use; climate; invasive species; and wildlife. Vegetation is also affected by natural processes, such as succession or natural events that create change and variation. Abrupt changes (disturbances), including wildfires, high winds and floods, can change the vegetation structure and composition very quickly and for long time periods. Human-induced changes, such as farming, pasturing, and tree cutting, can have the same effects. Natural succession, or the gradual change in structure and species composition, occurs as the vegetation changes and naturally modifies in response to changes in various environmental variables (light, water and nutrients) over time. These modifications change the variety of species most adapted to grow, survive and reproduce in an area and create slow and broadly predictable changes in the vegetation.

The effects of disturbance and succession can vary widely. Different areas will be at varying developmental stages, due to diverse local histories – particularly since the time of any last major disturbance. These

conditions interact with inherent environmental variability (e.g., soils, climate, topography, etc.) to create a mosaic of vegetation in various conditions across the Greenway Corridor and the larger landscape.

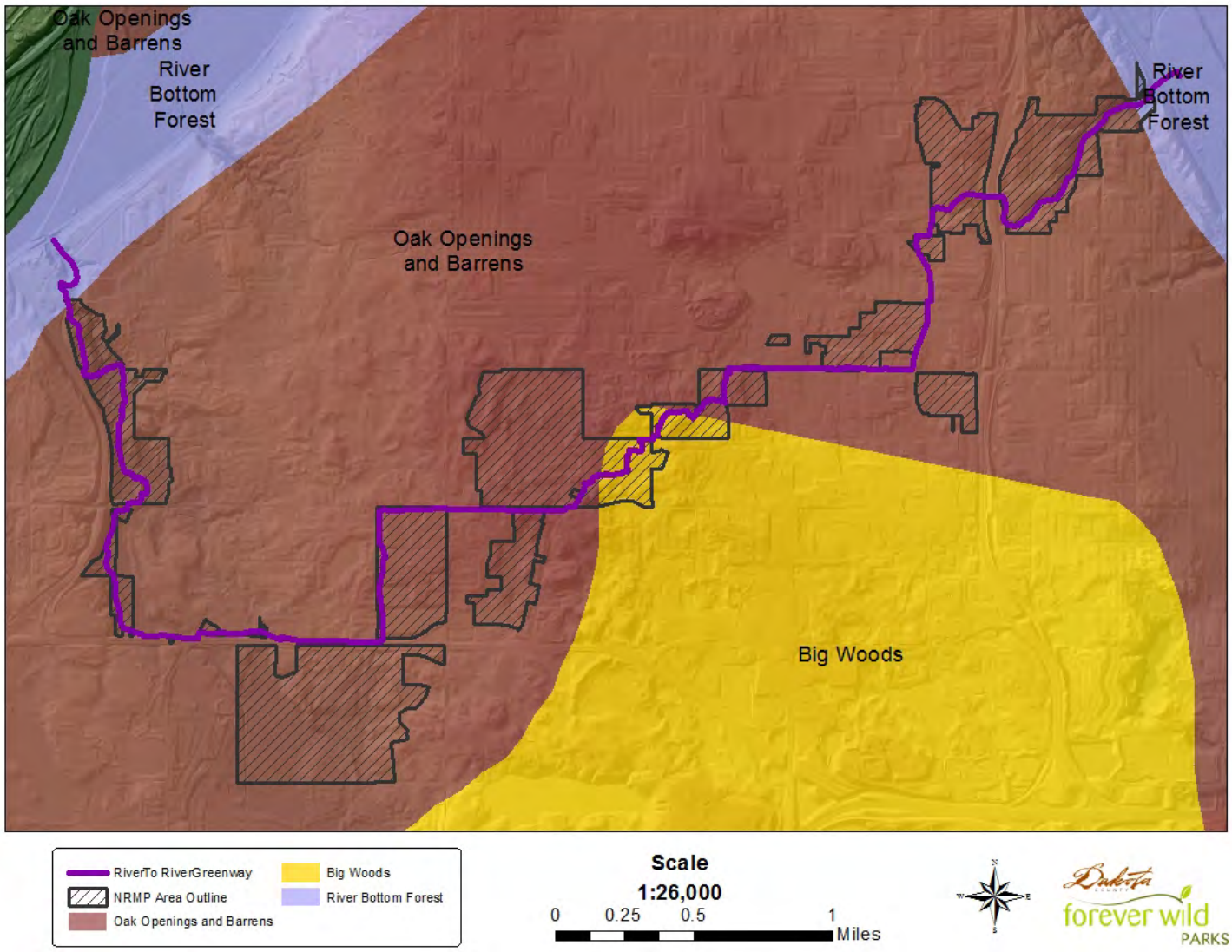
i. Historic

A major consideration for developing a comprehensive NRMP is to understand the types of vegetation found in the local area prior to European settlement. This information can be a helpful indicator of what plants may be found or thrive in the Greenway Corridor. Fortunately, field notes on vegetation were taken during original territorial surveys in the 1840s and compiled into a valuable information source called "The Original Vegetation of Minnesota," compiled from U.S. General Land Office Survey Notes and published in 1974. These records provide information about the pattern of plant communities across the State at the time of European settlement, and are used in this NRMP to inform restoration goals.

In general, the northern and western portions of the County consisted of hardwood forests around many lakes. American basswood, sugar maple, elm, red oak, and an understory of shade-loving wildflowers made up the "Big Woods" in the moist areas protected from fire. Bur and white oak, aspen and black cherry were the dominant tree species in the drier areas. The southern part of the County consisted primarily of prairie and savanna. Depending on soils, topography and hydrology, tall grasses measuring eight feet in height would have been the prominent vegetation type, with a diverse mix of other grasses and wildflowers (forbs). Shorter grasses and a wide variety of other types of forbs were found on sandy or gravelly areas, or steeper slopes. Savannas, with scattered oak trees, formed a transitional plant community between grasslands and forests. Forested floodplains, with cottonwood, silver maple, willow, and American elm were found in wider river valleys. Near smaller rivers, prairie or savanna would often be found, even up to the water's edge. A much larger number of wetlands existed in the southwestern portion of the County than are found today. In fact, only 12 to 15 percent of pre-statehood wetlands remain in Dakota County (Dakota County SWCD, November, 2013).

As shown in **Figure 15**, the predominant, pre-settlement plant communities of the Greenway Corridor consisted Oak Openings and Barrens in the upland moraine complex. These areas consisted of sandy, open prairies sparsely forested with interstitial savannas of bur oaks and shrublands in areas where the topography protected the vegetation from fire. The center of the Greenway Corridor graded to a more mesic, more heavily forested Big Woods hardwood forest, consisting of oak, maple, basswood, and hickory. This forest type also persisted in protected ravines leading down to the river floodplains. The River bottom forests along the Minnesota and Mississippi floodplains consisted of cottonwood and silver maple canopies with plant communities able to persist with periodic inundation during river flooding events. These river bottom forests were historically more open and less densely forested than they are today, possibly due to indigenous land management practices utilizing fire; these floodplain forests were further cut back significantly in the 19th century when steamboats began navigating these rivers and utilizing these trees for fuel.

FIGURE 15: Pre-Settlement Vegetation of the Greenway Corridor and Surrounding Region



ii. Ecological Communities

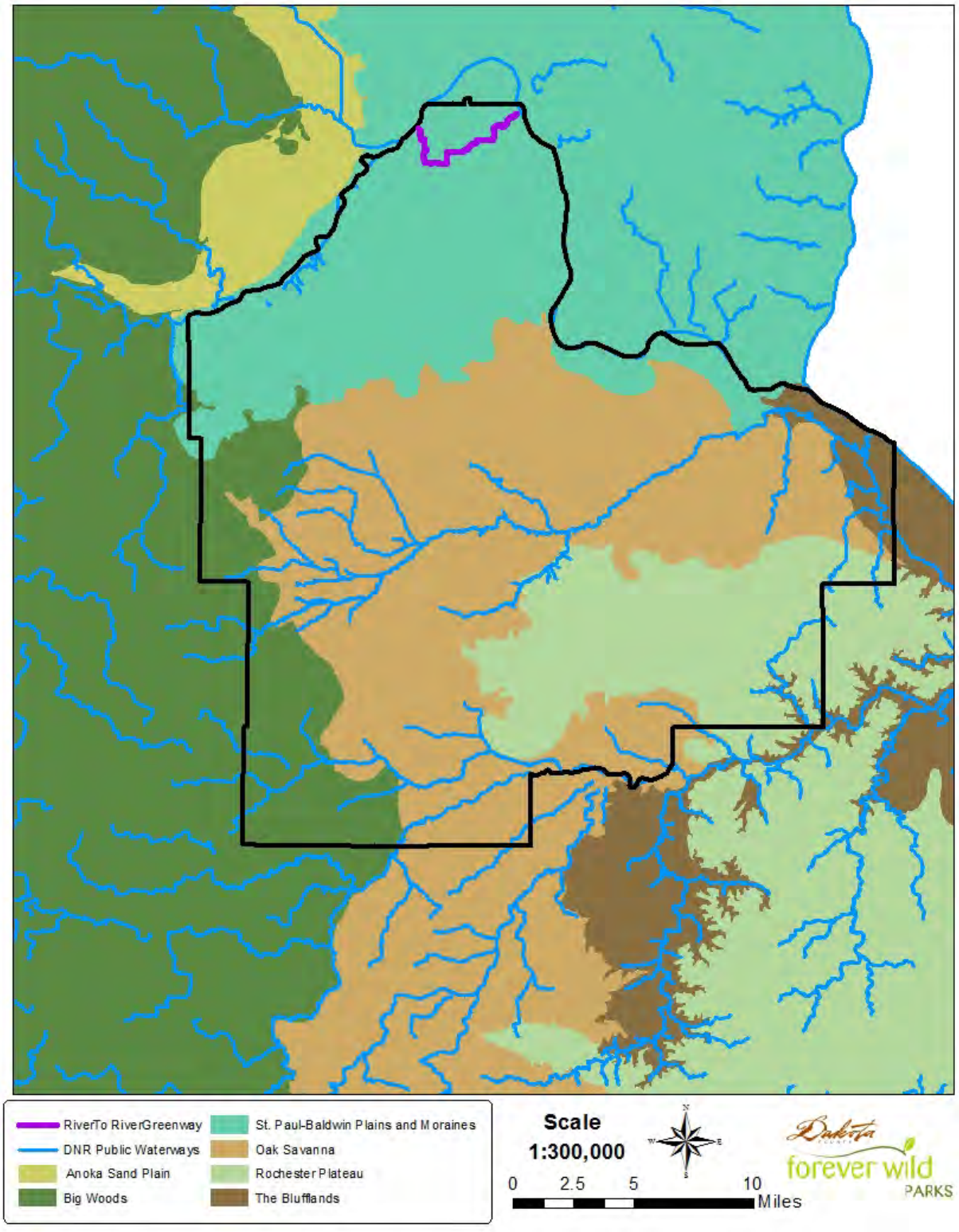
Minnesota contains three major biomes. Moving roughly northeast to southwest across the State, they are: coniferous forest, deciduous forest, and prairie/grassland. While these regions still exist, they have been greatly altered by human activity since the mid-1800s, in physical character and extent. The metropolitan region of Minnesota, including Dakota County, falls within the deciduous forest biome; however, there was and is significant plant community diversity within each biome and the County has historically been mostly tallgrass prairie and oak savanna, with oak and maple-basswood forests restricted to areas sheltered from fires, such as steep ravine slopes.

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 River to River Greenway Corridor is classified as follows (see Figure 14):

Ecological Province: *Eastern Broadleaf Forest Province*
Section: *Minnesota and Northeast Iowa Morainal Section*
Subsection: *Saint Paul Baldwin Plains and Moraine Subsection*

The Saint Paul Baldwin Plains and Moraine Subsection comprised of a mosaic of tallgrass prairie, oak savanna, and small interspersed clusters of Big Woods forest. The hilly terminal moraines created a poorly developed drainage network, except for ravines that had formed at the margins of the river valleys. This interrupted drainage network allowed for lakes and wetlands to occupy depressions within the prairie and oak savannas, and thus intercalating the open landscape with more heavily wooded areas that was otherwise maintained by periodic fire disturbance.

FIGURE 16: Ecological Subsections



iii. Plant Community Assessment

The Greenway Corridor was divided into Land Cover Management Units (Units), based on: 1) the Minnesota Land Cover Classification (MLCCS) system; 2) a Greenway Corridor land cover site evaluation; 3) realistic restoration goals (taking into consideration cost); and 4) proposed restoration tasks.

1. Land Cover

The Minnesota Department of Natural Resources (DNR) developed a system called the Minnesota Land Cover Classification System (MLCCS), which integrates cultural and vegetative features of the landscape into one comprehensive land cover classification system. This information was used as a basis for the site evaluation, which was conducted by Dakota County Staff in July and August of 2018. Based on changes in land use and plant communities over time, some of the classifications were updated to reflect current conditions. Refer to Figure 15 (MLCCS Land Cover) for updated MLCCS classifications.

MLCCS consists of five hierarchical levels that are reflected in the five digit classification code. At the most general level, land cover is divided into either Natural/Semi-Natural cover types or Cultural cover types. The Cultural classification system is designed to identify built-up / vegetation patterns and an area's imperviousness to water infiltration.

Level 1 - General growth patterns (e.g. forest, woodland, shrubland, etc.)
Level 2 - Plant types (e.g. deciduous, coniferous, grasslands, forbs, etc.)
Level 3 - Soil hydrology (e.g. upland, seasonally flooded, saturated, etc.)
Levels 4 & 5 - Plant species composition, (e.g. floodplain forest, rich fen sedge, jack pine barrens, etc.)

The following outlines the MLCCS codes, plant communities, and description for each site within the Greenway Corridor:

2. Site Evaluation

A site evaluation was conducted by Dakota County Natural Resources Staff in July and August 2019. The Greenway Corridor was divided into existing Land Cover Management Units, based on existing land cover, realistic restoration goals, and proposed restoration tasks. Land Cover Management Units are shown in **Figure 17** and summarized in **Table 3**, are used to best describe the plant communities and restoration tasks for the regions within the Greenway Corridor, and do not necessarily align with the boundaries of the MLCCS polygons. Plant species lists for each unit are provided in Appendix A. Each of the land cover units are evaluated using criteria explained below and other site conditions to develop a general score for overall "ecological health".

Valley Park

The 94-acre section encompassed by Valley Park in Mendota Heights is largely dominated by forest, with open grassland areas below high voltage power lines and both open and forested wetlands at the valley bottom. The forested area within Valley Park is largely dominated by altered/non-native deciduous forest, (MLCCS cover class 32170, **Figure 17A**), interspersed with pockets of oak forest (32110) at higher elevations. Some of the oaks in these areas were present in 1937 aerials and exhibit extensive lateral branches, indicating they

once grew in a more diffuse, open canopy. At lower elevations near the creek, floodplain forest or lowland hardwood forest (32210 or 32220) consisting primarily of boxelder, Amur maple, cottonwood, and aspen occur. Higher elevation areas along the west end bordering the freeway exhibit oak woodland/brushland with bur oak, black cherry and northern pin oak, as well as altered non-native deciduous woodland (42120 and 42130, resp.) consisting of green ash, boxelder, black walnut, and American elm. Planted conifers such as white pine, Norway pine and spruce exist within the altered forest matrix throughout the park, and this cover type is most notable in the white pine plantation (33140) in the portion of the Park just north of Marie Ave. The understory of much of these forested areas is shaded by a dense shrub layer of buckthorn and honeysuckle. Native species persisting on the forest floor include vines such as woodbine, wild and wild cucumber, as well as shrubs such as raspberry and gooseberry. Common forbs were present such as false Solomon's seal, stickseed, clearweed, jewelweed, bedstraw, avens, Pennsylvania smartweed and tall meadow rue. Other non-native plant cover includes reed canary grass smooth brome, chickweed, burdock, garlic mustard, and Japanese hedge parsley.

Upland open corridors under powerlines are classified as altered non-native dominated grasslands (61220) and shrubland (52130), where shrub encroachment is apparent. Open wetlands are dominated by reed canary grass (61530), with occasional willows (*Salix* spp.).

Dodge Nature Center

Lilly Property

The Dodge Lilly Property is a 170-acre matrix of upland oak woodlands, altered deciduous forest (42130, **Figure 17B**), lowland hardwood forest (32220), tallgrass prairie restorations (23212 and 61110) and altered grassland/oldfields, with wetland complexes separated by ridges and comprised of altered/non-native wet meadows, emergent marsh (61530), and shrub swamp (32420 and 52440).

Some of the altered hardwood forest in upland areas, especially the northwest-to-southeast trending ridge that subdivides the western wetlands from the remaining Property, is composed of oak forest that has significant presence of buckthorn and honeysuckle and tree species that have more recently colonized the area (especially boxelder, green ash, cottonwood, and black walnut).

The southeast corner of the property exhibits some recent woody encroachment in an area classified as long grasses and mixed trees (13115), where previously open areas have been overgrown with sumac, green ash, and other native species. The south- and west-facing aspect of this higher elevation area has many larger bur and white oaks that are present in the earliest aerial photography.

Significant native tree and shrub plantings have been undertaken along the trail systems throughout the Dodge properties, and planted species include bur oak, sugar maple, ninebark, red osier dogwood, downy arrowwood and nannyberry.

Marie Property

The Marie Property of Dodge Nature Center (**Figure 17C**) lies south of their Main campus on Marie Avenue. This 40-acre protected area is mostly forested, both with oak woodlands on upland knolls (32110), lowland

wet forest dominated by cottonwood, green ash, and box elder (32170). Areas in the map marked as altered grassland with sparse deciduous trees (62140) have significant encroachment of woody shrubs, including native elderberry as well as nonnative Amur maple and Siberian elm. Silver and Norway maples introduced to the site as part of old homesteads are present in higher abundance in the east side of these units and periodically within the deciduous forest (32170) units.

The South end of the Property contains a seasonally altered non-native dominated emergent wetland (61530) with reed canary grass and hybrid cattail cover. Willow shrubs and black willow trees grow in the periphery of the wetland. Interestingly, a single tamarack tree remains near the boardwalk on the northern portion of the wetland; its size suggests it was intentionally planted. The remnants of a poor fen were documented in a 2004 Management Brief (Harris, 2004), but Dakota County Staff did not evidence of sphagnum moss or other plants characteristic of poor fens during the field visit. Additional field work is needed to locate any remaining remnants of vegetation characteristic of poor fen.

A prairie reconstruction occupies a strip along the west edge of the property, and significant removal of exotic shrubs has occurred within 100 feet of the soft-surface walking paths throughout the property. Bur oaks and native shrubs have been planted in these clearings, but these planted oaks remain relatively shaded in the understory of the cottonwood-dominated canopy. Additional forb plantings occur along the pathways, some of which show evidence of deer herbivory.

Main Property

The Main Property of Dodge Nature Center is comprised of natural areas juxtaposed with a farm, nature play area and preschool, and nature center programming areas. Discounting trails, program space occupies approximately 15.8 ac (13% of the land), with the remaining natural areas consisting open water ponds (93300, 15.6 ac), open cattail marsh wetlands (61520 and 61530), mixed hardwood forest, reconstructed prairies (61110, 4.8 ac), and altered grasslands. Within MLCCS landcover areas demarcated as Altered/Non-native deciduous forest (32170) are pockets of white oaks and planted sugar maples. The intact oak woodland in the northwest section of the Main property (42120) has an additional assortment of secondary-growth trees (**Figure 17C**).

West Saint Paul Parks

Garlough Park

Garlough Park's developed infrastructure includes a picnic shelter and a disc golf course throughout an area with mature white and bur oaks (13114). This activity is compatible with the current vegetative structure as an altered oak savanna with turf grasses. The western portion of the park is an oak woodland (42120) with significant amounts of buckthorn. Additional trees have grown into the woodland, including box elder, cottonwood, and hackberry. Lower lying areas in the eastern portion of the Park are occupied by wet aspen forest (32160) and a shrub-carr wetland (52420). The disconnected northern unit of this aspen (32160) forest demarcated in **Figure 17D** is comprised of mature bigtooth aspen. While this wetland was not extensively surveyed, significant amounts of buckthorn and reed canary grass is present. Understory species are similar to those documented in Valley Park, with large amounts of burdock and poison ivy along the canopy gaps created by trails.

Marthaler Park

Located in West St. Paul, the 34-acre Marthaler Park features open, grassy areas, a small lake, and a forest matrix categorized by the MLCCS as an oak woodland-brushland (42120). The oak woodland section of the park is the most ecologically intact area of the park, as most other areas are altered and dominated by turf grass. Common trees observed in the oak-woodland brushland include aspen, bur oak, and red oak , while red maple, green ash, black cherry, and cottonwood are present but less abundant. A number of bur oaks appear to have an open-grown appearance, indicating that this forest is in the intermediate stages of transitioning from a fire-dependent oak savanna to an oak forest. This section of the park is heavily dominated by shrubs and understory trees, including mountain ash, alder buckthorn, sumac, and heavily abundant common buckthorn. Gooseberry, raspberry, woodbine, and wild grape are also present while less common understory forbs include jack-in-the-pulpit, Solomon's seal, and sensitive fern. Small sections of aspen forest (32160), and native dominated disturbed upland shrubland (52120) are present in and adjacent to the oak woodland section.

The lower section of the park, near the parking lot, is characterized by the MLCCS as dominated mostly by short grasses and mixed trees, with 26-50% impervious surfaces (13134). Trees in this section include red oak, sugar maple, box elder, white oak, and green ash. Wooded edges in this section are heavily dominated by common buckthorn.

Wentworth Library

Wentworth Library is located along the River to River Greenway in a highly developed area of West St. Paul. There is a small amount of land surrounding the front and back of the library. In the front of the library is a small pollinator garden that includes species such as anise hyssop, woodland sunflower, goldenrods, and bottle brush grass as well as large white oak trees. On the back side of the library, there is a turf grass lawn, large, open-grown white oak and silver maple trees, as well as small native vegetation plantings that include species such spotted joe-pye weed and goldenrods.

Thompson Oaks Golf Course

While the golf course grounds are predominantly covered with turf grass and landscaping trees, this section is slated for development and subsequent stormwater basin re-shaping with native prairie and woodland restorations (See Future Cover **Figure 18G** for proposed map).

Thompson County Park

Thompson County Park has a Natural Resource Management Plan (Adopted by County Board 21 January 2020, County Board Resolution No. 20-037). In summary, the 58-acre Park was cleared of the few trees that might have been there pre-settlement, as much of the Park was cultivated. The two areas that remained uncultivated included the wetland basin now containing Thompson Lake, and the southern sloped portion of the Park that forms the beginning of Simon's Ravine. The Thompson Lake basin did not exhibit any open water in the 1937 aerial photography (**Figures 4D, 5D**), suggesting that the drought of the 1930's resulted in the basin to be a shallow wetland with vegetative cover. Due to lack of aerial photography pre-dating 1937, it is difficult to determine how often this basin flooded, and whether it was dominated by either (wetter) emergent marsh or (drier) wet meadow vegetation. The beginning of the Ravine area in the south had much

sparser tree cover in the earliest aerial photography, but has since succeeded into an Oak-Basswood Forest (32110; **Figure 17D**).

Much of the remaining cleared agricultural area has since become forested with black walnut, box elder, cottonwood, green ash and black locust (32170 and 42130). One area east of the Dakota Lodge parking area remains unforested – designated as cover type 61220 this open area is dominated with smooth brome with 30% cover of sumac. The invasive species leafy spurge (*Euphorbia esula*) was found within one acre of this grassy knoll, such that *Aphthona* sp. flea beetles were released by the Minnesota Department of Agriculture as a biocontrol in June 2019.

Kaposia and Simon's Ravine

Kaposia Park encompasses 85 acres spanning from Highway 52 down to Kaposia Landing and the Mississippi River in South St. Paul. The western part of the park, near Highway 52 is characterized by areas of oak forest (32110), lowland hardwood forest (32220), turf grass lawns, and a wet meadow (61420). Common trees in this upper section of the park include bur oaks, black locust, green ash, and silver maple. The understory in this section of the park is largely cleared and planted with turf grass, and is used as a disc golf course. Near the paved trail that leads down to Simons Ravine, the understory is dense with shrubs including sumac and white mulberry. This part of the park also contains a degraded wet meadow, which is dominated by cattail and smaller populations reed canary grass around the periphery of the wetland.

Moving down the paved trail towards Simon's Ravine, the forest canopy transitions to an oak forest mesic subtype (32112). Trees in the canopy include red oak, white oak, sugar maple, American elm, green ash, and black cherry. This section has a dense shrub and tree understory, including sumac, white mulberry and black cherry trees. Grasses in this section include reed canary grass, Canada wild rye, and barnyard grass. Native forbs commonly encountered include woodland sunflower, woodbine, black snakeroot, raspberry, early meadow rue, cutleaf coneflower, joe-pye weed, and clearweed. Non-native forbs and shrubs encountered include garlic mustard, burdock, bittersweet nightshade, and motherwort. Slopes on either side of the trail are steep, and there are several instances of erosion. Downslope of the Park into Simon's Ravine exists one of the more intact and biologically diverse stands of native vegetation along the River to River Greenway Corridor. There are landscaped terraces along either side of the trail under the 19th Avenue North overpass. For approximately 200 feet, the vegetation is highly disturbed, with a border of Siberian elm on the south east side of the trail. It opens up to an oak forest mesic subtype (32112) with oak forest (32110) higher on the slopes to the east as you move down the trail. The canopy composition is similar to that higher on the trail including red and white oak, with box elder, black locust, American basswood, and sugar maple. Shrubs and understory include white mulberry, Amur maple, American basswood, garlic mustard, wild geranium, crown vetch, Virginia waterleaf and tall meadow-rue. Moving north, the trail transitions to an altered grassland with sparse deciduous trees (62140) and into Maple-Basswood forest (32150) on the south side of the trail. Canopy includes American basswood, sugar maple, black locust, black walnut, red oak, green ash, and cottonwood. The mid-canopy and understory varies, but includes buckthorn, chokecherry, pagoda dogwood, ironwood, bitternut hickory, American elm, sugar maple, wild ginger, garlic mustard, black snakeroot, cutleaf coneflower, carrion flower, Canada moonseed, bloodroot, jack-in-the-pulpit, wood anemone, Virginia waterleaf and Canadian honewort. The entrance to the

trail from the Simon's Ravine parking lot is flanked by impervious cover, short grasses and a mix of deciduous trees including oak forest (11220, 13144, 32110). Canopy includes sugar maples, American basswood, American elm, paper birch, red oak and ironwood. The midstory was mostly invasive buckthorn and honeysuckle, but it was not dense. A variety of forbs were in the groundcover and invasives did not dominate; little-leaf buttercup, sweet cicely, golden alexanders, jack-in-the-pulpit, bloodroot, wild sarsaparilla, false Solomon's seal, zigzag goldenrod, Virginia waterleaf, woodbine, Japanese hedge parsley and both Pennsylvania and Sprengel's sedges.

Table 3: Summary of Land Cover Management Unit Quality

Site	Land Cover Units	MLCCS Classifications	Area (ac)	Quality Index*
Valley Park	Oak Forest	32110	11.9	C
	Wet Forest	32210, 32220,	10.1	C
	Deciduous Forest	11210, 32170, 42130, 43110, 52120, 52130	38.1	NA/NN
	Conifer Plantation	33140	4.3	C
	Oak woodland	42120, 42130	3.8	C
	Grassland	13125, 13212, 13221, 52120, 52130, 61220, 62140	12.8	C/NA/NN
	Wetland	52430, 61330, 61520, 61530	11.3	C/NA
	Developed (>25% impervious)	11240, 13134, 13232	7.0	NN
Dodge Nature Center	Oak Forest	32110	1.9	C
	Wet Forest	32220, 32420	29.5	C
	Deciduous Forest	11210, 13114, 13115, 32170, 52130	72.2	NA/NN
	Oak Woodland	42120, 42130, 43110	40.3	C/NA/NN
	Grassland	13124, 13125, 13211, 13134, 23111, 23212, 24110, 61110, 61220, 62140, 62220	84.7	C/NA/NN
	Wetland	52130, 52420, 52440, 61330, 61480, 61520, 61530, 61620	67.8	C/NA/NN
	Developed (>25% impervious)	13124, 13125, 13134, 13135, 13241, 14123	10.7	NA
Garlough & Marthaler Park	Oak Forest	32110	1.4	C
	Oak Woodland	42120, 52120, 52130	17.8	C/NA
	Wet Forest	32160	7.5	C
	Deciduous Forest	32170, 42130	1.9	NA
	Grassland	13114, 13124, 13211, 23212	15.3	
	Wetland	52420	3.2	C
	Developed (>25% impervious)	13134, 13231, 14113, 14123	39.1	
Wentworth Library	Deciduous Forest	62140	2.5	NA
Thompson County Park	Oak Forest	32110	2.1	C
	Wet Forest	32160, 32220, 52220	1.5	C
	Deciduous Forest	21213, 32170, 42130	27.0	C/NA
	Grassland	13211, 23111, 23112, 23211, 23312	19.5	NA
	Wetland	52130, 52420, 52440, 61330, 61480, 61530, 61620	0.7	C
	Developed (>25% impervious)	11230, 13134, 13144, 13230	29.9	

Kaposia / Simon's Ravine	Oak Forest	32110, 32112	39.1	A/B/C
	Maple-Basswood Forest	32150	2.4	C
	Deciduous Forest	11220, 32170, 42130	8.2	
	Wet Forest	32160, 32220	4.5	C
	Wetland	61420	1.2	C
	Developed (>25% impervious)	11230, 13134, 13144, 13230, 14122	32.6	

*Quality Index is based on the Element Occurrence Ranking Guidelines (http://files.dnr.state.mn.us/ecological_services/nhnrp/eoranks2001.pdfp/eoranks2001.pdf A=Excellent, B=Good, C=Moderate, NA = native species present in altered/non-native community, and NN = altered/non-native community

FIGURE 17A: Existing Landcover – MLCCS Classes, Valley Park

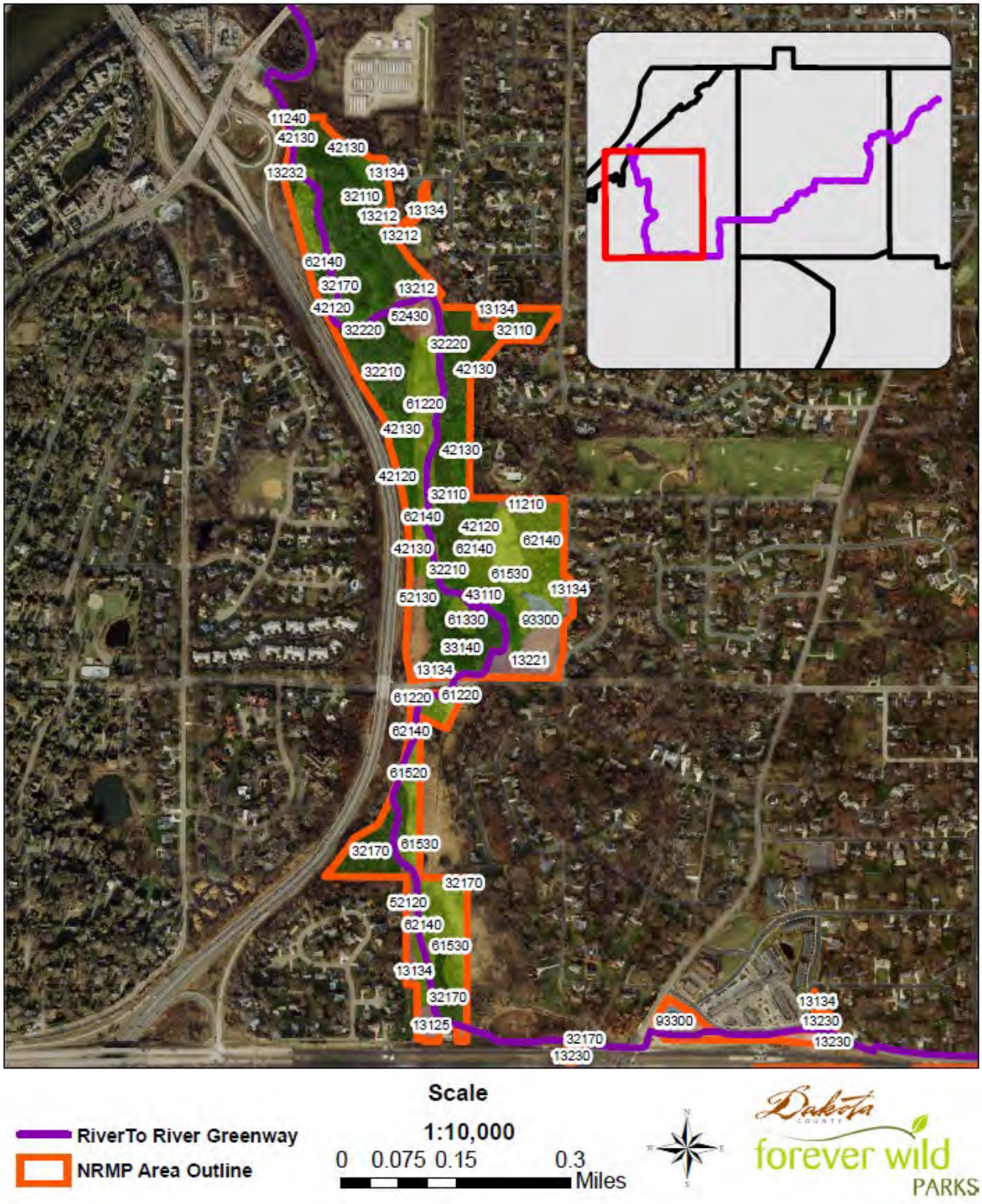
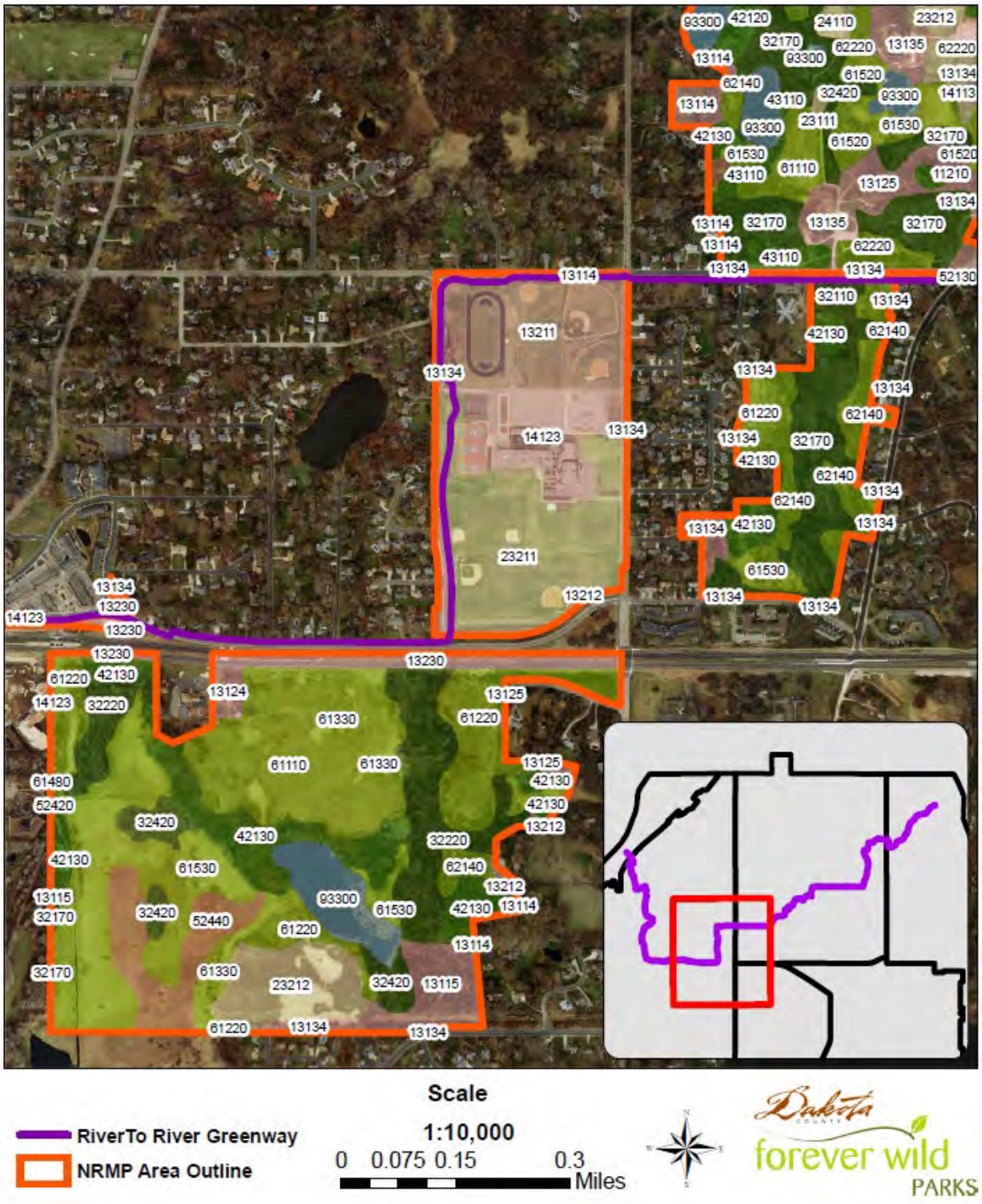


FIGURE 17B: Existing Landcover – MLCCS Classes, Dodge Nature Center



Scale

1:10,000

0 0.075 0.15 0.3 Miles

RiverTo River Greenway

NRMP Area Outline

Dakota County forever wild PARKS

FIGURE 17C: Existing Landcover – MLCCS Classes, West Saint Paul

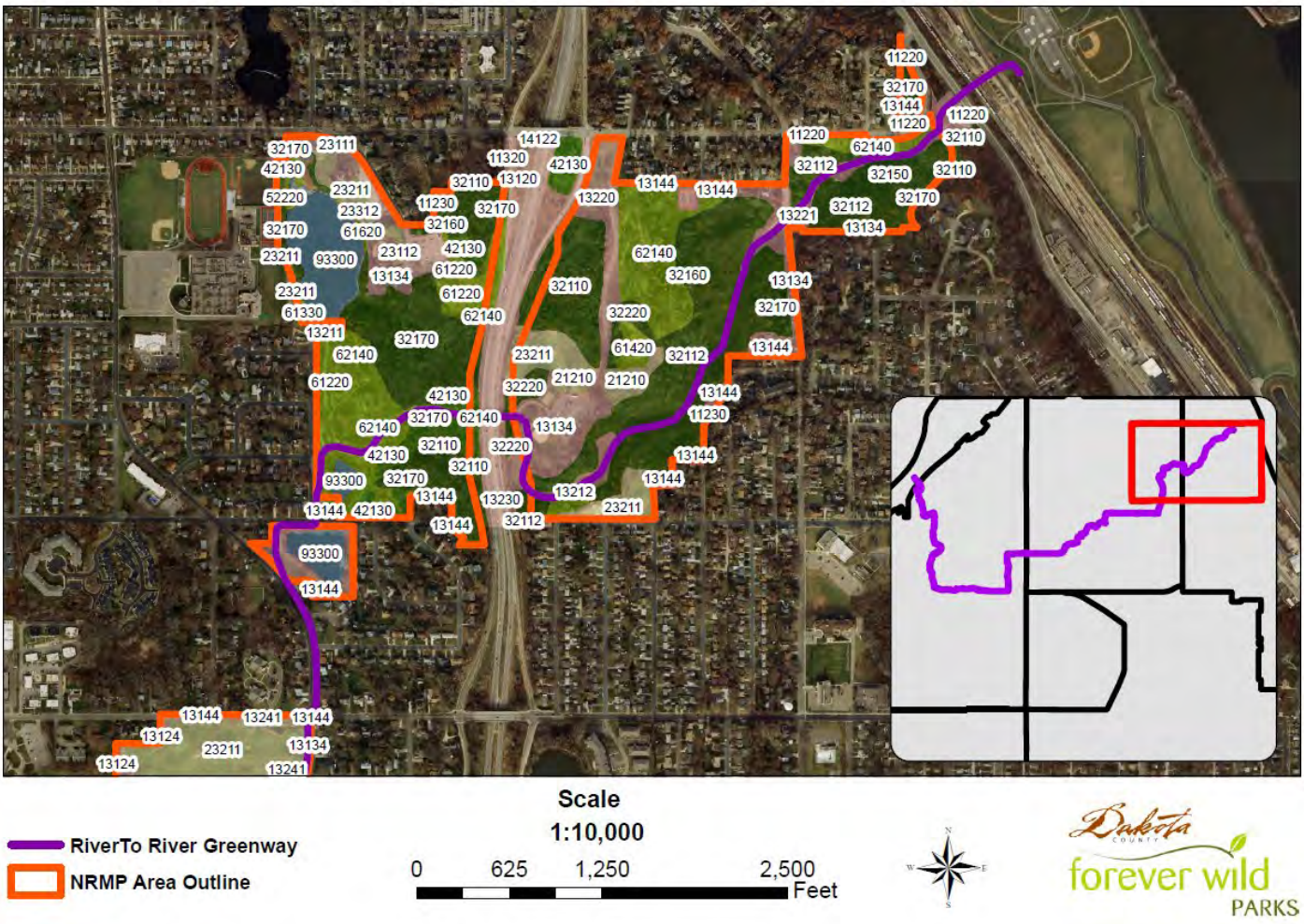
Scale
1:10,000

RiverTo River Greenway
NRMP Area Outline

0 625 1,250 2,500 Feet

Dakota County forever wild PARKS

FIGURE 17D: Existing Landcover – MLCCS Classes, Thompson County Park and Kaposia



VI. Wildlife

A. Historical

Dakota County encompasses a variety of ecological subsections, including Big Woods, Oak Savanna, the Rochester Plateau, and the St. Paul Baldwin Plains and Moraines. Each subsection contains multiple habitats, and hosts an associated suite of wildlife Species of Greatest Conservation Need (SGCN). Coupled with an abundance of water resources, these habitats supported diverse plant communities and associated wildlife. However, over time, European settlement brought many changes to the landscape. The deep, fertile soils of most prairies were converted to agricultural fields. Forests were logged, wetlands were drained and stream and river courses and flows were altered. Overhunting was also a major issue and many wildlife populations declined precipitously.

Large mammal species, including bison, elk, black bears, wolves, and mountain lions were once found in the County. In the 1800s, early explorers and settlers, from Radisson to Hennepin, documented bison grazing the prairie terraces near Fort Snelling. By 1860, bison were nearly extirpated from all of North America. During the

drought years in the 1930s, numerous elk antlers were retrieved from shallow lakes in southern Minnesota, evidence of their historical presence on the landscape. Black bears, among other predators, were common throughout the 18th and 19th centuries, demonstrating that the animal diversity in the state and the County could support a variety of large predators.

Smaller mammals were also likely more abundant in the County during the pre-settlement era. From fur traders' records in the 1930s, it is evident that beaver, muskrat, and mink were killed for their furs; and populations of these species declined precipitously. Prairie species, such as Franklin's ground squirrel, American badger, and a number of vole and mice species declined with the conversion of prairie and savanna to agriculture, though these declines are mostly anecdotal.

Hunting and land use changes also affected bird populations. The extinction of the passenger pigeon highlights the extreme pressure that hunting had on many of the County's wildlife species, while species, such as prairie chickens, were locally extirpated as prairie was converted to agriculture. Waterfowl populations declined as well, due to hunting and wetland drainage for agriculture and development. During the mid-20th century, predators such as hawks, bald eagles and owls, were negatively impacted by hunting and human-caused pollution. Chemicals, such as DDT, caused declines in populations of species like bald eagles, as the chemical weakened egg shells and led to low brood success. This particular species was listed as threatened on the first state endangered species list published in 1984.

Largely anecdotal information exists regarding the decline of reptiles and amphibians in the County. Many reptiles, such as eastern racers and six-lined racerunners, depend on prairie habitat – particularly bluff prairies – and have likely experienced precipitous declines given historical habitat conversion. Wetland drainage and pollution by fertilizers and other chemicals has led to declines in wetland species, including amphibians, such as Blanchard's cricket frog, and reptiles, such as Blanding's turtles. These more amphibious species are not only tied to land and water habitats, but are also often sensitive to pollution of these habitats.

Soil erosion from agricultural operations and intense land use increased sediment loads to rivers and streams, negatively affecting aquatic ecosystems. Suburban development resulted in more warm water runoff into cool streams, which led to adverse thermal effects and stressed aquatic life. These land use changes had many negative effects on wildlife. Frog and salamander species, sensitive to chemicals and changes in hydrology, declined. As runoff and pollution flowed into rivers like the Vermillion, it resulted in declines in many types of aquatic species. Brook trout, for example, are sensitive to warm water; and rivers like the Vermillion saw declines in trout populations as runoff, pollution, and warm water from treatment plants flowed into the river. While there is conflicting evidence as to whether brook trout were native to the river, having potentially been stocked in the 1800s, trout decline throughout the 20th century is a clear example of the effects of development on wildlife. Brook trout are now restricted to only three streams in the entire County.

Importantly, the combination of research, public interest, education, changing attitudes, laws and regulations, and increased land protection and natural resource management have had a generally beneficial effect on wildlife during the last decades. Increased environmental regulation has benefitted wildlife populations. Beginning in the 1980s, the introduction of water quality rules at the federal and state levels has improved

water quality impacted by point source pollution (e.g., waste-water treatment plants), and is also providing a solid framework to quantify and limit non-point sources (e.g., field runoff), which should greatly benefit wildlife that relies on clean water. Other pollution regulations, like the ban on the use of DDT, have resulted in increases in bald eagle and other raptor populations in the County and in the entire region. A greater focus on land conservation has also ensured that there is available habitat for County wildlife. For example, the establishment and expansion of critical protected public and private lands has protected habitat for numerous SGCN and other wildlife. Ecological restoration of these and other habitats has also ensured that quality habitat exists for these populations. And finally, an increase in public involvement in conservation has benefited a number of species. For example, the rebound of the bluebird population, from its historical low in the mid-1900s, was due in large part to nest box campaigns involving local citizens.

Unfortunately, residential and agricultural development, invasive species and climate change continue to have significant impacts on County wildlife. Animals that require specific habitat types, or habitats adversely impacted by development, agriculture and pollution, have been most impacted. Invasive species have become one of the most significant issues for native species diversity in Minnesota. Invasive shrubs, like buckthorn, not only adversely affect native plant diversity, but have been shown to cause declines in shrub-nesting bird species and can negatively impact frog development. Invasive European earthworms have also been linked to declines in forest floor dwellers like salamanders and ovenbirds.

Looking forward, tree pests and diseases, like the emerald ash borer and oak wilt, have been shown to provide avenues for the introduction of invasive plant species, which could negatively affect wildlife in the future. Conversely, these tree maladies may also provide welcome habitat for species like cavity-nesting birds. Climate change effects on wildlife will depend on a number of factors, and are predicted to shift the range of many species northward and potentially out of Dakota County. Ultimately, climate change may either create or remove habitat for many native wildlife species.

B. Existing Populations

While no mammal species were observed during the field visits to these sites, there were indications of the presence of deer, such as tracks, rubs, and evidence of browsing/grazing. Particularly, some native plants showed evidence of deer herbivory, such as cup plant (*Silphium perfoliatum*) that had been planted on Dodge properties.

In order to better document the wildlife using the River to River Greenway, occasional landowner surveys could provide useful data. These surveys could be low intensity, low effort undertakings, and could be accomplished by walking portions of the Greenway Corridor. For example, taking pictures of animal tracks, whether in the mud or snow, is a good way of identifying many mammal species. If landowners are not familiar with tracks, photos can be sent to local wildlife officials for verification. Moreover, landowners can keep a log of the species that visit their feeders and garden plots, taking photos when necessary. Trail cameras are another good resource for capturing photos of wildlife. Positioning these cameras near water, known

feeding areas, or along paths and deer trails can capture a variety of animals using these areas. Cameras can be purchased by the landowner or borrowed from other agencies.

Bird surveys can be conducted by landowners if they have birding knowledge, especially during breeding season. These surveys can capture resident birds that use the Greenway year-round, as well as migrants that use the property as an important stop-over or breeding ground. For reptiles, the use of artificial refugia (pieces of corrugated metal or heat-trapping materials like roofing material or rubber car mats) can attract individuals seeking to warm their bodies. Springtime is the best for surveying, when species like snakes are most active. Surveys consist of establishing refugia and checking on and under them when conditions are right (cool, sunny days in early to mid-spring are best). Amphibians are best surveyed during the spring and summer, often by identifying their calls in the evening or at night. Recording unknown calls can also allow experts to help identify them. Lastly, keeping a list of bees, butterflies and other insects can help characterize the overall insect community. Refer to Section C for a list of species that can be monitored.

Establishing a network of parks, preserves, and private conservation easements may allow species to use restored areas that may otherwise be inaccessible. Protecting properties with this connectivity in mind will provide important benefits for the wildlife of Dakota County.

C. Indicator Species

The following are relatively common species that are largely dependent on grassland or prairie habitat for breeding. Not all of these species would be expected at any given site. Presence/ absence can depend on multiple factors, including: size and shape of grassland, proximity to woods or other habitat types, degree of isolation, and structural and species diversity. There are many additional species that would also be expected on prairies, but are not considered as prairie dependent.

Table 4: **Indicator Species Observed in Dakota County**

MAMMALS	
American badger (requires large areas)	Franklin's ground squirrel
Plains pocket gopher (keystone species)	Prairie vole (Species of special concern [SPC])
Thirteen-lined ground squirrel	
GRASSLAND BIRDS	
American kestrel	Barn swallow
Clay-colored sparrow (SCGN)	Dickcissel (SGCN)
Eastern bluebird	Eastern kingbird
Eastern meadowlark (SGCN)	Field sparrow
Grasshopper sparrow (SCGN)	Henslow's sparrow (Endangered, SCGN)
Horned lark	Lark sparrow
Loggerhead shrike (Endangered, SGGN)	Northern rough-winged swallow (SGCN
Savannah sparrow (SPC)	Song sparrow
Tree swallow	
TREE NESTING BIRDS	

Note: These Species may be found along the edge of grassland and prairies because they require trees for nesting:	
American goldfinch	Baltimore oriole
Brown thrasher	Chipping sparrow
Indigo bunting	Orchard oriole
Ruby throated hummingbird	
REPTILES	
Bull snake (SPC)	Eastern racer (SPC, SGGN)
Plains (western) hognose snake (SPC)	Prairie skink
Six-lined racerunner (SGGN)	Smooth Green Snake (SGGN)
INSECTS	
Monarch butterfly	Regal Fritillary
Rusty Patched Bumblebee (Endangered)	

The following are relatively common bird species that are largely dependent on woodland habitat. Not all of these species would be expected at any given site. Presence/absence can depend on multiple factors such as size and shape of the woodland, proximity to prairie or other habitat types, degree of isolation, and structural and species diversity. There are many additional species that would also be expected on woodlands, but are not considered as woodland-dependent.

WOODLAND BIRDS		
Cooper's hawk	Eastern wood pewee	Brown creeper
Black-billed cuckoo	Eastern phoebe	Blue-gray gnatcatcher
Great horned owl	Least flycatcher	Ovenbird
Barred owl	Great crested flycatcher	Blue-winged warbler
Red-bellied woodpecker	Yellow-throated vireo	Yellow-rumped warbler
Yellow-bellied sapsucker	Warbling vireo	American redstart
Downy woodpecker	Red-eyed vireo	Scarlet tanager
Hairy woodpecker	Black-capped chickadee	Rose breasted grosbeak
Pileated woodpecker	White breasted nuthatch	Baltimore oriole

VII. Priority Features and Recommendations

Priority features identified in this plan focus attention on the preservation, restoration, or enhancement of particular species, plant communities, or ecosystem processes. Restoration/conservation objectives are listed for each priority feature. For priority features that discuss community types, the suggested activities are recommended for all areas corresponding to those future cover types indicated in **Figures 18A-I**. Future cover types were determined after evaluating landowner preferences (See maps **Appendix A**), existing vegetation, and considering costs for restoration

A. Oak Savanna

i. Eliminate cover of all exotic shrubs

Exotic buckthorn and honeysuckle species exhibit the greatest extent of cover in the understory of most forests within the study area of this NRMP. Removing this layer of vegetation and following up with maintenance to suppress shrub sprouts from stumps and their seedbed would significantly increase the amount of light available to for the establishment of desired understory vegetation, including the recruitment of oak trees for future desired canopy cover.

ii. Remove secondary growth trees and shrubs

Native tree species such as box elder, cottonwood, green ash and black walnut have all grown into savanna areas since fire suppression began. To re-establish savanna, it is recommended that these species, in addition to any non-native (Siberian elm, homestead cultivar) trees should be removed to reduce the tree density to between 10 and 20 percent canopy cover, with a preference towards retaining white and bur oaks.

iii. Establish prairie grasses and forbs as the dominant ground cover

Native prairie grasses and forbs are the dominant vegetative cover within intact oak savannas. In areas where extensive tree and shrub removal has occurred, there is little likelihood for native seedbank establishment. Once the canopy has been thinned with tree removal (*ii* above), it is recommended to undergo a season of site preparation by way of herbicide application after an initial flush of weedy vegetation has expressed itself from the seedbank. Urban and suburban sites typified by the areas identified in this Greenway Corridor have a long history of human-mediated disturbance, such that weed pressure will be high and prioritizing initial weed control with prolonged site preparation will support better establishment of installed native species.

iv. Utilize fire as a management tool to control woody encroachment

Native prairie grasses provide fuel for management by fire, a major missing historical process that maintained these areas as open savannas. The reintroduction of fire through prescribed burning in these areas will kill fire-intolerant seedling trees and shrubs. Selecting less frequent fire return intervals that allow initial establishment of young white/bur oak trees, or selectively protecting tree species from fire, would allow for some oak recruitment and ensure continued regeneration of savanna.

B. Oak Woodlands

i. Eliminate cover of all exotic shrubs

As in oak savanna areas, these shrubs prevent the recruitment of younger oak trees and the establishment of native graminoids and forbs on the forest floor. Follow-up management of resprouts is recommended in the fall season after initial removal and prior to the onset of dormancy.

ii. Thin forest to promote future canopy composition

The aforementioned tree species indicative of secondary growth can be thinned to achieve a 20 to 80 percent canopy cover, preserving oaks in general and white/bur oaks in particular, but thinning activities can fluctuate allowing for a naturalized mosaic grading to adjacent cover types. By thinning less desirable trees, the composition of future canopy cover can be directed to sustain the continued presence of oaks.

iii. Establish dispersed native shrub layer

Native shrubs offer greater habitat advantages to wildlife in terms of both food and structural complexity compared to the buckthorn and honeysuckle they replace. While use of competition and shading is an emerging strategy for buckthorn management, it is not meant to take the place of periodic maintenance sweeps to keep exotic shrubs from re-establishing within this matrix. Fire-tolerant shrubs would succeed in cases where woodland burns are also elected as a strategy for maintaining exotic species and woodland structure.

iv. Establish native shade-tolerant forbs for increased pollinator value

Woodland forbs, especially spring ephemerals such as bloodroot, *Anemone* spp., and Jack-in-the-pulpit support early emerging insects, some of which have developed specialized ecological roles in association with host plants (e.g., plants providing pollen to bees or inducing ant-mediated seed dispersal known as myrmecochory). Native woodland forb cover also helps to reduce erosion of bare forest soils, as leaves intercept rain drops and increase water infiltration rates, all contributing to greater water quality.

C. Mesic Hardwood Forests

i. Eliminate cover of all exotic shrubs

As previously mentioned, this is the single greatest threat and first step in the restoration process. Some of the hardwood forests found in the Greenway Corridor differ in the extend to which exotic shrubs are problematic; namely, the Sugar Maple/ Basswood Forest in Simon's Ravine has relatively low levels of introduced shrub layer due to the denser canopy and diminished sunlight, especially compared to some of the more recently afforested areas and mixed hardwood-oak stands with lower tree densities.

ii. Establish dispersed native tree and shrub layer

Planting native shrubs in the understory of these forests contributes to added complexity to the structure of these forests, competes with exotic shrubs, and provides enhanced wildlife habitat value.

iii. Diversify canopy species

While some of these mesic hardwood forests are results of afforestation within the last 50 years, in some cases there would not be much public support for complete removal and replacement of existing tree cover with a prairie planting. In such cases where large degrees of effort would need to be made to convert to an existing altered forest to a documented Minnesota native plant community, a broader target community can allow for a more flexible approach to selecting future canopy species composition. Forests dominated by cottonwood, boxelder, ash and walnut can be transitioned to other forest types by selectively removing tree species. In particular, even mature specimens impacted by insects such as ash (due to Emerald Ash Borer) or disease will need to be selectively removed, and replacement plantings will consider species appropriate to various target communities. For example, replacing pioneering tree species with oaks or basswood would set a successional trajectory more closely resembling native plant communities such as Southern Dry-Mesic Oak Forest (MHs37) and Southern Mesic Oak Basswood Forest (MHs38). More mesic sites can be targeted for introducing species more common in SE forests, including bitternut hickory in Southern Wet-Mesic Hardwood Forests (MHs49) or Southern Terrace Forests (FFs59) found along streams.

iv. Establish native ground cover

Planting woodland sedges, grasses, and forbs (especially spring ephemerals) will create opportunities for slowing down erosion, controlling invasive species with competition and fire, and add pollinator resources to these altered forests. Continued management to remove garlic mustard will ensure diverse species composition on the forest floor.

D. Prairies

i. Convert turf and altered grasslands to native prairies

Under-utilized park areas with maintained turf cover or former pastured lands dominated by exotic forage grasses can be converted to native shortgrass or tallgrass prairies, depending on soil type and hydrological conditions. A year of herbicide site preparation is recommended to exhaust the weed seed bank prior to seeding with native prairie vegetation.

ii. Remove encroaching woody species

Prairie/woodland margins are succeeding to wooded secondary forest, thus shading out prairie grasses and forbs. Re-establishing prairie boundaries by removing encroaching shrubs such as sumac, gray dogwood and/or prickly ash will ensure fine fuel (grass) cover for continued management by fire.

iii. Ongoing prairie management

Prairie maintenance is dependent upon periodic burning, with three to four years as a typical burn interval depending on biomass accumulation. Spot mowing and herbicide treatments should be utilized to manage invasive species and promote native species diversity. In sites where burning may be prohibitive due to proximity to residential neighborhoods, alternative management techniques such as haying or grazing might be explored.

E. Wet Forests

Management activities recommended for wet forests are similar to those of more mesic and dry woodlands, with a few exceptions. Canopy species composition is expected to be more highly dominated by tree species such as cottonwood and aspen. Maintenance by fire is less effective, such that these forests will continuously need to be managed to avoid encroachment of invasive shrubs.

F. Wetlands and Shorelines

i. Manage invasive species

Due to the large extent and highly altered state of the wetlands within the Greenway Corridor, a significant effort must be made to convert these altered wetlands to native plant communities. Efforts to restore these areas will require combinations of techniques such as herbicide application, prescribed fire, and manipulation of hydrological conditions. Some of these wetlands occur on the margins of stormwater ponds and creek banks, and the degree to which water level fluctuations occur with precipitation events is dependent upon upstream watershed connectivity and degree of impervious development.

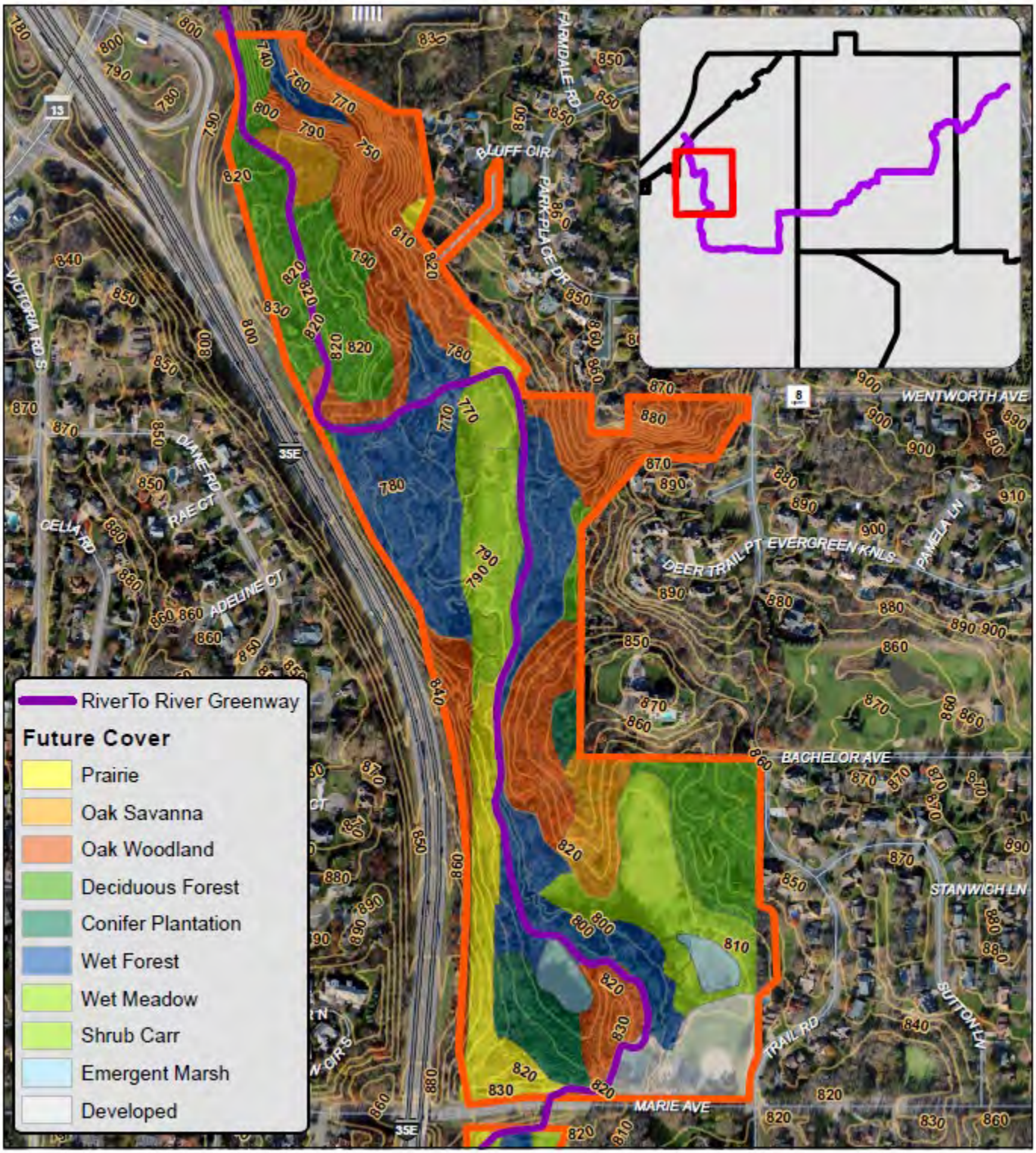
For emergent wetlands, control of hybrid cattails would enable establishment of a native graminoid cover, including bulrushes (*Scirpus* spp.) and sedges (especially *Carex lacustris*), in addition to emergent forbs such as arrowhead (*Sagittaria* spp.) and bur reeds (*Sparganium* spp.). Adjacent upland areas currently dominated by reed canary grass can be restored native cover by way of herbicide application and/or mechanical removal, but they require significant (two growing seasons of) site preparation time to remove viable reed canary grass rhizomes and exhaust its seedbank.

Table 5: Existing Land Cover and Recommended Target Community

Existing Plant Community	Restoration Process	Long-Term Maintenance
Oak-Basswood Forest **Target Community: Oak-Basswood Forest, (MHs38)**	• Invasive shrub removal • Remove ash, boxelder, cottonwood, hackberry, walnut • Plant white and bur oak saplings in canopy gaps • Plant native shrubs • Seed/plug native woodland grasses, sedges and forbs	• Periodic sweeps to remove invasive shrubs • Continue long-term canopy management for oak persistence • Monitor for oak wilt, removals/vibratory plowing when necessary • Reduce deer population
Altered Oak Savanna **Target Communities: Southern Dry and Mesic Savanna (UPs14 and UPs24)**	• Invasive shrub removal • Remove ash, boxelder, cottonwood, hackberry, walnut • Seed/plug native prairie grasses and forbs	• Prescribed burns • Spot treatment of invasive plants • Periodic sweeps to remove invasive shrubs • Reduce deer population
Oak Woodland **Target Community: Southern Dry-Mesic Oak Woodland (FDs37)**	• Invasive shrub removal • Remove ash, boxelder, cottonwood, hackberry, walnut • Plant white and bur oak saplings in canopy gaps • Plant native shrubs • Seed/plug native woodland grasses, sedges and forbs	• Prescribed burns • Spot treatment of invasive plants • Periodic sweeps to remove invasive shrubs • Continue long-term canopy management for oak persistence • Monitor for oak wilt, removals/vibratory plowing when necessary • Reduce deer population
Altered Deciduous Forest **Target Communities: Southern Dry-Mesic Oak Forest (MHs37)**, Southern Dry-Mesic Oak-Hickory Woodland (FDs38), **Southern Mesic Maple-Basswood Forest (MHs39)**, Southern Wet-Mesic Hardwood Forest (MHs49), or Southern Terrace Forest (FFs59).	• Invasive shrub removal • Remove ash, other species dependent upon target • Plant tree saplings in gaps, species dependent, southerly (hickory) • Plant native shrubs • Seed/plug native woodland grasses, sedges and forbs	• Prescribed burns where appropriate • Spot treatment of invasive plants • Periodic sweeps to remove invasive shrubs • Reduce deer population
Altered Wet Forest **Target Communities: Southern Wet Aspen Forest (WFs55) or Southern Floodplain Forest (FFs68)**	• Invasive shrub removal • Plant native shrubs • Seed/plug native woodland grasses, sedges and forbs	• Spot treatment of invasive plants • Periodic sweeps to remove invasive shrubs • Reduce deer population
Wetlands and Shorelines	• Invasive shrub removal	• Periodic prescribed burns

Target Communities: Northern Bulrush-Spikerush Marsh (MRn93), Northern Wet Meadow/Carr (WMn82) and Southern Wet Prairie (WPs54)	• Herbicide application in combination with mechanical removal (cutting, burning, scrape, hydrological manipulations) • Seed/plug with wetland grasses, sedges, and forbs • Plant appropriate wetland shrubs	• Spot treatment of invasive plants
Conifer Plantations **Target Community:** Southern Mesic White Pine – Oak Woodland **(FDs27b)**	• Thin conifer stands by approximately 30%, clear gaps of 30m x 30m for diversified tree establishment • Plant white, bur and red (*Quercus alba, Q. macrocarpa*, and *Q. rubra*) oaks, bitternut hickory, and paper birch in gaps • Plant native shrubs, especially American hazel (*Corylus americana*) • Seed/plug Pennsylvania sedge (*Carex pensylvanica*), woodland forbs	• Continue to thin conifers over time, targeting maximum 75% canopy cover • Periodic prescribed burns • Spot treatment of invasive plants • Periodic sweeps to remove invasive shrubs • Reduce deer population

FIGURE 18A: Future Cover – Valley Park North Unit, Mendota Heights



Scale 1:5,500

0 250 500 1,000 Feet

Dakota County forever wild PARKS

FIGURE 18B: Future Cover – Valley Park South Unit, Mendota Heights

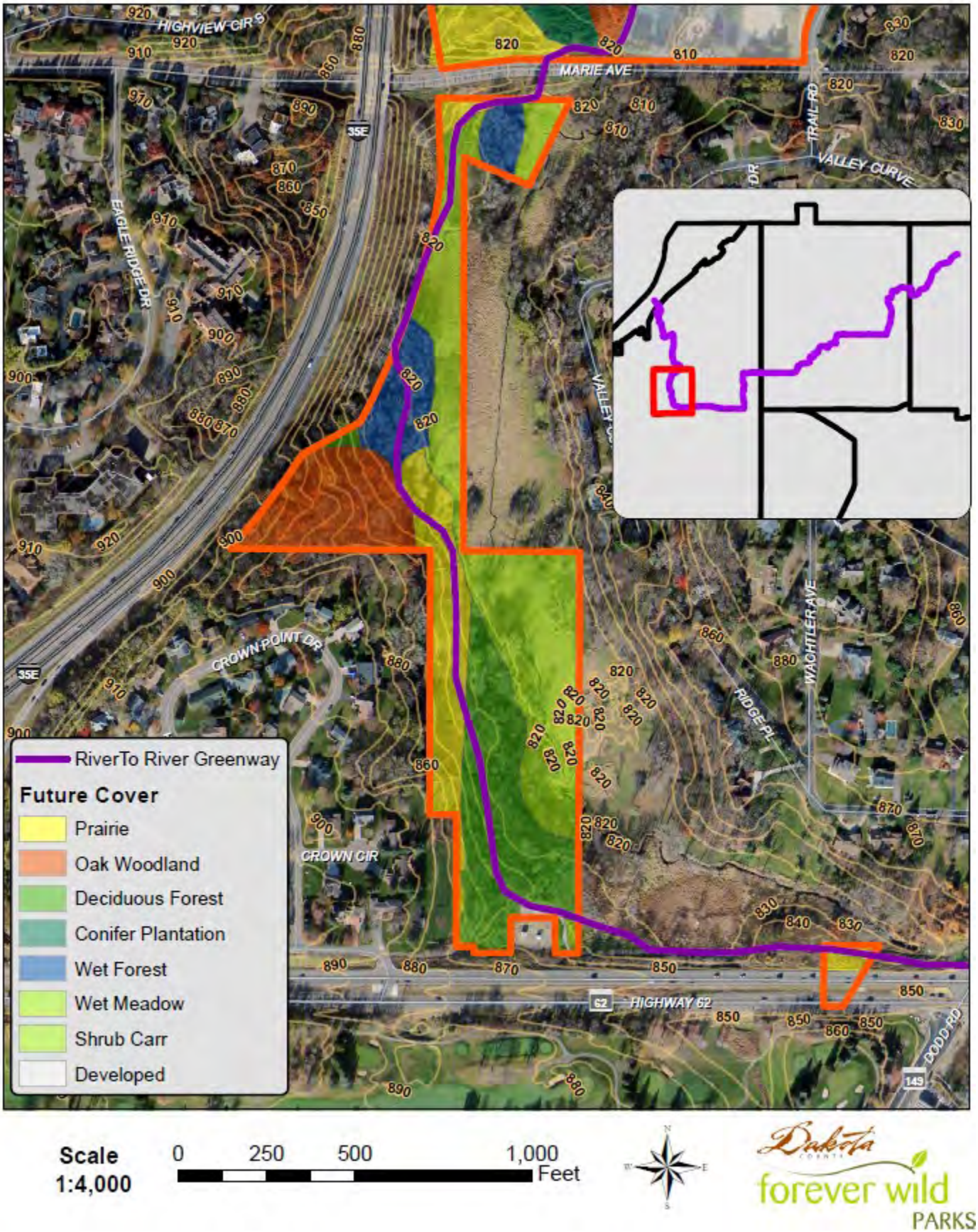


FIGURE 18C: Future Cover – Dodge Nature Center, Lilly Property, Mendota Heights

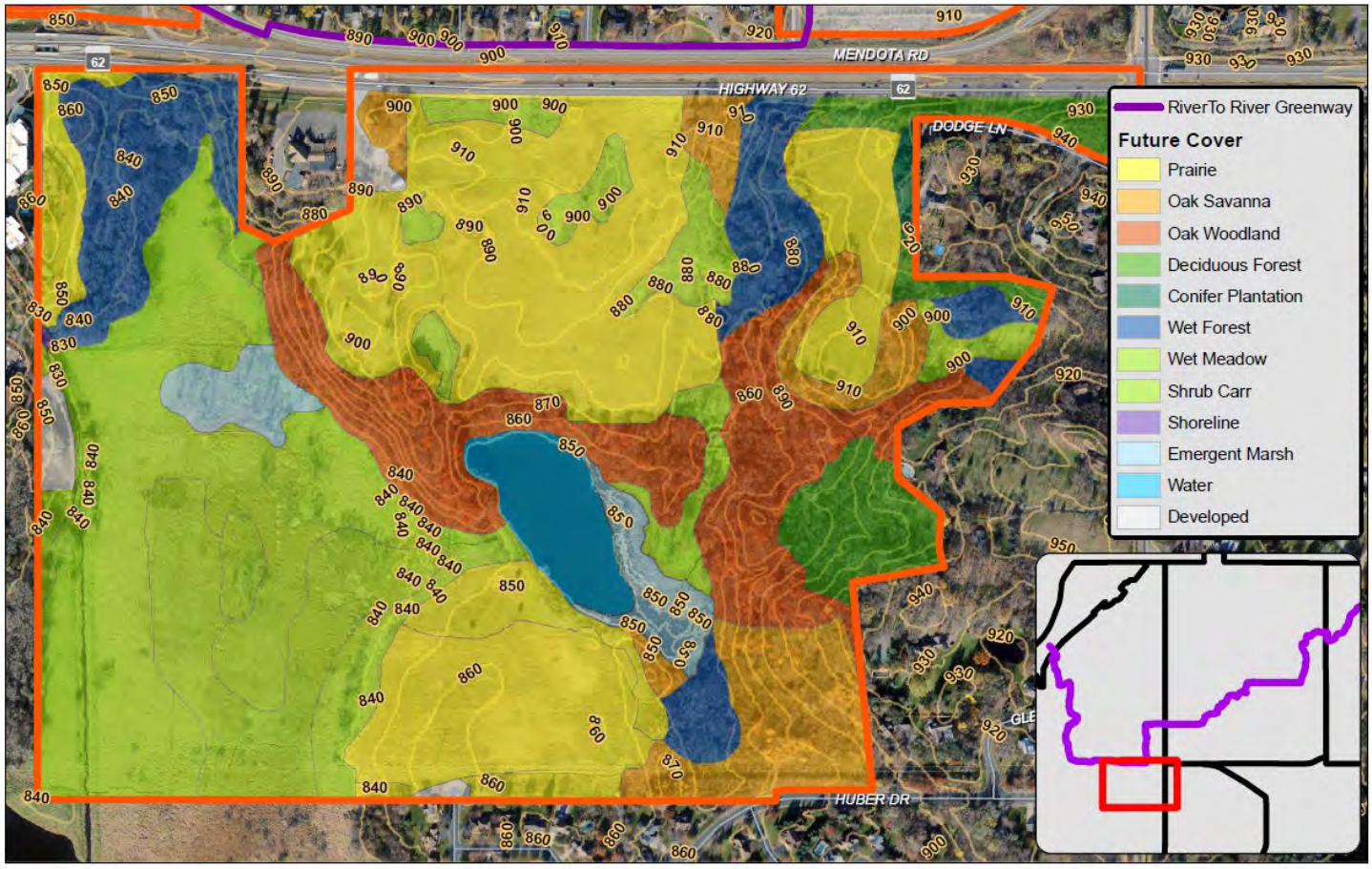


FIGURE 18D: Future Cover – Henry Sibley HS and Dodge Nature Center, Marie Property

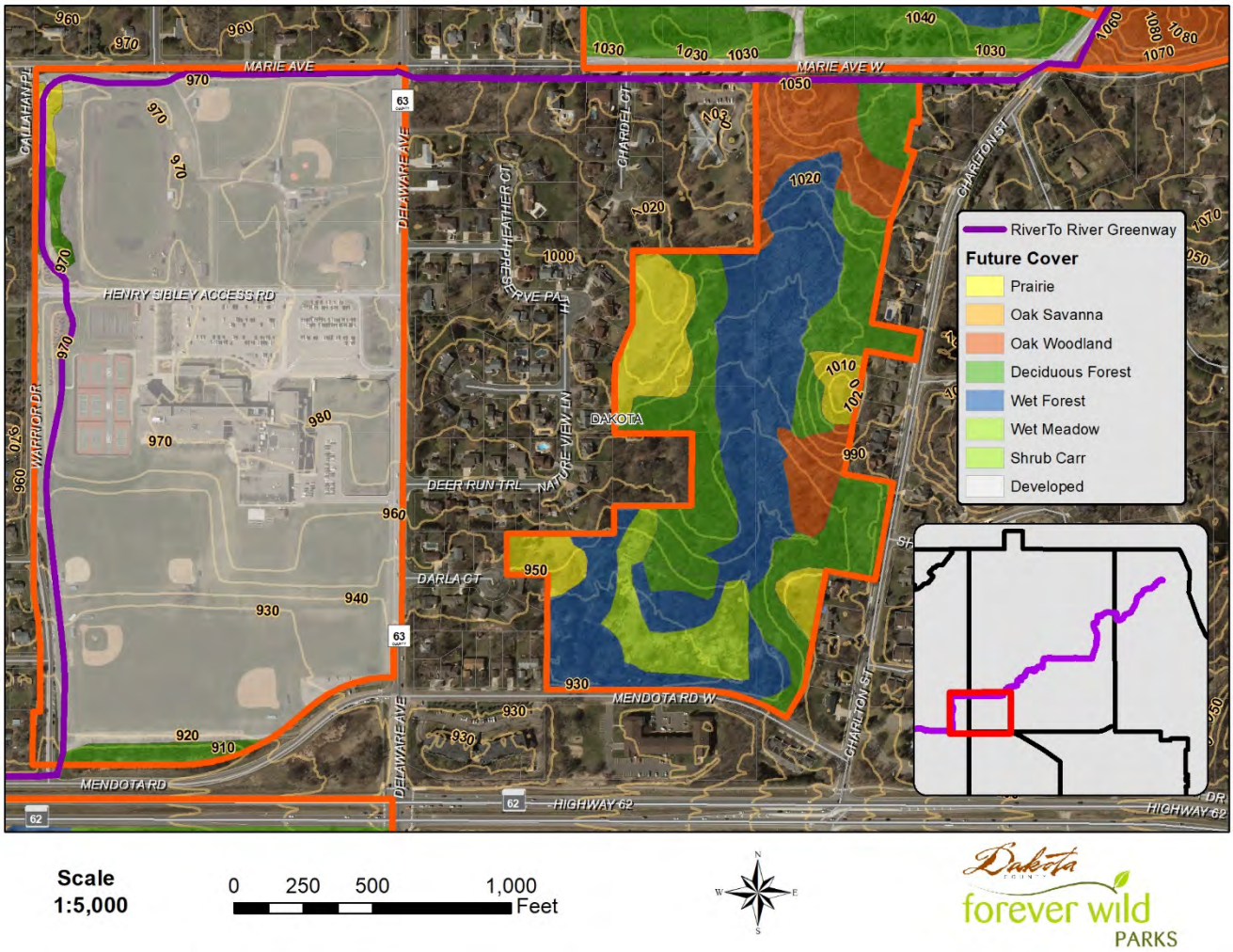


FIGURE 18E: Future Cover – Dodge Nature Center, Main Property, West Saint Paul

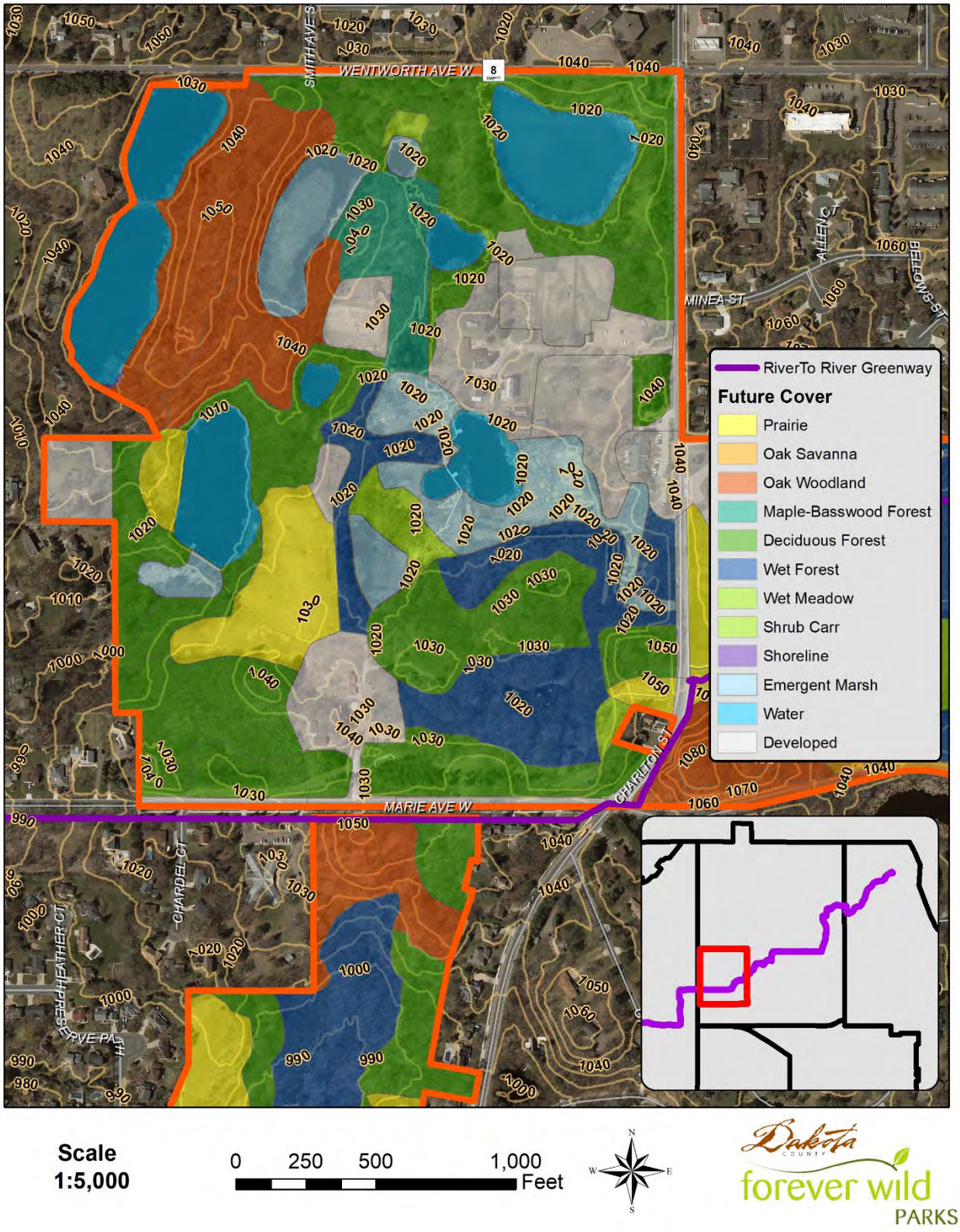
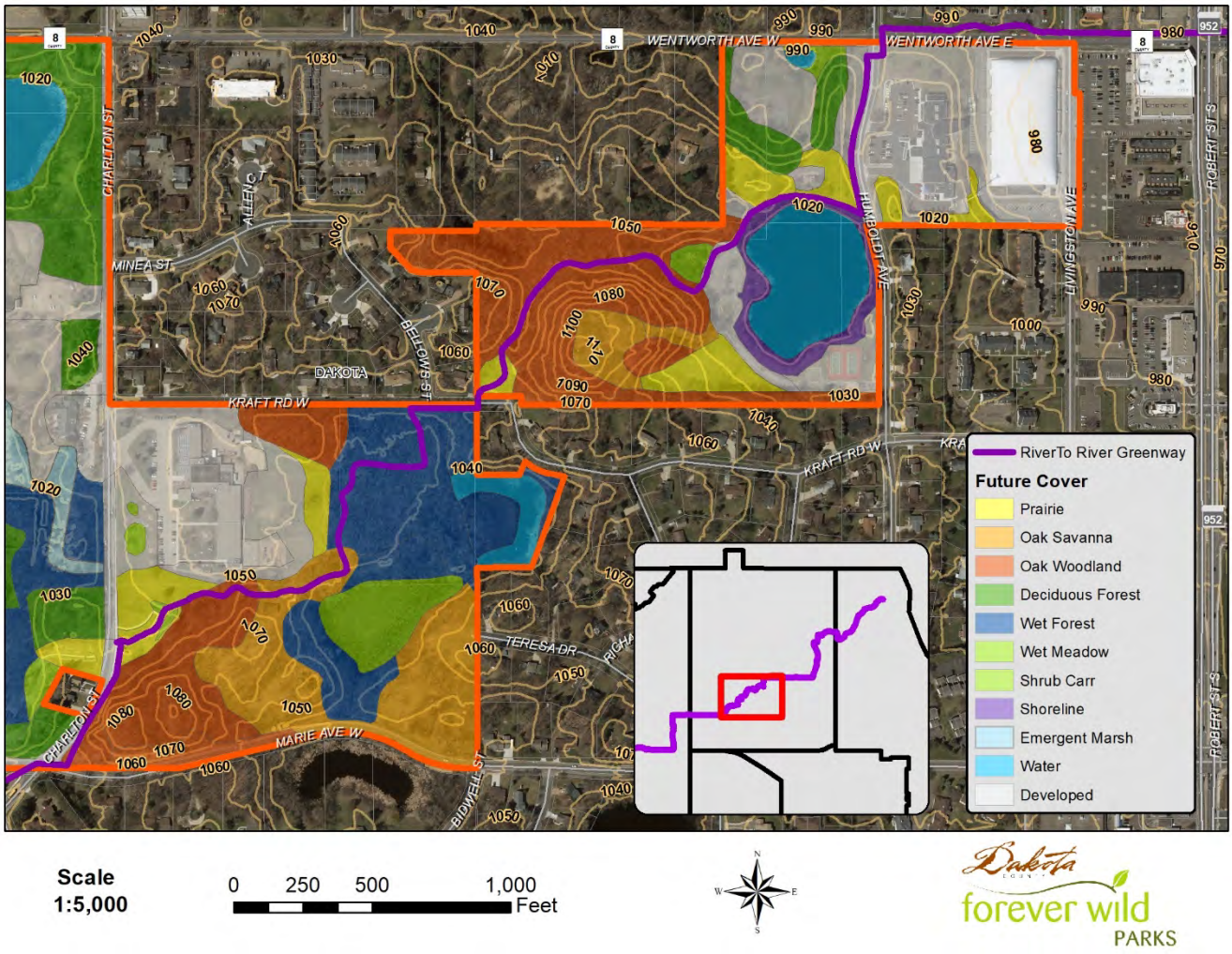


FIGURE 18F: Future Cover – Garlough and Marthaler Parks, West Saint Paul



Scale
1:5,000

0 250 500 1,000 Feet

Dakota County forever wild PARKS

FIGURE 18G: Future Cover – Thompson Oaks, West Saint Paul

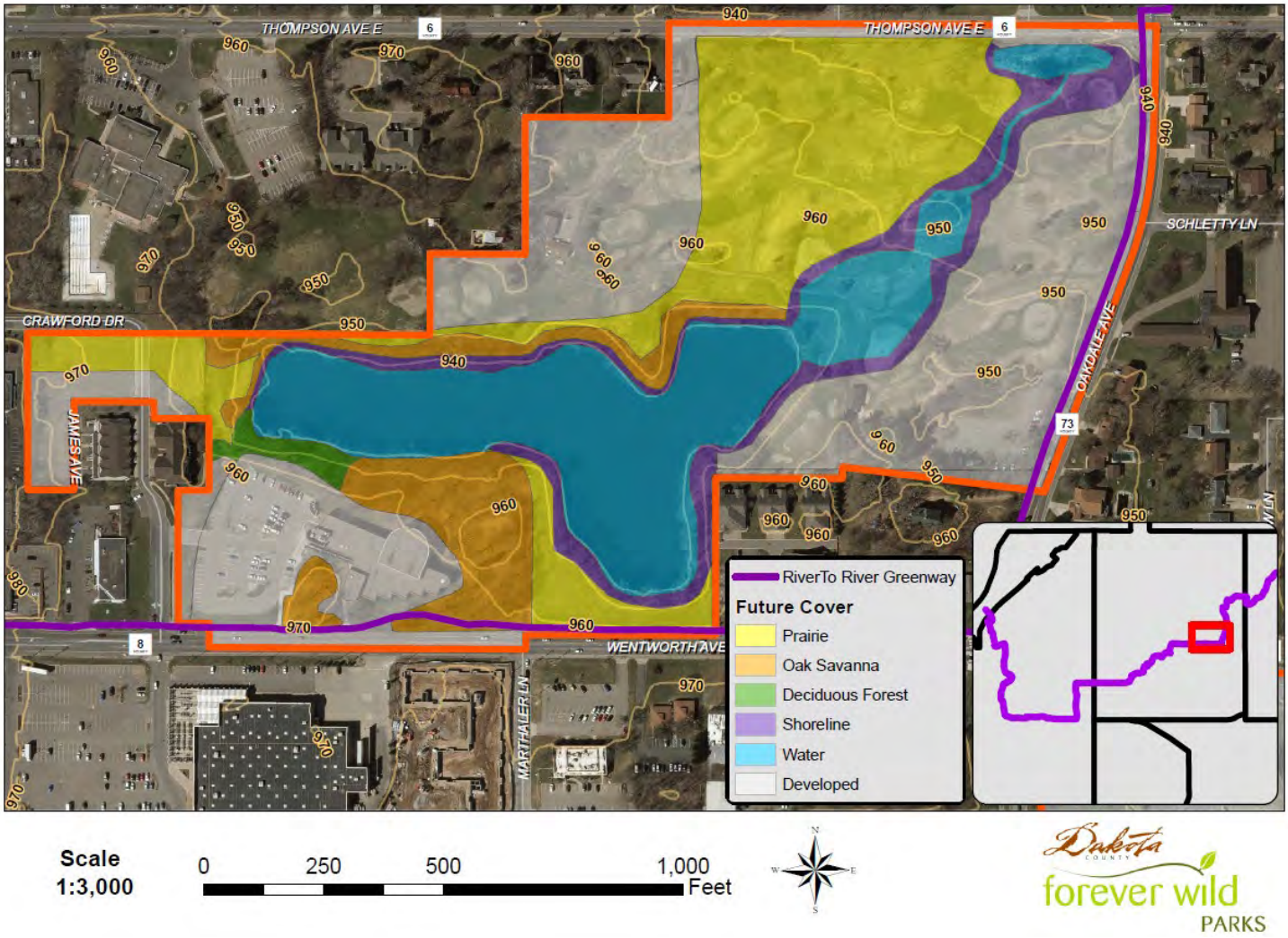


FIGURE 18H: Future Cover – Thompson County Park, West Saint Paul

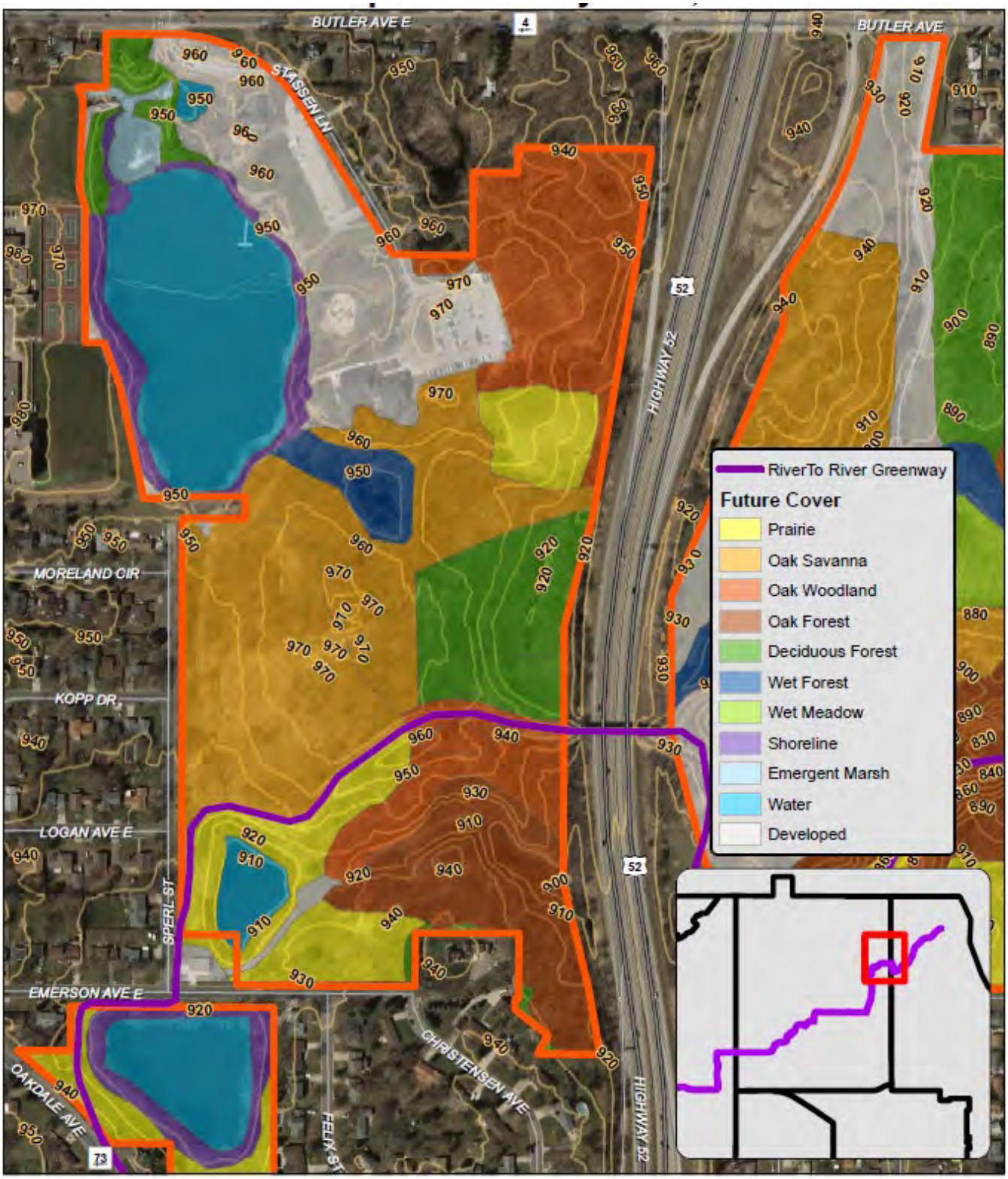
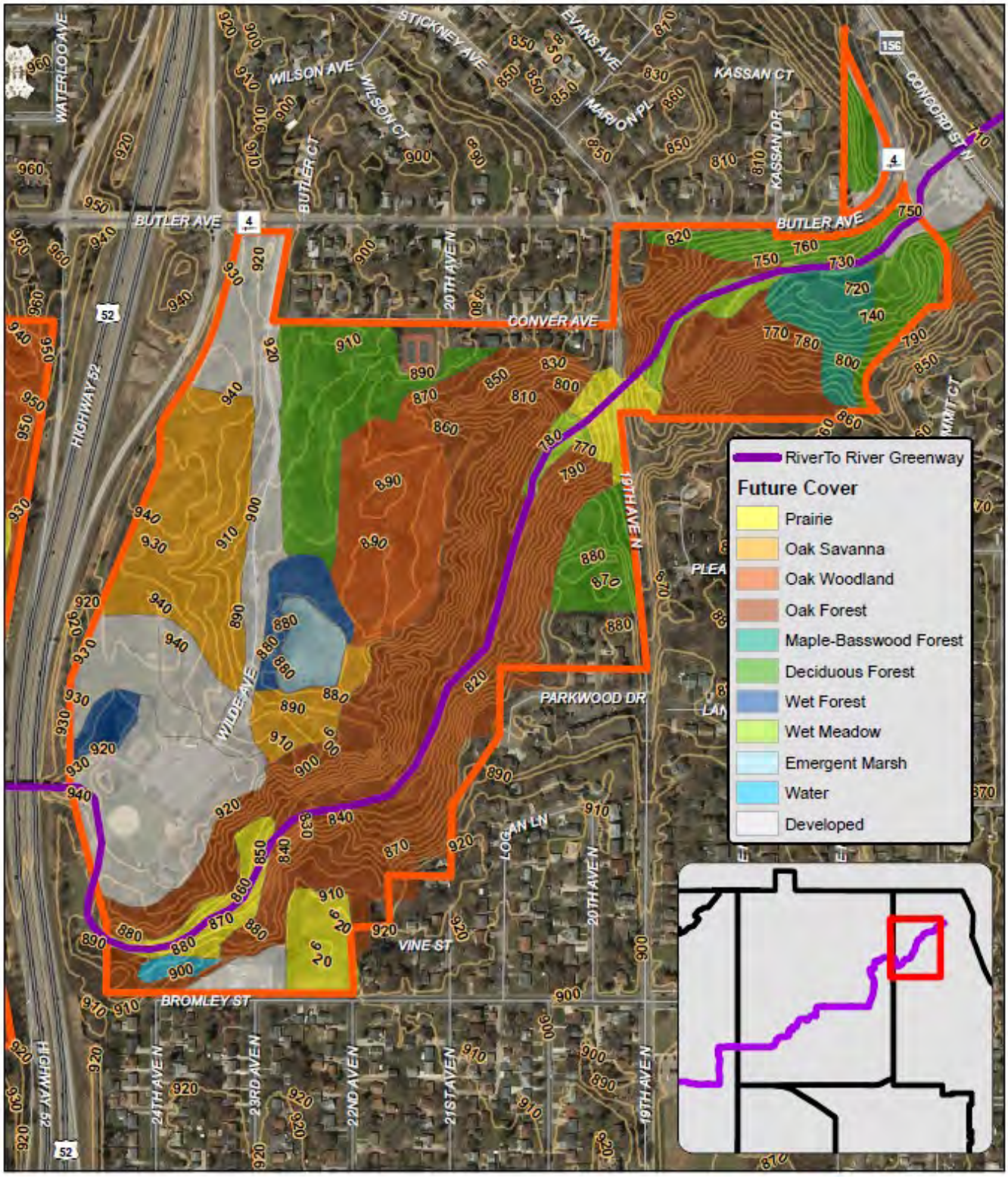


FIGURE 18I: Future Cover – Kaposia and Simon's Ravine, South Saint Paul



VIII. Implementation

Historic and existing conditions, and the relative effort versus anticipated benefits are weighed when determining the optimal target plant communities for restoration (see **Table 5**). These considerations govern the optimal and most suitable goals for restoration.

Based on the geology, soils, topography, hydrology, existing land cover and use, current and anticipated ecological conditions, and Landowner and County goals, target plant communities are recommended for each of the existing land cover types in **Table 5** and as shown on Figure 18. Target plant communities are indicated consistent with the *Field Guide to the Native Plant Communities of Minnesota: the Eastern Broadleaf Forest* (DNR 2005), and detailed descriptions of these communities are found in Appendix G.

Implementation of these restoration projects are prioritized primarily by the ecological value gained in converting altered and non-native plant cover to native plant communities described in **Table 5**. Other factors that inform the prioritization include their adjacency to previously restored areas, contractor/equipment access, and cost of projects, availability of funding through grant and public funding sources, and staff capacity of parternship organizations to oversee implementation.

A. Previous and Ongoing Restoration Efforts

Before addressing the specific priorities and activities for each land management unit, it is important to acknowledge the past efforts to restore sites within the Greenway Corridor undertaken by the landowner(s) and the County. Those efforts are listed in **Table 6**:

Table 6: Historic Land Management Activity

Greenway Segment – Partner	**Habitat Type**	**Acres**	**Activities**	**Dates**
Valley Park – City of Mendota Heights, Great River Greening, and Xcel Energy	**Prairie** **Forest**		**Restoration** **Buckthorn removal** **Seeding/planting**	**2019-2020** **2014-2020** **2009-2020**
Dodge Nature Center	**Prairie** **Forest**		**Restoration, Rx burning** **Buckthorn Removal, Tree and shrub planting**	**2015-2018** **2015-2020**
Henry Sibley HS – ISD 197, Dakota County	**Prairie**		**Restoration**	**2014**
Garlough Park – City of West Saint Paul	**Forest**		**Buckthorn removal**	**2018-2019**
Thompson Oaks/Wentworth Library – City of West Saint Paul, Dakota County	**Forest**		**Buckthorn removal** **Oak Savanna restoration**	**2019** **2017-2020**
Thompson County Park – Dakota County	**Forest**		**Buckthorn removal**	**2017-2020**

B. Work Plans

i. Restoration Sequence Work Plan

A Restoration Sequence work plan (see **Table 7**) was developed to provide guidelines toward achieving the target communities shown in Figure 17. This work plan was developed to focus on the natural resource management and restoration priorities for protecting and improving areas within the Greenway Corridor. The primary goals are listed in **Table 7**. The table includes a list of priorities, activities, schedules, responsibilities, and estimated costs. A general sequence for restoration activities at each site is described in **Table 7,** but note that, as an example, "3.1" denoting first year activities in Site 3 may have independent timing compared to 5.1, i.e., the first year activities in Site 5 (or in any other sites), although they may also coincide. Also note that the costs shown are estimates, based on similar work at other sites. Actual costs may be higher or lower, depending on multiple factors. Each management unit was prioritized for restoration need, on a scale of 1 to 5, with 1 being the highest.

Table 7: Restoration Sequence Work Plan for Natural Resource Projects

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
HENRY SIBLEY HIGH AND GARLOUGH ELEMENTARY MAGNET SCHOOLS							
1. Turf Grass to Prairie	3	1.1	summer, fall	Site preparation herbicide sprayout, hand seeding, cover with Type 3N natural net erosion control blanket on slopes >3:1, install 5,000 plugs	4.3	$4,500	$15,050
		1.2 to 1.5	Spring, summer, fall	Establishment management – mowing, spot spraying, burn year 5	4.3	$1,200	$5,160
						TOTAL	**$20,210**

GARLOUGH AND MARTHALER PARKS							
SITE	**PRIORITY**	**SITE RESTORATION SEQUENCE [Site #] . [Year]**	**SEASON**	**ACTIVITY**	**ACRES**	**COST/AC**	**COST ESTIMATE**
2. Oak Savanna, Woodlands and Wet Forest	1	2.1	fall, winter	Control exotic shrubs in woodlands	18	$1,500	$27,000
		2.1 to 2.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts	18	$900	$16,200
		2.2 to 2.5	fall, spring	Seed with native woodland seed mix that contains a high percentage of graminoids, to ensure that ground fires will carry in the future. This cost estimate includes both material and labor costs.	18	$1,600	$28,800
						SUBTOTAL	**$72,000**
3. Stormwater Pond Shoreline and Wetland	2	3.1	fall, winter	Control exotic shrubs along shorelines	1,800 linear feet (l.f.)	$4.4/l.f.	$8,000
		3.2 to 3.3	fall (yr 2) or spring (yr 3)	Plant and seed shoreline. For shrub plantings, obtain protective cages or fencing and stakes to secure them. Include Type 3N natural net erosion control blanket.	1,800 l.f.	$10/l.f.	$18,000
		3.1 to 3.3	fall, spring	Control hybrid cattail & reed canary grass in wetland, plant native sedge and emergent plugs, seed	0.3	$16,666	$5,000
						SUBTOTAL	**$31,000**
4. Turf Grass to Prairie	1	4.1	summer, fall	Site preparation herbicide sprayout, hand seeding, cover with Type 3N natural net erosion control blanket on slopes >3:1, install 5,000 plugs	8.4	$4,500	$28,000
		4.2 to 4.5	Spring, summer, fall	Establishment management – mowing, spot spraying, burn year 5	8.4	~$1,200	$10,000
						SUBTOTAL	**$38,000**
						TOTAL	**$141,000**

VALLEY PARK							
SITE	**PRIORITY**	**SITE RESTORATION SEQUENCE [Site #] . [Year]**	**SEASON**	**ACTIVITY**	**ACRES**	**COST/AC**	**COST ESTIMATE**
5. Prairie	1	5.1	spring, summer, fall	Site preparation herbicide sprayout,	7.9	$2,025	$16,000
		5.2	spring, fall	Seed and plug planting			
		5.3 to 5.5	spring, summer, fall	Establishment management			
6. Oak Savanna and Woodlands	1	6.1	winter	Control exotic shrubs, remove ash, cottonwood and walnut trees	34.3	$3,000	$102,900
		6.2 to 6.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		6.2	fall, spring	Seed with native woodland or prairie (savanna) seed mix to ensure that ground fires will carry in the future.			
7. Deciduous Forest	3	7.1	winter	Remove exotic shrubs	15.7	$1,530	$24,000
		7.2 to 7.5	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		7.2	fall, spring	Plant native shrubs, seed and plug native woodland forbs			
8. Wet Forest	3	8.1	winter	Remove exotic shrubs	17.9	$2,000	$35,800
			fall	Follow-up foliar herbicide control of exotic shrub resprouts			
			fall, spring	Plant native shrubs, seed and plug native woodland forbs			
9. Conifer Plantation	1	9.1	fall, winter	Thin conifer stand, cut gaps	2.8	$3,000	$8,400
		9.1	winter	remove exotic shrubs			
		9.2 to 9.5	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		9.2 to 9.5	spring, fall	Plant oak trees and native shrubs, seed/plug woodland sedges and forbs, burn year 4			

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
10. Wetlands	4	10.1 to 10.2	spring, summer, fall	Site preparation: water level manipulation, mechanical removal and/or herbicide sprayout of hybrid cattail and reed canary grass, Rx burn	18.2	$4,500	$82,000
		10.3 to 10.5	spring, fall	seed, plant plugs, shrubs			
		10.3 to 10.5	spring, summer, fall	Establishment management – mowing, spot spraying, burn year 5			
						TOTAL	**$269,100**
DODGE NATURE CENTER							
11. New Prairie - Lilly	1	11.1	spring, summer, fall	Site preparation herbicide sprayout,	4.6	$3,000	$13,800
		11.2	spring, fall	Seed and plug planting			
		11.3 to 11.5	spring, summer, fall	Establishment management			
12. Old Prairie Enhancement – Lilly Property	3	12.1	fall, winter	Control shrub encroachment on borders	3	$1,000	$38,200
		12.1 to 12.4	spring, summer, fall	Spot mowing/herbicide, suppression of cool season grasses (smooth brome) with grass-specific herbicide	44	$300	
		12.2 to 12.5	fall, spring	Overseed with forb mix after Rx burn, plug	44	$500	

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
13. Oak Savanna – Lilly Property	1	13.1	winter	tree and shrub removal, chip/remove from site	13.5	$6,000	$81,000
		13.2	spring, fall	Site preparation herbicide sprayout, Rx burn			
		13.2	fall	Seed and plug planting			
		13.3 to 13.5	spring, summer, fall	Establishment management			
14. Oak Woodlands – Lilly Property	1	14.1	fall, winter	Control exotic shrubs in woodlands	20.8	$2,000	$41,600
		14.1 to 14.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		14.2 to 14.3	fall, spring	Plant woodland seed and plug mix			
		14.3 to 14.5	spring, summer, fall	Establishment management, Rx burn			
15. New Prairie – Marie Property	2	15.1	winter	Siberian elm, boxelder, shrub removal, chip/remove from site	3.3	$5,000	$16,500
		15.2	spring, fall	Site preparation herbicide sprayout, Rx burn			
		15.2	fall	Seed and plug planting			
		15.3 to 15.5	spring, summer, fall	Establishment management			
16. Oak Woodland – Main and Marie Property	1	16.1	fall, winter	Control exotic shrubs in woodlands	17.9	$2,000	$35,800
		16.1 to 16.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		16.2 to 16.3	fall, spring	Plant woodland seed and plug mix			
		16.3 to 16.5	spring, summer, fall	Establishment management			

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
17. Maple-Basswood Forest – Main Property	2	17.1	fall, winter	Control exotic shrubs in woodlands	3.7	$2,000	$7,400
		17.1 to 17.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		17.1 to 17.5	fall, spring	plant woodland seed, plug, sugar maple trees and shrubs			
18. Mesic and Wet Forests – All Dodge Properties	3	18.1	fall, winter	Control exotic shrubs in woodlands	101.3	$1,000	$101,300
		18.1 to 18.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		18.2 to 18.3	fall, spring	Plant woodland seed and plug mix			
		18.3 to 18.5	spring, summer, fall	Establishment management			
19. Wetlands – All Dodge Properties	5	19.1	spring, summer, fall	Hybrid cattail management on emergent wetlands; herbicide, Rx burn	15.2	$2,000	$30,400
		19.1 to 19.3	spring, summer, fall	Reed canary grass management on wet meadows; 2 yrs site prep, herbicide, Rx burn, seeding final spring	62.3	$4,000	$249,200
		19.1 to 19.3	fall, spring	Establishment management of wet meadow plantings – spot mow/herbicide	62.3	$1,000	$62,300
						TOTAL	**$676,500**
THOMPSON COUNTY PARK							
20. Future Oak Savanna Expansion	1	20.1	winter	Removal of black locust, ash, boxelder, silver maple and walnut trees;	10.2	$14,700	$150,000
		20.2 to 20.3	spring, summer, fall	Site preparation, seeding/plugging of mesic prairie grass and forb cover			
		20.3 to 20.5	spring, summer, fall	Establishment management – mowing, spot spraying, burn year 5			
21. Current Oak Savanna Maintenance	1	21.1 to 21.5	spring, summer, fall	Establishment management – mowing, spot spraying, burn year 3	3.0	$1,670	$5,000
22. Oak-Basswood Forest	1	22.1	winter	Removal of ash, boxelder, walnut trees;	10.4	$11,500	$120,000

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
23. Mixed Deciduous Forest	2	23.1	winter	Removal of ash, boxelder, silver maple and select walnut trees	4.5	$8,000	$36,000
		23.2	spring, fall	tree and shrub planting			
		23.3 to 23.5	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		23.3 to 23.5	spring, fall	seed and plug woodland grasses and forbs			
24.Stormwater Pond	4	24.1	winter	Removal of ash, boxelder, walnut trees;	1.6	$3,125	$5,000
		24.2	spring, summer, fall	seed/plug with mesic prairie species, transition to wet meadow community on shoreline. Install type 3N erosion control blanket on steep slopes >3:1.			
		24.3 to 24.5	spring, summer, fall	Establishment management			
25.Thompson Lake Shoreline	1	25.1	Winter, fall	Brush removal	2.0		$180,000
		25.1	spring, summer, fall	Site preparation			
		25.1	Spring, summer or fall	Cattail scrape and reshape banks			
		25.1 to 25.2	Summer, fall (plugs); spring or fall (seed)	Plant materials and labor			
		25.1 to 25.3	spring, summer, fall	Establishment management			
		25.3	Spring or fall	Rx burn			

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
26. Prairie Restoration	3	26.1	spring, summer, fall	Sumac removal, site preparation, seeding/plugging of mesic prairie grass and forb cover	1.6	$5,000	$8,000
27. NW Oak Woodland	3	27.1	winter	Removal of black locust, willow trees	5.0	$8,000	$40,000
		27.2	spring, fall	native tree and shrub planting			
		27.3 to 27.5	fall	follow-up foliar herbicide control of exotic shrub resprouts			
		27.3 to 27.5	spring, fall	seed and plug woodland grasses and forbs			
						TOTAL	**$544,000**
KAPOSIA PARK AND SIMON'S RAVINE							
28. Oak Savanna	1	28.1	fall, winter	Control exotic shrubs in woodlands, remove secondary growth trees (box elder, Siberian elm, etc.)	9	$5,000	$45,000
		28.1 to 28.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		28.2 to 28.5	fall, spring	Site preparation Seed with native prairie mix, establishment management			
29. Oak Woodlands and Deciduous/Wet Forest	2	29.1	fall, winter	Control exotic shrubs	20.5	$2,000	$41,000
		29.1 to 29.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		29.2 to 29.5	fall, spring	Seed with native woodland seed mix, Rx burn in Oak Woodlands			
30. Oak-Basswood and Maple-Basswood Forest	3	30.1	fall, winter	Control exotic shrubs and trees, remove select trees for gaps (EAB ash, oak wilt)	55.5	$540	$30,000
		30.1 to 30.4	fall	Follow-up foliar herbicide control of exotic shrub resprouts			
		30.2	spring, fall	Plant oak trees, native shrubs in gaps			

SITE	PRIORITY	SITE RESTORATION SEQUENCE [Site #] . [Year]	SEASON	ACTIVITY	ACRES	COST/AC	COST ESTIMATE
31. Ravine Erosion Stabilization/ Creekbank Wetlands	3	31.1	summer, fall	Exotic plant management/site preparation	2,400 l.f.	$40 / l.f.	$96,000
		31.1	fall	Native seed, plugs and blanket w/ Type 3N Natural Net fabric			
		31.2 to 31.5	spring, summer, fall	Establishment management			
						TOTAL	**$212,000**
32. Subwatershed Assessment	1	32.1	all seasons	Identify streambank erosion and stormwater best management practices for water quality		**TOTAL**	**$50,000**
				GRAND TOTAL RESTORATION COSTS		**$1,913,610**	

i. Twenty-Year Work Plan

A 20-year work plan (see **Table 8**) was developed to provide guidelines toward maintaining the target communities restored in the Restoration Sequence Work Plan. This 20-year work plan was developed to focus on the long-term goals for protecting and improving natural resource management and restoration within the Greenway Corridor. The table includes a list of maintenance activities, responsibilities, and estimated costs. Actual costs may be higher or lower, depending on multiple factors. For example, annual weed management will be higher in formative years immediately after restoration establishment, and these costs will decrease over time through the 20-year period.

Table 8: Twenty-Year Work Plan for Long-Term Maintenance

SITE	RESPONSIBILITY	SEASON	ACTIVITY	ACRES	COST/AC	ANNUAL COST ESTIMATE
HENRY SIBLEY HIGH AND GARLOUGH ELEMENTARY MAGNET SCHOOLS						
Prairie	ISD 197	spring, summer, fall	annual spot treatment of invasives, Rx burn every 3 yrs	4.3	$250	$1,075
					TOTAL	**$1,075/yr**
GARLOUGH AND MARTHALER PARKS						
Oak Savanna, Woodlands and Wet Forest	WSP	spring, summer, fall	Annual spot treatment of invasives	18	$150	$2,700
		fall	Survey and remove buckthorn/honeysuckle every 3 years	18	$150 every 3 yr	$900
		fall, spring	Savanna Rx burn every 3 yrs	5	$300 every 3 yr	$500
					SUBTOTAL	**$4,100**
Stormwater Pond Shoreline and Wetland	WSP	spring, summer, fall	Annual spot treatment of invasives	5.4	$150	$810
		fall	Survey and remove buckthorn/honeysuckle every 3 years	5.4	$150 every 3 yr	$280
		fall, spring	Rx burn every 3 yrs (~$250/ac per burn)	5.4	$1,350 every 3 yr	$450
					SUBTOTAL	**$1,540**
Prairie	WSP	summer, fall	Annual spot treatment of invasives	8.4	$150	$1,260
		spring, fall	Rx burn every 3 yrs	8.4	~$250 every 3 yr	$700
		late fall	mow for sledding hill	0.7	$200	$200
					SUBTOTAL	**$2,160**
					TOTAL	**$7,800/yr**

VALLEY PARK						
SITE	**RESPONSIBILITY**	**SEASON**	**ACTIVITY**	**ACRES**	**COST/AC**	**ANNUAL COST ESTIMATE**
Prairie	MH	summer, fall	Annual spot treatment of invasives	7.9	$150	$1,200
		spring, fall	Rx burn every 3 yrs	7.9	~$250 every 3 yr	$700
					SUBTOTAL	**$1,900**
Oak Savanna and Woodlands	MH	spring, summer, fall	Savanna - annual spot treatment of invasives	3.3	$150	$500
		fall	Survey and remove buckthorn/honeysuckle every 3 years	34.3	$150 every 3 yr	$1,700
		fall, spring	Savanna Rx burn every 3 yrs	3.3	$300 every 3 yr	$330
		spring	Woodland Rx burn every 5 yrs	31	$350 every 5 yr	$2,170
					SUBTOTAL	**$4,700**
Deciduous Forest	MH	spring	Annual spot treatment of invasives (garlic mustard, burdock)	15.7	$150	$2,400
		fall	Survey and remove buckthorn/honeysuckle every 3 years	15.7	$150 every 3 yr	$800
					SUBTOTAL	**$3,200**
Wet Forest	MH	spring	Annual spot treatment of invasives (garlic mustard, burdock)	17.9	$150	$2,700
		fall	Survey and remove buckthorn/honeysuckle every 3 years	17.9	$150 every 3 yr	$900
					SUBTOTAL	**$3,600**
Conifer Plantation	MH	spring	Annual spot treatment of invasives (garlic mustard, burdock)	2.8	$150	$420
		fall	Survey and remove buckthorn/honeysuckle every 3 years	2.8	$150 every 3 yr	$140
		winter, spring	periodically thin conifers, plant oaks	2.8	$2,000 every 10 years	$560
					SUBTOTAL	**$1,120**
Wetlands	MH	spring, summer, fall	Annual spot treatment of invasives (esp. reed canary grass)	18.2	$150	$2,730
		late spring	Rx burns every five years to control cool season grasses, RCG	18.2	$130 every 5 yr	$470
					SUBTOTAL	**$3,200**
					TOTAL	**$17,720/yr**

DODGE NATURE CENTER						
SITE	**RESPONSIBILITY**	**SEASON**	**ACTIVITY**	**ACRES**	**COST/AC**	**ANNUAL COST ESTIMATE**
Prairies	DNC	spring, summer, fall	Annual spot treatment of invasives	61.9	$150	$9,300
		spring, fall	Rx burn every 3 yrs	61.9	$200 every 3 yr	$4,100
					SUBTOTAL	**$13,400**
Oak Savanna	DNC	spring, summer, fall	Savanna - annual spot treatment of invasives	13.5	$150	$2,000
		fall	Survey and remove buckthorn/honeysuckle every 3 years	13.5	$150 every 3 yr	$700
		fall, spring	Savanna Rx burn every 3 yrs	13.5	$150 every 3 yr	$700
					SUBTOTAL	**$3,400**
Oak Woodlands	DNC	spring	Annual spot treatment of invasives (garlic mustard, burdock)	38.7	$150	$5,800
		fall	Survey and remove buckthorn/honeysuckle every 3 years	38.7	$150 every 3 yr	$1,900
		spring	Woodland Rx burn every 5 yrs	38.7	$200 every 5 yr	$1,500
					SUBTOTAL	**$9,200**
Deciduous Forests	DNC	spring	Annual spot treatment of invasives (garlic mustard, burdock)	105	$150	$15,750
		fall	Survey and remove buckthorn/honeysuckle every 3 years	105	$150 every 3 yr	$5,250
					SUBTOTAL	**$21,000**
Wetlands	DNC	spring, summer, fall	Annual spot treatment of invasives (esp. reed canary grass)	62.3	$150	$9,360
		late spring	Rx burns every five years to control cool season grasses, RCG	62.3	$130 every 5 yr	$1,640
					SUBTOTAL	**$11,000**
					TOTAL	**$58,000/yr**

THOMPSON COUNTY PARK						
SITE	**RESPONSIBILITY**	**SEASON**	**ACTIVITY**	**ACRES**	**COST/AC**	**ANNUAL COST ESTIMATE**
Prairie	DC	spring, summer, fall	Annual spot treatment of invasives	5.2	$190	$1,000
		spring, fall	Rx burn every 3 yrs	5.2	$170 every 3 yr	$300
					SUBTOTAL	**$1,300**
Oak Savanna	DC	spring, summer, fall	Savanna - annual spot treatment of invasives	14.7	$150	$2,200
		fall	Survey and remove buckthorn/honeysuckle every 3 years	14.7	$150 every 3 yr	$750
		fall, spring	Savanna Rx burn every 3 yrs	14.7	$150 every 3 yr	$750
					SUBTOTAL	**$3,700**
Oak Woodland	DC	spring	Annual spot treatment of invasives (garlic mustard, burdock)	8.3	$150	$1,250
		fall	Survey and remove buckthorn/honeysuckle every 3 years	8.3	$150 every 3 yr	$400
		spring	Woodland Rx burn every 5 yrs	8.3	$200 every 5 yr	$350
					SUBTOTAL	**$2,000**
Deciduous Forest	DC	spring	Annual spot treatment of invasives (garlic mustard, burdock)	11	$150	1650
		fall	Survey and remove buckthorn/honeysuckle every 3 years	11	$150 every 3 yr	550
					SUBTOTAL	**$2,200**
Shoreline	DC	spring, summer, fall	Annual spot treatment of invasives (esp. reed canary grass)	2	$400	$800
		late spring	Rx burns every five years to control cool season grasses, RCG	2	$200 every 3 yr	$130
					SUBTOTAL	**$930**
					TOTAL	**$10,130/yr**

KAPOSIA PARK AND SIMON'S RAVINE						
SITE	**RESPONSIBILITY**	**SEASON**	**ACTIVITY**	**ACRES**	**COST/AC**	**ANNUAL COST ESTIMATE**
Oak Savanna	SSP	spring, summer, fall	Savanna - annual spot treatment of invasives	9	$150	$1,300
		fall	Survey and remove buckthorn/honeysuckle every 3 years	9	$150 every 3 yr	$450
		fall, spring	Savanna Rx burn every 3 yrs	9	$150 every 3 yr	$450
					SUBTOTAL	**$2,200**
Oak Woodlands	SSP	spring	Annual spot treatment of invasives (garlic mustard, burdock)	5.8	$150	$870
		fall	Survey and remove buckthorn/honeysuckle every 3 years	5.8	$150 every 3 yr	$290
		spring	Woodland Rx burn every 5 yrs	5.8	$200 every 5 yr	$240
					SUBTOTAL	**$1,400**
Deciduous Forests (Oak-Basswood, Maple-Basswood, and Mixed Mesic Deciduous Forests)	SSP	spring	Annual spot treatment of invasives (garlic mustard, burdock)	70.2	$150	$10,500
		fall	Survey and remove buckthorn/honeysuckle every 3 years	70.2	$150 every 3 yr	$3,500
		spring	Oak forest burn every 5 yrs	53.1	$150 every 5 yr	$1,600
					SUBTOTAL	**$15,600**
Prairie and Streambank Wet Meadows	SSP	spring, summer, fall	Annual spot treatment of invasives	6	$200	$1,200
		spring, fall	Rx burn every 3 yrs	6	$200 every 3 yr	$400
					SUBTOTAL	**$1,600**
					TOTAL	**$20,800/yr**
					GRAND TOTAL MAINTENANCE COSTS	**$115,525/yr**

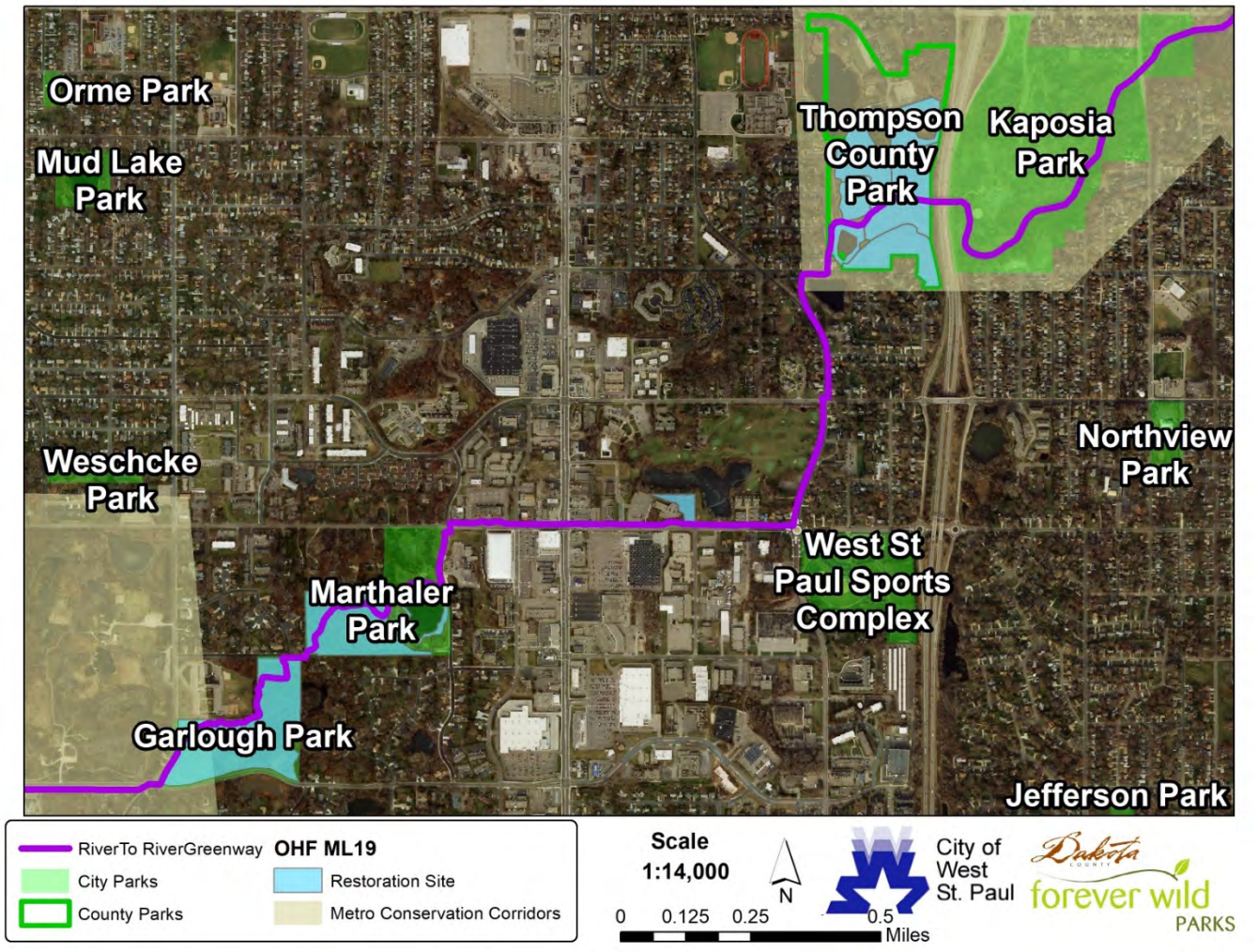
C. Future Restoration Implementation Schedule

The Restoration Sequence work plans outline the priorities and staging for each individual natural resource project in each region of the Greenway Corridor, however, these implementation plans are specific to each project, where Year 1 responds to the first year of project implementation regardless of the timing of other projects. While the priority of each project is suggested in **Table 7**, the particular timing of implementation is dependent in part upon availability of grant funds and the capacity of Partnership members to carry out the project.

Adjacency to existing restoration areas are another important factor to consider for the staging of individual projects with respect to the implementation schedule of the entire Greenway. Due to the approval of the Thompson County Park Natural Resource Management Plan (County Board Resolution No. 20-037, 21 January

2020) and the availability of funds through an ML 2019 appropriation of the Lessard-Sams Outdoor Heritage Council's Outdoor Heritage Fund (ML19-OHF), the County will begin restoration of Thompson County Park in 2020. Furthermore, a partnership with the City of West Saint Paul has been initiated to use ML19-OHF grant funds to extend these restorations to Garlough and Marthaler city parks, commensurate with trail surface and infrastructure improvements within these parks and a trail re-alignment for a grade-separated tunnel under Robert Street. Future improvements to the former Thompson Oaks Golf Course will continue to work toward establishing native plantings between the County Park and these two city Parks, thus working to close the gap between the identified Metro Conservation Corridors in this region (**Figure 19**).

FIGURE 19: Dakota County Parks and City of West Saint Paul Partnership Restoration Project



Additional initial project areas that have existing or future restoration projects identified include Partnerships between Great River Greening and the City of Mendota Heights for ongoing work in Valley Park and with Dodge Nature Center for ongoing work on their properties (**Table 6**), such that the next future phases would likely occur in these areas.

IX. Strategic Partnerships for Implementing Greenway Natural Resource Projects

A. Precedent of County Policy Supporting Natural Resources Improvements of County Greenways

Two County Documents illustrate the precedent for addressing natural resource management projects along the County Greenway System, namely the Natural Resources Management System Plan (NRMSP) adopted on May 23, 2017 (Resolution No. 17-274), and the Dakota County Greenway Collaborative Guidebook (henceforth the Greenway Guidebook) adopted September 28, 2010 (Resolution No. 10-487). These documents establish the motivation and guidelines for the use of County resources to address natural resource management projects and improvements on non-County land.

The NRMSP acknowledged that natural resources are transboundary in nature and for the County to be effective at protecting and improving them, it must work with landowners and partners on lands outside of County ownership. The NRMSP states the following:

> "*To implement this system-wide plan, the County recognizes it will need to continue to pursue and secure state and other grants, capitalize on partnerships, collaborate with municipalities and other entities in the County, and commit additional internal County resources for staff, volunteer coordination, equipment, and external contractor work (NRMSP pg. 4).*"

Goals for Greenways outlined in the NRMSP include the following:

> *10.3.4 Greenway Goals*
>
> - *The most highly invasive species should be controlled since greenways can contribute to the spread of invasive species.*
> - *Restoration and enhancement of high quality areas within County-owned lands and easements will improve visitor experience and can reduce long- term maintenance costs.*
> - *It will be important to work with a wide range of partners to restores and enhance non-County-owned lands and easements within regional greenway corridors and to identify opportunities for collaboration and increased efficiencies (NRMSP pg. 93)*

To effectively manage greenways to intercept the spread of invasive species and ensure the quality of natural resource improvements, the following was determined:

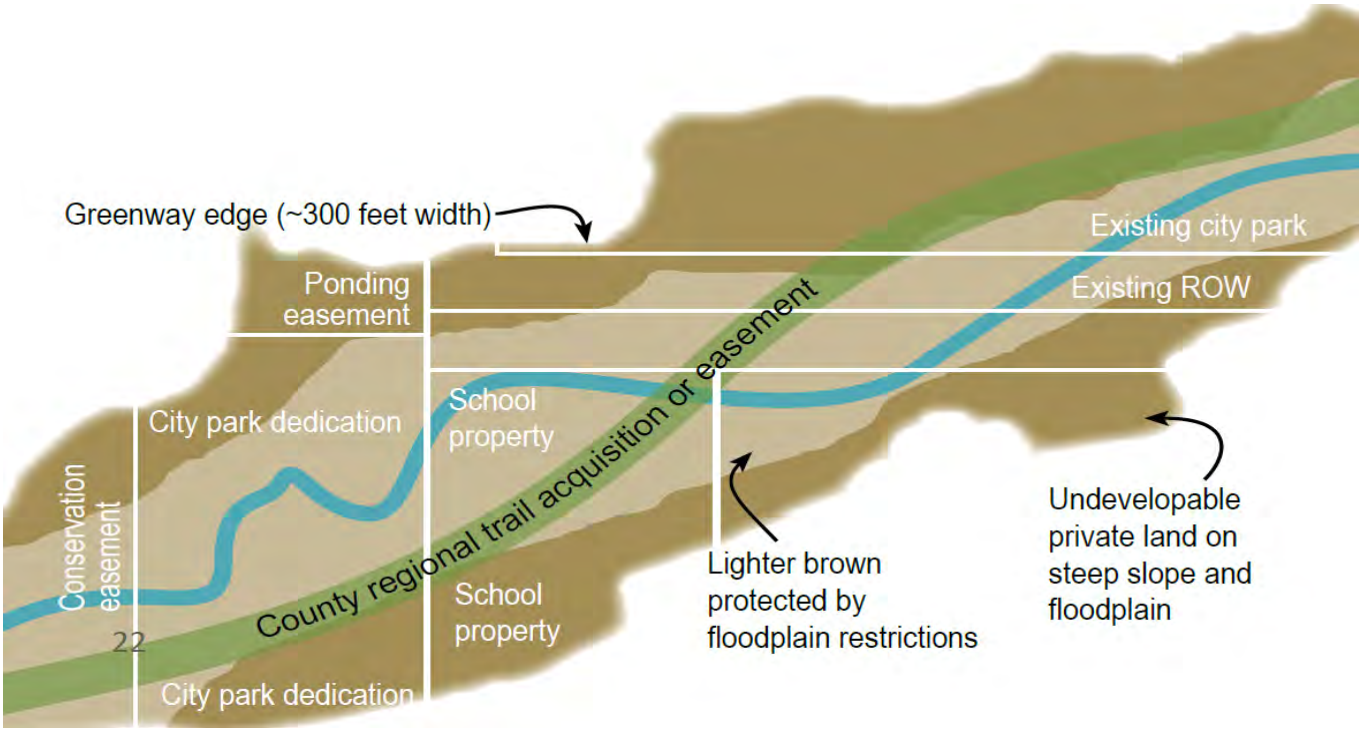
> *11.3.4. Management of Greenways*
>
> *Due to the multiple-ownerships in greenways and the County's limited control, only priority investments should be made in greenways. The County, working with partners, should control the most highly invasive species, restore and*

enhance the most important greenway lands and easements, monitor wildlife indicator species, and develop NRMPs for each greenway (NRMSP pg. 108).

Furthermore, the Dakota County Greenway Guidebook established guidelines for typical cost-share structures and roles pertaining to different components of Greenways.

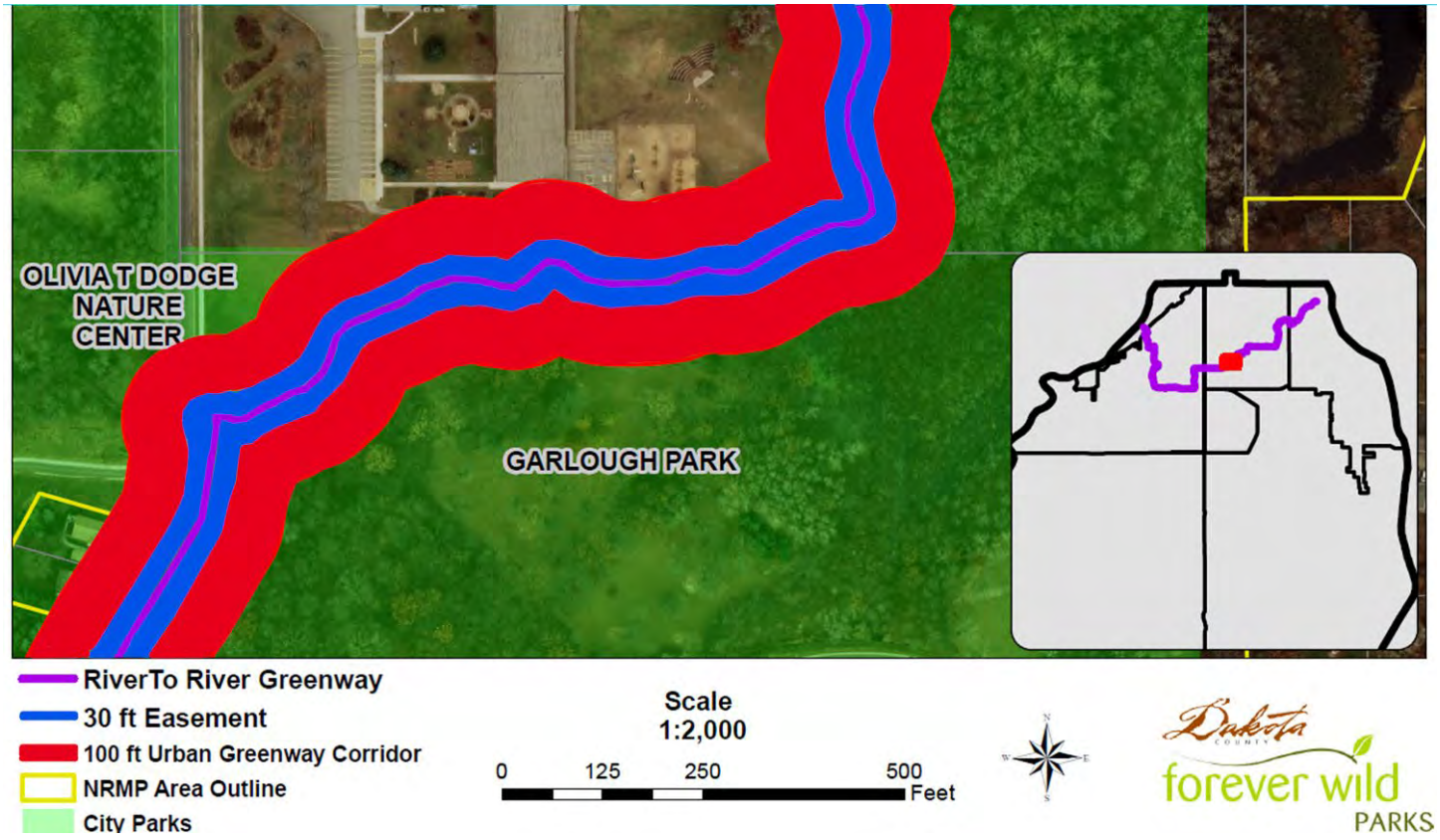
The County establishes 30-foot easements for Greenway trails and assumes all native vegetation maintenance within the easement. While a native planting within this easement provides some benefit, there is need to provide wildlife with wider contiguous corridors to establish any real habitat value. The Greenway Guidebook established 100 ft, 200 ft and 300 ft wide corridors depending upon whether the Greenway occurred within an urban, suburban, or rural context, respectively (See **Figures 20** and **21**). The Guidebook specifically calls upon initiating natural resource restoration and enhancement efforts within these corridors, which necessitates working in partnerships in the frequent case that these corridors occur within public, non-County lands such as city parks and school properties.

FIGURE 20: **Greenway Corridor Scenarios**



(Taken from the Greenway Guidebook pg. 22)

FIGURE 21: **Particular Greenway Corridor Example Along the River to River Greenway**



Finally, outside of these 100 to 300 ft-wide Corridors, there may exist other Sensitive Lands such as stream buffers or the remaining areas within the boundaries of city parks or other public natural areas through which the Greenway passes. To maintain a holistic approach to managing natural resource projects with respect to the natural community and to exercise flexibility towards working in partnership with multiple landowners, the Greenway Guidebook offers the following guiding principles:

> *Greenway corridors: The first stewardship priority is restoring continuous native habitat in greenway corridors themselves. This continuous ribbon of varying widths will function as a wildlife corridor and buffer streams from damaging effects like runoff, pollution, and invasive species.*
>
> *Adjoining Sensitive Lands: The next order of stewardship priority is habitat restoration and protection of the most sensitive lands, including uplands, which link greenways to the broader landscape. These landscapes perform vital functions of preserving habitat and species diversity and stormwater infiltration and cleansing. Prioritization of adjoining landscapes will be based on intrinsic sensitivities like erodibility, aquifer recharge, the presence of wetlands and the presence of native plant communities.*
>
> *A Healthy Natural Framework: Stewardship of the first- and second-order landscapes will reestablish a stronger habitat network that will have greater*

resilience and will provide a strong framework for future growth (The Greenway Guidebook, pg. 35-36).

The installation of natural plantings (i.e., native prairie grasses and forbs, trees and shrubs) and stormwater treatment best management practices (i.e., raingardens, infiltration and bioretention basins, bioswales, etc.) are commensurate with new Greenway trail design and implementation as much as possible, and the County is committed to continually maintaining and enhancing these plantings for high levels of biodiversity to sustain benefits to pollinators and water quality. Additionally, the County would construct additional needed stormwater practices to any trail sections that are re-constructed as capital infrastructure components are replaced to meet current standards.

B. Guidelines for Cost-Share

The Greenway Guidebook offers guidelines for assisting Partnerships for the implementation of Greenway trail installations and supporting facilities (trailhead restrooms, parking lots, wayfinding; see Greenway Guidebook pg. 21) and a similar model can be extended towards implementing Natural Resource projects. **Table 9** outlines the Roles and Responsibilities of Dakota County and Landowner Partner organizations for each of the consideration areas discussed above.

Table 9: Proposed Management Activities and Responsibilities

Greenway Roles / Location	30-foot Easement	100 – 300-foot Corridor	Natural Lands Beyond Corridor
Grant Match Cost Share	County	County and Landowner have equal cost share (50/50).	County/Landowner have 25/75 cost share. County may assist more in high value areas.
Restoration Project Management	County	County/Landowner Partnership.	Landowner. County may assist.
Maintenance	County	County. Landowner may assist.	Landowner.

i. Grant opportunities and requirements

Dakota County utilizes external grant funding to implement natural resources projects on County owned land, but there exist opportunities for these projects to be bundled with smaller, non-County owned lands within Greenway Corridors that would not receive the same competitive consideration if they were submitted to granting organizations as separate projects. Likewise, many local government or non-governmental organization public land owners along these Corridors may not have the staff capacity or organizational structure to take advantage of grant opportunities to implement natural resource projects on their lands, despite their willingness and interest to enact these improvements.

The State of Minnesota's Legacy Amendment offers funding opportunities for ecological restoration by way of the Outdoor Heritage Fund (through direct appropriations or through the Department of Natural Resources

Conservation Partners Legacy Grant Program) or Clean Water Fund (through the Board of Water and Soil Resources competitive grant programs).

Dakota County typically leverages 20% of requested grant funds as cash match when applying for State grants. For areas included in grants not owned in fee by Dakota County, part of these match funds would need to be contributed by Landowner Partners. Partnership contributions towards grant match funds would be agreed upon in the form of a Joint Powers Agreement in advance of initiating grant-funded natural resource projects. Additionally, this JPA would detail the roles of staff from the County or Landowner in terms of contributions of staff time for project management, contractor oversight, public and volunteer engagement, plant material acquisition, and other pertinent details within the scope of Natural Resource management of the site during the project period.

C. Continued Natural Resource Management

i. Maintenance Agreements

Dakota County and both City and civic partners collaborating on Natural Resource project implementation will establish management agreements that ensure the restoration areas paid for with grant dollars will be maintained into the future. Such maintenance activities are outlined in the 20-Year Work Plan (**Table 8)** and include revisiting sites multiple times a year to target undesirable plants for spot chemical treatment or mechanical removal. The maintenance activities should be agreed upon at the initiation of the partnership and before project implementation agreement, and documents such as Joint Powers Agreements (JPAs) or Supplemental Maintenance Agreements (SMAs) must be approved through normal business procedures for each partner in the agreement (i.e., Board or Council approval).

ii. Ongoing management activities

Ongoing management activities included in JPAs or SMAs ensure the future integrity of restoration targets. Ideally, upon completion of these restoration projects, the routine vegetation maintenance on these sites (outside the County trail easement boundaries) are carried out either by the Landowner staff members or through contractors specialized in installing and maintaining native plantings. Coordinated maintenance activities could be utilized via contributions to a shared maintenance contract to simultaneously address lands falling within the County Easement, the 100 to 300-foot-wide Greenway Corridor, and adjacent Natural Lands Outside Corridor, with County and Landowner contributions detailed in JPAs or SMAs.

Ongoing management activities need not be restricted solely to vegetation maintenance, and the following possibilities would work toward managing native plantings within agreed upon parameters for maintaining their ecological integrity.

Other possibilities for activities that Landowners could utilize include the following:

- Hosting Conservation Corps or Green Corps positions for organizing maintenance and enhancement projects
- Leading volunteer groups for restoration projects (buckthorn hauling, garlic mustard pulls, tree and shrub plantings, litter pick-up) adjacent to or follow-up within grant-funded project areas

- Leading school and volunteer groups in enhancement planting activities
- Hosting public meetings educating private landowners about cost-share opportunities for native plantings (BWSR - Lawns to Legumes, Dakota SWCD – Landscaping for Clean Water) and guidance on activities that they can take to improve the ecological diversity on their own property.
- Working with specialized volunteers such as Master Gardeners, Master Water Stewards and Master Naturalists for additional planting events

The above activities could be considered as alternatives to cash-match requirements for partnership grants if completed during the project implementation phase, or they could be considered as contributions towards offsetting long-term maintenance costs as estimated in JPAs or SMAs.

Additionally, Dakota County Staff can assist Landowners in some of the following ways within Greenway Corridors:

- Training staff in native and invasive plant identification
- Training staff with management techniques for in-house long-term native planting maintenance
- Organizing volunteer events for enhancement plantings
- Conducting vegetation and wildlife monitoring on public lands to assess effectiveness of restoration projects
- Coordinating Conservation Corps crews for limited maintenance activities and enhancement plantings

X. Monitoring and Adaptive Management

A. Methods

Ecological restoration is a long-term process. It takes time to restore ecosystems to their former functionality and diversity. And even under the best circumstances and human abilities, generally, this can only be approximated. It took many decades to degrade the ecosystem and biological communities within the Greenway Corridor, so it will not be restored overnight. Many steps are typically involved in a successful restoration; even deciding when a restoration is complete can be very difficult. Restoration should be viewed as a process and not as an end point. 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 the key to continual progress at the site. Adaptive management is a strategy commonly used by land managers, which 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 as illustrated in **Figure 22** below.

FIGURE 22: Adaptive Natural Resource Management

Thus, moving forward with restoration, each round of adaptive management refines and hones the process to better fit the current ecological conditions. This strategy should be emphasized within the Greenway Corridor.

XI. References

Congdon, J. D., D. W. Tinkle, G. L. Breitenbach, and R. C. van Loben Sels. 1983. Nesting ecology and hatching success in the turtle *Emydoidea blandingii*. Herpetologica 39(4):417-429.

Mossler, J.H. 2008. Paleozoic stratigraphic nomenclature for Minnesota: Minnesota Geological Survey Report of Investigations 65, 76 p., 1 pl.

Oldfield, B., and J. J. Moriarty. 1994. Amphibians and reptiles native to Minnesota. University of Minnesota Press, Minneapolis, Minnesota. 237 pp.

Piepgras, S. A., and J. W. Lang. 2000. Spatial ecology of Blanding's Turtle in central Minnesota. Chelonian Conservation and Biology 3(4):589-601.

APPENDICES

Appendix A: Landowner Visioning of Future Cover

The following maps were results of discussion during the Technical Advisory Committee meeting on the River to River Greenway. Project Partners were consulted on future cover types and development projects occurring within the River to River Greenway Corridor, and these plans informed the Future Cover types recommended for restoration in this NRMP (**Figures 18A-I**).

Figure A1: Valley Park

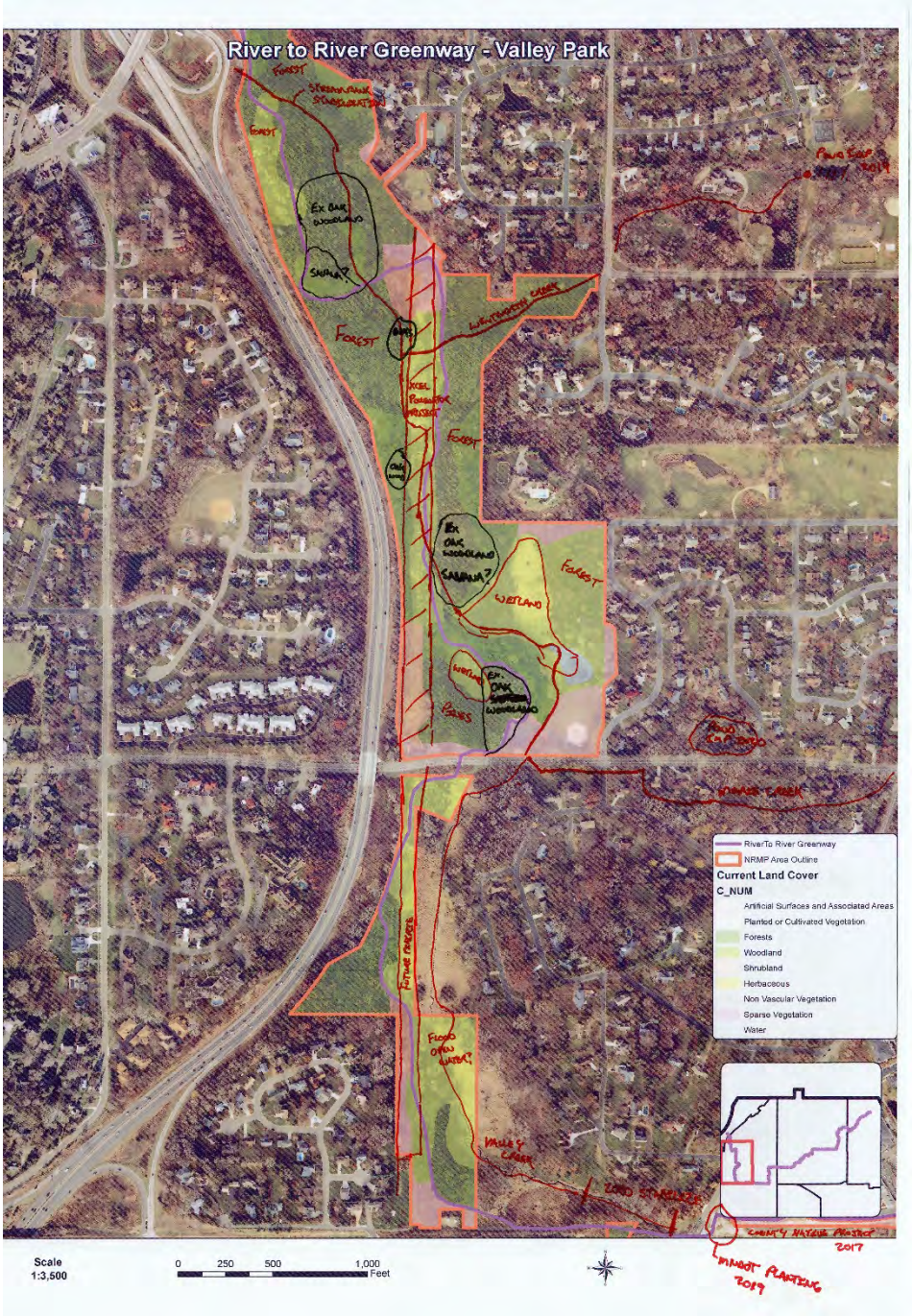


Figure A2: Dodge Nature Center- Lilly Property

Figure A3: Dodge Nature Center- Main/Marie Properties

Figure A4: Garlough and Marthaler Parks – West Saint Paul

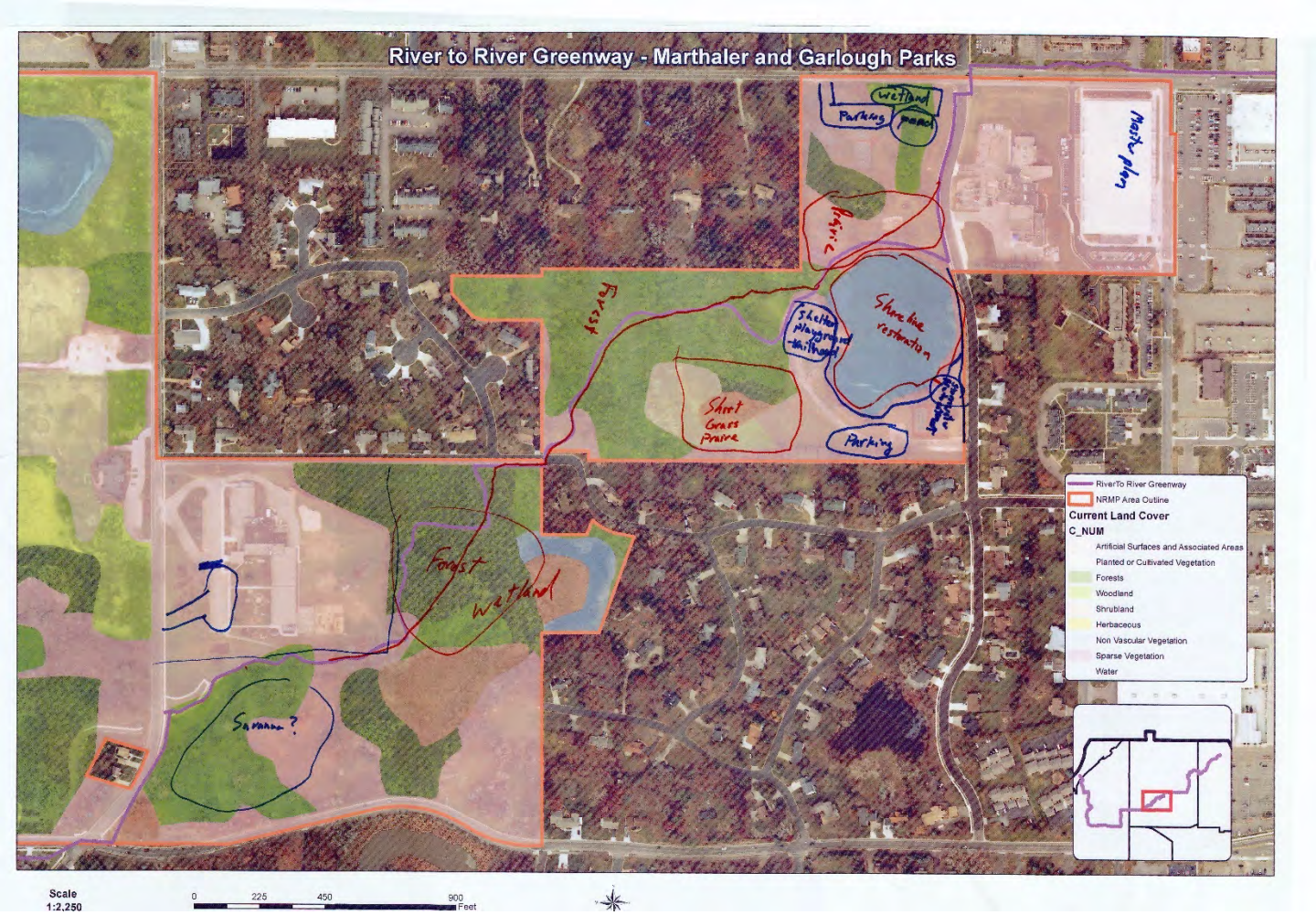


Figure A5: Kaposia – South Saint Paul

Appendix B: Potential Ecological Impacts

A. Fire Suppression

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

B. Disease

1. Oak Wilt

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

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

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

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

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

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

Control

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

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

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

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

In some circumstances, monitoring and replanting, with a different tree species or a diversity of tree species is the most parsimonious solution.

2. Bur Oak Blight

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

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

3. Dutch Elm Disease

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

C. Exotic and Over Populated Animals

1. Earth Worms

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

2. White-tail Deer

Another factor of the woodland decline is over-browsing/over-grazing. Areas that were pastured by cattle or sheep received heavy grazing pressure that was previously unknown. Native grazers (primarily bison and antelope) would move around and not concentrate in one area for long periods of time. This allowed a very diverse forb layer to thrive. With the introduction of cattle in the last century and a half, that grazing pattern changed. Cattle will concentrate their grazing much longer and their impacts are much greater. Many native forbs simply cannot survive this type of grazing pressure.

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

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

3. Emerald Ash Borer

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

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

Another potential method of biological control is with three species of Asian wasps. These wasps are tiny and stingless, about the size of a gnat. In their native China, they parasitize the larvae and eggs of emerald ash beetles, which reduce EAB populations over the long term. EAB will never be eradicated by wasps since there

will always be a level of population that does not get parasitized, but the wasps have the potential to keep EAB in-check.

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

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

D. Climate Change

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

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

Appendix C: List of Noxious and Invasive Plants

Trees/Canopy				
Plant	MDA and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
Black Locust	Restricted Noxious Weed	Native to lower Appalachian mountain slopes. It has been extensively planted for its nitrogen-fixing qualities and hard wood.	Re-produces vigorously by root suckering and stump sprouting. It Invades primarily disturbed habitats, degraded wood, thickets, and old field and crowds out native vegetation of prairies, oak savannas, and upland forests, forming single species stands	Mechanical: Mowing and burning is only temporarily effective because of the tree's ability to re-sprout and spread vegetatively Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark spray treatment around the stem with triclopyr
Norway Maple	Not Regulated	Native to Europe and Asia and widely sold in nurseries in the U.S.	Although sold primarily as a boulevard tree it spreads its seeds into disturbed forest communities. It Invades native woodlands where it out-competes sugar maple Wildflower diversity is reduced because it forms a dense canopy.	Mechanical: Pulling seedlings when soil is moist Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark spray treatment around stem with triclopyr
Siberian Elm	Not Regulated	A native of East Asia, it was introduced to the U.S. in the 1860s for its hardiness, fast growth and ability to grow in various moisture conditions. It is still sold commercially as a shelterbelt and windbreak tree.	Seed germination rate is high and seedlings establish quickly in sparsely vegetated areas. The tree can invade and dominate disturbed prairies in just a few years.	Mechanical: (1) Girdling in late spring, plants will die over one to two years (2) Prescribed burn (3) Pulling seedlings Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark treatment around the stem with triclopyr
Tree of Heaven	Restricted Noxious Weed	A native of eastern and central China it is reported by the U.S. Forest Service as close to Minnesota as Wisconsin and Iowa.	Tree-of-heaven reproduces both sexually (seeds) and asexually (vegetative sprouts). Established trees also produce numerous suckers from the roots and re-sprout vigorously from cut stumps and root fragments. It is found in disturbed soils, fields, roadsides, fencerows, and woodland and forest edges.	Mechanical: Young seedlings may be pulled or dug up, preferably when the soil is moist. Cutting large seed producing female trees should temporarily reduce spreading by this method. Chemical: Use any of several readily available general use herbicides, such as trichlopyr and imazapyr. The herbicides may be applied using foliar (to the leaves), basal bark, cut stump, or hack and squirt methods.
Sub-Canopy/Shrub				
Plant	MDA Status	Mode of Introduction	Ecological Threat	Control Methods
Amur Maple	Specially Regulated Plant	Native of temperate China, Manchuria, and Japan, and introduced to North America in the 1860s. It is still sold commercially as an ornamental, and for a	A prolific seed producer and re-sprouts easily from the cut stump. Displaces native shrubs and understory trees in open woods, and shades out native grasses and herbaceous plants in savanna habit.	Mechanical: (1) Prescribed burning will set it back but not eliminate it (2) Grubbing out small infestations Chemical: (1) Cut-stump treatment with glyphosate; cut-stump or basal (2) Bark Spray treatment around the stem with triclopyr

		wildlife and shelter belt planting.		
Common Buckthorn	Restricted Noxious Weed	First brought to Minnesota in the mid-1800s as a very popular hedging material.	Out-competes native plants for nutrients, light, and moisture Degrades wildlife habitat and threatens the future of woodlands. Contributes to erosion by shading out other plants that grow on the forest floor. Serves as a host to other pests, such as crown rust fungus and soybean aphid.	Mechanical Individuals: Small plants: if < 3/8 inches in diameter, remove by hand. If > 3/8 inches, use a hand toll to pull the shrub out. Large stems, > 2 inches, can be cut and covered with a tin can or black plastic. Chemical: Spray with a herbicide. Glyphosate (e.g., Round-up) will kill all actively growing vegetation. Triclopyr will kill broadleaf plants and will not harm grasses. Combination: Cut stems, and treat immediately with a herbicide containing triclopyr or glyphosate to prevent re-sprouting, best in late summer and throughout the fall.
Glossy or alder Buckthorn	Restricted Noxious Weed	Introduced to North America as an ornamental shrub, often planted in hedgerows.	Aggressively invades wetlands and also grows in upland habitat. Plants leaf-out early and retain leaves late into the fall, creating dense shade. Seeds have a laxative effect on birds that disperse them.	Mechanical: Prescribed fire for seedlings and pulling in small infestations Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark spray treatment around the stem with triclopyr
Exotic Honeysuckle	Bell's, Morrow's, Tartarian, and Amur Honeysuckles Restricted noxious weed	Introduced to North America as ornamental shrubs and beneficial to wildlife. Commercial propagation continues with many cultivars available from nurseries.	Seeds are readily dispersed by birds. Honeysuckles shade out herbaceous ground cover and deplete soil nursery. Exotic honeysuckle replaces native forest shrubs and herbaceous plants by their invasive nature and early leaf-out.	Mechanical: Pulling seedlings out in small infestations when the soil is moist. Prescribed burning will kill seedlings and top kill mature shrubs, repeated burns may be needed to control infestations. Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark spray treatment around the stem with triclopyr. Foliage spraying with glyphosate solution, where burning is not possible, prior to leaf out of the native species.
Japanese Barberry	Certain cultivars are Specially Regulated Plant	Introduced to North America as an ornamental, a living fence, and for wildlife and erosion control.	Spreads vegetatively through horizontal lower branches that root freely. Seeds are dispersed by birds. It invades oak woodlands and oak savanna and prefers well-drained soils.	Mechanical: Prescribed fire effectively kills the plant. Regular mowing of re-sprouts after initial removal and pulling plants in small infestations. Chemical: Cut-stump treatment with glyphosate, cut-stump or basal bark spray treatment around the stem with triclopyr
Russian Olive	Not Regulated	A native of southern Europe and western Asia it was introduced on North America as a ornamental and as a windbreak plant in the later 1800s.	Tolerates shade and a variety of soil moisture conditions. It propagates vegetatively by sprouts from buds formed in the root crown and by root suckers. It quickly takes over streambanks, lake shores, and prairies, choking out native	Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark spray treatment around the stem with triclopyr Biological: Natural disease affects Russian olive to a great extent, such as *Verticillium* wilt and *Phomopsis* canker.

			riparian habitat. It can grow on bare mineral soil which encouraged planting on mine spoils.	
Multiflora rose	Restricted Noxious Weed	Brought to the U.S. from Japan in 1866 for rootstock for ornamental roses. Starting in the 1930s it was widely planted in the U.S.	Forms dense thickets which are painful to walk through and reduces populations of native plants. Reduces grazing quality by invading pastures and grazing lands. Invades forest edges, woodlands, oak savannas, prairies, fields, pastures, and road-sides.	Mechanical: Pull seedlings in small infestations when the soil is moist. Larger plants can be pulled using hand tools. Chemical: Cut-stump treatment with glyphosate or triclopyr; cut-stump or basal bark spray treatment around the stem with triclopyr. Foliar spray with glyphosate or triclopyr solution. Biological: Rose rosette disease is a native virus spread by the eriophyid mite and can be fatal to multifloral roses. However, it can also infect other members of the rose family (e.g., native roses, plums, apples, and ornamental roses).
Siberian peashrub	Not regulated	A native of Siberia and Manchuria, it is still sold as an ornamental and for shelter belt and wildlife plantings	It invades savanna and woodland edge environments where it competes with native shrubs. Invades disturbed grasslands as well.	Mechanical: Repeated prescribed burning, it will stump sprout but be weakened eventually (2) Pulling Chemical: Cut-stump treatment with glyphosate; cut-stump or basal bark treatment around the stem with triclopyr
Grasses				
Plant	MDA Status	Mode of Introduction	Ecological Threat	Control Methods
Amur Silver grass	Not Regulated	A native to parts of eastern Asia, it is currently grown as an ornamental in the U.S.	The wind dispersed seeds can spread the plant beyond landscaped areas. It also reproduces vegetatively by rhizomes. It can form monocultures in wetter habitats, including marginal cropland, water corridors, roadsides, railways, and pond edges.	Mechanical: Digging entire roots and re-sprouts from root pieces Chemical: Cutting and spot treatment with glyphosate and continued periodically until flowering
Non-native Species of Common Reed	Restricted Noxious Weed	Native to Europe	Common reed re-produces by spreading rhizomes that from large colonies. Common reed has become a destructive weed, quickly displacing desirable plant species such as wild rice, cattails, and native wetland orchids.	Mechanical: Common reed can be cut and the rhizomes can be dug up, but physical control is difficult because it can re-establish from seed or remaining rhizomes. Frequent mowing is sometimes effective on control of common reed. Chemical: It can be controlled using any of several available general use herbicides such as glyphosate. Biological: There is no known biological control for common reed, although goats are known to forage on many types of emergent vegetation.

Reed canary grass	Not regulated	This Eurasian species has been planted through-out the U.S. since the 1800s for forage and erosion control.	Invasion is associated with disturbances, such as ditch building, stream channeling, sedimentation, and intentional planting. It out-competes native species. Reed canary grass is a major threat to natural wetlands.	Mechanical: (1) Consecutive burns spring or fall (2) Mowing mid-June and October to reduce seed and encourage native species (3) Frequent cultivation followed by fall seeding Chemical: (1) Application of glyphosate (Rodeo) (2) Preliminary research indicates that fall chemical application may be most effective
Smooth brome	Not regulated	Imported in the late 1800s and is widely used as a forage grass and for erosion control	It is tolerant of a wide variety of conditions, but prefers moist soils and sunny locations. Spreads into degraded prairies, roadsides and ditches and moist wooded areas.	Mechanical: Late spring burns will decrease Chemical: Mowing and then after a flush of growth spraying repeatedly with glyphosate
Forbs				
Plant	MDA Status	Mode of Introduction	Ecological Threat	Control Methods
Birdsfoot Trefoil	Not regulated	This European species has been introduced to the U.S. and Canada for livestock forage and erosion control along roadsides. It is still sold commercially.	Birdsfoot trefoil forms dense mats choking and shading out most other vegetation. Prescribed burns increase seed germination making it trouble-some in native prairies. It grows best in the Midwest and is most problematic in prairies and disturbed open areas, such as road-sides.	Mechanical: Mowing frequently at a height of less than two inches for several years (which will be stressful to native plants, as well). Chemical: Spot spraying affected areas (after re-greening from a burn or mowing), with clopyralid plus a surfactant plus dye (this will also effect native plants of the sunflower and the pea family).
Black Swallow-wort	Prohibited Noxious Weed (Eradicate List) and Early Detection Species	Native to France, Italy, Portugal, and Spain, and is believed to have arrived in North America as a horticultural plant.	Invades natural areas and suppress other plant species by competing for soil moisture and nutrients, light, and other environmental factors. Hatching caterpillars can't develop on this plant. It is found in disturbed areas such as highway, rail, utility, and other transportation corridors. According to the USDA Plant database, this species is not present or has a limited distribution in Minnesota.	Mechanical: Mowing or hand pulling pods as they are forming minimizes seed production; dig out isolated plants and dispose properly. Chemical: It can be effectively controlled using any readily available general use herbicides such as glyphosate in late summer and fall. Repeat applications of necessary.
British Yellow-head	Not regulated and Early Detection Species.	Native to Europe and Asia, and has been introduced into North America.	Plants reproduce by seed, short rhizomes, and root fragments. Once established, it spreads rapidly. This plant tolerates a wide range of soil types and is found primarily in moist habitats, including river and stream banks, marshes, moist meadows, ditches, wet grasslands, and wet woods.	Mechanical: Hand pull small infestations; disposal of rhizomes and root fragments is important to prevent re-occurrences. Use caution not to spread green plant segments in composted trash. Chemical: It can be effectively controlled using any of several readily available general use herbicides such as Dicamba, clopyralid, triclopyr plus clopyralid, and glyphosate.

			According to the USDA Plant database, this species is not present or with a limited distribution in Minnesota	
Bull Thistle	Not Regulated	Native to Europe and Asia and introduced into the U.S. in the early 1800s	Bull thistle is distasteful to most grazing animals, giving the thistle a competitive edge. It colonizes primarily in disturbed areas such as pastures, roadsides, and ditch banks, but also in hayfields and disturbed prairies.	Mechanical: Pulling or mowing and dispose off-site to avoid re-seeding. Chemical: Spot-spraying with glyphosate, triclopyr or metsulfuron when plants are in rosette stage (first year) in the fall when non-target plants are less susceptible. Biological: Thistlehead-feeding weevil and rosette-feeding weevil. Caution: There have been observations of weevils feeding on native thistles.
Butter and Eggs	Not regulated	The plant was introduced into North America as an ornamental from the steppes of Europe and Asia in the 1700s, and is still sold commercially.	It competes well against less aggressive plants in gravelly and sandy soils; its capability to spread vegetatively is largely responsible for its invasive behavior. Plants have the ability to adapt to various site conditions; it grows along roadsides, railroad yards, waste places, dry fields, pastures, and croplands.	Mechanical: Frequent mowing will weaken the plant Chemical: Spray with 2,4-D broadleaf herbicide Biological: Two European beetles feed on buds, flowers, and seed capsules
Canada Thistle	Prohibited Noxious Weed (Control List)	Canada Thistle occurs throughout the northern U.S. from northern California to Maine.	Once it has established itself it spreads quickly replacing native plants, diminishing diversity. It grows in circular patches spreading vegetatively through horizontal roots which can spread twelve feet in one season. Canada thistle invades natural areas such as prairies, savannas, glades, and dunes, if some degree of disturbance already exists. It also invades wet areas with fluctuating water levels such as streambanks, sedge meadows and wet prairies.	Mechanical: Repeated pulling and mowing will weaken roots; especially mow when flower buds are just about to open. Late spring burns (May/June) are most detrimental, but also stimulate seed germination; burn consecutively for three years. Chemical: Spot application with glyphosate or with selective herbicide clopyralid, or metsulfuron. Biological: Stem weevil, bud weevil and stem gall fly are commercially available.
Common Tansy	Prohibited noxious weed (Control List)	Was introduces to the U.S. from Europe for medicinal and horticultural purposes. It is still cultivated in gardens.	Numerous tufted seeds. Spreads vegetatively forming new plants from even small root fragments. Tansy is distasteful and even toxic to some grazing animals. Common along roadsides and abandoned farmyards in northern Minnesota.	Grazing: One source claims that sheep graze it and are not affected. Chemical: Spot-spraying with selective broadleaf herbicide such as clopyralid, metsulfuron, or 2,4-D
Common Teasel	Prohibited Noxious Weed (Eradicate List) and	Native to Europe and temperate Asia. Common teasel may have been introduced to North America as	It frequent use in dried flower arrangements may aid in its dispersal; for example common teasel often occurs in and near cemeteries. It also commonly disperses along roads and	Mechanical: Cutting or roots below ground and removal of as much as possible will limit sprouting. Mowing of the flowering stalks can disrupt seed production.

	Early Detection Species and	early as the 1700s, and was likely cultivated for producing wool or as an ornamental.	waterways. It occupies sunny and open sites such as riparian areas, meadows, grassland, savannas, forest openings, and disturbed sites.	Thermal: Prescribed fire can be used to increase competition from native warm season grasses, if they are present. Chemical: Herbicides such as metsulfuron methyl, clopyralid, triclopyr, or 2, 4-D amine work on teasel at the rosette stage.
Cow Vetch and Hairy Vetch	Not regulated	Both vetches have naturalized in the U.S. and are grown for forage, green fertilizer or cover crop. They occur through-out thee eastern and Midwestern states extending into southern Canada.	Their week stems grow two to three feet high and clamber over other vegetation, smothering it. They grow best on the dry sandy soils of disturbed fields and thickets. Both vetches are not a threat to healthy native prairies at this time, but can be a problem in prairie re-construction and on disturbed sites.	Mechanical: Pulling small infestations before seeds develop, to free native plants. Chemical: Spray with selective herbicide such as clopyralid.
Creeping Charlie	Not regulated	Ground ivy is found in most of the world with a similar climate as Minnesota, and is known to have medicinal properties.	Ground ivy grows best in semi-shaded to shaded moist soils and forms a dense mat, smothering other vegetation. Roots grow from each leaf node as it creeps along the ground surface while also spreading vegetatively. It is a common garden weed and grows mostly in disturbed degraded places.	Mechanical: Repeated pulling can control small infestations Chemical: Spraying with glyphosate will also affect native plants. Selective herbicide 2,4-D or Dicamba (Banvel) will control it but is hard on trees.
Cut-leaved Teasel	Prohibited Noxious Weed (Eradicate List) and Early Detection Species	Cut-leaved teasel is an aggressive species native throughout central and southern Europe and Asia. Introduction was probably made by early settlers. It was used as an ornamental, and toys were made from the flowering heads Teasels were also used commercially for combing wool. Teasel has spread rapidly in the last 20 to 30 years, probably aided by construction of the interstate highway system, where dispersal is aided by mowing equipment.	Teasels produce massive amounts of seed that can remain viable in the soil for several years and have germination rates as high as 86%. It forms extensive mon-cultures. Teasels grow in open sunny habitats, ranging from wet to dry conditions. Optimal conditions seem to be mesic habitats. Teasel sometimes occurs in high quality prairies, savannas, seeps, moist forest opening and sedge meadows, though roadsides, dumps, cemeteries and heavily disturbed areas are the most common habitats.	Mechanical: Individual rosettes can be removed using a dandelion digger; removal of the entire root is essential to eliminate re-sprouting. Flowering stalks may be cut down once the plant has initiated flowering, but if cut too soon plant may send up new flowering stalks. Cutting flowering stems may need to be repeated for several years to control teasel. Thermal: Late spring burns may be useful fir controlling teasel before it becomes dense. Once an area is densely covered with teasel rosettes, fire does not move well through an infested area. Chemical: Foliar application of herbicides is effective and useful when mechanical treatments are not feasible. Glyphosate or 2,4-D should be applies to the rosette state.
Dalmatian toadflax	Prohibited Noxious Weed (Eradicate List) and	A plant native from central Europe east to central Asia; originally introduced into North	Dalmatian toadflax is capable of forming colonies through adventitious buds from creeping root systems. It can rapidly colonize disturbed or cultivated ground to out-compete desirable native	Manual: Hand pulling, mowing, and tillage can be effective in preventing seed production and starving toadflax roots, thereby controlling infestation under certain

	Early Detection Species; it is reported in Minnesota	America as an ornamental plant.	plant species and decrease plant species diversity. It is typically found along disturbed sites, road-sites, clear-cuts, railroad right-of-ways, fences, croplands, pastures, and rangelands.	conditions only if done repeatedly and/or in combination with other control methods. Chemical: Effective herbicides for toadflax include chlorsulfuron, Dicamba, picloram, and imazapic. It may be necessary to retreat infestations every three to four years. Triclopyr and glyphosate do not effectively control this plant.
Garlic mustard	Restricted Noxious Weed	This European exotic occurs now in 27 mid-western and northeastern states, and in Canada.	Seed are viable in the soil for five years. Invaded sites undergo a decline in native herbaceous cover within ten years. Garlic mustard spreads into high quality woodlands upland and floodplain forests, not just into disturbed areas.	Mechanical: Cutting in areas of light infestations. Flowering stem cutting at ground level. Thermal: Prescribed burning if there is enough fuel to carry the flames Chemical: Spot application of 2% glyphosate in early spring or late fall when native plants are dormant. Biological: Control insects are not available at this time.
Giant Hogweed	Prohibited Noxious Weed (Eradicate List) and Early Detection Species	Native to Europe introduces as an ornamental or spice	Giant hogweed is an aggressive competitor because of its size and rapid growth, reducing the amount of suitable habitat available for wildlife. It dies back in winter months, leaving bare ground that can lead to an increase in soil erosion on riverbanks and steep slopes. This species is common is common along railroads, roadsides, rights-of-way, vacant lots. Streams, rivers, u uncultivated or waste lands, and agricultural areas.	Mechanical: Clear above ground leaf and stem material by hand; remove ground material of roots and seeds. Chemical: It can effectively controlled using any of serval readily available general use herbicides such as glyphosate early in the season when leaves are less than two feet tall and before the plant flowers and sets seed. Biocontrol: Cattle and pigs are cited as possible biocontrol agents. Both eat giant hogweed without apparent harm. Trampling also damages plant.
Grecian foxglove	Prohibited Noxious Weed (Eradicate List)	Native to southeastern Europe's scrub oak forests	Caution: Toxic to humans and animals. Wear long sleeves and gloves to avoid prolonged skin contact It grows in single species stands and is a potential threat to savanna and prairie communities. It can be found in Washington County in the vicinity of the St. Croix River along sunny and semi-shaded road ditches.	Mechanical: Pulling and cultivation Chemical: Spot spraying with glyphosate, or selective herbicide metsulfuron
Hoary alyssum	Not regulated	Native to Europe	It can be a nuisance in prairie re-construction but declines as prescribed burns are administered. It displaces native species particularly in dry	Mechanical: Mowing and pulling Thermal: Prescribed burning

			prairies and sand blow-outs where vegetation is sparse. It is most abundant in dry areas, fields, and waste places.	
Japanese Hedge Parsley	Not Regulated but Early Detection Species	Native to Asia	Although often found in areas of partial to full shade, it can tolerate a wide range of light intensity. Bristle-covered seeds are easily dispersed by animals. Invades forest edges, fields, fence rows, roadsides, and disturbed areas.	Mechanical: Pull or mow prior to flowering Chemical: Treat foliage with glyphosate, triclopyr, or metsulfuron methyl in early spring or on plants that are re-sprouting after having been cut.
Japanese Hops	Prohibited Noxious Weed (Eradicate List) and Early Detection Species; limited distribution in Minnesota	Native to eastern Asia and were introduced as an ornamental in the mid to late 1880s, and escaped cultivation.	Grows so rapidly that it can smother other plants. It can form dense patches that out-compete and displace native vegetation. Prefers full or partial sun in riparian areas, grasslands, hay fields, and roadsides. It will invade disturbed habitats, but can also colonize undisturbed sites like forest edges and fields.	Mechanical: Repeated hand-pulling is an option to control small infestations. Repeated cutting with tolls such as weed-whip, brush-cutter or mower is another option for controlling small infestations. Chemical: Repeated foliar application of a systemic herbicide containing glyphosate can be effective.
Japanese Knotweed	Specially Regulated Plant	Introduced in the U.S. in the late 1800s for ornamental purposes and erosion control.	Spreads vegetatively to form dense thickets that suppress native vegetation. It tolerates full shade, high temperatures, high salinity, and drought. It can pose a significant threat to riparian areas, such as disturbed stream sides, lakeshores and other low lying areas, where it can rapidly colonize.	Mechanical: Digging plants is effective for small infestations and in sensitive areas. Pulling of juvenile plants is also effective. Chemical: Cut stems and treat with glyphosate and triclopyr. Foliar spray in large species populations.
Leafy Spurge	Prohibited Noxious Weed (Control List0	Native to Europe and Asia it occurs across much of the northern U.S. in the grasslands and savannas of the Great Plains.	Explosive dispersal from a seed capsule up to fifteen feet; high germination rate; seeds remain viable in the soil for seven years. Tolerant of a wide range of habitats, from dry to moist, and from sunny to semi-shade. Rapidly invades primarily non-cropland disturbed environments, such as roadsides. Is a threat primarily to moist and dry prairies and savannas, quickly displacing native plants.	Thermal and Chemical: Prescribed burning in conjunction with repeated treatment with glyphosate plus 2,4,-D (one pint per acre Chemical: Imazapic (Plateau): Apply 1 to 1.3 ounces/gallon water plus 1 ounce/gallon water methylated seed oil (MSO) for spot treatment of 8-12 ounces per acre for spot treatment of 8 to 12 ounces per acre plus MSO in late September through October when native plants have gone dormant and leafy spurge has a second flush of growth. Biological: Root-boring beetle, four root-mining beetles, shoot-tip gall midge; grazing goats.
Meadow Knapweed	Prohibited Noxious Weed	Native to Europe and likely a fertile hybrid between black and	Grows aggressively and forms dense patches of vegetation.	Mechanical: Combination of hand-pulling and digging is an option for small infestations

	(Eradicate List)	brown knapweeds. It may have been introduces to western North America for forage, but is not palatable and has low nutritional value	Out-competes other plants in pastures, hayfields, meadows, riparian areas, forest margins, and rights-of-way.	Chemical: Herbicides are a very effective management tool
Musk or Nodding Thistle	Prohibited Noxious Weed (Control List)	A native of western Europe which was introduces to the U.S. in the early 1800s, and was declared an agricultural pest.	It is distasteful to grazing animals, giving it a competitive edge. It generally does not pose a threat to high quality areas. It colonizes primarily in disturbed areas. It grows best in disturbed areas such as pastures, road-sides, and ditch banks, but also in hayfields and disturbed prairies.	Mechanical: Pulling or mowing in early bud or bloom stage, then dispose off-site Chemical: Spot spraying with glyphosate, triclopyr or metsulfuron when plants are in the rosette stage (first year) in the fall when non-target plants are less susceptible Biological: Thistlehead-feeding weevil and rosette-feeding weevil. Caution: There are observations of weevils feeding on native thistles.
Narrowleaf bittercress	Prohibited Noxious Weed (Control List) and Early Detection Species; limited distribution in Minnesota	It is not known how it was introduces to North America from Eurasia. It was first reported in New England in 1916. The first report in Minnesota was in 2008. By 2009, multiple discrete infestations were reported in several counties.	This species can tolerate a variety of conditions and has been reported in areas such as road-sides, vacant lots, as well as yards and gardens. Moist woodlands, forested areas, and on margins of thickets is its preferred habitat. River bottom sites, streambanks, and other moist areas are very good habitat and provide avenues for dispersal.	Mechanical: Hand pulling timed to prevent flower and/or seed production is recommended. Thermal: In spring to top-kill basal rosettes and seedlings. Follow-up treatment with herbicide after seedling germination to further slow progress of infestation. Herbicide: Applications to forage with formulations of triclopyr, metsulfuron-methyl, or imazapic. Use glyphosate or 2,4-D after native plants have entered dormancy and narrowleaf bittercress is still active.
Orange Hawkweed	Not regulated	Native of Europe	Its greatest density occurs on newly disturbed sites, as it is am early succession plant. There is a loss of plant diversity in infected areas, and it colonizes rapidly forming a solid mat of rosettes. The plant has allelopathic effect on neighboring plants. It invades northern moist prairies, forest openings, abandoned fields, clear-cuts, and roadsides.	Chemical: Most effective control is with clopyralid or 2,4-D in the rosette stage. A surfactant should be added to the mix to ensure herbicide adherence to the hairy leaf.
Oxeye daisy	Not regulated	Probably introduced as an ornamental from Europe that escaped to become one of the most common roadside weeds.	Spread vegetatively with horizontal stems growing below the soil surface, called rhizomes, forming roots and producing new plants. It is the only large white daisy that has escaped gardens. It frequently invades disturbed fields and meadows, competing with native	Mechanical: Repeated pulling of small infestations is effective.

			plants, especially under grazing pressure.	
Perennial Sow thistle	Not regulated	Common throughout the U.S. and Minnesota	Widely spreading roots penetrating five to ten feet, producing new plants from small root pieces. Spreads vegetatively as well as through wind-born seeds. It colonizes in cultivated fields, pastures, woodlands, roadsides and gardens.	Mechanical: Cutting and pulling Chemical: Spraying with glyphosate or triclopyr, a selective broadleaf herbicide.
Poison Hemlock	Not regulated	Native to Europe, northern Africa, and western Asia. It was introduced to North America as a garden plant.	Highly Poisonous: Do not ingest any parts of the plant, because it is poisonous to humans and livestock. Use gloves when handling the plant. Spreads by seeds and is present in most states in the continental U.S. Can grow in dense patches and displaces species along streams, wet areas, fields, and disturbed habitats such as roadsides.	Mechanical: Hand pull while wearing gloves. Use a shovel to cut the taproot 1 – 2 inches below ground, and then remove the plant. Mow plants after flowers emerge, but before seeds form. Repeatedly mow in future years. First year plants may be too low to the ground to be impacted by mowing. Mowing reduces seed set by removing the flowering stalks of second-year-plants. Chemical: Foliar spray of triclopyr, glyphosate, or 2,4-D.
Purple loosestrife	Prohibited Noxious Weed (Control List)	Native of Europe and Asia, it was introduced to the east coast of North America in the 1800s. Seeds escape from gardens and nurseries into wetlands, lakes and rivers. Once in aquatic systems, seeds are easily spread by moving water and wetland animals.	The plant can form dense, impenetrable stands which are unsuitable as cover, food, or nesting sites for a wide range of native wetland animals. Purple loosestrife invades marshes and lakeshores, replacing cattails and other wetland plants.	Mechanical: Cutting of flower spikes can be an effective control of seed production. Hand pulling or digging of plants can also be effective but care should be taken to remove entire root system. Chemical: Herbicide formulations labeled for use on rights-of-way and near water: 2,4-D, glyphosate, imazamox, metsulfuron-methyl + aminopyralid, triclopyr, imazapyr, and aminocyclopyrachlor. Biological: Two leaf feeding beetles of the same genus (*Galerucella calmariensis* and *G. pusilla*) have been very effective in Minnesota.
Queen Anne's lace	Restricted Noxious Weed	Native of Europe and Asia it now occurs through-out the U.S.	Barbed small seeds, promote dispersal by animals and wind. It invades disturbed dry prairies, abandoned fields, waste places, and roadsides.	Mechanical: Hand pulling or mowing in mid to late summer before seed set.
Spotted knapweed	Prohibited Noxious Weed (Control List)	Native of Europe and Asia which spreads rapidly to artificial corridors, gravel pits, agricultural fields margins and overgrazed pastures	Caution: Wear long sleeves and gloves, can be an irritant to humans. Especially threatens dry prairie, oak and pine barrens, dunes and sandy ridges.	Mechanical: Early detection and pulling (2) Mowing as needed so plants can't go to seed (3) Prescribed burning, only very hot burns are effective which may also damage plants Chemical: Apply selective herbicide clopyralid during bud growth in early June for best results. Use caution in quality

				natural areas, because this herbicide affects plants in the sunflower and pea family Biological: Seed-head weevils, root-boring weevils, and seed-head flies are commonly used.
White and Yellow clover	Not regulated	Native to Europe and was brought to the U.S. in the 1600s and still used today as a forage crop and soil enhancer predominately in the Great Plains and the Upper Midwest	Strong tap root and seeds stay viable in the soil for 30 years. Sweet clover invades and degrades native grasslands by overtopping and shading native sun-loving plants thereby reducing diversity. It grows abundantly on disturbed lands, roadsides and abandoned fields.	Mechanical: (1) Hand pulling is effective on small infestations when the soil is moist(2) Cutting, before flowers emerge Thermal: Prescribed burning by a hot early complete first year burn followed by a hot late spring second-year burn (repeat after two years) Chemical: Spray emergent seedlings with 2,4-D amine or MecAmine after a fall burn, or after a spring burn before native vegetation emerges.
Wild parsnip	Prohibited Noxious Weed (Control List)	A native of Europe and Asia that has escaped cultivation, it is grown as a root vegetable, and is common through-out the U.S.	Warning: Avoid skin contact with the toxic sap of the plant by wearing gloves, long sleeves and long plants. The juice of the wild parsnip on the skin, in the presence of sunlight, can cause a rash, blistering and discoloration of the skin. Well-established prairies are not likely to be invaded by wild parsnip, but it readily moves into disturbed habitats, along edges and/or in disturbed patches. It invades slowly, but once population builds, it spreads rapidly and can severely modify open dry, moist, and wet-moist environments.	Mechanical: (11) Do nothing in healthy prairies, natives can sometimes out-compete the parsnip (2) Hand pulling and removing of plants (3) Cut the plant below the root crown before seeds set, and remove the cut plant (4) Mow or cut the base of the flowering stem and remove Chemical: Use sparingly in quality habitats (2); spot application with glyphosate and selective metsulfuron after a prescribed burn, parsnip is one of the first plants to green-up
Yellow Iris	Regulated Invasive Species	Eurasian plant that is still sold commercially for use in garden pools	Competed with native shore-land vegetation.	Mechanical: Dig to eliminate vegetative spreading. Chemical: Spray with glyphosate (Rodeo, for aquatic areas) Note: A permit is required to work in public waters.
Yellow Star Thistle	Prohibited Noxious Weed (Eradicate List)	Origin in Mediterranean region of Europe	Spread is by seed and each seed head can produce 35 to 80 seeds. Chokes out native plants, reducing biodiversity, and wildlife habitat and forage.	Mechanical: Plants can be pulled, tilled, or mowed before bloom. Thermal: Controlled burns are successful, if repeated every 3 years. Chemical: Use any readily available chemical herbicide.

				Biological: Six biological control insects have been released in the U.S and available for use. Grazing: Sheep, goats, and cattle graze on yellow starthistle in early spring, before the flower's spines develop.
Vines				
Plant	MDA Status	Mode of Introduction	Ecological Threat	Control Methods
Oriental Bittersweet	Prohibited Noxious Weed (Eradicate List)	Seed is moved by using fruiting stems in flowering arrangements.	Highly invasive in the eastern U.S., vines girdle trees as they climb to dominate the canopy and shade the understory, reducing and preventing the growth of other species. At times, the weight of vines in the canopy can break tees.	Mechanical: For small populations, pull up or dig plants. Regular weekly mowing will control the plant, but less frequent mowing may result in suckering from the roots. Chemical: Cut stems and apply herbicide (such as glyphosate or triclopyr) to the cut stem.

Appendix D: Methods for Controlling Exotic, Invasive Plant Species

A. Trees and Shrubs

Common Buckthorn, Tartarian Honeysuckle, Siberian Elm, and Black Locust are some of the most common woody species likely to invade native woodlands or prairies in Minnesota. Buckthorn and honeysuckle are European species that escaped urban landscapes and invaded woodlands in many parts of the country. They are exceedingly aggressive and, lacking natural disease and predators, can out-compete native species. Invasions result in a dense, impenetrable brush thicket that reduces native species diversity.

Siberian elm, native to eastern Asia, readily grows, 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, and readily invades disturbed areas. It reproduces vigorously by root suckering and can form a monotypic stand.

1. Chemical Control

The most efficient way to remove woody plants that are half 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 much greater removal difficulty.

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 can help to make treated stumps more visible. 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. Do not use diesel fuel, as it is much more toxic in the environment and for 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. 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 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 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.

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 re-sprouting 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.

Basal bark herbicide treatment is another effective control method. A triclopyr herbicide such as 10% Garlon 4, mixed with a penetrating oil, is applied all around the base 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.

2. Mechanical Control

Three mechanical methods for woody plant removal are hand pulling (only useful on 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 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 dirt 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 weed germination. This method is probably best used in areas that have very little 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. Cutting in mid spring (late May) intercepts the flow of nutrients from the roots to the leaves. 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.

3. Stems, Seedlings and Re-sprouts

Prescribed burning is the most efficient, cost effective, and least harmful way to control very small stems, seedlings, and re-sprouts of all woody plants. It also restores an important natural process to fire-dependent 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 conditions at the site.

If burning is not feasible, critical cutting in the spring is also effective, though it can impact desirable herbaceous plants as well. Foliar (leaf) application of a bud-inhibitor herbicide (Krenite) during fall is also effective. This method can also affect non-target species, though most natives will be dormant by that time.

4. Disposal

The easiest and most cost-effective method to handle large amounts of brush is usually to stack it and burn it in winter. In areas where brush is not dense, it can be cut up into smaller pieces 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.

B. Forbs

1. 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 at a site. Chemical control is most effective when the plants are in the rosette stage and least effective when the plants are flowering. A broadleaf herbicide such as 2,4-D is appropriate to minimize damage to native grasses. It is most effective when applied 10 to 14 days before the flowering stems bolt. It is applied at rate of two to four pounds per acre using a backpack or tractor-mounted sprayer or in granular form. Dicamba could also be used, with the advantages that it can be applied earlier in the spring at a rate of one pound per acre. Plants that do not respond to treatment or that are more widely dispersed could be controlled mechanically.

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

2. Wild Parsnip

Treat wild parsnip similar to Canada thistle. These are the recommendations listed by MN DNR:

<u>Mechanical</u>

- Do nothing in healthy prairies, natives can sometimes outcompete the parsnip
- Hand pulling and removing of plants
- Cut the plant below the root crown before seeds set, and remove the cut plant
- Mow or cut the base of the flowering stem and remove

<u>Chemical</u>

- Use sparingly in quality habitats

- Spot application with glyphosate or selective metsulfuron after a prescribed burn; parsnip is one of the first plants to green up

This plant can be very irritating to the skin for some people. It contains a toxin that reacts with sunlight to produce welts on the skin, similar to poison ivy. The welts can itch and get infected. Use gloves and long sleeves when handling this plant.

3. Sweet Clover

White and yellow sweet clovers are very aggressive annual species that *increase* with fire. Sweet clover can be eliminated by using a treatment that eliminates smooth brome. However, it is a common plant in agricultural areas, so if restoration is implemented, the area should be surveyed for this species on an annual basis. Individual plants or small populations can be removed by hand-pulling. If seed production occurs, prodigious amounts of seed could be spread at the site.

C. Reed Canary Grass

These recommendations are taken from Reinhardt, C. H. and Galatowitsch, S. M. 2004. Best Management Practices for the Invasive Reed Canary Grass *(Phalaris arundinacea* L.) in Wetland Restorations.

1. General recommendations for Reed Canary Grass (RCG) control

Dense populations that currently exist on-a site will need to be removed for native species to establish. In addition to the existing vegetation, in areas where RCG has been established for multiple years the RCG seed bank may be as high as 1200 seeds per square meter. Because this density of the RCG seed bank presents competition for any planting of native species, it must be considered in the NRMP. Seeds near the surface will germinate when the RCG canopy is removed. Subsequent herbicide applications will remove these seedlings, and burning/ herbicide treatments will deplete the seed bank in this way. For the RCG seed bank to deplete to levels that will not prevent native species establishment, RCG control will likely need to take place over several growing seasons. Minimize disturbance of the soil to prevent turning up additional RCG seed in these areas. While areas are undergoing herbicide treatment, large areas of exposed soil will need to be stabilized, e.g. through the use of stabilization blankets.

Herbicide applications are a major part of the plan to control RCG. A glyphosate-based herbicide is recommended because 1) it is relatively non-toxic, 2) its effect on RCG has been demonstrated, and 3) it is widely available and easy to apply. To maximize glyphosate herbicide effectiveness, apply herbicide in the later season, after late August, to ensure translocation of the herbicide to rhizomes (and therefore inducing rhizome mortality). Apply glyphosate herbicide at the rate and concentration specified by the label for weedy perennial grasses; this will differ with respect to the glyphosate-based product chosen.

RCG -dominated areas will require herbicide control over several growing seasons. Removal of RCG will result in areas of temporarily exposed soil that are subject to erosion. Implementing control on selected management units separately through time will minimize erosion-related problems at a site. Further discoveries about best management practices may result from observing the implementation of this plan over time, and the plan may be modified according to lessons learned during the management process.

For RCG-dominated areas, a broad-scale herbicide application is recommended, as damage to non-target species within these management units does not need to be considered. Apply herbicide in late August and later as this application timing maximizes translocation of the herbicide to the rhizomes, ensuring maximum rhizome mortality, which is crucial to control of RCG. Two herbicide applications can be implemented during this window if necessary.

After the standing RCG vegetation is killed in the first year of treatment, a heavy layer of thatch will remain. A controlled burn will be applied to remove thatch and encourage germination of RCG from the seed bank in the interests of reducing RCG seed bank density. Subsequent herbicide applications will control this flush from the seed bank. A late fall burn is recommended to remove thatch (spring burns may encourage growth from rhizome-based shoots).

Even after two years of effective herbicide application, RCG will recolonize, largely from the seed bank and from incoming propagules, and outcompete new native vegetation from a restoration seeding. Therefore, three years of herbicide application are recommended.

For areas with native species cover, selective removal of RCG will be critical to the maintenance of these native populations. We recommend hand weeding of RCG seedlings in the early spring as soon as they reach an identifiable stage (removal will be easiest before the seedlings establish a network of rhizomes) and herbicide wicking of established RCG individuals in the fall (damage to non-target species will be lowest at this time when many native species have already senesced). Herbicide wicking is also an option in the early spring, but hand weeding is preferable, as herbicide applications during the early spring may not achieve complete mortality. Selective control of RCG in these areas can begin immediately and continue for as long as needed.

2. Areas with woody species cover

Some management units with woody species cover (shrub units) have been invaded by RCG, although other species exist in the understory. Similar to the areas with native species cover, selective removal of RCG rather than homogeneous treatment over a large-scale area, will be necessary. We recommend hand weeding of RCG seedlings in the early spring and herbicide wicking of established RCG individuals in the fall. Herbicide wicking is also an option in the early spring, but hand weeding is preferable, as herbicide applications during the early spring may not achieve complete mortality. Selective control of RCG in these areas can begin immediately and continue for as long as needed.

3. Reestablishment of native vegetation

Following control of RCG seeding with a native species restoration mix will be needed to stimulate reestablishment of native vegetation. If there are no high quality wetlands nearby to serve as propagule sources, and years of drainage have made the seed bank depauperate, it is highly unlikely that native vegetation will establish through natural means of propagule dispersal to a site.

Areas that have been treated with broad-scale herbicide applications must be seeded uniformly. Prepare the soil for seeding, by first performing a prescribed burn on the area (either in the previous fall or the early spring

of that year) if necessary to remove dead vegetation. The appropriate seeding rate will depend on the target community, but since RCG is most problematic in a wet but not saturated soil environment, it is not unlikely that the NRMP will target such a community as a wet meadow. In such a case, a wet meadow grass mixture will be seeded at 13 pounds per acre Pure Live Seed (PLS) or greater, and a wet meadow forb mixture will be seeded at four pounds per acres PLS or greater. The combined seeding rate of 17 pounds per acre PLS is an average seeding rate, and increasing the rate will likely increase native species establishment.

For areas that have received selective removal of RCG (not broadcast herbicide application), inter-seeding is recommended for areas left open after RCG removal. Species-appropriate seedlings will be necessary, e.g. woodland forb species in the understory of areas with woody species cover, and aquatic species in a Seepage meadow/carr area. After seeding with native species, monitoring of RCG recruits will likely be necessary for as long as Greenway Corridor wetlands are exposed to an influx of new RCG (i.e., indefinitely in a riparian environment). As native species begin to establish, selective removal of new recruits of RCG is necessary as they emerge within the establishing native community, via hand-weeding or selective treatment with herbicide.

Appendix E: Suggested Native Shrubs for Replacing Common Buckthorn

Dry Upland Areas					
Common Name	**Scientific Name**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
New Jersey tea	*Ceanothus americanus*	2 to 3	Full sun	High: butterflies and hummingbirds	Dry prairie –forms patches.
Gray dogwood	*Cornus racemosa*	9	Sun/shade	Very high	Used by over 40 species of wildlife. Spreads
American hazelnut	*Corylus americana*	6 to12t	Sun/part shade	highly valued by mammals and birds	Spreads, but slowly; forms very deep roots
Beaked hazelnut	*Corylus cornuta*	6 to 12	Sun/shade	high	Spreads, but slowly. More northern range than American hazelnut.
Eastern red cedar	*Juniperus virginiana*	20	Sun	high	Invades prairies in absence of fire. Important bird cover in winter and summer heat.
Pin cherry	*Prunus pensylvanica*	10 to30	Sun	Excellent	Used by 81 species of wildlife
Smooth rose	*Rosa blanda*	4 to 6	Sun/part shade		
Silver buffaloberry	*Shepherdia argentea*	8 to 10	Full sun	High: birds	Thicket forming in prairies; silvery green foliage; red berries in late summer. Native to west edge Minnesota
Wolfberry	*Symphoricarpos occidentalis*	2 to 4	Full sun		Thicket forming in prairie; small pinkish flowers
Dry-Mesic Upland Areas					
Common Name	**Scientific Name**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
Allegheny serviceberry	*Amelanchier laevis*	15 to 25	Sun/part shade	high	
Round-leaved dogwood	*Cornus rugosa*	8 to 12	Part sun/shade	Butterflies use flowers; birds eat berries	
Eastern wahoo	*Euonymus atropurpurea*	6 to 20	Sun/shade		Spreads
Common ninebark	*Physocarpus opulifolius*	8 to 10	Full sun	Bird food	Dense growth habit
American plum	*Prunus americana*	20 to 35	Sun	high	
Choke cherry	*Prunus virginiana*	20 to 30	Sun/part shade	Excellent	

Sambucus pubens	*Red-berried elder*	10 to12	Sun/part shade	High value: bird food	Cluster of white flowers; red berries in early summer.
smooth rose	*Rosa blanda*	4 to 6	Sun/part shade		
Red-berried elder	*Sambucus pubens*	6 to 12	Shade	Very high	Excellent massing, fast growing.
Bladdernut	*Staphylea trifolia*	8 to 15	Shade		Tolerates many soil conditions, disease resistant
Arrowwood viburnum	*Viburnum rafinesquianum*	5 to 8	Part shade, shade	high	Pretty foliage
Highbush cranberry	*Viburnum trilobum*	6 to 12	Sun to shade	High -Birds eat fruits.	Foliage open form in shade, dense in sun.
Wafer ash	*Ptelea trifoliata*	10 to15	Sun to shade	Larval host for swallowtail butterfly	Foliage open form in shade, dense in sun.

Flood Tolerant Areas

Common Name	Scientific Name	Height	Light	Wildlife Value	Comments
American elder	*Sambucus canadensis*	8 to10	Full sun	High value: bird food	Very tolerant of soil conditions; blue-black fruit in late summer
False Indigo	*Amorpha fruticosa*	8 to10	Sun/part shade	Butterflies	Attractive flower
Black chokeberry	*Aronia melanocarpa*	5 to 8	Sun/shade	Bird food	
Buttonbush	*Cephalanthus occidentalis*	6 to 12	Full sun	Birds, butterflies	Round flower head; fragrant
Pagoda dogwood	*Cornus alternifolia*	15 to 20	Sun/shade		Beautiful growth form.
Silky dogwood	*Cornus amomum*	6 to 12	Full sun	Bird food	Blue fruit; reddish-purple bark
Red twig dogwood	*Cornus sericea*	6 to 12	Sun/part shade	Bird food	Red twigs, greenish-white fruit
Witch hazel	*Hamamelis virginiana*	20 to 30	Sun or shade	Late-season pollinators	Unique, spider-shaped yellow flowers that bloom late in the year.
St. Johns Wort	*Hypericum kalmianum*	2 to 3	Sun/part shade	Pollinators	Masses of yellow flowers in summer
Winterberry	*Ilex verticillata*	6 to 8	Sun/light shade	Bird food	Showy red fruit in fall.
Black Currant	*Ribes americanum*	3 to 6	Sun/light shade	High value: birds and mammals	White flowers and black-purple fruit

Pussy willow	*Salix discolor*	20	Full sun	Soil stabilizer	Showy catkins and ornamental
Red willow	*Salix sericea*	6 to 8	Full sun	Bird food	Upright, rounded form; and reddish-brown twigs
Meadowsweet	*Spirea alba*	3 to 6	Full sun	Bird food	Of wet meadows. Erect branching; white flower spikes in July
Nannyberry	*Viburnum lentago*	16 to 20	Sun/part shade	high	Dense foliage
Highbush cranberry	*Viburnum trilobum*	6 to 12	Sun/part shade	High value: bird food	White flat-topped flower clusters; red fruit persists until spring; red color to foliage in autumn

Appendix F: Description of Target Plant Communities

***Prairie* - UPs13 Southern Dry Prairie and UPs23 Southern Mesic Prairie**

Grass-dominated herbaceous communities on level to steeply sloping sites with droughty (Dry) to poorly or well-drained loam (Mesic) soils. Mesic prairies tend to be higher in forb richness. While Mesic Prairies irregularly experience drought stress, moisture deficits in Dry Prairies occur most years, and severe moisture deficits are frequent, especially during periodic regional droughts. Historically, fires probably occurred every few years for both communities.

Vegetation Structure & Composition

• Graminoid cover is usually continuous (75–100%) in Mesic Prairie, patchy to continuous (50%-100%) in Dry Prairie. Tallgrasses dominate in Mesic Prairies, but several midheight grasses are also important. In dry prairies, midheight and shortgrass species are prominent, although tallgrass species are typically important as well. Dry prairie species composition varies considerably, reflecting variation in soils and topography; several species in the community are restricted to sites on deep sands. Little bluestem is generally the dominant grass; other major midheight grasses are side-oats grama, prairie dropseed, porcupine grass, and plains muhly. Junegrass and hairy grama are common minor grasses. Of the tallgrasses, big bluestem is usually important, while Indian grass is less frequent, being more strongly associated with more mesic sites within the community. Mesic Prairie species composition is fairly uniform, although relative abundances shift across the moisture gradient within the community. Big bluestem and Indian grass are the dominant tallgrasses, with prairie dropseed either a codominant or subdominant component. On the drier end of the gradient, little bluestem, porcupine grass, and side-oats grama are important. On moister sites, switchgrass may be common, and prairie cordgrass is usually present. Leiberg's panic grass is distinctive, although usually minor in terms of cover.

• Forb cover is sparse to patchy (5–50%). Forb species composition also responds to moisture. A number of species are common across the moisture gradient, including heart-leaved alexanders, heath aster, stiff and Canada goldenrods, purple and white prairie clovers, silverleaf scurfpea, stiff sunflower, white sage, northern bedstraw, and smooth blue aster. Maximilian's sunflower, tall meadow-rue, prairie phlox, and gray-headed coneflower are most common on the moister end of the gradient. Rough blazing star, Missouri and gray goldenrods and bird's foot coreopsis are common in the drier end. Rattlesnake master and compass plant are typical species in southeastern Minnesota but rare to absent in the community elsewhere. Common species that are more abundant in UPs13 than in other UP classes include gray goldenrod, silky aster, aromatic aster, dotted blazing star, hairy golden aster, pasqueflower, harebell, western ragweed, false boneset and flowering spurge.

• Shrub layer is sparse (5–25% cover). The low semi-shrubs leadplant and prairie rose are generally common. Sparse patches of wolfberry are occasional. Gray dogwood, American hazelnut, and wild plum are rare.

• Trees are absent except bur oak where fire suppression has allowed invasion by woody species.

Natural History

The xeric conditions and lower soil fertility of UPs13 strongly favor species having physiological and morphological adaptations to cope with these stresses. Reduced aboveground biomass, narrow, small, or

deeply dissected leaves, and dense hairy vestiture are examples of such adaptations. UPs23 is present on level to gently sloping sites where the water table is below the rooting zone except for brief periods during the growing season. Soil moisture availability remains high on average because of soil texture and composition. Recurrent fire is essential for the existence of UPs23, as environmental conditions are otherwise suitable for the growth of trees; where propagules are available, succession to forest occurs rapidly in the absence of fire. Fires also recycle nutrients bound up in litter and promote flowering and seed production. These events temporarily expose the soil surface and so probably play an important role in plant regeneration. Before Euro-American settlement, grazing and trampling by large ungulates were regular occurrences in UPs23. The contribution of this disturbance to the composition and structure of the vegetation is not well understood, although it is known that confined grazing by domestic livestock can quickly destroy mesic prairies, promoting the replacement of most native species by introduced ones. Episodic grazing probably enables the persistence of some native species that cannot otherwise reproduce in the dense canopy of tall grasses and forbs characteristic of UPs23; these would include shorter species and especially annual or biennial species. Spatial patchiness in grazing intensity is also thought to have influenced fire behavior, providing a shifting patchwork of refugia for fire-sensitive animal species. The fertile soils and gentle relief of UPs23 are ideal for row-crop agriculture, and almost all of the land that supported this class has been converted to cropland. As for all prairie classes in Minnesota, recurrent fire is necessary to prevent succession of UPs13 to woodland or forest, although the fire frequency required to maintain dry prairies is lower than for mesic prairies because the xeric conditions and lower fertility of the sites somewhat inhibit tree and shrub invasion. Smooth sumac and eastern red cedar are two of the most aggressive prairie invaders in the absence of fire. The first spreads clonally into prairies from woodland edges, while the second invades from seed dropped by birds. Once these woody species establish dense stands, it is difficult for fire to remove them. Other trees present in nearby woods and forests also can become established in dry prairies unless eliminated by fire.

***Oak Savanna* - Southern Dry and Mesic Savanna (UPs14 and UPs24)**

Sparsely treed communities with grass-dominated herbaceous ground layers on nearly level to steeply sloping sites with droughty (Dry) or somewhat poorly drained to well-drained loam (Mesic) soils. Moderate growing-season moisture deficits occur during most years for Dry sites, and severe moisture deficits are frequent, especially during periodic regional droughts. Drought stress is irregular in occurrence in Mesic sites and usually not severe. Trees are open grown, typically small and gnarled. Historically, these communities burned every few years.

Vegetation Structure & Composition

• Graminoid cover is patchy to continuous (25–100%) for Dry sites and interrupted to continuous (50-100%) for Mesic sites. Midheight grasses (Dry) to tallgrass species (Mesic) are dominant depending on moisture availability. Species composition varies with variation in soils and topography and is similar to that of Southern Dry Prairie (UPs13) and Southern Mesic Prairie (UPs23). Little bluestem and porcupine grass are generally dominant; big bluestem and Indian grass are usually present and often common, more so than in UPs13. Pennsylvania sedge, a woodland species, is often present.

• Forb cover is sparse to patchy (5–50%). Of characteristic forbs in Dry sites, the most common are western ragweed , Virginia ground cherry, gray goldenrod, white sage, hairy and hoary puccoon, hoary frostweed, and

starry false Solomon's seal. The fern ally rock spikemoss is usually common on sand substrates. The most common species for Mesic sites include heart-leaved alexanders, heath aster, stiff and Canada goldenrods, purple and white prairie clovers, silverleaf scurfpea, stiff sunflower, white sage, northern bedstraw, and smooth blue aster. Maximilian's sunflower, tall meadow-rue, prairie phlox, and gray-headed coneflower are common in moister examples; rough blazing star, Missouri and gray goldenrods, and bird's foot coreopsis are common in drier ones.

• Woody vines are a minor component. Virginia creeper (Parthenocissus spp.) is frequently present, and wild grape (Vitis riparia) is occasionally present

• In Dry Savanna sites, shrub layer is sparse to patchy (5–50% cover) and composed of low (< 20in [50cm]) semi-shrubs, taller (up to 6ft [2m]) shrubs, and oak seedlings and stunted (< 6ft) oak "grubs." Leadplant, prairie rose, and poison ivy are common low shrubs; chokecherry, American hazelnut, and smooth sumac are the most important tall shrubs. Mesic sites have higher levels of patchy to interrupted shrub cover (50–75% cover). Additional shrubs at Mesic sites include gray dogwood, wolfberry, low juneberry, and wild plum.

• Trees occur as scattered individuals or as scattered small clumps (with total cover < 70%, typically 25–50%). Trees are usually < 33ft (10m) tall and frequently < 16ft (5m), with open-grown form. Bur oak is most common, but northern pin oak is also usually present.

• Notes: The exotic grasses Kentucky bluegrass (Poa pratensis) and smooth brome (Bromus inermis) are often problematic in UPs24. Pennsylvania sedge (Carex pensylvanica var. pensylvanica), a native graminoid that is naturally a minor component of UPs24, increases in abundance with prolonged heavy grazing. With fire suppression, trees other than the oaks become established, especially green ash, quaking aspen, and basswood.

Natural History

Savannas form where fire recurs frequently enough to prevent trees and shrubs from dominating and shading out sun-loving herbaceous plants, but where frequency and severity are low enough to allow fire-tolerant trees to become established and sometimes reach maturity. Historically, savannas typically occurred in physical proximity to prairie, but where various factors provided some amelioration of the fire regime of the adjoining or surrounding prairie. These factors include streams, lakes, and steep topography, which limited the spread of fire and thus created conditions conducive to savanna formation in the prairie region. The very low productivity of sandy substrates as well as surface instability result in reduced fuel loads and thus fire intensity is lower in savannas than in typical prairies. All savannas are highly sensitive to fire suppression, quickly succeeding to woodland and eventually to forest in the absence of fire. The higher productivity of sites where UPs24 occurs makes it even more susceptible to succession than UPs14. UPs24 occupies sites where soil moisture availability remains high on average because of soil texture and composition, although the water table is below the rooting zone during the growing season except for brief periods. Dry savannas are more resilient than mesic savannas because the xeric conditions and lower fertility of the soils inhibit tree and shrub growth and reproduction. These same factors also greatly influence herbaceous species composition, eliminating species not adapted to either frequent drought or low nutrient availability. Before Euro-American settlement, browsing, grazing, and trampling by large ungulates were regular occurrences in savannas. The contribution of these activities to the composition and structure of the vegetation is not well understood, although it is known that confined grazing by domestic livestock can badly degrade savannas by promoting the

replacement of most of the native species by introduced ones. The fertile soils and gentle relief of UPs24 are ideal for row-crop agriculture, and almost all of the land that supported UPs24 has been converted to cropland; areas not converted have either been so heavily pastured that almost none of the native herbaceous flora survives, or they have become woodland or forest with fire suppression.

***Oak Woodland* - Southern Dry-Mesic Oak Woodland (FDs37)**

Dry-mesic hardwood forests on undulating sand flats, hummocky moraines, and river bluffs. Present mostly on fine sand or sand-gravel soils. Often on south- or west-facing slopes but common also on flat to undulating sandy lake plains. Historically, fires were common in this community, and many stands are on sites occupied by brushlands 100–150 years ago.

Vegetation Structure & Composition

• Ground-layer cover is patchy to continuous (25–100%). Pointed-leaved tick trefoil, Clayton's sweet cicely, hog peanut, Canada mayflower, and wild geranium are commonly present. Pennsylvania sedge is the most abundant graminoid. Dewey's sedge and starry sedge may also be present.
• Shrub-layer cover is patchy to continuous (25–100%). Common species include black cherry, red maple, chokecherry, American hazelnut, gray dogwood, prickly ash, Virginia creeper, and poison ivy.
• Subcanopy cover is patchy to interrupted (25–75%). The most common species are black cherry, red maple, and bur oak.
• Canopy cover is usually interrupted to continuous (50–100%). Bur oak and northern pin oak are the most common species. Northern red oak, white oak, and red maple are occasionally present. Older trees are often open grown, indicating previously more open conditions on the site.

Natural History

Natural History In the past, fires were very common throughout the range of FDs37. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was about 110 years, and the rotation of mild surface fires about 10 years. The rotation of all fires combined is estimated to be 9 years. Windthrow was not common, with an estimated rotation exceeding 1,000 years. Based on the historic composition and age structure of these forests, FDs37 had two growth stages.
• 0–75 years—Young forests recovering from fire, dominated by bur oak with some northern red oak or white oak. Quaking aspen, northern pin oak, and black cherry are minor components.
• > 75 years—Mature forests dominated by a mixture of bur oak, white oak, northern pin oak, and some northern red oak, with minor amounts of American elm.

Native Plant Community Types in Class

• FDs37a Oak - (Red Maple) Woodland: Canopy is dominated by northern red oak, northern pin oak, and white oak with lesser amounts of bur oak and red maple. Red maple is also common in the subcanopy and shrub layers. Chokecherry, American hazelnut, gray dogwood, and prickly ash are common in the shrub layer. FDs37a is distinguished from FDs37b by the presence of northern red oak or white oak in the canopy or understory. Other species that can help to differentiate FDs37a from FDs37b include red maple, bush honeysuckle, lady fern, interrupted fern, and starflower.

• FDs37b Pin Oak - Bur Oak Woodland: Canopy has abundant northern pin oak and bur oak. The subcanopy is not well differentiated from the canopy; bur oak, black cherry, and green ash are the most common subcanopy species. The shrub layer is often dense, with prickly ash, chokecherry, American hazelnut, gray dogwood, prickly gooseberry, and downy arrowwood all common. FDs37b is distinguished from FDs37a by the greater dominance of northern pin oak and bur oak in the canopy. Other species that help to differentiate FDs37b from FDs37a when present include green ash, wild honeysuckle, snowberry or wolfberry, giant Solomon's seal, Lindley's aster, and sideflowering aster.

***Oak Forest* - Oak-Basswood Forest (MHs38)**

Mesic hardwood or, occasionally, hardwood-conifer forests. Present on wind-deposited silt on bedrock bluffs, on calcareous till on rolling till plains, and, rarely, in association with natural fire breaks in prairie landscapes or on weakly calcareous till on stagnation moraines.

Vegetation Structure & Composition
• Ground-layer cover is patchy to interrupted (25–75%); important species include zigzag goldenrod, large-flowered bellwort, and Virginia waterleaf. Other common species include Clayton's sweet cicely, Virginia creeper, bloodroot, lopseed, common enchanter's nightshade, early meadow-rue, wild sarsaparilla, Pennsylvania sedge, and honewort.
• Shrub-layer cover is patchy to interrupted (25–75%); common species include sugar maple, ironwood, prickly gooseberry, and chokecherry.
• Subcanopy cover is interrupted to continuous (50–100%); important species include ironwood, sugar maple, and basswood. American elm, red elm, and bitternut hickory are occasionally present, with blue beech occasional in southeastern and east-central Minnesota
• Canopy cover is interrupted to continuous (50–100%); the most common species are basswood, northern red oak, and sugar maple, with bur oak and green ash replacing northern red oak in importance in western Minnesota, and white oak abundant in some stands in eastern Minnesota. On rare occasions a supercanopy with abundant white pine is present.

Natural History
In the past, catastrophic disturbances were rare in MHs38. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was in excess of 1,000 years, and the rotation of catastrophic windthrow was about 360 years.1 Events that resulted in partial loss of trees, especially light surface fires, were much more common, with an estimated rotation of 35 years. Based on the historic composition and age structure of these forests, MHs38 had two growth stages separated by a period of transition.
• 0–35 years—Young forests recovering from fire or wind, dominated by northern red oak mixed with basswood, American elm, and some quaking aspen.
• 35–75 years—A transition period marked by the gradual decline of northern red oak and its replacement by sugar maple. Basswood, American elm, and ironwood increase during this period, and white oak becomes established.
• > 75 years—Mature forests of sugar maple mixed evenly with basswood, American elm, ironwood, northern red oak, and white oak.

Native Plant Community Types in Class

• MHs38a White Pine - Oak - Sugar Maple Forest: Mesic hardwood-conifer forests, mostly on steep north-facing slopes on thin, windblown silty soil over bedrock. Canopy is dominated by northern red oak, often with sugar maple and occasionally with smaller amounts of basswood, paper birch, white oak, and other hardwood species. Most often a supercanopy of white pine is present. Subcanopy has abundant ironwood and sugar maple. MHs38a is distinguished from other types in this class by the presence of white pine in the canopy or understory; other species that can help to distinguish MHs38a include bush honeysuckle, elm-leaved goldenrod, starry campion, and Virginia thimbleweed.

• MHs38b Basswood - Bur Oak - (Green Ash) Forest: Mesic hardwood forests on hummocky topography or near lakes on till plains and stagnation moraines; slopes are generally not steep. Canopy most often is dominated by basswood, bur oak, or green ash, with northern red oak abundant in a few stands. Subcanopy and shrub layer have abundant ironwood with occasional basswood. In general, MHs38b can often be distinguished from the other types in this class by the presence of abundant green ash in the canopy and abundant Virginia waterleaf in the ground layer. It is further distinguished from MHs38c by lower frequency of northern red oak and almost complete lack of sugar maple in the canopy. Additional species that can help to distinguish MHs38b include snowberry or wolfberry, starry false Solomon's seal, and nodding trillium.

• MHs38c Red Oak - Sugar Maple - Basswood - (Bitternut Hickory) Forest: Mesic hardwood forests on steep, mostly north-facing slopes on thin silt over bedrock and also on till plains with hummocky topography. Northern red oak and sugar maple are the most abundant canopy trees; basswood is also common. Ironwood and sugar maple are the most abundant subcanopy and shrub-layer species; bitternut hickory is common in both the subcanopy and shrub layers. When present, mayapple distinguishes MHs38c from MHs38a in the PPL; the absence of white pine also differentiates MHs38c from MHs38a. Farther north, MHs38c can be differentiated from MHs38b by the significantly higher abundance of northern red oak. Other species that can help to differentiate MHs38c from MHs38a and MHs38b include rue anemone and hairy Solomon's seal.

Maple Basswood Forest - Southern Mesic Maple-Basswood Forest (MHs39)

Rich mesic hardwood forests on loamy soils derived from calcareous till or wind-deposited silt over bedrock. Present on sites that have been historically protected from fires on hummocky stagnation moraines, on till plains along rivers, and on middle or lower slopes of bedrock bluffs.

Vegetation Structure & Composition

• Ground-layer cover is interrupted to continuous (50–100%); important species include Virginia waterleaf, bloodroot, yellow violet, largeflowered bellwort, wild leek, blue cohosh, and early meadowrue. Spring ephemeral species such as cut-leaved toothwort and Dutchman's breeches are characteristic.

• Shrub-layer cover is rare to interrupted (5–75%); common species include sugar maple, bitternut hickory, basswood, prickly gooseberry, and chokecherry.

• Subcanopy cover is most commonly patchy to interrupted (25–75%); important species include sugar maple, ironwood, basswood, and bitternut hickory.

• Canopy cover is interrupted to continuous (50–100%) and strongly dominated by sugar maple, with basswood, northern red oak, and occasionally red elm and American elm.

Natural History

In the past, catastrophic disturbances were rare in MHs39. An analysis of Public Land Survey records indicates the rotation of catastrophic fires was in excess of 1,000 years, and the rotation of catastrophic windthrow was about 680 years.1 Events that result in partial loss of trees, especially light surface fires, were more common, with an estimated rotation of about 50 years. Based on the historic composition and age structure of these forests, MHs39 had two growth stages separated by a period of transition.

• 0–35 years—Young forests recovering from wind or fire, dominated by northern red oak mixed with basswood, quaking aspen, and some American elm.

• 35–75 years—A transition period marked by the gradual decline of northern red oak and its replacement by sugar maple. Basswood declines slightly, and quaking aspen is essentially eliminated during this stage. American elm and ironwood increase, and white oak seedlings become established during this period.

• > 75 years—Mature forests mostly of sugar maple mixed evenly with basswood, American elm, ironwood, and northern red oak, and with some white oak in the eastern part of the range of the community.

Native Plant Community Types in Class

• MHs39a Sugar Maple - Basswood - (Bitternut Hickory) Forest: Rich mesic hardwood forests on moderate to steep north-facing slopes on hummocky stagnation moraines, on till plains along the Minnesota River, and on middle and lower slopes on bedrock bluffs. Most often, canopy is strongly dominated by sugar maple with lesser amounts of basswood and, often, northern red oak or bur oak. Ironwood and sugar maple are the most abundant subcanopy species. Sugar maple is also common in the shrub layer with bitternut hickory, prickly gooseberry, chokecherry, and pagoda dogwood. MHs39a is the most widespread of the three community types in MHs39.

• MHs39b Sugar Maple - Basswood - Red Oak - (Blue Beech) Forest: Rich mesic hardwood forests on shady, moist, middle and lower parts of moderate to steep north-facing slopes. Canopy is strongly dominated by sugar maple, with basswood and northern red oak. Ironwood, blue beech, sugar maple, basswood, and bitternut hickory are the most abundant subcanopy species. These same species are also common in the shrub layer with bladdernut, pagoda dogwood, and leatherwood. Species that help to differentiate MHs39b from the other types in this class include blue beech in the canopy and understory, and bladdernut, Wood's sedge, woodland millet grass, shining bedstraw, mayapple, bulblet fern, interrupted fern, Virginia spring beauty, two-leaved miterwort, and hispid buttercup in the understory. MHs39b has very high species diversity and provides important habitat for a variety of rare plant species.

• MHs39c Sugar Maple Forest (Big Woods): Rich mesic hardwood forests on gently sloping sites on hummocky stagnation moraines and also on till plains along the Minnesota River. Canopy is strongly dominated by sugar maple, often with basswood and less frequently with northern red oak, red elm, or American elm. Sugar maple is also abundant in the subcanopy and shrub layer. Other common species in the shrub layer are basswood, bitternut hickory, prickly gooseberry, red-berried elder, and chokecherry. MHs39c has been documented mainly in the Big Woods Subsection of the MIM, where it may overlap with MHs39a. Species that help to differentiate MHs39c in this area include hackberry (especially when present in the canopy), red-berried elder, puttyroot, giant Solomon's seal, and hairy Solomon's seal. MHs39c is also more likely to have dense patches of wood nettle in the ground layer.

Wet Forest **- Southern Wet Aspen Forest (WFs55)**

Wet to wet mesic forests on slightly raised "islands" in large open wet meadows and in transition zones between wet meadows and adjacent forested uplands. Present mostly on level to gently rolling outwash plains.

Vegetation Structure & Composition

• Ground-layer cover is patchy to continuous (25–100%) and composed of a mixture of wet prairie, wet forest and upland forest species. Common species include mountain rice grass, bluejoint, false melic grass, longstalked sedge, largeleaved aster, wild sarsaparilla, dwarf raspberry, common strawberry, Canada mayflower, Peck's sedge, and field horsetail. In wetter parts of the community, lake sedge, tussock sedge, Hayden's sedge, swamp thistle, spotted water hemlock, and bottle gentian are common.
• Shrub layer cover is patchy to interrupted (25–75%). Common species include downy arrowwood, Saskatoon juneberry, chokecherry, gray dogwood, prickly rose, wild honeysuckle, highbush cranberry, pussy willow, beaked hazelnut, red raspberry, poison ivy, and nannyberry.
• Subcanopy cover is patchy to interrupted (25–75%). The most common species are quaking aspen, bur oak, American elm, and black ash.
• Canopy cover is mostly interrupted to continuous (50–100%). The most common species are quaking aspen, black ash, and bur oak.

Natural History

Wet aspen forests develop in the absence of fire on small, slightly raised "islands" in areas of open wet prairie, wet meadow, or shrub swamp. They may also occur in transition areas between wet prairies and upland forests and around the edges of wet meadows. Soil moisture can vary from site to site. In transition areas between uplands and lowlands and also around the edges of raised islands, where broad-leaved sedges are dominant, soils are wet. In the interior of these islands, species with affinity for mesic and dry-mesic soils are common.

Native Plant Community Types in Class

• WFs55a Lowland Aspen Forest: WFs55a is the only plant community type recognized in this class. Further sampling and analysis is needed to better describe the community class and may result in alteration of the concept of the community.

Wet Forest **- Southern Floodplain Forest (FFs68)**

Deciduous riparian forests on sandy or silty alluvium on low, level, annually flooded sites along medium and large rivers in the southern half of Minnesota. Community is characterized by evidence of recent flooding such as rows and piles of debris, ice scars on trees, high-water channels, and freshly deposited silt and sand.

Vegetation Structure & Composition

• Ground-layer cover is generally very sparse during spring due to inundation and scouring by floodwaters, becoming variable by midsummer (5–50% cover) and characterized by annual or flood-tolerant perennial

species. Important herbaceous species include false nettle, clearweeds, Ontario aster, Virginia wild rye, cut grasses, hop umbrella sedge, and cattail sedge. Wood nettle often forms dense patches. Species typical of wetland communities are also often present, including mad dog skullcap, southern blue flag, and beggarticks. The invasive species kidney-leaved buttercup, creeping charlie, moneywort, motherwort, yellow wood sorrels, garlic mustard, and reed canary grass are present in many stands and sometimes abundant.
• Climbing plants and vines are important in this community; characteristic are climbing poison ivy, wild grape, and moonseed.
• Shrub layer and subcanopy are mostly sparse (0–25% cover) and occasionally patchy (25–50% cover); silver maple, green ash, American elm, and hackberry are most common. Climbing poison ivy is occasionally present in the tall-shrub layer. Silver maple seedlings are often abundant.
• Canopy is interrupted to continuous (50–100% cover), and strongly dominated by silver maple with occasional green ash, cottonwood, or American elm.

Deciduous Forest - Southern Dry-Mesic Oak Forest (MHs37)

Dry-mesic hardwood forests occurring most often on thin, wind-deposited silt on crests and upper slopes of bedrock bluffs and less often on hummocky stagnation moraines in calcareous, partially sorted drift.

Vegetation Structure & Composition
• Ground-layer cover varies from patchy to continuous (25–100%); important species include lady fern, pointed-leaved tick trefoil, Clayton's sweet cicely, common enchanter's nightshade, wild geranium, hog peanut, and white snakeroot.
• Shrub-layer cover is patchy to interrupted (25–75%); common species include northern red oak and black cherry saplings, chokecherry, American hazelnut, Missouri gooseberry, and pagoda dogwood.
• Subcanopy cover is patchy to interrupted (25–75%); important species include basswood, black cherry, northern red oak, white oak, and shagbark hickory.
• Canopy cover is interrupted to continuous (50–100%); the most common species are northern red oak, white oak, and basswood. Shagbark hickory is occasionally present.

Natural History
In the past, catastrophic disturbances were rare in MHs37. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was in excess of 1,000 years, and the rotation of catastrophic windthrow was about 390 years. Events that resulted in partial loss of trees, especially light surface fires, were much more common, with an estimated rotation of about 20 years. Based on the historic composition and age structure of these forests, MHs37 had two growth stages separated by a long period of transition.

Deciduous Forest - Southern Dry-Mesic Oak-Hickory Woodland (FDs38)

Dry-mesic (or dry) deciduous woodlands on steep, exposed, south- to westfacing bluffs in southeastern Minnesota, often adjacent to bedrock bluff prairies.

Vegetation Structure & Composition
• Ground-layer cover is mostly patchy to continuous (25–100%). Important species include woodland

sunflower, white snakeroot, elm-leaved goldenrod, shining bedstraw, Canadian and gregarious black snakeroots, and heart-leaved alexanders. Other common species include honewort, Clayton's sweet cicely, lopseed, pointed-leaved tick trefoil, hog peanut, common enchanter's nightshade, and Pennsylvania sedge.
• Climbing plants and vines are sparse to patchy (5–50% cover); greenbrier, wild grape, and Virginia creeper are often present.
• Shrub-layer cover ranges from patchy to often dense (25–100%). Shagbark hickory and hackberry are important tree saplings. Other common species include American hazelnut, gray dogwood, poison ivy, prickly ash, prickly gooseberry, red raspberry, black cherry, and American elm.
• Subcanopy is patchy to continuous (25–100% cover) and often poorly differentiated from the canopy. Shagbark hickory, black cherry, hackberry, and black walnut are characteristic; other common species include American elm, red elm, box elder, bur oak, and paper birch.
• Canopy cover is interrupted to continuous (75–100%), often with large, open-grown trees present. Bur oak, shagbark hickory, American elm, black walnut, and box elder are characteristic. Other common species include northern pin oak, white oak, northern red oak, and black cherry.

Natural History
In the past, fires were very common throughout the range of FDs38. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was about 150 years, and the rotation of mild surface fires about 15 years. The rotation of all fires combined is estimated to be 11 years. Windthrow was not common, with the estimated rotation exceeding 1,000 years. Based on the historic composition and age structure of these forests, FDs38 had three growth stages.
• 0–55 years—Young forests recovering from fire and dominated by bur oak mixed with northern pin oak and northern red oak. Paper birch is a minor component.
• 55–135 years—Mature forests dominated by bur oak mixed with lesser amounts of pin oak, paper birch and northern red oak than young forests. Shagbark hickory and white oak are minor components.
• > 135 years—Old forests dominated by bur oak mixed with white oak and some northern red oak; shagbark hickory is apparently absent (Most current examples of FDs38 originated as brushlands, oak savannas, or dry prairies and developed into woodlands in the past 75-150 years following suppression of wildfires).

Native Plant Community Types in Class
• FDs38a Oak - Shagbark Hickory Woodland: FDs38a is the only community type recognized in this class at present. The sample size of the community is small, however, with many of the plots from Great River Bluffs State Park in Winona County. In addition, it is likely that the composition of much of the community in Minnesota—including the plots used in this classification—has been influenced by livestock grazing. Collection of additional data in dry-mesic woodlands in the PPL and to the west in the MIM and the CGP would improve the understanding of this community.

Deciduous Forest - Southern Wet-Mesic Hardwood Forest (MHs49)

Rich, wet-mesic lowland hardwood forests on level silty alluvium in stream valleys and on level glacial till bordering lakes. Sites are protected from fire, and soils remain moist throughout the growing season.

Vegetation Structure & Composition

• Ground-layer cover is mostly continuous (75–100%). Important species include false rue anemone, blue phlox, common blue violet, hispid buttercup, appendaged waterleaf, Virginia spring beauty, tall coneflower, white trout lily, yellow trout lily, white bear sedge, and hairy-leaved sedge. Other common and often abundant species include Virginia waterleaf, cleavers, and wood nettle.

• Shrub-layer cover is variable, ranging from sparse to continuous (5–100%); typical species are chokecherry, Missouri gooseberry, basswood, sugar maple, black ash, hackberry, bitternut hickory, American elm, red elm, and rock elm.

• Subcanopy is generally patchy to continuous (25–100% cover), with sugar maple, basswood, hackberry, ironwood, black ash, and elms the most common species.

• Canopy cover is mostly interrupted to continuous (50–100%). Species composition is variable, but basswood, black ash, sugar maple, American elm, red elm, rock elm, green ash, hackberry, box elder, and bur oak are common. Butternut, black walnut, and black maple are present in some stands.

Natural History

In the past, catastrophic disturbances were rare in MHs49. An analysis of Public Land Survey records indicates the rotation of catastrophic windthrow was in excess of 1,000 years, and there were no references to fire.1 Events that result in partial loss of trees, especially light surface fires, were much more common, with an estimated rotation of about 160 years. There are almost no compositional changes among historic age classes in the community. Young, mature, and old stands were all dominated by elm—probably including American, red, and rock elm—mixed with lesser amounts of basswood and sugar maple. Because of Dutch elm disease, elms (especially American elm) are less abundant today than historically. In contrast, black ash is common in modern forests across much of the range of the community, but was a minor component in historic records.

Native Plant Community Types in Class

• MHs49a Elm - Basswood - Black Ash - (Hackberry) Forest: Wet-mesic hardwood forests, most often with abundant basswood and elm in the canopy; other occasionally abundant species are black ash, sugar maple, and bitternut hickory. Hackberry and green ash are present in the canopy in many stands but are seldom abundant. Hackberry is more important in MHs49a, especially in the understory and seedling layers, than in MHs49b. Other species that help to distinguish MHs49a from MHs49b include greenbrier, starry false Solomon's seal, carrion-flowers, Pennsylvania sedge, and starry sedge.

• MHs49b Elm - Basswood - Black Ash - (Blue Beech) Forest: Wet-mesic hardwood forests. Sugar maple is the most common and abundant canopy species, often present with basswood, black ash, elms, and hackberry. Some stands are strongly dominated by bur oak. Blue beech is much more important in all height layers in MHs49b than in MHs49a. Other species that help to distinguish MHs49b from MHs49a include black walnut, nannyberry, cut-leaved toothwort, appendaged waterleaf, two-leaved miterwort, woodmint, cow parsnip, squirrel corn, silvery spleenwort, white bear sedge, Wood's sedge, and graceful sedge.

Deciduous Forest - Southern Terrace Forest (FFs59)

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.

• Ground-layer cover is mostly interrupted to continuous (50–100%); often with abundant wood nettle. Other typical species include Virginia waterleaf, spotted touchme-not, tall coneflower, stinging nettle, cleavers, common blue violet, honewort, aniseroot, Virginia bluebells, and eastern narrowleaf sedge. Reed canary grass is highly invasive on sites where the canopy has been opened by disturbance.
• Woody vines are sparse to patchy (5–50% cover), mostly present in lower strata; Virginia creeper and wild grape are typical.
• Shrub layer and subcanopy are sparse to patchy (5–50% cover); typical species include American elm, hackberry, box elder, Missouri gooseberry, prickly ash, and chokecherry.
• 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. Swamp white oak is important in some stands in southeastern Minnesota.

Natural History
In the past, catastrophic disturbances were rare in FFs59. There are no references to fire in the Public Land Survey records, and the rotation of catastrophic windthrow was about 310 years. Events that result in partial loss of trees, especially flood damage (and possibly light surface fires), were much more common, with an estimated rotation of just 40 years. Based on the historic composition and age structure of these forests, FFs59 had three growth stages.
• 0–35 years—Young forests recovering from severe flooding or wind, often dominated by elm (most often American elm, but red elm was present as well). Basswood, willows (Salix amygdaloides and S. nigra), and green ash are also present.
• 35–155 years—Mature forests dominated by elm and ash, including American elm, red elm, green ash, and black ash. Basswood, bur oak, silver maple, hackberry, black walnut, and butternut are minor components. Willows are essentially absent.
• > 155 years—Old forests similar in composition to mature forests except walnuts, silver maple, and bur oak are more abundant, and basswood is mostly absent.

Native Plant Community Types in Class
• FFs59a Silver Maple - Green Ash - Cottonwood Terrace Forest: Present on terraces of medium to large rivers. The most common canopy trees are American elm, silver maple, box elder, and green ash, with occasional cottonwood and hackberry. Most of these species are also important in the understory. Important shrubs include wahoo, red-berried elder, hawthorns, and prickly gooseberry. Important ground-layer species include Ontario aster, jack-in-the-pulpit, Maryland black snakeroot, Clayton's sweet cicely, early meadow-rue, and virgin's bower.
• FFs59b Swamp White Oak Terrace Forest: Present on terraces of the lower Mississippi River. Swamp white oak is diagnostic for this type, occurring in the canopy of all known examples and often in the understory as well. Other common canopy and understory trees are green ash, hackberry, silver maple, bitternut hickory,

American elm, and basswood, with occasional cottonwood and river birch. Important shrubs include prickly ash, wild black currant, and gray dogwood. Climbing poison ivy, greenbrier, wild grape, and Canada moonseed are important vining species. Important ground-layer species include Virginia knotweed, moneywort, green dragon, sensitive fern, rough bedstraw, obedient plant, false nettle, Virginia wild rye, nodding fescue, Gray's sedge, and muskingum sedge.

• FFs59c Elm - Ash - Basswood Terrace Forest: Present on terraces of small to large rivers. The most common canopy trees are American elm, box elder, basswood, black ash, and red elm, with occasional cottonwood, hackberry, silver maple, black maple, black walnut, and rock elm. Most of these are likewise important in the understory. Important shrubs include Missouri gooseberry and chokecherry. Important ground-layer species include Virginia waterleaf, cleavers, stinging nettle, aniseroot, blue phlox, false rue anemone, stemless blue violets, hispid buttercup, Virginia bluebells, cow parsnip, mayapple, and yellow trout lily.

Conifer Plantation - Southern Mesic White Pine – Oak Woodland (FDs27b)

Dry-mesic (or dry) hardwood or pine-hardwood woodlands on sand deposits, primarily in the blufflands of southeastern Minnesota.

Vegetation Structure & Composition

• Ground-layer cover is variable, ranging from sparse to interrupted (5–75%), with prairie species often present. Important species include flowering spurge, pussytoes, harebell, elliptic shinleaf, white rattlesnakeroot, round-lobed hepatica, downy rattlesnake plantain, heart-leaved aster, and yarrow. Other common species include northern bedstraw, Clayton's sweet cicely, lopseed, columbine, hog peanut, white snakeroot, bracken, and Pennsylvania sedge. The community provides important habitat for several rare sand-loving plants, especially Canada forked chickweed and marginal shield fern and also rough-seeded fameflower, goat's rue, ebony spleenwort, and seaside three-awn.

• Climbing plants and vines are common but generally short. Common species include Virginia creeper and wild grape.

• Shrub-layer cover is mostly patchy to interrupted (25–75%). White pine, bitternut hickory, white oak, pin cherry, and eastern red cedar are important tree saplings, while ninebark, bush juniper, and black raspberry are important shrubs. Other common shrub-layer species include American hazelnut, prickly ash, black cherry, gray dogwood, and common poison ivy. Pipsissewa and leadplant are typical half-shrubs.

• Subcanopy is sparse to patchy (25–100% cover) and often poorly differentiated from the canopy. White pine, eastern red cedar, black cherry, black oak, and white oak are often present.

• Canopy cover is patchy to interrupted (25–75%). Canopy is typically dominated by one or more of the following: white pine, jack pine, black oak, or bitternut hickory. Other common species include bur oak, northern pin oak, white oak, and paper birch. Northern red oak, black cherry, quaking aspen, and basswood are occasional.

Natural History

In the past, fires were very common throughout the range of FDs27. An analysis of Public Land Survey (PLS) records indicates that the rotation of catastrophic fires was about 135 years, and the rotation of mild surface

fires about 15 years. The rotation of all fires combined is estimated to be 14 years. Windthrow was not reported in the surveyors' notes for this community.

Native Plant Community Types in Class

• FDs27a Jack Pine - Oak Woodland (Sand): Dry to dry-mesic pine-hardwood woodlands. The presence of jack pine in the canopy and understory differentiate FDs27a from the other types in this class. Important halfshrub and ground-layer plants include pipsissewa, lowbush blueberry, pussytoes, bluets, round-headed bush-clover, hairy puccoon, and starry false Solomon's seal. FDs27a is rare and has been documented at only three sites in the Blufflands of SE MN.

• FDs27b White Pine - Oak Woodland (Sand): Dry-mesic pine-hardwood woodlands. The presence of white pine and northern red oak in the canopy and understory helps to distinguish FDs27b from the other types in this class. Important herbaceous plants include wild sarsaparilla, zigzag goldenrod, common enchanter's nightshade, harebell, bastard toadflax, and carrion flowers. FDs27b is uncommon.

• FDs27c Black Oak - White Oak Woodland (Sand): Dry to dry-mesic hardwood woodlands. The presence of northern pin oak or black oak as canopy dominants helps to distinguish FDs27c from the other types in this class. Pin cherry is also more likely to occur in FDs27c. Important ground-layer plants include woodland sunflower, Indian pipe, wild strawberries, and elm-leaved goldenrod. FDs27c is the most common of the three community types in this class.

Wet Meadow/Shrub Carr - Northern Wet Meadow/Carr (WMn82)

Open wetlands dominated by dense cover of broad-leaved graminoids or tall shrubs. Present on mineral to sapric peat soils in basins and along streams.

Vegetation Structure & Composition

• Moss cover most often is < 5% but can range to > 75%. Brown mosses are usually dominant, but Sphagnum can be dominant on some sites.

• Graminoid layer consists of dense stands of mostly broad-leaved graminoids, including bluejoint, lake sedge, tussock sedge, and beaked sedge.

• Forb cover is variable, with tufted loosestrife, marsh bellflower, marsh skullcap, and great water dock common, and small or three-cleft bedstraw, bulb-bearing water hemlock, northern bugleweed, linear-leaved, marsh, or downy willow-herb, water smartweed, and northern marsh fern occasional.

• Shrub cover is variable. Tall shrubs such as willows, red-osier dogwood, and speckled alder can be dense, along with meadowsweet. Paper birch, black ash, red maple, American elm, and tamarack saplings are occasionally present in the shrub layer.

• Trees taller than 16ft (5m) are rarely present and if so, have low cover (< 25%).

Natural History

WMn82 is subjected to moderate inundation following spring runoff and heavy rains, and periodic drawdowns during summer. Peak water levels are high enough and persistent enough to prevent trees (and often shrubs) from becoming established, although there may be little or no standing water much of the growing season. As a result of water-level fluctuations, the surface substrate alternates between aerobic and anaerobic

conditions. Any organic matter that may accumulate over time is usually oxidized during drawdowns following drought or is removed by fire. Where deep peat is present in the community, it likely was formed previously on the site by a peat-producing community—such as a forested rich peatland—that was flooded by beaver activity and ultimately converted to a wet meadow. Deep peat may also develop from debris settling into basins with standing water, forming sedimentary peat. Because surface water in WMn82 is derived from runoff, stream flow, and groundwater sources, it has circumneutral pH (6.0–8.0) and high mineral and nutrient content. Although mosses are typically sparse in WMn82 because of alternating flooding and drawdown, moss cover can be relatively high in settings where water levels have become stabilized. In these situations, it appears that Sphagnum can quickly invade the community, especially on floating mats that are completely above the water surface. The water chemistry in these sites can be rapidly converted by Sphagnum to rich fen or even poor fen conditions before characteristic wet meadow species, especially wide-leaved sedges, have been replaced by plants of rich or poor fens such as narrow-leaved sedges. The process of succession of WMn82 to rich or poor fens is readily reversed by return of higher or more variable water levels, such as from beaver activity or variation in precipitation.

Native Plant Community Types in Class

• WMn82a Willow - Dogwood Shrub Swamp: Open wetlands with abundant broad-leaved graminoids, and shrub cover typically > 25%. Shrubs that may be abundant include willows, red-osier dogwood, speckled alder, and occasionally bog birch.

• WMn82b Sedge Meadow: Open wetlands with abundant broad-leaved graminoids, and shrub cover typically < 25%. The invasive species common reed grass and reed canary grass have become increasingly abundant in this community type over the past several decades, reducing species diversity in many occurrences. WMn82b is divided into four subtypes, based on dominant graminoid species.

- WMn82b1 Bluejoint Subtype
- WMn82b2 Tussock Sedge Subtype
- WMn82b3 Beaked Sedge Subtype
- WMn82b4 Lake Sedge Subtype

Wet Meadow/Shrub Carr - Southern Wet Prairie (WPs54)

Grass-dominated but forb-rich herbaceous communities on poorly drained to very poorly drained loam soils formed in lacustrine sediments, unsorted glacial till, or less frequently outwash deposits. Typically in slight depressions, sometimes on very gentle slopes. Flooded for brief periods at most; upper part of rooting zone is not saturated for most of growing season, but saturation usually persists in lower zone for much of season.

Vegetation Structure & Composition

• Graminoid cover is usually continuous (75–100%). Tallgrasses dominate, but several midheight and low grasses and sedges are also important. Prairie cordgrass and big bluestem are the dominant tallgrasses; Indian grass and switchgrass are frequently important. Narrow reedgrass is a major species in the western part of the state. Woolly sedge is often an important component, and rigid sedge and flattened spikerush are frequently present. Mat muhly grass is sometimes abundant, growing under taller species or even forming most of the cover on saline sites in western Minnesota.

• Forb cover is sparse to patchy (5–50%). Canada goldenrod and giant, sawtooth, or Nuttall's sunflower are typically most common. Other common taller forbs are giant goldenrod, tall meadow-rue, eastern panicled aster, and great blazing star. Common midheight species are heath aster, clasping dogbane, Virginia mountain mint, and golden alexanders. Common strawberry, golden or false golden, and northern bog violet are typically common in the lowest layer. Forb diversity and height decrease where soil salinity is elevated.
• Shrub layer is absent to sparse (0–25% cover). The low semi-shrub prairie rose is most frequent; red-osier dogwood and pussy willow are occasional.

Natural History

Although WPs54 is characterized by wet-mesic or wet conditions, WPs54 is not as strongly influenced by wetland processes associated with inundation and soil saturation as Wet Meadow communities. Flooding episodes are brief following snowmelt and heavy rains. The water table typically remains within the rooting zone of most plants for several weeks during the growing season, but at least the upper part of the zone is not saturated for most of the season. In some situations on slopes, groundwater seepage maintains continuously moist but not saturated soil conditions. The dominant plant species in WPs54 lack the physiological and morphological adaptations to tolerate anoxic soil conditions that typify the plants of wetter communities. In western Minnesota, local areas of salt accumulation within wet sites favor species tolerant of salinity, including several species associated with droughty upland sites that can tolerate osmotically induced moisture stress. Recurrent fire is essential for the existence of WPs54, as environmental conditions are otherwise favorable for the development of forest. Fire also recycles nutrients bound up in litter and promotes flowering and seed production; fire temporarily opens up the soil surface and so probably plays an important role in plant regeneration. Before Euro-American settlement, grazing and trampling by large ungulates were presumably regular occurrences in WPs54, although it is possible that wet prairies were less favored than upland prairies. The contribution of this disturbance to the composition and structure of the vegetation is not well understood, although confined grazing by domestic livestock can quickly destroy wet prairies, promoting the replacement of most of the native species by introduced ones. Disturbance can be especially severe when soils are saturated. Episodic grazing probably allows for the persistence of some native species that cannot otherwise reproduce in the dense canopy of tall grasses and forbs of WPs54; these would include shorter-stature species and especially annual or biennial plants. Spatial patchiness in grazing intensity also influenced fire behavior, providing a shifting patchwork of refugia for fire-sensitive animal species.

Native Plant Community Types in Class

• WPs54b Wet Prairie (Southern): Grass-dominated, forb-rich herbaceous communities. Big bluestem and prairie cordgrass are the usual dominant species, either together or separately. Switchgrass and Indian grass are frequently present and often are major components. Woolly sedge and mat muhly grass are often common. The forb component of WPs54b is species rich. Canada goldenrod is usually present and often abundant. Other common forbs are tall meadow-rue, eastern panicled aster, Virginia mountain mint, clasping dogbane, heath aster, great blazing star, golden alexanders, giant, sawtooth, or Nuttall's sunflower, and giant goldenrod.

Emergent Marsh - Northern Mixed Cattail Marsh (MRn83)

Emergent marsh communities, typically dominated by cattails. Present on floating mats along shorelines in lakes, ponds, and river backwaters or rooted in mineral soil in shallow wetland basins.

Vegetation Structure & Composition

• Floating-leaved and submergent aquatic plant cover is sparse, with species such as duckweed and greater duckweed frequent, and common bladderwort and common coontail occasionally present. Seasonally prolific, floating clones of the liverworts *Riccia fluitans* and *Ricciocarpos natans* may be present, becoming stranded during watertable drawdown.

• Graminoid cover is variable, with lake sedge and bristly sedge commonly present.

• Forb cover is strongly dominated by cattails, usually with > 50% cover. Other common forbs include emergent species such as broad-leaved arrowhead, marsh skullcap, small or three-cleft bedstraw, and bur marigold and beggarticks.

• Shrubs are absent or very sparse.

• Notes: Vegetation is often composed of dense stands of cattails interspersed with pools of open water. Associated species are highly variable. MRn83 and other shallowwater wetlands throughout much of the state (particularly the agricultural region) have been invaded by dense stands of the non-native species narrow-leaved cattail (*Typha angustifolia*) and hybrid cattail (*T*. x *glauca*). Invasion and dominance of marshes by non-native cattail species is likely related to alterations in wetland hydrology, commonly from drain tiling, ditching, and impoundments; high levels of nutrient-rich runoff from agricultural fields; and salt-containing runoff from roads. Marshes dominated by non-native cattail species are considered to be low-quality or disturbed examples of MRn83. Marshes dominated by the native species broad-leaved cattail (*T. latifolia*) are considered higher-quality examples of MRn83 and are increasingly rare in Minnesota.

Natural History

MRn83 develops in areas where standing water is present most of the year, providing conditions favorable for hydrophytic plants. Occurrences of the community with plants rooted in muck or peat substrates may succeed to shallow aquatic communities if the water table rises for prolonged periods, or to wet meadows if the water table drops or if silt or sedimentary peat accumulation causes the substrate surface to become elevated above the water surface. Floating mats, which rise and fall with changes in water level, are presumably successionally stable but may be fragmented by strong winds or beaver activity. Variation in species composition observed in the class is likely due to differences in water depth, the permanence of standing water, and variation in substrate. Fires during severe droughts can remove accumulated peat in fens or wet meadows, effectively lowering the growing surface and creating the wetter conditions that favor marsh over fen or wet meadow vegetation.

Native Plant Community Types in Class

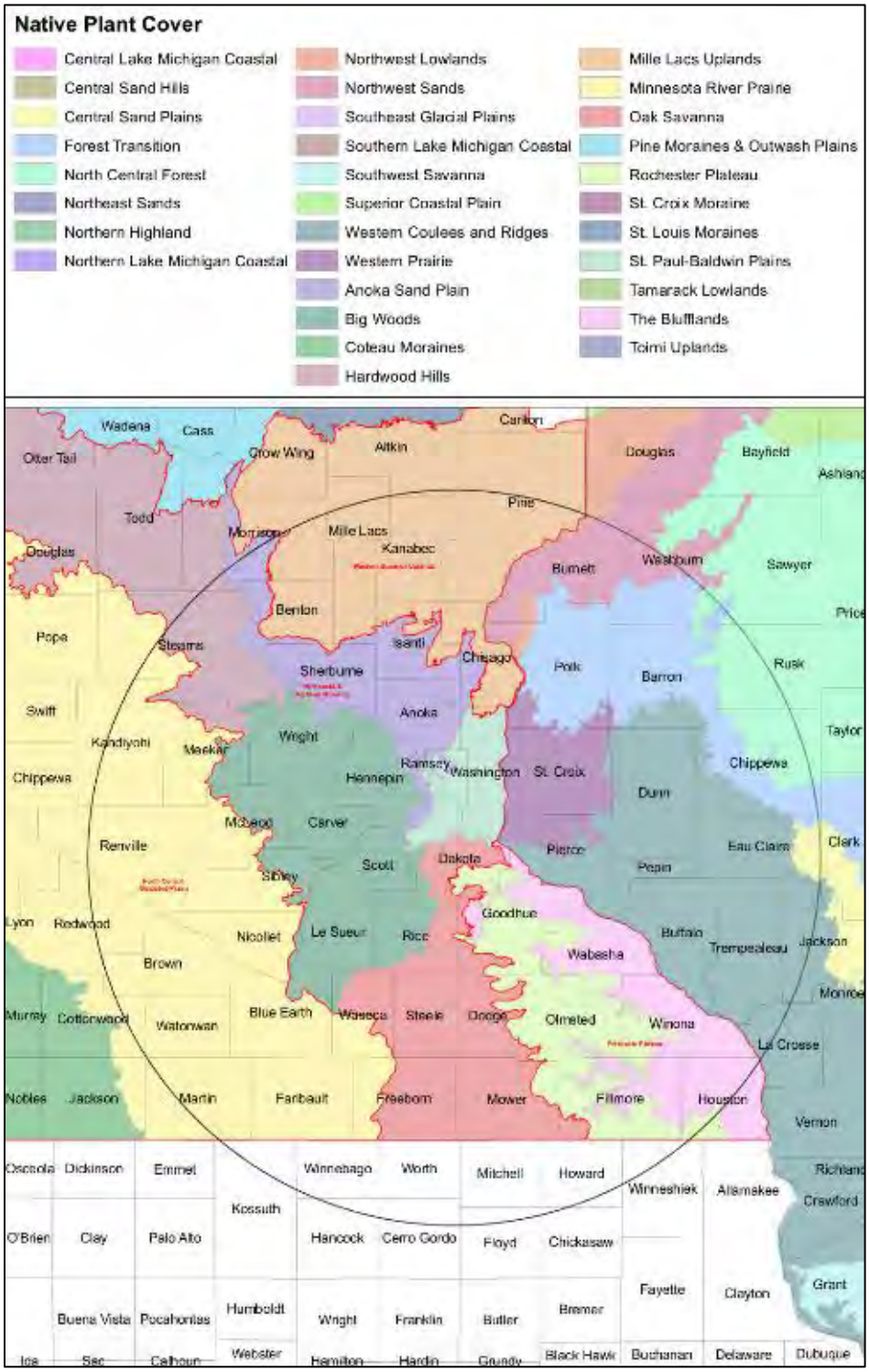
• MRn83a Cattail - Sedge Marsh (Northern): Emergent marshes typically dominated by cattails but with a significant component of graminoids including sedges, woolgrass, and bluejoint. MRn83a is more likely than MRn83b to be dominated by the native species broad-leaved cattail and is uncommon.

• MRn83b Cattail Marsh (Northern): Emergent marshes dominated by nearly pure stands of cattails. If sedges and grasses are present, they are minor components. MRn83b is the most common of the two community

types in this class and often is dominated by the non-native species narrowleaved and hybrid cattail. Marshes dominated by pure stands of the native species broad-leaved cattail were likely more common in the past but are now rare across much of the range of the community

Appendix G: Acceptable Source Origin of Native Seed for Dakota County

Native seed source origin should be from within circle shown below. Some allowance may be made to accommodate facilitation of more southerly species into the county to respond to climate change.



Appendix H: Public Engagement

Public engagement for this project consisted of reaching out to the general public via one public meeting at Draft Plan phase, posting updates on the County's webpage for the project, meeting with stakeholder groups, and releasing the final draft plan for a 45-day public review period.

PHASE I RESEARCH & FINDINGS

- **County Board, PDC, July 9, 2019**
    - The initial scope and draft of the cost share structure was presented to the County Board
- **Stakeholder Meeting, Technical Advisory Committee July 25, 2019**
    - Cities and public landowners within the Greenway Corridor participated in a Technical Advisory Committee to recommend their preferred land use plans, identify future infrastructure, and recommend compatible vegetation types for visitor use.

PHASE II VISION, GOALS, RECOMMENDATIONS

- **Planning Commission, October 24, 2019**
    - The Planning Commission was introduced to the scope of the Plan, and the draft findings and initial recommendations were presented. An early draft of the proposed Cost Share structure was discussed.

PHASE III DRAFT FINAL PLAN

- **Planning Commission, February 27, 2020**
    - The draft River to River NRMP was submitted to the Planning Commission for their review. A five-year and twenty-year work plan were included that had not been presented before. The commission had several questions, but primarily, the plan was well received and supported by the commission. Comments and edits were incorporated into the plan by staff, following the meeting.

- **County Board, PDC, July 7, 2020**
    - An update and a request to release the plan to the public for a 30-day review period was presented to the Board, which was on the regular agenda with a 15 minute presentation.
    - The Board unanimously approved releasing the draft plan for public review.

- **45-Day Public Review Period**
    - The plan was released for a Public Review period starting on July 15 and ending on August 31, 2020 (was extended by 15 days from 30 to 45 days).
    - Public engagement during the review period consisted of the following:
        - Posting the draft plan on the County's website
        - Reaching out to cities, townships, and other stakeholders via email, phone calls, etc.
- **City Administrators and Managers Meeting, June 26, 2020**

- The draft cost share structure was presented to City Managers and Administrators to ensure undue burden was not being placed on Local Governmental Units and to obtain feedback as to the interest and capacity for LGUs to partner on natural resources projects. Managers and Administrators in turn asked that County Staff meet individually with applicable city staff.
- Follow-up meetings with Park Directors and Public Works Directors took place with the Cities of Apple Valley, Burnsville, Eagan, Farmington, and Inver Grove Heights to illustrate the proposed Cost Share plan.
    - Feedback was generally positive from city staff members, and there was interest in identifying Greenway Corridor features for future Greenway NRMPs.
    - Concerns were raised about whether the requirements of grant funding agencies or the County's commitment to maintain native vegetation within the Greenway Corridor on non-County Land would necessitate the County requiring additional Easement acquisitions. County staff assured that no additional easements would be necessary, all maintenance costs and activities would be agreed upon by initial Joint Powers Agreements (JPAs) or Supplemental Maintenance Agreements (SMAs) prior to project implementation.
    - Questions arose about the scope of County maintenance activities, whether NRMPs would give 'holistic' guidance in maintaining physical infrastructure in addition to native plantings.
    - The timing of County maintenance was addressed, such that JPAs and SMAs would determine when the County would take over maintenance of vegetation installations.

- **Public Open House -Thursday, August 6, 2020**
    - 18 people attended, plus 3 commissioners and 3 staff
    - The plan was summarized in a Powerpoint presentation
    - Response to the plan was positive and attendees were supportive.
    - There were **5** poll questions asked of attendees during the presentation. The questions and results of responses are summarized below:

Q1. How much do you use the Greenway?

Never	(0) 0%
Daily	(0) 0%
Weekly	(3) 43%
Monthly	(2) 29%
Other	(2) 29%

Q2. If you use the Greenway regularly, what are the primary reasons (choose all that apply)?

Transportation	(1/7) 14%
Nature Connection	(5/7) 71%
Exercise	(4/7) 57%
Other	(0) 0%

Q3. Do you support the restoration to target plant communities proposed in this plan?

Yes – without reservations	(5) 50%

Mostly – with some changes	(4) 40%
Somewhat – with many changes	(1) 10%
No – I have a different vision	(0) 0%

Q4. What should the County's primary role be in managing natural resources along Greenway Trails (choose all that apply)?

Removing invasive species	(1) 13%
Creating additional habitat for wildlife	(2) 25%
Maintaining aesthetics	(2) 25%
Improving water quality	(2) 25%
Other	(1) 13%

Q5. Do you support the proposal that the County would help other public landowners (cities, schools, non-profits) to complete natural resource projects along the Greenway?

Yes	(9) 100%
No	(0) 0%

In addition to polling questions, one participant asked "*How will you reconcile planting for the anthropocene using a pre Lewis & Clarke plant community paradigm*?" In response, County Staff identified their use of Adaptive Management to better understand and adapt goals to consider *i)* climate change impacts, *ii)* presence of more southerly species and *iii)* warmer shoulder seasons/altered precipitation regimes.

- **Additional Stakeholder Input during the Public Comment Period**

  Both the Vermillion River Watershed Joint Powers Organization and the Dakota Soil and Water Conservation District reviewed the plan and made several comments, mostly regarding water resources management. Some of the comments are listed here:

  - We recommend you consider improvements which can extend into the larger NRMP Area Outline shown on Figures 1 and 3. These could include subwatershed assessments to improve local water quality and solve local erosion issues, (either ravine or in stream erosion), identify stormwater management projects (both regional stormwater treatment opportunities and local water quality projects), identify wetland restoration opportunities, and prioritize water quality improvements as future opportunities arise. This could include the trail corridors as well as the main natural resource areas (including but not limited to Kaposia Park, WSP Sports Complex, Marthaler Park, Garlough Park, Dodge Nature Center, Dodge Nature Preserve, and Valley Park).
  - In Valley Park, consider partnering with the LMRWMO on potential streambank restoration projects that may extend throughout Valley Creek. A study will be implemented to identify areas of streambank erosion in 2021 and to identify opportunities for rate control in the watershed to reduce peak flows through the stream. The County could consider assisting in future bank stabilization/restoration projects.
  - The issue of altered hydrology via ditching in wetlands is mentioned, however strategies to identify options for restoring hydrology are not included. Consider including more information on how restored hydrology could be further studied.

- Erosion issues are noted in Kaposia Park/Simons Ravine and a remedy of native plant stabilization is noted. Consider assessing the full extent of erosion issue in Kaposia park/ravine as a first step through partnerships with the Dakota County SWCD and (or) the LMRWMO.
- In Section IV.2 – Surface Water, only wetlands are shown in the corresponding figures. Consider including all surface waters (DNR public waterbodies, streams, intermittent streams, lakes, ponds, etc.) in the figures.In Section VII.F – Wetlands and Shorelines, riverine systems are not mentioned. Consider including more information on riverine systems and recommendations for bioengineering stabilization of shoreline and streambank erosion issues in this section.
- Section IX.A states that "The installation of…stormwater of stormwater treatment best management practices (i.e., raingardens, infiltration and bioretention basins, bioswales, etc.) are commensurate with new Greenway trail design and implementation as much as possible". We recommend the inclusion of a policy to incorporate new stormwater BMPs when trail sections are re-constructed as well in the future.

- **Comments captured by phone, email or Zoom during from the Public Comment Period:**
  Mendota Heights Master Gardener and ISD197 staff identified changes in Figures 18D and 18F.

  - **Planning Commission, September 24, 2020**
    - The plan was brought back to the Planning Commission
    - Comments from the Public Review period and a final draft plan were presented to the Commission
    - The Commission had the following comments and questions: _____
    - The Planning Commission reacted this way: _____ and approved/disapproved of the final draft plan
  - **County Board, PDC, October 13. 2020**
    - The plan was brought back to the PDC (County Board)
    - Comments from the Public Review period and a final draft plan were presented to the Commission
    - The PDC had the following comments and questions: _____
    - The PDC reacted this way: _____ and approved/disapproved of the final draft plan
  - No changes/Staff added a few changes to the plan, as a result of Planning Commission and County Board comments, and
  - Plan Adoption, County Board, October 20, 2020
    - The plan was adopted by the County Board; the vote was _____.

Resolution # _____.