DAKOTA COUNTY PLANNING COMMISSION

Dakota County Western Service Center – Room L139
14955 Galaxie Avenue
Apple Valley, MN 55124
Thursday, February 24, 2022
7:00 PM – 9:00 PM

This is an in-person meeting. In accordance with a resolution passed by the County Board of Commissioners, all visitors in Dakota County buildings must wear a mask regardless of their vaccination status. The decision is due to Dakota County being at a substantial level of community transmission of COVID-19. According to the CDC, masks may reduce the transmission of COVID-19 among both vaccinated and unvaccinated persons.

Agenda

I. Call to Order

II. Pledge of Allegiance

III. Public Comments:
Anyone wishing to address the Planning Commission on an item not on the agenda may address the Planning Commission at this time (comments are limited to 5 minutes).

IV. Approval of the Agenda

V. Approval of Previous Meeting Minutes

VI. Welcome New Planning Commissioner—Anna Boroff (Led by Amy Hunting)

VII. North Creek Greenway and Lake Marion Greenway Natural Resource Management Plans – Action (Chris Klatt - Parks)

VIII. Veterans Memorial Greenway Alignment and Memorial Design - Information
(Matt Parent - Transportation, and Kurt Chatfield - Planning)

IX. Planning Manager Update and County Board Actions

- Reviewed greenway wayfinding design standards
- Reviewed the proposed Agricultural Chemical Reduction Effort (ACRE) program
- Approved Joint Powers Agreement with Lakeville for Antlers Park Trailhead on Lake Marion Greenway

X. Upcoming Public Meetings – Community Outreach

CSAH 33 and CSAH 46 Intersection Improvement Open House	Thursday, February 17, from 6:30pm – 8:30pm East Lake Elementary School, Lakeville
Lake Marion Greenway Trail Design (Sunset Pond to Williams Drive) Live Webinar	Thursday, March 3, from 6pm-7:30pm https://burnsvillemn.gov/2298/Lake-Marion-Trail
County 42 Visioning Study Study Virtual Open House	Comments due by March 7th https://www.co.dakota.mn.us/Transportation/TransportationStudies/Current/Pages/county-highway-42-visioning-study.aspx.
County Road 6 (Thompson), and CSAH 73 (Oakdale) Improvements Open House	Wednesday, March 9, from 5pm-7pm Wentworth Library, West St. Paul, Large Meeting Room

North Creek, and Lake Marion Greenway Natural Resources Management Plan Open House	Tuesday, March 22, from 5pm-7pm Burnsville Library, Large Public Meeting Room

XI. Topics for Next Meeting (Thursday, March 24, 2022)

- Parks Capital Improvement Program
- Highway Ped Crossing Study

XII. Planning Commissioner Announcements/Updates

XIII. Adjourn

DAKOTA COUNTY PLANNING COMMISSION

Date AGENDA ITEM: Lake Marion and North Creek Greenway Natural Resource Management Plans

PURPOSE

Provide Planning Commission:

1. *A summary of the findings and recommendations of the Lake Marion and North Creek Greenway Natural Resource Management Plans (NRMPs)*
2. *A request that the plans be released for public review*

BACKGROUND

The Dakota County Parks Department is developing Natural Resource Management Plans for both the Lake Marion Greenway and North Creek Greenways. The Plans will include the cities of Burnsville, Lakeville, Apple Valley, and Farmington to co-develop habitat corridors along these greenways, and establish the grounds for future partnership restoration projects along County easements and municipal properties.

ATTACHMENTS

Attachment A: The Lake Marion Greenway Natural Resource Management Plan
Attachment B: The North Creek Greenway Natural Resource Management Plan

QUESTIONS

The following questions are intended to help assist in review of the packet materials.

1. *How shall the County bring aid for natural resource-related projects along Greenways when municipalities are willing but lack staff and funding capacity for implementation?*

2. *Do you have additional natural resource recommendations or considerations regarding these Plans?*

3. *How shall we proceed to strive for a balance between recreational use and natural resource restoration in Greenways?*

Lake Marion Greenway

Natural Resource Management Plan

02/17/2022

Table of Contents Instructions (Read and delete before using template)

After you have completed your document, you can update the Table of Contents (TOC) below by going to References > Update Table in the Word Ribbon. The Table of Contents will be updated to reflect the new headings that appear in your document.

Alternatively, you can insert a new Table of Contents by using the Automatic Table of Contents feature. This will automatically create a TOC based on the Style Headings you have used and assign bookmarks to each entry. This is also a good way to see if the Styles you've used are correct. Here's how to insert a TOC:

- Go to the References Tab.
- Click the dropdown arrow in the Table of Contents section.
- Choose one of the Automatic Table of Contents.
- Then modify it to include the number of levels you want to display.
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- Insert a Page Break at the end of the TOC entries. Do not use the Enter key to add extra lines. If you are simply updating the existing table of contents, rather than adding a new one, simply leave the existing page break in place.

Table of Contents

Acknowledgements

Dakota County Parks Department

14955 Galaxie Avenue, Apple Valley, MN 55124

Project Lead and Contact

Christian Klatt
christian.klatt@co.dakota.mn.us
952-891-7947

Natural Resource Management Plan Consultant

Stantec Consulting Services, Inc.

Mimi Wagner, Project Manager
Diane Narem, Vegetation Ecologist
Erica Christiansen, Wildlife Biologist
Anna Varian, Aquatic Environmental Scientist

Partners

City of Apple Valley
City of Farmington
City of Lakeville
City of Burnsville
Minnesota Zoo
Vermillion River Watershed Joint Powers Organization

Technical Advisory Group

John Mertens, Dakota County
John Hennen, City of Lakeville
Kellee Omlid, City of Farmington
Daryl Jacobson, City of Burnsville
Michael Lynn, Dakota County
Ann Messerschmidt, City of Lakeville
Jeremy Pire, City of Farmington
Dave Grommesch, City of Burnsville
Tom Lewinski, Dakota County
McKenzie Cafferty, City of Lakeville
Caleb Ashling, City of Burnsville

Executive Summary

Background

The Lake Marion Greenway is a planned 20-mile trail that will connect the Minnesota River to Farmington, travelling through the communities and parks of Burnsville, Lakeville, and Farmington. The greenway connects 3,517 acres of public land within western Dakota County, including Murphy-Hanrehan Park Reserve.

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 rivers 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, 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. Utilizing the Adaptive Management strategy (**Executive Figure 1**), Dakota County approaches land management with the understanding that changing environmental conditions and human activities require constant learning and adaptation. 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.

Executive Figure 1: Adaptive Management Strategy

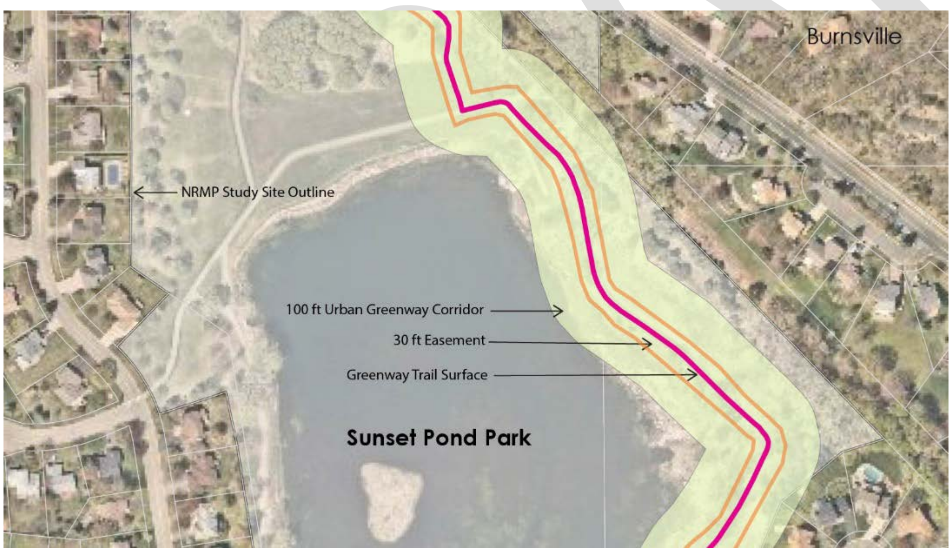
Greenway Partners formulated summaries of issues, concerns and interests related to natural resources in their jurisdiction at the outset of the project (Appendix A). These summaries guided the development of background data for the project and collaboration with additional partners. Elements included in each of the Natural Resource Management Plan Site Recommendation Plans were guided and vetted by the jurisdictional partner and the Vermillion River Watershed Joint Powers Organization. Dakota County completed a final review on each recommendation. Recommendations address water resources, vegetation communities, and human behavior in and near the Greenway corridor. A thirty-day public review of this plan was conducted during January-February 2022. The final plan was adopted by the Dakota County Board of Commissioners on _____, 2022.

Natural Resource Management Plan Recommendations

Restoration projects within public lands along the Lake Marion Greenway Corridor amount to approximately **$1.5 million** in project costs. **Table 10** 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 Lake Marion 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 those with high ecological health (wetland in Kelleher Park).

The implementation of natural resource projects outlined in **Table 10** 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 2** 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 2: 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** exhibits Funding Scenarios for natural resource restoration activities based upon the cost estimates presented in **Table 10** and were constructed with the following assumptions:

- Dakota County assumes 100% of the costs associated with Easements and with restoration in a typical park setting (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 is that the County assists with 25% cost share for grant match outside the 100 ft Urban Greenway Corridor or 25% of total costs if no grant is obtained;
- 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 10**), 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.

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.

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)**.**

Vision, Goals and Approach

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.

Goals

- **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.
- **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.
- **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.

- **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.
- **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.

Approach

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 **Executive Figure 1**.

Natural History and Current Conditions

Landscape Context

Location

The Lake Marion Greenway is a planned 20-mile trail that will connect the Minnesota River to Farmington, travelling through the communities and parks of Burnsville, Lakeville, and Farmington. The greenway connects 3,517 acres of public land within western Dakota County, including Murphy-Hanrehan Park Reserve. (**Figure 1**). The Greenway connects regions designated as Metro Conservation Corridors (MeCC, a regional land protection plan of the MN DNR), highlighting the importance these greenspaces play in facilitating movement and providing contiguous habitat for pollinators and other wildlife (**Figures 2**).

The parks and greenspaces connected by the Lake Marion Greenway vary in size from small neighborhood parks to 40-acre parks and school grounds to large holdings including Ritter Farm, Murphy-Hanrehan, and Sunset Pond parks. Taken together, they form semi-contiguous linear corridors of natural land that range from 80 feet to over 2,500 feet in width. Some of these city park lands accommodate recreational uses such as picnic areas, disc golf, and athletic fields. In addition to city parks and public spaces, Lakeville Elementary and McGuire Middle School are both connected to the Lake Marion Greenway corridor and are managed by Independent School District 194.

There are linear tracts of the Lake Marion Greenway that pass through contiguous habitat up to a mile long, however, much of these greenspaces are dissected by roads and highways, in particular Egan Drive, Burnsville

Parkway, 205th Street W., 210th Street W., and Cedar Avenue. These streets and other smaller crossings creating barriers to the movement of wildlife. 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

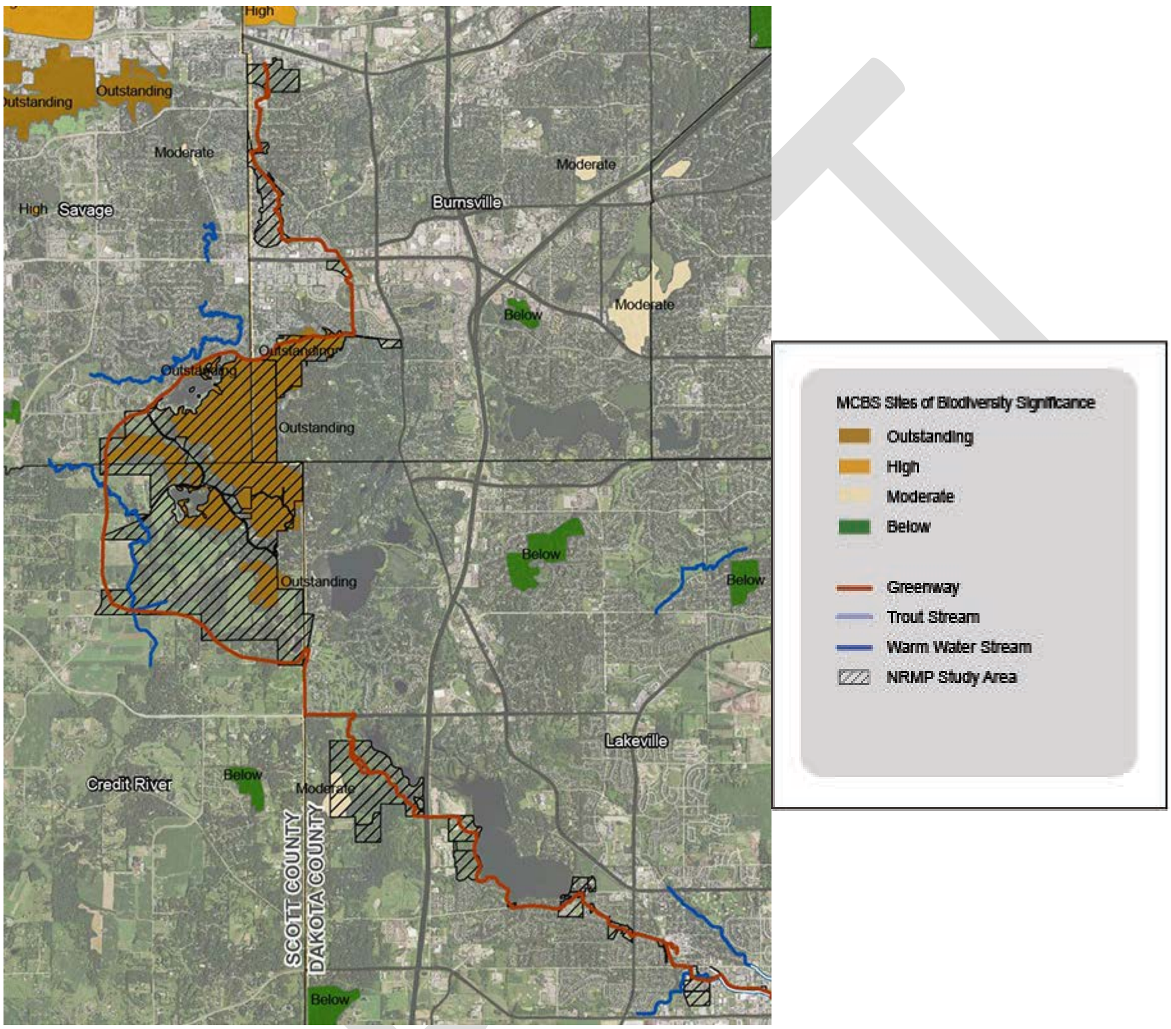
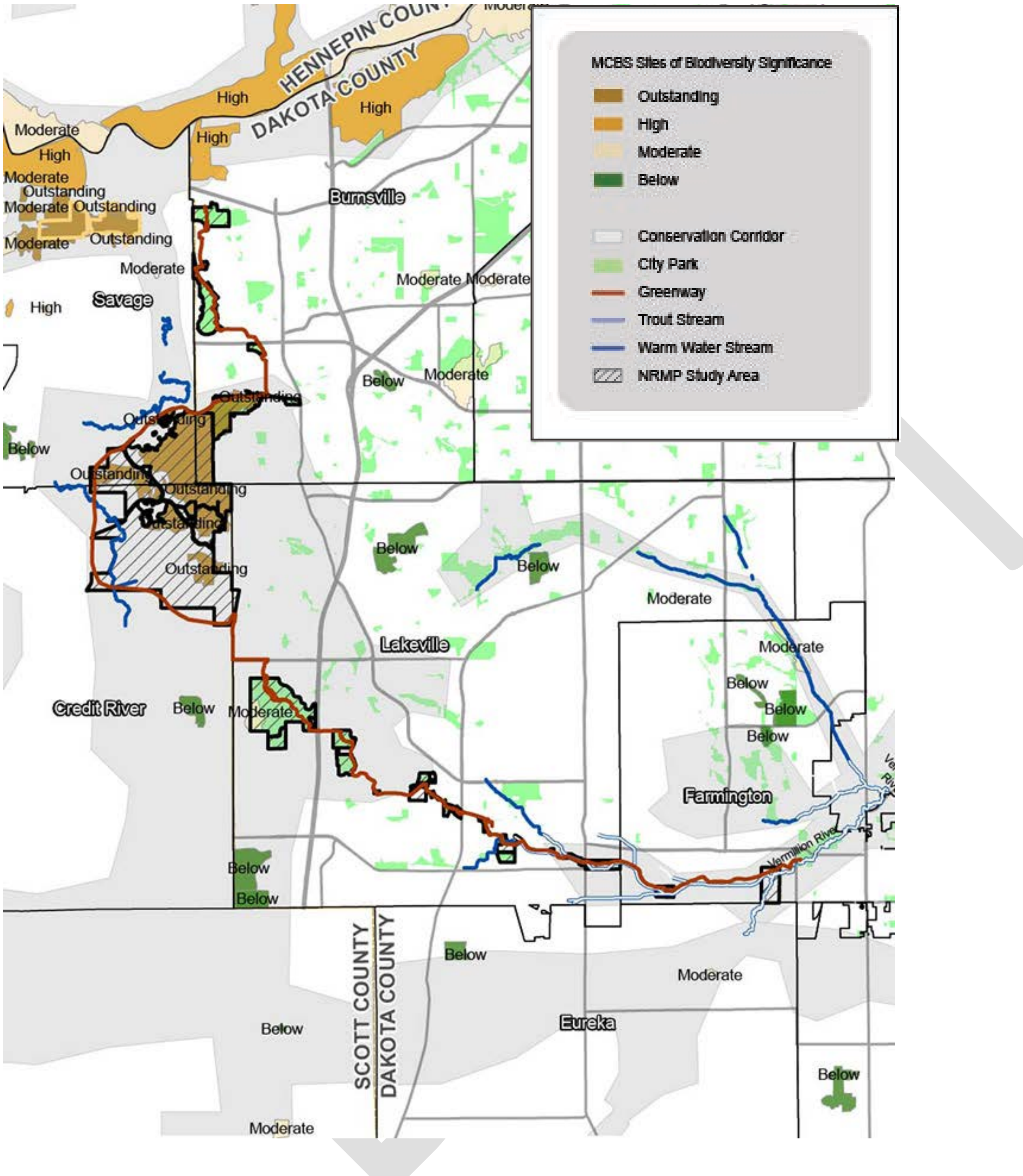


FIGURE 2: Sub-Regional Landscape Context



Historic and Existing Landscape Patterns

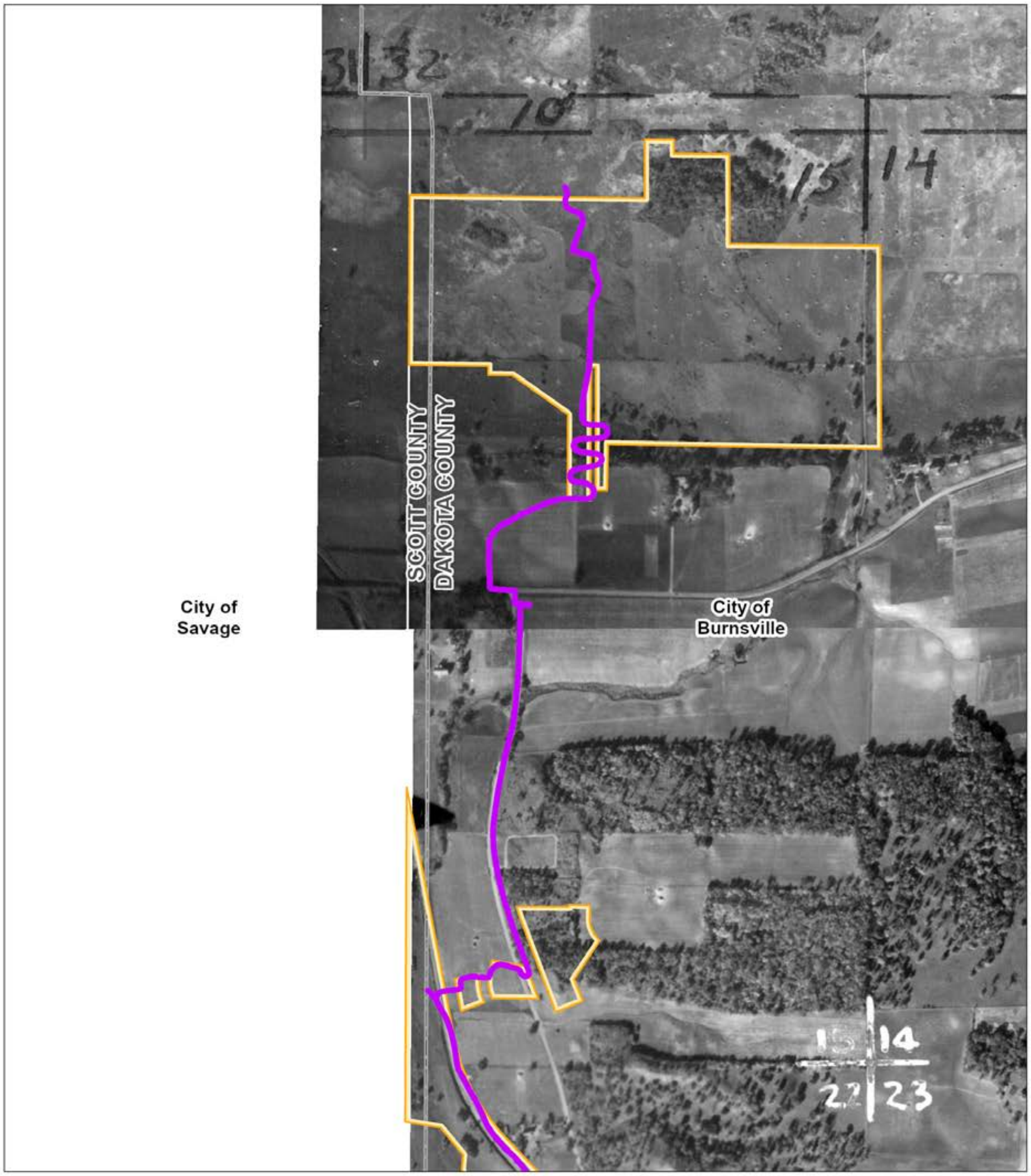
European settlement significantly changed the County landscape. Native prairies were plowed, forests and woodlands cut, wetlands drained, fires suppressed, and intense agricultural practices introduced, including row cropping and livestock grazing.

Some of the best evidence of past land use is depicted in historic aerial photographs. **Figures 3** and **5** are historic aerial photos for natural segments of the Lake Marion 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 have persisted to the present day.

The following comments address these issues in more detail:

- Between Rudy Kramer Park and Preserve and Murphy-Hanrehan Park, In the earliest 1937 aerial photos, the wetland areas were almost always in some form of perennial herbaceous cover. Row cropped land surrounded these wetter areas. Occasional small clumps of overstory trees as well as farmsteads were also present in non-cropped dry areas, and savanna-type landcover was present on dryer ridge landforms. Moving south of Murphy Hanrehan, patches of closed canopy forest interspersed open wetlands and savanna areas dominated the near-corridor areas. with was present in some areas of Murphy-Hanrehan Park. South of Murphy-Hanrehan Park, agricultural patterns of herbaceous perennial cover in wet areas and row cropped agriculture on dryer lands with slopes less than 30%. Steeper areas retained closed canopy and savanna cover. Savanna patches held their form mostly through the late 1950's when tract housing patterns begin to appear.
- Row cropped landcover near the corridor is dominant in 1937 south of Lake Marion, surrounding the small town of Lakeville, with herbaceous cover in wetter areas near streams. Drastic reductions in row-cropped land are noticeable in Ritter Farm Park by 2017 with woody encroachment and tree plantings present. Most developable land surrounding the entire corridor in Burnsville and Lakeville was developed by 2017, including lake edges.
- Herbaceous perennial cover enclosed the meander belt for both South Creek and the Vermillion River in 1937 aerial photos, with a nearly 900' width at the confluence of the two rivers. Smaller streams in the northern parts of the corridors had little woody landcover until the 1960's, when these areas often became wider and closed canopy.
- North Creek and Middle Creek channels, as well as their tributaries, are barely visible on the land in the 1937 aerial photos. Riparian areas were mostly in row cropped production and some grassland. Distinct mostly straight channels appear by the 1964 aerial photos, but most riparian areas remain primarily pasture and row-cropped agriculture.
- New techniques in agricultural drainage allowed expanded row-cropped production by the 1950's in all areas of the corridor, but particular downstream of South Creek Cedar East Park, with larger fields and fewer wet areas in perennial cover.
- A segment of South Creek was channelized in the South Creek Cedar E Park area by the mid-1960's, as well as a large section of the channel downstream of the Lakeville/Farmington municipal boundary up to near the Adelmann PCA property. The remainder of South Creek channelization was complete by 2017. Re-meandering of South Creek in Cedar Creek East Park was evident by 2017, but the channel remained straightened otherwise up through the 2021 aerial photos.

FIGURE 3: Earliest Historical Aerial Photographs of the Corridor



Legend
- Greenway Trail
- Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

0 100 200 Meters
1:10,000

Project Location
Dakota and Scott Counties, Minnesota

Client/Project 193708547
Dakota County, MN
Lake Marion Greenway NRMP

Stantec

Dakota forever wild PARKS

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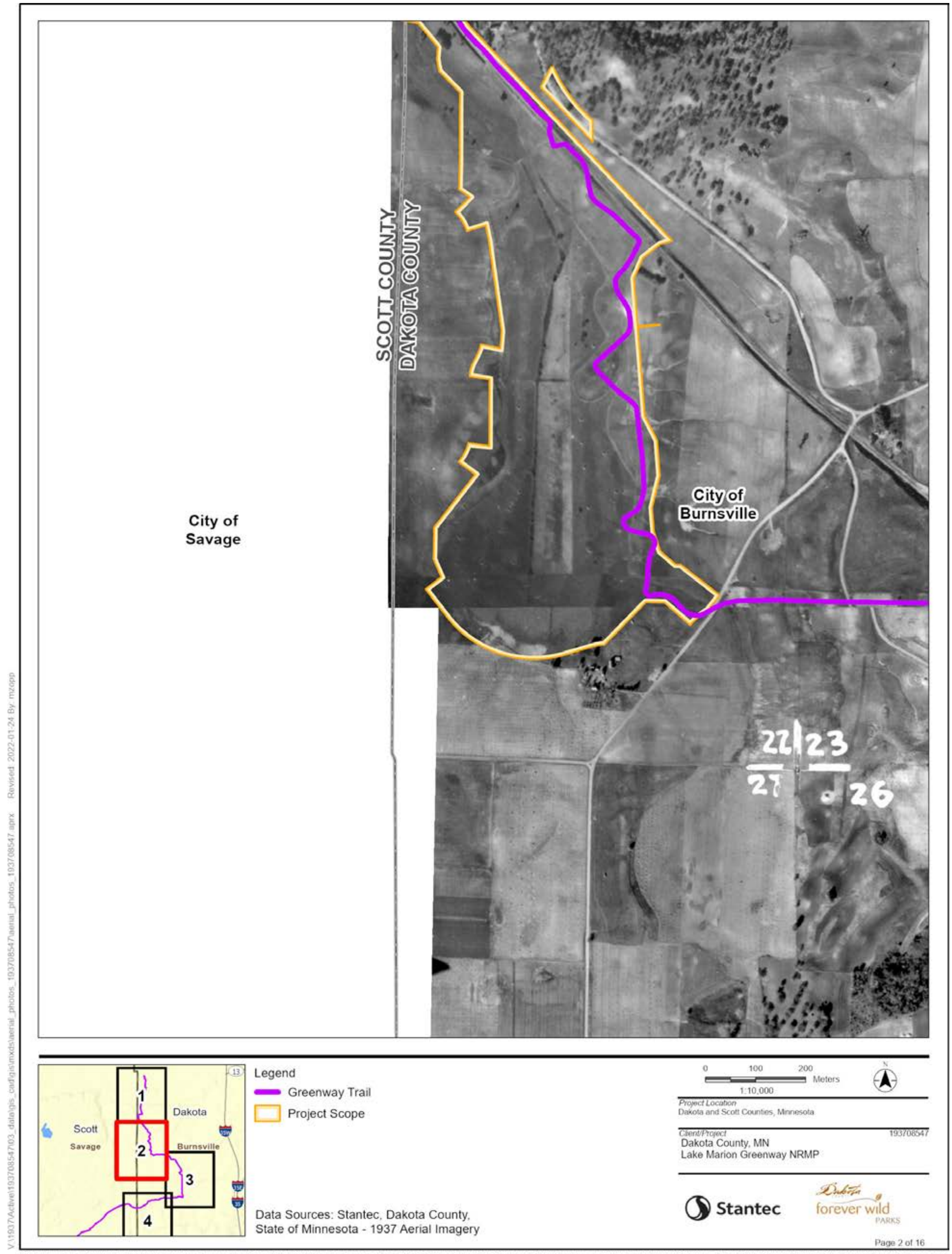

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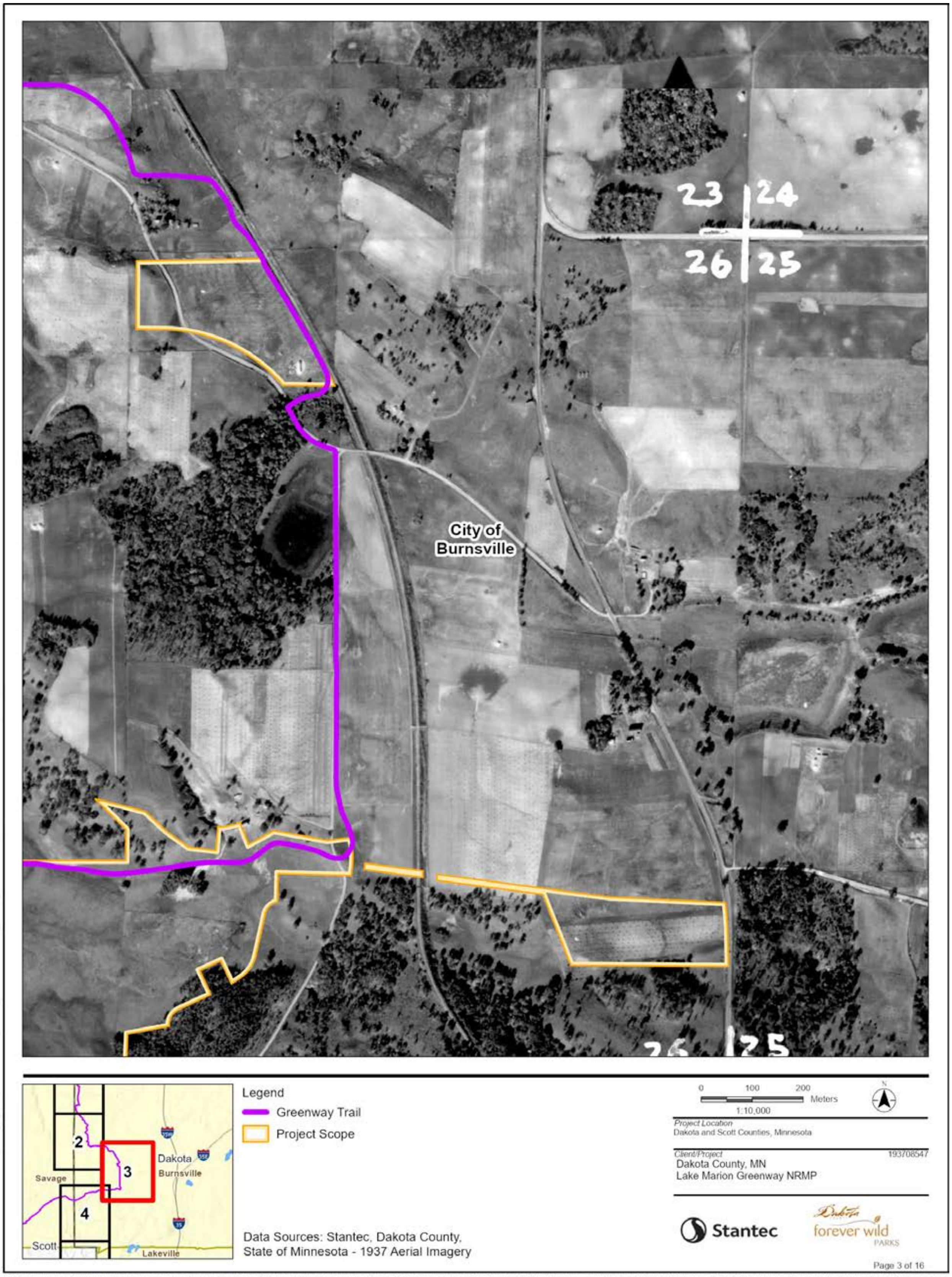

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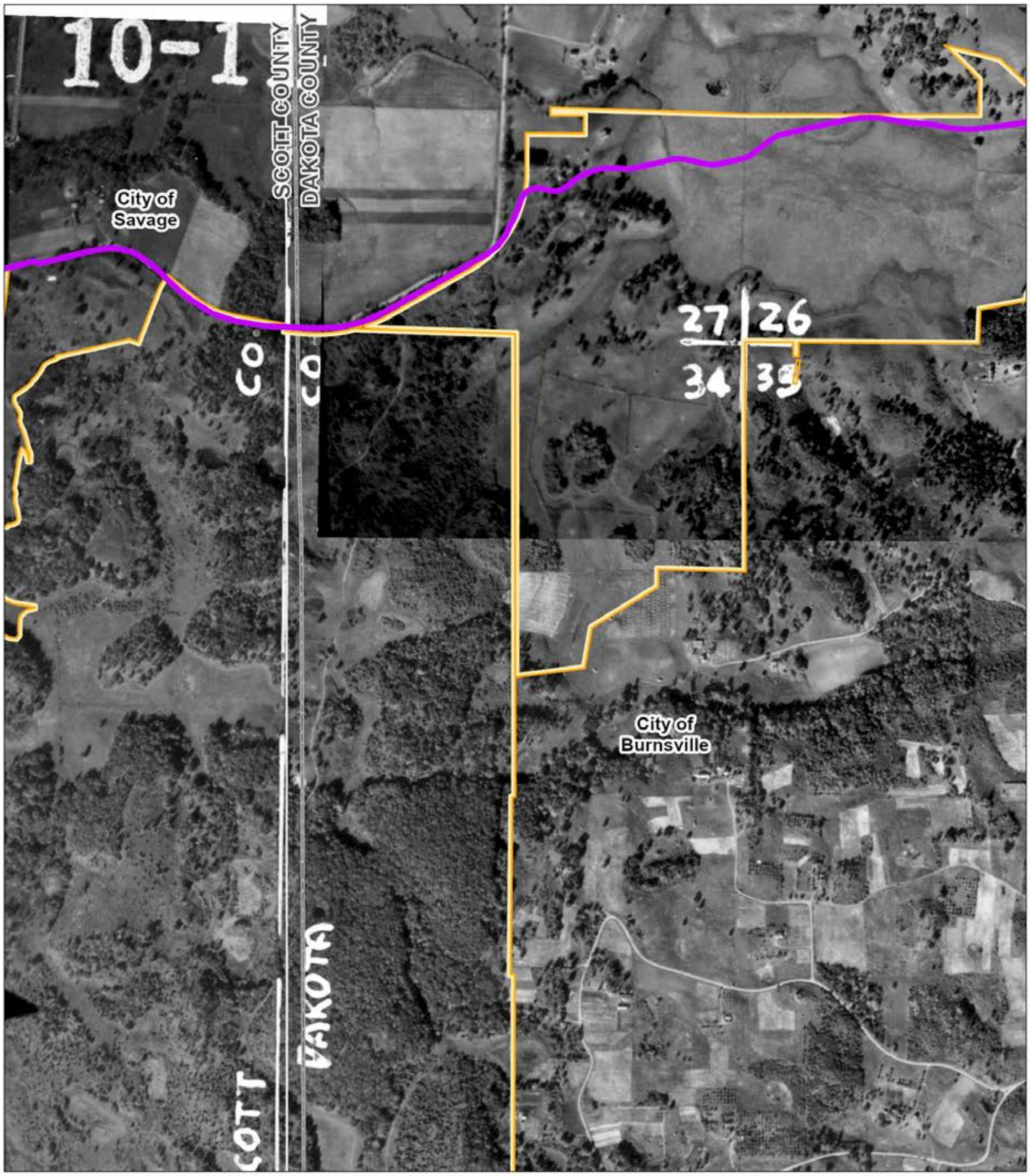

Legend

Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

0 100 200 Meters

1:10,000

Project Location
Dakota and Scott Counties, Minnesota

Client/Project 193708547
Dakota County, MN
Lake Marion Greenway NRMP

Stantec

Dakota forever wild PARKS

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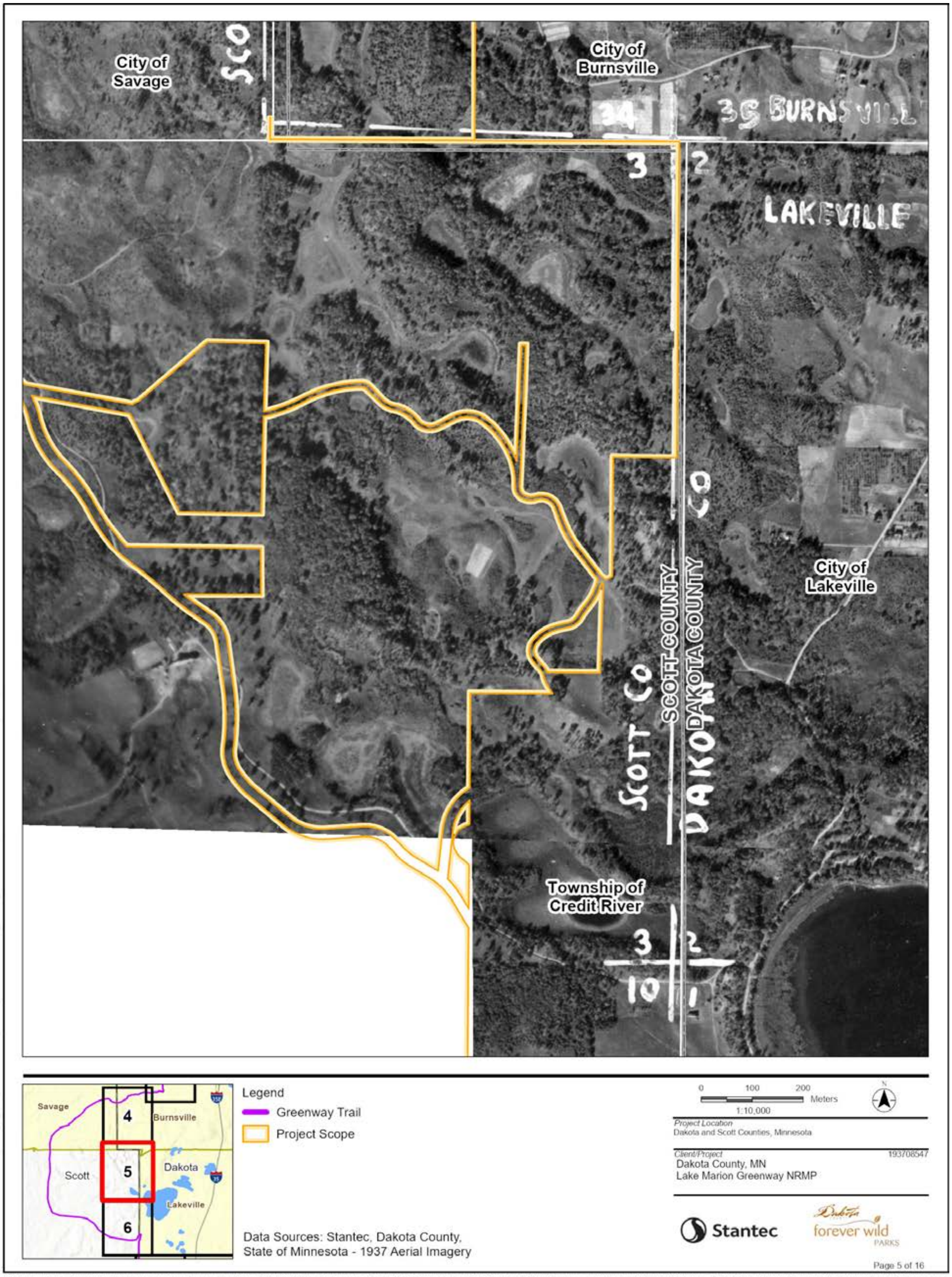

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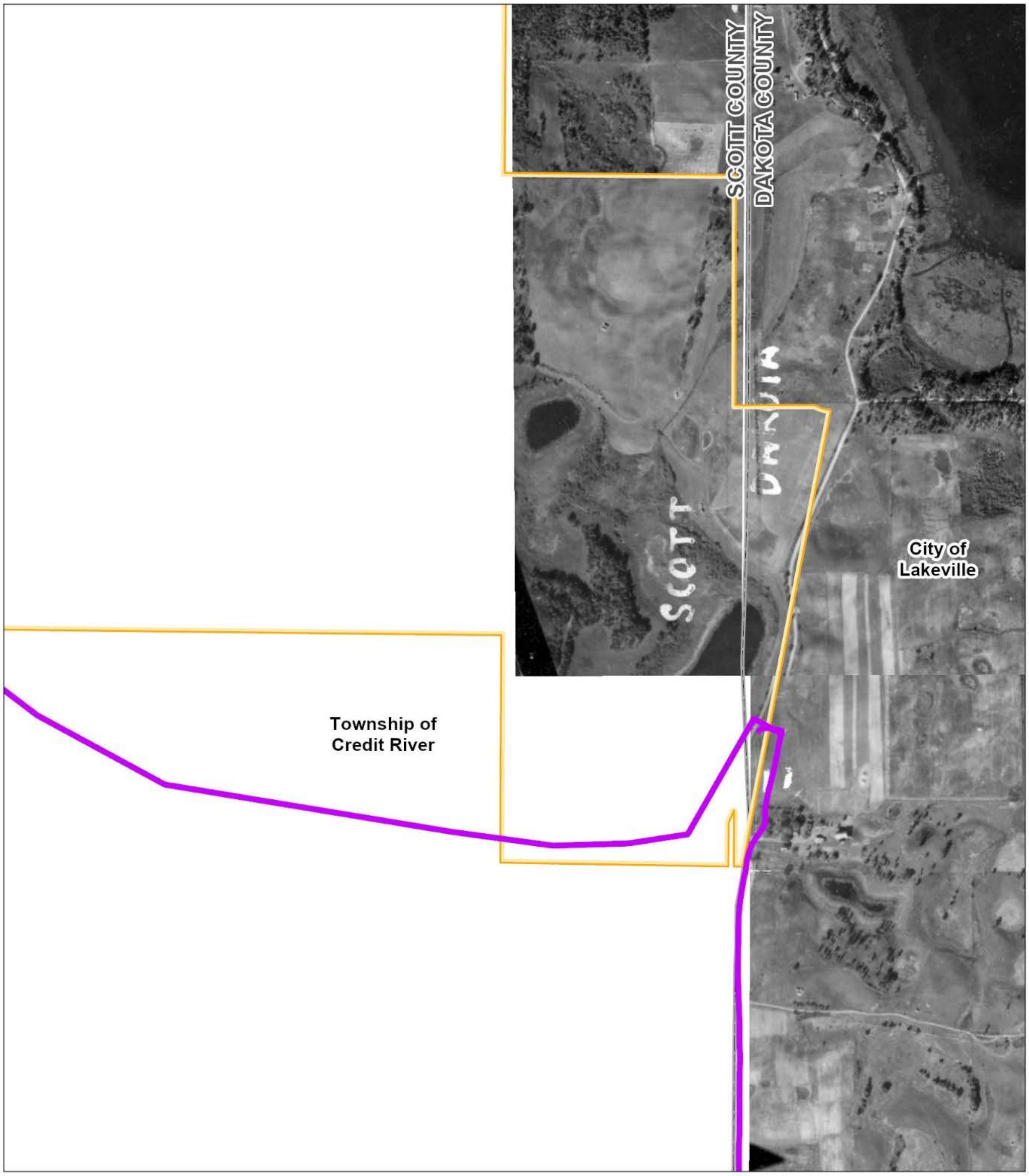

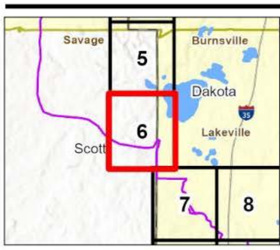

Legend
Greenway Trail
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Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

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Dakota forever wild PARKS

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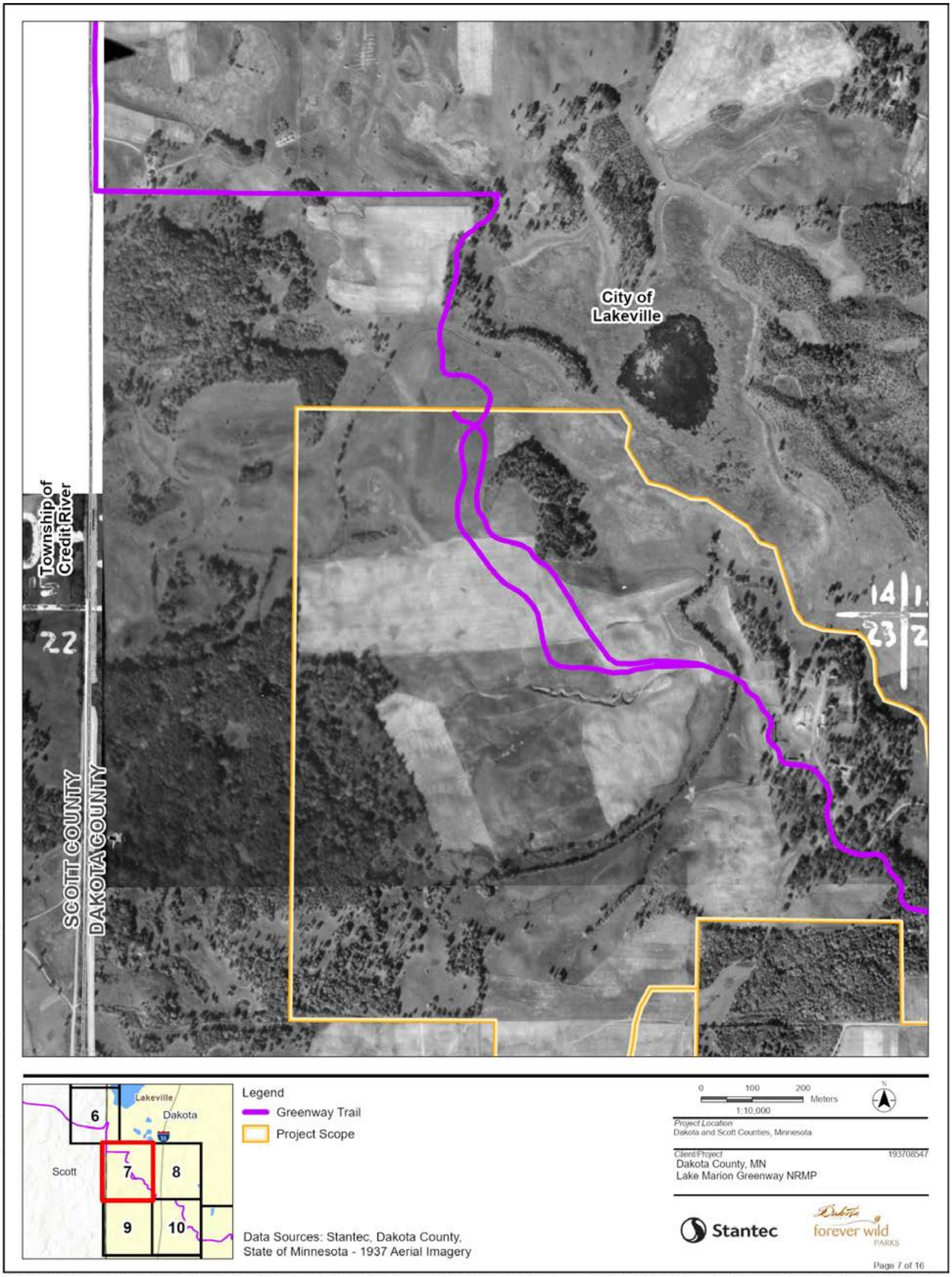

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Legend

Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

0 100 200 Meters

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Project Location
Dakota and Scott Counties, Minnesota

Client/Project 193708547
Dakota County, MN
Lake Marion Greenway NRMP

Stantec

forever wild PARKS

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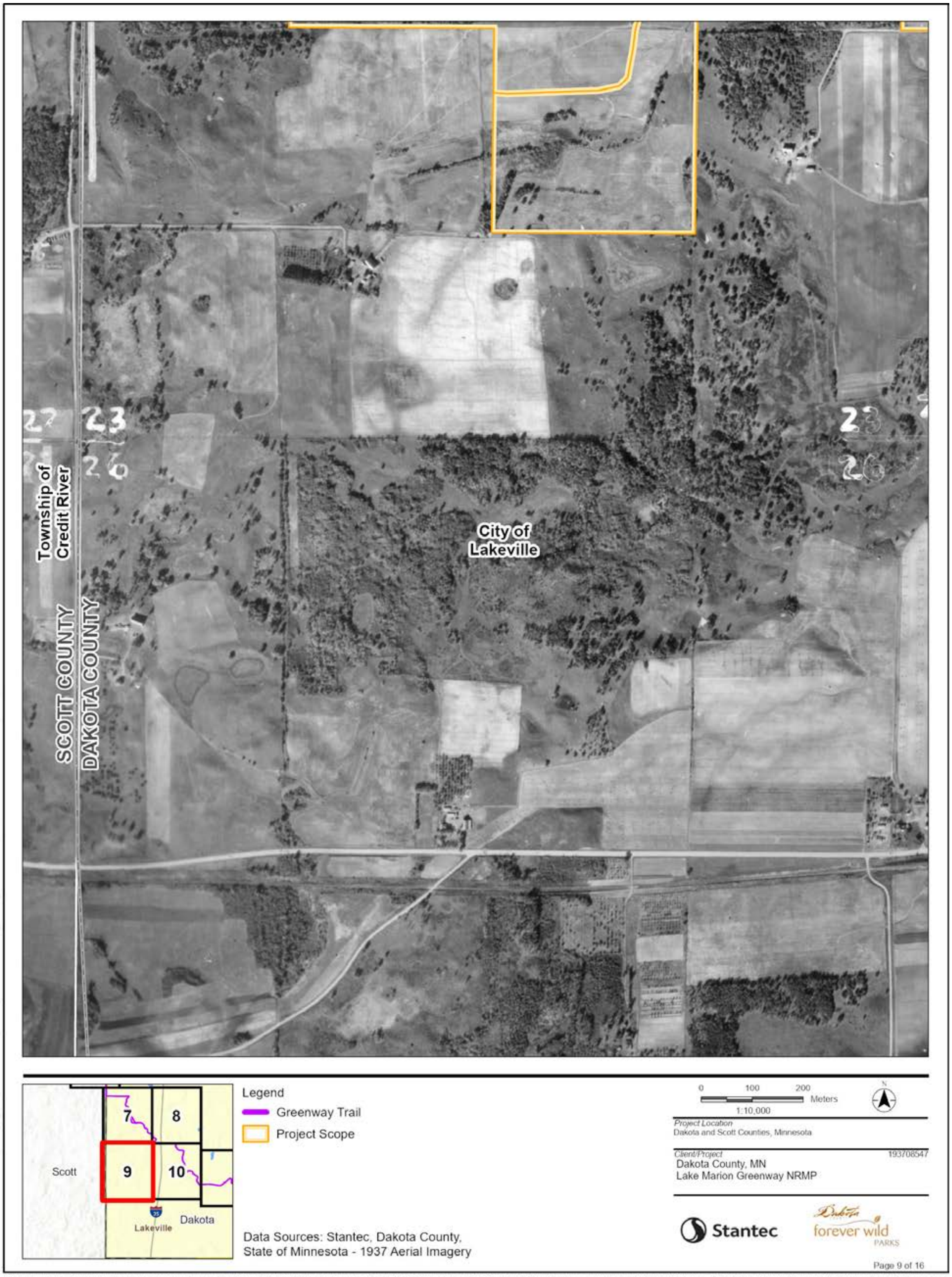

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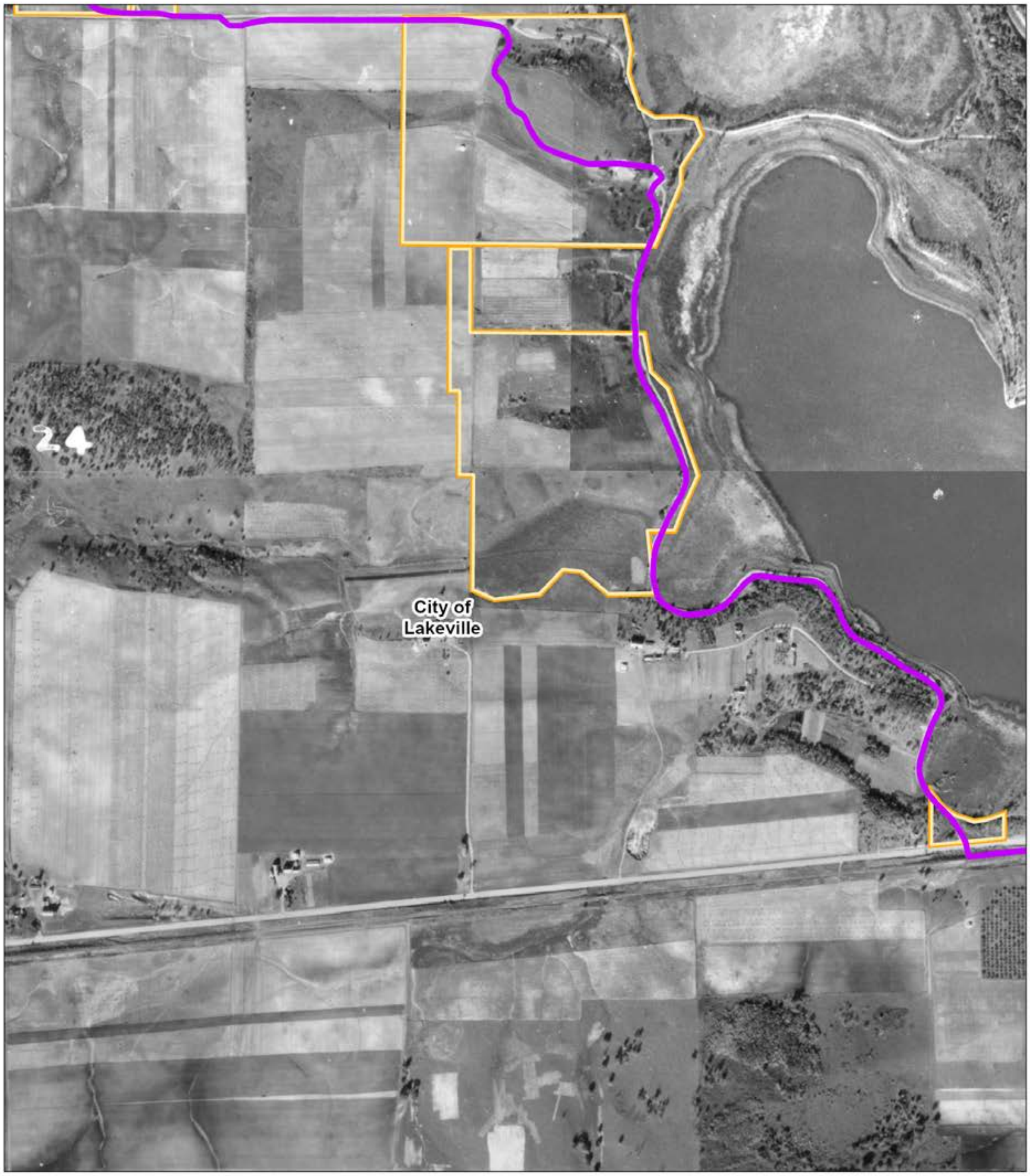

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Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

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Project Location
Dakota and Scott Counties, Minnesota

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Dakota County, MN
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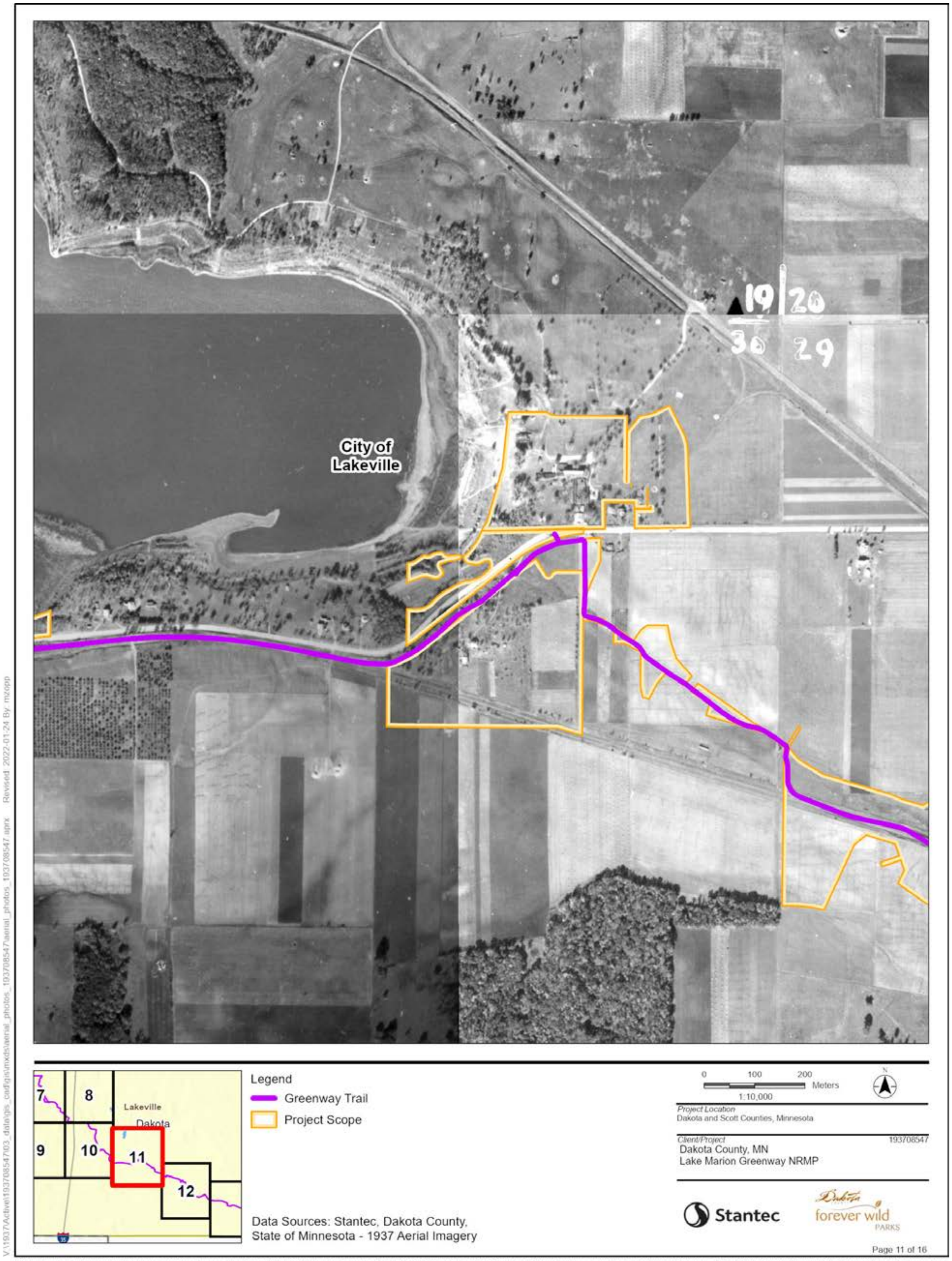

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City of Lakeville
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Project Scope
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Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery
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Project Location
Dakota and Scott Counties, Minnesota
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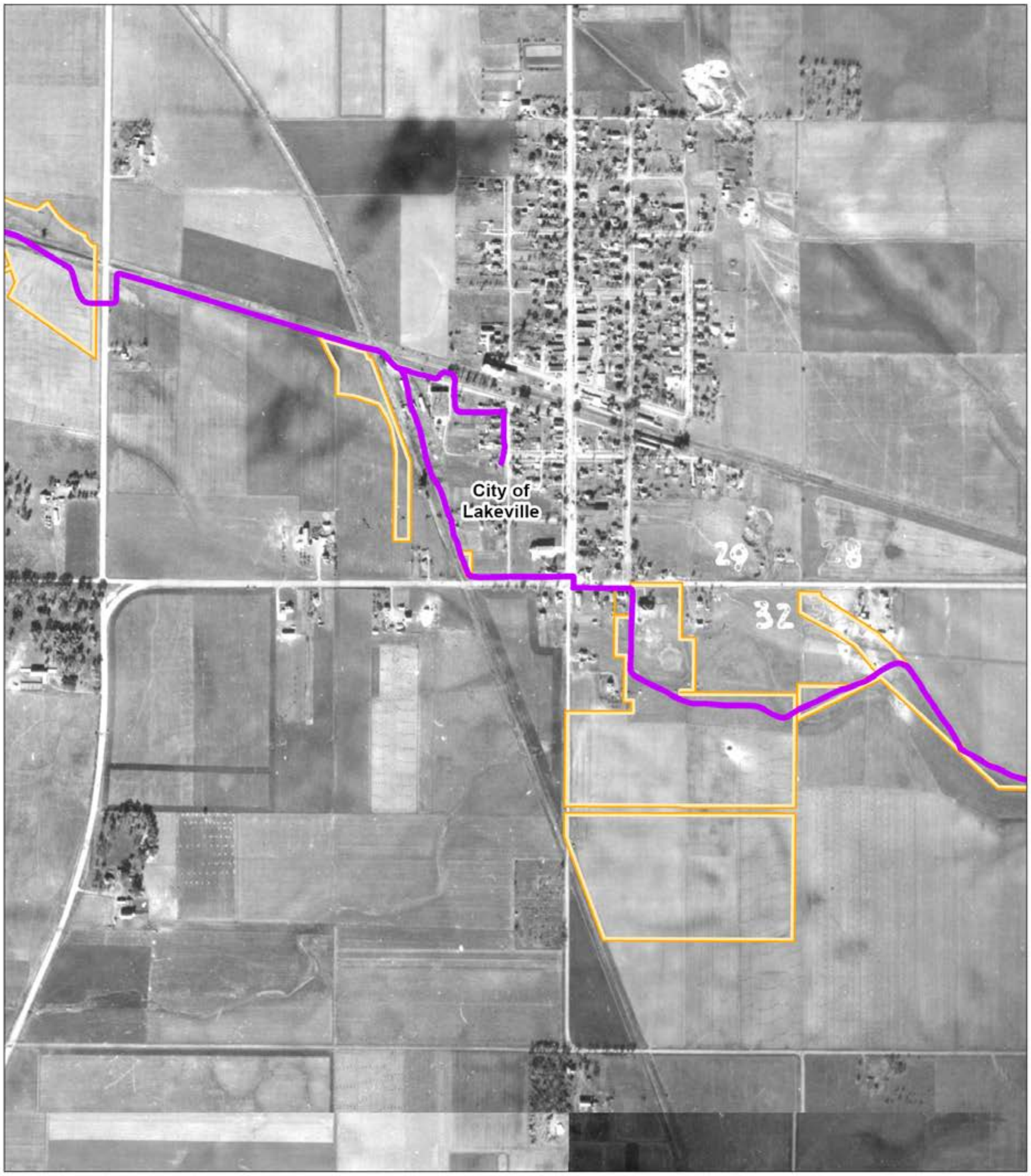

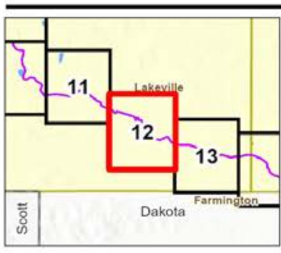

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Greenway Trail

Project Scope

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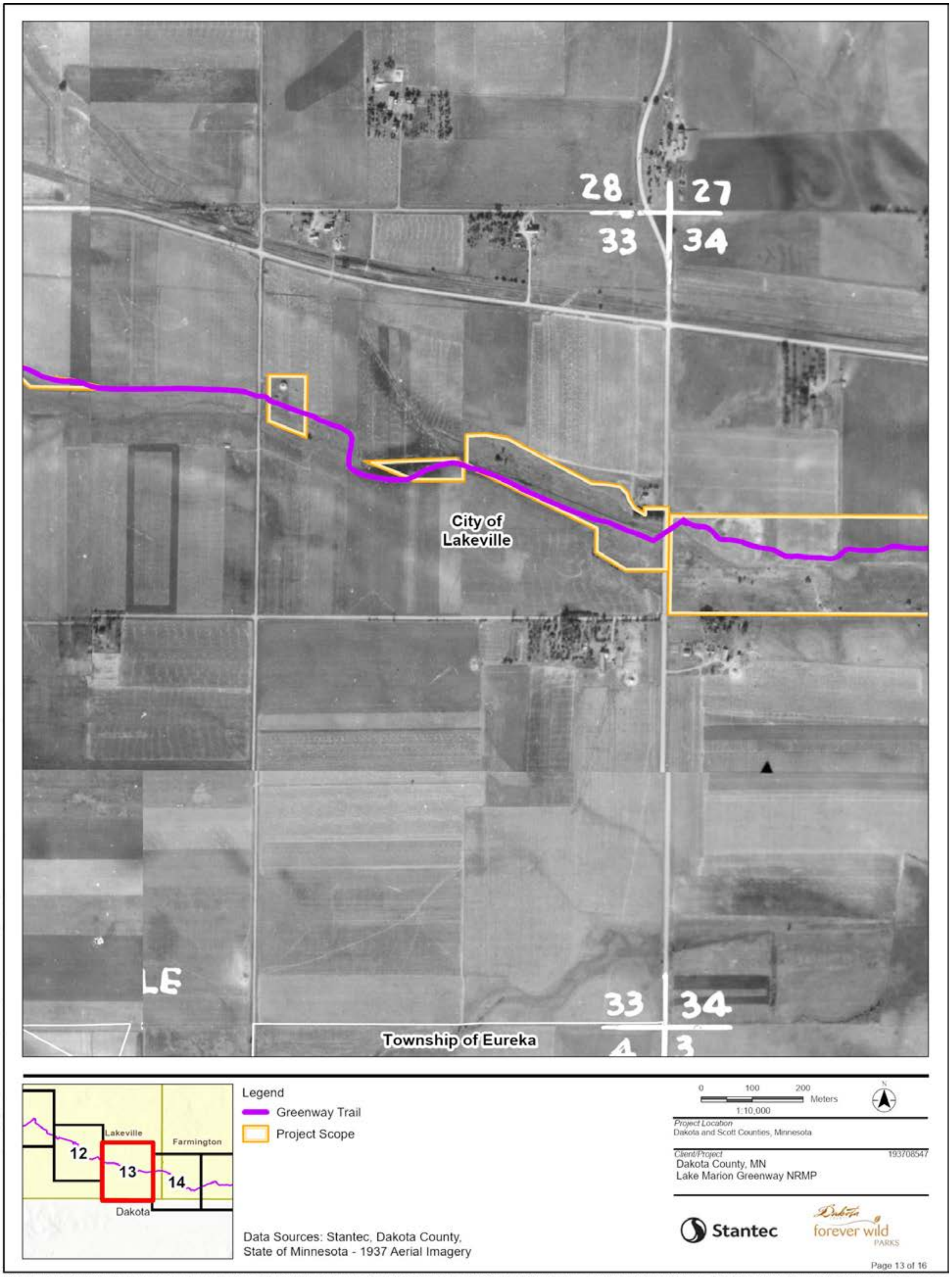

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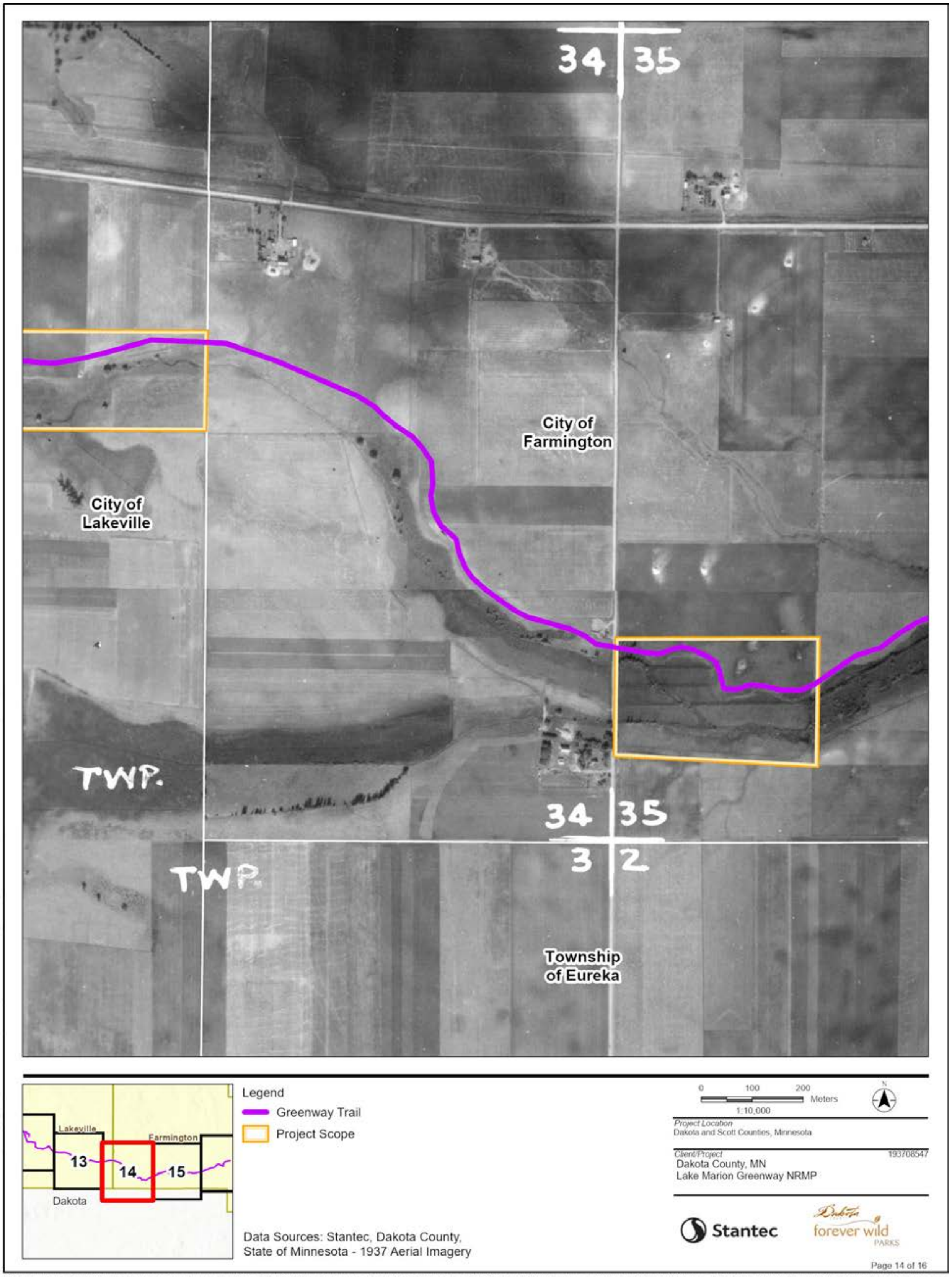

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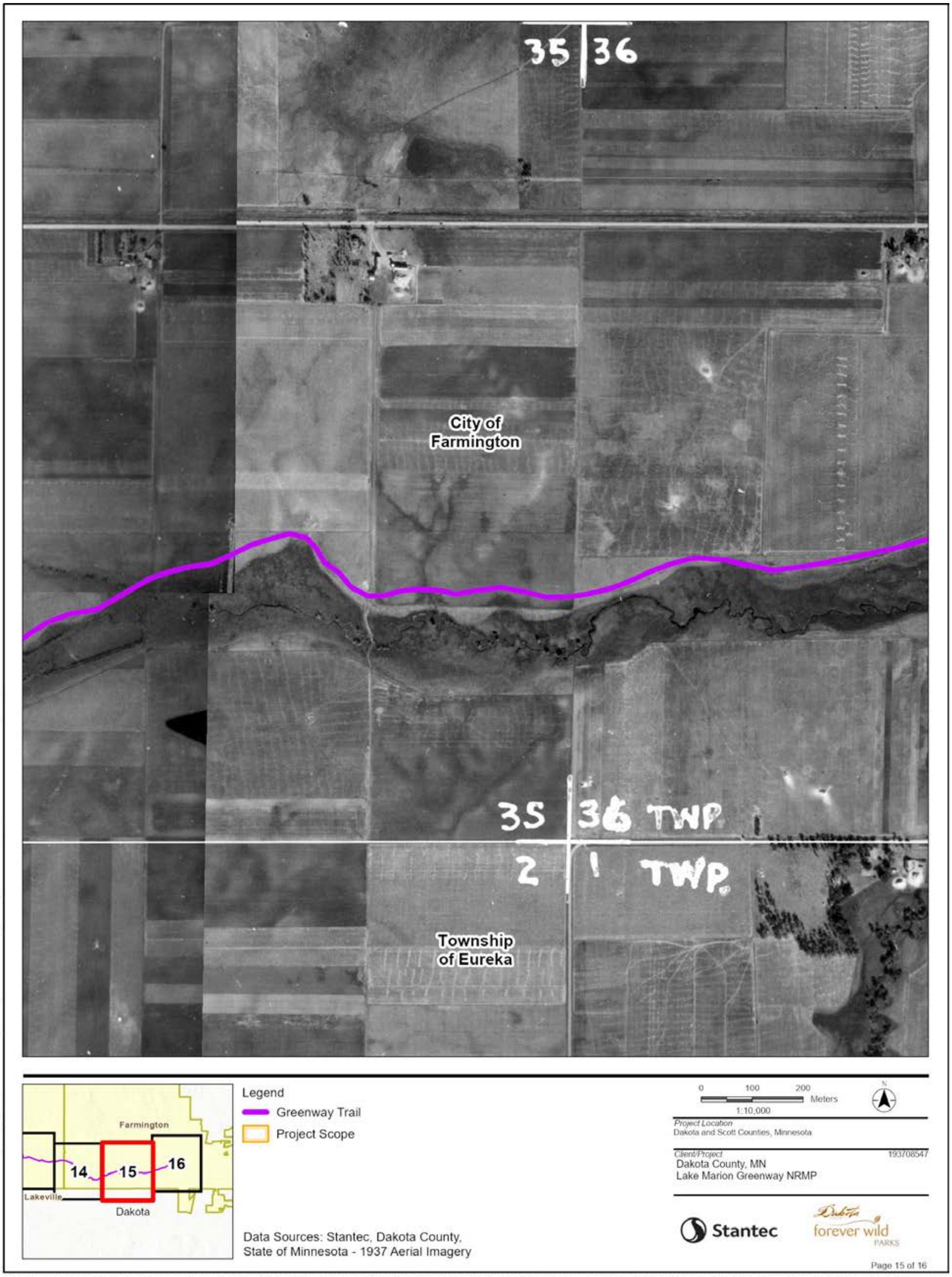
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Legend
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Dakota
Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery
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Project Location
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Dakota
forever wild
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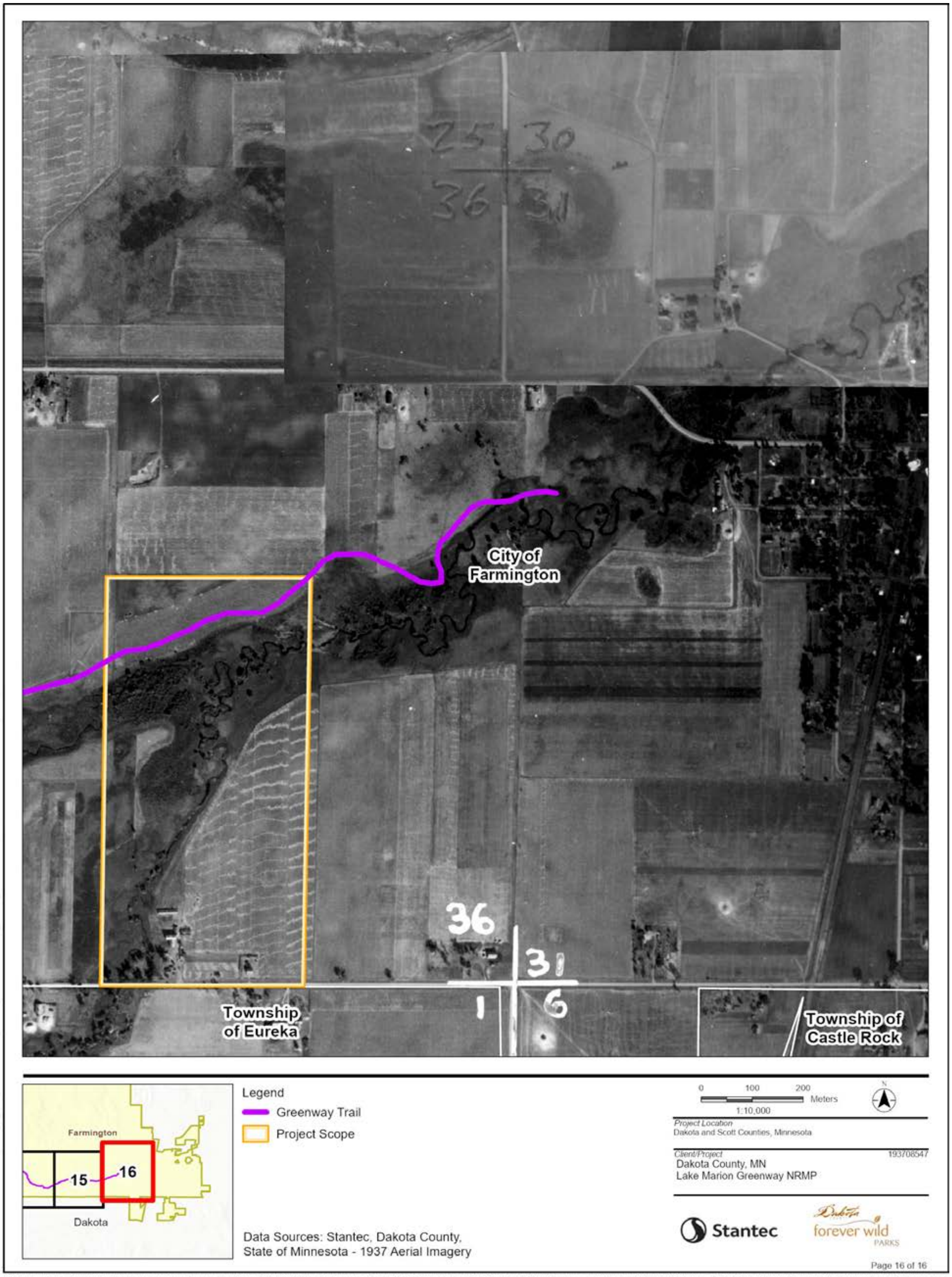

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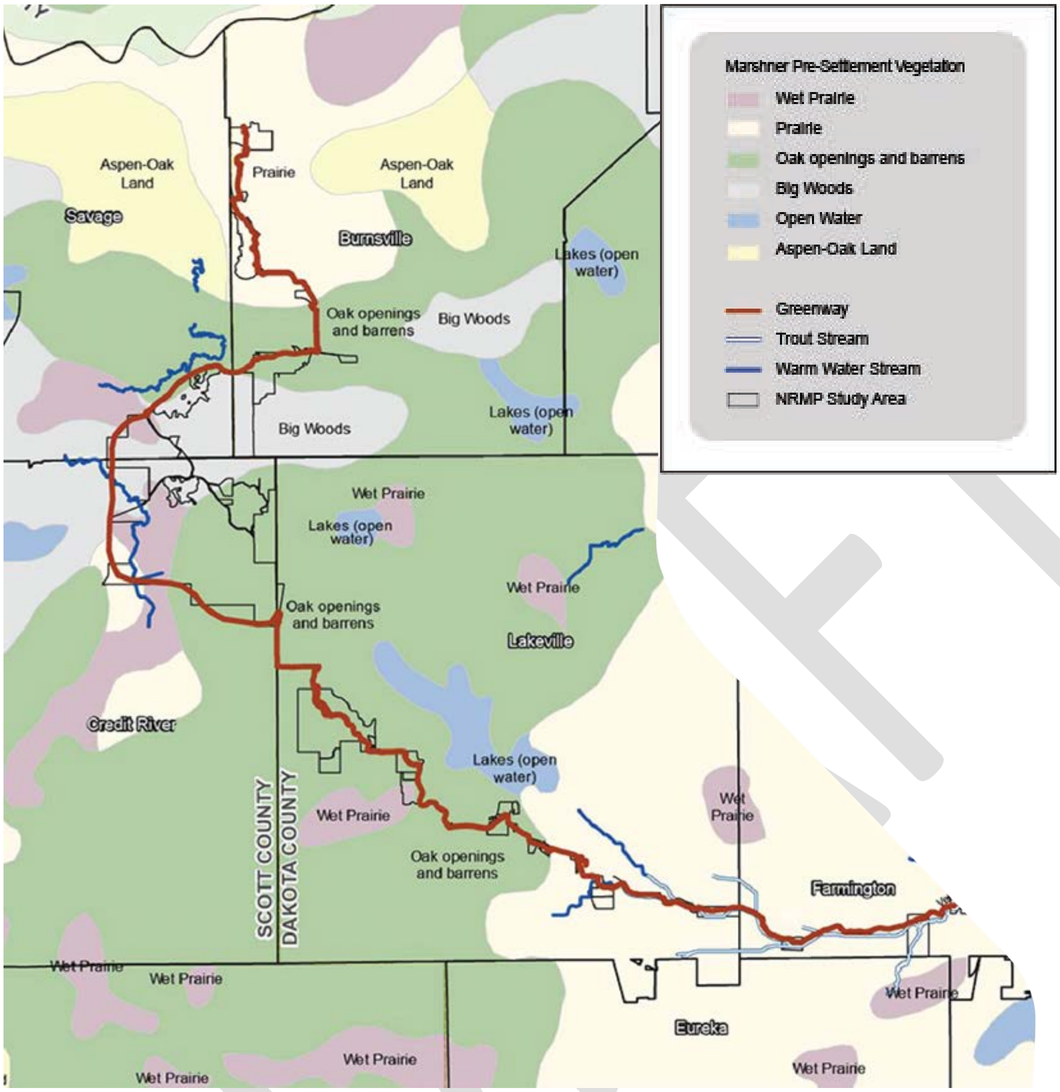
Historic Vegetation Patterns

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 4**, the pre-settlement vegetation patterns of the greenway corridor were highly variable. The southern arm of the corridor through Farmington and the eastern half of Lakeville was predominantly oak openings and barrens. North of the Burnsville / Lakeville municipal boundary, areas with Big Woods, wet prairie and prairie were mapped.

FIGURE 4: Pre-Settlement Vegetation of Greenway Corridor and Surrounding Region



The Oak Savanna subsection of the corridor, in the Lakeville and Farmington area, historically consisted largely of gently rolling hills with bur oak savanna being the primary vegetation community, but with areas of tallgrass prairie and maple-basswood forest also being common. The bur oak savanna consisted primarily of mesic to dry tallgrass prairie with an occasional and interspersed canopy of fire-resistant trees such as bur oaks. Fire was a key disturbance that maintained the open structure of these savannahs and kept wooded vegetation from encroaching and succeeding to forests. Wetlands were once plentiful throughout the subsection and provided critical habitat for wildlife. The patchy nature of this subsection supported a variety of habitat types, depending upon fire frequency and topography, including but not limited to dry sand-gravel prairies, mesic tallgrass prairies, dry and mesic oak savannahs and brushlands, wet prairie, and fire-dependent oak woodlands.

FIGURE 5: Historic Aerial Composites

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 (**Figures 6 and 7**). Today, the relatively high percentage of impervious surfaces surrounding many sections of this corridor significantly increases stormwater runoff rates and changes hydrological conditions of wetlands, streams and ponds within the Corridor **(Figure 8)**.

Figure 6 Planned Land Use near the Corridor

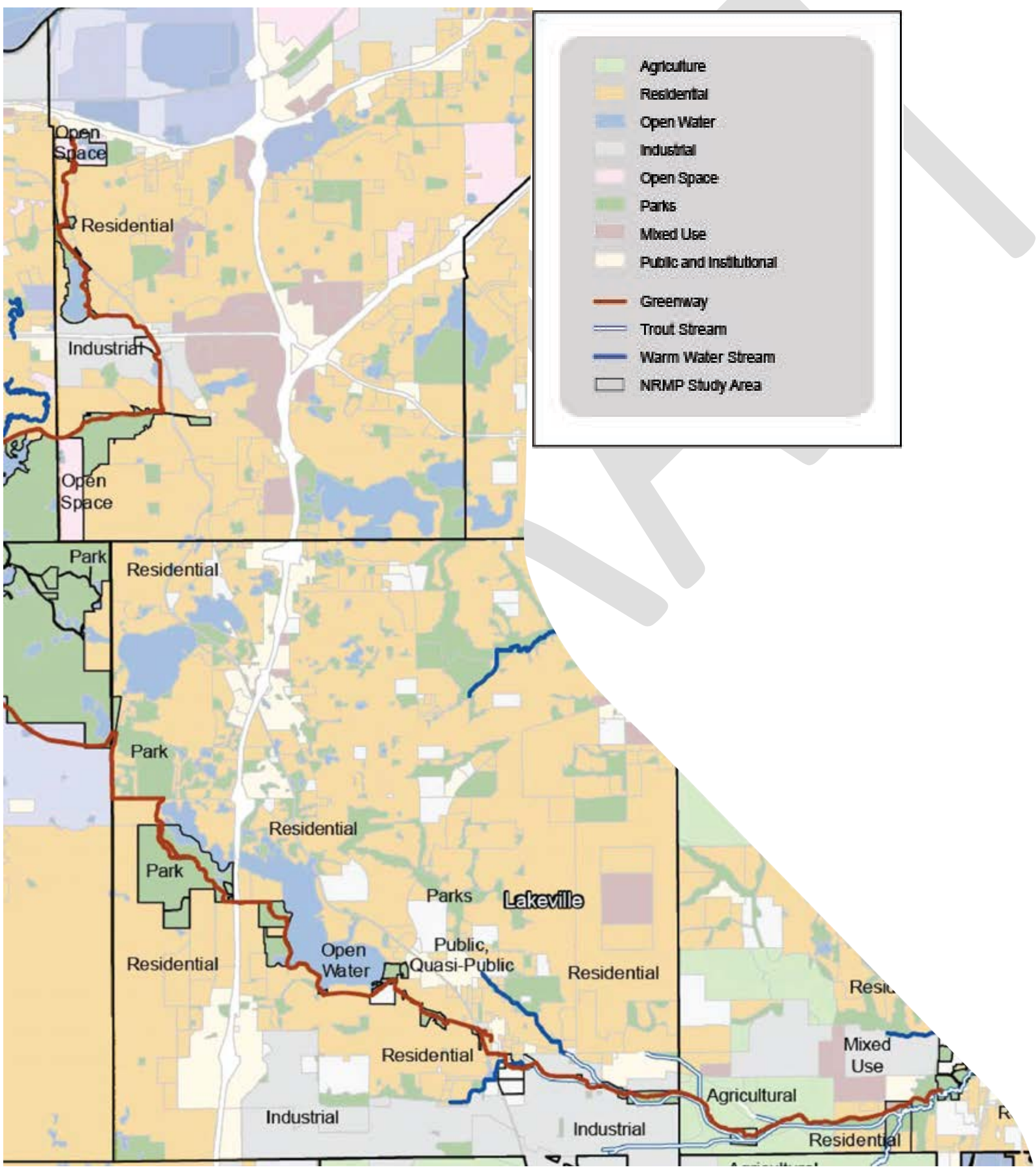
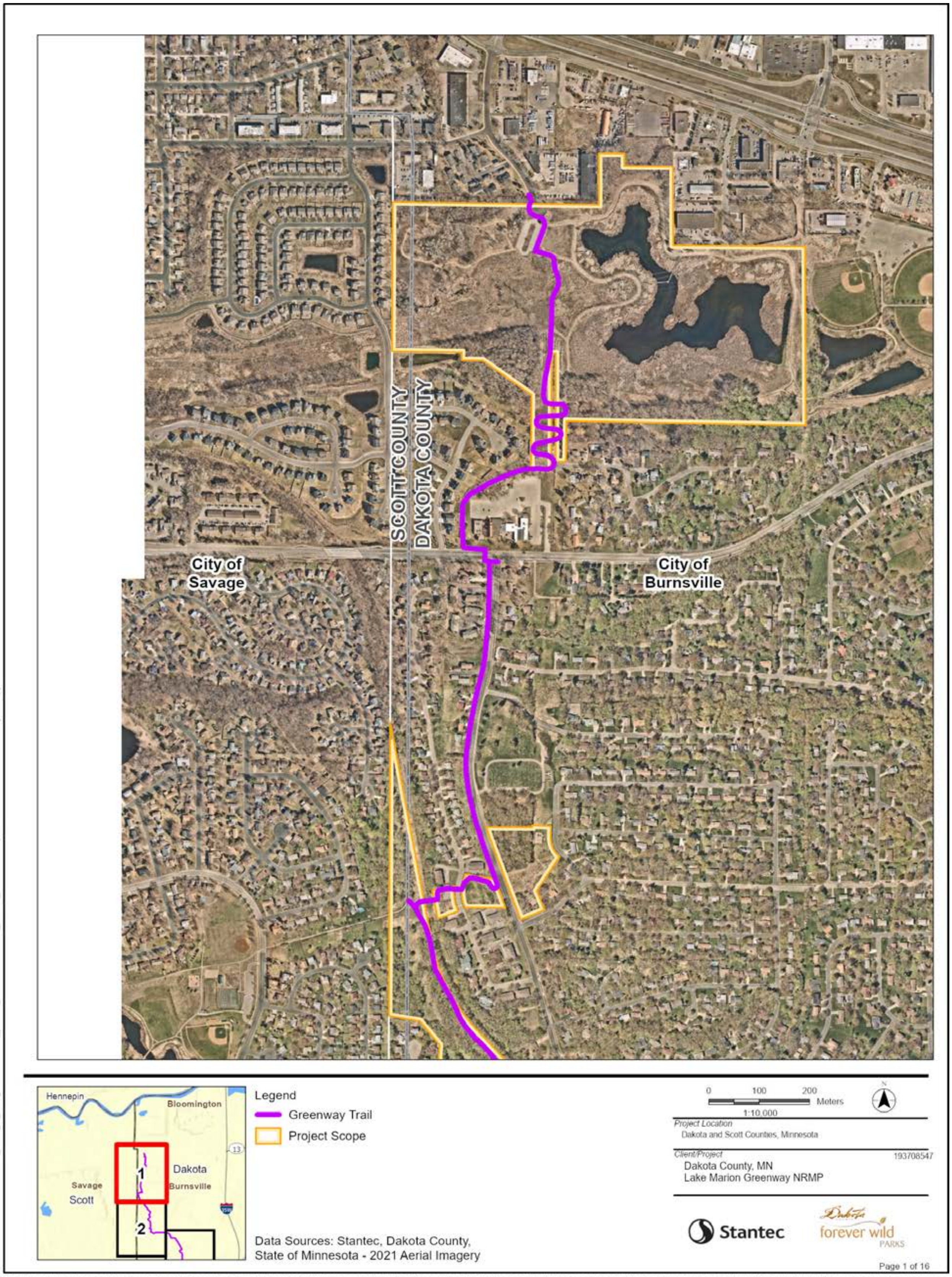


Figure 7 Current Aerial Photos



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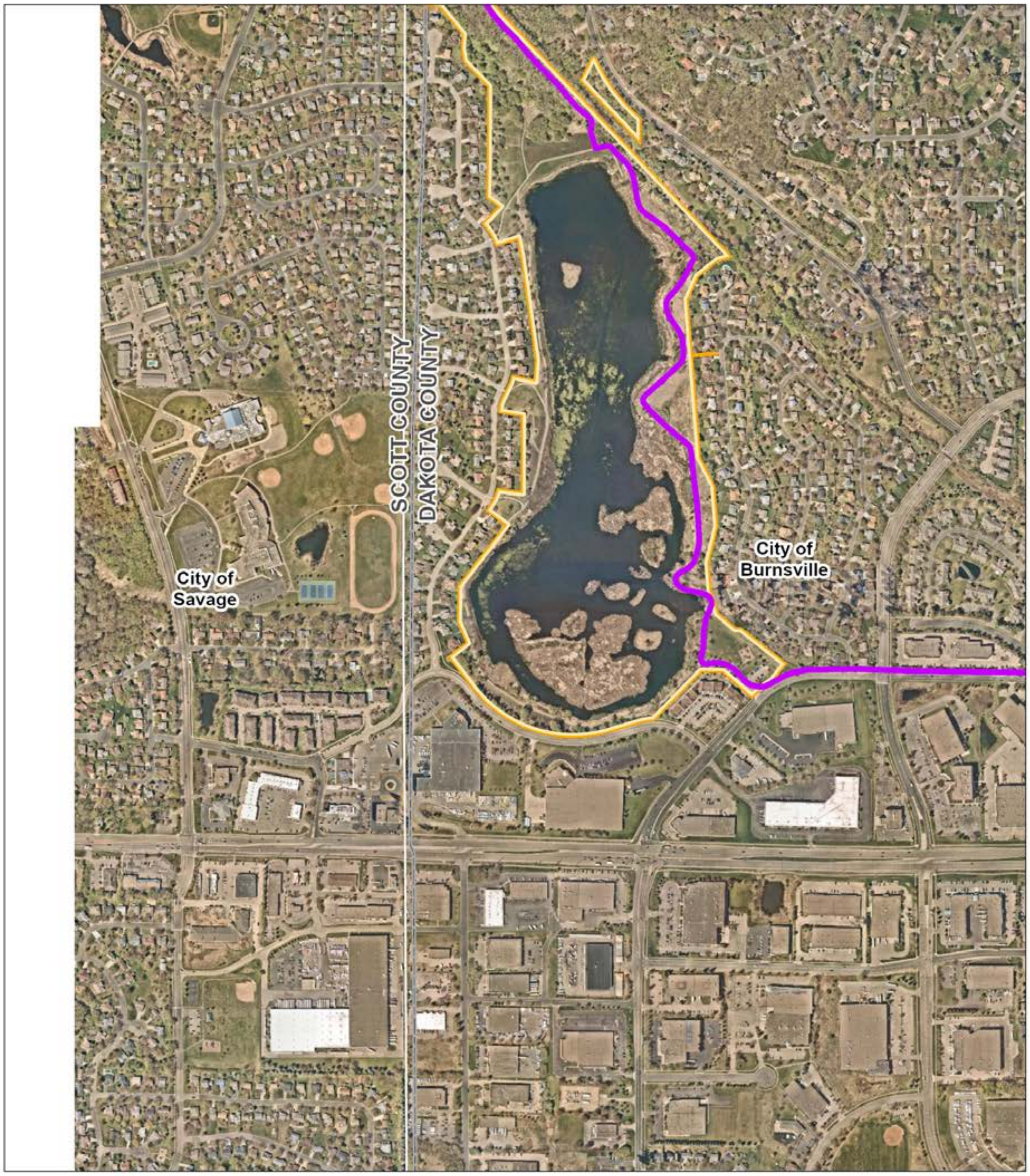

Legend
Greenway Trail
Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 2021 Aerial Imagery

0 100 200 Meters
1:10,000

Project Location
Dakota and Scott Counties, Minnesota

Client/Project 193708547
Dakota County, MN
Lake Marion Greenway NRMP

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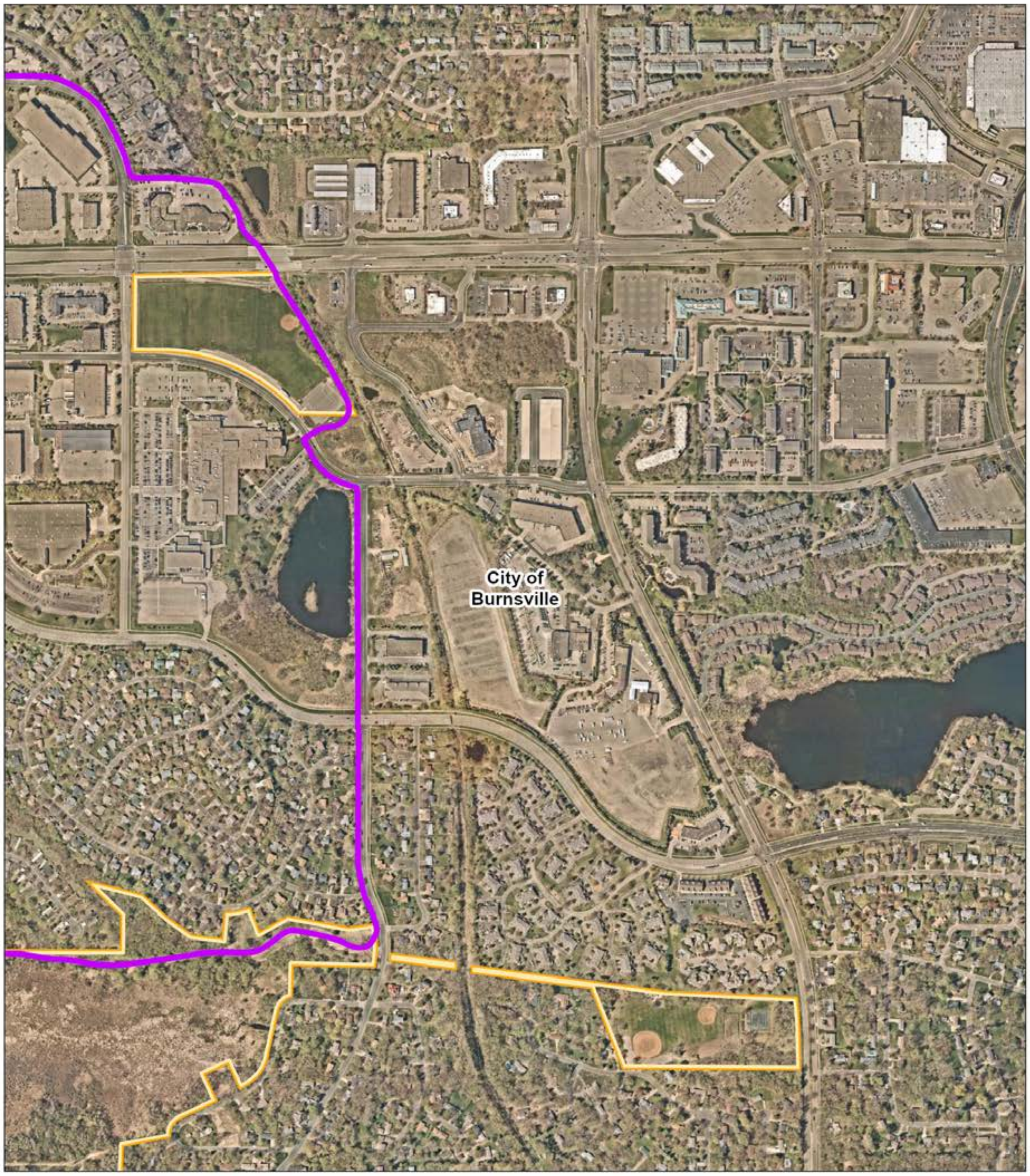

Legend
Greenway Trail
Project Scope

Data Sources: Stantec, Dakota County,
State of Minnesota - 2021 Aerial Imagery

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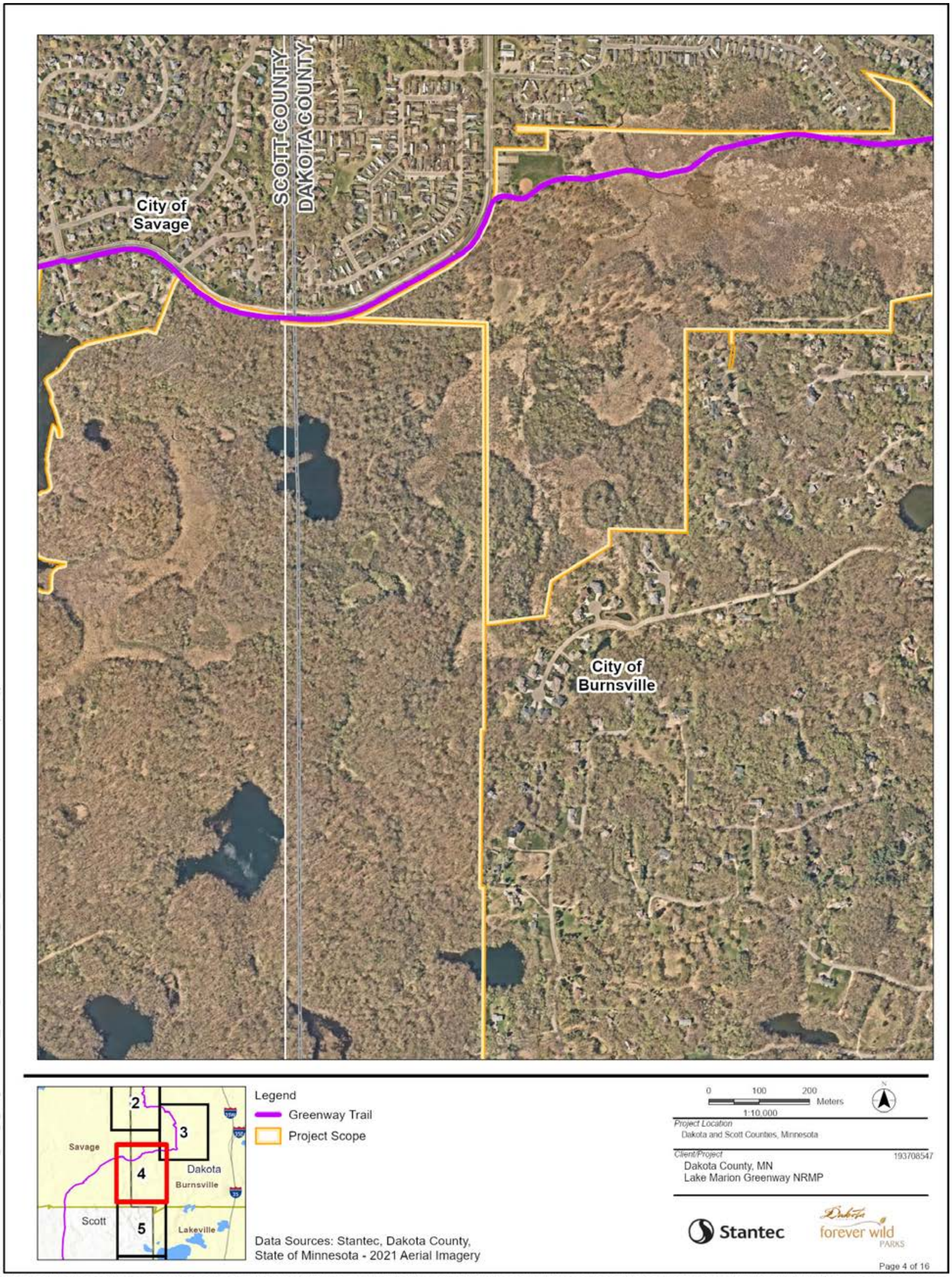

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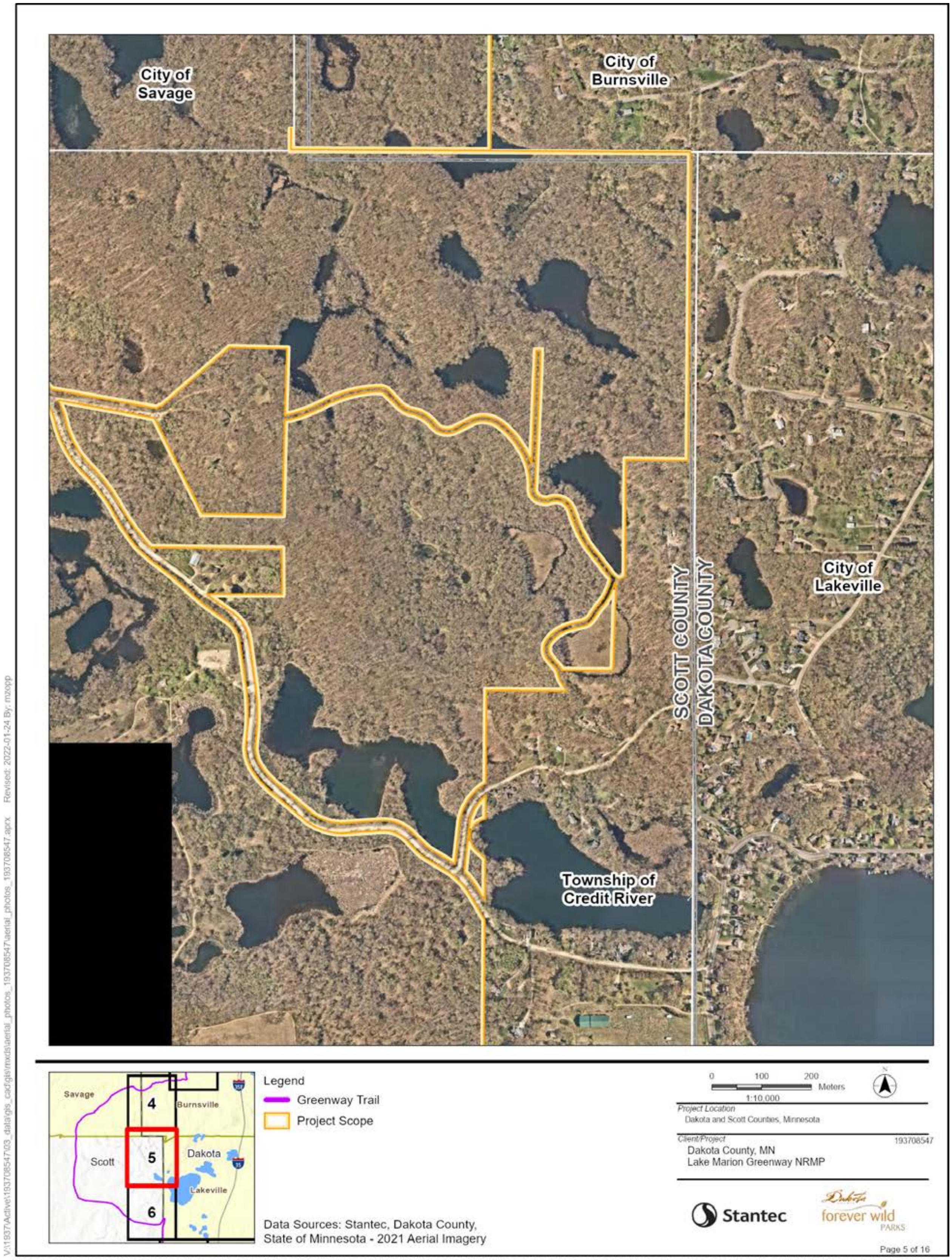

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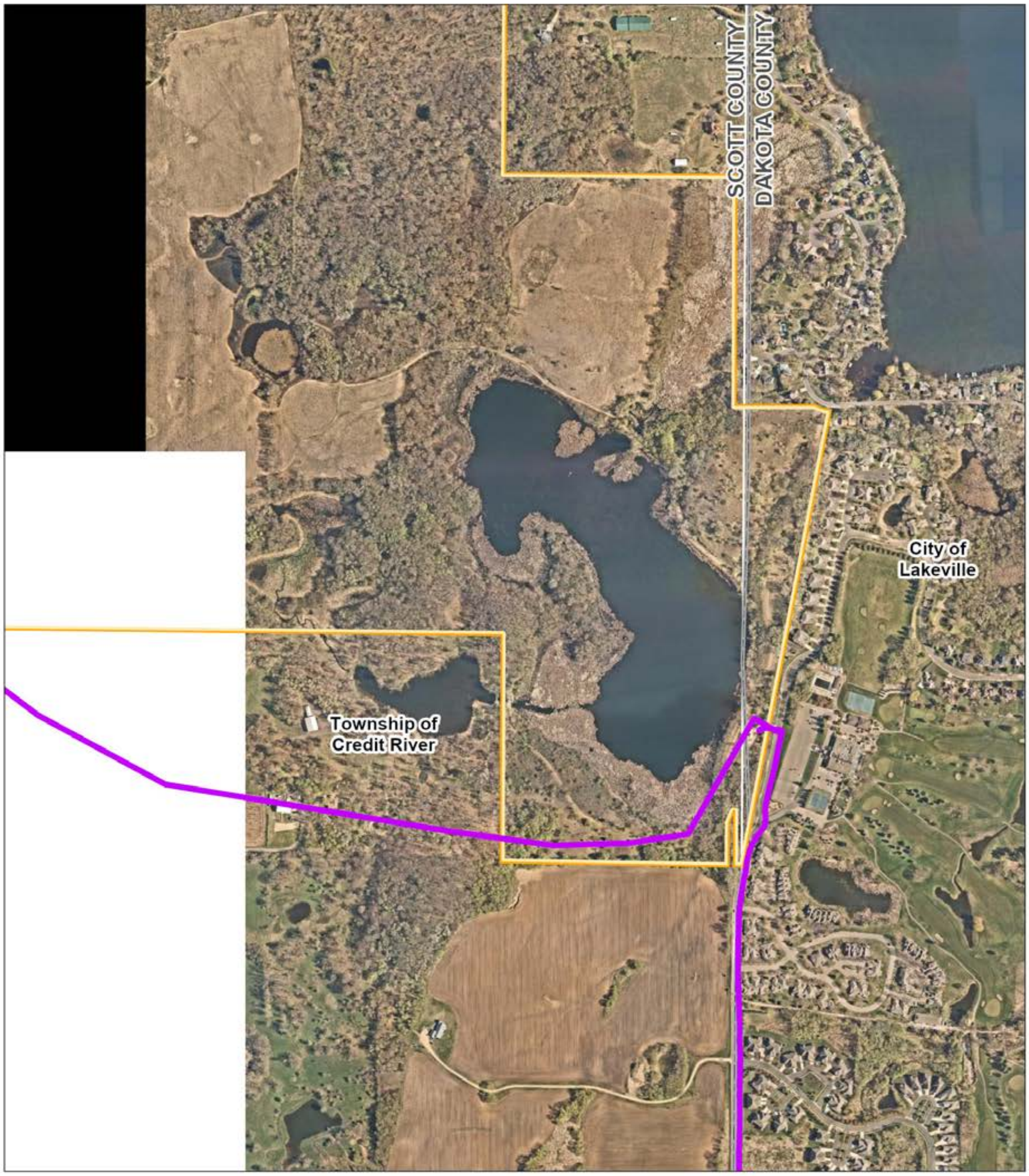

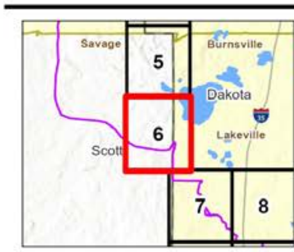

Legend

Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 2021 Aerial Imagery

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Project Location
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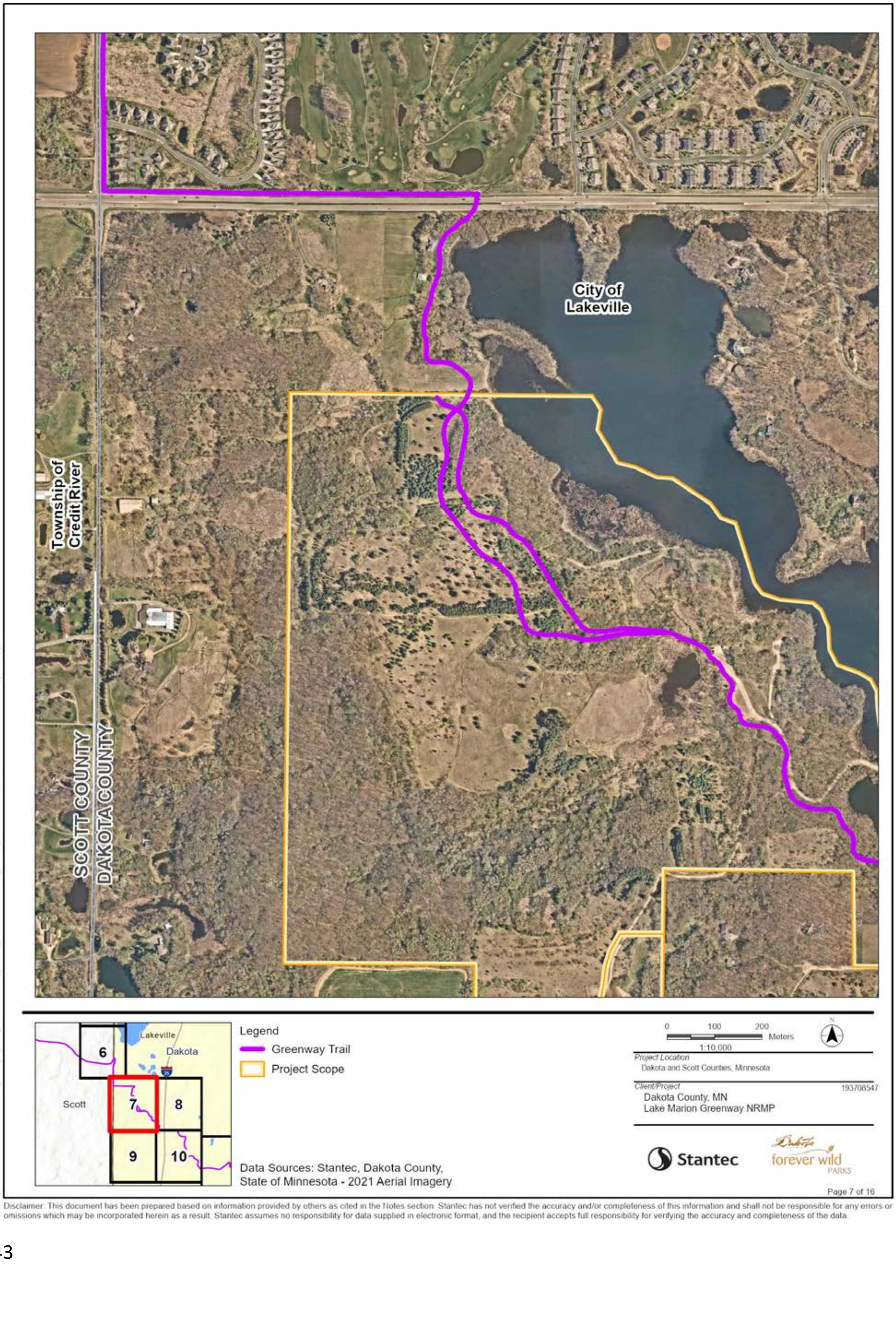

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State of Minnesota - 2021 Aerial Imagery

0 100 200 Meters

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Project Location

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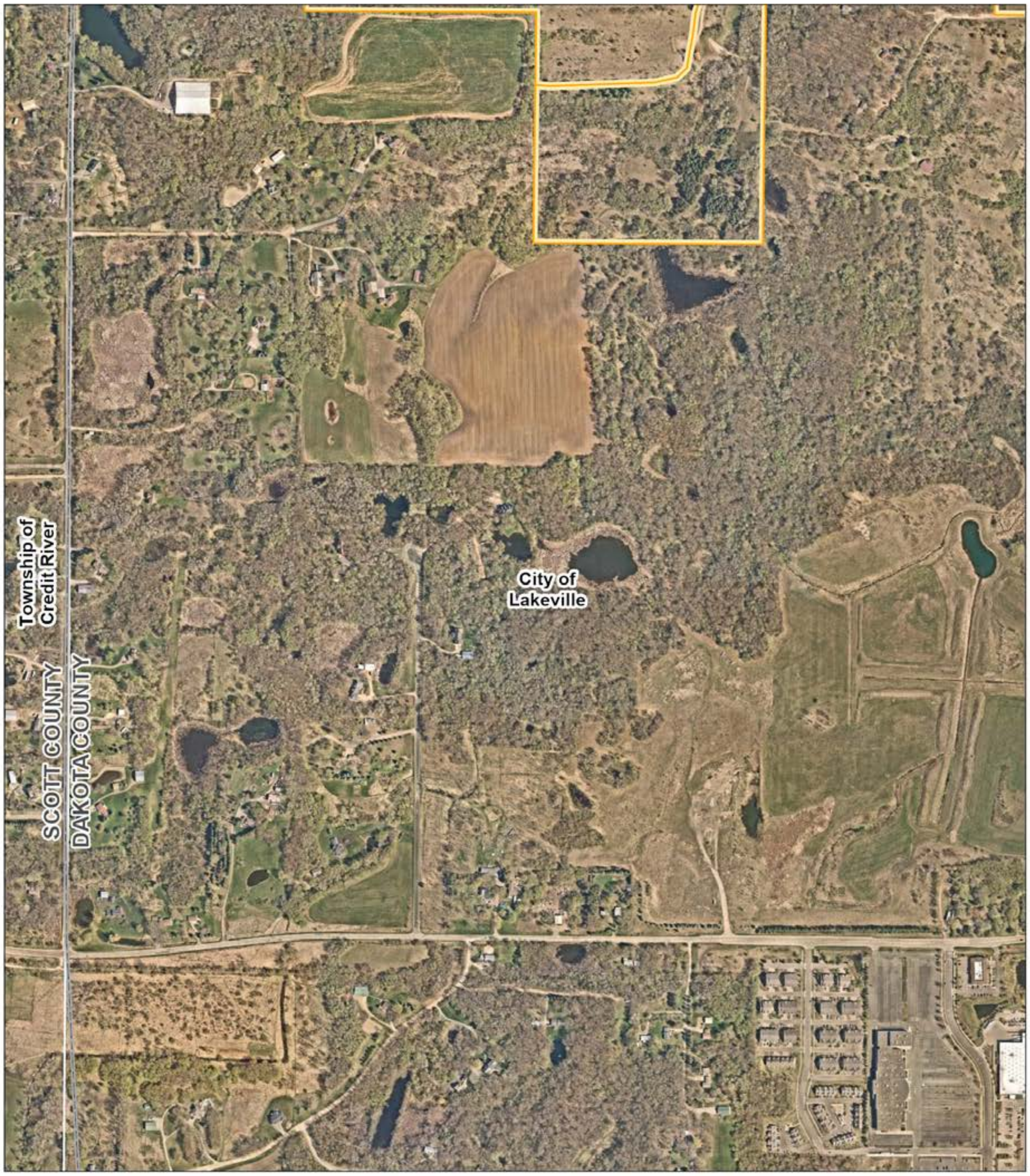

Legend
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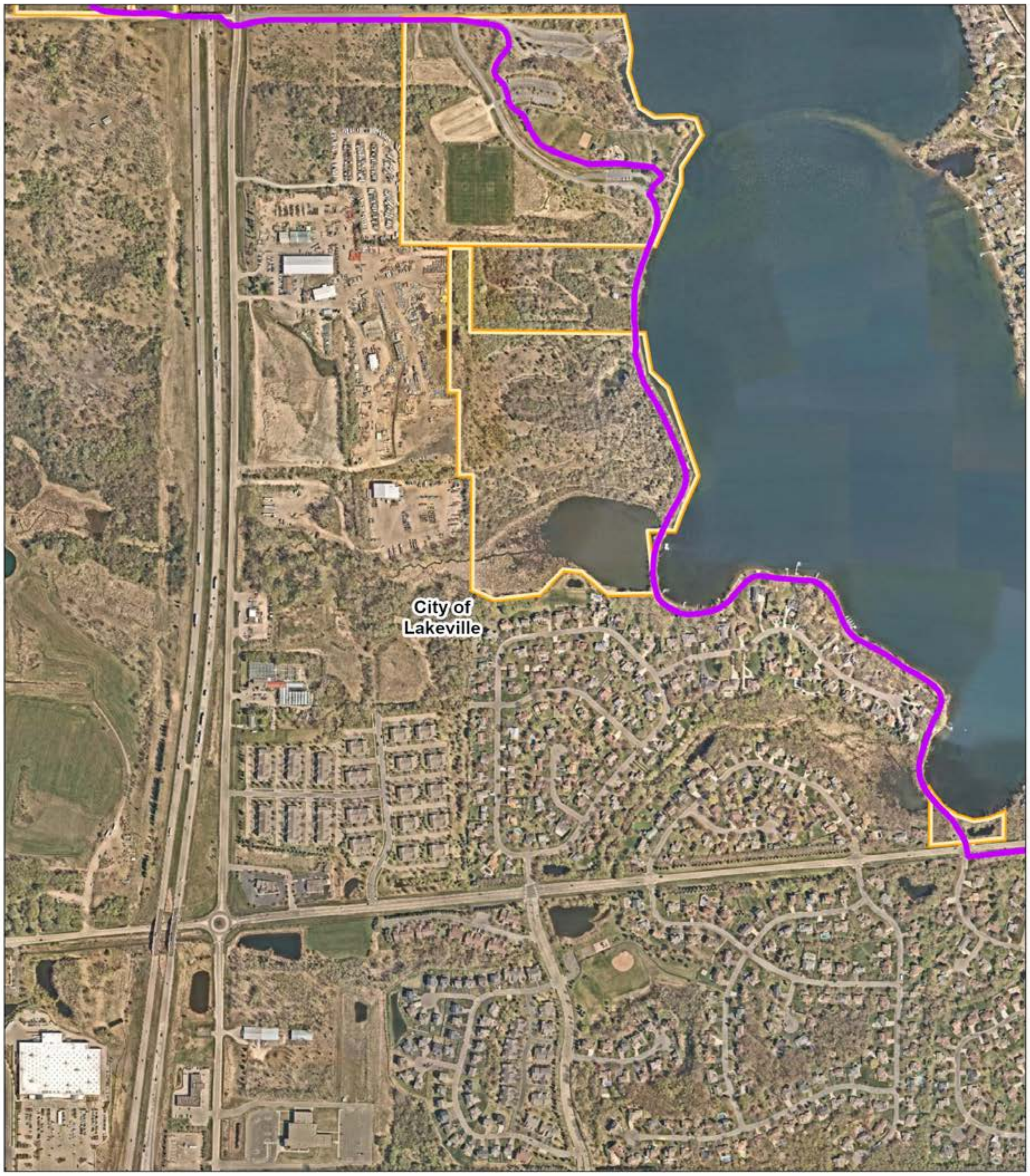

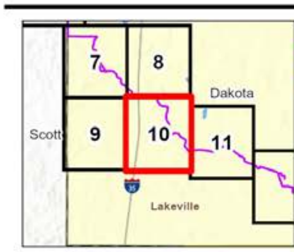

Legend

Greenway Trail

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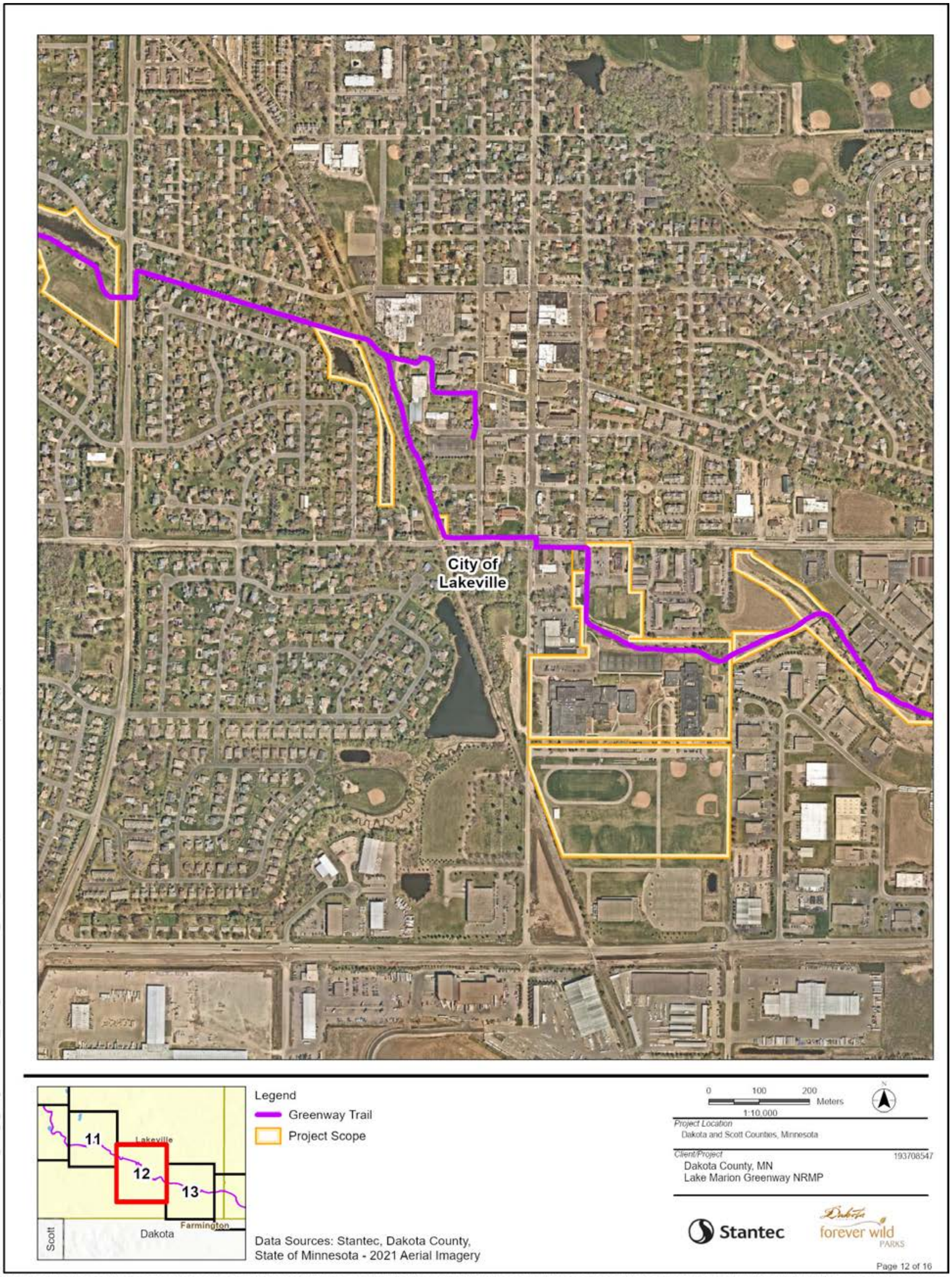

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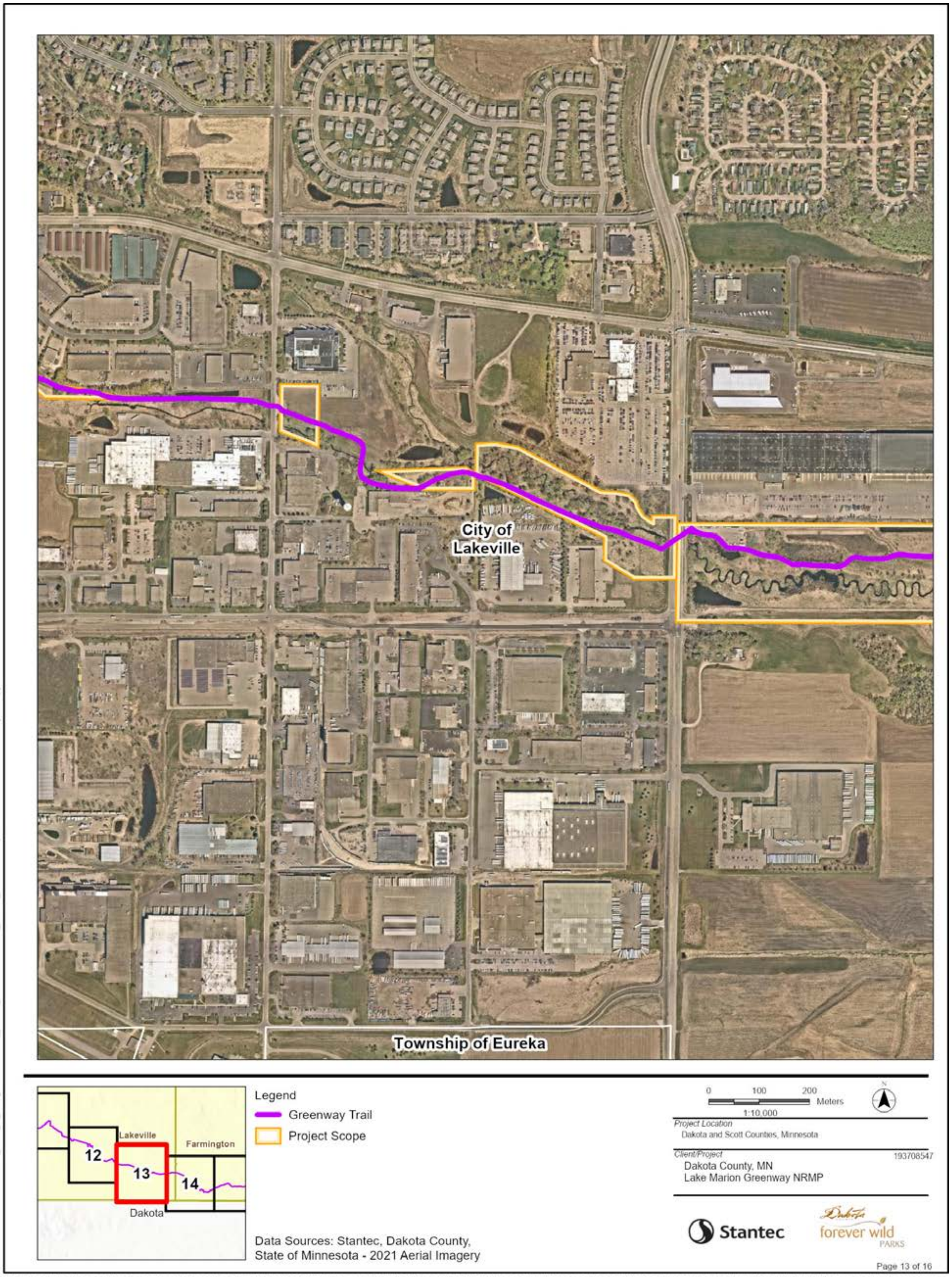

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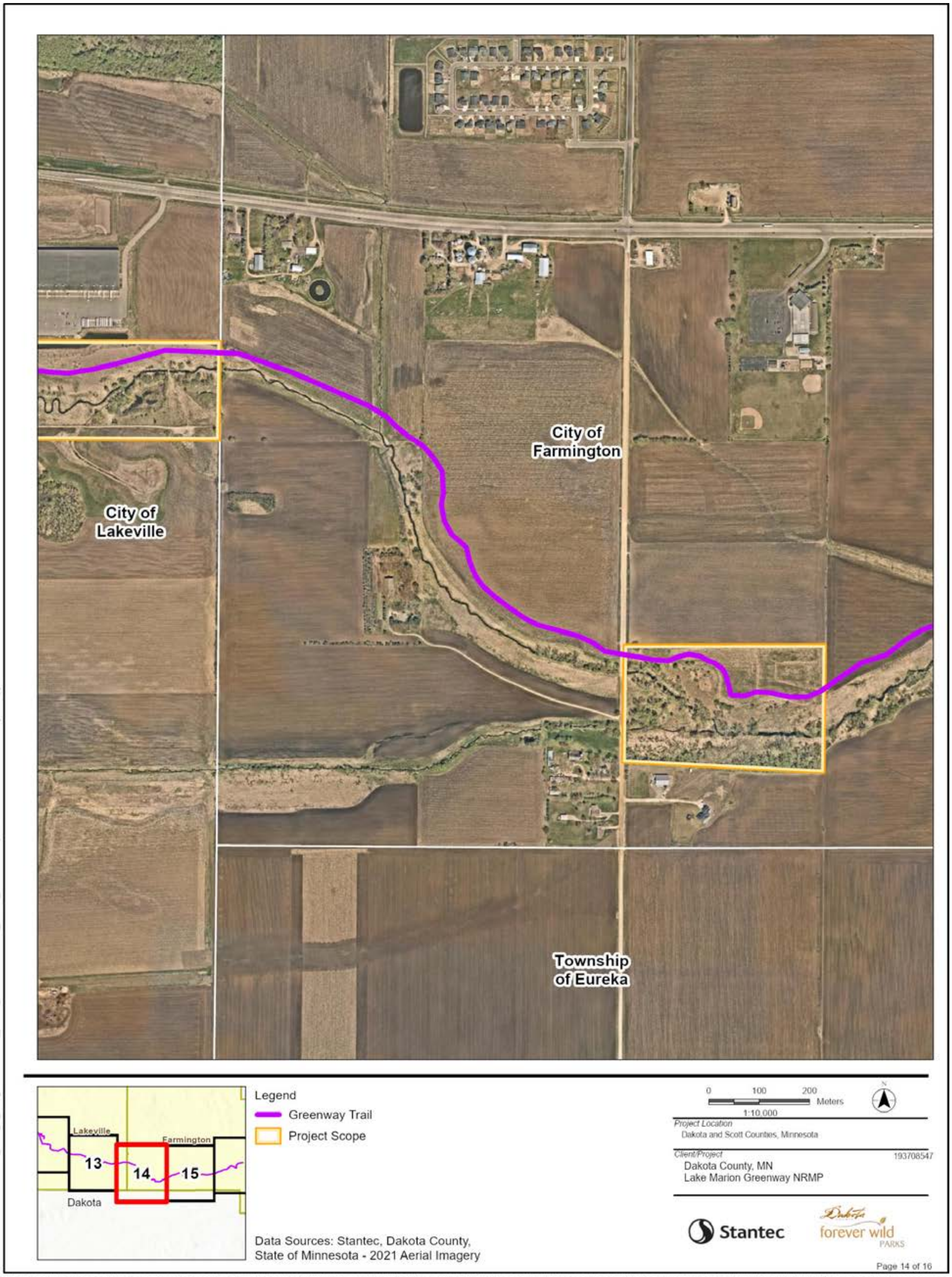

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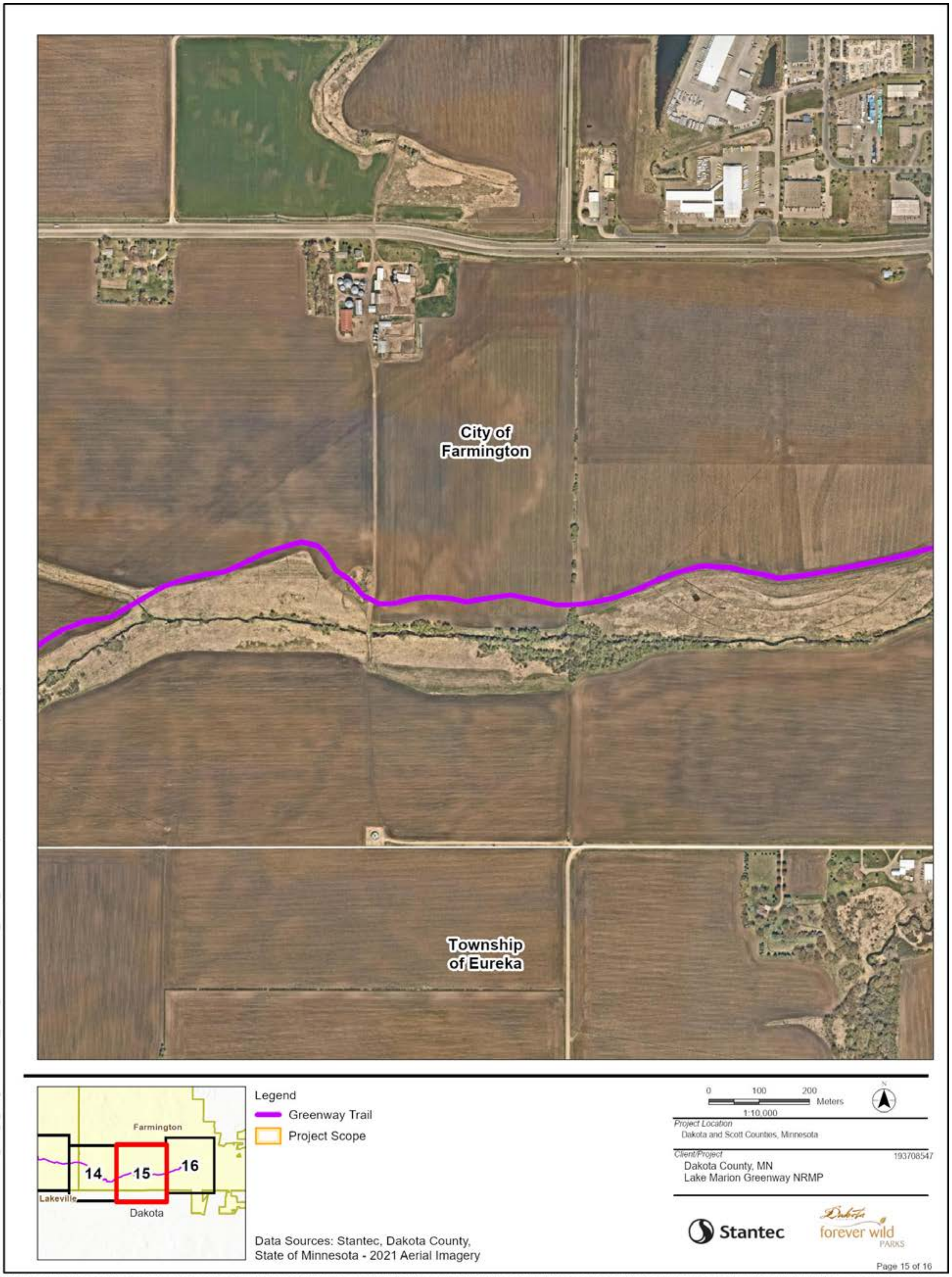

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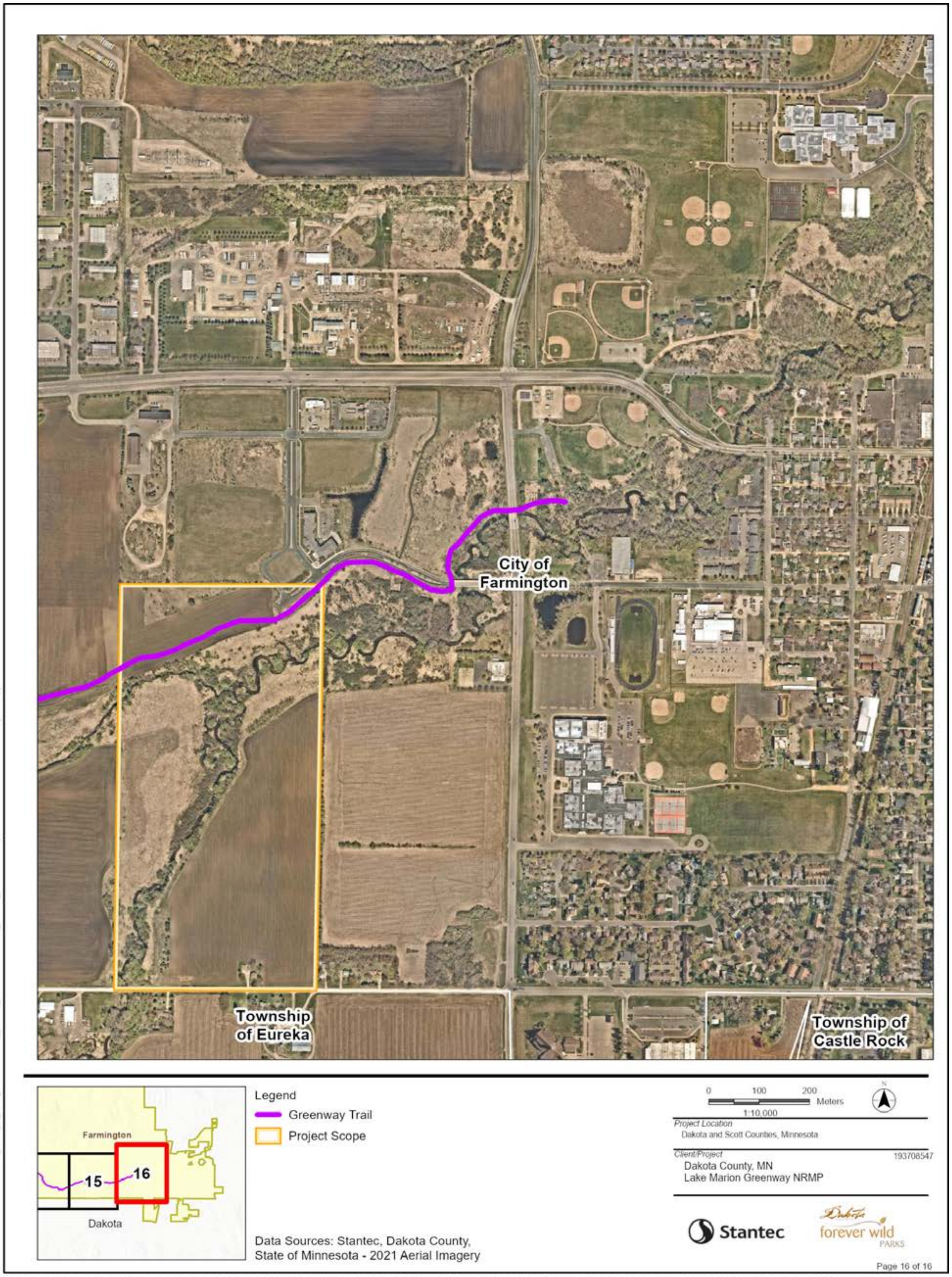

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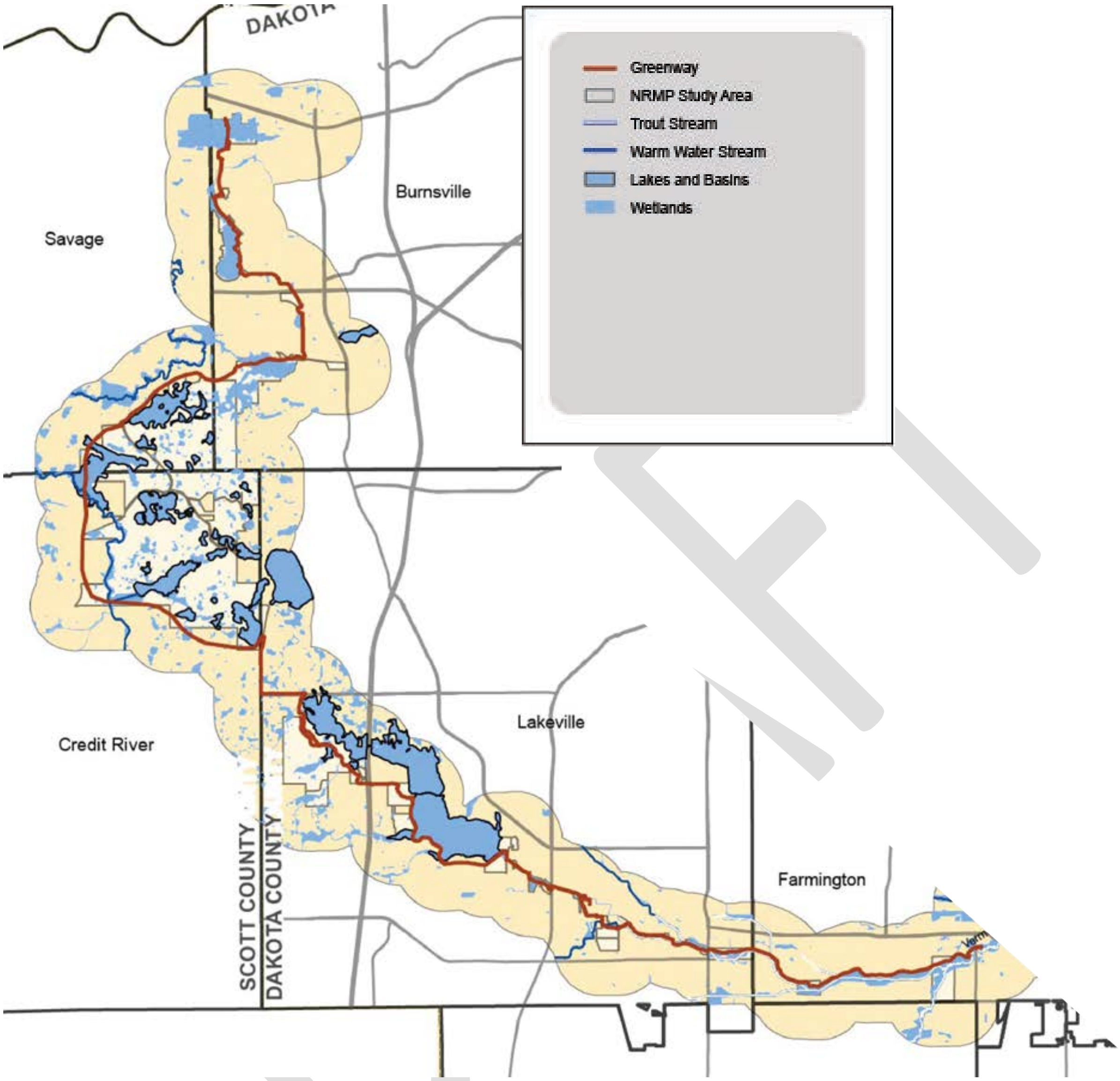
FIGURE 8 Hydrologic Features near the Corridor



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.

Rare Features

The MN 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 of Natural Heritage Information System Biotics database was reviewed for occurrences within one mile of the Lake Marion Corridor study area. This data is presented in Table 1 (Copyright 2020, State of Minnesota DNR, License Agreement #971). Rare features data included here were provided by the Division of Ecological and Water Resources, MN DNR and were current as of October 25, 2020. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic areas shall not be construed to mean that no significant features are present.

Table 1. Rare Features Near the Lake Marion Greenway Corridor.

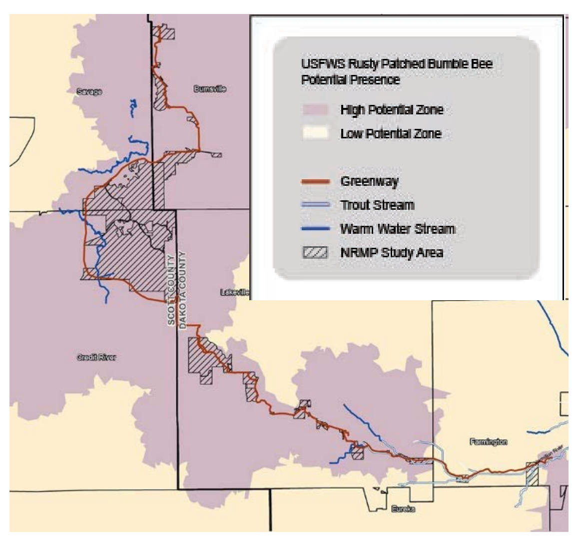
Taxon	***Scientific Name***	**Common Name**	**State Status**	**Federal Status**
Bird	*Buteo lineatus*	Red-shouldered hawk	SC	NL
Bird	*Chondestes grammacus*	Lark sparrow	SC	NL
Bird	*Empidonax virescens*	Acadian flycatcher	SC	NL
Bird	*Setophaga cerulea*	Cerulean warbler	SC	NL
Bird	*Setophaga citrina*	Hooded warbler	SC	NL
Reptile	*Emydoidea blandingii*	Blanding's turtle	THR	NL
Bee	*Bombus affinis*	Rusty-patched bumble bee	NL	E
Vascular Plant	*Agalinis auriculata*	Eared false foxglove	END	NL
Vascular Plant	*Alisma gramineum*	Narrow-leaved water plantain	SC	NL
Vascular Plant	*Asclepias sullivantii*	Sullivant's milkweed	THR	NL
Vascular Plant	*Besseya bullii*	Kitten-tails	THR	NL
Vascular Plant	*Cirsium pumilum var. hillii*	Hill's thistle	SC	NL
Vascular Plant	*Cladium mariscoides*	Twig Rush	SC	NL
Vascular Plant	*Cypripedium candidum*	Small white lady's slipper	SC	NL

Vascular Plant	*Valeriana edulis var. ciliata*	Edible valerian	THR	NL

Abbreviations: END = Endangered; THR = Threatened; SC = Special Concern; NL = Not Listed

- **Blanding's Turtle.** 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.
- **Rusty-patched Bumble Bee.** The rusty-patched bumble bee (*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 Lake Marion Greenway Corridor occurs within the High Potential Range of the rusty-patched bumble bee (**Figure 9**).

Figure 9 Rare Features near the Corridor



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.

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 Lake Marion Greenway Corridor include St. Peter Sandstone and Prairie du Chien Group, underlain by Jordan Sandstone. These layers were formed from deposits within shallow ancient seas during the Ordovician period 480 to 440 Million Years Ago (MYA). 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.

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. 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.

The Lake Marion Greenway in Dakota County is located largely within a collapsed outwash plain landform. In the northern section, from Kelleher Park to near Sunset Pond Park, the corridor skirts the edges of kame or ice walled lake bed landforms. The north and south sections of the corridor are located on terraces (**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.

Soils

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

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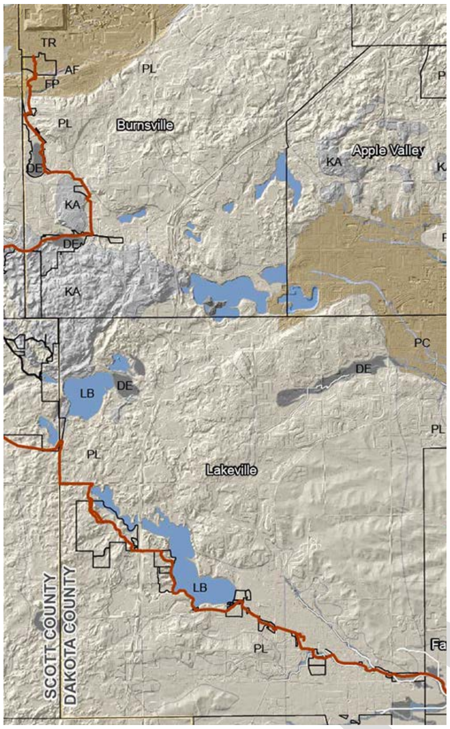
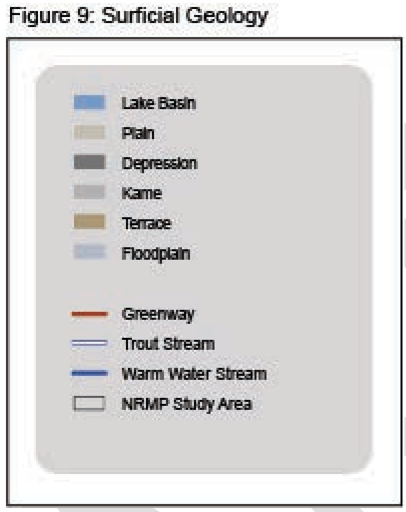
FIGURE 10: Surficial Geology and Landforms near the Corridor





generalized depiction and description of soils in the County. 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.

Drainage classification is one of the most important characteristics as it relates to land management in the Greenway corridor. Hayden loam, Hawick gravelly sandy loam, and Seelyville muck are the most common soils associated with the greenway corridor, and these soils range from excessively drained to very poorly drained. Poorly drained soils in general are located in nearly every study unit in the corridor. The most prevalent occurrences are in Rudy Kramer Park and Preserve, Kelleher Park, Ritter Farm Park, South Creek PCA and Adelmann PCA.

A summary of soil types and their drainage classifications in the corridor study area is included in **Appendix B**. Soil drainage class for each site are also depicted on each NRMP Recommendation Site Plan (Figure 14).

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 northeast-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. Together with soils, topography had significant impacts on the species distributions and community associations of vegetation on the landscape.

Topography is also critical in undertaking the physical work of vegetation restoration. Motorized mechanical equipment, such as forestry mowers, generally are not functional on slopes steeper than 30%. These slopes typically require hand work for restoration tasks. Evidence of slopes ≥ 30%, as depicted from Lidar data, are illustrated on each NRMP Recommendation Site Plan (Figure 14). Unit costs for vegetation restoration tasks in these areas were calculated separately from areas with less steep slopes.

Water Resources

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

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.

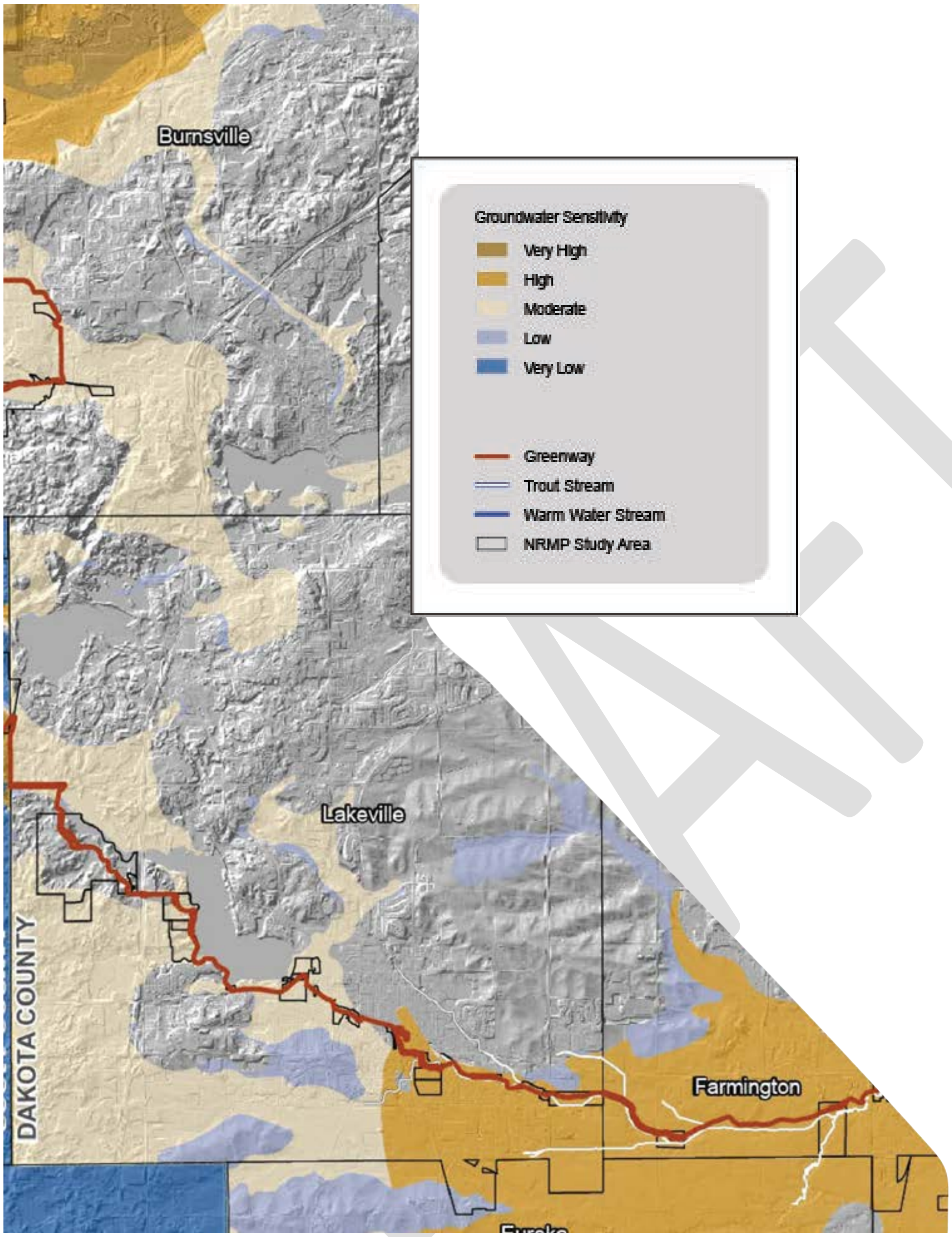
The MN DNR defines groundwater sensitivity as an area where natural geologic factors create a significant risk of groundwater degradation through the migration of waterborne contaminants. Migration of contaminants dissolved in water through unsaturated and saturated sediments is affected by many things, 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 and the texture of surficial geology. 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.

The pollution sensitivity is inversely proportional to the time of travel. Five relative classes of geologic sensitivity are based on overlapping time of travel ranges (Very High, High, Medium, Low, and Very Low). **Figure 11** illustrates the sensitivity of groundwater to pollution in the corridor area. 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.

Figure 11 Sensitivity of Groundwater to Pollution near the Corridor



The southern section of the corridor from approximately the McGuire Middle School location south to the end of the corridor is mapped as high sensitivity. The remaining portion of the corridor north of McGuire Middle School to near Rudy Kramer Nature Preserve is mapped as moderate.

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.

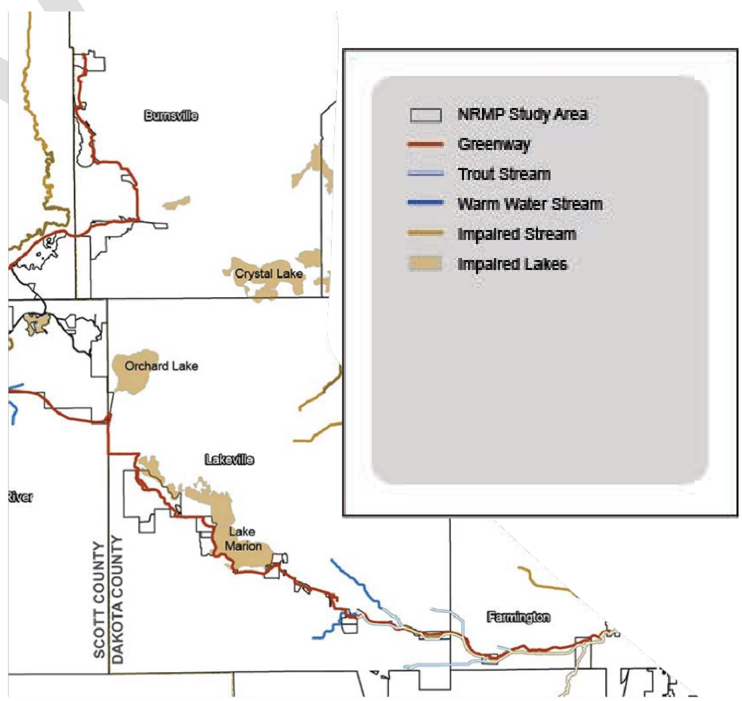
Surface Water: Streams, Lakes, Ponds and Wetlands

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 freshwater emergent, freshwater pond (often stormwater basins), and freshwater forested/shrub. Freshwater emergent are the dominant wetland in the northern section of the corridor, and freshwater emergent forested/shrub begin to appear in the area of Murphy Hanrehan and continue to be present throughout the remaining southern part of the corridor. Wetland types are generally depicted on each NRMP Recommendation Site Plan (Figure 14).

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. **Figure 12** depicts public waters (streams, lakes and wetlands) included on Minnesota's 2020 Impaired Waters List.

Figure 12. Minnesota's Impaired Waters near the Corridor



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 (Figure 13). The Lake Marion Greenway Corridor is classified as follows):

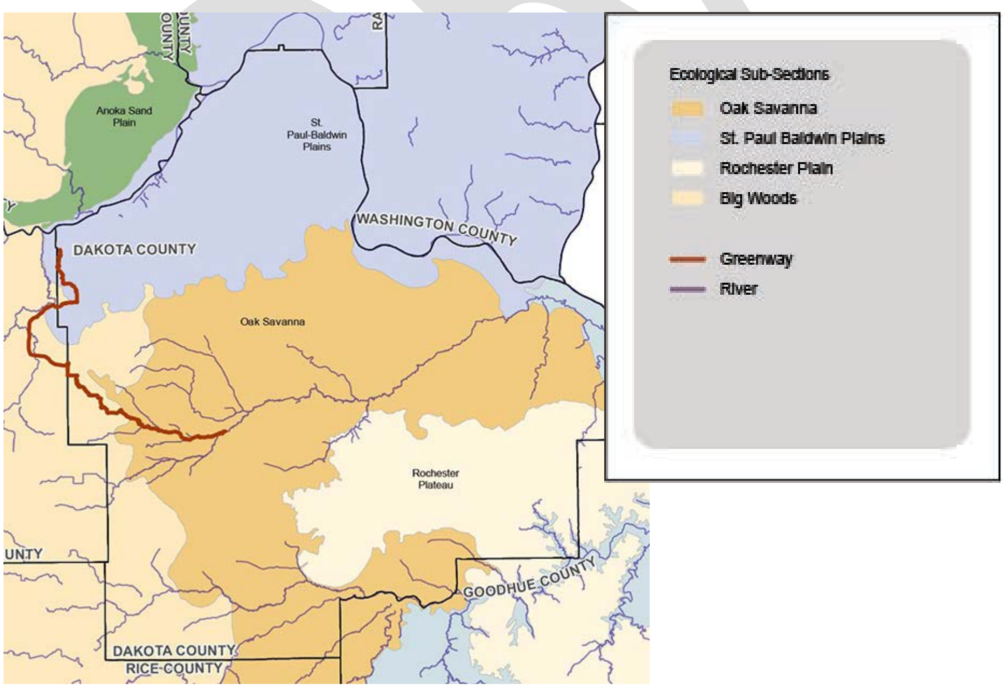
Ecological Province: Eastern Broadleaf Forest Province
Section: Minnesota and Northeast Iowa Morainal Section
Subsections: Saint Paul Baldwin Plains and Moraine Subsection, Big Woods Subsection, and Oak Savanna Subsection

The Saint Paul Baldwin Plains and Moraine Subsection is 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.

Deciduous forest made up most of the Big Woods Subsection before European settlement. Similar to the Saint Paul Baldwin Plains and Moraine Subsection, the primary landform are terminal moraines that pair with a poorly formed drainage network. The most common landscape features are level-topped hills with peat bogs or lakes often occurring in the depressions between hills.

Most of the Oak Savanna Subsection is characterized by rolling plains. Due to the difference in topography fires were more frequent in this subsection, which led to oak savanna being the prominent vegetation before European settlement with prairie and bass-oakwood forests occurring occasionally.

FIGURE 13: Ecological Subsections



Vegetation

The vegetation found within the Lake Marion 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. 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.

Plant Community Assessment

The Greenway Corridor and surrounding natural areas were surveyed using the Minnesota Land Cover Classification (MLCCS) system as base map.

- *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 evaluations, which was conducted by a Stantec ecologist in September and October of 2021. Based on changes in land use and plant communities over time, some of the classifications were updated to reflect current conditions.

  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.)

- *Site Evaluations***.** An evaluation was conducted by a Stantec ecologist in September and October of 2021 of each park/easement along the Lake Marion Greenway Corridor. Sites were defined by property boundaries. For example, West Lake Marion Park was considered one Site. The existing MLCCS mapping was used as a base to do the Site evaluations. Each MLCCS unit is based on a land cover class, so each polygon represented its own unit. Each unit that intersected the Greenway Corridor was surveyed using a meander survey, noting general species abundance in each stratum. Outside of the Greenway Corridor, meander surveys were completed if units had high-quality ecological communities. If not, units were visited from the edge so that the landcover class could be confirmed. In rare instances, where access was difficult, landcover within polygons was confirmed through aerial imagery. Highly developed polygons, such as those with a high amount of impervious surface and/or turf grass were not visited from the edge if they were not within the Greenway, and if aerial imagery could confirm their MLCCS landcover classification. At Ritter Farm Park only the 300-foot Greenway corridor was surveyed by Stantec. The polygons outside of the corridor was surveyed by a Dakota County ecologist. MLCCS land cover categories were used to categorize the existing landcover, but information for MLCCS modifier codes was not collected.
- Existing landcover is summarized in **Table 2**. **Table 3** summarizes invasive species identified within each Site. The ecological health of land cover units made up of native communities was scored using the Element Occurrence Ranking Guidelines.

Table 2 Summary of Land Cover and Quality in the Corridor

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
	Burnsville			
Howell Park	Short grasses and mixed trees with 26-50% impervious cover	13134		1.1
Kelleher Park	26% to 50% impervious cover with deciduous trees	11230		0.9
Kelleher Park	Dry oak savanna hill subtype	62121	AB	3.7
Kelleher Park	Dry oak savanna hill subtype	62121	BC	10.7
Kelleher Park	Dry prairie	61210	BC	0.8
Kelleher Park	Floodplain forest	32210		2.3
Kelleher Park	Long grasses and mixed trees with 11-25% impervious cover	13125		0.4
Kelleher Park	Lowland hardwood forest	32220		5.1

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
Kelleher Park	Medium-tall grass altered/non-native dominated grassland	61220	NA	8.7
Kelleher Park	Mixed emergent marsh	61620	C	1.6
Kelleher Park	Mixed emergent marsh - seasonally flooded	61520		0.6
Kelleher Park	Mixed hardwood swamp - seasonally flooded	32420	C	5
Kelleher Park	Oak forest	32110		1.2
Kelleher Park	Oak forest mesic subtype	32112	AB	12.5
Kelleher Park	Oak forest mesic subtype	32112		14.9
Kelleher Park	Oak woodland-brushland	42120	AB	6.3
Kelleher Park	Oak woodland-brushland	42120	C	2.1
Kelleher Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	3.9
Kelleher Park	Short grasses and mixed trees with 26-50% impervious cover	13134		0.8
Kelleher Park	Short grasses and mixed trees with 51-75% impervious cover	13144		0.2
Kelleher Park	Short grasses with 4-10% impervious cover	13211		3.3
Kelleher Park	Temporarily flooded altered/non-native dominated grassland	61330	NA	3.9
Kelleher Park	Wet meadow	61420	B	40.2
Kelleher Park	Wet meadow	61420		10
Kelleher Park	Wet meadow shrub subtype	52420	C	10.6
Kelleher Park	Willow swamp	52430		7.2
Northview Park	Short grasses and mixed trees with 26-50% impervious cover	13134		2.4
Northview Park	Short grasses with 11-25% impervious cover	13221		9.3
Rose Park	Long grasses and mixed trees with 26-50% impervious cover	13135		0.1
Rose Park	Non-native dominated long grasses with 51-75% impervious cover	13242		0.3
Rose Park	Short grasses and mixed trees with 26-50% impervious cover	13134		0.5
Rose Park	Short grasses on upland soils	23211		12.8
Rose Park	Temporarily flooded altered/non-native dominated grassland	61330	NA	0.1
Rudy Kramer	4% to 10% impervious cover with perennial grasses	13210		2
Rudy Kramer	Altered/non-native deciduous forest	32170	NN	0.1
Rudy Kramer	Altered/non-native deciduous woodland	42130	NN	0.1

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
Rudy Kramer	Altered/non-native dominated saturated shrubland	52330	NN	15.1
Rudy Kramer	Altered/non-native dominated upland shrubland	52130	NN	0.7
Rudy Kramer	Aspen forest - temporaily flooded	32230		3.7
Rudy Kramer	Buildings and pavement with 76-90% impervious cover	14113		2.7
Rudy Kramer	Buildings and pavement with 91-100% impervious cover	14123		0.1
Rudy Kramer	Cattail marsh - semipermanently flooded	61610		11.4
Rudy Kramer	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	0.1
Rudy Kramer	Long grasses on upland soils	23212		0.2
Rudy Kramer	Lowland hardwood forest	32220		8.7
Rudy Kramer	Medium-tall grass altered/non-native dominated grassland	61220	NN	2.5
Rudy Kramer	Mesic prairie	61110		15
Rudy Kramer	Palustrine open water	93300		15.1
Rudy Kramer	Short grasses and mixed trees with 26-50% impervious cover	13134		0.1
Rudy Kramer	Temporarily flooded altered/non-native dominated grassland	61330	NN	0.8
Sunset Pond	Altered/non-native dominated seasonally flooded shrubland	52440	NN	1.1
Sunset Pond	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220	NA	1.9
Sunset Pond	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	0.9
Sunset Pond	Long grasses and mixed trees with 4-10% impervious cover	13115		2.2
Sunset Pond	Lowland hardwood forest	32220		1.9
Sunset Pond	Lowland hardwood forest	32220	C	4.4
Sunset Pond	Medium-tall grass altered/non-native dominated grassland	61220	NA	0.7
Sunset Pond	Mesic prairie	61110	C	0.9
Sunset Pond	Mixed emergent marsh - seasonally flooded	61520		7.9
Sunset Pond	Mixed emergent marsh - seasonally flooded	61520	C	8.7
Sunset Pond	Non-native dominated long grasses with 4-10% impervious cover	13212		11.2
Sunset Pond	Palustrine open water	93300		45.2

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
Sunset Pond	Planted, maintained, or cultivated mixed coniferous/deciduous trees	21300	C	2
Sunset Pond	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	7.6
Sunset Pond	Short grasses and mixed trees with 26-50% impervious cover	13134		1.5
Sunset Pond	Short grasses with 26-50% impervious cover	13231		6.1
Sunset Pond	Short grasses with 4-10% impervious cover	13211		4.1
Sunset Pond	Short grasses with 51-75% impervious cover	13241		0.6
Westview Park	Oak woodland-brushland	42120	D	1.5
Westview Park	Short grasses and mixed trees with 26-50% impervious cover	13134		0.2
Westview Park	Short grasses and mixed trees with 4-10% impervious cover	13114		2.2
City of Lakeville				
210th Parcel	Short grasses and mixed trees with 26-50% impervious cover	13134		0.2
Antlers Park	Limnetic open water	92100		2.6
Antlers Park	Non-native dominated long grasses with 26-50% impervious cover	13232		0.2
Antlers Park	Palustrine open water	93300		8.7
Antlers Park	Pavement with 91-100% impervious cover	14122		2.2
Antlers Park	Short grasses and mixed trees with 26-50% impervious cover	13134		4.1
Antlers Park	Short grasses and mixed trees with 4-10% impervious cover	13114		9
Antlers Park	Short grasses on upland soils	23211		10.3
Antlers Park	Short grasses with 26-50% impervious cover	13231		6.6
Antlers Park	Short grasses with 4-10% impervious cover	13211		0.1
Antlers Park	Upland soils - cropland	24110		3
Casperson Park	Altered/non-native deciduous woodland	42130	NN	4.8
Casperson Park	Buildings and pavement with 91-100% impervious cover	14123		0.1
Casperson Park	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	2.5
Casperson Park	Limnetic open water	92100		2
Casperson Park	Medium-tall grass altered/non-native dominated grassland	61220	NA	14.1
Casperson Park	Short grasses with 26-50% impervious cover	13231		21.7
Juno Trailhead	Limnetic open water	92100		0.1

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
Juno Trailhead	Mixed emergent marsh - seasonally flooded	61520		0
Juno Trailhead	Oak woodland-brushland	42120	D	0.4
Juno Trailhead	Palustrine open water	93300		0
Juno Trailhead	Short grasses and mixed trees with 26-50% impervious cover	13134		1.4
Ritter Farm Dog Park	4% to 10% impervious cover with deciduous trees	11210		1.1
Ritter Farm Dog Park	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	0.1
Ritter Farm Dog Park	Non-native dominated long grasses with 4-10% impervious cover	13212		5.1
Ritter Farm Dog Park	Short grasses with 4-10% impervious cover	13211		0.1
Ritter Farm Park	11% to 25% impervious cover with deciduous trees	11220		5.1
Ritter Farm Park	26% to 50% impervious cover with deciduous trees	11230		0
Ritter Farm Park	4% to 10% impervious cover with deciduous trees	11210		0.1
Ritter Farm Park	Altered/non-native deciduous forest	32170	NN	59
Ritter Farm Park	Altered/non-native deciduous woodland	42130	NN	14.9
Ritter Farm Park	Altered/non-native dominated seasonally flooded shrubland	52440		1.9
Ritter Farm Park	Altered/non-native dominated upland shrubland	52130		4.7
Ritter Farm Park	Dry prairie	61210	B	3.9
Ritter Farm Park	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220	NN	12.4
Ritter Farm Park	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	2.1
Ritter Farm Park	Limnetic open water	92100		1.9
Ritter Farm Park	Lowland hardwood forest	32220		13.8
Ritter Farm Park	Medium-tall grass altered/non-native dominated grassland	61220	NN	57.8
Ritter Farm Park	Mixed hardwood swamp - seasonally flooded	32420		12.6
Ritter Farm Park	Non-native dominated long grasses with 11-25% impervious cover	13222		0.9
Ritter Farm Park	Non-native dominated long grasses with 4-10% impervious cover	13212		2.5
Ritter Farm Park	Oak forest	32110	C	57.6
Ritter Farm Park	Oak forest	32110		0.5

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
Ritter Farm Park	Oak woodland-brushland	42120	C	8
Ritter Farm Park	Palustrine open water	93300		37
Ritter Farm Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	14.2
Ritter Farm Park	Short grasses and mixed trees with 4-10% impervious cover	13114		5.6
Ritter Farm Park	Short grasses with 11-25% impervious cover	13221		3.7
Ritter Farm Park	Short grasses with 4-10% impervious cover	13211		5.1
Ritter Farm Park	Short grasses with sparse tree cover on upland soils	23111		3
Ritter Farm Park	Upland soils with planted, maintained, or cultivated coniferous trees	21110	NN	31.7
Ritter Farm Park	Wet Meadow	61420	B	0.2
Ritter Farm Park	Wet meadow	61420	C	0.4
South Creek 210th	Altered/non-native deciduous woodland - seasonally flooded	42130		0.2
South Creek 210th	Buildings and pavement with 76-90% impervious cover	14113		0
South Creek 210th	Exposed earth	14200		1.1
South Creek 210th	Medium-tall grass altered/non-native dominated grassland	61220	NN	0
South Creek 210th	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	4.2
South Creek 210th	Short grasses and mixed trees with 26-50% impervious cover	13134		2.1
South Creek 210th	Short grasses and mixed trees with 51-75% impervious cover	13144		0
South Creek 210th	Short grasses on upland soils	23211		2.6
South Creek Cedar E	Buildings and pavement with 91-100% impervious cover	14123		1
South Creek Cedar E	Long grasses on hydric soils	23222		7.3
South Creek Cedar E	Long grasses on upland soils	23212		15.5
South Creek Cedar E	Palustrine open water	93300		1.4
South Creek Cedar E	Seasonally flooded altered/non-native dominated emergent vegetation	61530		13.4
South Creek Cedar E	Seasonally flooded altered/non-native dominated emergent vegetation	61530		0.9

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
South Creek Cedar E	Short grasses and mixed trees with 11-25% impervious cover	13124		0.1
South Creek Cedar E	Short grasses and mixed trees with 26-50% impervious cover	13134		0.6
South Creek Cedar W	Long grasses on upland soils	23212		3.6
South Creek Cedar W	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	6.2
South Creek Cedar W	Short grasses and mixed trees with 26-50% impervious cover	13134		0.5
South Creek Cedar W	Upland soils - cropland	24110		0.4
South Forty Archery Range	Altered/non-native dominated seasonally flooded shrubland	52440		1.5
South Forty Archery Range	Aspen forest	32160		1.4
South Forty Archery Range	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220		10.4
South Forty Archery Range	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NA	0.6
South Forty Archery Range	Lowland hardwood forest	32220		5.5
South Forty Archery Range	Medium-tall grass altered/non-native dominated grassland	61220	NN	4.8
South Forty Archery Range	Mixed emergent marsh	61620		0.2
South Forty Archery Range	Mixed emergent marsh - seasonally flooded	61520	NN	0
South Forty Archery Range	Mixed hardwood swamp - seasonally flooded	32420		1.4
South Forty Archery Range	Non-native dominated long grasses with 11-25% impervious cover	13222		2.6
South Forty Archery Range	Palustrine open water	93300		0
South Forty Archery Range	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	2.6
South Forty Archery Range	Semipermanently flooded altered/non-native dominated vegetation	61630		2
South Forty Archery Range	Temporarily flooded altered/non-native dominated grassland	61330		0.3

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
West Lake Marion Park	Altered/non-native deciduous woodland	42130	NN	8.1
West Lake Marion Park	Buildings and pavement with 91-100% impervious cover	14123		2.5
West Lake Marion Park	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	18
West Lake Marion Park	Limnetic open water	92100		1.2
West Lake Marion Park	Long grasses and mixed trees with 4-10% impervious cover	13115		0.6
West Lake Marion Park	Medium-tall grass altered/non-native dominated grassland	61220	NA	0
West Lake Marion Park	Mixed emergent marsh - seasonally flooded	61520	NN	4.6
West Lake Marion Park	Palustrine open water	93300		5.8
West Lake Marion Park	Short grasses and mixed trees with 26-50% impervious cover	13134		1.9
Dakota County Parks				
Adelmann PCA	Altered/non-native dominated seasonally flooded shrubland	52440	NN	1.5
Adelmann PCA	Long grasses on upland soils	23212		0.1
Adelmann PCA	Medium-tall grass altered/non-native dominated grassland	61220	NN	2.1
Adelmann PCA	Mixed hardwood swamp - seasonally flooded	32420		3.6
Adelmann PCA	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	20.2
Adelmann PCA	Short grasses and mixed trees with 11-25% impervious cover	13124		1.3
Adelmann PCA	Short grasses with 4-10% impervious cover	13211		1.2
Adelmann PCA	Slow moving linear open water habitat	91100		2.4
Adelmann PCA	Temporarily flooded altered/non-native dominated grassland	61330	NN	8.5
Adelmann PCA	Upland soils - cropland	24110		39.5
South Creek PCA	Floodplain forest	32210	C	9.9
South Creek PCA	Long grasses on upland soils	23212		0
South Creek PCA	Mesic prairie	61110	C	7.5

Site	MLCCS Land Cover	MLCCS Code	Ecological Rank	Acres
South Creek PCA	Non-native dominated long grasses with 4% to 10% impervious cover	13212		0.4
South Creek PCA	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	6.6
ISD 194				
Antlers S Shoreline	Limnetic open water	92100		3.8
Antlers S Shoreline	Short grasses and mixed trees with 26-50% impervious cover	13134		0.8
Antlers S Shoreline	Short grasses and mixed trees with 4-10% impervious cover	13114		0.5
Lakeville Elementary	Oak woodland-brushland	42120	B	1.7
Lakeville Elementary	Palustrine open water	93300		0.5
Lakeville Elementary	Short grasses and mixed trees with 26-50% impervious cover	13134		0.3
Lakeville Elementary	Short grasses with 26-50% impervious cover	13231		0.7
Lakeville Elementary	Short grasses with 4-10% impervious cover	13211		10.7
Lakeville Elementary	Short grasses with 51-75% impervious cover	13241		9.7
McGuire Middle School	Buildings and pavement with 76-90% impervious cover	14113		3.5
McGuire Middle School	Buildings and pavement with 91-100% impervious cover	14123		7.1
McGuire Middle School	Long grasses and mixed trees with 4-10% impervious cover	13115		0.1
McGuire Middle School	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	0
McGuire Middle School	Short grasses and mixed trees with 11-25% impervious cover	13124		1.1
McGuire Middle School	Short grasses and mixed trees with 26-50% impervious cover	13134		0.1
McGuire Middle School	Short grasses and mixed trees with 51-75% impervious cover	13144		2.3
McGuire Middle School	Short grasses on upland soils	23211		0
McGuire Middle School	Short grasses with 4-10% impervious cover	13211		31.1

Table 3 Invasive Species Identified in the Corridor

	garlic mustard, *Alliaria petiolata*	common burdock, *Arctium minus*	smooth brome, *Bromus inermis*	spotted knapweed, *Centaurea stoebe* L. ssp. *micranthos*	Canada thistle, *Cirsium arvense*	bull thistle, *Cirsium vulgare*	leafy spurge, *Euphorbia virgata*	glossy buckthorn, *Frangula alnus*	Asian bush honeysuckle, *Lonicera tatarica*, L. *morrowii*, L. *maackii*	bird's foot trefoil, *Lotus corniculatus*	purple loosestrife, *Lythrum salicaria*	common mulberry, *Morus alba*	reed canary grass, *Phalaris arundinacea*	common buckthorn, *Rhamnus cathartica*	black locust, *Robinia pseudoacacia*	crown vetch, *Securigera varia*	narrow-leaved cattail, *Typhus angustifolia*	Siberian elm, *Ulmus pumila*
Rudy Kramer Nature Preserve			x	x	x		x	x		x			x	x			x	
Westview Park			x		x									x				x
Howell Park																		
Sunset Pond			x		x		x		x	x			x	x			x	x
Rose Park		x	x	x			x						x	x				x
Northview Park		x	x															x
Kelleher Park	x	x						x	x		x		x			x	x	
Ritter Farm Park	x		x						x				x		x			
Ritter Farm Dog Park																		
Casperson Park			x	x					x				x	x		x		x
Lake Marion Park				x					x				x	x				x
Juno Trailhead		x	x						x				x	x			x	x
Lakeville Elementary			x												x			
Antlers Park			x	x	x							x	x			x	x	x
McGuire Middle School		x												x				x
South Creek 210th		x	x										x					

	garlic mustard, *Alliaria petiolata*	common burdock, *Arctium minus*	smooth brome, *Bromus inermis*	spotted knapweed, *Centaurea stoebe* L. ssp. *micranthos*	Canada thistle, *Cirsium arvense*	bull thistle, *Cirsium vulgare*	leafy spurge, *Euphorbia virgata*	glossy buckthorn, *Frangula alnus*	Asian bush honeysuckle, *Lonicera tatarica*, L. *morrowii*, L. *maackii*	bird's foot trefoil, *Lotus corniculatus*	purple loosestrife, *Lythrum salicaria*	common mulberry, *Morus alba*	reed canary grass, *Phalaris arundinacea*	common buckthorn, *Rhamnus cathartica*	black locust, *Robinia pseudoacacia*	crown vetch, *Securigera varia*	narrow-leaved cattail, *Typhus angustifolia*	Siberian elm, *Ulmus pumila*
South Creek Cedar E			x		x					x							x	x
South Creek Cedar W			x							x				x				
South Creek PCA			x		x	x				x			x	x				x
Adelmann PCA			x										x	x				

<u>Landcover Change in the Corridor</u>

Tracking landcover change over time is a good indicator of trends in the greenway corridor. Quantifying cover types associated with a greenway is also a way to promote each greenway corridor and identify unique qualities for visitors and neighbors. Approximately 1,430 acres of public land was included in the North Creek Greenway Corridor study area. MLCCS landcover data from prior to this project was compared with edited MLCCS data post-site evaluation. The area for each landcover class in both GIS shapefiles was tabulated, and classes with increases and decreases of at least one acre are summarized in **Table 4**. Some changes are likely due to succession, while others may be a result of human changes on the land such as restoration activities or agricultural production.

Table 4 Landcover Change in the Corridor

MLCCS Landcover Class	Acre Increase	Acre Decrease
Exposed earth	1.1	
Upland soils with planted, maintained, or cultivated coniferous trees	3.8	
Planted, maintained, or cultivated mixed coniferous/deciduous tree	2.0	
Short grasses with sparse tree cover on upland soils	3.0	
Long grasses on hydric soils	7.9	
Upland soils with planted or maintained grasses and forbs	1.8	
Cultivated herbaceous vegetation	3.2	
Upland soils - cropland	57.2	
Oak forest	3.1	
Oak woodland-brushland	1.7	
Altered/non-native deciduous woodland	4.7	
Mesic prairie	8.5	
Short grasses and mixed trees with 26-50% impervious cover		-2.7
Upland soils with planted, maintained or cultivated deciduous trees		-7.3
Short grasses on upland soils		-1.1
Mixed hardwood swamp - seasonally flooded		-2.0
Mixed emergent marsh - seasonally flooded		-1.5
Seasonally flooded altered/non-native dominated emergent vegetation		-1.4
Grassland with sparse deciduous trees - altered/non-native dominated vegetation		-2.0

Wildlife

Dakota County encompasses a variety of ecological subsections, including Big Woods, Oak Savanna, the Rochester Plateau, and the St. Paul Baldwin Plains and Moraines (MN DNR 2000). Subsections are units within ecological sections that are defined by glacial deposition processes, surface bedrock formation, local climate, topographic relief, and the distribution of plants (MN DNR 2022). Each subsection contains multiple habitats, an abundance of water resources, and hosts a diverse assemblage of plant communities and wildlife, including Species of Greatest Conservation Need (SGCN) whose populations are rare, declining, or vulnerable to decline in Minnesota. 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 an excessive amount of prairie was converted to row crop 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 eggshells 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 in recent 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.

Indicator Species

Table 5 list relatively common species dependent on grassland or prairie habitat for breeding that are known or likely to occur within the study area. 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 *5*. Indicator Species Observed in Dakota County.

Common Name	*Scientific Name*	Endangered	Threatened	Special Concern	SGCN
Mammals					
American badger	*Taxidea taxus*				X
Franklin's ground squirrel	*Poliocitellus franklinii*				X
Plains pocket gopher	*Geomys bursarius*				
Prairie vole	*Microtus ochrogaster*			X	X

Common Name	***Scientific Name***	**Endangered**	**Threatened**	**Special Concern**	**SGCN**
Thirteen-lined ground squirrel	*Ictidomys tridecemlineatus*				
Grassland Birds					
American kestrel	*Falco sparverius*				X
Barn swallow	*Hirundo rustica*				
Clay-colored sparrow	*Spizella pallida*				
Dickcissel	*Spiza americana*				X
Eastern bluebird	*Sialia sialis*				
Eastern kingbird	*Tyrannus tyrannus*				
Eastern meadowlark	*Sturnella magna*				X
Field sparrow	*Spizella pusilla*				X
Grasshopper sparrow	*Ammodramus savannarum*				X
Henslow's sparrow	*Ammodramus henslowii*	SE			X
Horned lark	*Eremophila alpestris*				
Lark sparrow	*Chondestes grammacus*			X	X
Loggerhead shrike	*Lanius ludovicianus*	SE			X
Northern rough-winged swallow	*Stelgidopteryx serripennis*				X
Savannah sparrow	*Passerculus sandwichensis*				
Song sparrow	*Melospiza melodia*				
Tree swallow	*Tachycineta bicolor*				
Tree Nesting Birds					
American goldfinch	*Spinus tristis*				
Baltimore oriole	*Icterus galbula*				
Brown thrasher	*Toxostoma rufum*				X
Chipping sparrow	*Spizella passerina*				
Indigo bunting	*Passerina cyanea*				
Orchard oriole	*Icterus spurius*				
Ruby-throated hummingbird	*Archilochus colubris*				
Reptiles					
Bullsnake	*Pituophis catenifer sayi*			X	X
Eastern racer	*Coluber constrictor*			X	X
Plains (western) hognose snake	*Heterodon nasicus*			X	X

Common Name	*Scientific Name*	Endangered	Threatened	Special Concern	SGCN
Prairie skink	*Plestiodon septentrionalis*				
Six-lined racerunner	*Aspidoscelis sexlineata*				X
Smooth greensnake	*Opheodrys vernalis*				X
Insects					
Monarch butterfly	*Danaus plexippus*				X
Regal Fritillary	*Speyeria idalia*			X	X
Rusty-patched bumble bee	*Bombus affinis*	FE			X

Source: MN DNR 2016
Abbreviations: SE = State Endangered; FE = Federally Endangered; SGCN = Species of Greatest Conservation Need

Table 6 contains a list of relatively common bird species that are largely dependent on woodland habitat that are known or likely to occur in woodland habitats within the study area. 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 woodland dependent.

Table 6. Local Woodland Birds Likely to Occur in the Study Area.

Common Name	*Scientific Name*
Cooper's hawk	*Accipiter cooperii*
Eastern wood pewee	*Contopus virens*
Brown creeper	*Certhia americana*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Least flycatcher	*Empidonax minimus*
Ovenbird	*Seiurus aurocapilla*
Barred owl	*Strix varia*
Great crested flycatcher	*Myiarchus crinitus*
Blue-winged warbler	*Vermivora chrysoptera*
Red-bellied woodpecker	*Melanerpes carolinus*
Yellow-throated vireo	*Vireo flavifrons*
Yellow-rumped warbler	*Setophaga coronata*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Warbling vireo	*Vireo gilvus*

American redstart	*Setophaga ruticilla*
Downy woodpecker	*Picoides pubescens*
Red-eyed vireo	*Vireo olivaceus*
Scarlet tanager	*Piranga olivacea*
Hairy woodpecker	*Leuconotopicus villosus*
Black-capped chickadee	*Poecile atricapillus*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Pileated woodpecker	*Dryocopus pileatus*
White-breasted nuthatch	*Sitta carolinensis*
Baltimore oriole	*Icterus galbula*

Natural Resource Management Plan Priority Features and Recommendations

Priority features identified in this plan focus attention on the preservation, restoration, or enhancement of particular species, plant communities, water resources, or ecosystem processes. Restoration/conservation objectives are listed for each priority feature.

Surface Water

General types of enhancements to surface water mentioned during partner conversations in this planning process included:

- Enhancing the quality of wetland vegetation
- Removal of excess stream-edge trees to increase light reaching the ground layer and decrease bank erosion
- Adding stream-edge tree plantings on cold water streams, and their tributaries, to maintain or reduce stream water temperatures
- Adding in-stream habitat features including, but not limited to meandering
- Bring completed meandered segments online, if they are not already
- Continue maintenance on meandered segments
- Install barriers for invasive fish species

Table 7 details water resource recommendations are included in this plan. Specific locations are included in the NRMP Recommendation Site Plans (Figure 14). The lead agency for each recommendation is shown in **bold text.**

Table 7. Water Resource Recommendations

Water Resource Recommendation	Priority	Study or Implement	Recommendation	Jurisdiction	Partners
1	2	Study	Kelleher Park wetland complex study	**Burnsville**	
2	4	Implement	Outreach: Trash accumulating in wetland from adjacent neighbor	**Burnsville**	Dakota County
3	1	Implement	In-stream habitat improvements, meandering on South Creek	Dakota County	**VRWJPO**
4	?	Study	Study potential for wetland restoration at confluence of South Creek and tributary	Dakota County	**VRWJPO**
5	2	Study	Address erosion near trail crossing at Vermillion River	**Farmington**	VRWJPO
6, 7, 8, 9	1	Implement	Shoreline stabilization/restoration on Lake Marion	**Lakeville**	VRWJPO
10	2	Implement	Vegetation management and signage to enhance stream buffer function	**Lakeville**	VRWJPO
11	3	Implement	Maintain in-stream features recently constructed on South Creek	**Dakota County**	VRWJPO

Vegetation Communities

Oak Savanna

- **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.
- **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.

- **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.
- **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.

Oak Woodlands

- **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.
- **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.
- **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.
- **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.

Mesic Hardwood Forests

- **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.
- **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.
- **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.
- **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.

Prairies

- **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.
- **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.

- **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.

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.

Wetlands and Shorelines

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.

Future cover types were determined after evaluating landowner preferences, existing vegetation, and considering costs for restoration. Future cover recommendations are included in each NRMP Recommendation Site Plan (**Figure 14**). A set of suggested activities is recommended for future cover type in the Greenway Corridor. **Table 8** outlines these activities.

Table 8: Existing Land Cover and Recommended Target Community

Existing Plant Community	Restoration Process	Long-Term Maintenance
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
Mesic Hardwood Forest Target Communities: Southern Mesic Oak-Basswood Forest (MHs38) or Southern Mesic Maple-Basswood Forest (MHs39)	• 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

Existing Plant Community	Restoration Process	Long-Term Maintenance
Wetlands and Shorelines Target Communities: Northern Bulrush-Spikerush Marsh (MRn93), Northern Wet Meadow/Carr (WMn82), Southern Seepage Carr (WMs83) and Southern Wet Prairie (WPs54)	• Invasive shrub removal • Herbicide application in combination with mechanical removal (cutting, burning, scrape, hydrological manipulations) • Seed/plug with wetland grasses, sedges, and forbs • Plant appropriate wetland shrubs	• Periodic prescribed burns • 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
Altered Grasslands/Prairie Target Community: Southern Dry Prairie (UPs13) or Southern Mesic Prairie (UPs23)	• Control woody encroachment/invasive shrubs • Control invasives in the herbaceous layer • Native seeding • Prescribe burn/mow	• Spot treatment of invasive plants • Prescribe burn or mow

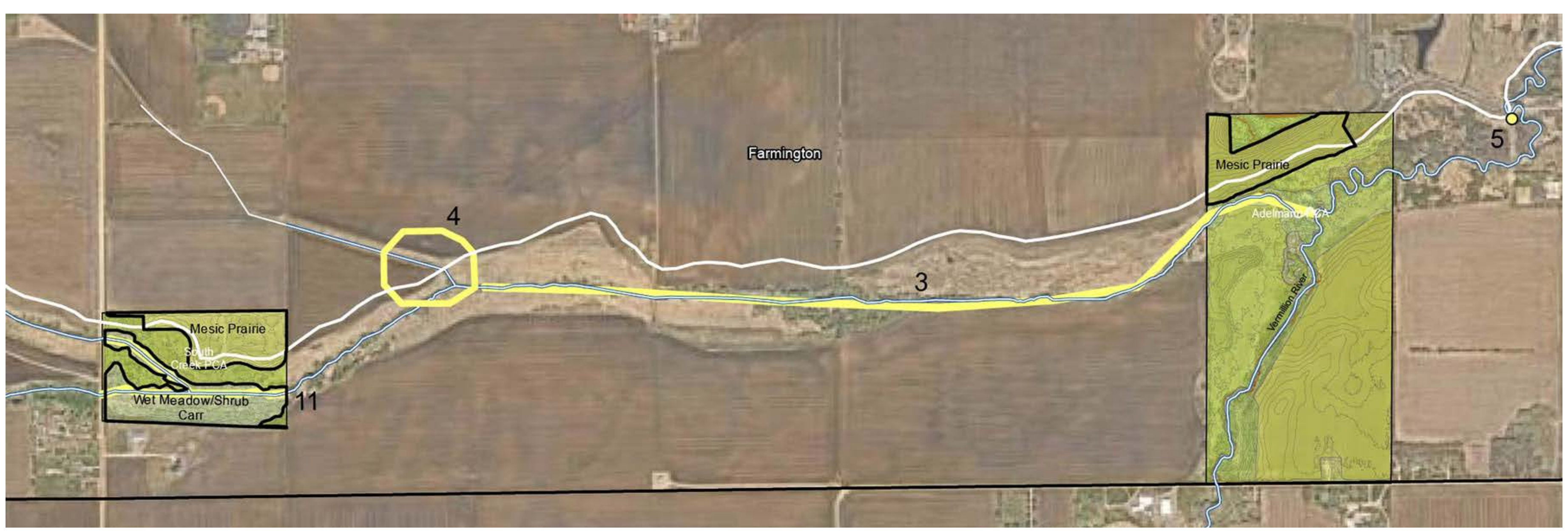
Natural Resource Management Plan Recommendation Site Plans

Site Plans for each unit are included in the following pages (**Figure 14 A-D**). Each Site Plan includes written background information about the land use and existing vegetation conditions in the unit. An inventory map for each unit illustrates NRCS soil drainage classifications and existing National Wetlands Inventory (NWI) features. A larger recommendation map depicts recommended water resource-related features as well as future vegetation cover types. Site Plans are organized by Greenway Corridor Partner:

- Farmington plans are found in **Figures 14A**
- Lakeville plans are found in **Figures 14B and 14C**
- Burnsville plans are found in **Figure 14**

Figure 14A. Lake Marion Greenway, Farmington: South Creek PCA – Adelmann PCA

Water Resource Recommendation	Description
3	Get this finished!
4	
5	
11	



South Creek PCA/Dakota County

South PCA is a 24-acre parcel of undeveloped land. South Creek flows through the parcel entering the west side and exiting the east side. An unnamed stream flows into South Creek from the southeast side of the parcel.

Types of landcover that occur in the parcel are non-native dominated long grasses with 4% to 10% impervious cover, mesic prairie, seasonally flooded altered/non-native dominated emergent vegetation, and floodplain forest.

The non-native dominated grasses occur along the side of the gravel road on the west side of the polygon. The mesic prairie is dominated by native grasses and forbs. Common species include Indiangrass, switch grass, Canada goldenrod, wild bergamont, round-headed bush clover, and Virginia mountain mint (*Pycnanthemum virginianum*). The seasonally flooded altered/non-native dominated emergent vegetation is dominated by reed canary grass. There are some native species such as candle anemone (*Anemone canadensis*), giant ragweed, and aster sp. (*Symphyotrichum* sp.). Trees in the floodplain forest include boxelder, willow sp, and aspen with common buckthorn common in the understory and reed canary grass common in the herbaceous layer.

There is a pipeline that runs through the parcel. At the time of the survey esc blanket had

Adelmann Property

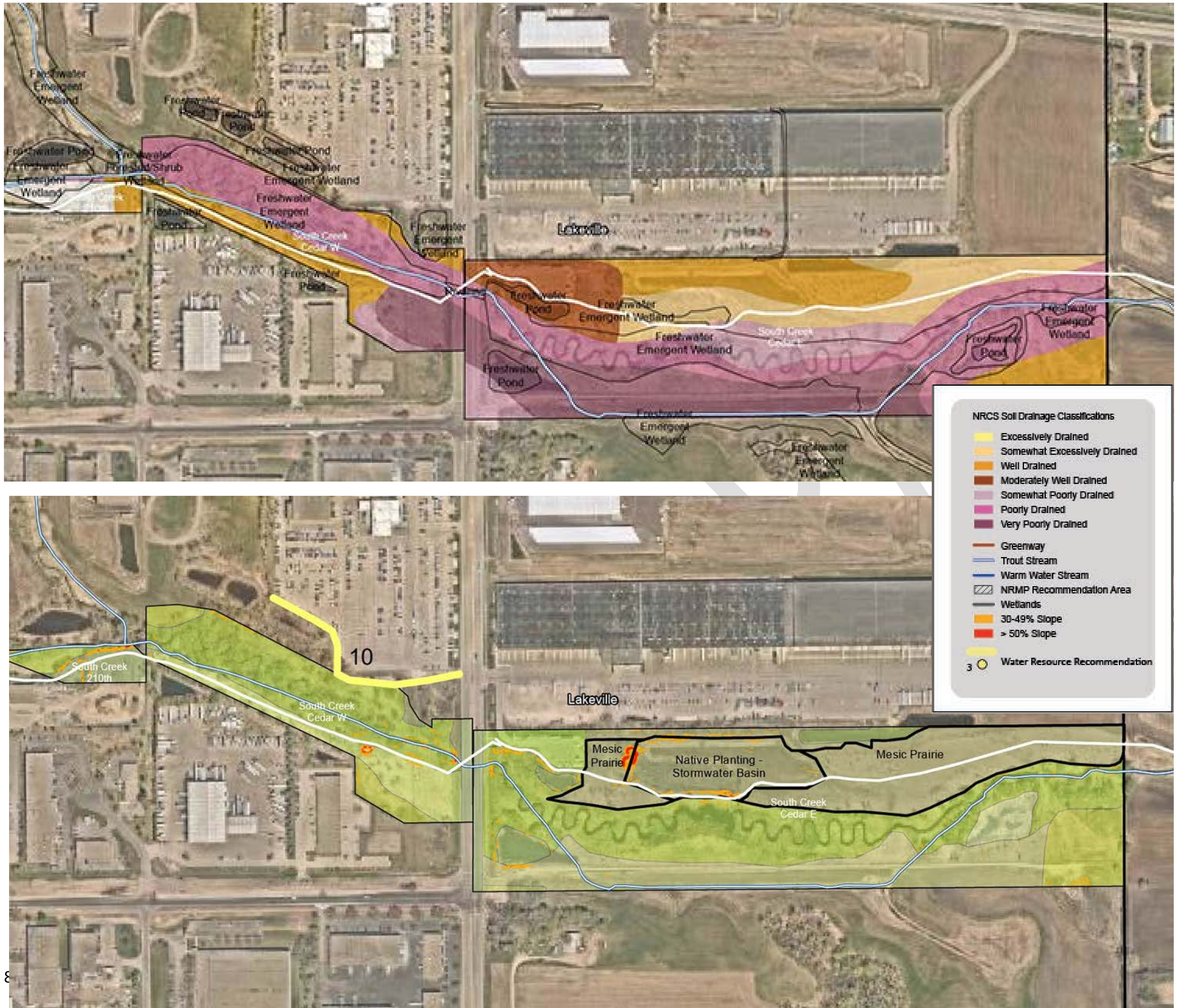
The Adelmann property is an 81-acre property that is a mix of undeveloped land and cropland. The northwestern corner of the property and a large portion of the southeastern corner of the property is cropland. On the south property boundary there is a farmstead. There is a road from a nearby development that dead ends in the northeastern corner of the property.

Landcover types that occur on the property are mixed hardwood swamp – seasonally flooded, long grass on upland soils, seasonally flooded altered/non-native dominated vegetation, temporarily flooded altered/non-native dominated grass land, medium-tall grass altered/non-native dominated vegetation, altered/non-native dominated seasonally flooded shrubland, slow moving linear open water habitat, cropland, and short grass with 4%-10% impervious cover.

Seasonally flooded altered/non-native dominated emergent vegetation and the temporarily flooded altered/non-native dominated grass land are dominated by reed canary grass. The altered/non-native dominated seasonally flooded shrubland is dominated by reed canary grass and willows. The mixed hardwood swamp is also dominated by reed canary grass with willows, dogwoods and common buckthorn occurring occasionally.

Figure 14B. Lake Marion Greenway, Lakeville: South Creek Cedar West – South Creek Cedar East

Water Resource Recommendation	Description
10	Get this finished!



South Creek West

South Creek West is an 11-acre undeveloped parcel of land west of Cedar Avenue. South Creek meanders through the parcel. The types of landcover that occur within the parcel, not including the portion that overlaps with Cedar Avenue are long grasses on upland soils, seasonally flooded/altered non-native vegetation, and upland cropland.

The upland grassland areas are dominated by smooth brome. The seasonally flooded/altered non-native vegetation is dominated by reed canary grass in open areas. Occurring occasionally are thickets of willow sp., sandbar willow, chokecherry, and Pagoda dogwood. Trees that occur occasionally include swamp white oak, silver maple, green ash, boxelder, and plains cottonwood, especially along the riparian corridor. The cropland occurs in the northwest corner.

There is high cover of invasive species throughout the parcel.

South Creek East

South Creek East is a mostly undeveloped 40-acre parcel of land just east of Cedar Avenue, across the road from South Creek West. South Creek continues through this parcel of land, entering on the west side and exiting on the east side. There are five stormwater basins located in the parcel, four wet and one dry. There is one parking lot in the northwestern corner and a gravel road that runs east-west near the southern edge of the parcel.

The types of landcover that occur are long grasses on upland soils, open water, seasonally flooded/altered non-native emergent vegetation, and long grasses on hydric soils.

The upland grassland is dominated by smooth brome and goldenrods in some areas and dominated by native bunch grasses such as big bluestem and switch grasses in other areas. The dry stormwater basin is dominated by native grasses and has willows and plains cottonwood saplings growing commonly throughout. Willows and reed canary grass dominate the seasonally flooded/altered non-native emergent vegetation. Other species that occur occasionally include green ash, plains cottonwood, chokecherry, goldenrods, common milkweed, and smooth oxeye (*Heliopsis helianthoides*). The grassland on hydric soils is dominated by non-native grasses such as smooth brome, reed canary grass, and barnyard grass. The gravel road runs through this landcover polygon. On the south side of the road the grasses appear as if they are hayed.

Figure 14C. Lake Marion Greenway, Lakeville: Ritter Farm Park – Casperson Park – West Lake Marion Park

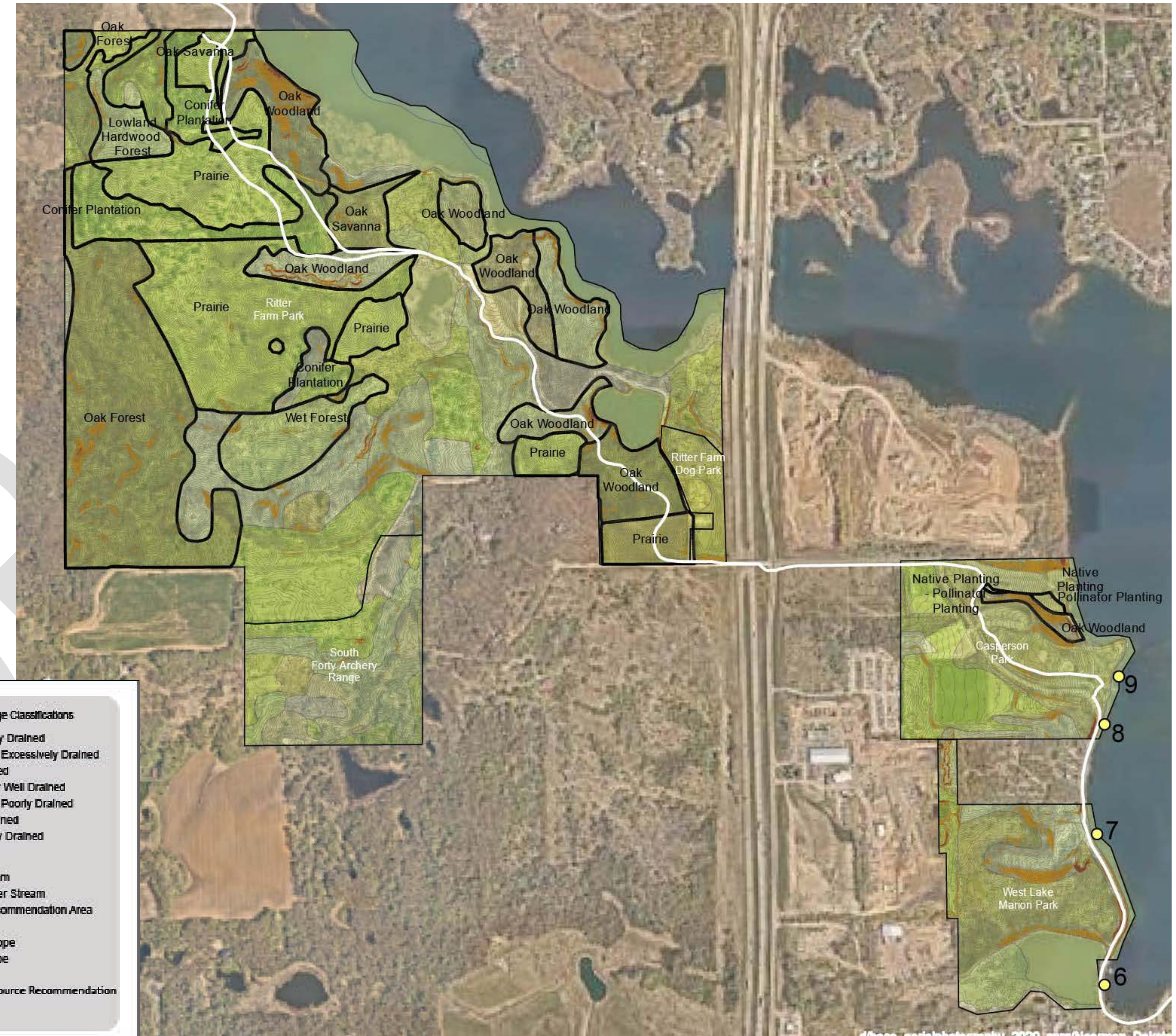
Ritter Farm Park is 334 acres and includes parking lot, pavilion, picnic areas, restrooms, small picnic shelters, trails, and equestrian trails. Land cover within the park includes seasonally flooded altered/non-native emergent vegetation dominated by reed canary grass, oak woodland-brushland, non-native/altered grassland, oak forest, mixed hardwood swamp, open water, lowland hardwood forest, altered/non-native deciduous forest and woodland and mowed cool-season grasses with bur oaks.

The non-native/altered grassland is dominated by cool-season non-natives in the grass layer. Canada goldenrod, wild bergamot, stiff goldenrod, and heath aster (*Symphyotrichum ericoides*) are common in the herbaceous layer. Woody encroachment is happening in the form of trees and shrubs such as chokecherry, smooth sumac, red cedar, apple and black walnut. Adjacent to the grassland is the altered/non-native deciduous woodland. Trembling aspen, black walnut and apple are common in the canopy layer and prickly ash, non-native bush honeysuckles, and common buckthorn are common in the shrub layer. Cool-season non-native grasses dominate the herbaceous layer where there are openings in canopy and shrub layer.

The oak woodland-brushland and oak forest are comprised mainly of northern pin oak (*Quercus ellipsoidalis*), red oak (*Quercus rubra*), bur oak, black cherry, black walnut and trembling aspen in the canopy. Non-native bush honeysuckle sp., common buckthorn, and raspberry sp. (*Rubus* sp.) are common in the shrub layer. Wild grape, arrowleaf aster, and white snakeroot are common in the herbaceous layer.

The mixed hardwood swamp is comprised mainly of hackberry and boxelder in the canopy layer, common buckthorn and non-native bush honeysuckles in the shrub layer, and white snakeroot, avens sp. (*Geum* sp.), and Soloman's seal (*Polygonatum* sp.) can be found in the herbaceous l

Water Resource Recommendation	Description
6, 7, 8, 9	Get this finished!



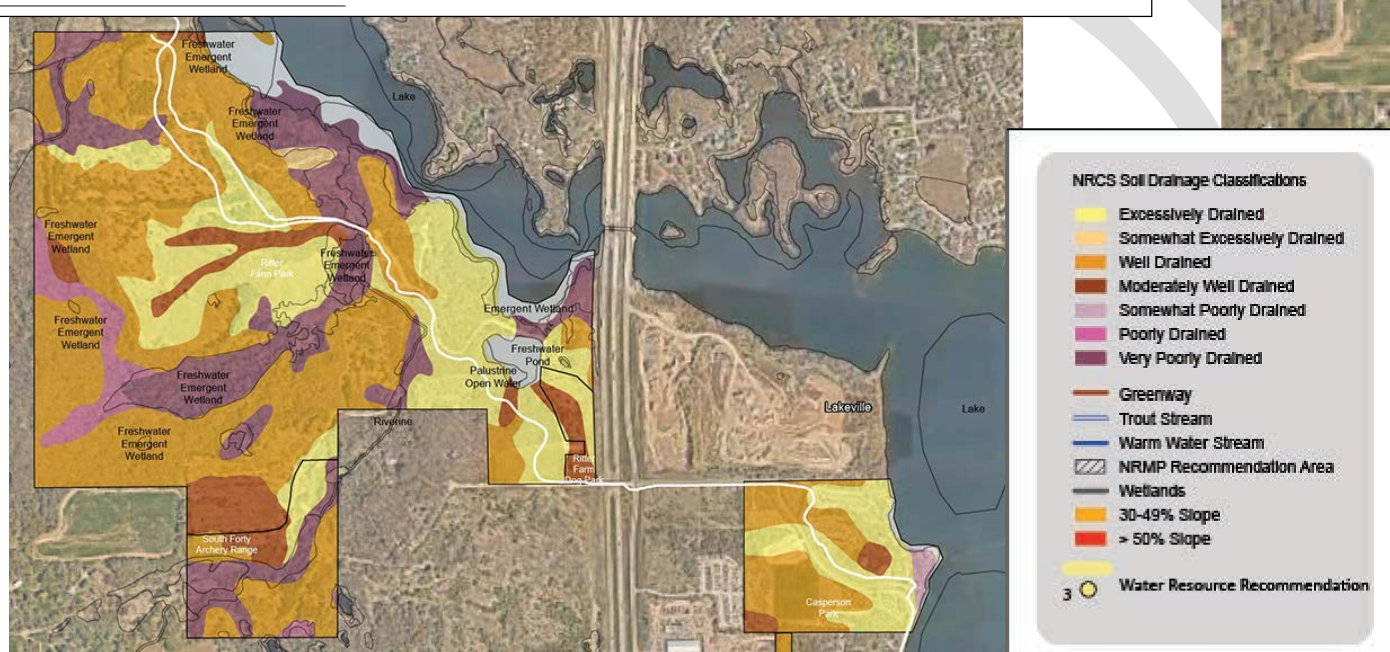
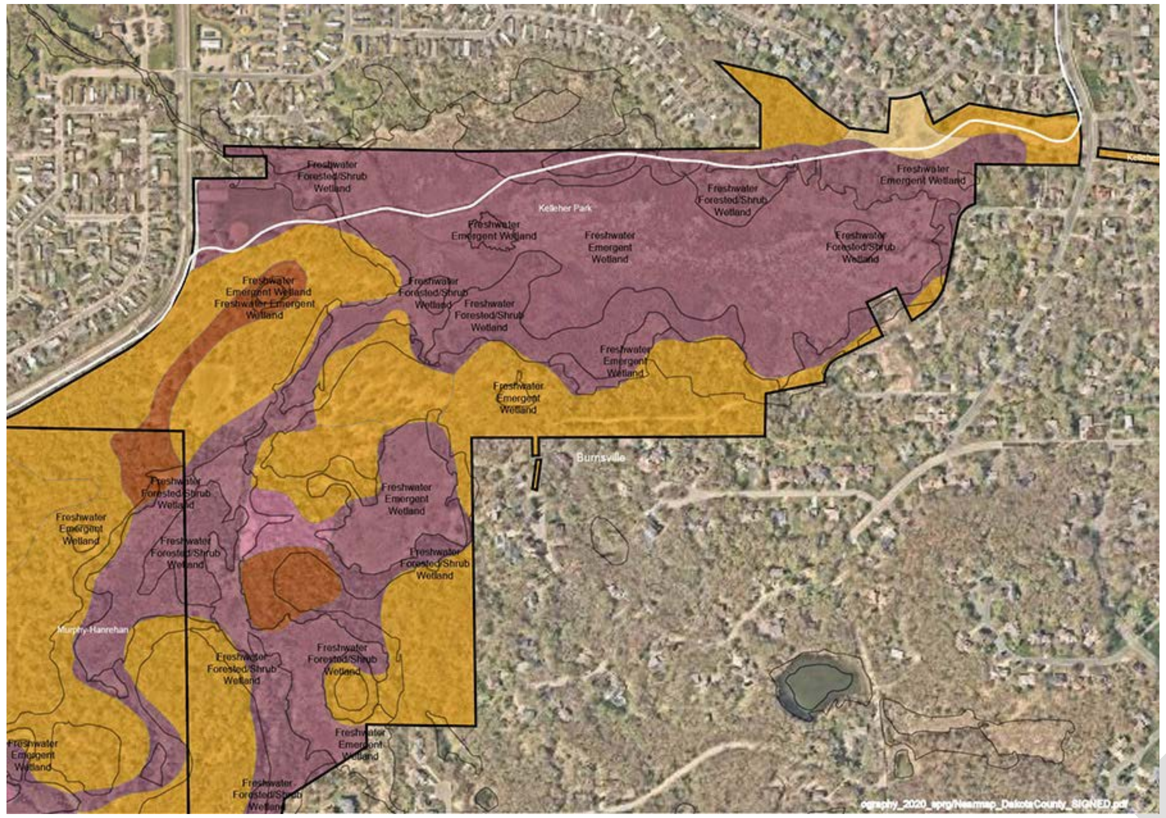


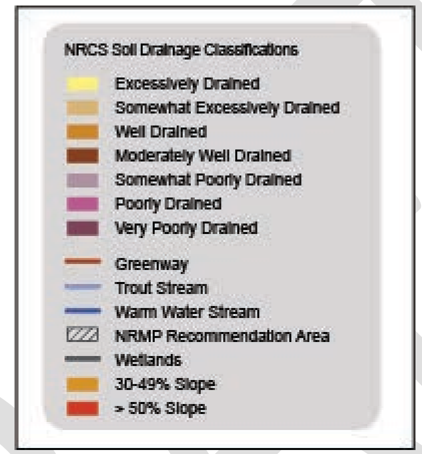
Figure 14D. Lake Marion Greenway, Burnsville: Kelleher Park

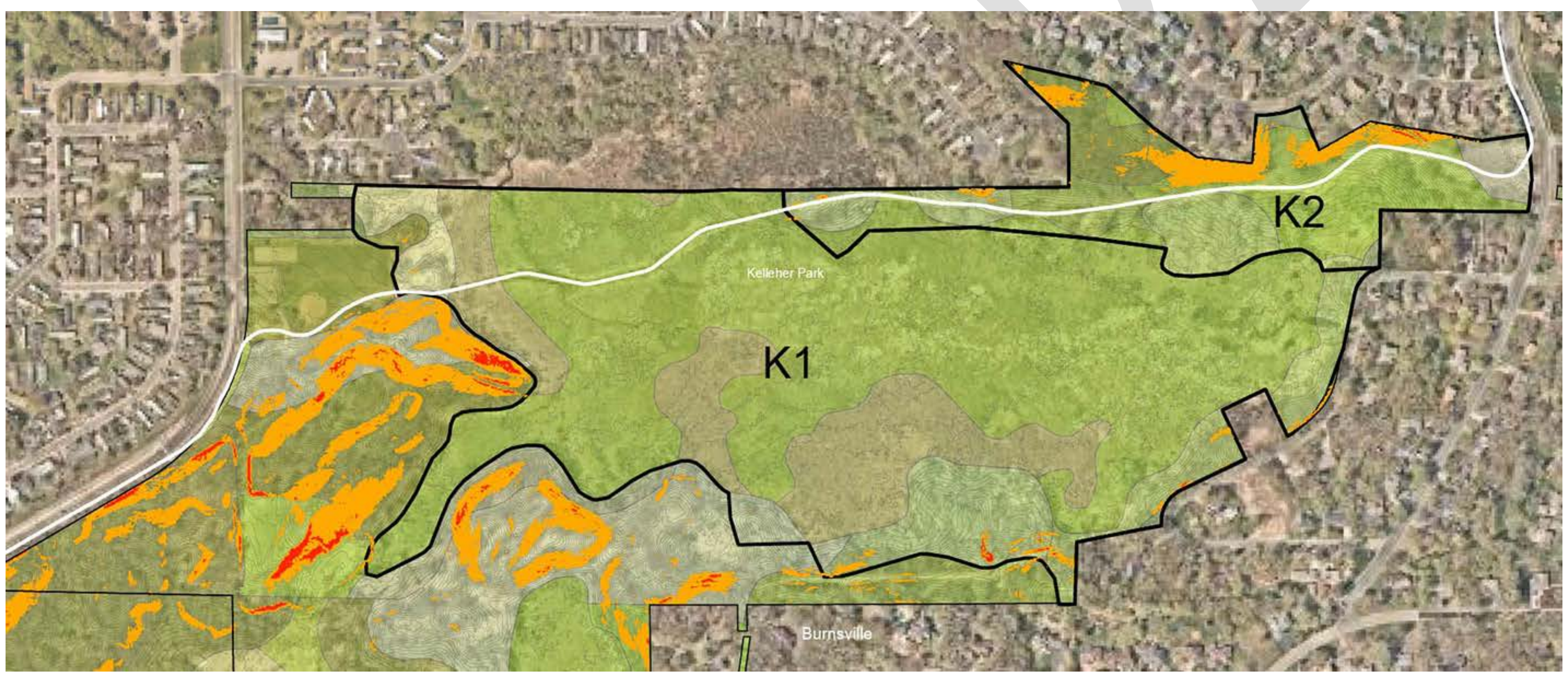


Burnsville Natural Resources Master Plan Goals for Kelleher Park include:

K!: Target Community: wet meadow/marsh/shrub swamp mosaic

K2: Target Community: upland community: oak savanna/woodland pockets, lowland mesic forest, mesic prairie





The landcover in this park consists of dry prairie, non-native/altered grassland, oak woodland, wet meadow, wet meadow shrub subtype, oak-savanna, mixed hardwood swamp, lowland hardwood, oak forest, seasonally flooded altered/non-native dominated emergent vegetation, and willow swamp.

A small area of dry pairie occurs in the northeast corner of the park composed of mainly native warm season grasses and forbs such as purple prairie clover (*Dalea purpurea*) and wild bergamot (*Monarda fistulosa*). Adjacent to the dry prairie is grassland dominated by smooth brome that transitions into a non-native/altered woodland characterized by cottonwood, boxelder and common buckthorn. The non-native/altered woodland transitions to oak-woodland characterized by bur oak (*Quercus macrocarpa*), black cherry (*Prunus serotina*), hackberry, and elm in the canopy layer, common buckthorn in the shru b layer, and motherwort (*Leonurus cardiaca*), garlic mustard (*Alliaria petiolata*), and pointed leaf tick-trefoil (*Desmodium glutinosum*) in the herbaceous layer.

A large high-quality wet meadow occurs along the greenway trail and has a high level of species diversity and ecosystem integrity. Although narrow-leaved cattail is present, occurring in high density in some areas, native sedges and rushes are common. Forbs include include orange jewelweed, flat-topped aster (*Doellingeria umbellata*), spotted Joe-pye weed (*Eutrochium maculatum*), common boneset (*Eupatorium perfoliatum*), and arrowhead sp. (*Sagittaria* sp.). Shrubs and some trees become more common along the edge of the west and south edges of the wet meadow including dogwoods, boxelder, aspen, green ash, willow sp. and common elderberry (*Sambucus canadensis*).

The oak-woodland in the western and southern portions of the park is more species rich than the oak woodland in the eastern portion of the park. It is comprised mainly of bur oak, trembling aspen, red oak basswood, American elm, black cherry, and boxelder in the canopy layer. The shrub layer is dominated by common buckthorn, but also occurring are dogwoods, American hazelnut (*Corylus americana*), and smooth sumac. Forbs in the herbaceous layer include pointed leaf tick trefoil, arrowleaf aster (*Symphyotrichum urophyllum*), white snakeroot (*Ageratina altissima*), waterleaf (*Hydrophyllum virginianum*), and hog peanut (*Amphicarpaea bracteata*). Dry oak savanna occurs within the oak-woodland. Within the canopy openings native dry prairie plants occur such as common milkweed (*Asclepias syriaca*), round-headed bush clover (*Lespedeza capitata*), stiff goldenrod (*Oligonueron rigidum*), purple prairie clover, and brown eyed Susan (*Rudbeckia triloba*), little bluestem (*Schizachyrium scoparium*), Indiangrass, and Kalm's brome (*Bromus kalmii*).

There is little to no invasive species cover in the dry prairie. The wet meadow areas have a moderate to high cover of invasive species, mostly made up of narrow-leaved cattail and reed canary grass. The oak woodland and brushlands have moderate to high levels of invasive species cover, made up of mainly common buckthorn.

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 8**). 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 8** and as shown in **Figure 14**. Target plant communities indicated are consistent with the *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province* (MN DNR 2005), and detailed descriptions of these communities are found in Appendix G.

Implementation of these restoration projects are prioritized primarily by the landowner or effort lead's understanding of ecological value gained in converting altered and non-native plant cover to native plant communities described in **Table 8**. 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 partnership organizations to oversee implementation.

Previous and Ongoing Restoration Efforts

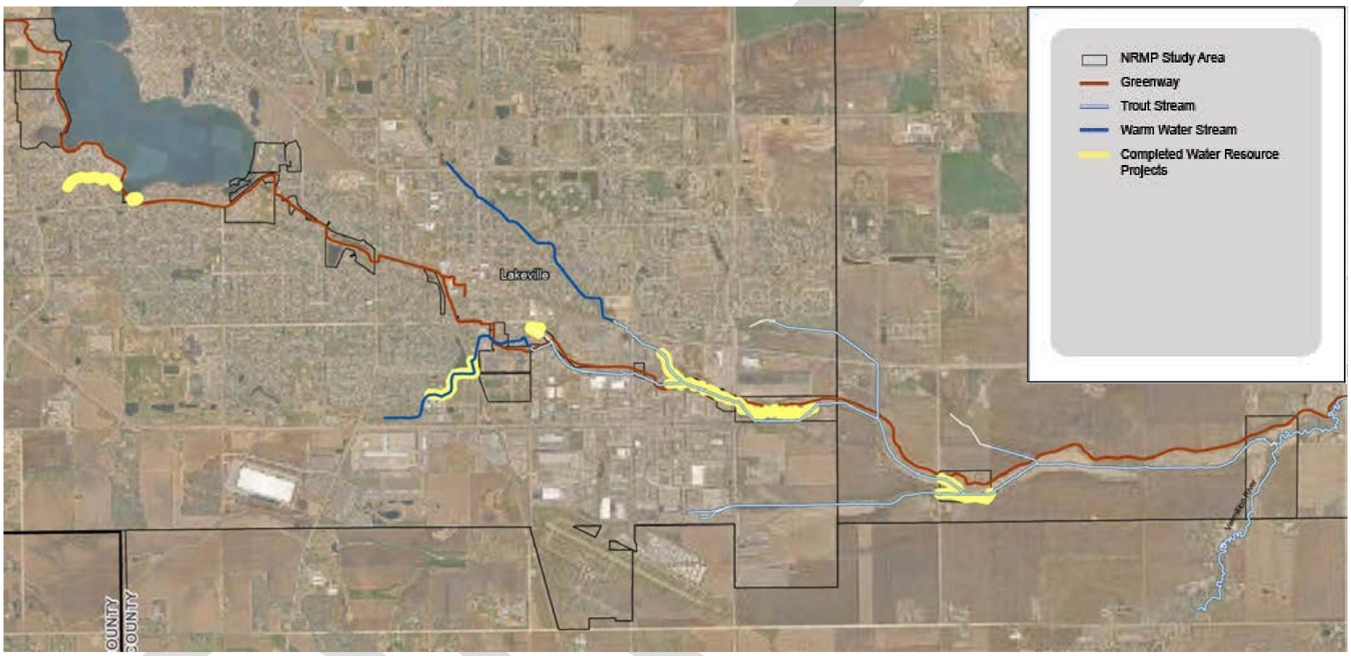
Before addressing the specific priorities and activities for each unit, it is important to acknowledge the past efforts to restore sites within the Greenway Corridor undertaken by the landowner(s), the County and other partners. Past water resource restoration efforts are illustrated in **Figure 15**. Vegetation restoration efforts are listed in **Table 9**.

Table 9 Past and Current Vegetation Restoration

Greenway Segment – Partner	Plant Community	Activity	Year
Ritter Farm Park	Prairie	Restoration	
	Woodland	Forestry mow	2022
	Woodland	Black locust removal	
Casperson Park	Woodland	Forestry mow	
South Creek Cedar East	Prairie	Restoration	

Greenway Segment – Partner	Plant Community	Activity	Year
South Creek PCA	Prairie	Restoration	

Figure 15. Past Water Resource Improvement Activities in Greenway



Work Plans

Restoration Sequence Work Plan

Table 10 details Restoration Sequence work plans for vegetation management at each unit included in this NRMP. These work plans were developed to provide guidelines toward achieving the target communities shown in Figure 14. 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 as well as a prioritization made by the landowner, activities, schedules, responsibilities, and estimated costs. Table 10 describes the restoration activities at each site, 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 importance of the restoration need by the landowner or the effort lead, on a scale of 1 to 4, with 1 being the highest.

Table 10: Restoration Sequence Work Plan for Natural Resource Projects

PLANT COMMUNITY	PRIORITY	SITE RESTORATION SEQUENCE [Site #].[Year]	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Owner: Lakeville									
Site: Ritter Farm Park									
1. Oak Woodland and Oak Savanna	1	1.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	46.6	3.5	$3,500	$5,000	$180,600
		1.2 to 1.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	46.6	3.5	$900	$1,300	$46,490
		1.2	spring	Hand seed/broadcast seed native ground layer mix with emphasis on grasses	46.6	3.5	$1,600	$1,800	$80,860
		1.3 or 1.4	spring, fall	Prescribe burn, timing dependent on development of fine fuels	46.6	3.5	$8000/ unit		$80,000
									Subtotal $387,950
2. Oak Forest	2	2.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	46.8	1.8	$3,500	$5,000	$172,800
		2.2 to 2.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	46.8	1.8	$900	$1,300	$44,460
		2.2	spring	Hand seed/Broadcast seed native ground layer mix with emphasis on grasses	46.8	1.8	$1,600	$1,800	$78,120
									Subtotal $295,380
3. Lowland Hardwood Forest	2	3.1	fall, winter	Treat invasive shrubs	5.7	0.1	$3,500	$5,000	$20,450
		3.2 to 3.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	5.7	0.1	$900	$1,300	$5,260

Table 10: Restoration Sequence Work Plan for Natural Resource Projects

PLANT COMMUNITY	PRIORITY	SITE RESTORATION SEQUENCE [Site #].[Year]	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
		3.2	spring	Plant native groundlayer species via seed and/or plugs	5.7	0.1	$1,600	$1,800	$9,300
									Subtotal $35,010
4. Prairie	1	4.1 and 4.4	spring	Prescribe burn or mow	59.2	0.2	$3500/ unit		$17,500
		4.1	fall, winter	Treat woody encroachment	50	0.2	$1,500		$75,000
		4.1 to 4.5	spring, summer, fall	Spot spray herbaceous invasives	59.2	0.2	$300		$17,760
		4.2	spring	Enrichment native seeding where needed	50	0.2	$650		$32,500
								Subtotal	$142,760
5. Conifer Plantations	3	5.1 to 5.5	winter	Remove red pines and thin white pines	21.4		$6,000		$128,400
		5.1	fall, winter	Treat invasive shrubs	21.4		$3,500		$74,900
		5.2 to 5.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	21.4		$900		$19,260
		5.2 to 5.5	spring, fall	Under plant oak trees and native ground layer species	21.4		$2,600		$55,640
								Subtotal	$278,200
6. Wet Forest	2	6.1	fall, winter	Treat invasive shrubs	10.7	0.2	$3,500	$5,000	$38,450

Table 10: Restoration Sequence Work Plan for Natural Resource Projects									
PLANT COMMUNITY	**PRIORITY**	**SITE RESTORATION SEQUENCE [Site #].[Year]**	**SEASON**	**ACTIVITY**	**SLOPE <30% ACRES**	**SLOPE >30% ACRES**	**COST/AC SLOPE <30%**	**COST/AC SLOPE >30%**	**COST PER TASK**
		6.2 to 6.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	10.7	0.2	$900	$1,300	$9,890
		6.2	spring	Plant native groundlayer species via seed and/or plugs	10.7	0.2	$1,600	$1,800	$17,480
								Subtotal	$65,820
Site: Casperson Park									
7. Native Planting - Pollinator Planting Maintenance	3	7.1	spring	Prescribe burn or mow			$2500/ unit		$2,500
		7.1 to 7.5	late spring, summer, fall	Spot spray herbaceous invasives			$300.00		$300
								Subtotal	$2,800
8. Native Planting - Pollinator Planting Expansion	4	8.1	spring, summer, fall	Site preparation herbicide sprayout (2x)			$600 this site		$600
		8.2	spring	Seed and plug planting			$200 this site		$200
		8.3 to 8.5	spring, summer, fall	Establishment maintenance: continue invasive treatment, mow or Rx burn			$1250 this site		$1,250
									Subtotal $2,050
9. Oak Woodland Maintenance	2	8.1 to 8.5	fall, winter	Foliar herbicide on invasive shrub resprouts	1	0.7	$900.00		$900

Table 10: Restoration Sequence Work Plan for Natural Resource Projects

PLANT COMMUNITY	PRIORITY	SITE RESTORATION SEQUENCE [Site #].[Year]	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
		8.2	spring, fall	Hand seed/Broadcast seed native ground layer mix with emphasis on grasses	1	0.7	$1,600.00		$1,600
									Subtotal $2,500
Site: South Creek Cedar East									
10. Native Planting - Stormwater Basin Maintenance	4	10.1	fall, winter	Treat cottonwood saplings growing in stormwater basin	3.6	0.1	$1,600		$5,760
									Subtotal $5,760
11. Mesic Prairie	2	11.1 and 11.4	spring	Prescribe burn or mow	3.6	0.1	$3500/ unit		$7,000
		11.1	fall, winter	Treat woody encroachment	3.6	0.1	$1,500		$5,400
		11.1 to 11.5	spring, summer, fall	Spot spray herbaceous invasives	3.6	0.1	$300		$1,080
		11.2	spring	Enrichment native seeding where needed	3.6	0.1	$650		$2,340
									Subtotal $15,820
Owner: Dakota County									
Site: South Creek PCA									

Table 10: Restoration Sequence Work Plan for Natural Resource Projects									
PLANT COMMUNITY	PRIORITY	SITE RESTORATION SEQUENCE [Site #].[Year]	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
12. Mesic Prairie	2	12.1 and 12.4	spring	Prescribe burn or mow	8.5		$3500/ unit		$3,500
		12.1	fall, winter	Treat woody encroachment	8.5		$1,500		$12,750
		12.1 to 12.5	spring, summer, fall	Spot spray herbaceous invasives	8.5		$300		$2,550
		12.2	spring	Enrichment native seeding where needed	8.5		$650		$5,525
									Subtotal $24,325
13. Wet Meadow/Shrub Carr	2	13.1	fall, winter	Treat invasive shrubs	9.7	0.2	$3,500		$33,950
		13.2 to 13.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	9.7	0.2	$900		$8,730
		13.2	spring	Plant native species via seed and/or plugs	9.7	0.2	$1,600		$15,520
									Subtotal $58,200
Site: Adelmann PCA									
14. Mesic Prairie - Conversion from Cropland	3	14.1 to 14.2	spring, summer, fall	Site preparation herbicide sprayout (2x) and drill seed native prairie mix (including the seed)	8.4		$2,000		$16,800
		14.2 to 14.5	spring - fall	Establishment maintenance: Invasive treatment and mow 2x	8.4		$1,250		$10,500

Table 10: Restoration Sequence Work Plan for Natural Resource Projects

PLANT COMMUNITY	PRIORITY	SITE RESTORATION SEQUENCE [Site #].[Year]	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
									Subtotal $27,300
				Partner: Burnsville					
				Site: Kelleher Park					
15. Wetland (K1)	1								$81,731*
16. Oak Woodland and Prairie (K2)	1								$103,035*
									GENERAL RESTORATION COST: $1,528,641

*Cost estimate submitted by City of Burnsville NRMP Update

Twenty-Year Work Plan

A 20-year work plan (see **Table 11**) 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 initial years of intensive ecological restoration, and these costs will generally decrease after intense, initial restoration activities are completed.

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 12**, 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.

Table 12. 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.

Table 21 Twenty Year Work Plan for Long-Term Maintenance

PLANT COMMUNITY	RESPONSIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/TASK
Partner: Lakeville								
Site: Ritter Farm Park								
1. Oak Woodland and Oak Savanna		spring, summer, fall	Annual spot 99reatment of invasives	46.6	3.5	$250	$300	$12,700
		fall, winter	Survey and remove invasive shrubs every 3	46.6	3.5	$900	$1,300	$46,490
		spring, fall	Prescribed burn every 3 to 8 years	46.6	3.5	$8000/unit		$50,000
								Subtotal $109,190
2. Oak Forest		spring, summer, fall	Annual spot 99reatment of invasives	46.8	1.8	$250	$300	$12,240
		fall, winter	Survey and remove invasive shrubs every 3 years	46.8	1.8	$900	$1,300	$44,460
								Subtotal $56,700
3. Lowland Hardwood Forest		spring, summer, fall	Annual spot 99reatment of invasives	5.7	0.1	$250	$300	$1,455
		fall, winter	Survey and remove invasive	5.7	0.1	$900	$1,300	$5,260

PLANT COMMUNITY	RESPONSIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/TASK
			shrubs every 3 years					
							Subtotal	$6,715
4. Prairie		summer, fall	Annual spot treatment of invasives	60.8	0.2	$250		$15,200
		fall, winter	Prescribe burn every 3 to 5 years	60.8	0.2	$3500/unit		$17,500
								Subtotal $32,700
5. Conifer Plantations		spring, summer, fall	Annual spot 100reatment of invasives	21.4		$250		$5,350
		fall, winter	Survey and remove invasive shrubs every 3 years	21.4		$900		$19,260
		winter	Periodically thin conifers	21.4		$1,000		$21,400
								Subtotal $46,010
6. Wet Forest		spring, summer, fall	Annual spot 100reatment of invasives	10.7	0.2	$250	$300	$2,735
		fall, winter	Survey and remove invasive shrubs every 3 years	10.7	0.2	$900	$1,300	$9,890
								Subtotal $12,625
Site: Casperson Park								

PLANT COMMUNITY	RESPONSIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/TASK
7. Native Planting - Pollinator Planting		summer, fall	Annual spot treatment of invasives	0.6		$250		$150
		fall, winter	Prescribe burn every 3 years	0.6		$2000/unit		$5,000
								Subtotal $5,150
8. Oak Woodland Maintenance		spring, summer, fall	Annual spot treament of invasives	1	0.7	$250	$300	$460
		fall, winter	Survey and remove invasive shrubs every 3 years	1	0.7	$900	$1,300	$1,810
		spring, fall	Prescribed burn every 3 to 8 years	1	0.7	$5000/unit		$5,000
								Subtotal $7,270
Site: South Creek Cedar East								
9. Native Planting - Stormwater Basin Maintenance		fall, winter	Periodically survey for and control cottonwood saplings	3.6	0.1	$1,000		$1,000
								Subtotal $1,000
10. Mesic Prairie		summer, fall	Annual spot treatment of invasives	3.6	0.1	$250		$900

PLANT COMMUNITY	RESPONSIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/TASK
		fall, winter	Prescribe burn every 3 to 5 years	3.6	0.1	$3500/unit		$3,500
								Subtotal $4,400
Site: South Creek PCA								
11. Mesic Prairie		summer, fall	Annual spot treatment of invasives	8.5		$250		$2,125
		fall, winter	Prescribe burn every 3 to 5 years	8.5		$3500/unit		$3,500
								Subtotal $5,625
12. Wet Meadow/Shrub Carr		spring, summer, fall	Annual spot 102reatment of invasives	9.7	0.2	$250	$300	$2,485
		fall, winter	Survey and remove invasive shrubs every 3 years	9.7	0.2	$900	$1,300	$8,990
								Subtotal $11,475
Site: Adelmann PCA								
13. Mesic Prairie - Conversion from Cropland		summer, fall	Annual spot treatment of invasives	8.4		$250		$2,100
		fall, winter	Prescribe burn every 3 to 5 years	8.4		$3500/unit		$3,500
								Subtotal $5,600
								GENERAL RESTORATION TOTAL: $304,460

Strategic Partnerships for Implementing Greenway Natural Resource Projects

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 19** and **20**). 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 19: Greenway Corridor Scenarios. Taken from Greenway Guidebook, page 22.

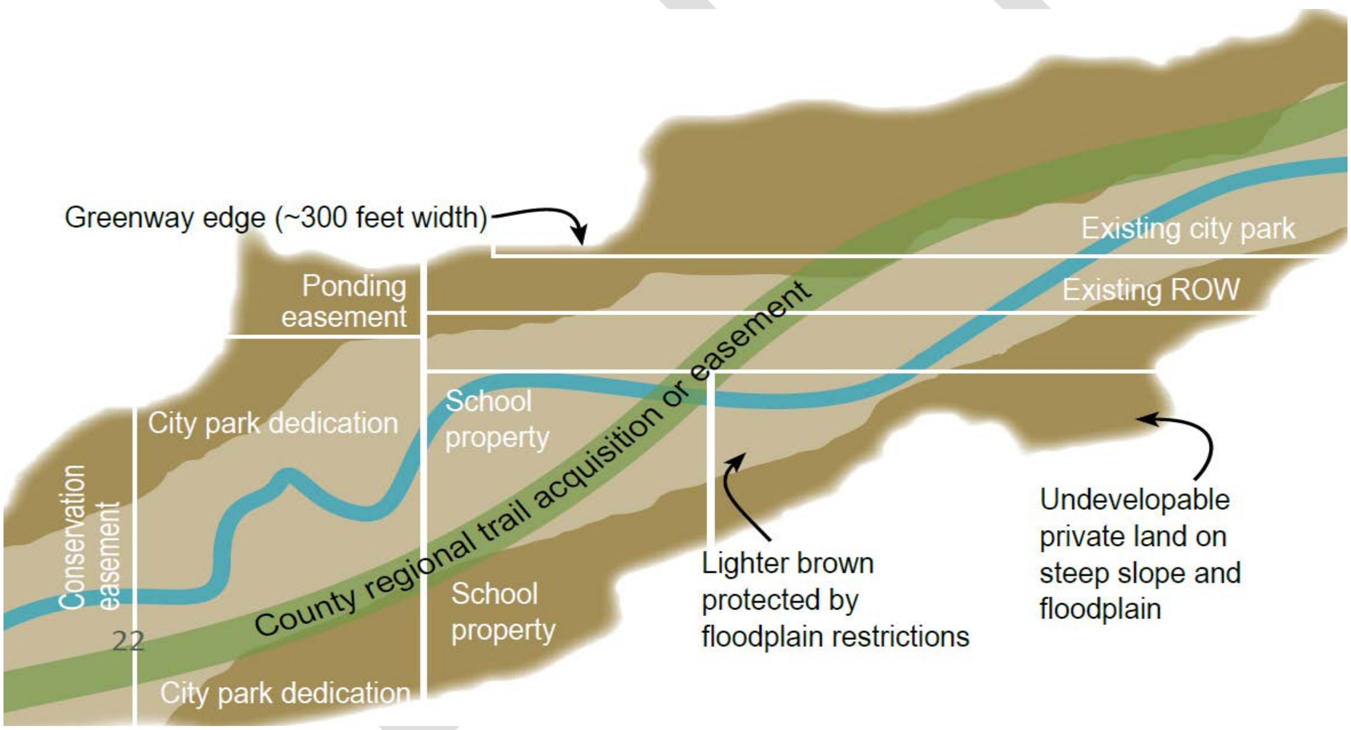
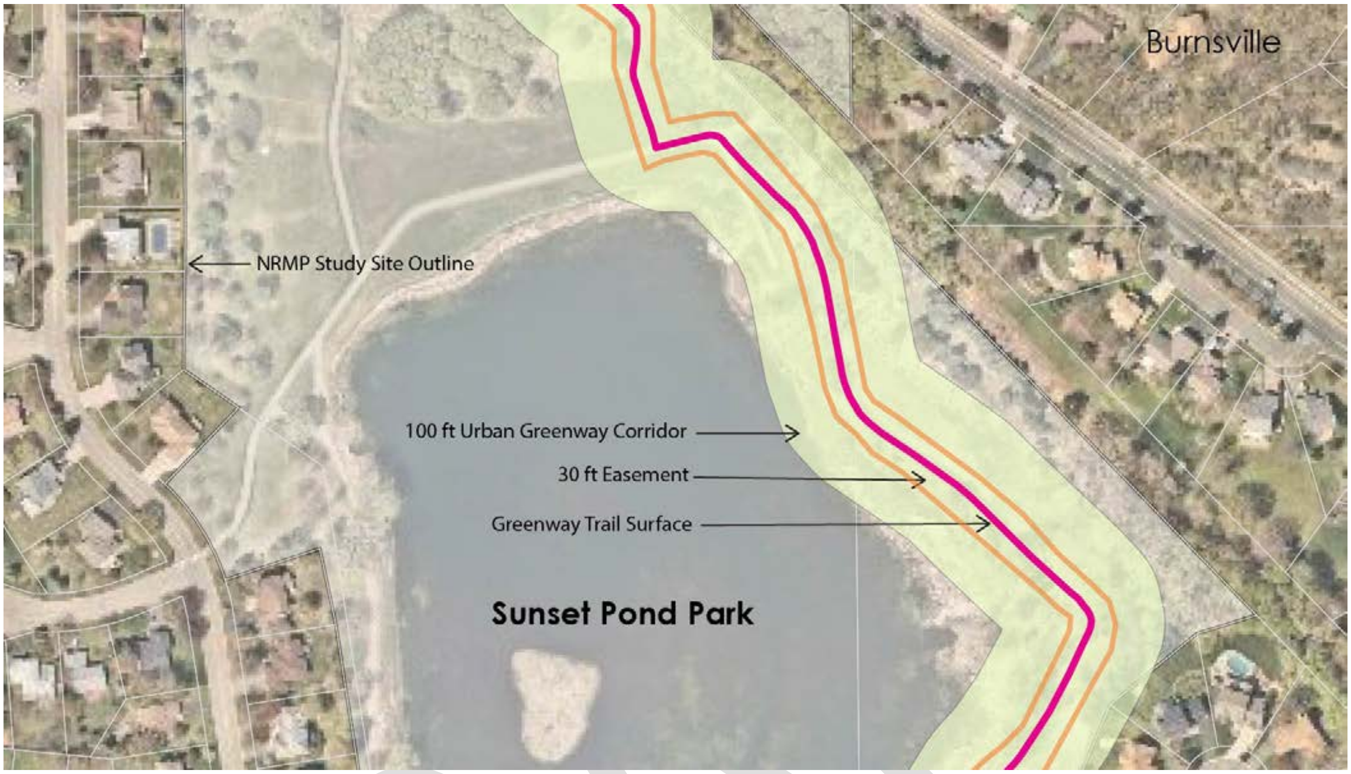


Figure 20. A Local Greenway Corridor Example on the Lake Marion Greenway



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.

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 12** outlines the Roles and Responsibilities of Dakota County and Landowner Partner organizations for each of the consideration areas discussed above.

Table 12: 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.

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 title 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 (JPA) 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.

Continued Natural Resource Management

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 11)** 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).

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 ecological restoration contractors that specialize 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 of Minnesota & Iowa 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

Monitoring

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.

As mentioned earlier, Dakota County embraces the Adaptive Management approach in land management. 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 learning into planning and management. It is set up like a feedback loop as illustrated in Executive Figure 1. 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.

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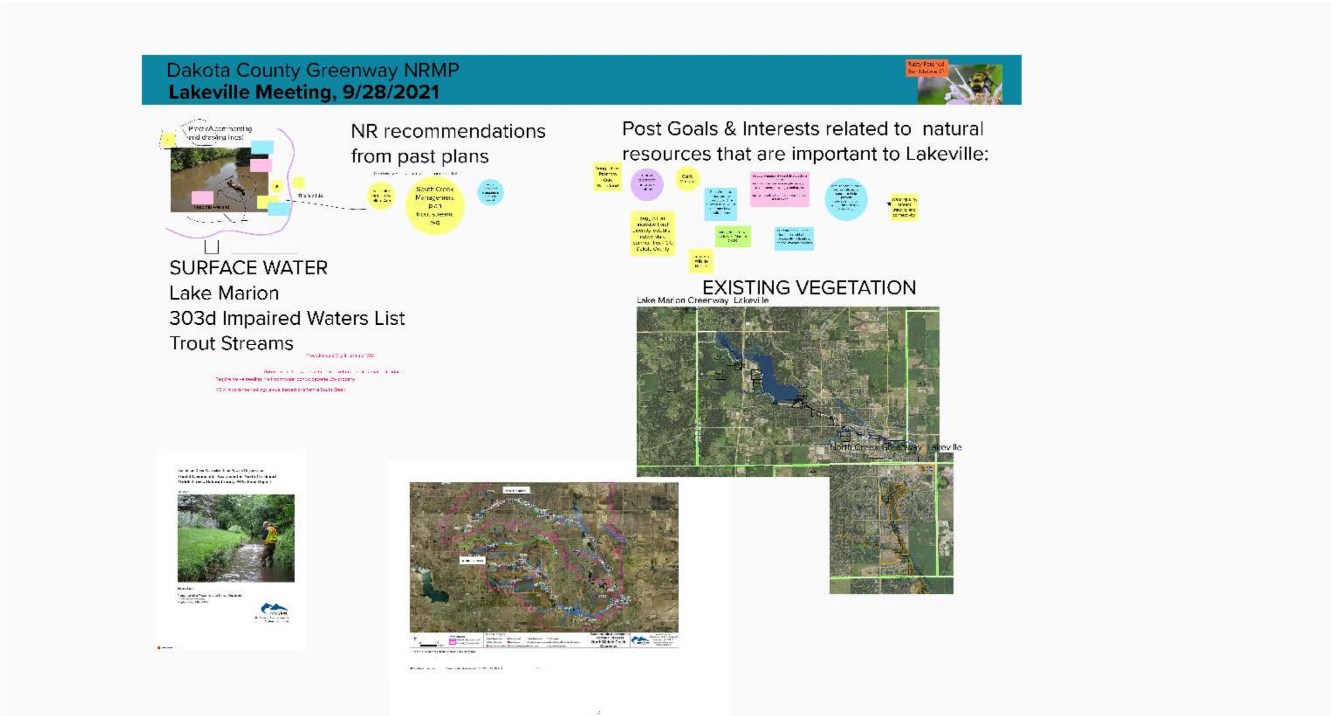
Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Farmington

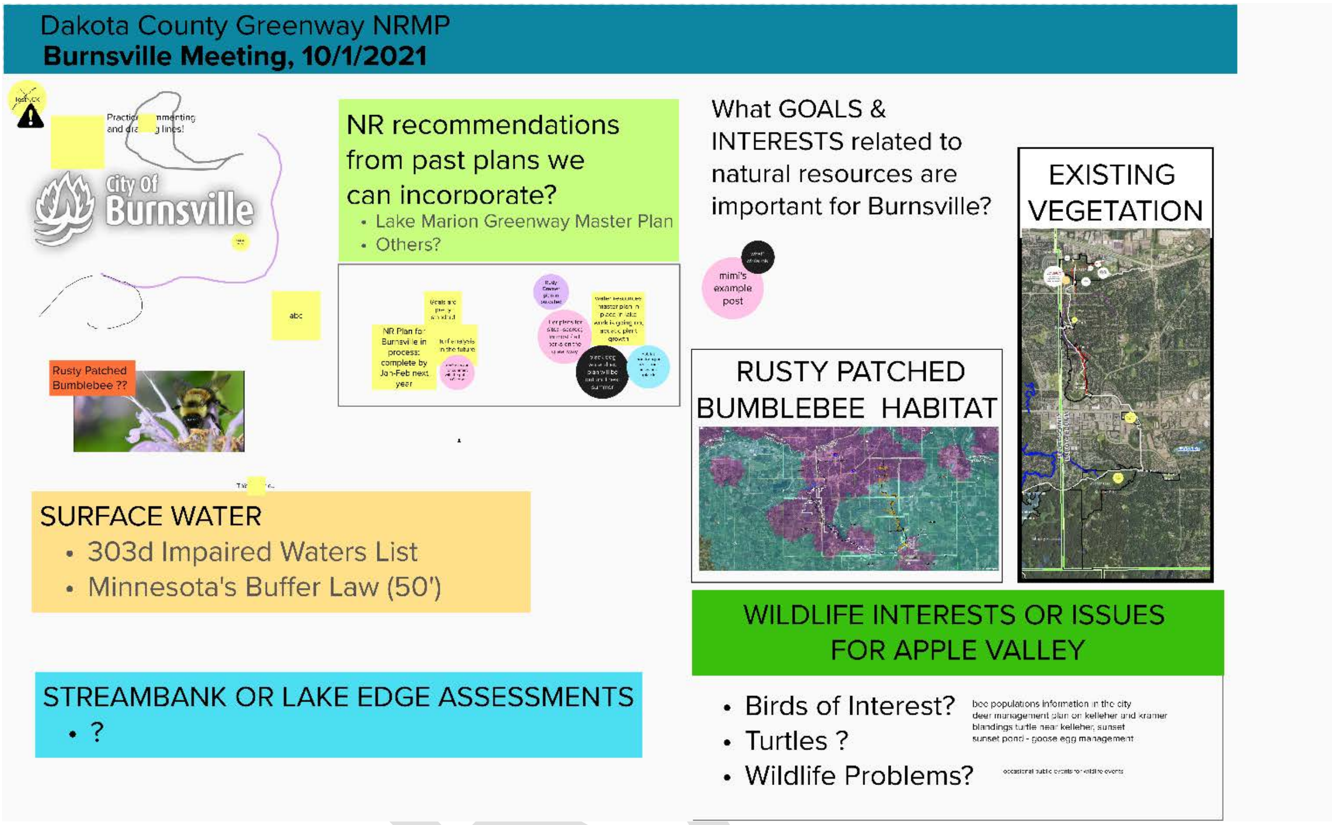
Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Lakeville



Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Burnsville



Appendix B. Soils in the Greenway Study Area

MUSYM	MUName	Drainage Class	Area (ac)
98	Colo silt loam, occasionally flooded	Poorly drained	14
129	Cylinder loam, 0 to 2 percent slopes	Somewhat poorly drained	20.6
189	Auburndale silt loam	Poorly drained	15.7
208	Kato silty clay loam	Poorly drained	96.1
250	Kennebec silt loam	Moderately well drained	19.2
252	Marshan silty clay loam	Poorly drained	25.7
344	Quam silt loam	Very poorly drained	42.1
408	Faxon silty clay loam	Poorly drained	28
522	Boots muck	Very poorly drained	8
539	Klossner muck, 0 to 1 percent slopes	Very poorly drained	51.1
540	Seelyeville muck	Very poorly drained	202.5
1003	Anthroportic Udorthents-Pits-Dumps complex, abandoned, 2 to 45 percent slopes	Moderately well drained	7.7
1030	Pits, sand and gravel	Excessively drained	0.01
1055	Aquolls and Histosols, ponded	Very poorly drained	4.4
1078	Anthroportic Udorthents, 2 to 9 percent slopes	Moderately well drained	9.5
1816	Kennebec variant silt loam	Moderately well drained	4.4
1821	Algansee sandy loam, occasionally flooded	Somewhat poorly drained	1.7
1824	Quam silt loam, ponded	Very poorly drained	5.5

106D2	Lester loam, 10 to 16 percent slopes, moderately eroded	Well drained	2.9
150B	Spencer silt loam, 2 to 6 percent slopes	Moderately well drained	13.5
155B	Chetek sandy loam, 3 to 8 percent slopes	Somewhat excessively drained	1.7
299B	Rockton loam, 2 to 6 percent slopes	Well drained	1.2
342B	Kingsley sandy loam, 3 to 8 percent slopes	Well drained	2.7
342C	Kingsley sandy loam, 8 to 15 percent slopes	Well drained	2.8
342E	Kingsley sandy loam, 15 to 25 percent slopes	Well drained	1.3
39B2	Wadena loam, 2 to 6 percent slopes, eroded	Well drained	4
411A	Waukegan silt loam, 0 to 1 percent slopes	Well drained	52
411B	Waukegan silt loam, 1 to 6 percent slopes	Well drained	6.4
415A	Kanaranzi loam, 0 to 2 percent slopes	Well drained	9
415B	Kanaranzi loam, 2 to 6 percent slopes	Well drained	51.7
415C	Kanaranzi loam, 6 to 12 percent slopes	Well drained	8.8
41B	Estherville sandy loam, 2 to 6 percent slopes	Somewhat excessively drained	50.7
42C	Salida gravelly coarse sandy loam, 2 to 12 percent slopes	Excessively drained	3.5
449B	Crystal Lake silt loam, 1 to 8 percent slopes	Moderately well drained	0.8
49B	Antigo silt loam, 1 to 8 percent slopes	Well drained	5.1
611C	Hawick gravelly sandy loam, 6 to 12 percent slopes	Excessively drained	131.4
611D	Hawick gravelly sandy loam, 12 to 20 percent slopes	Excessively drained	32

611F	Hawick loamy sand, 20 to 40 percent slopes	Excessively drained	0.5
857B	Urban land-Waukegan complex, 1 to 8 percent slopes	<Null>	47.6
858C	Urban land-Chetek complex, 1 to 15 percent slopes	<Null>	10
860C	Urban land-Lester complex, 3 to 15 percent slopes	<Null>	0.2
888B	Kingsley-Lester complex, 2 to 6 percent slopes	Well drained	4.6
888C	Kingsley-Lester complex, 6 to 12 percent slopes	Well drained	7.3
895C	Kingsley-Mahtomedi-Spencer complex, 8 to 15 percent slopes	Well drained	103.3
896E	Kingsley-Mahtomedi complex, 15 to 25 percent slopes	Well drained	211
896F	Kingsley-Mahtomedi complex, 25 to 40 percent slopes	Well drained	5.4
Ab	Alluvial land, frequent overflow, 0 to 6 percent slopes	Moderately well drained	17.8
BdB	Kingsley, Mahtomedi and Hayden complex, 2 to 6 percent slopes	Well drained	3.5
BdC2	Kingsley, Mahtomedi and Hayden complex, 6 to 12 percent slopes, moderately eroded	Well drained	29.8
BdD2	Kingsley, Mahtomedi and Hayden complex, 12 to 18 percent slopes, moderately eroded	Well drained	86.4
BdE2	Kingsley, Mahtomedi and Hayden complex, 18 to 25 percent slopes	Well drained	542.7
BdF	Kingsley, Mahtomedi and Hayden complex, 25 to 50 percent slopes	Well drained	61.4

BeD3	Kingsley, Mahtomedi and Hayden complex, 12 to 18 percent slopes, severely eroded	Well drained	1.9
BeE3	Kingsley, Mahtomedi and Hayden complex, 18 to 25 percent slopes	Well drained	10.2
DaA	Dakota loam, 0 to 2 percent slopes	Well drained	33.3
DaB	Dakota loam, 2 to 6 percent slopes	Well drained	0.4
DaC2	Dakota loam, 6 to 12 percent slopes, moderately eroded	Well drained	1.8
EaA	Estherville loam and sandy loam, 0 to 2 percent slopes	Somewhat excessively drained	6.1
EbC2	Salida gravelly sandy loam, 6 to 12 percent slopes, moderately eroded	Excessively drained	1.9
EbC2	Salida gravelly sandy loam, 6 to 12 percent slopes, moderately eroded	Excessively drained	68.8
HaB	Hayden loam, 2 to 6 percent slopes	Well drained	182.1
HaC	Hayden loam, 6 to 10 percent slopes	Well drained	95.4
HaC2	Hayden loam, 6 to 10 percent slopes, moderately eroded	Well drained	70.3
HaD	Hayden loam, 10 to 22 percent slopes	Well drained	55.3
HaD2	Hayden loam, 10 to 22 percent slopes, moderately eroded	Well drained	37.6
HaE2	Hayden loam, 18 to 25 percent slopes	Well drained	152.2
HbB	Hayden sandy loam, 0 to 6 percent slopes	Well drained	26.6
HbB2	Hayden sandy loam, 0 to 6 percent slopes, moderately eroded	Well drained	68.2
HbC	Hayden sandy loam, 6 to 12 percent slopes	Well drained	14

HbC2	Hayden sandy loam, 6 to 12 percent slopes, moderately eroded	Well drained	22.1
HbD2	Hayden sandy loam, 12 to 18 percent slopes, moderately eroded	Well drained	3.6
HbE2	Hayden sandy loam, 18 to 25 percent slopes	Well drained	29.5
HcD3	Hayden soils, 12 to 18 percent slopes, severely eroded	Well drained	2.3
INT	Water, intermittent	<Null>	7.4
LaA	Wadena loam, 0 to 2 percent slopes	Well drained	4.4
LaB	Estherville loam, 2 to 6 percent slopes	Somewhat excessively drained	5.6
LaC2	Estherville loam, 6 to 12 percent slopes, moderately eroded	Somewhat excessively drained	11.8
LaD	Estherville loam, 12 to 18 percent slopes	Somewhat excessively drained	0.9
LbB2	Estherville-Burnsville complex, 2 to 6 percent slopes, moderately eroded	Somewhat excessively drained	1.1
LbC	Estherville-Burnsville complex, 6 to 12 percent slopes	Somewhat excessively drained	3.1
LbC2	Estherville-Burnsville complex, 6 to 12 percent slopes, moderately eroded	Somewhat excessively drained	7.6
LbD	Estherville-Burnsville complex, 12 to 50 percent slopes	Somewhat excessively drained	35.5
LcB	Lester loam, 2 to 6 percent slopes	Well drained	6.5
LcB2	Lester loam, 2 to 6 percent slopes, moderately eroded	Well drained	18.3
LcC2	Lester loam, 6 to 10 percent slopes, moderately eroded	Well drained	14.2
LcD2	Lester loam, 10 to 16 percent slopes, moderately eroded	Well drained	1.5

Ma	Marsh	Very poorly drained	166.4
PaA	Klossner muck, 0 to 1 percent slopes	Very poorly drained	1.4
PbA	Houghton muck, 0 to 1 percent slopes	Very poorly drained	151.4
Ta	Terrace escarpments	<Null>	0.1
TcA	Terril loam, 0 to 2 percent slopes	Moderately well drained	1.2
TcB	Terril loam, 2 to 6 percent slopes	Well drained	9.9
W	Water	<Null>	120.4
WaA	Waukegan silt loam, 0 to 2 percent slopes	Well drained	8
WaB2	Waukegan silt loam, 2 to 6 percent slopes, moderately eroded	Well drained	5
WaD2	Waukegan silt loam, 12 to 18 percent slopes, moderately eroded	Well drained	5.3
Wb	Webster-Glencoe silty clay loams	Poorly drained	32.2
Wc	Webster-Le Sueur silty clay loams	Poorly drained	0.2
ZaB2	Sartell fine sand, 2 to 6 percent slopes, moderately eroded	Excessively drained	3.6
		Total:	3575.81

Appendix C. Potential Ecological Impacts

Fire Suppression

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

Disease

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 throughthe 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 shouldinclude 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 areof 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 theprotection 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 nativegenotype, DED-resistant elms become commercially available.

Exotic and Over Populated Animals

4. 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 arevery invasive in our native woodlands and forests. These species move into new areas in waves, one speciesfollowing 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.

5. 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. Theconversion 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 notedthat 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 managementactivities.

6. 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 degreesF, 7 percent at -20 degrees F, and 98 percent at -30 degrees F. However, since the larvae overwinter under thebark and are insulated, air temperatures need to be slightly colder to have the measured effect, and larvae need to be exposed for prolonged periods of time for mortality to occur.

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

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

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

Climate Change

With the advent of global climate change, conditions for plant communities are changing. By the end of the century, scientists believe that much of Minnesota will not be conducive for the growth of boreal pine or boreal mixed forests. The climate of the Twin Cities will be more like that surrounding Sioux Falls, South Dakota, or Oklahoma City, Oklahoma. Minnesota is expected to receive the same average amounts of precipitation or slightly more, but yearly distributions will be different. More rain is expected during the wintermonths 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 D. List of Noxious and Invasive Plants

Plant	MD 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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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				
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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			savanna habit.	
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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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 riparian habitat. It	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			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	MD and MN DNR Status	Mode of Introduction	Ecological Impact	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.	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			It out-competes native species. Reed canary grass is a major threat to natural wetlands.	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				
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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			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.	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. According to the USDA Plant database, this species is not present or with a limited distribution in Minnesota	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.
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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			such as pastures, roadsides, and ditch banks, but also in hayfields and disturbed prairies.	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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			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.	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 Early Detection Species and	Native to Europe and temperate Asia. Common teasel may have been introduced to North America as early as the 1700s, and was likely cultivated for producing wool or as an ornamental.	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 waterways. It occupies sunny and open sites such as riparian areas, meadows, grassland, savannas, forest openings, 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. 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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			disturbed sites.	
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.	Teasels produce massive amounts of seed that can remain viable in the soil for several years and have germination	Mechanical: Individual rosettes can be removed using a dandelion digger; removal of the entire root is essential to eliminate re-sprouting. Flowering stalks

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
		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.	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.	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 Early Detection Species; it is reported in Minnesota	A plant native from central Europe east to central Asia; originally introduced into North America as an ornamental plant.	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 plant species and decrease plant species diversity. It is typically found along disturbed sites, road-sites, clear-cuts, railroad right-of-ways, fences,	Manual: Hand pulling, mowing, and tillage can be effective in preventing seed production and starving toadflax roots, thereby controlling infestation under certain 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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			croplands, pastures, and rangelands	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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 prairies and sand blow-outs where vegetation is sparse. It is most abundant in dry areas, fields, and waste places.	Mechanical: Mowing and pulling Thermal: Prescribed burning
apanese 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	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			disturbed areas.	
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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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 (Eradicate List)	Native to Europe and likely a fertile hybrid between black and brown knapweeds. It may have been introduces to western North America for forage, but is not palatable and has low nutritional value	Grows aggressively and forms dense patches of vegetation. Out-competes other plants in pastures, hayfields, meadows, riparian areas, forest margins, and rights-of-way.	Mechanical: Combination of hand-pulling and digging is an option for small infestations 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	It is distasteful to grazing animals, giving it a competitive edge. It generally does not pose a threat to high	Mechanical: Pulling or mowing in early bud or bloom stage, then dispose off-site Chemical: Spot spraying with glyphosate, triclopyr or

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
		agricultural pest.	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.	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	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			effect on neighboring plants. It invades northern moist prairies, forest openings, abandoned fields, clear-cuts, and roadsides.	
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 plants, especially under grazing pressure.	Mechanical: Repeated pulling of small infestations is effective.
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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
				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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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				
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 E. Methods for Controlling Exotic, Invasive Plant Species

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. Theyare 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 closeto 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. Itis 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, andReclaim.

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 fromthe 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 licensedapplicators 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 thebark 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% Garlon4, mixed with a penetrating oil, is applied all around the base of the tree or shrub, taking care so that it doesnot 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 forweed 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 ofthe 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 whereit 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.

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 controlis 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 maynot be as dense.

2. Wild Parsnip

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

- 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 removeChemical
- Use sparingly in quality habitats
- Spot application with glyphosate or selective metsulfuron after a prescribed burn; parsnip is one of thefirst 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.

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.

4. 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 weedyperennial 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 overtime, 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 andlater as this application timing maximizes translocation of the herbicide to the rhizomes, ensuring maximumrhizome mortality, which is crucial to control of RCG. Two herbicide applications can be implemented duringthis 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 andfrom 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 thistime 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.

5. 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.

6. 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 propagulesources, 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 F. Suggested Native Shrubs for Replacing Common Buckthorn

Dry Upland Areas					
CommonName	**ScientificName**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
New Jersey tea	*Ceanothus americanus*	2 to 3	Full sun	High: butterflies andhummingbirds	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 to 12	Sun/part shade	highly valued by mammalsand birds	Spreads, but slowly; forms very deep roots
Beaked hazelnut	*Corylus cornuta*	6 to 12	Sun/shade	high	Spreads, but slowly. More northern range thanAmerican hazelnut.
Eastern red cedar	*Juniperus virginiana*	20	Sun	high	Invades prairies in absence of fire. Important birdcover in winter and summer heat.
Pin cherry	*Prunus pensylvanica*	10 to 30	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; redberries 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					
CommonName	**ScientificName**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
Allegheny serviceberry	*Amelanchierlaevis*	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 earlysummer.
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	*Viburnumtrilobum*	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 swallowtailbutterfly	Foliage open form in shade, dense in sun.
Flood Tolerant Areas					
CommonName	**ScientificName**	**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 inlate summer
False Indigo	*Amorphafruticosa*	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 G. 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 shallow water 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.

Southern Seepage Meadow/Carr (WMs83)

Open wetlands dominated by a dense cover of hummock-forming broadleaved sedges or tall shrubs. Present in areas of groundwater seepage along streams and drainage ways, on sloping terraces, and at bases of slopes. Vegetation Structure & Composition Description is based on summary of vegetation data from 63 plots (relevés).

• Moss cover is typically absent, although brown mosses may be present.

• Graminoid cover is interrupted to continuous (50–100%); typically dominated by tussock sedge (Carex stricta) or aquatic sedge (C. aquatilis) with bluejoint (Calamagrostis canadensis), lake sedge (C. lacustris), prairie sedge (C. prairea), woolly sedge (C. pellita), and fowl manna grass (Glyceria striata) common. Hairy-fruited sedge (Carex trichocarpa) is dominant on some sites.

• Forb cover is variable (5–75%); common species include spotted Joe pye weed (Eupatorium maculatum), great water dock (Rumex orbiculatus), common boneset (Eupatorium perfoliatum), marsh bellflower (Campanula aparinoides), red-stemmed aster (Aster puniceus), swamp milkweed (Asclepias incarnata), northern and cut-leaved bugleweeds (Lycopus uniflorus and L. americanus), common marsh marigold (Caltha palustris), giant sunflower (Helianthus giganteus), and touch-me-nots (Impatiens spp.)

• Shrub cover is variable. Tall shrubs, if present, include red-osier dogwood (Cornus sericea), pussy willow (Salix discolor), slender willow (S. petiolaris), and Bebb's willow (S. bebbiana).

Landscape Setting & Soils

WMs83 is typically associated with groundwater seepage areas at bases of river terraces or beach ridges, on gentle slopes, or on bottomlands between steep bluffs. It also can occur in level wetlands dissected by streams and rivers that may be fed by groundwater discharge. Surface water is derived primarily from groundwater sources and has neutral to basic pH, reflecting the surrounding calcareous till and bedrock substrate. Soils range from mineral or muck soil to sapric peat. Organic sediments range from very shallow to greater than 36in (100cm) in depth.

Natural History

WMs83 is associated with wetlands influenced by lateral groundwater flow, in contrast to the gravitational water of basins of other wet meadow communities. WMs83 may experience moderate inundation following spring runoff and heavy rains, and periodic drawdowns during summer or as a result of fluctuations in groundwater seepage related to precipitation trends. Water levels are high and persistent enough to prevent trees (and often shrubs) from becoming established, although standing water may be absent by the end of the growing season. Because of water-level fluctuations, surface substrates alternate between aerobic and anaerobic conditions. Organic matter that accumulates over time on the substrate surface is usually oxidized during drought influenced drawdowns or is removed by fire during periods of severe drought. In basins where water flow becomes stabilized, accumulation of peat may cause succession of WMs83 to rich fen; otherwise, the constant inputs of minerals from groundwater flow that typically influence the community, along with warm climatic conditions and frequent drawdown, prevent succession of WMs83 to rich fen. WMs83 WET MEADOW/CARR SYSTEM Southern Floristic Region Frequent fires in the surrounding landscape may be an important factor in reducing the presence of shrubs or accumulation of peat in the community. The lack of a distinct shade-tolerant flora in occurrences of WMs83 dominated by shrubs may be due to historically high fire frequency, which prevents shrubs from becoming established in any one place for very long. It is possible that shrub-dominated areas are more frequent now than in the past because of fire suppression over the past 100–150 years.

Native Plant Community Types in Class

• WMs83a Seepage Meadow/Carr WMs83a is the only community type recognized in this class at present; it is divided into three subtypes, based on dominant species. WMs83a1 is the most abundant of the three subtypes; WMs83a3 is not well documented and appears to be uncommon. WMs83a has been documented in the PPL, MIM, LAP, CGP, RRV, and WSU.

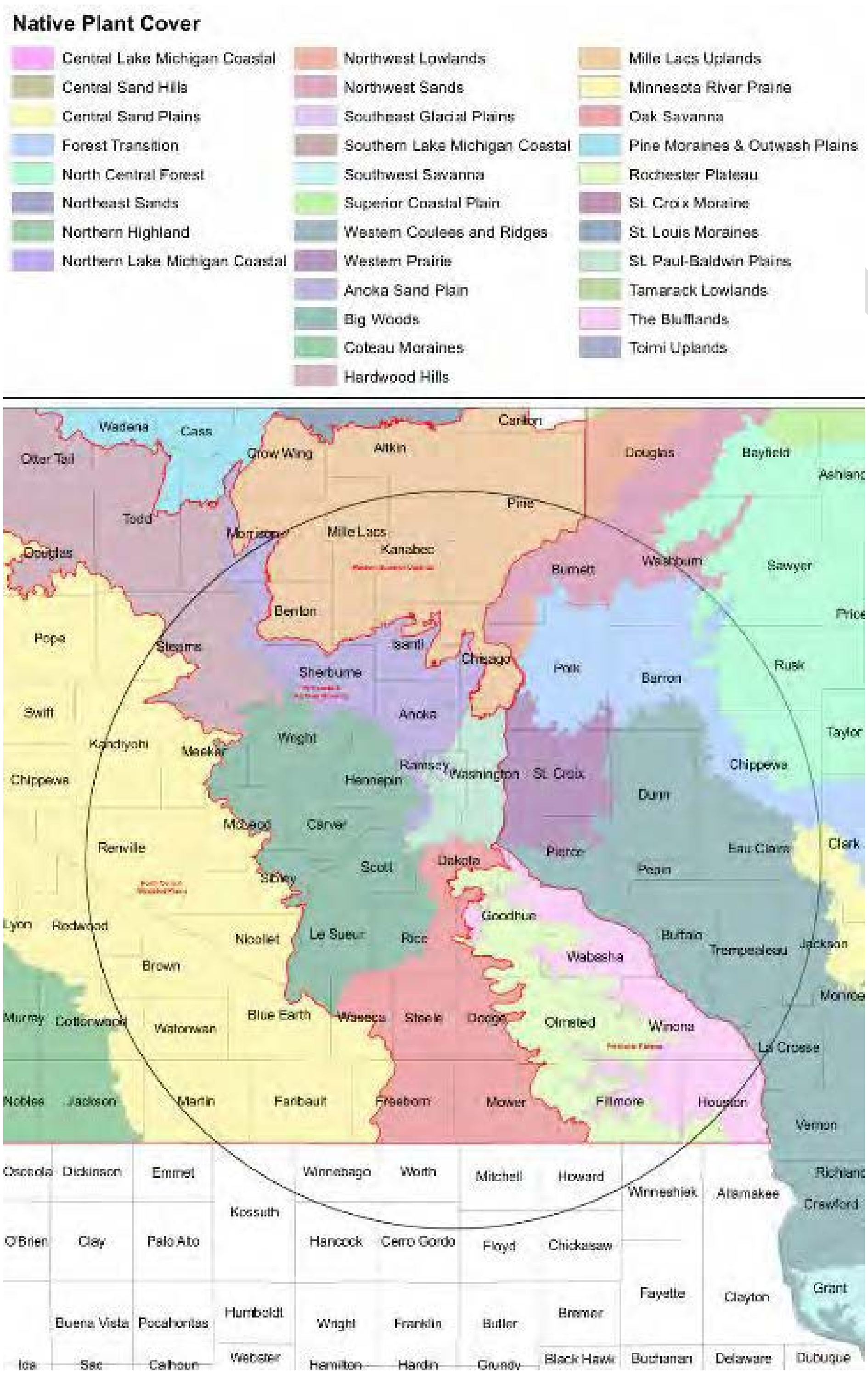
• WMs83a1 Tussock Sedge Subtype Open, graminoid-dominated meadows. WMs83a1 differs from the other subtypes in WMs83a by the dominance of tussock sedge (Carex stricta) or, rarely, hairy-fruited sedge (C. trichocarpa). WMs83a1 is present throughout the EBF Province, although uncommon in some areas. Description is based on summary of vegetation data from 48 plots.

• WMs83a2 Aquatic Sedge Subtype Open, graminoid-dominated meadows, often associated with calcareous fens (OPp93). WMs83a2 differs from the other subtypes in WMs83a by the dominance of aquatic sedge (Carex aquatilis), with interior sedge (C. interior), Sartwell's sedge (C. sartwellii), and hardstem bulrush (Scirpus acutus) also typical in the graminoid layer. Shrub cover is low with pussy willow and red-osier dogwood common, and sage-leaved willow and bog birch occasional. Common forbs include bog aster (Aster borealis), common marsh marigold, and bulb-bearing water hemlock (Cicuta bulbifera). WMs83a2b is present throughout the MIM and also present in the CGP, RRV, and very locally in the PPL. Description is based on summary of vegetation data from 13 plots.

• WMs83a3 Impatiens Subtype Small, open, forb-dominated meadows in forested settings. WMs83a3 often differs from the other subtypes in WMs83a by being dominated by forbs and having low cover of sedges and other graminoids. WMs83a3 is often associated with Southern Wet Ash Swamps (WFs57), developing where areas of strong groundwater seepage create large gaps in the tree canopy and favor the presence of shade-intolerant species. WMs83a3 has been documented in seepage areas on terraces along streams and rivers in the MIM and PPL. Description is based on summary of vegetation data from 2 plots

Appendix H. 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 I. Public Engagement

Public engagement for this project consisted of reaching out to the general public via one online public meeting at the Final 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 30-day public review period.

Phase I Research and Findings

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Phase II Vision, Goals, Recommendations

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Phase III Draft Final Plan

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North Creek Greenway

Natural Resources Management Plan

02/17/2022

Table of Contents

Acknowledgements

Dakota County Parks Department

14955 Galaxie Avenue, Apple Valley, MN 55124

Project Lead and Contact

Christian Klatt
christian.klatt@co.dakota.mn.us
952-891-7947

Natural Resource Management Plan Consultant

Stantec Consulting Services, Inc.

Mimi Wagner, Project Manager
Diane Narem, Vegetation Ecologist
Erica Christiansen, Wildlife Biologist
Anna Varian, Aquatic Environmental Scientist

Partners

City of Apple Valley
City of Farmington
City of Lakeville
City of Burnsville
Minnesota Zoo
Vermillion River Watershed Joint Powers Organization

Technical Advisory Group

John Mertens, Dakota County
John Hennen, City of Lakeville
Kellee Omlid, City of Farmington
Mike Endres, City of Apply Valley
Seth Stapleton, Minnesota Zoo
Samantha Berger, City of Apple Valley

Michael Lynn, Dakota County
Ann Messerschmidt, City of Lakeville
Jeremy Pire, City of Farmington
Jessica Schaum, City of Apple Valley
Travis Thiel, VRWJPO

Tom Lewinski, Dakota County
McKenzie Cafferty, City of Lakeville
Thomas Root, Minnesota Zoo
Erik Runquist, Minnesota Zoo
Mark Ryan, VRWJPO

Executive Summary

Background

The North Creek Greenway is a planned 14-mile trail that runs north – south through central Dakota County. The Minnesota Zoo and Rambling River Park act as bookends on the route. The greenway passes through Eagan, Apple Valley, Lakeville and Farmington. The greenway connects 1,464 acres of public land including multiple parks and conservation areas associated with North Creek

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 forests along rivers 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, 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. Utilizing the Adaptive Management strategy (**Executive Figure 1**), Dakota County approaches land management with the understanding that changing environmental conditions and human activities require constant learning and adaptation. 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.

Executive Figure 1: Adaptive Management Strategy

Planning Process

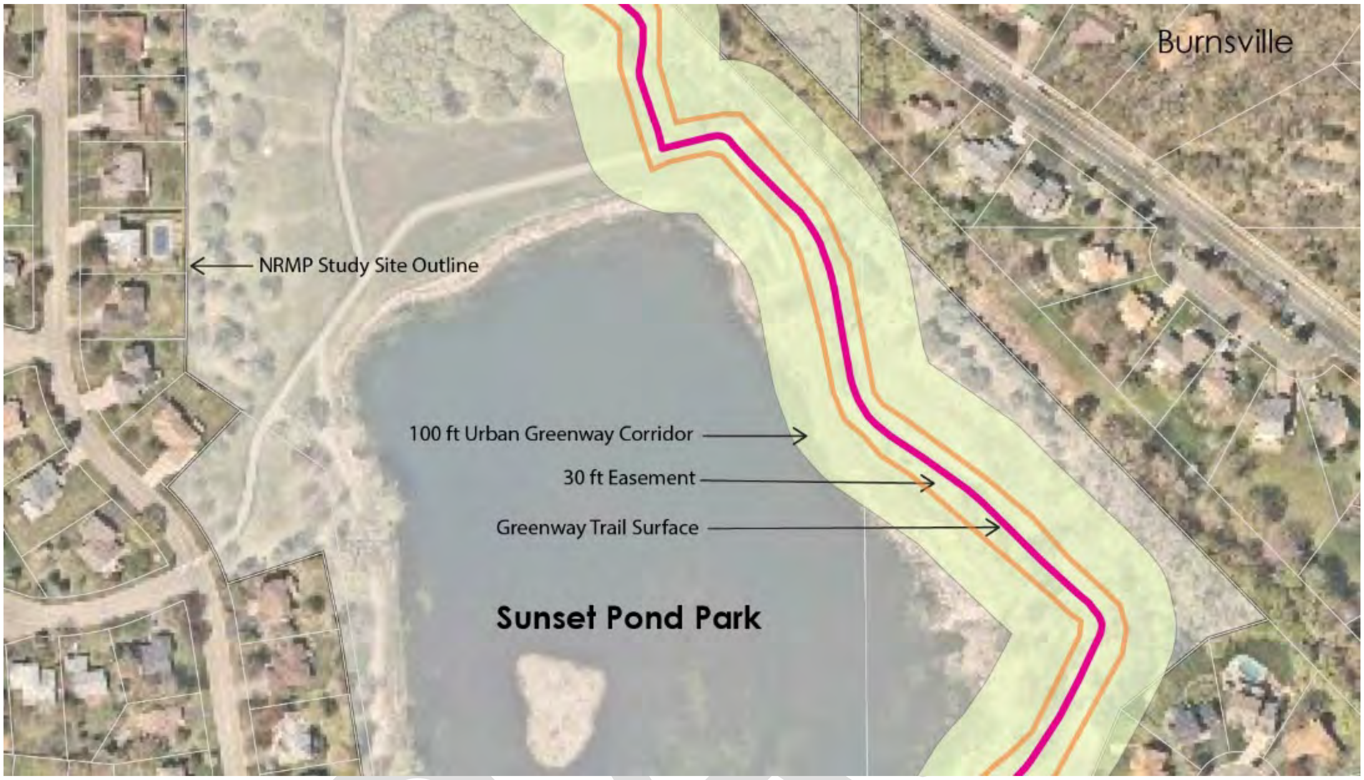
Greenway Partners formulated summaries of issues, concerns and interests related to natural resources in their jurisdiction at the outset of the project (Appendix A). These summaries guided the development of background data for the project and collaboration with additional partners. Elements included in each of the Natural Resource Management Plan Site Recommendation Plans were guided and vetted by the jurisdictional partner and the Vermillion River Watershed Joint Powers Organization. Dakota County completed a final review on each recommendation. Recommendations address water resources, vegetation communities, and human behavior in and near the Greenway corridor. A thirty-day public review of this plan was conducted during January-February 2022. The final plan was adopted by the Dakota County Board of Commissioners on _____, 2022.

Natural Resource Management Plan Recommendations

Restoration projects within public lands along the North Creek Greenway Corridor amount to approximately **$1.5 million** in project costs. **Table 8** 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 North Creek 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 those that are still in relatively good ecological health (the wetland in Jim Bell Preserve).

The implementation of natural resource projects outlined in **Table 8** 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 2** 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 2: 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** exhibits Funding Scenarios for natural resource restoration activities based upon the cost estimates presented in **Table 11** and were constructed with the following assumptions:

- Dakota County assumes 100% of the costs associated with Easements and with restoration in a typical park setting (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 is that the County assists with 25% cost share for grant match outside the 100 ft Urban Greenway Corridor, or 25% of total costs if no grant is obtained;
- 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 11**), 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.

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.

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)**.**

Vision, Goals and Approach

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.

Goals

- **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.
- **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.
- **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.
- **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.
- **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.

Approach

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 **Executive Figure 1**.

Natural History and Current Conditions

Landscape Context

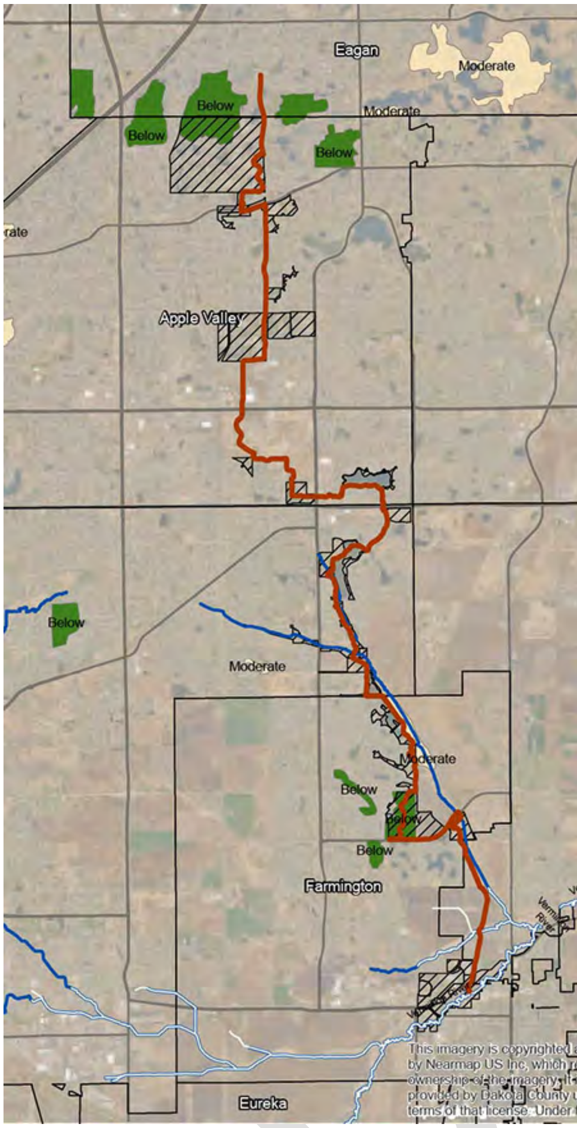
Location

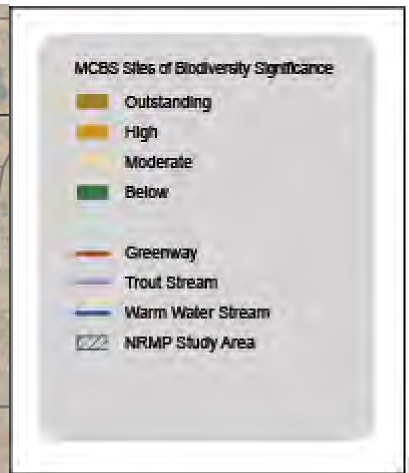
The North Creek Greenway is a planned 14-mile trail that runs north – south through central Dakota County. The Minnesota Zoo and Rambling River Park act as bookends on the route. The greenway passes through Eagan, Apple Valley, Lakeville and Farmington. The greenway connects 1,464 acres of public land including multiple parks and conservation areas associated with North Creek (**Figure 1**). The Greenway connects regions designated as Metro Conservation Corridors (MeCC, a regional land protection plan of the MN DNR), highlighting the importance these greenspaces play in facilitating movement and providing contiguous habitat for pollinators and other wildlife (**Figure 2**).

The parks and greenspaces connected by the North Creek Greenway vary in size from small community parks and easements up to city parks of more than 100 acres 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. In addition to city parks and public spaces, the greenway connects the School of Environmental Studies, Falcon Ridge Elementary, Apple Valley High School, Scott Highlands Middle School, East Lake Elementary, Levi P. Dodge Middle School and Riverview Elementary. These schools are managed by Independent School Districts 196 and 192. The School of Environmental Studies is situated on the Minnesota Zoo property and, in particular, has access to quality natural spaces and ongoing student ecological restoration projects.

The North Creek Greenway, compared to other greenways such as Lake Marion, often parallels the edges of public lands rather than traversing through them. There are multiple road crossings that dissect what would otherwise contiguous greenspaces. In particular, 140th Street W., 150th Street W., Pilot Knob Road, 160th Street W., 170th Street W. are high traffic roads with wide crossings. 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





Historic and Existing Landscape Patterns

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 3** and **5** are historic aerial photos for natural segments of the REPLACE 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

FIGURE 2: Sub-Regional Landscape Context

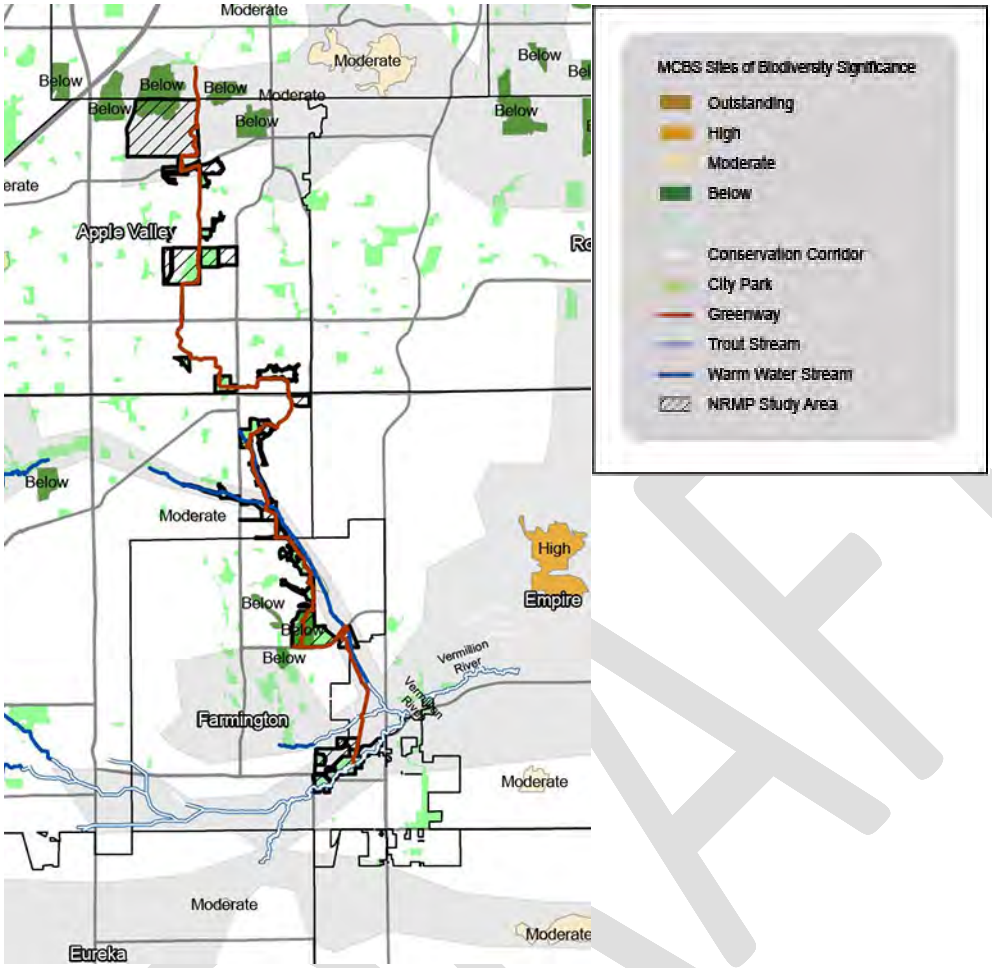
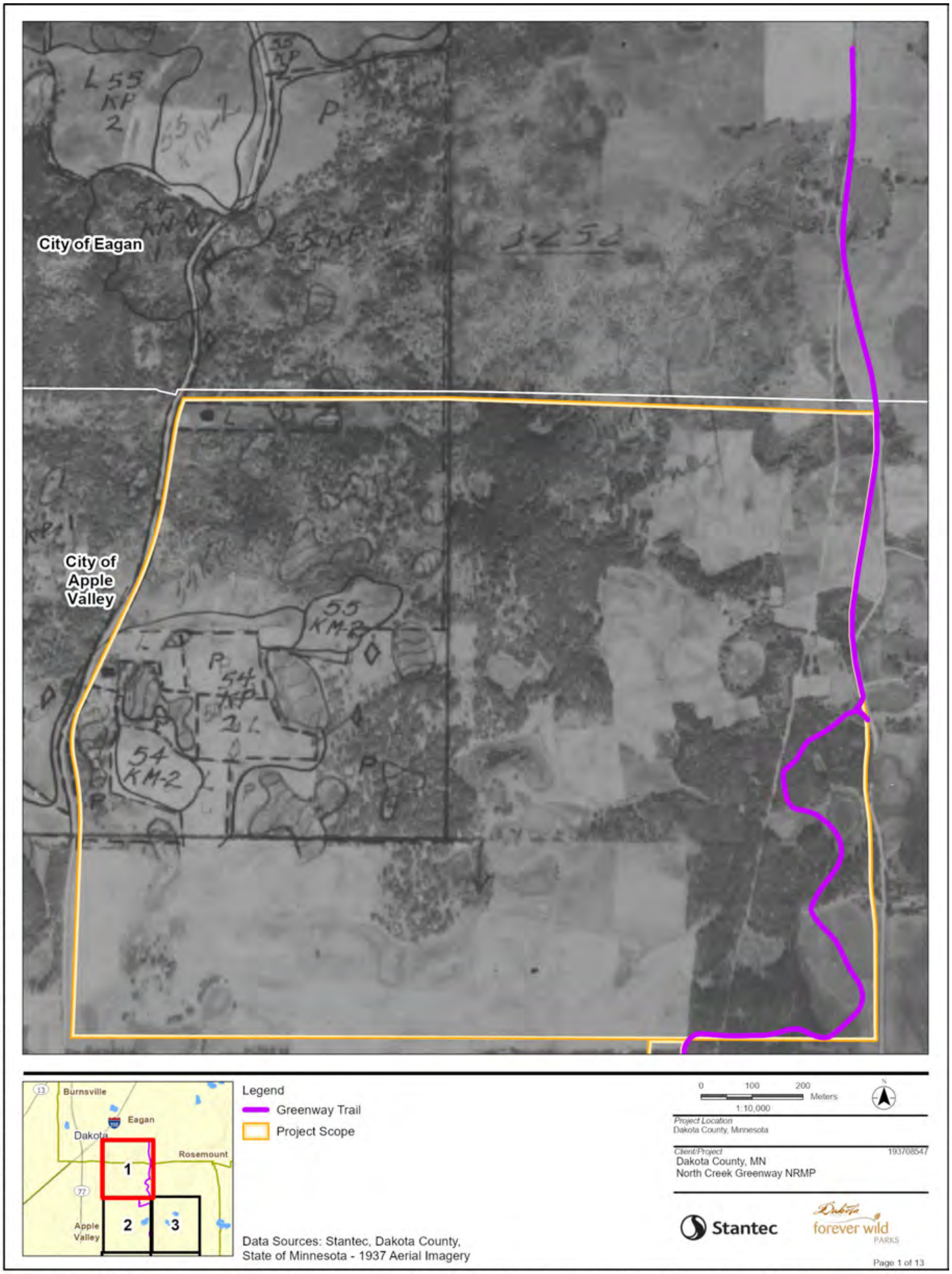


FIGURE 3: Earliest Historical Aerial Photographs of the Corridor



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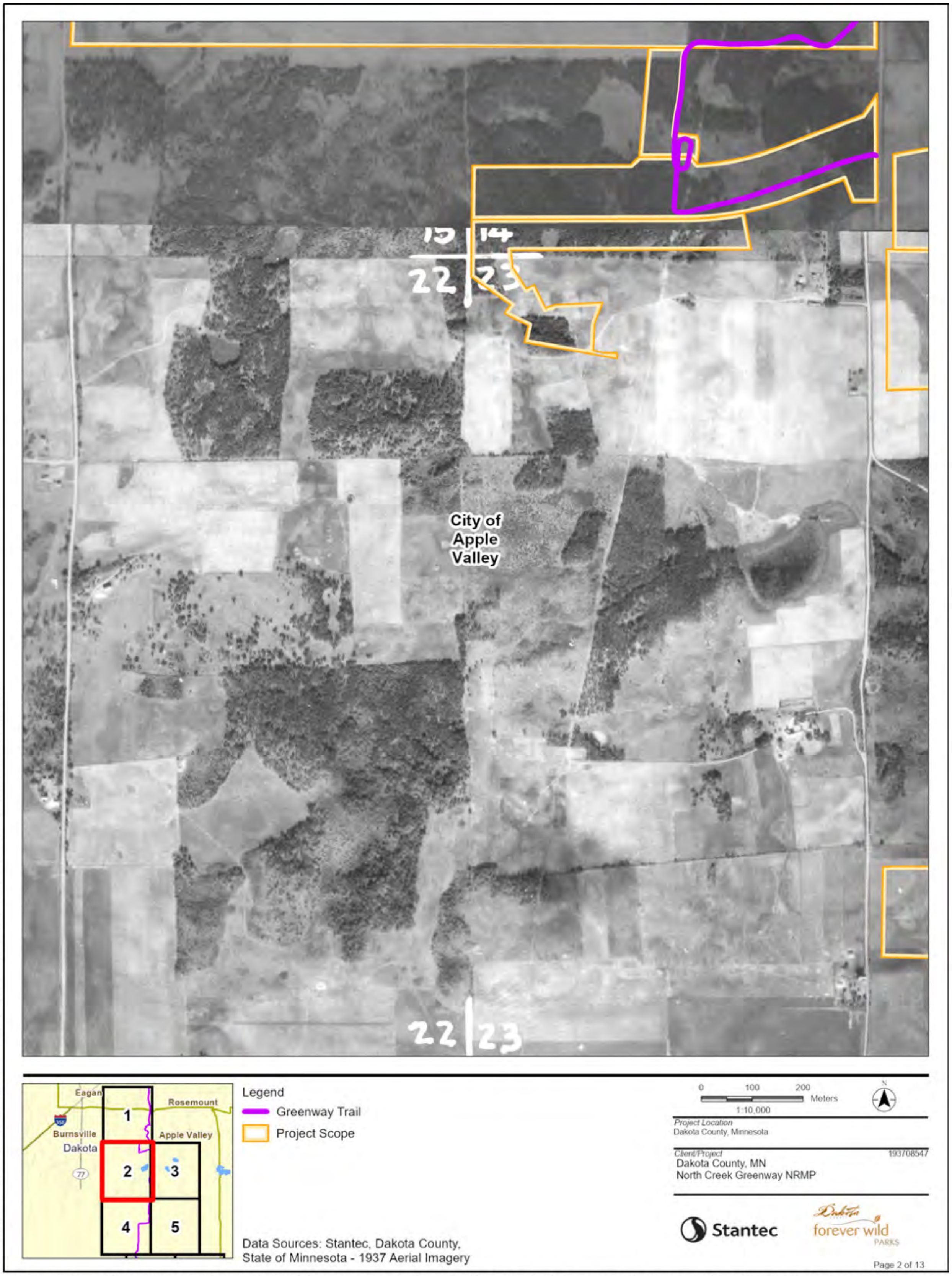

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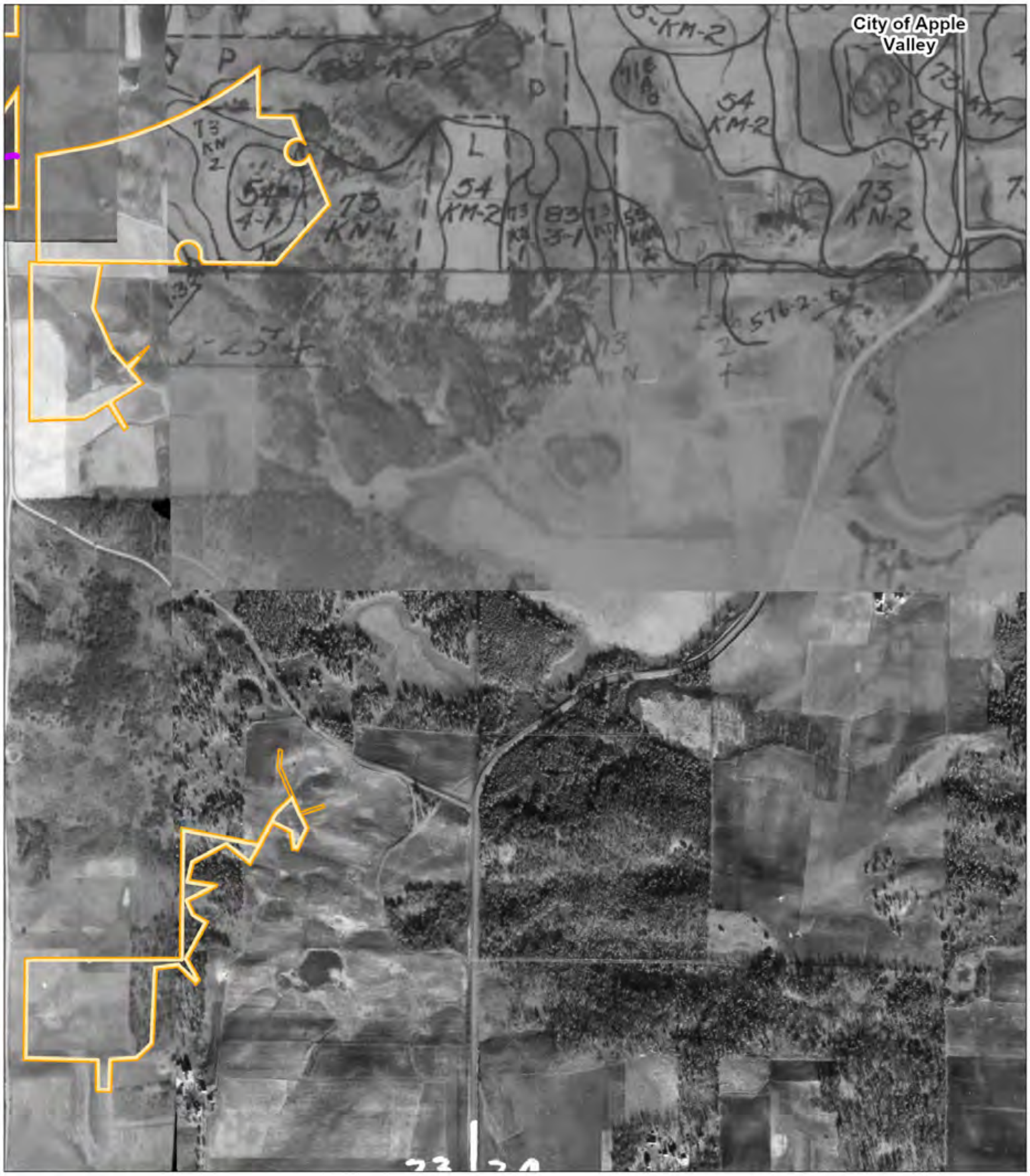

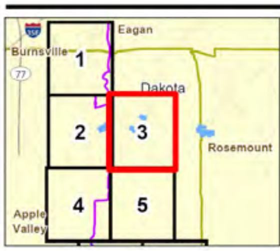

Legend

Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

0 100 200 Meters

1:10,000

Project Location
Dakota County, Minnesota

Client/Project 193708547
Dakota County, MN
North Creek Greenway NRMP

Stantec

Dakota forever wild PARKS

Page 3 of 13

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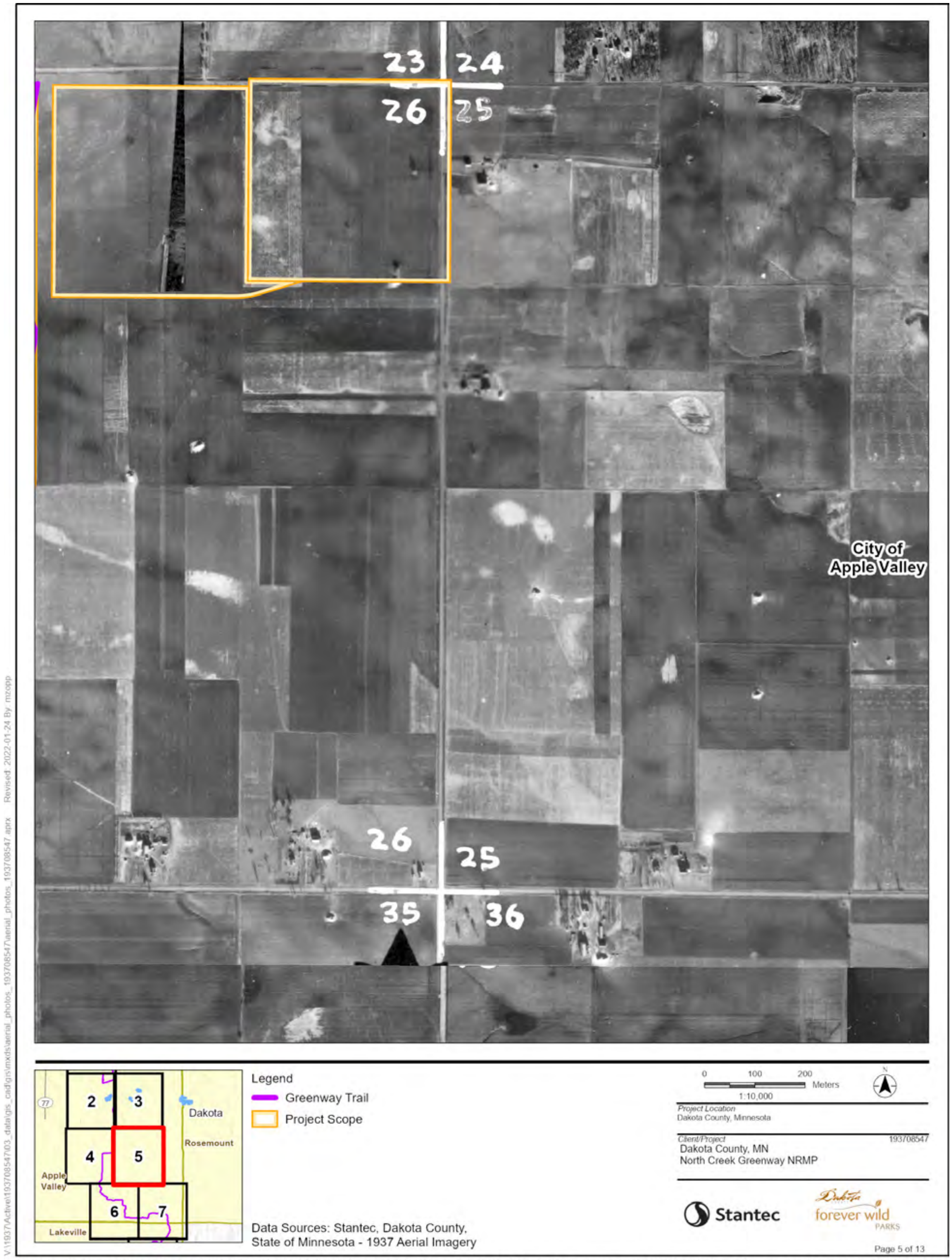
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24
26
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City of Apple Valley
26
25
35
36
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7
77
Dakota
Rosemount
Apple Valley
Lakeville
Legend
Greenway Trail
Project Scope
Data Sources: Stantec, Dakota County,
State of Minnesota - 1937 Aerial Imagery
0 100 200 Meters
1:10,000
Project Location
Dakota County, Minnesota
Client/Project
193708547
Dakota County, MN
North Creek Greenway NRMP
Stantec
Dakota forever wild PARKS
Page 5 of 13
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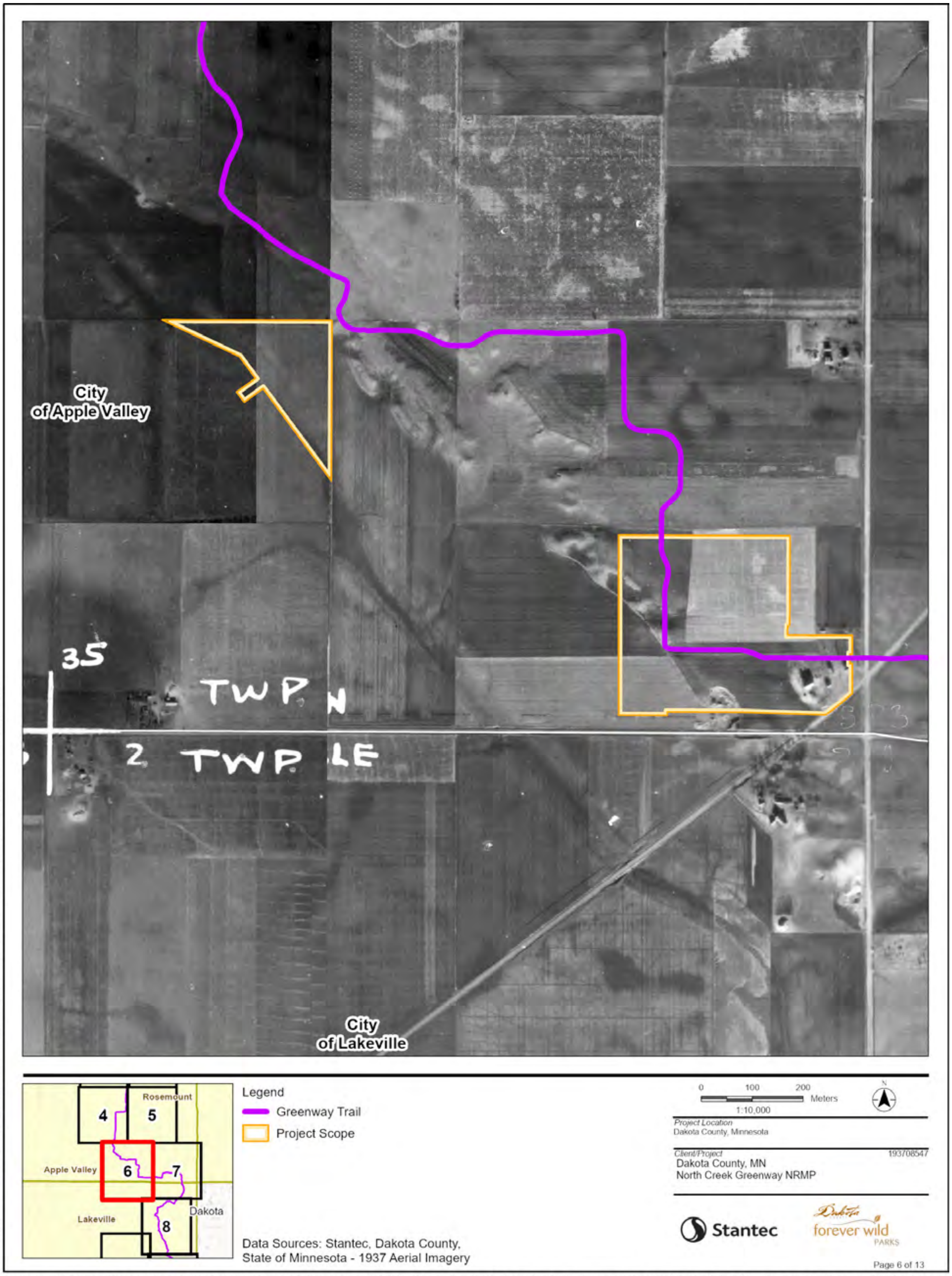

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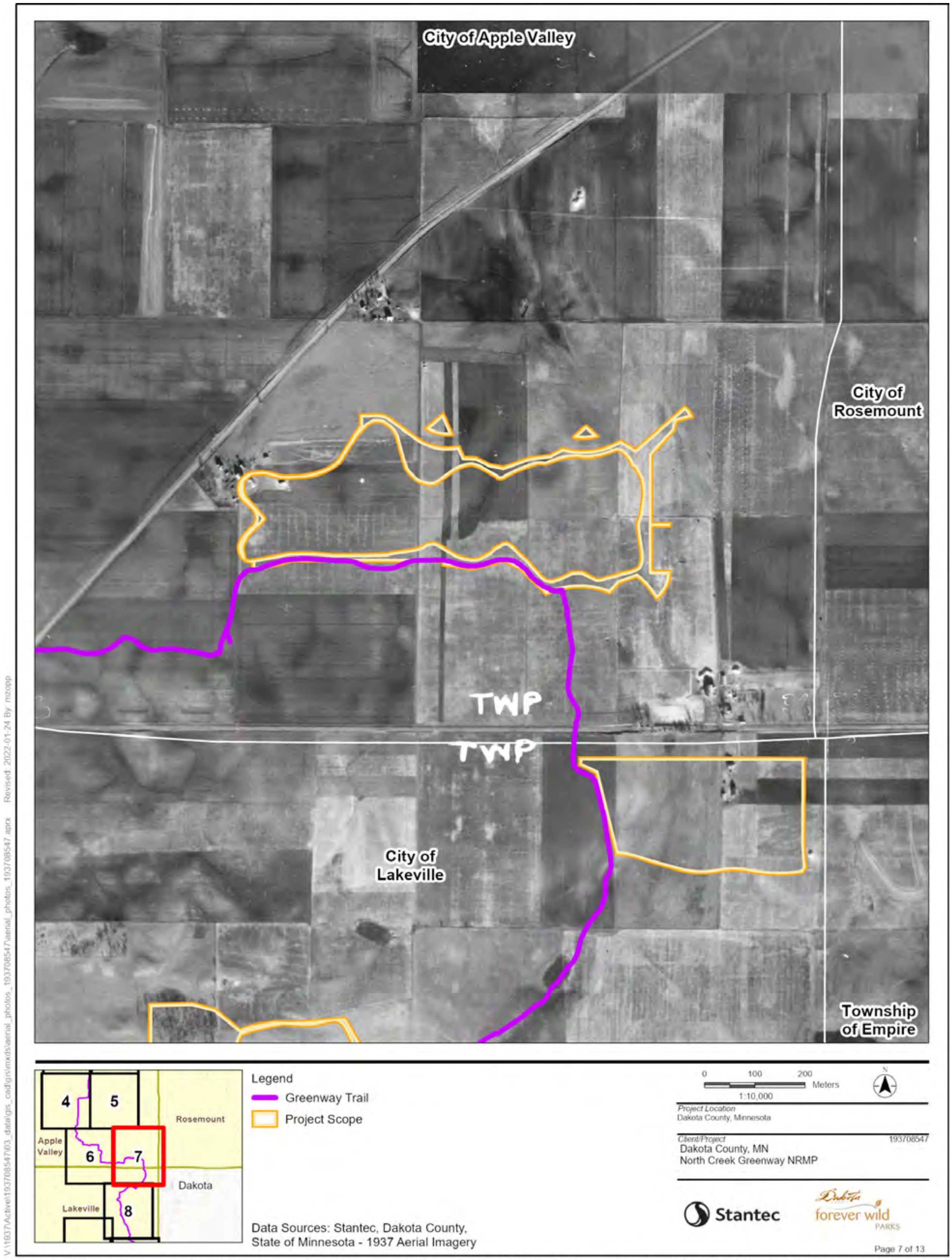

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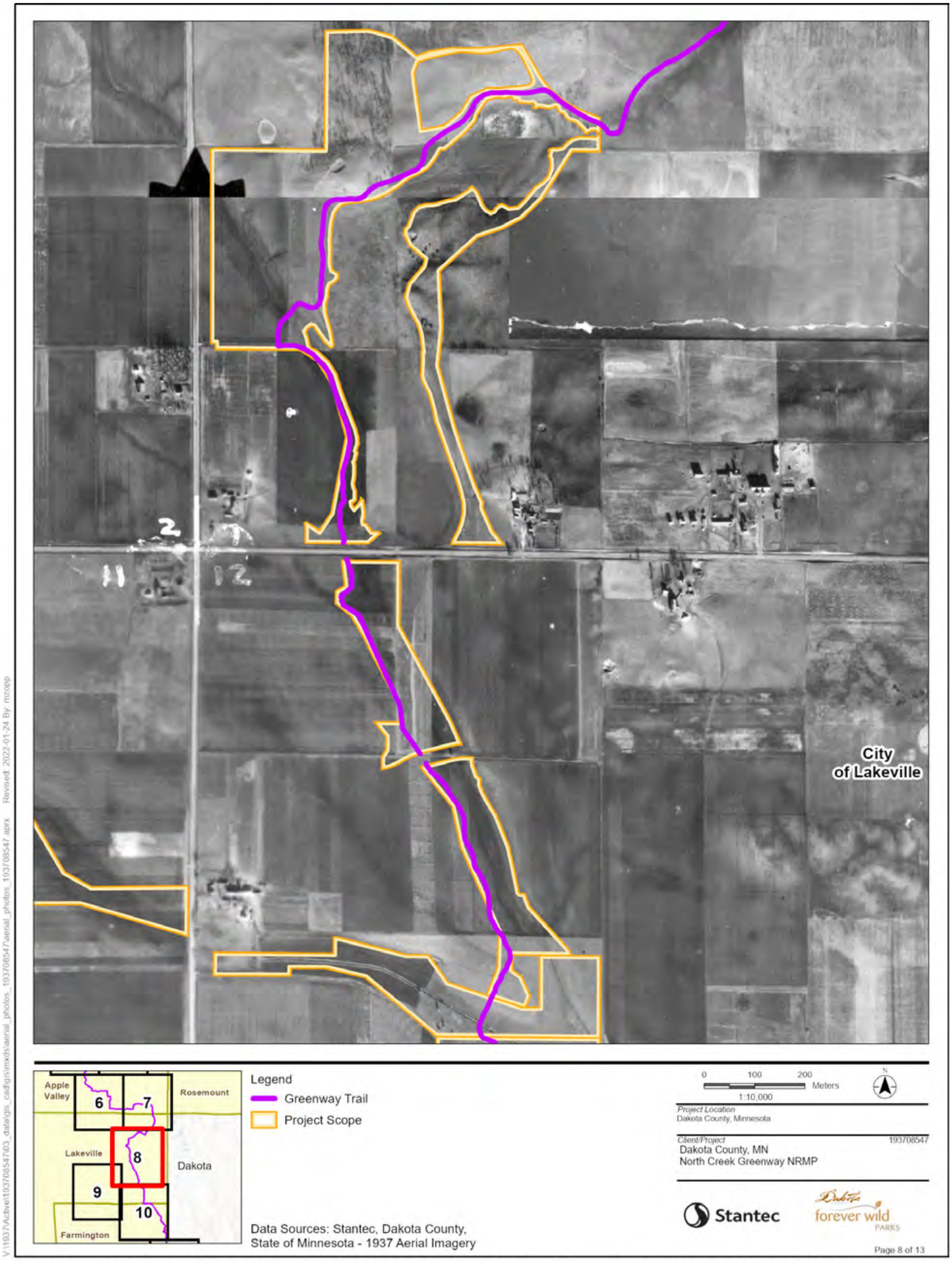

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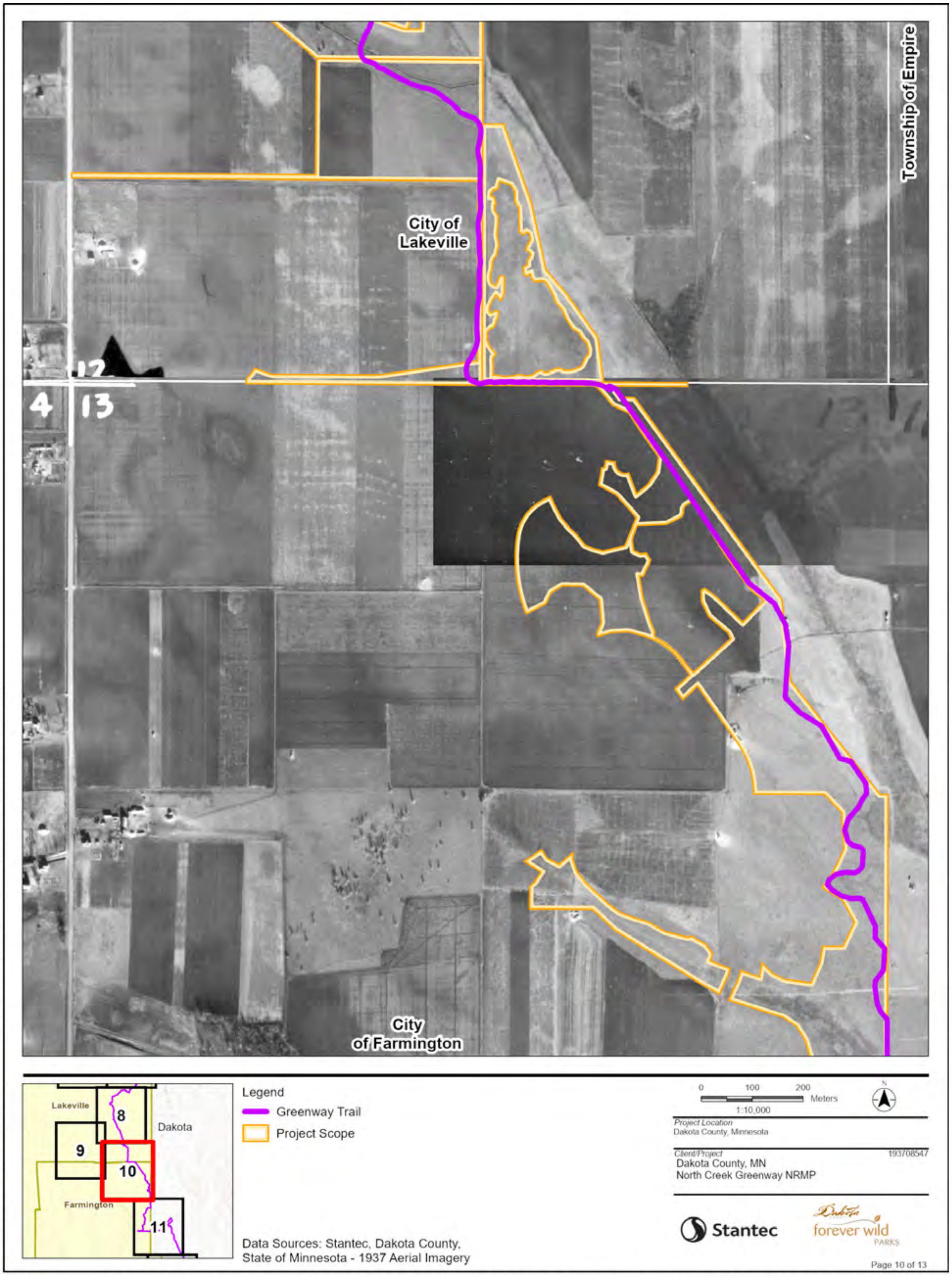

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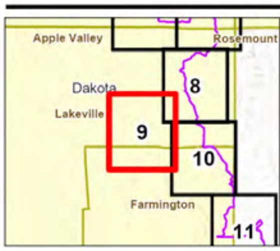

Legend

Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 1937 Aerial Imagery

0 100 200 Meters

1:10,000

Project Location
Dakota County, Minnesota

Client/Project
193708547
Dakota County, MN
North Creek Greenway NRMP

Stantec

Dakota forever wild PARKS

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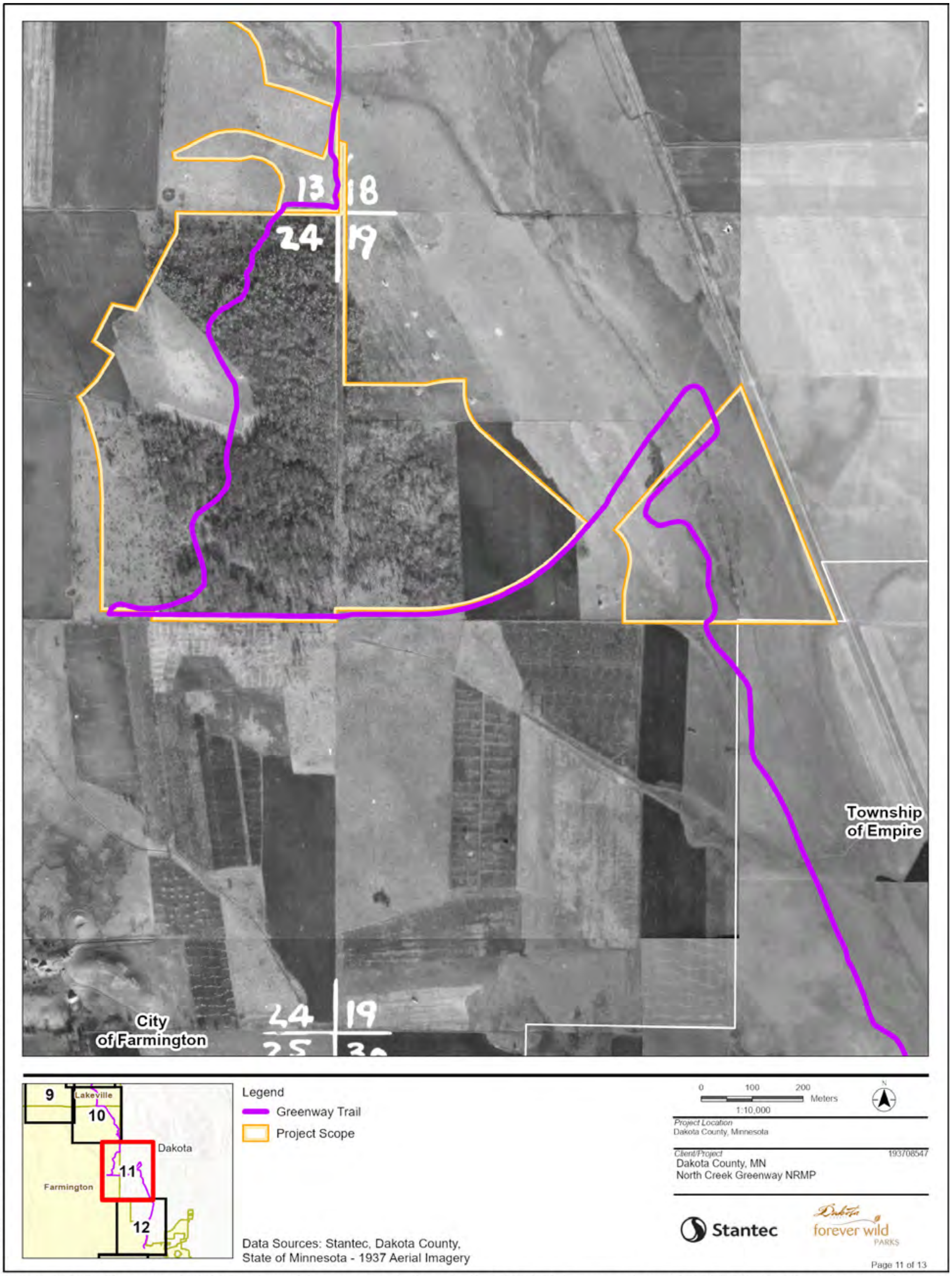

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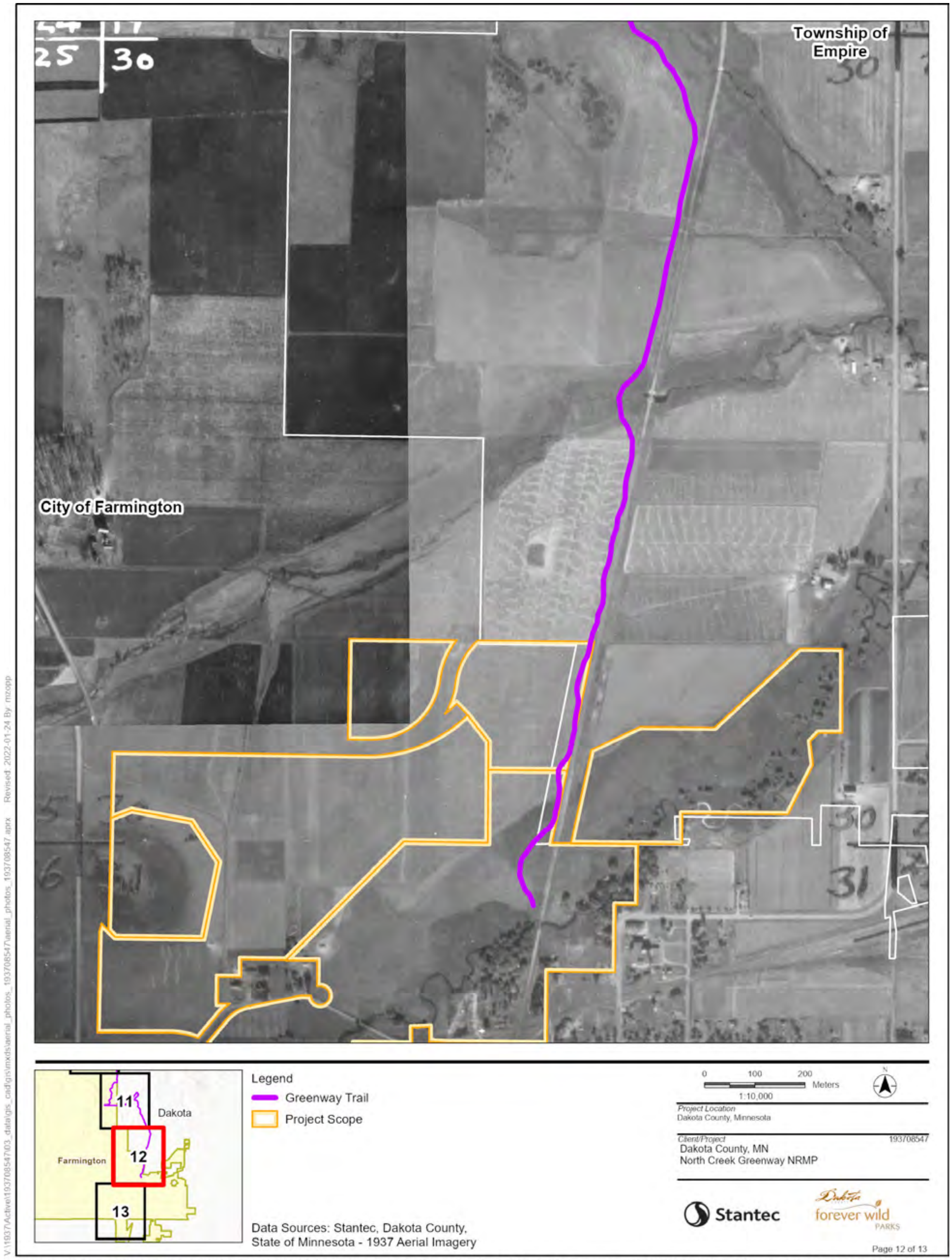

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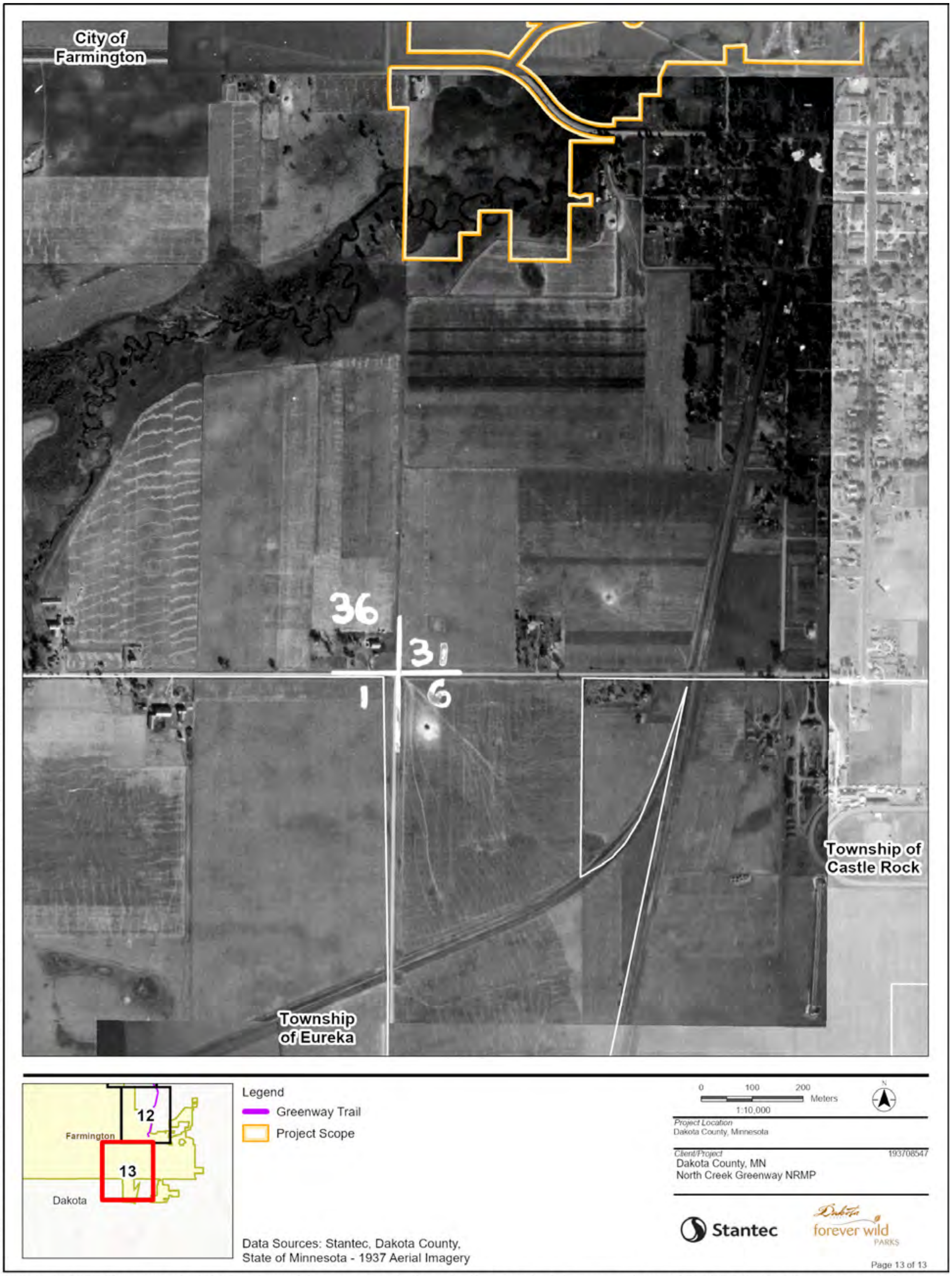

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The following comments address these issues in more detail:

- Nearly the entire greenway route south of Findlay Park was already in row cropped production by the 1937 aerial photos. Forested areas existed in what is now the Minnesota Zoo, Findlay Park, East Lake Community Park and Jim Bell Park and Preserve, and have largely remained intact between 1937 and today.
- North Creek and Middle Creek channels, as well as their tributaries, are barely visible on the land in the 1937 aerial photos. Riparian areas were mostly in row cropped production and some grassland. Distinct mostly straight channels appear by the 1964 aerial photos, but most riparian areas remain primarily pasture and row-cropped agriculture.
- The Finden Property Easement appears uncultivated in the 1937 aerial photo, although it is surrounded by cropland. The area may have been grazed or hayed during dryer periods; a few scattered large trees are evident near the river.
- The Vermillion River floodplain, both on the Finden parcel as well as what would become Rambling River Park, contained limited scattered trees and other woody growth in 1937. Overtime, housing overtook the adjacent agricultural lands and tree density has steadily increased up to the present. Today, floodplain forest is the dominant vegetation type in this reach of the Vermillion River. In the past, the land cover would likely have consisted of a shrubby, wet-meadow plant community.
- The Vermillion River channel near the greenbelt appeared wildly meandering in the earliest aerial photos. Evidence of lateral migration, including cut off meanders and former floodplains, are present. The width of the floodplain began to be encroached with housing in the 1950's. Sections of the river were straightened between 1937 and 1951. The visual channel appears wider today compared to 1964. This is evidence of the hydrological changes in the watershed including the introduction of large amounts of impervious surfaces, construction of storm sewers and agricultural drain tile lines, and replacement of native vegetation with agricultural production.
- Most NWI wetlands were row cropped in 1937; some appear as marshy wetlands with close proximity to row cropped areas.
- Rural housing was scattered at a low density along much of the greenbelt in 1937. Neighborhood developments began appearing near the area of the greenway corridor after 1974 and surrounded the corridor by 2019.

Historic Vegetation Patterns

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 4**, 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.

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 (**Figures 6 and 7**).

Figure 6 Planned Land Use near the Corridor

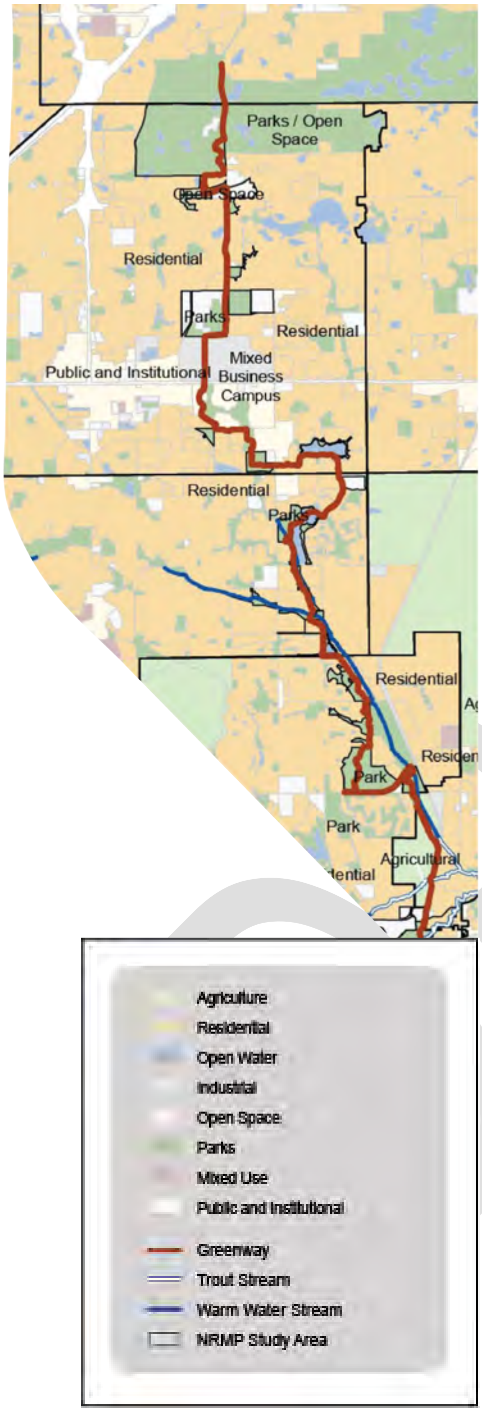
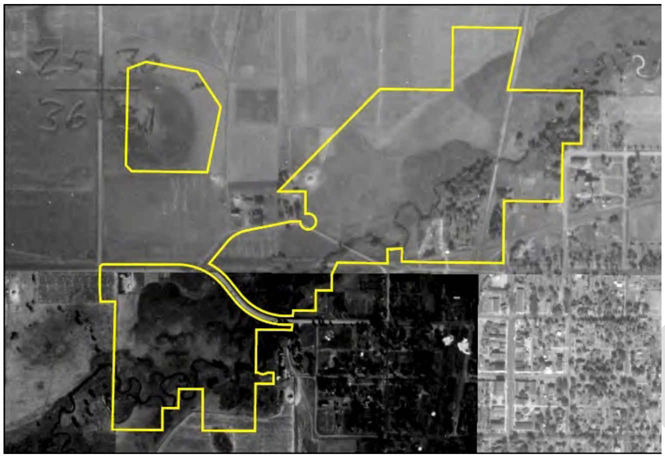


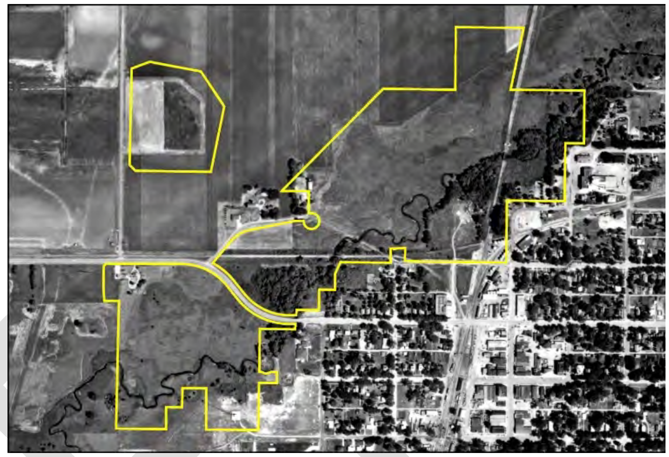
FIGURE 4: Pre-Settlement Vegetation of Greenway Corridor and Surrounding Region

FIGURE 5: Historic Aerial Composites: Rambling River Park

1937



1964



1991

2010

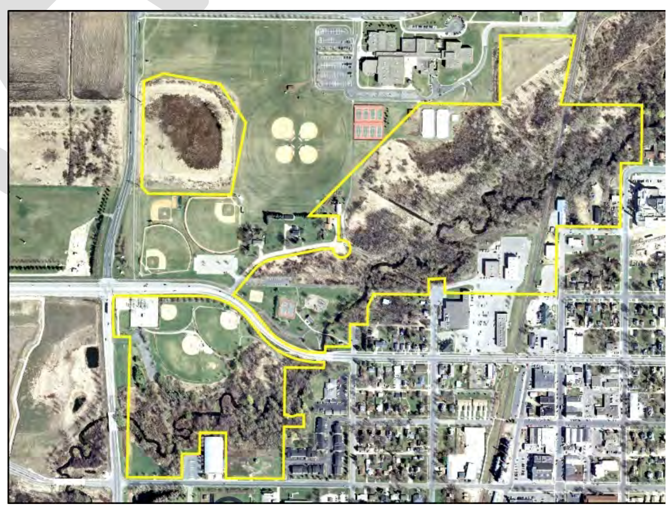
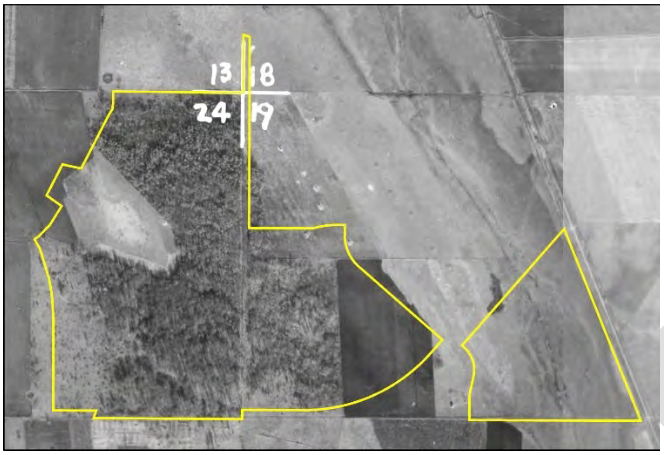


FIGURE 5: Historic Aerial Composites: Jim Bell Park and Preserve – Fairhill Park

1937



1964

1991

2010

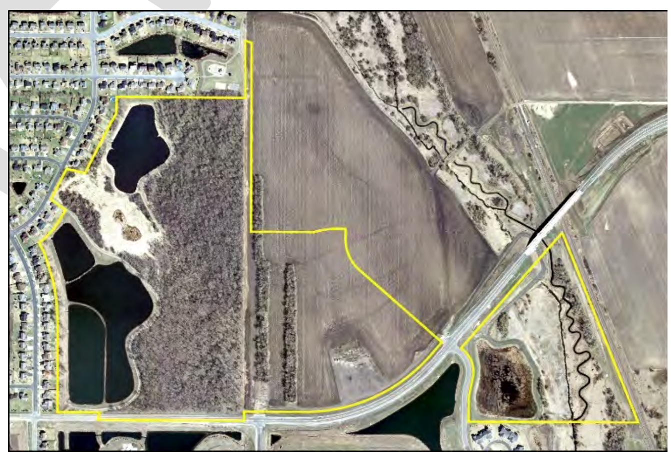
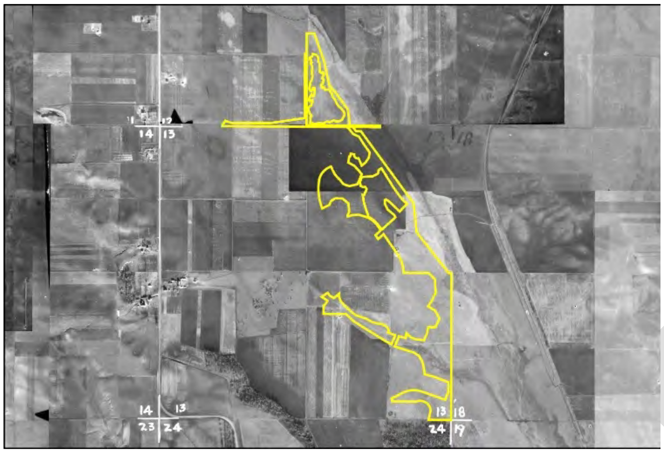
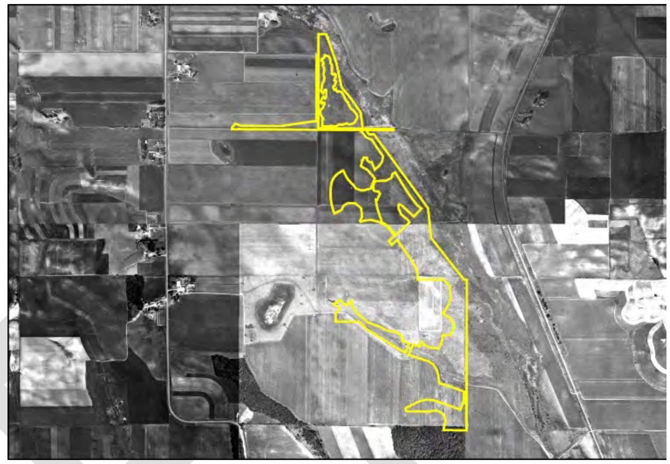


FIGURE 5: Historic Aerial Composites: North Creek Park – Pheasant Run Stormwater Pond

1937



1964



1991

2010

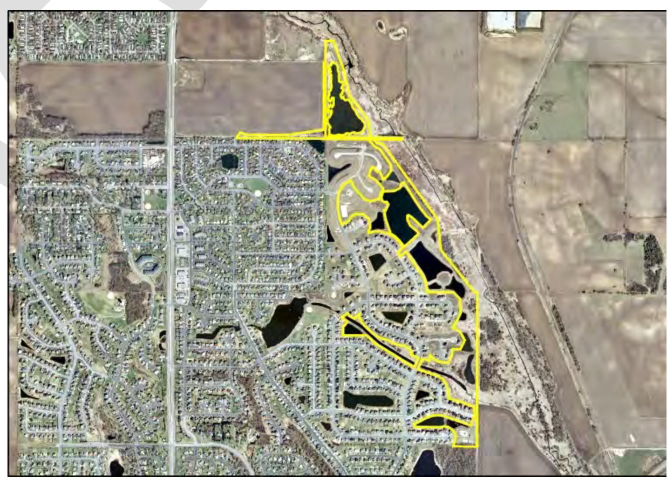
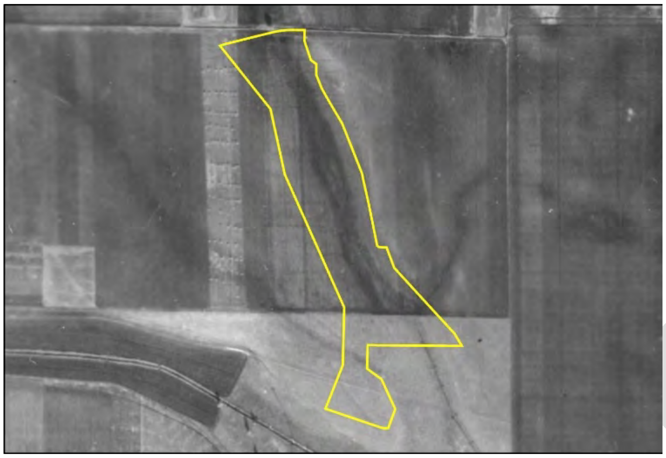
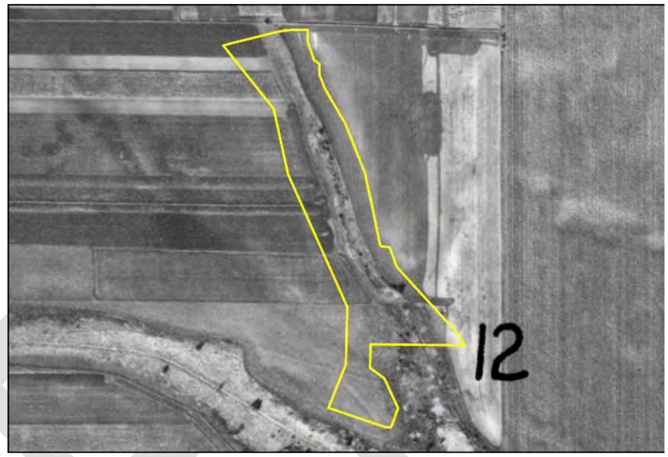


FIGURE 5: Historic Aerial Composites: North Creek PCA

1937



1964

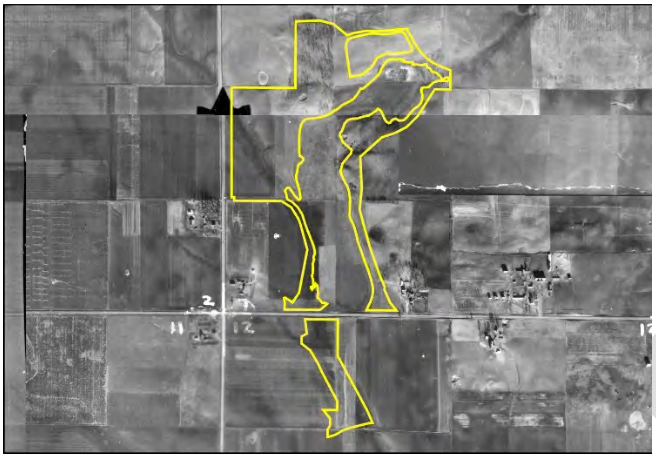


1991

2010

FIGURE 5: Historic Aerial Composites: East Lake Community Park

1937



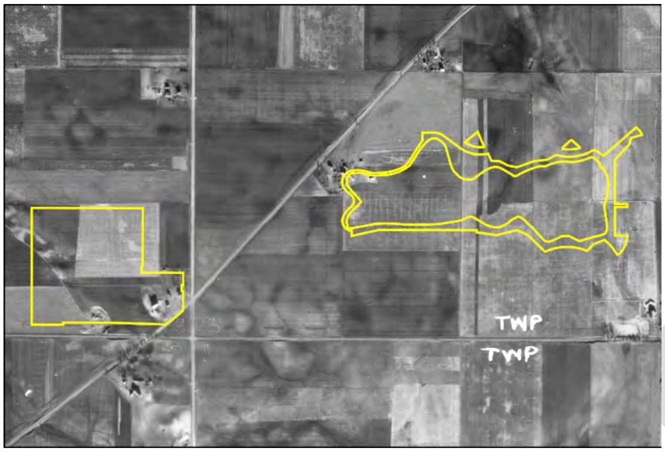
1964

1991

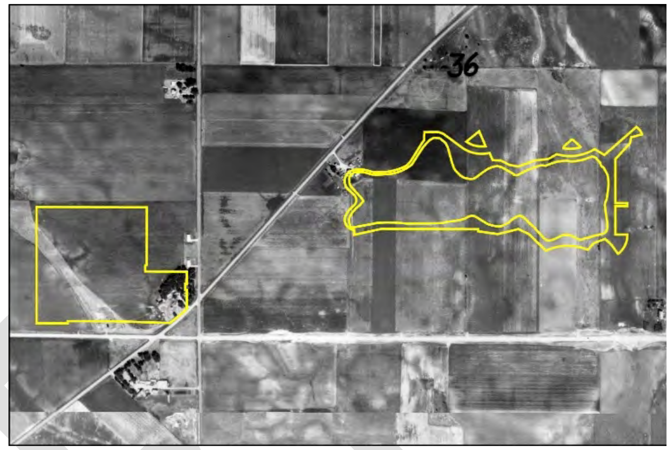
2010

FIGURE 5: Historic Aerial Composites: Cobblestone Lake Park – Quarry Point Park

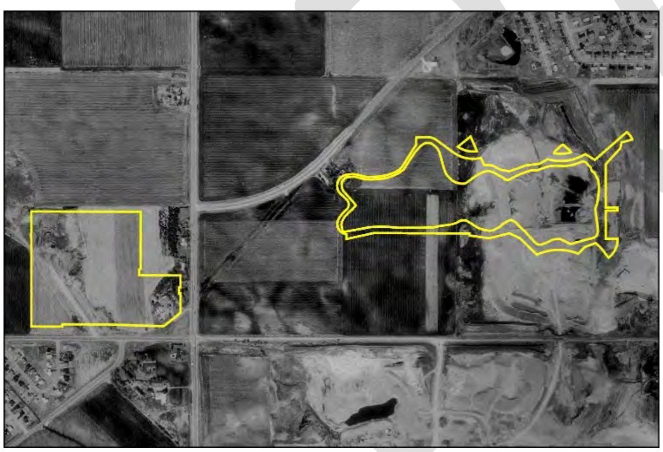
1937



1964



1991



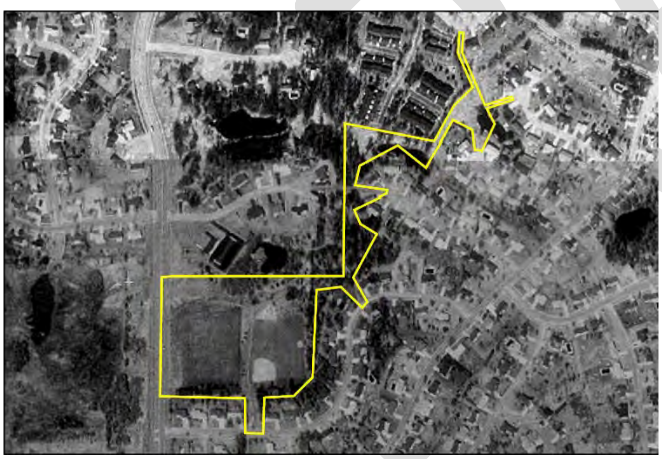
2010

FIGURE 5: Historic Aerial Composites: Moeller Park

1937

1964

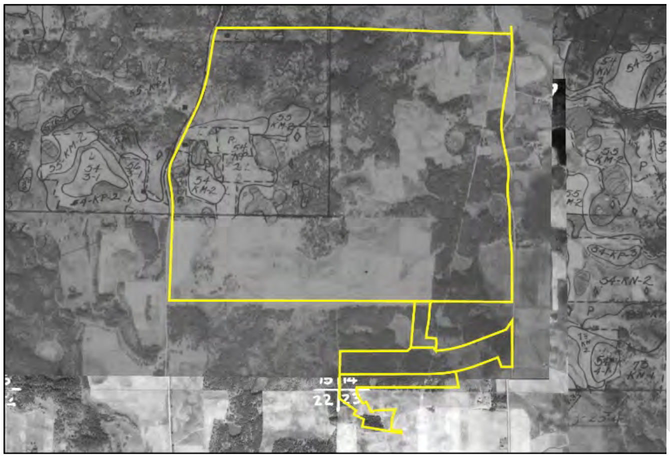
1991



2010

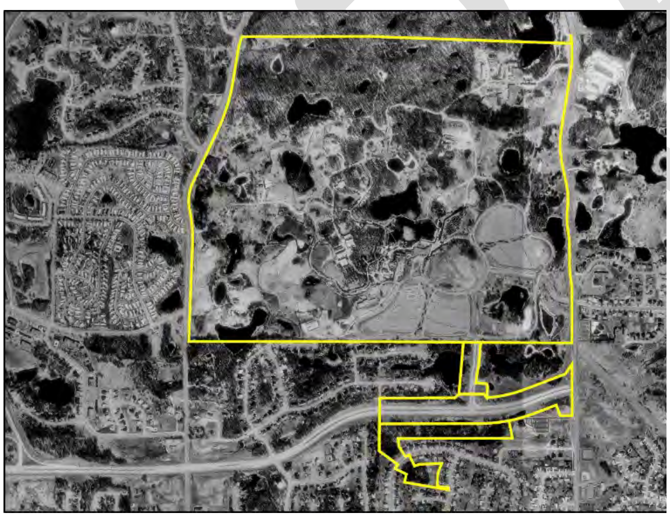
FIGURE 5: Historic Aerial Composites: Findlay Park – Minnesota Zoo

1937



1964

1991



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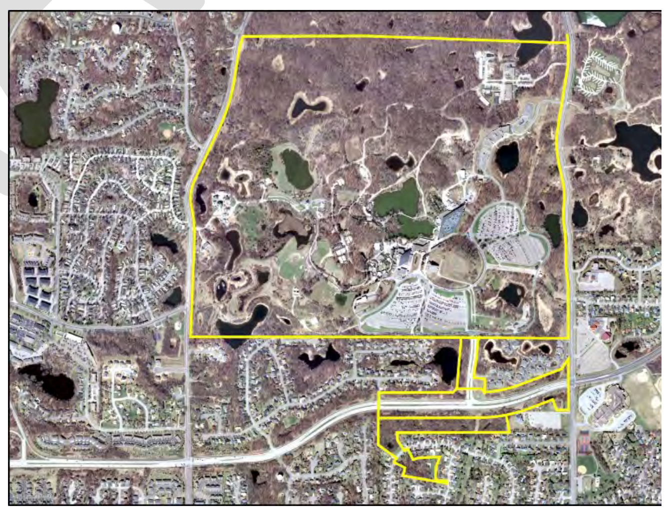
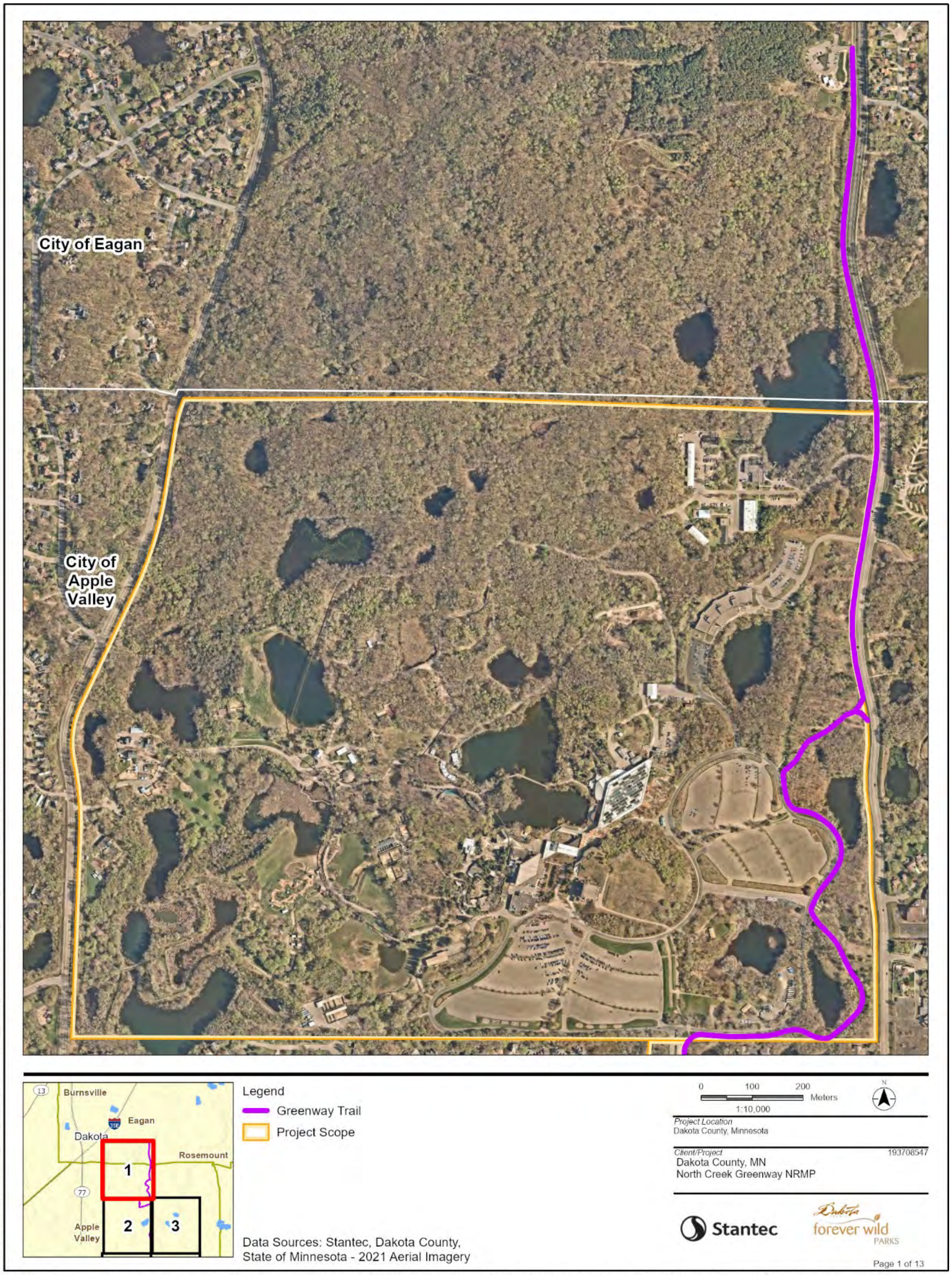


Figure 7 Current Aerial Photos



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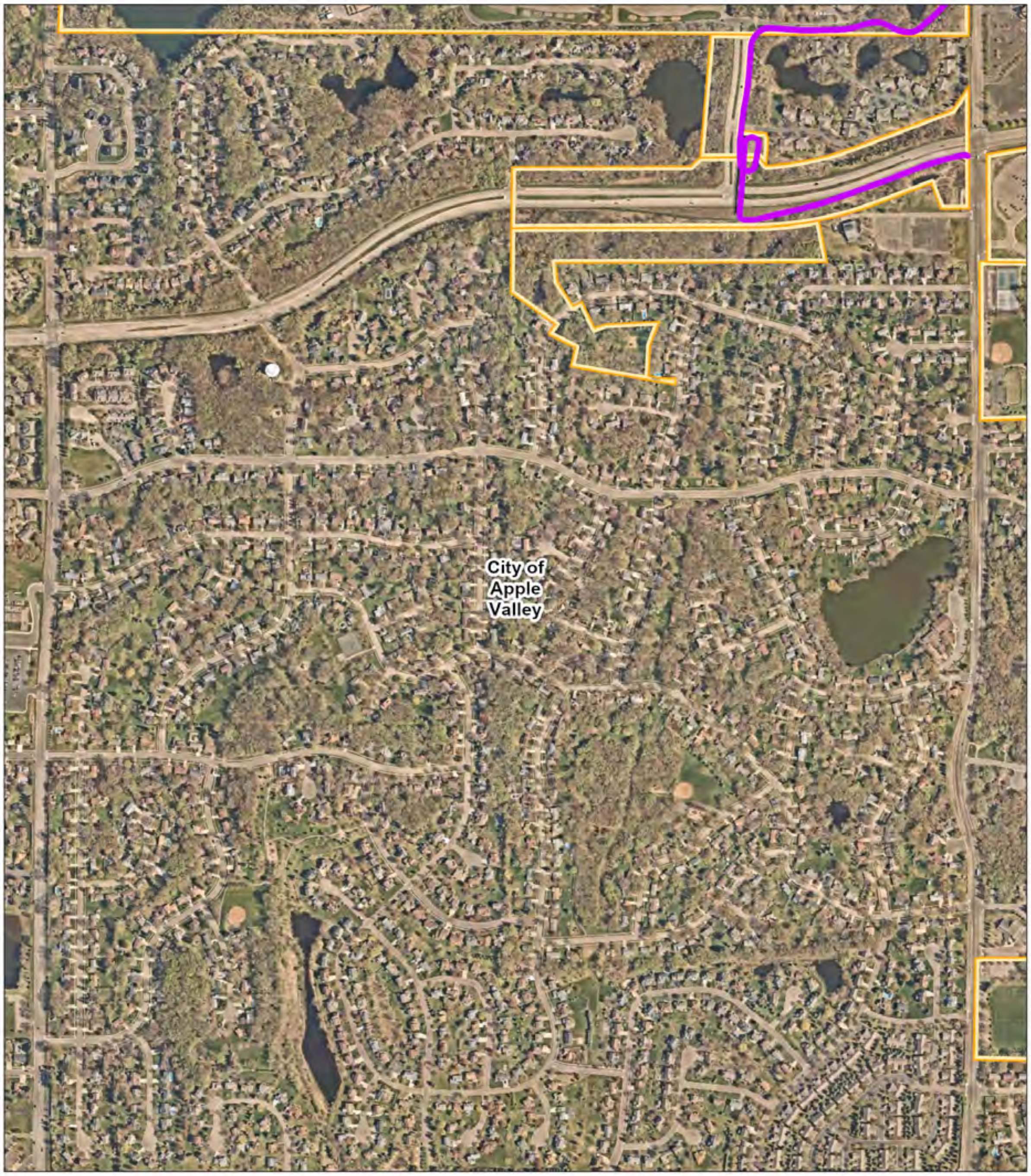

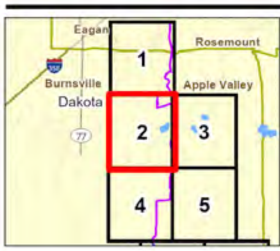

Legend

Greenway Trail

Project Scope

Data Sources: Stantec, Dakota County, State of Minnesota - 2021 Aerial Imagery

0 100 200 Meters

1:10,000

Project Location
Dakota County, Minnesota

Client/Project
Dakota County, MN
North Creek Greenway NRMP

193708547

Stantec

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Page 2 of 13

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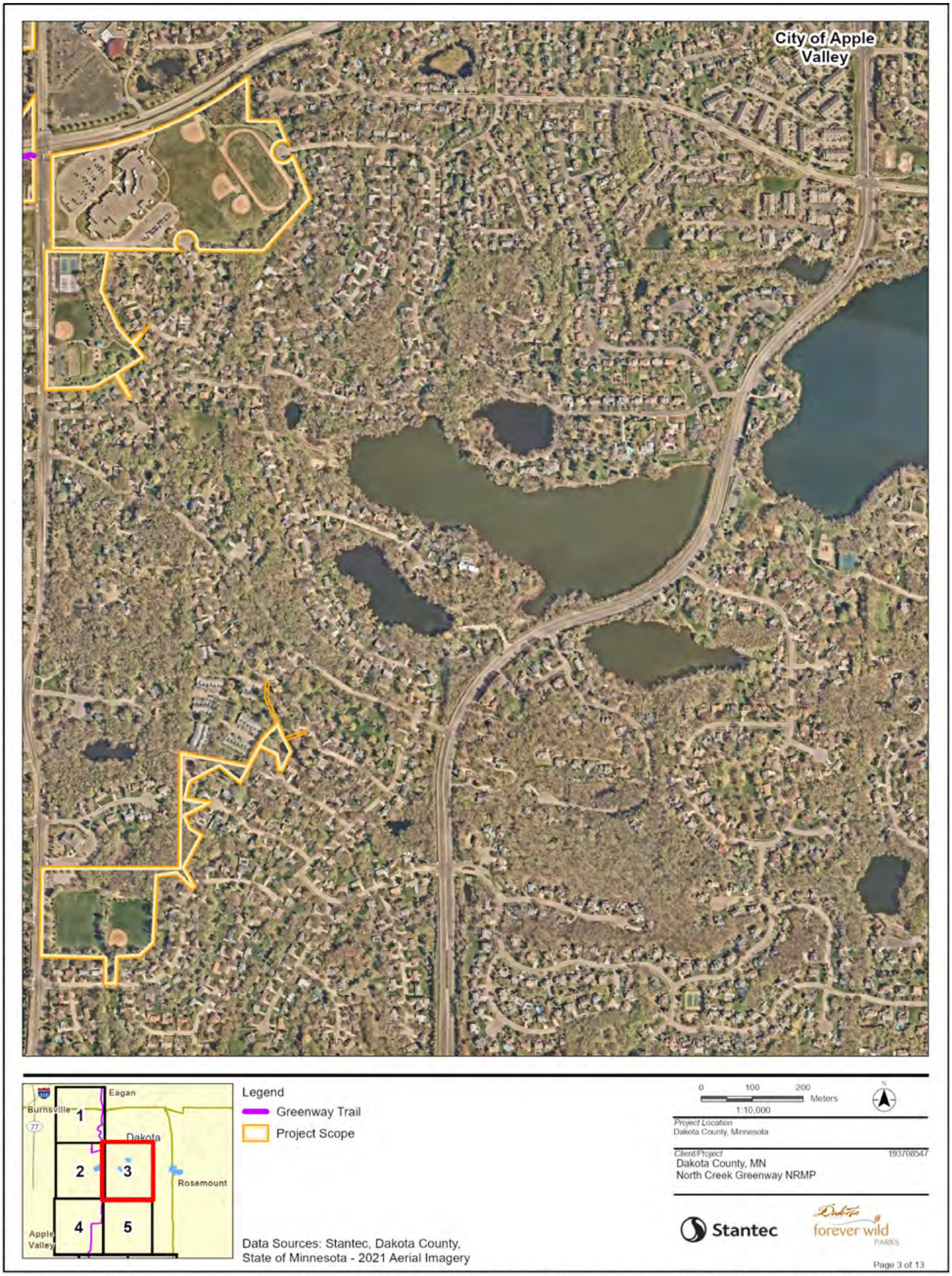

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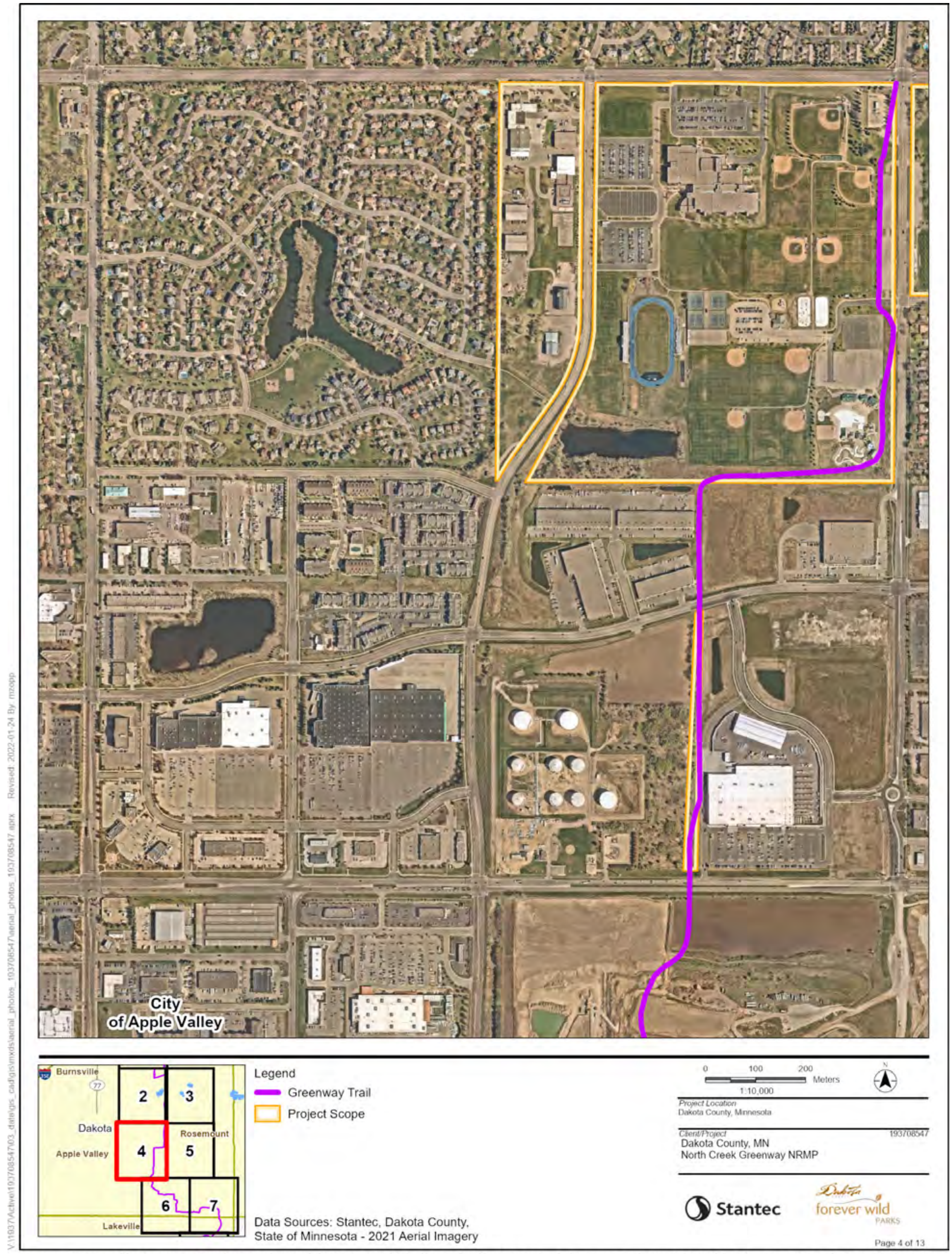

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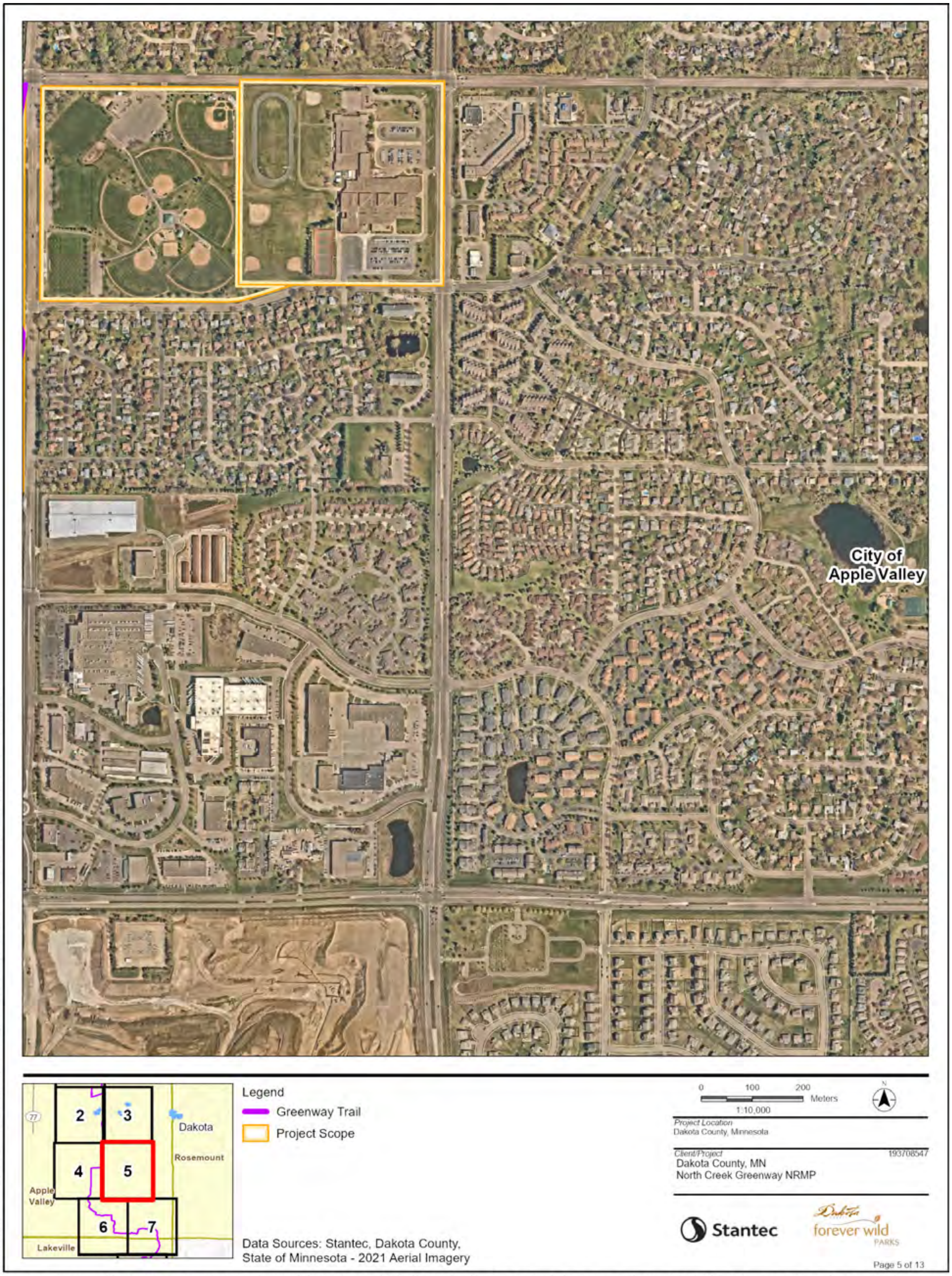

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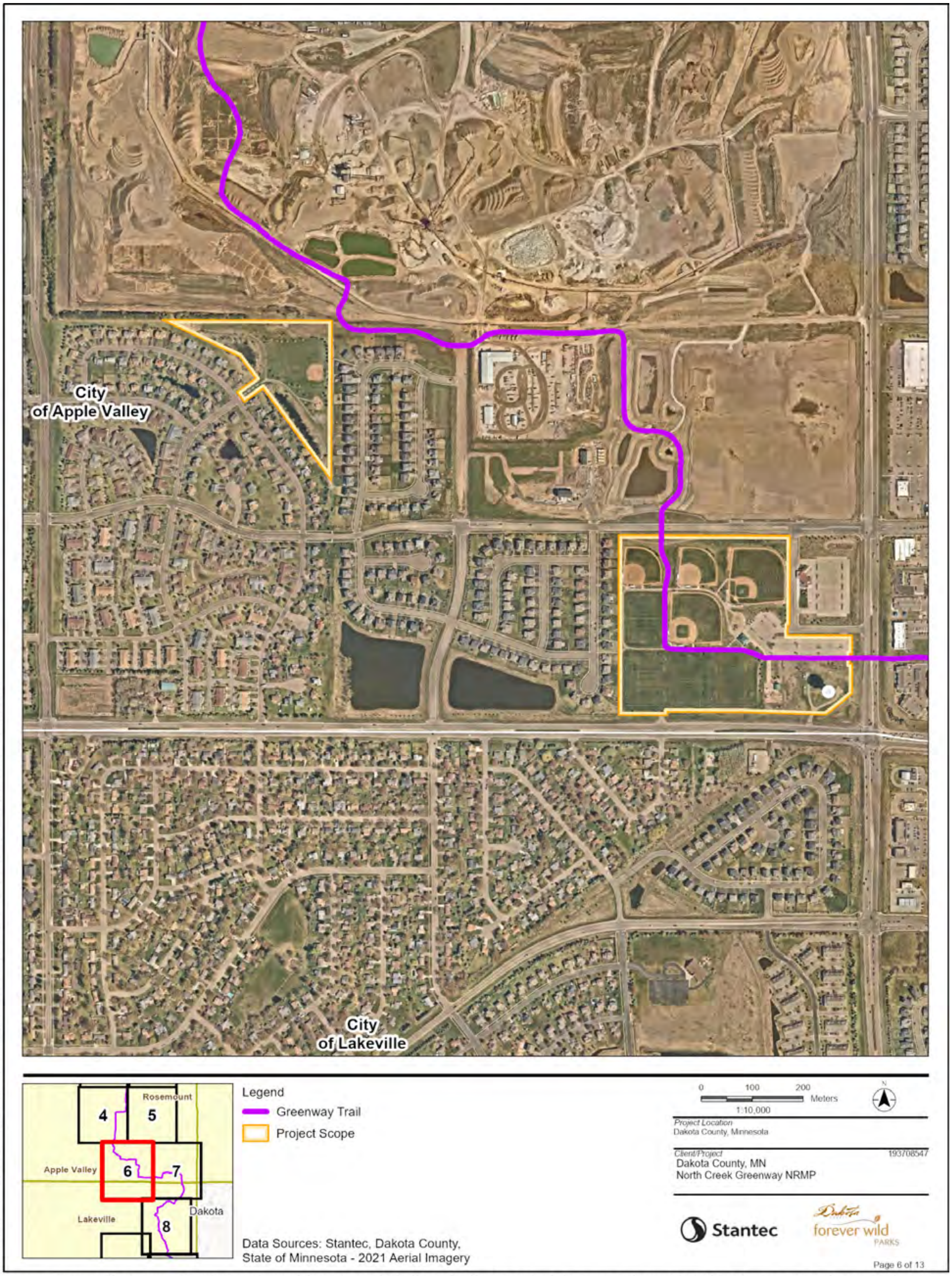

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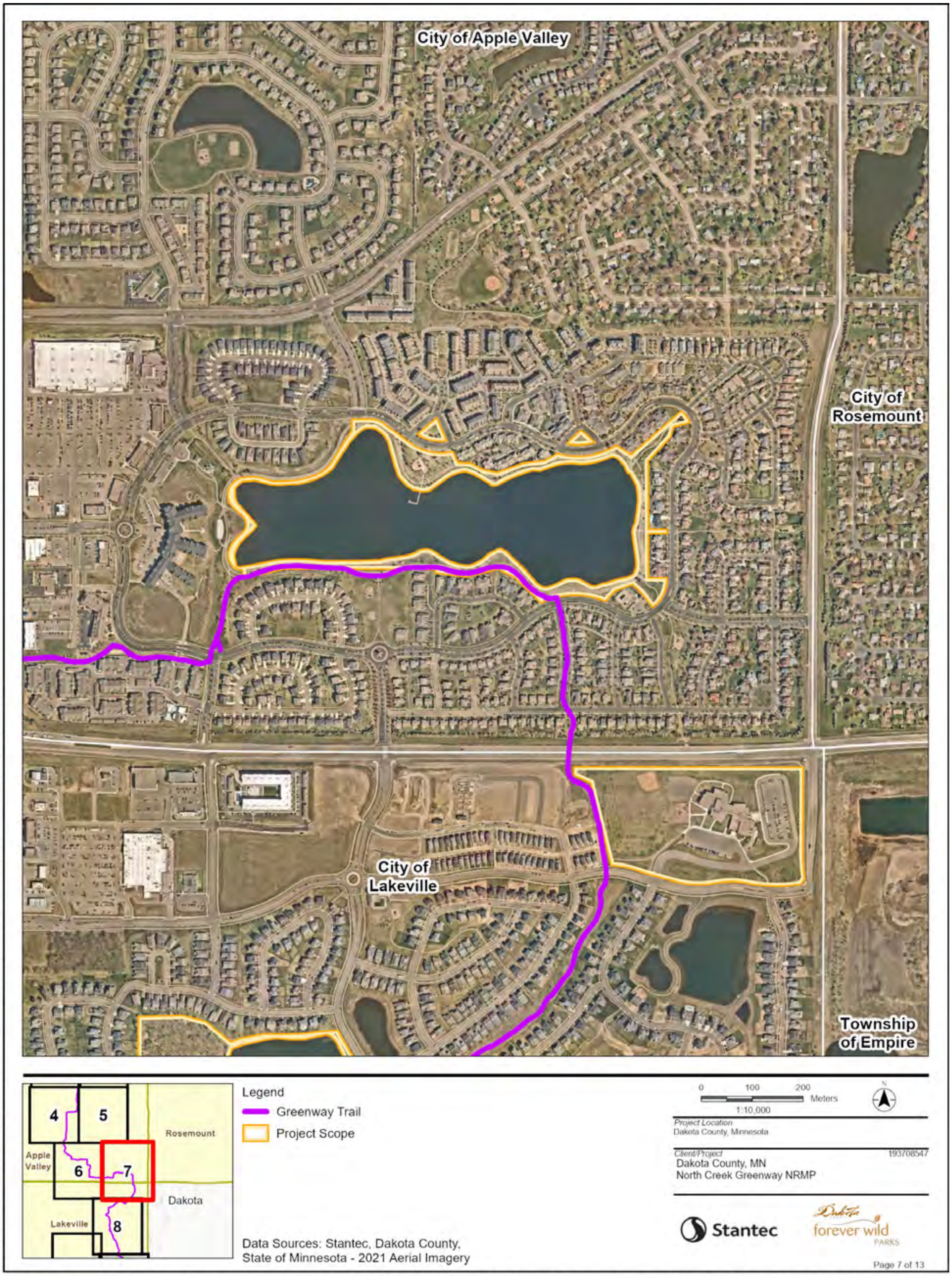

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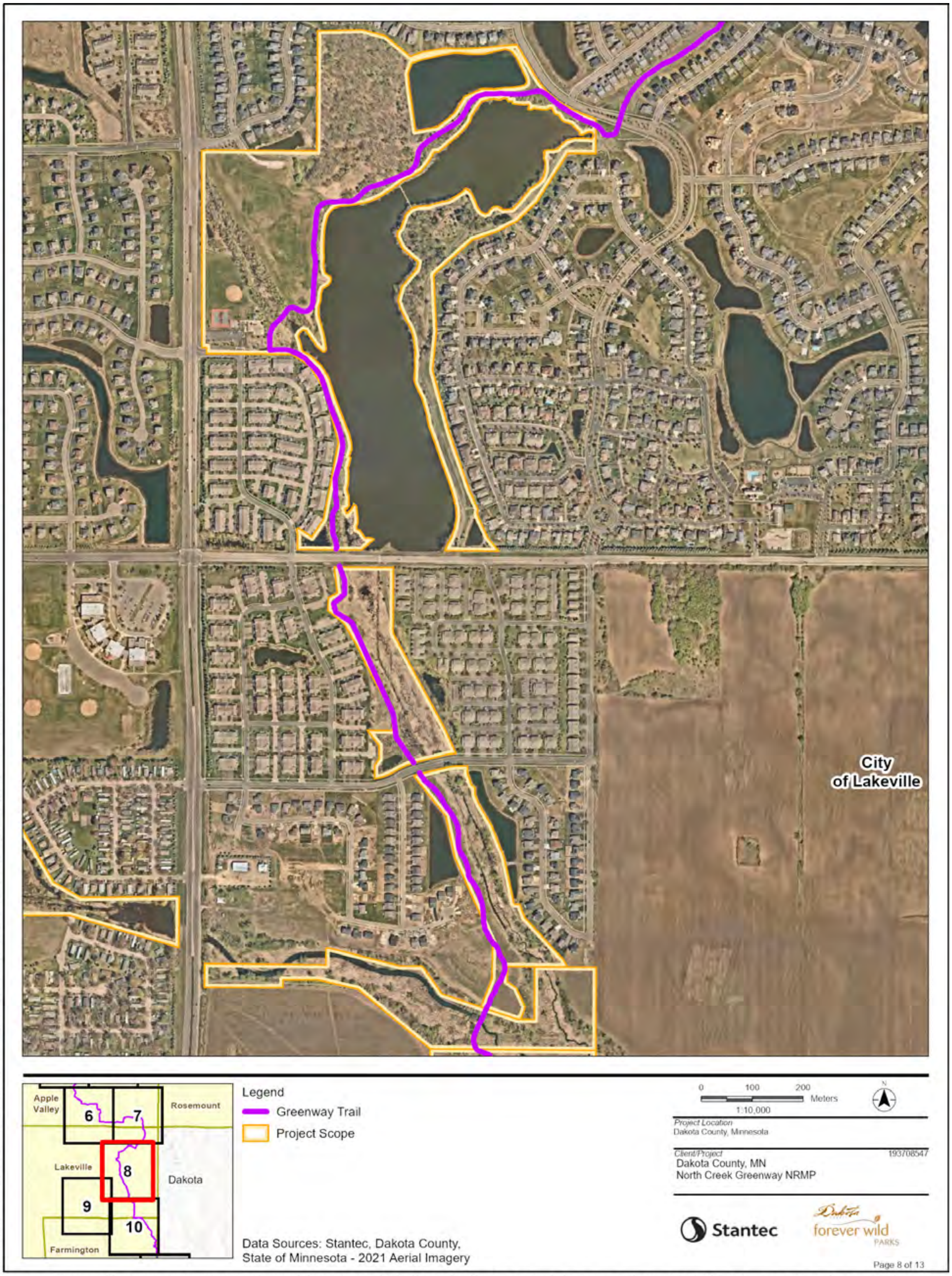

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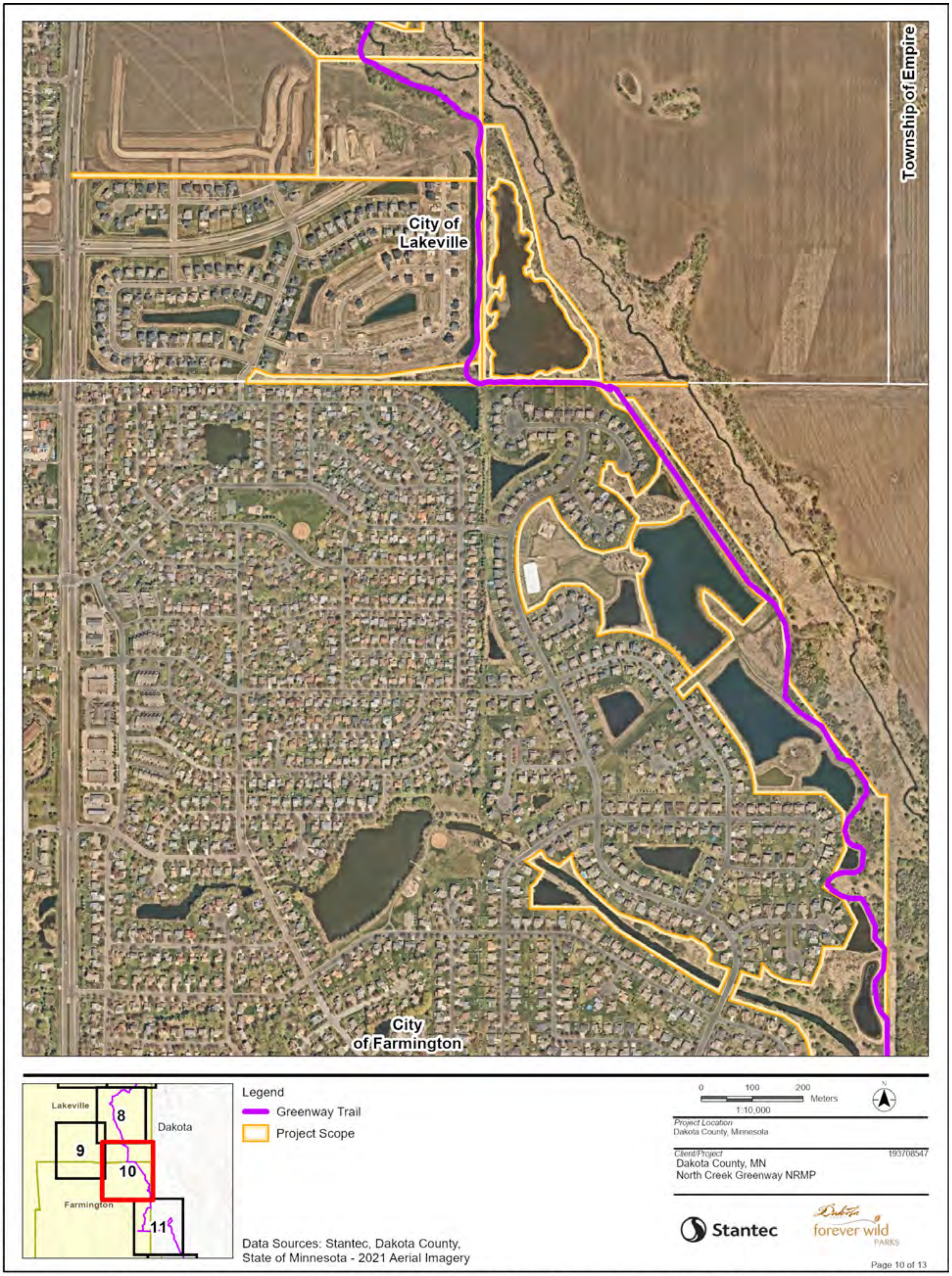

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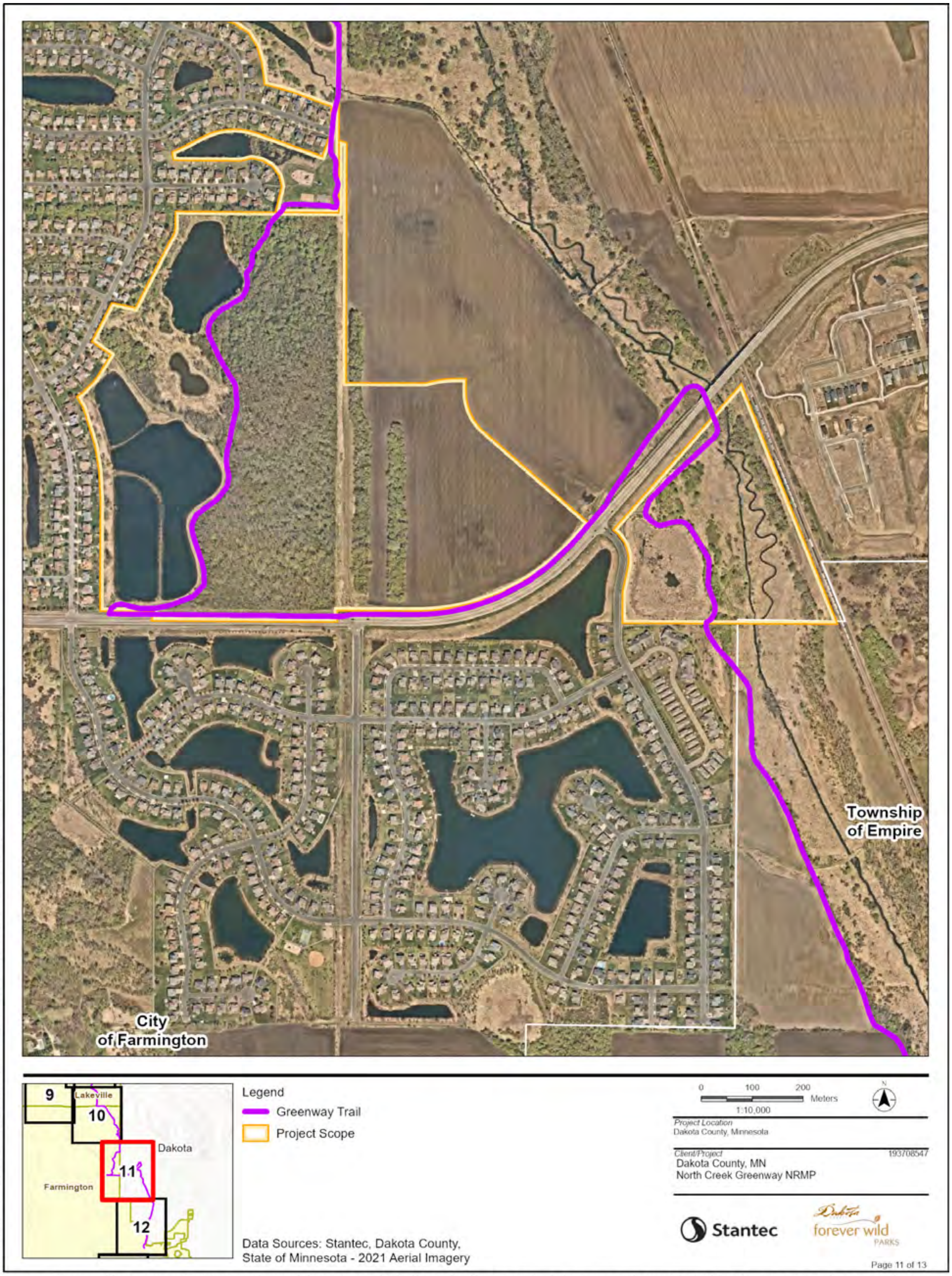

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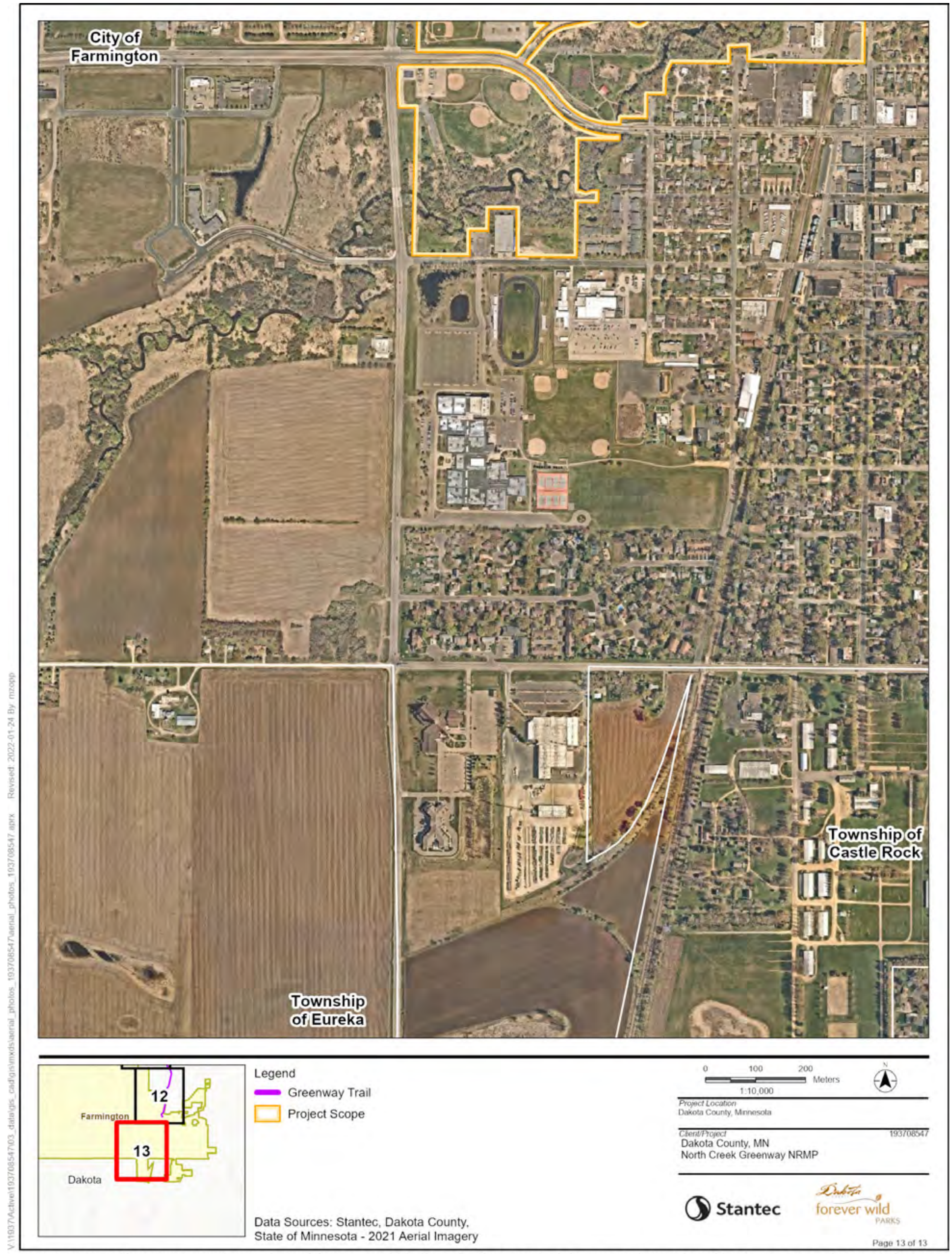

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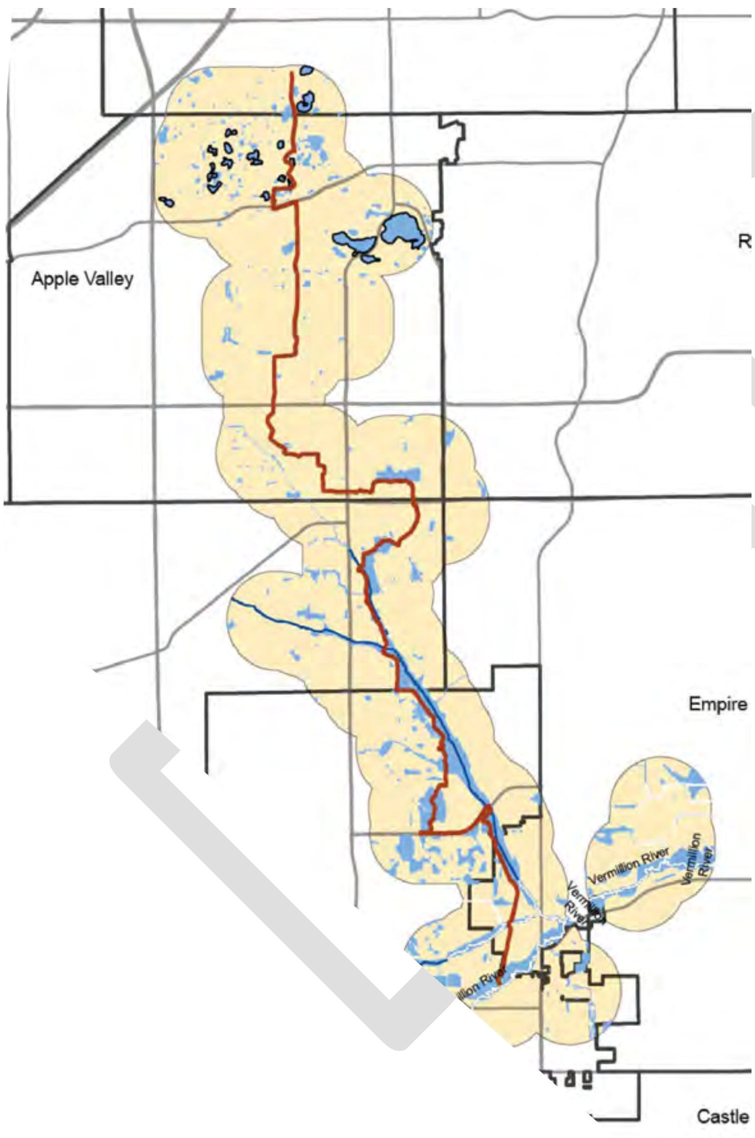
Today, the relatively high percentage of impervious surfaces surrounding many sections of this corridor significantly increases stormwater runoff rates and changes hydrological conditions of wetlands, streams and ponds within the Corridor (**Figure 8**).

FIGURE 8 Hydrologic Features near the Corridor



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.

Rare Features

The MN 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 of Natural Heritage Information System Biotics database was reviewed for occurrences within one mile of the Lake Marion Corridor study area. This data is presented in **Table 3** (Copyright 2020, State of Minnesota DNR, License Agreement #971). Rare features data included here were provided by the Division of Ecological and Water Resources, MN DNR and were current as of October 25, 2020. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic areas shall not be construed to mean that no significant features are present.

Table 3: Rare Features near the Corridor

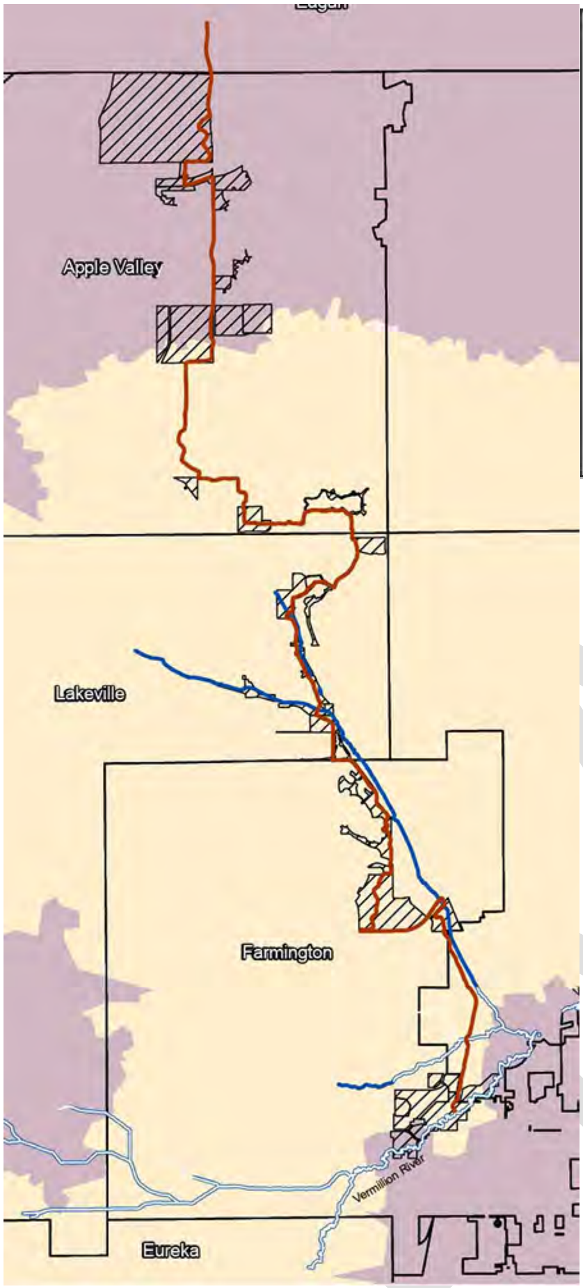
Taxon	*Scientific Name*	Common Name	State Status	Federal Status
Bird	*Chondestes grammacus*	Lark sparrow	SC	NL
Bird	*Lanius ludovicianus*	Loggerhead shrike	END	NL
Reptile	*Emydoidea blangingii*	Blanding's turtle	THR	NL
Bee	*Bombus affinis*	Rusty-patched bumble bee	NL	E

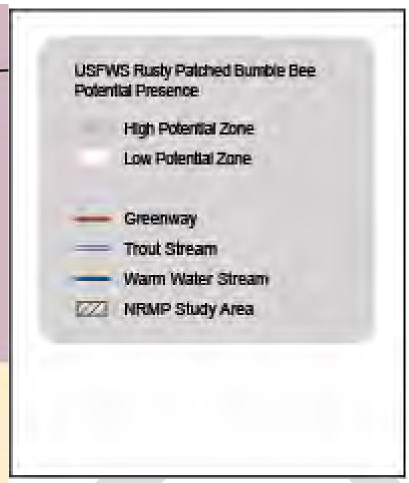
Abbreviations: END = Endangered; THR = Threatened; SC = Special Concern; NL = Not Listed

- **Blanding's Turtle**

  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

Figure 9 Rare Features near the Corridor





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.

- **Rusty-patched Bumble Bee**

The rusty-patched bumble bee (*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 North Creek Greenway Corridor occurs within the High Potential Range of the rusty-patched bumble bee (**Figure 9**).

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.

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 North Creek Greenway Corridor include St. Peter Sandstone and Prairie du Chien Group, underlain by Jordan Sandstone. Small areas of Platteville and Glenwood Formations are found in Lakeville and Farmington. These layers were all formed from deposits within shallow ancient seas during the Ordovician period 480 to 440 Million Years Ago (MYA). 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.

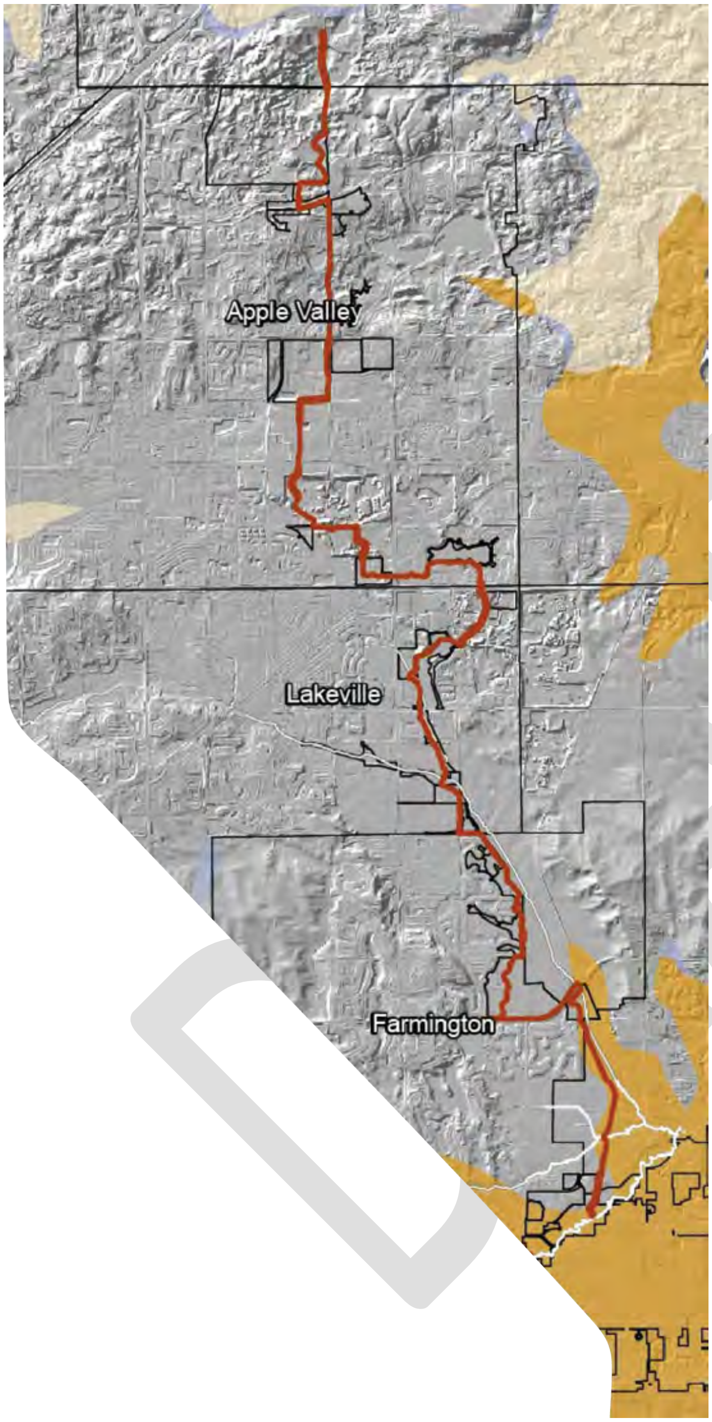
Dakota County has very diverse surficial geology that created a scenic and ecologically diverse landscape. The most recent glaciers extended south into the northern portion of the County and the resulting terminal moraines are characterized by a typical "knoll and basin" topography. South of these moraines, 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. 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. The greenway corridor is located primarily on a terrace landform beginning at East Lake and continuing south to the end of the corridor. North of East Lake, the remainder of the corridor occupies a collapsed outwash plain (**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.

Soils

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

FIGURE 10: Surficial Geology and Landforms near the Corridor



Drainage classification is one of the most important characteristics as it relates to land management in the Greenway corridor. Marshan silty clay loam and Waukegan silt loam are the two most common soils associated with the greenway corridor. Waukegan silt loam is well drained, while Marshan silty clay loam is poorly drained. A large proportion of soils in the corridor, however, are well drained. The majority of poorly drained soils occur in Farmington including Jim Bell Park and Preserve, Fairhill Park, and Rambling River Park.

A summary of soil types and their drainage classifications in the corridor study area is included in **Appendix B**. Soil drainage class for each site are also depicted on each NRMP Recommendation Site Plan (Figure 14).

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 northeast-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. Together with soils, topography had significant impacts on the species distributions and community associations of vegetation on the landscape.

Topography is also critical in undertaking the physical work of vegetation restoration. Motorized mechanical equipment, such as forestry mowers, generally are not functional on slopes steeper than 30%. These slopes typically require hand work for restoration tasks. Evidence of slopes ≥ 30%, as depicted from Lidar data, are illustrated on each NRMP Recommendation Site Plan (Figure 14). Unit costs for vegetation restoration tasks in these areas were calculated separately from areas with less steep slopes.

Water Resources

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

<u>Groundwater</u>

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.

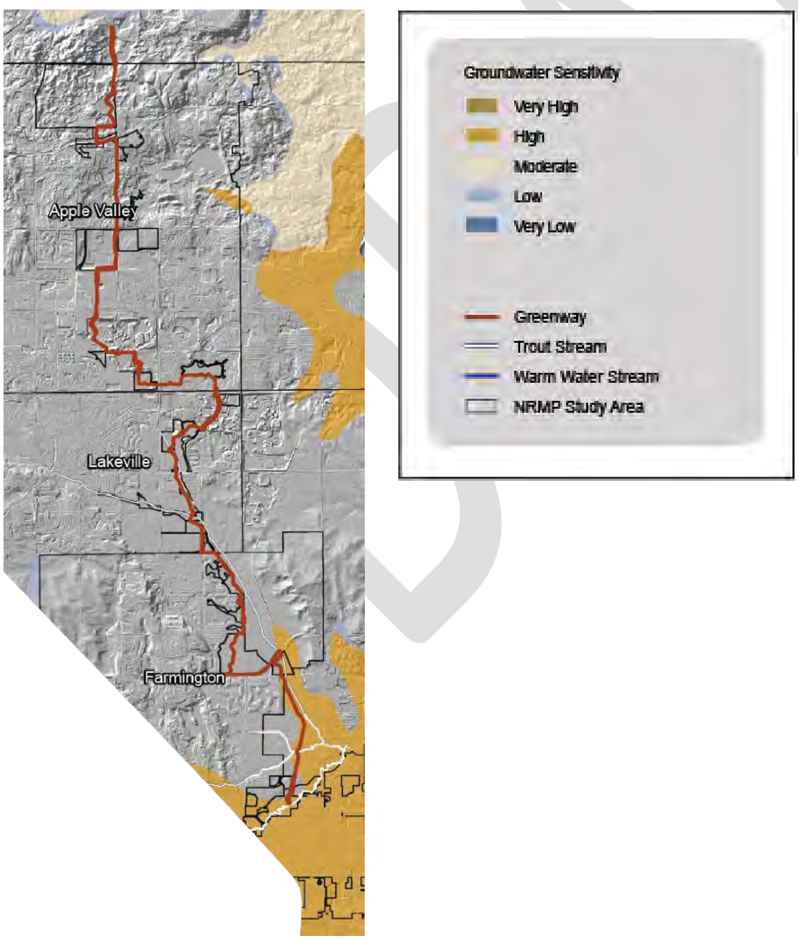
MN DNR defines groundwater sensitivity as an area where natural geologic factors create a significant risk of groundwater degradation through the migration of waterborne contaminants. Migration of contaminants dissolved in water through unsaturated and saturated sediments is affected by many things, 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 and the texture of surficial geology. 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.

The pollution sensitivity is inversely proportional to the time of travel. Five relative classes of geologic sensitivity are based on overlapping time of travel ranges (Very High, High, Medium, Low, and Very Low). **Figure 11** illustrates the sensitivity of groundwater to pollution in the corridor area. 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.

Figure 11 Sensitivity of Groundwater to Pollution near the Corridor



The southern section of the greenway corridor, from approximately Fairhill Park south to the end of the corridor, is mapped as high sensitivity. 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.

Surface Water: Streams, Lakes, Ponds and Wetlands

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 freshwater emergent, freshwater pond (often stormwater basins), and freshwater forest/shrub. Freshwater emergent are the dominant wetland in the North Creek and Middle Creek riparian area, while freshwater emergent forested/shrub are typical in the Vermillion River riparian area. Wetland types are generally depicted on each NRMP Recommendation Site Plan (Figure 14).

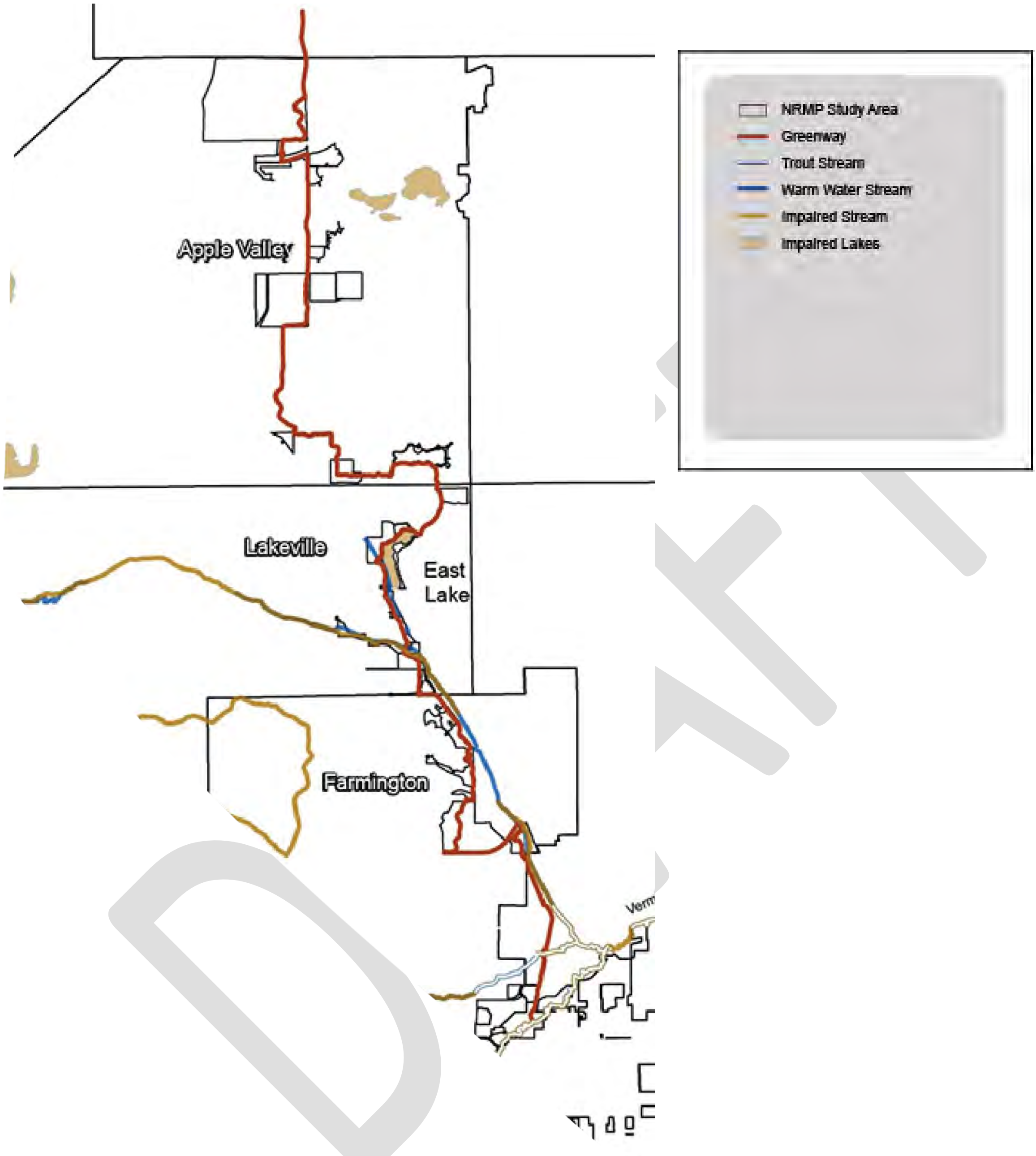
Over time, most of these surface waters have been significantly degraded, due to agricultural and municipal stormwater run-off. Entire wetland complexes have been lost that were important for filtering and retaining water, which was critical for recharging groundwater levels. Pollution often includes 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. **Figure 12** depicts public waters (streams, lakes and wetlands) included on Minnesota's 2020 Impaired Waters List.

The Vermillion River and South Creek, as well as sections of North Creek within Farmington are included on Minnesota's 2020 Impaired Water List. East Lake in Lakeville is also included. Impaired uses for these water bodies include combinations of aquatic consumption, aquatic life and aquatic recreation.

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.

Figure 12. Minnesota's Impaired Waters near the Corridor



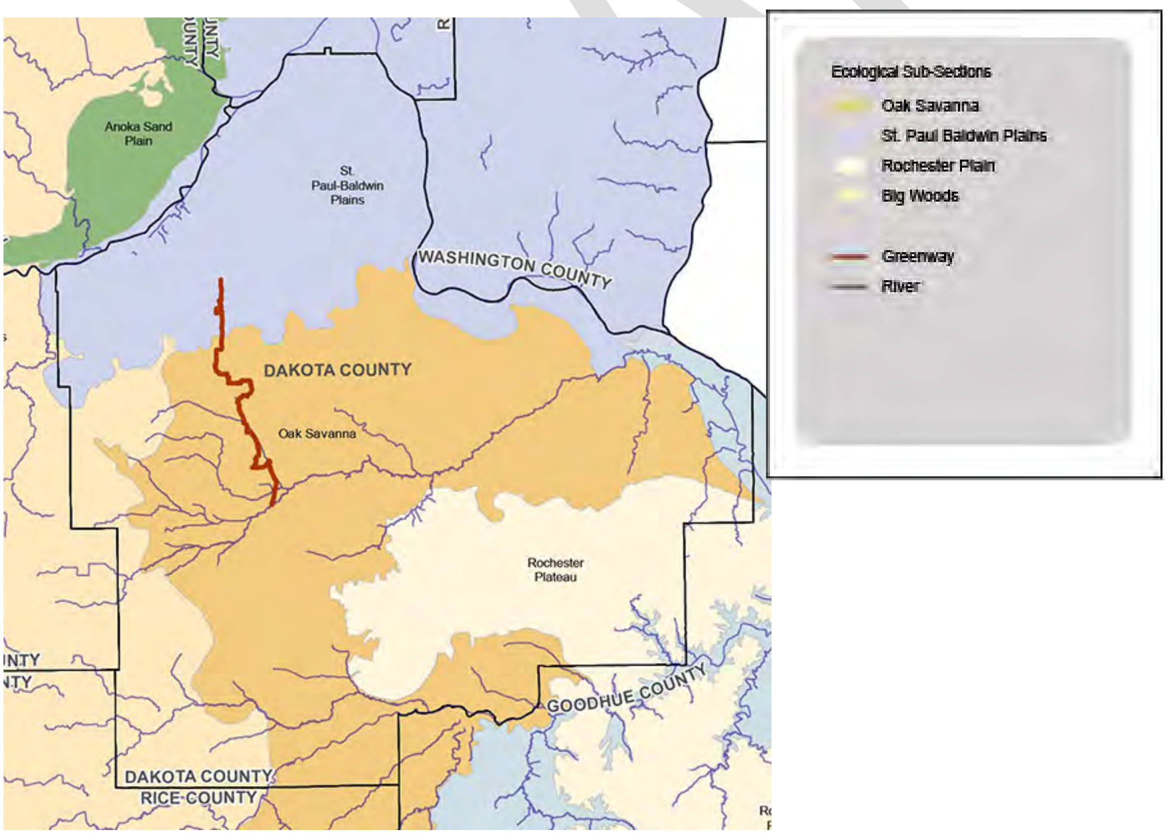
There are four ecological provinces in Minnesota (prairie parkland, eastern broadleaf forest, Laurentian mixed forest, and tallgrass aspen parkland), ten sections within the provinces, and 26 subsections. The North Creek Greenway Corridor is classified as follows (see Figure 14):

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

The Saint Paul Baldwin Plains and Moraine Subsection is 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.

Most of the Oak Savanna Subsection is characterized by rolling plains. Due to the difference in topography fires were more frequent in this subsection, which led to oak savanna being the prominent vegetation before European settlement with prairie and bass-oakwood forests occurring occasionally.

FIGURE 14: Ecological Subsections



Vegetation

The vegetation found within the North Creek 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. 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.

Plant Community Assessment

The Greenway Corridor and surrounding natural areas were surveyed using the Minnesota Land Cover Classification (MLCCS) system as base map.

- **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 evaluations, which was conducted by a Stantec ecologist in September and October of 2021. Based on changes in land use and plant communities over time, some of the classifications were updated to reflect current conditions.

  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.)

- **Site Evaluations.** An evaluation was conducted by a Stantec ecologist in September and October of 2021 of each park/easement along the Lake Marion Greenway Corridor. Sites were defined by property boundaries. For example, West Lake Marion Park was considered one Site. The existing MLCCS mapping was used as a base to do the Site evaluations. Each MLCCS unit is based on a land cover class, so each polygon represented its own unit. Each unit that intersected the Greenway Corridor was surveyed using a meander survey, noting general species abundance in each stratum. Outside of the Greenway Corridor, meander surveys were completed if units had high-quality ecological communities. If not, units were visited from the edge so that the landcover class could be confirmed. In rare instances, where access was difficult, landcover within polygons was confirmed through aerial imagery. Highly developed polygons, such as those with a high amount of impervious surface and/or turf grass were not visited from the edge if they were not within the Greenway, and if aerial imagery could confirm their MLCCS landcover classification. On the Minnesota Zoo property only the 300-foot Greenway corridor was surveyed by Stantec. MLCCS land cover categories were used to categorize the existing landcover, but information for MLCCS modifier codes was not collected.
- Existing landcover is summarized in **Table 4** and depicted in Figures 14A – 14H. **Table 5** summarizes invasive species identified within each Site. The ecological health of land cover units made up of native communities was scored using the Element Occurrence Ranking Guidelines

Table 4 Summary of Land Cover Management Unit and Quality in the Corridor

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
City of Apple Valley				
City of Apple Valley Maintenance	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	0
City of Apple Valley Maintenance	Short grasses with 26-50% impervious cover	13231		0.4
City of Apple Valley Maintenance	Short grasses with 51-75% impervious cover	13241		27.6
Cobblestone Lake Park	Palustrine open water	93300		0.1
Cobblestone Lake Park	Short grasses with 26-50% impervious cover	13231		14
Findlay Park	Altered/non-native deciduous forest	32170	NA	7.1
Findlay Park	Mixed emergent marsh	61620		0.4

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
Findlay Park	Non-native dominated long grasses with 26-50% impervious cover	13232		0
Findlay Park	Oak forest	32110	BC	2
Findlay Park	Palustrine open water	93300		0.5
Findlay Park	Short grasses and mixed trees with 26-50% impervious cover	13134		3.8
Findlay Park	Short grasses with 26-50% impervious cover	13231		0.1
Hagemeister Park	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220	NN	1.4
Hagemeister Park	Short grasses and mixed trees with 26-50% impervious cover	13134		1.1
Hagemeister Park	Short grasses with 4-10% impervious cover	13211		7.3
Johnny Cake Ridge Park	Buildings and pavement with 76-90% impervious cover	14113		0.8
Johnny Cake Ridge Park	Mixed emergent marsh - seasonally flooded	61520		0.2
Johnny Cake Ridge Park	Pavement with 91-100% impervious cover	14122		2.8
Johnny Cake Ridge Park	Short grasses with 26-50% impervious cover	13231		0.1
Johnny Cake Ridge Park	Short grasses with 4-10% impervious cover	13211		37.1
Moeller Park	Altered/non-native deciduous forest	32170	NA	0.4
Moeller Park	Oak forest	32110	C	2.3
Moeller Park	Palustrine open water	93300		0.5
Moeller Park	Short grasses and mixed trees with 26-50% impervious cover	13134		3.3
Moeller Park	Short grasses with 26-50% impervious cover	13231		0.6
Moeller Park	Short grasses with 4-10% impervious cover	13211		7.3
Old Wastewater Treatment Facility	Altered/non-native dominated temporarily flooded shrubland	52220		2.4
Old Wastewater Treatment Facility	Medium-tall grass altered/non-native dominated grassland	61220	NN	12.1
Old Wastewater Treatment Facility	Mixed emergent marsh - seasonally flooded	61520	D	0.1
Old Wastewater Treatment Facility	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	2.8
Old Wastewater Treatment Facility	Short grasses and mixed trees with 51-75% impervious cover	13144		0
Old Wastewater Treatment Facility	Short grasses with 51-75% impervious cover	13241		1.4
Old Wastewater Treatment Facility	Temporarily flooded altered/non-native dominated grassland	61330		1.2

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
Old Wastewater Treatment Facility	Upland soils - cropland	24110		0.2
Old Wastewater Treatment Facility	Wet meadow shrub subtype	52420		0.1
Quarry Point Park	Short grasses with 26-50% impervious cover	13231		32.5
Quarry Point Park	Short grasses with 51-75% impervious cover	13241		1
Regatta Park	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220	NN	0
Regatta Park	Palustrine open water	93300		0.4
Regatta Park	Sand and gravel pits with 0-10% impervious cover	14212		0
Regatta Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530		0.5
Regatta Park	Short grasses on upland soils	23211	NN	7
Regatta Park	Short grasses with 26-50% impervious cover	13231		2.4
City of Farmington				
Fairhill Park	Hydric soils - row cropland	24120		3.1
Fairhill Park	Medium tall upland herbaceous vegetation	61220	NN	0.8
Fairhill Park	Mesic prairie	61110	NN	2.3
Fairhill Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	6
Fairhill Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	18.2
Fairhill Park	Short grasses with 26-50% impervious cover	13231		0.1
Fairhill Park	Wet meadow - temporarily flooded soils	61320	NN	0
Jim Bell Park and Preserve	Altered/non-native dominated seasonally flooded shrubland	52440	NN	1.8
Jim Bell Park and Preserve	Hydric soils - row cropland	24120		36
Jim Bell Park and Preserve	Lowland hardwood forest	32220	BC	47.3
Jim Bell Park and Preserve	Lowland hardwood forest	32220		5.5
Jim Bell Park and Preserve	Palustrine open water	93300		20.5
Jim Bell Park and Preserve	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	5.6
Jim Bell Park and Preserve	Short grasses with 26-50% impervious cover	13231		6.8

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
Jim Bell Park and Preserve	Wet prairie	61310	NN	4.1
North Creek Park	Hydric soils - row cropland	24120		0
North Creek Park	Lowland hardwood forest	32220	BC	0.6
North Creek Park	Mesic prairie	61110	C	2.2
North Creek Park	Mixed emergent marsh - seasonally flooded	61520	NN	0
North Creek Park	Native dominated temporarily flooded shrubland	52210	B	0.5
North Creek Park	Palustrine open water	93300		14.2
North Creek Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	14.1
North Creek Park	Short grasses with 26-50% impervious cover	13231		27.6
North Creek Park	Slow moving linear open water habitat	91100		3.2
North Creek Park	Temporarily flooded altered/non-native dominated grassland	61330		2.5
North Creek Park	Temporarily flooded deciduous shrubland	52200	NN	0.7
North Creek Park	Wet meadow	61420		1.6
Rambling River Park	Altered/non-native dominated temporarily flooded shrubland	52220	NA	15.6
Rambling River Park	Buildings and pavement with 76-90% impervious cover	14113		1.9
Rambling River Park	Buildings and pavement with 91-100% impervious cover	14123		0.1
Rambling River Park	Cattail marsh - seasonally flooded	61510	C	4.4
Rambling River Park	Floodplain forest	32210	C	15.8
Rambling River Park	Long grasses and mixed trees with 4-10% impervious cover	13115		5.9
Rambling River Park	Non-native dominated long grasses with 26-50% impervious cover	13232		0.5
Rambling River Park	Non-native dominated long grasses with 51-75% impervious cover	13242		2.9
Rambling River Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	5.9
Rambling River Park	Short grasses and mixed trees with 26-50% impervious cover	13134		17.7
Rambling River Park	Short grasses on upland soils	23211		0.8
Rambling River Park	Short grasses with 11-25% impervious cover	13221		12.9
Rambling River Park	Short grasses with 4-10% impervious cover	13211		0.8
Rambling River Park	Short grasses with 51-75% impervious cover	13241		5.8

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
Rambling River Park	Slow moving linear open water habitat	91100		3
Rambling River Park	Temporarily flooded altered/non-native dominated grassland	61330	NA	1.4
Rambling River Park	Wet meadow shrub subtype	52420	C	11.4
City of Lakeville				
East Lake Community Park	Altered/non-native deciduous woodland	42130	NA	5.7
East Lake Community Park	Buildings and pavement with 91-100% impervious cover	14123		0.1
East Lake Community Park	Cattail marsh - seasonally flooded	61510		4.1
East Lake Community Park	Cattail marsh - semipermanently flooded	61610		0.4
East Lake Community Park	Dry prairie	61210	B	1.2
East Lake Community Park	Floodplain forest	32210	C	2.7
East Lake Community Park	Medium-tall grass altered/non-native dominated grassland	61220	NN	10
East Lake Community Park	Oak wooland-brushland	42120	C	11.6
East Lake Community Park	Palustrine open water	93300		1.9
East Lake Community Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	3.7
East Lake Community Park	Short grasses and mixed trees with 26-50% impervious cover	13134		1
East Lake Community Park	Short grasses on upland soils	23211		11.4
East Lake Community Park	Short grasses on upland soils	23211		2.5
East Lake Community Park	Short grasses with 51-75% impervious cover	13241		12.9
North Creek Greenway Park	Altered/non-native dominated temporarily flooded shrubland	52220		0.1
North Creek Greenway Park	Cattail marsh - seasonally flooded	61510		3.6
North Creek Greenway Park	Long grasses and mixed trees with 51-75% impervious cover	13145		3
North Creek Greenway Park	Medium-tall grass altered/non-native dominated grassland	61220	NA	2.4

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
North Creek Greenway Park	Medium-tall non-native dominated herbaceous vegetation	61220		0.1
North Creek Greenway Park	Mixed emergent marsh	61620	C	4.2
North Creek Greenway Park	Mixed emergent marsh - seasonally flooded	61520		4.9
North Creek Greenway Park	Mixed hardwood swamp - seasonally flooded	32420		0.1
North Creek Greenway Park	Palustrine open water	93300		6.3
North Creek Greenway Park	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	2.3
North Creek Greenway Park	Short grasses and mixed trees with 51-75% impervious cover	13144		1.7
North Creek Greenway Park	Short grasses with 26-50% impervious cover	13231		1.1
North Creek Greenway Park	Short grasses with 4-10% impervious cover	13211		0.7
North Creek Greenway Park	Slow moving linear open water habitat	91100		1.5
North Creek Greenway Park	Temporarily flooded altered/non-native dominated grassland	61330	NN	0.5
North Creek Greenway Park	Upland soils - cropland	24110		0.5
North Creek Greenway Park	Wet meadow shrub subtype	52420		3
Pheasant Run Easement - LKVL	Mesic prairie	61110	C	0.2
Pheasant Run Easement - LKVL	Mixed emergent marsh - seasonally flooded	61520	D	0.5
Pheasant Run Easement - LKVL	Palustrine open water	93300		0.3
Pheasant Run Easement - LKVL	Short grasses with 26-50% impervious cover	13231		0.1
Pheasant Run Easement - LKVL	Short grasses with 51-75% impervious cover	13241		0.8
Pheasant Run Easement - LKVL	Short grasses with sparse tree cover on upland soils.	23111	NN	1.8
ISD192				
Levi P Dodge Middle School	Altered/non-native dominated temporarily flooded shrubland	52220	NA	0.3

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
Levi P Dodge Middle School	Buildings and pavement with 91-100% impervious cover	14123		4.2
Levi P Dodge Middle School	Buildings and pavement with 91-100% impervious cover	14123		0.4
Levi P Dodge Middle School	Non-native dominated long grasses with 51-75% impervious cover	13242		2.4
Levi P Dodge Middle School	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NA	0.1
Levi P Dodge Middle School	Short grasses on upland soils	23211		24.6
Levi P Dodge Middle School	Short grasses with 26-50% impervious cover	13231		0
Levi P Dodge Middle School	Short grasses with 4-10% impervious cover	13211		9
Levi P Dodge Middle School	Short grasses with 51-75% impervious cover	13241		17.9
Riverview Elementary	Buildings and pavement with 91-100% impervious cover	14123		7.6
Riverview Elementary	Non-native dominated long grasses with 26-50% impervious cover	13232		0
Riverview Elementary	Short grasses on upland soils	23211		7.9
Riverview Elementary	Short grasses with 26-50% impervious cover	13231		0
Riverview Elementary	Short grasses with 51-75% impervious cover	13241		6.4
Riverview Elementary	Temporarily flooded altered/non-native dominated grassland	61330		0.4
Riverview Elementary	Upland soils - cropland	24110		0.1
	ISD196			
Apple Valley High School	Buildings and pavement with 76-90% impervious cover	14113		45.2
Apple Valley High School	Buildings and pavement with 91-100% impervious cover	14123		0
Apple Valley High School	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NN	3.8
Apple Valley High School	Non-native dominated long grasses with 26-50% impervious cover	13232		0
Apple Valley High School	Palustrine open water	93300		3.3
Apple Valley High School	Short grasses on upland soils	23211		3.3
Apple Valley High School	Short grasses with 4-10% impervious cover	13211		66.2
Apple Valley High School	Short grasses with 51-75% impervious cover	13241		0.9
Apple Valley High School	Upland soils - cropland	24110		0.7

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
East Lake Elementary	Short grasses and mixed trees with 26-50% impervious cover	13134		22.1
Falcon Ridge Elementary	Altered/non-native deciduous woodland	42130		1.1
Falcon Ridge Elementary	Buildings and pavement with 91-100% impervious cover	14123		11.6
Falcon Ridge Elementary	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220	NN	0.2
Falcon Ridge Elementary	Oak forest	32110		0.9
Falcon Ridge Elementary	Short grasses and mixed trees with 26-50% impervious cover	13134		1.1
Falcon Ridge Elementary	Short grasses with 4-10% impervious cover	13211		13.8
Scott Highlands Middle School	Buildings and pavement with 91-100% impervious cover	14123		17
Scott Highlands Middle School	Short grasses and mixed trees with 26-50% impervious cover	13134		0.9
Scott Highlands Middle School	Short grasses with 11-25% impervious cover	13221		0.4
Scott Highlands Middle School	Short grasses with 26-50% impervious cover	13231		0.4
Scott Highlands Middle School	Short grasses with 26-50% impervious cover	13231		2.1
Scott Highlands Middle School	Short grasses with 4-10% impervious cover	13211		19.2
Scott Highlands Middle School	Short grasses with 51-75% impervious cover	13241		0
MN Zoo				
MN Zoo	26% to 50% impervious cover with deciduous trees	11230		20.1
MN Zoo	4% to 10% impervious cover with deciduous trees	11210		3.6
MN Zoo	Altered/non-native deciduous forest	32170	NN	15.6
MN Zoo	Altered/non-native deciduous woodland	42130	NN	16.4
MN Zoo	Altered/non-native dominated seasonally flooded shrubland	52440	NN	1.4
MN Zoo	Altered/non-native dominated upland shrubland	52130	NN	7.2
MN Zoo	Aspen forest	32160		5.4
MN Zoo	Buildings and pavement with 76-90% impervious cover	14113		27.9

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
MN Zoo	Buildings and pavement with 91-100% impervious cover	14123		14.3
MN Zoo	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	NA	25.9
MN Zoo	Long grasses and mixed trees with 11-25% impervious cover	13125		11.8
MN Zoo	Long grasses and mixed trees with 4-10% impervious cover	13115		3.5
MN Zoo	Long grasses on upland soils	23212		26.8
MN Zoo	Mixed emergent marsh	61620		9.5
MN Zoo	Mixed hardwood swamp - seasonally flooded	32420		0.4
MN Zoo	Native dominated disturbed upland shrubland	52120		2.7
MN Zoo	Non-native dominated long grasses with 26-50% impervious cover	13232		0.7
MN Zoo	Non-native dominated long grasses with 51-75% impervious cover	13242		2.1
MN Zoo	Oak (forest or woodland) with 11- 25% impervious cover	11221		19
MN Zoo	Oak forest	32110	C	6.2
MN Zoo	Oak forest	32110		10.2
MN Zoo	Oak woodland-brushland	42120	C	97.3
MN Zoo	Oak woodland-brushland	42120		3
MN Zoo	Palustrine open water	93300		46.1
MN Zoo	Pavement with 91-100% impervious cover	14122		34
MN Zoo	Short grasses and mixed trees with 11-25% impervious cover	13124		33.3
MN Zoo	Short grasses and mixed trees with 26-50% impervious cover	13134		2.7
MN Zoo	Short grasses and mixed trees with 51-75% impervious cover	13144		11.8
MN Zoo	Short grasses with 4-10% impervious cover	13211		4.7
MNDOT				
McAndrews overpass/ZooEntrance	Altered/non-native deciduous forest	32170	NA	1.9
McAndrews overpass/ZooEntrance	Altered/non-native deciduous woodland	42130		1.3
McAndrews overpass/ZooEntrance	Mixed emergent marsh - seasonally flooded	61520		0.9

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
McAndrews overpass/ZooEntrance	Non-native dominated long grasses with 26-50% impervious cover	13232		13.1
McAndrews overpass/ZooEntrance	Oak woodland-brushland	42120	C	2.1
McAndrews overpass/ZooEntrance	Short grasses and mixed trees with 26-50% impervious cover	13134		0
McAndrews overpass/ZooEntrance	Short grasses and mixed trees with 26-50% impervious cover	13134		3.5
McAndrews overpass/ZooEntrance	Short grasses on upland soils	23211		0
McAndrews overpass/ZooEntrance	Short grasses with 26-50% impervious cover	13231		0
Dakota County				
FINDEN, STEPHEN AND SUSAN	Altered/non-native dominated seasonally flooded shrubland	52440	NN	11.1
FINDEN, STEPHEN AND SUSAN	Floodplain forest	32210		1.9
FINDEN, STEPHEN AND SUSAN	Floodplain forest	32210	C	3.3
FINDEN, STEPHEN AND SUSAN	Medium-tall grass altered/non-native dominated grassland	61220	NN	5
FINDEN, STEPHEN AND SUSAN	Non-native dominated long grasses with 4-10% impervious cover	13212		0.1
FINDEN, STEPHEN AND SUSAN	Short grasses and mixed trees with 26-50% impervious cover	13134		0.2
FINDEN, STEPHEN AND SUSAN	Slow moving linear open water habitat	91100		1.5
FINDEN, STEPHEN AND SUSAN	Temporarily flooded altered/non-native dominated grassland	61330	NN	4.7
MN Zoo Entrance	Oak forest	32110	C	0.2
MN Zoo Entrance	Oak woodland-brushland	42120	C	1.8
MN Zoo Entrance	Palustrine open water	93300		0.2
MN Zoo Entrance	Short grasses and mixed trees with 26-50% impervious cover	13134		2
Menards easement	Buildings and pavement with 91-100% impervious cover	14123		0.8
Menards easement	Medium-tall grass altered/non-native dominated grassland	61220	NA	1.6
Menards easement	Upland soils - cropland	24110		0.4
North Creek PCA	Medium-tall non-native dominated herbaceous vegetation	61220	NN	4

Site	MLCCS Landcover	MLCCS Landcover Code	Ecological Rank	Acres
North Creek PCA	Mixed emergent marsh - seasonally flooded	61520		4.3
North Creek PCA	Seasonally flooded altered/non-native dominated emergent vegetation	61530	NN	2
Pheasant Run Easement	Mesic prairie	61110	C	0.4
Pheasant Run Easement	Mixed emergent marsh - seasonally flooded	61520	NN	0.3
Pheasant Run Easement	Palustrine open water	93300		0
Pheasant Run Easement	Wet meadow	61420		0
Pheasant Run Stormwater Pond	Altered/non-native dominated temporarily flooded shrubland	52220		0.1
Pheasant Run Stormwater Pond	Mesic prairie	61110	C	0.2
Pheasant Run Stormwater Pond	Mixed emergent marsh - seasonally flooded	61520	D	5.8
Pheasant Run Stormwater Pond	Palustrine open water	93300		1.3
Pheasant Run Stormwater Pond	Short grasses with 51-75% impervious cover	13241		0.6

Table 5 Invasive Species Identified in the Corridor

Invasive Species	Amur maple, *Acer ginnala*	Asian bush honeysuckle, *Lonicera tatarica, L. morrowii, L. maackii*	bird's foot trefoil, *Lotus corniculatus*	black locust, *Robinia pseudoacacia*	bull thistle, *Cirsium vulgare*	butter and eggs, *Linaria vulgaris*	Canada thistle, *Cirsium arvense*	common buckthorn, *Rhamnus cathartica*	common burdock, *Arctium minus*	common mulberry, *Morus alba*	crown vetch, *Securigera varia*	garlic mustard, *Alliaria petiolata*	glossy buckthorn, *Frangula alnus*	Japanese hedge parsley, *Torilis japonica*	narrow-leaved cattail, *Typhus angustifolia*	reed canary grass, *Phalaris arundinacea*	Siberian elm, *Ulmus pumila*	spotted knapweed, *Centaurea stoebe* L. ssp. *micranthos*
Rambling River Park		x					x	x				x	x		x	x	x	
Fairhill Park							x	x				x			x	x	x	
Jim Bell Park and Preserve							x	x	x			x				x	x	
North Creek Park/Distad Park and Greenway		x					x	x	x		x	x			x	x	x	x
Pheasant Run Stormwater Pond and Easements								x							x	x	x	
Old Wastewater Treatment Facility							x	x	x						x	x		
North Creek Greenway Park					x		x	x		x	x	x			x	x	x	x
North Creek PCA			x				x				x					x		x
East Lake Community Park		x	x					x		x		x			x	x	x	x
Cobblestone Lake Park																	x	x
Quarry Point Park																		
Regatta Park																		
Moeller Park	x	x						x									x	

Invasive Species	Amur maple, *Acer ginnala*	Asian bush honeysuckle, *Lonicera tatarica, L. morrowii, L. maackii*	bird's foot trefoil, *Lotus corniculatus*	black locust, *Robinia pseudoacacia*	bull thistle, *Cirsium vulgare*	butter and eggs, *Linaria vulgaris*	Canada thistle, *Cirsium arvense*	common buckthorn, *Rhamnus cathartica*	common burdock, *Arctium minus*	common mulberry, *Morus alba*	crown vetch, *Securigera varia*	garlic mustard, *Alliaria petiolata*	glossy buckthorn, *Frangula alnus*	Japanese hedge parsley, *Torilis japonica*	narrow-leaved cattail, *Typhus angustifolia*	reed canary grass, *Phalaris arundinacea*	Siberian elm, *Ulmus pumila*	spotted knapweed, *Centaurea stoebe* L. ssp. *micranthos*
Hagemeister Park								x										
Findlay Park								x										
McAndrews overpass/ZooEntrance		x						x								x		
Minnesota Zoo	x	x				x	x	x						x		x	x	x

Landcover Change in the Corridor

Tracking landcover change over time is a good indicator of trends in the greenway corridor. Quantifying cover types associated with a greenway is also a way to promote each greenway corridor and identify unique qualities for visitors and neighbors. Approximately 1,430 acres of public land was included in the North Creek Greenway Corridor study area. MLCCS landcover data from prior to this project was compared with edited MLCCS data post-site evaluation. The area for each landcover class in both gis shapefiles was tabulated, and classes with increases and decreases of at least one acre are summarized in **Table 6**. Some changes are likely due to succession, while others may be a result of restoration activities.

Table 6 Landcover Change in the Corridor

MLCCS Landcover Class	Acre Increase	Acre Decrease
Short grasses and mixed trees with 26-50% impervious cover	10.9	
Short grasses and mixed trees with 51-75% impervious cover	11.8	
Short grasses with 26-50% impervious cover	91.7	
Short grasses with 51-75% impervious cover	3.4	
Short grasses on upland soils	14.4	
Non-native dominated long grasses with 26-50% impervious cover		1.3
Sand and gravel pits with 0-10% impervious cover		56.8
Upland soils - cropland		23.2
Hydric soils - row cropland		4.4
Altered/non-native deciduous forest		11.4
Medium-tall grass altered/non-native dominated grassland		27
Wet prairie		4.7
Grassland with sparse deciduous trees - altered/non-native dominated vegetation		5.1

Wildlife

Dakota County encompasses a variety of ecological subsections, including Big Woods, Oak Savanna, the Rochester Plateau, and the St. Paul Baldwin Plains and Moraines (MN DNR 2000). Subsections are units within ecological sections that are defined by glacial deposition processes, surface bedrock formation, local climate, topographic relief, and the distribution of plants (MN DNR 2022). Each subsection contains multiple habitats, an abundance of water resources, and hosts a diverse assemblage of plant communities and wildlife, including Species of Greatest Conservation Need (SGCN) whose populations are rare, declining, or vulnerable to decline in Minnesota. 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 an excessive amount of prairie was converted to row crop 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 eggshells 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 in recent 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.

Indicator Species

Table 6 list relatively common species dependent on grassland or prairie habitat for breeding that are known or likely to occur within the study area. 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 6. Indicator Species Observed in Dakota County.

Common Name	*Scientific Name*	Endangered	Threatened	Special Concern	SGCN
Mammals					
American badger	*Taxidea taxus*				X
Franklin's ground squirrel	*Poliocitellus franklinii*				X
Plains pocket gopher	*Geomys bursarius*				
Prairie vole	*Microtus ochrogaster*			X	X
Thirteen-lined ground squirrel	*Ictidomys tridecemlineatus*				
Grassland Birds					
American kestrel	*Falco sparverius*				X
Barn swallow	*Hirundo rustica*				

Common Name	***Scientific Name***	**Endangered**	**Threatened**	**Special Concern**	**SGCN**
Clay-colored sparrow	*Spizella pallida*				
Dickcissel	*Spiza americana*				X
Eastern bluebird	*Sialia sialis*				
Eastern kingbird	*Tyrannus tyrannus*				
Eastern meadowlark	*Sturnella magna*				X
Field sparrow	*Spizella pusilla*				X
Grasshopper sparrow	*Ammodramus savannarum*				X
Henslow's sparrow	*Ammodramus henslowii*	SE			X
Horned lark	*Eremophila alpestris*				
Lark sparrow	*Chondestes grammacus*			X	X
Loggerhead shrike	*Lanius ludovicianus*	SE			X
Northern rough-winged swallow	*Stelgidopteryx serripennis*				X
Savannah sparrow	*Passerculus sandwichensis*				
Song sparrow	*Melospiza melodia*				
Tree swallow	*Tachycineta bicolor*				
Tree Nesting Birds					
American goldfinch	*Spinus tristis*				
Baltimore oriole	*Icterus galbula*				
Brown thrasher	*Toxostoma rufum*				X
Chipping sparrow	*Spizella passerina*				
Indigo bunting	*Passerina cyanea*				
Orchard oriole	*Icterus spurius*				
Ruby-throated hummingbird	*Archilochus colubris*				
Reptiles					
Bullsnake	*Pituophis catenifer sayi*			X	X
Eastern racer	*Coluber constrictor*			X	X
Plains (western) hognose snake	*Heterodon nasicus*			X	X
Prairie skink	*Plestiodon septentrionalis*				
Six-lined racerunner	*Aspidoscelis sexlineata*				X

Common Name	*Scientific Name*	Endangered	Threatened	Special Concern	SGCN
Smooth greensnake	*Opheodrys vernalis*				X
Insects					
Monarch butterfly	*Danaus plexippus*				X
Regal Fritillary	*Speyeria idalia*			X	X
Rusty-patched bumble bee	*Bombus affinis*	FE			X

Source: MN DNR 2016

Abbreviations: SE = State Endangered; FE = Federally Endangered; SGCN = Species of Greatest Conservation Need

Table 7 contains a list of relatively common bird species that are largely dependent on woodland habitat that are known or likely to occur in woodland habitats within the study area. 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 woodland dependent.

Table 7. Local Woodland Birds Likely to Occur in the Study Area.

Common Name	*Scientific Name*
Cooper's hawk	*Accipiter cooperii*
Eastern wood pewee	*Contopus virens*
Brown creeper	*Certhia americana*
Black-billed cuckoo	*Coccyzus erythropthalmus*
Least flycatcher	*Empidonax minimus*
Ovenbird	*Seiurus aurocapilla*
Barred owl	*Strix varia*
Great crested flycatcher	*Myiarchus crinitus*
Blue-winged warbler	*Vermivora chrysoptera*
Red-bellied woodpecker	*Melanerpes carolinus*
Yellow-throated vireo	*Vireo flavifrons*
Yellow-rumped warbler	*Setophaga coronata*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Warbling vireo	*Vireo gilvus*
American redstart	*Setophaga ruticilla*
Downy woodpecker	*Picoides pubescens*
Red-eyed vireo	*Vireo olivaceus*
Scarlet tanager	*Piranga olivacea*

Hairy woodpecker	*Leuconotopicus villosus*
Black-capped chickadee	*Poecile atricapillus*
Rose-breasted grosbeak	*Pheucticus ludovicianus*
Pileated woodpecker	*Dryocopus pileatus*
White-breasted nuthatch	*Sitta carolinensis*
Baltimore oriole	*Icterus galbula*

Natural Resource Management Plan Priority Features and Recommendations

Priority features identified in this plan focus attention on the preservation, restoration, or enhancement of particular species, plant communities, water resources, or ecosystem processes. Restoration/conservation objectives are listed for each priority feature.

Surface Water

General types of enhancements to surface water mentioned during partner conversations in this planning process included:

- Enhancing the quality of wetland vegetation
- Removal of excess stream-edge trees to increase light reaching the ground layer and decrease bank erosion
- Adding stream-edge tree plantings on cold water streams, and their tributaries, to maintain or reduce stream water temperatures
- Adding in-stream habitat features including, but not limited to meandering
- Bring completed meandered segments online, if they are not already
- Continue maintenance on meandered segments
- Install barriers for invasive fish species

Table 8 details water resource recommendations are included in this plan. Specific locations are included in the NRMP Recommendation Site Plans (Figure 14). The lead agency for each recommendation is shown in **bold text.**

Table 8. Water Resource Recommendations

Water Resource Recommendation	Priority	Study or Implement	Recommendation	Jurisdiction	Partners
12	3	Implement	In-stream habitat, meandering on tributary to North Creek	**VRWJPO**	Farmington
13	?	Implement	Additional shade on tributary to North Creek	**VRWJPO**	Farmington
14	?	Implement	In-stream habitat, meandering on North Creek	**Dakota County**	VRWJPO
15	2	Implement	In-stream habitat, tree planting on North Creek	Farmington	**VRWJPO**
16	3	Implement	Remove small bridge on North Creek	**Farmington**	VRWJPO
17	1	Implement	Re-connect re-meandered channel on North Creek	Farmington	**VRWJPO**
18	1	Implement	Invasive electric fish barrier on East Lake	Lakeville	**VRWJPO**
19	4	Study	Potential flood storage, wetland mitigation/restoration adjacent to North Creek	Dakota County	**VRWJPO**
20	3	Implement	Restore blocking fish passage through culvert on North Creek	**Empire Township**	VRWJPO
21	2	Study	In-stream habitat, meandering, additional shading on North Creek	**Farmington**	VRWJPO
22	4	Implement	Additional shading on tributary to North Creek	Farmington	**VRWJPO**
23	2	Implement	Additional shading on North Creek	Farmington	**VRWJPO**
24	4	Implement	Remove old bridge structure on North Creek	Lakeville	**VRWJPO**

Vegetation Communities

Oak Savanna

- **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.

- **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.
- **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.
- **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.

Oak Woodlands

- **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.
- **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.
- **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.
- **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.

Mesic Hardwood Forests

- **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.
- **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.
- **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.
- **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.

Prairies

- **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.
- **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.

- **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.

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.

Wetlands and Shorelines

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.

Future cover types were determined after evaluating landowner preferences, existing vegetation, and considering costs for restoration. Future cover recommendations are included in each NRMP Recommendation Site Plan (**Figure 14**). A set of suggested activities is recommended for future cover type in the Greenway Corridor. **Table 9** outlines these activities.

Table 9: Existing Land Cover and Recommended Target Community

Existing Plant Community	Restoration Process	Long-Term Maintenance
Oak Savanna Target Communities: Southern Dry and Mesic Savanna (UPs14 and UPs24)	• Invasive shrub removal • Remove ash, boxelder, cottonwood, hackberry, walnut	• Prescribed burns • Spot treatment of invasive plants • Periodic sweeps to remove invasive shrubs

	• Seed/plug native prairie grasses and forbs	• 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

Mesic Hardwood Forest Target Communities: Southern Mesic Oak-Basswood Forest (MHs38) or Southern Mesic Maple-Basswood Forest (MHs39)	• 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 Target Communities: Northern Bulrush-Spikerush Marsh (MRn93), Northern Wet Meadow/Carr (WMn82), Southern Seepage Carr (WMs83) and Southern Wet Prairie (WPs54)	• Invasive shrub removal • Herbicide application in combination with mechanical removal (cutting, burning, scrape, hydrological manipulations) • Seed/plug with wetland grasses, sedges, and forbs • Plant appropriate wetland shrubs	• Periodic prescribed burns • 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
Altered Grasslands/Prairie Target Community: Southern Dry Prairie (UPs13) or	Control woody encroachment/invasive shrubs Control invasives in the herbaceous layer	Spot treatment of invasive plants Prescribe burn or mow

Southern Mesic Prairie (UPs23)	Native seeding Prescribe burn/mow	

Natural Resource Management Plan Recommendation Site Plans

Site Plans for each unit are included in the following pages (**Figure 14 A-H**). Each Site Plan includes written background information about the land use and existing vegetation conditions in the unit. An inventory map for each unit illustrates NRCS soil drainage classifications and existing National Wetlands Inventory (NWI) features. A larger recommendation map depicts recommended water resource-related features as well as future vegetation cover types. Site Plans are organized by Greenway Corridor Partner:

- Farmington plans are found in **Figures 14A-C**
- Lakeville plans are found in **Figures 14D-E**
- Apple Valley plans are found in **Figures 14F-G**
- Minnesota Zoo plans are found in **Figure14H**

Figure 14A North Creek Greenway, Farmington: Rambling River Park – Middle Creek

Water Resource Recommendation	Description
12	In-stream habitat, meandering on tributary to North Creek
13	Additional shade on tributary to North Creek
19	Potential flood storage, wetland mitigation/restoration adjacent to North Creek
20	Restore blocking fish passage through culvert on North Creek

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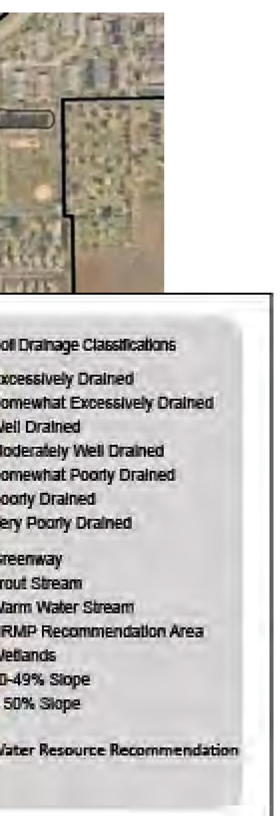


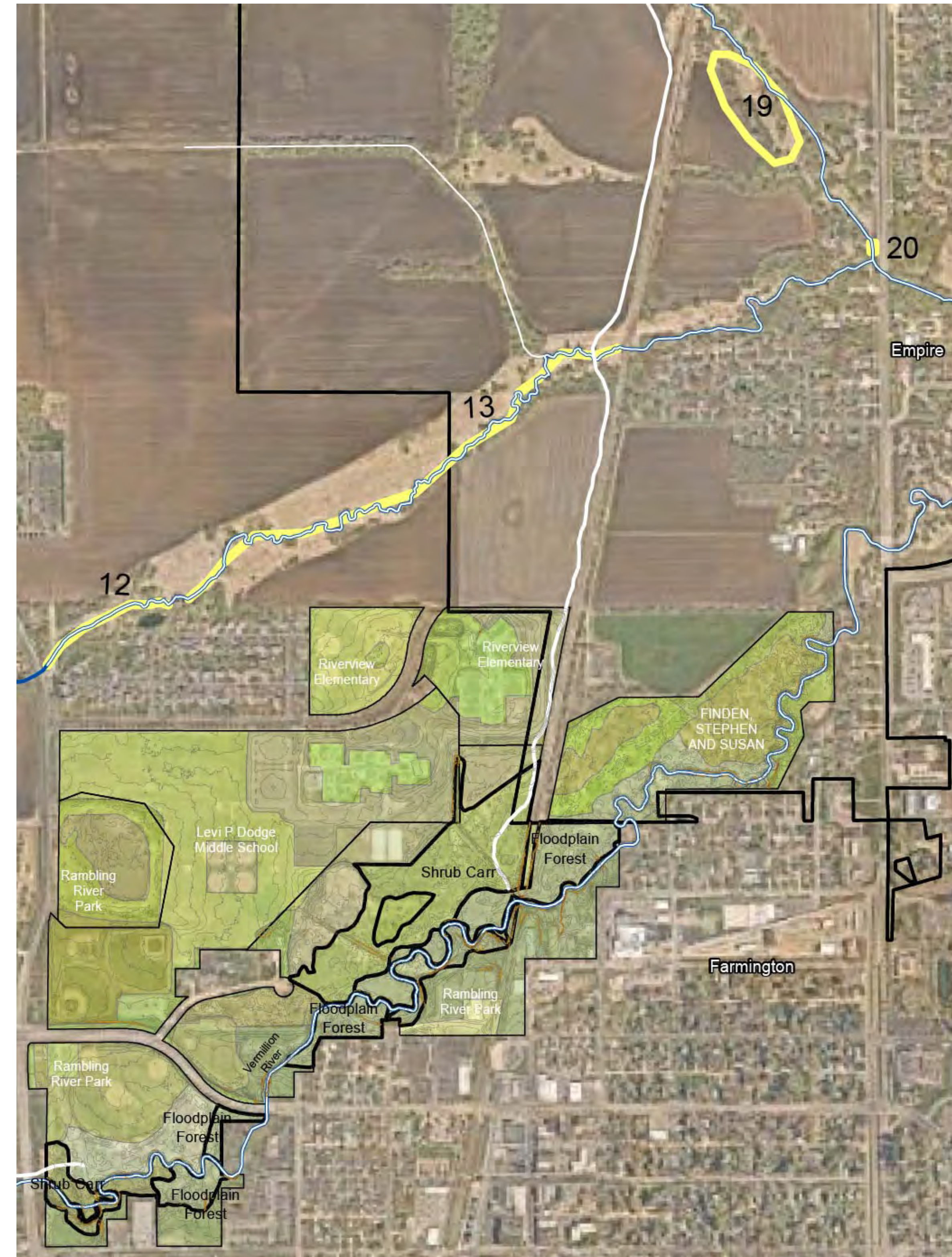


Figure 14B North Creek Greenway, Farmington: Jim Bell Park – Fairhill Park – North Creek

Water Resource Recommendation	Description
14	In-stream habitat, meandering on North Creek
15	In-stream habitat, tree planting on North Creek
16	Remove small bridge on North Creek
17	Re-connect re-meandered channel on North Creek

Jim Bell Park and Preserve is a 136-acre city park and preserve. The park portion is approximately six acres of turf grass and mixed deciduous trees that has a playground, picnic shelter, a basketball court, portable restrooms and two stormwater ponds.

The preserve portion that is located to the south of the park is made up of a large wetland complex, lowland hardwood forest, four stormwater ponds, and cropland. The wetland complex is comprised of an emergent wetland dominated by reed canary grass, wetland shrubland characterized by willows, plains cottonwood, boxelder and aspen, and a forested wetland that occurs within the larger lowland hardwood forest. The lowland hardwood forest exhibits fairly high levels of diversity both in the canopy layer and ground layer, despite having high cover of common buckthorn. The most common trees in the canopy layer include boxelder, trembling aspen, plains cottonwood, trembling aspen, swamp white oak (*Quercus bicolor*), basswood (*Tilia americana*), black cherry, and green ash. Common buckthorn cover is greater along the edges of the forest. Farther in the interior there is less buckthorn, and the structure is more open and intact, leading to more native ground layer species being present. Around the stormwater ponds mesic prairie has been planted that is periodically managed by mowing. Approximately 39 acres of the park is in cropland with two strips of remnant lowland hardwood forest running through it.

Outside of turf grass areas, invasive species cover is high throughout the park and preserve.

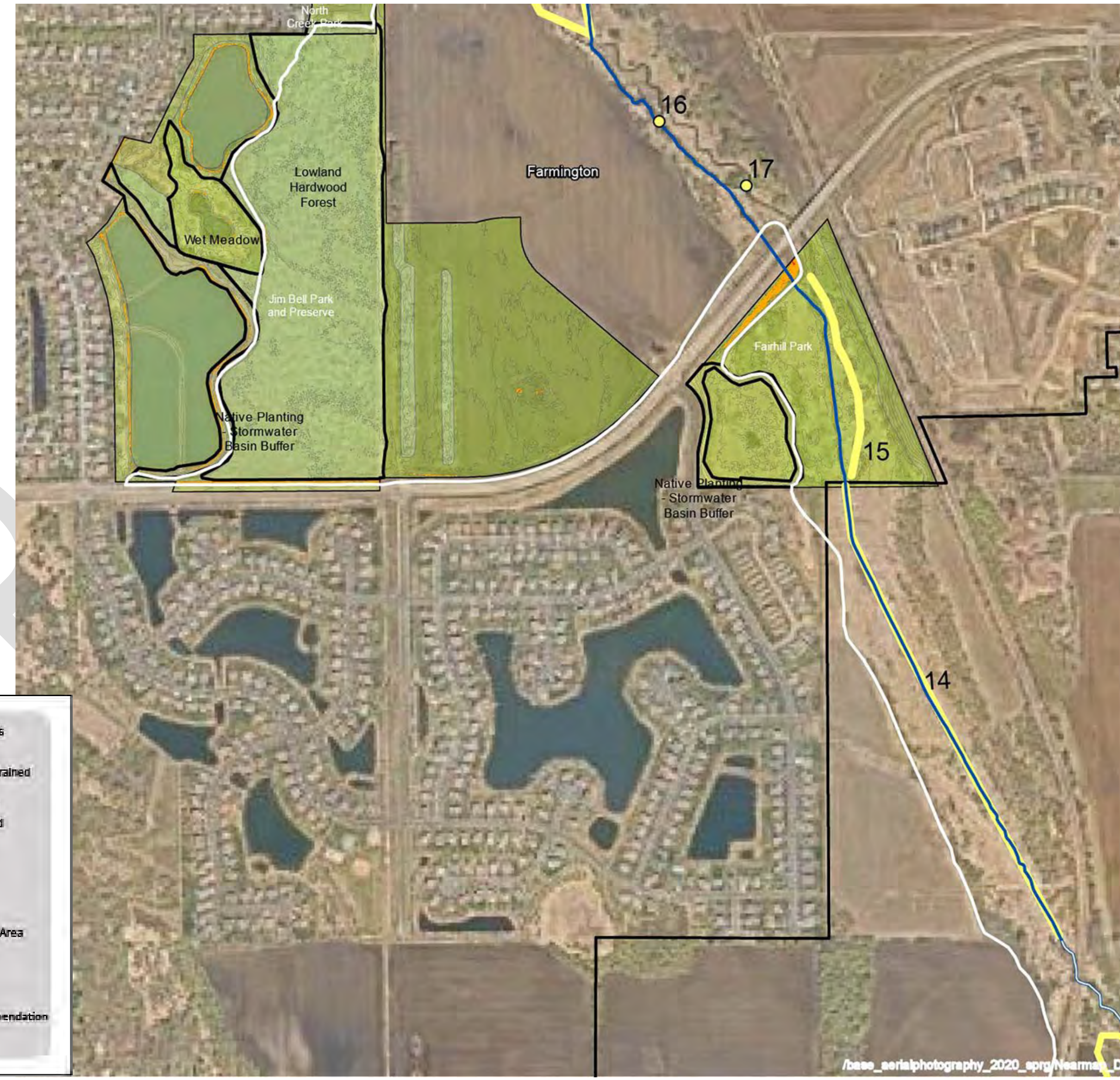
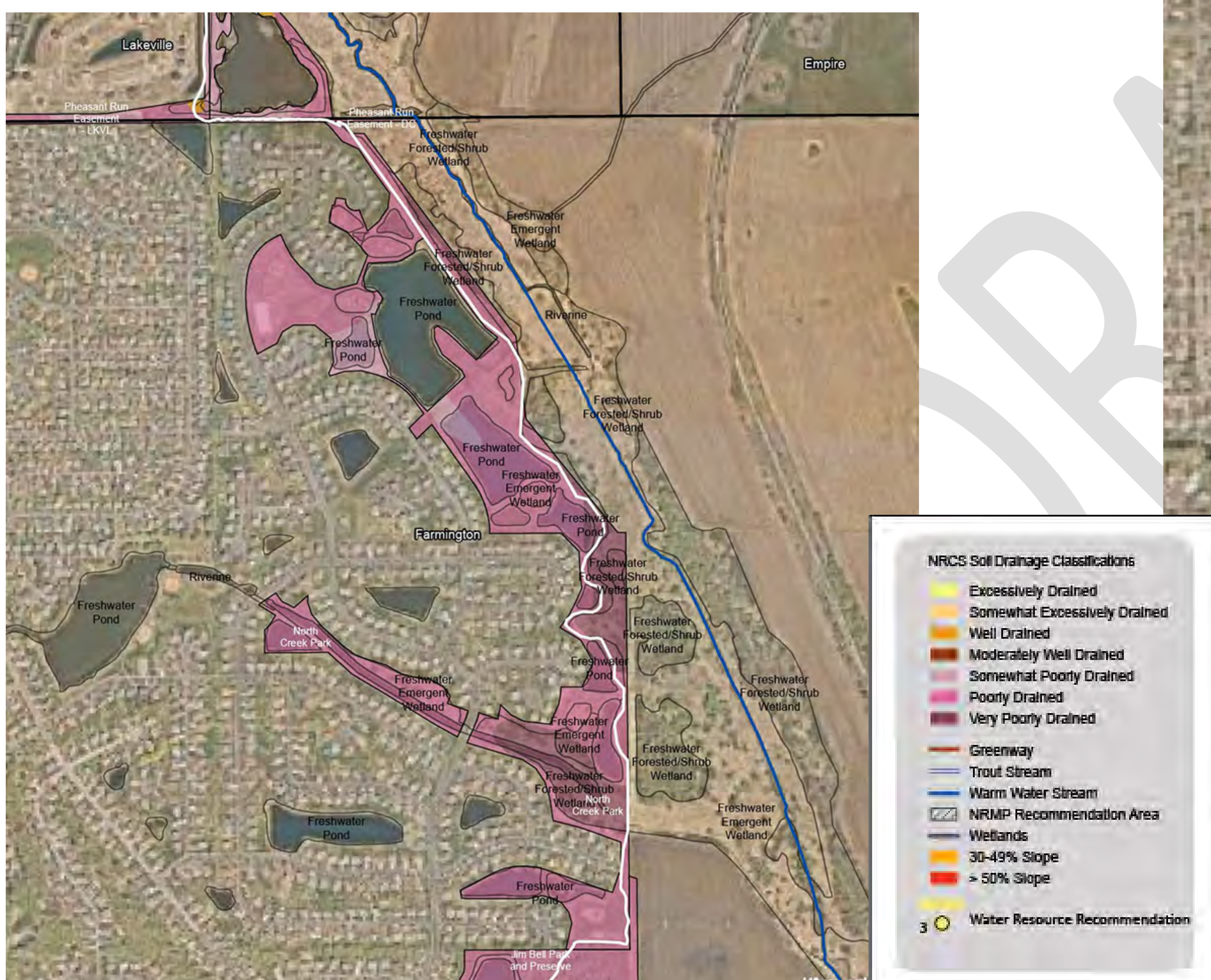


Figure 14C North Creek Greenway, Farmington: North Creek Park – North Creek – North Creek Tributary

North Creek Greenway Park is 36 acres of undeveloped land along North Creek located adjacent to residential neighborhoods. Wetlands that have been invaded by reed canary grass and non-native cattail make up the majority of the landcover. The few upland areas are similar condition with moderate to high cover of invasive species.

Invasive species cover is moderate to high

Water Resource Recommendation	Description
21	In-stream habitat, meandering, additional shading on North Creek
23	Additional shading on North Creek



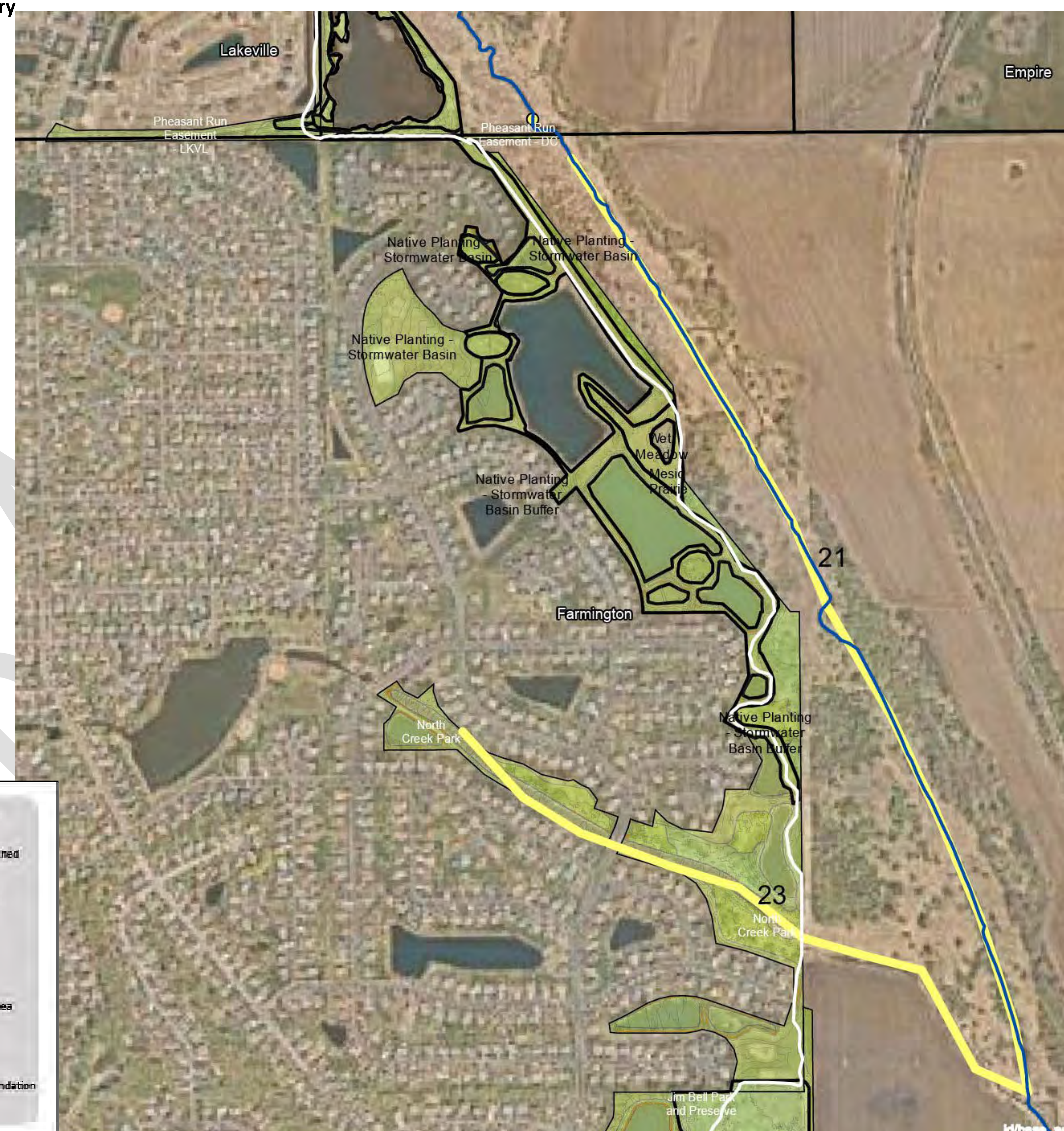


Figure 14D North Creek Greenway, Lakeville: Pheasant Run Stormwater Pond – North Creek PCA – North Creek

Water Resource Recommendation	Description
18	Invasive electric fish barrier on East Lake
24	Remove old bridge structure on North Creek

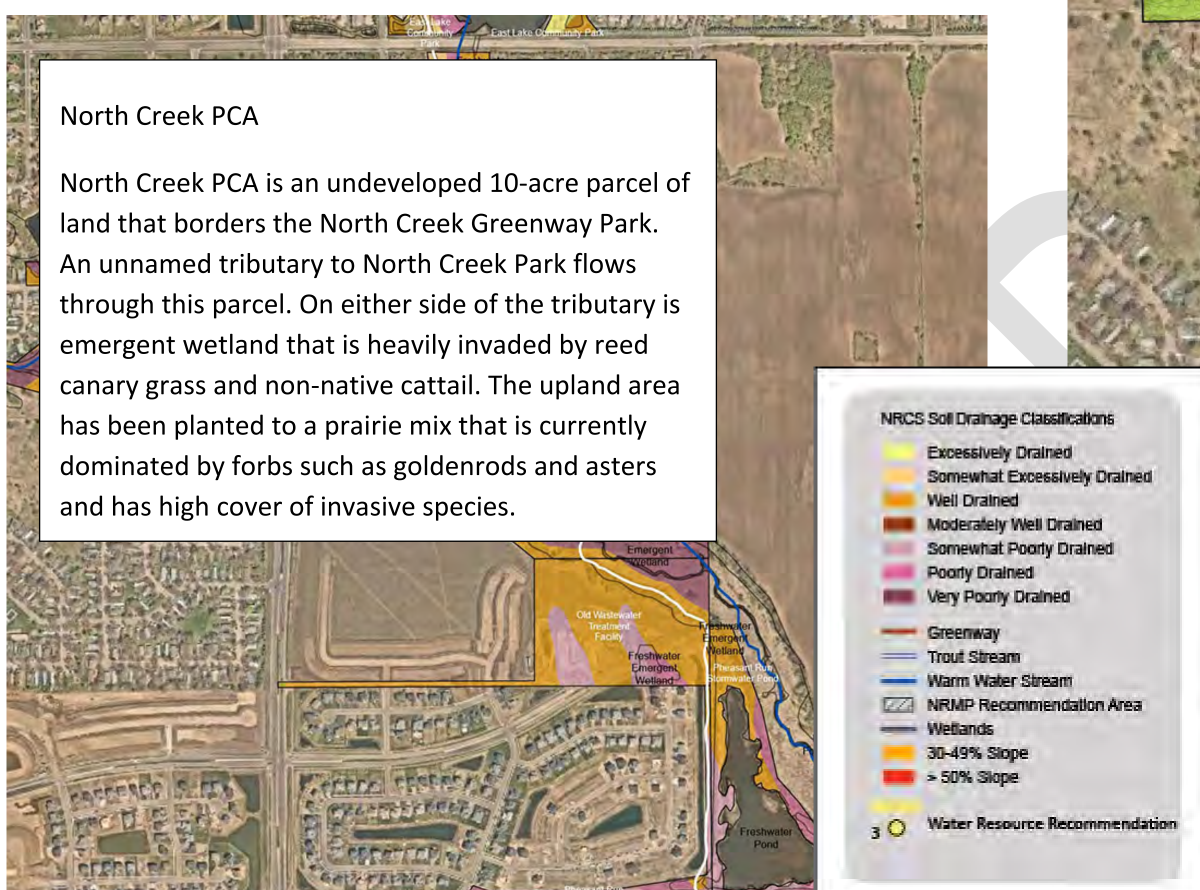
Pheasant Run Easements and Stormwater Pond

There are two Pheasant Run easements, one owned by Dakota County and one owned by the city of Lakeville. They occur on the south and west borders of the Pheasant Run stormwater pond. Altogether, the properties total 13 acres. Surrounding the Pheasant Run stormwater pond is mixed emergent marsh. On the south end of the property on the Pheasant Run easement owned by Dakota County, the mixed emergent transitions to mesic prairie. Non-native cattail and reed canary grass are prevalent, but native species are still present. Landcover transitions to short grass with planted/maintained trees in the western portion of the easement.

Invasive species cover is moderate.

North Creek PCA

North Creek PCA is an undeveloped 10-acre parcel of land that borders the North Creek Greenway Park. An unnamed tributary to North Creek Park flows through this parcel. On either side of the tributary is emergent wetland that is heavily invaded by reed canary grass and non-native cattail. The upland area has been planted to a prairie mix that is currently dominated by forbs such as goldenrods and asters and has high cover of invasive species.



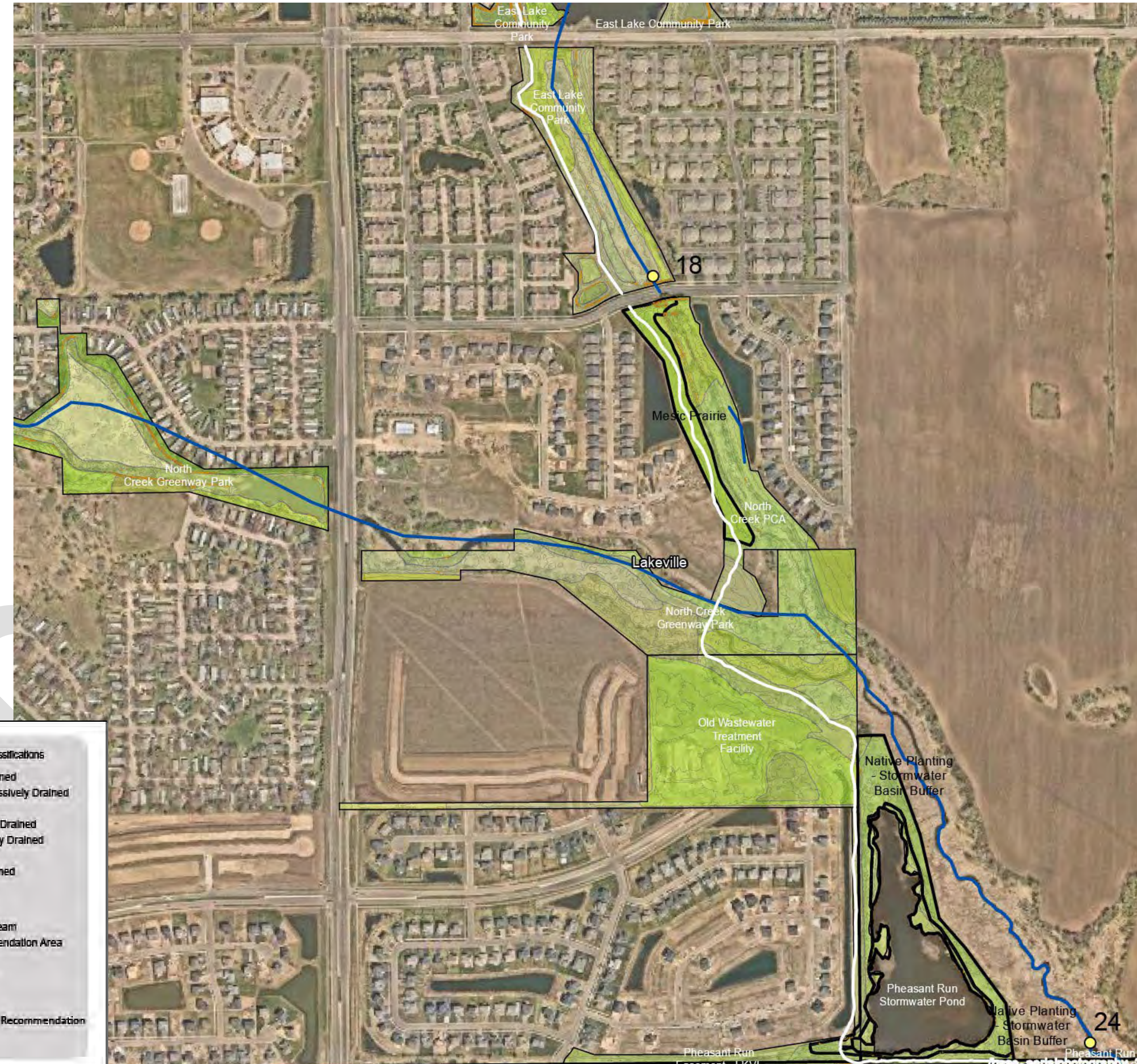


Figure 14E North Creek Greenway, Lakeville: East Lake Community Park

The 60-acre city park features multiple amenities including tennis courts, parking, baseball/softball field, grills, picnic shelters, playground equipment, and a paved trail which follows East Lake. East Lake is at the center of the park. Along the border of the lake land cover is mostly non-native/altered grassland and woodland. Trees include oak species, boxelder, and American elm. Shrubs include willows and smooth sumac, forbs include common milkweed, goldenrod, and smooth oxeye. The most common grass is reed canary grass. An unnamed stream that is a tributary of North Creek flows from the northwest border to the southern border. Landcover in and around the stream is characterized by floodplain forest characterized by silver maple and plains cottonwood, wetland emergent communities dominated by reed canary grass, and non-native cattail marsh. Five stormwater ponds are located throughout the park. Sandbar willow grows densely around the border of three of the smaller ponds.

Approximately 13 acres of dry prairie and oak woodland-brushland occur in the northwestern corner of the park. The high-quality dry prairie has a diverse set of native forbs including wild bergamot, prairie coreopsis, purple prairie clover, common milkweed, and New England aster (*Symphyotrichum novae-angliae*), and grasses including big bluestem, Indiangrass, and side-oats grama. Although, there has been some invasion by Siberian elm (*Ulmus pumila*), butter and eggs (*Linaria vulgaris*), and common buckthorn (*Rhamnus cathartica*), overall invasive species cover is low. The oak-woodland wraps around the dry prairie. The structure of the oak woodland is open with large spaces present in the canopy. Although common buckthorn cover is high through most of the shrub layer, there are still native species present in the ground layer. Trees include bur oak, black cherry, swamp white oak, American elm, ironwood, hackberry, and boxelder. Shrubs other than common buckthorn include smooth sumac and prickly ash. Herbaceous species in the ground layer include smooth Solomon's seal, candle anemone, Virginia waterleaf, hog peanut and white snakeroot.

Invasive species cover is low in the dry prairie and moderate throughout the rest of the park.

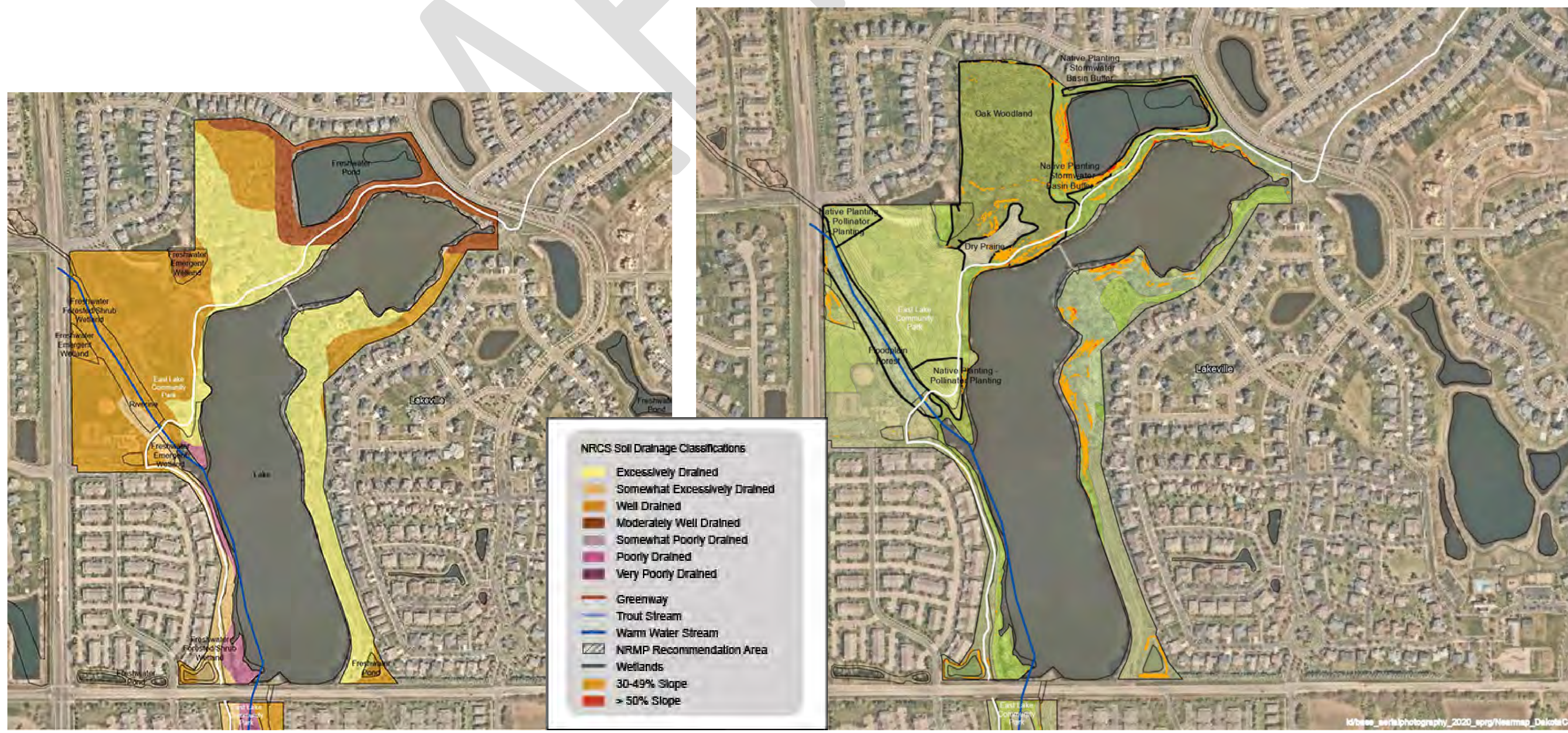


Figure 14F North Creek Greenway, Apple Valley: Cobblestone Lake Park

Cobblestone Lake Park

This 14-acre city park encircles Cobblestone Lake and has a canoe launch, picnic shelter, playground equipment, and a paved trail. The landcover is a mixture of native plantings and short grass and planted/maintained trees.

Invasive species cover is moderate.

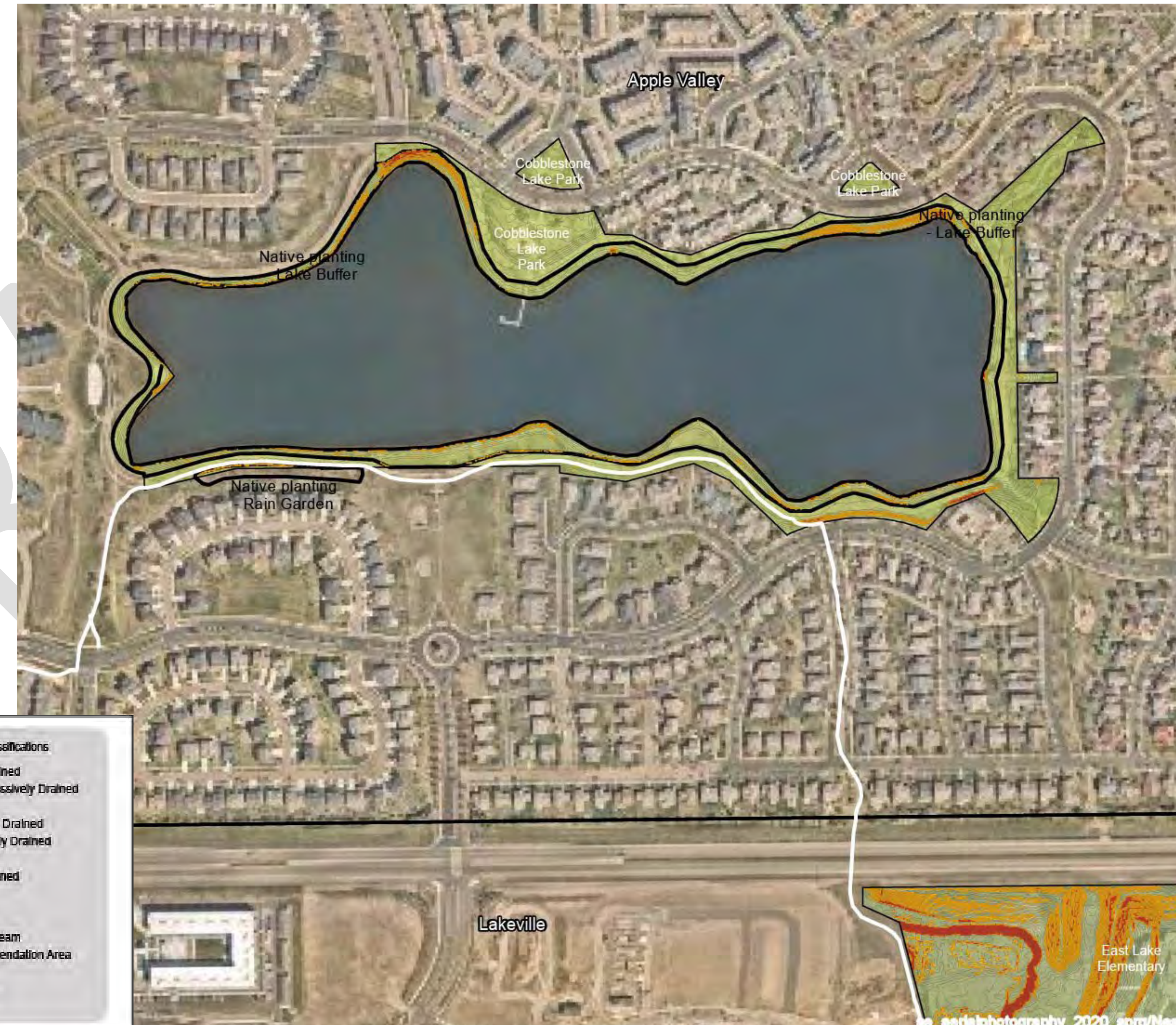
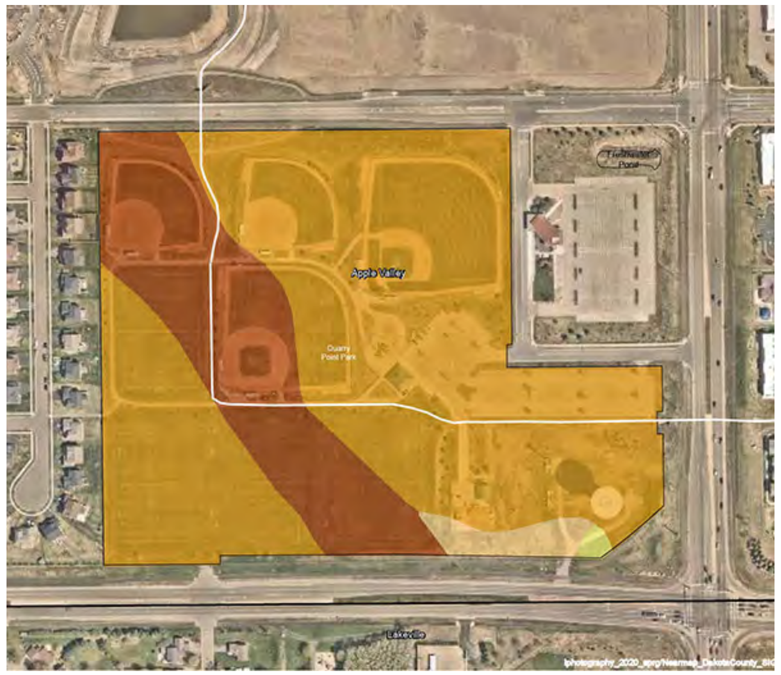


Figure 14G North Creek Greenway, Apple Valley: Quarry Point Park – Moeller Park



Quarry Point Park

This 33-acre city park is a large athletic complex made up of multiple softball/baseball fields and soccer fields. It also has playground equipment and parking lots. Landcover for the park is turf grass and short grass and planted/maintained trees.

Moeller Park

Moeller Park encompasses 14 acres. It has a baseball/softball field, a soccer field, and a paved path. The grass is maintained in and around the athletic fields and planted and maintained trees are located along the paved path and altered woodland occurs along the park's edges.

Oak forest occurs along a paved path that extends into the neighboring residential developments. Trees include white oak, boxelder, American elm, aspen, black cherry, and black walnut. The shrub layer is dominated by common buckthorn. Other shrubs include prickly ash, chokecherry, and green ash. Some native ground layer species were observed including native ferns and smooth Solomon's seal.

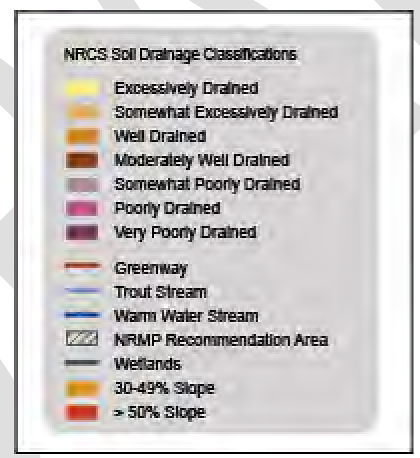


Figure 14H North Creek Greenway, Apple Valley: Findlay Park – Minnesota Zoo

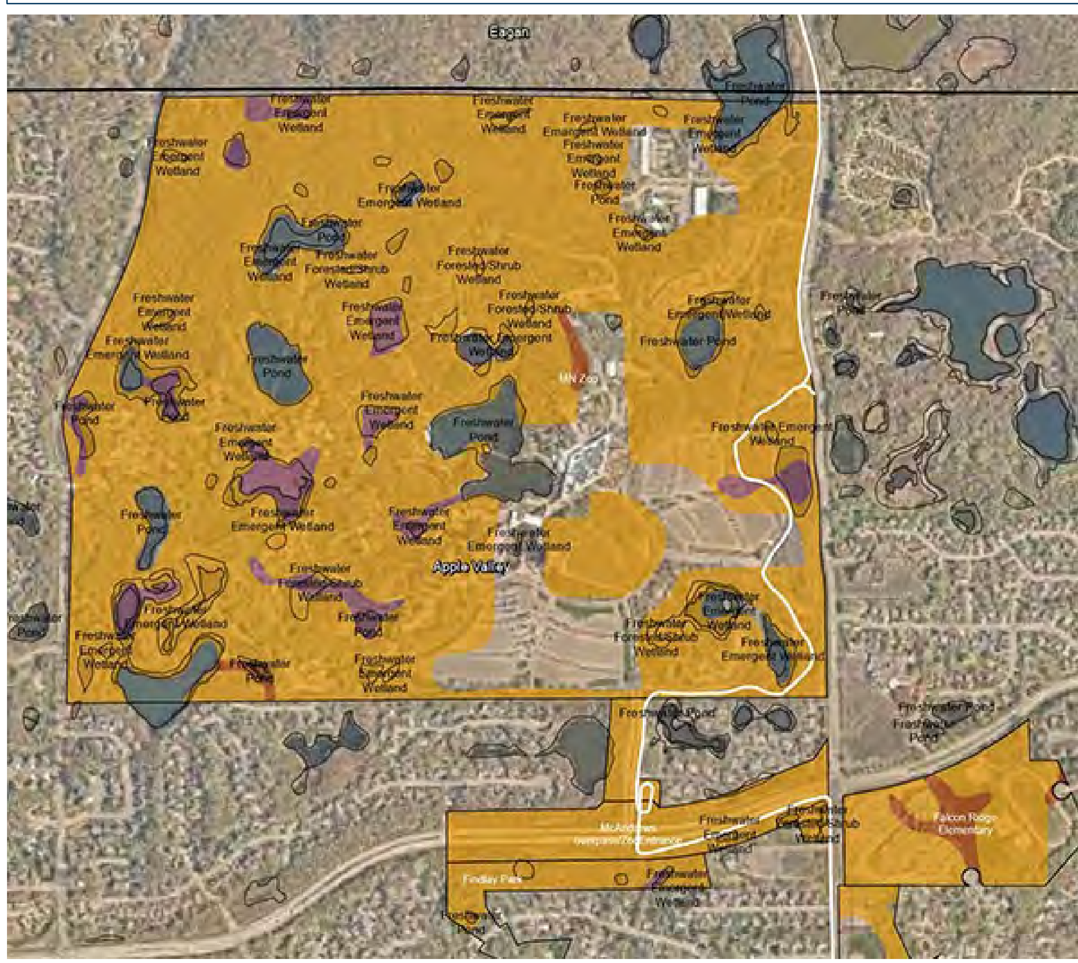
The paved trail that runs through the Minnesota Zoo property that is planned to be part of the Dakota County North Creek Greenway intersects with a matrix of short grasses and mixed trees, oak woodland-brushland, altered/non-native deciduous forest, non-native grassland with sparse deciduous trees, long grass on upland soils, non-native shrubland and short grasses. Three open water wetlands occur adjacent to the trail.

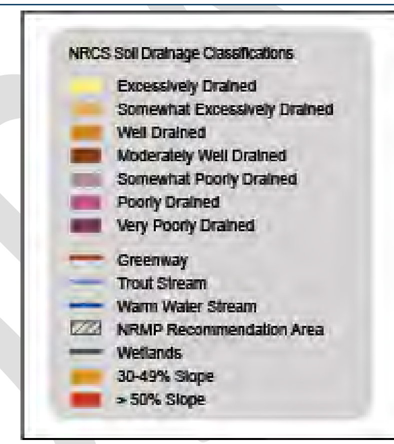
The oak woodland-brushland is characterized by northern pin oak (*Quercus ellipsoidalis*), red oak, white oak, and trembling aspen in the canopy. Shrubs include common buckthorn, chokecherry, prickly ash, and raspberry. Ground layer species include white snakeroot, lady fern (*Athyrium filix-femina*), hog peanut, arrowleaf aster, and long-stalked sedge (*Carex pendunculata*). Canopy cover is open enough for oak regeneration to be occurring in the herbaceous layer.

The altered/non-native deciduous forest was characterized by trembling aspen, black cherry, American elm, plains cottonwood, and northern pin oak in canopy. Shrubs include prickly ash, common buckthorn, chokecherry and currants (*Ribes* sp.). Forbs include New England aster and Canada goldenrod. Where the tree cover thins out, smooth brome dominates the herbaceous layer. Native grass such as big bluestem, Indiangrass and switchgrass become more common in and around a dry stormwater basin adjacent to building facilities along the trail. Mixed in the oak-woodland is shrubland dominated by chokecherry and sumac in the shrub layer and cool season non-native grasses in the herbaceous layer.

The School of Environmental Studies is located within the Minnesota Zoo property. The facility includes a parking lot and garden area. Turf grass with mixed trees is managed around the school building, parking lot, and the road to the school.

Invasive species cover is moderate.

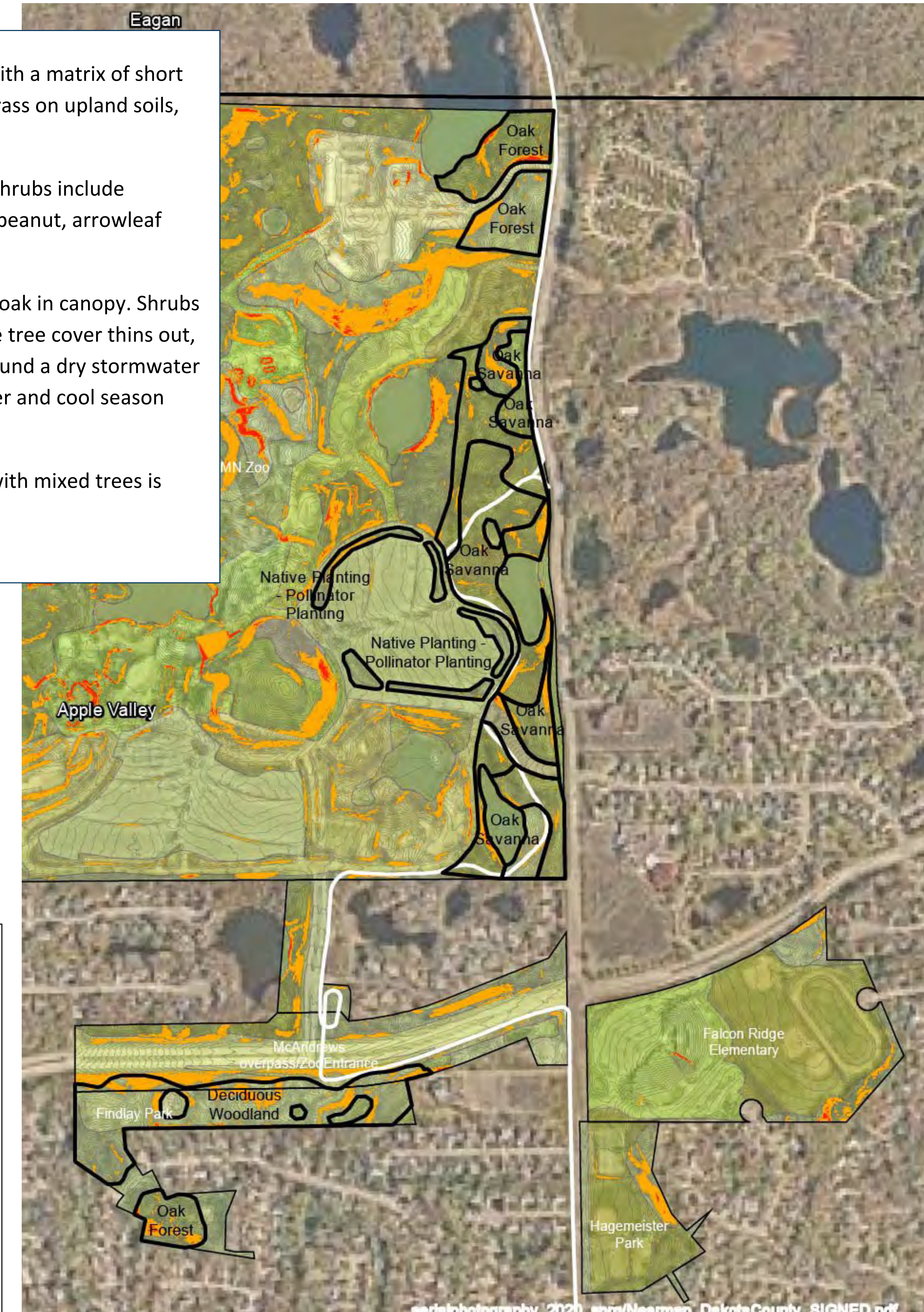




Findlay Park

This 14-acre park is located within and adjacent to a residential development. A reasonably high-quality oak forest occurs within the portion of the park encircled by residential homes. Across the street from the oak forest is an altered/non-native deciduous woodland that contains four wetlands.

Invasive species cover is low in the oak forest and moderate in the altered/non-native deciduous woodland.



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 7**). 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 7** and as shown in **Figure 14**. Target plant communities indicated are consistent with the *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province* (MN DNR 2005), and detailed descriptions of these communities are found in Appendix G.

Implementation of these restoration projects are prioritized primarily by the landowner or effort lead's understanding of ecological value gained in converting altered and non-native plant cover to native plant communities described in **Table 7**. 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 partnership organizations to oversee implementation.

Previous and Ongoing Restoration Efforts

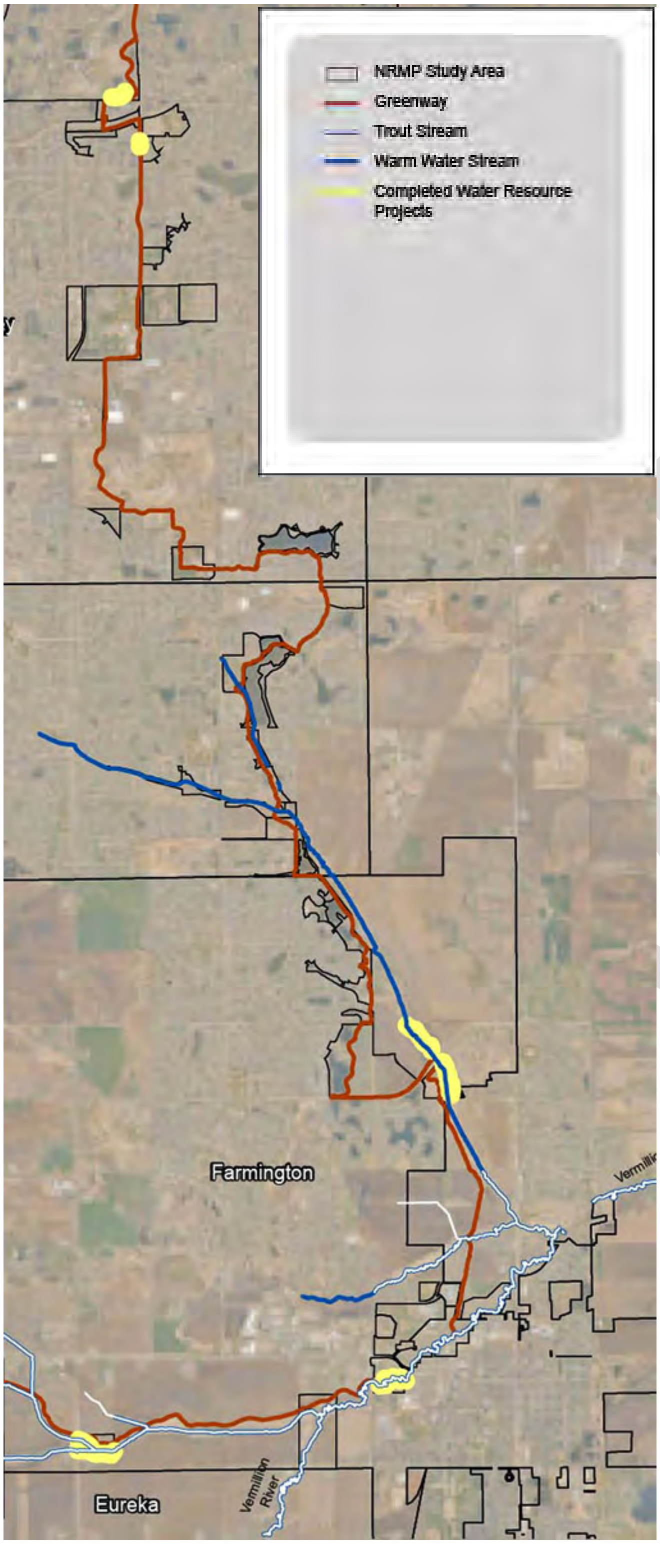
Before addressing the specific priorities and activities for each unit, it is important to acknowledge the past efforts to restore sites within the Greenway Corridor undertaken by the landowner(s), the County and other partners. Past water resource restoration efforts are illustrated in **Figure 15**. Vegetation restoration efforts are listed in **Table 10**.

Table 10 Past and Current Vegetation Restoration (not complete 1/24/22)

Greenway Segment – Partner	Plant Community	Activities	Years
Rambling River Park	Shrub Carr and Floodplain Forest	Buckthorn removal	2017, 2018, 2019
		Trail replacement and restoration	2018
Jim Bell Preserve	Lowland Hardwood Forest	Buckthorn removal	2008, 2012, 2017
	Wet Meadow	Willow removal	2016, 2018, 2020
Distad Park	Prairie	Willow and buckthorn removal	2020

Greenway Segment – Partner	Plant Community	Activities	Years
Finden Easement – Dakota County	All Units north of the Vermillion River	All exotic woody species and approximately 2/3 of native shrubs: cut, treat stumps, haul, burn brush piles.	2017
	Unit 3 South Bank and Northeast Unit 3	Prescribed burn and seeding with native species after prescribed burn	2018
	Riparian community	Planting of red dogwood stems during volunteer event	2018
	Riparian community	Planting of herbaceous species plugs	2019
	Entire property	Control RCG	2019
East Lake Community Park	Dry Prairie	Restoration	2007
	Oak Woodland	Woodland restoration	2008
	Stormpond buffer	Shoreline restoration	2022
Minnesota Zoo	Pollinator planting	Initial native planting	2012
	Pollinator planting	General maintenance (including 2 RX burns)	2012-2020
	Oak savanna	Restoration and management	2012-2018

Figure 17: Past Water Resource Improvement Activities in Greenway



Work Plans

Restoration Sequence Work Plan

Table 11 details Restoration Sequence work plans for vegetation management at each unit included in this NRMP. These work plans were developed to provide guidelines toward achieving the target communities shown in Figure 14. 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 as well as a prioritization made by the landowner, activities, schedules, responsibilities, and estimated costs. Table 7 describes the restoration activities at each site**,** 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 importance of the restoration need by the landowner or the effort lead, on a scale of 1 to 4, with 1 being the highest.

Table 11: Restoration Sequence Work Plan for Natural Resource Projects

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
Owner: Farmington									
Site: Rambling River Park									
1. Shrub Carr and Floodplain Forest	1	1.1	fall, winter	Treat invasive shrubs	0.5	34.9	$5,000	$3,500	$124,650
		1.2 to 1.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	0.5	34.9	$1,300	$900	$32,060
		1.2	spring	Plant native groundlayer species via seed and/or plugs	0.5	34.9	$1,800	$1,600	$56,740
								Subtotal	$213,450
Site: Fairhill Park									
2. Native Planting - Stormwater Basin Buffer - Mesic Prairie	2	2.1 and 2.4	spring	Prescribed burn or mow		2.3		$2500/unit	$2,500
		2.1	fall, winter	Treat invasive shrubs including sandbar willow		2.3		$1,500	$3,450
		2.1 to 2.5	spring, summer, fall	Spot spray herbaceous invasives		2.3		$300	$690
		2.2	spring	Enrichment native seeding where needed		2.3		$650	$1,495
								Subtotal	$8,135
Site: Jim Bell Preserve									
3. Native Planting - Stormwater Basin Buffer - Mesic Prairie	2	3.1 and 3.4	spring	Prescribed burn or mow	0.2	3.9		$2500/unit	$2,500
		3.1	fall, winter	Treat invasive shrubs including sandbar willow	0.2	3.9		$1,500	$5,850
		3.1 to 3.5	spring, summer, fall	Spot spray herbaceous invasives	0.2	3.9		$300	$1,170

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
		3.2	spring	Enrichment native seeding where needed	0.2	3.9		$650	$2,535
								Subtotal	$12,055
4. Lowland Hardwood Forest	1	4.1	fall, winter	Treat invasive shrubs		47.9	$5,000	$3,500	$167,650
		4.2 to 4.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts		47.9	$1,300	$900	$43,110
		4.2	spring	Plant native groundlayer species via seed and/or plugs		47.9	$1,800	$1,600	$76,640
								Subtotal	$287,400
5. Wet Meadow	1	5.1	fall	Herbicide overspray to kill reed canary grass areas		5.6		$450	$2,520
		5.1	fall, winter	Treat invasive shrubs around edges of wetland		2		$2,500	$5,000
		2.2 to 2.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts		2		$900	$1,800
		5.1	spring	Plant native seed and install plug plantings		5.6		$1,600	$8,960
		5.2 to 5.5	spring - fall	Establishment maintenance: continue invasive treatment, mowing, burn year 5		5.6		$1,000	$5,600
								Subtotal	$23,880
Site: Distad Park									
6. Native Planting - Stormwater Basin Buffer	3	6.1 and 6.4	spring	Prescribed burn or mow		13.8		$3500/unit	$10,500
		6.1	fall, winter	Treat invasive shrubs including sandbar willow		13.8		$1,500	$20,700

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
		6.1 to 6.5	spring, summer, fall	Spot spray herbaceous invasives		13.8		$300	$4,140
		6.2	spring	Enrichment native seeding where needed and plug planting along shoreline		13.8		$1,600	$22,080
								Subtotal	$57,420
7. Mesic Prairie	2	7.1 and 7.4	spring	Prescribed burn or mow		2.2		$3500/unit	$3,500
		7.1	fall, winter	Treat woody encroachment		2.2		$1,500	$3,300
		7.1 to 7.5	spring, summer, fall	Spot spray herbaceous invasives		2.2		$300	$660
		7.2	spring	Enrichment native seeding where needed		2.2		$650	$1,430
								Subtotal	$8,890
8. Wet Meadow	2	8.1	fall, winter	Treat invasive shrubs including sandbar willow		0.5		$1,500	$750
		8.1 to 8.5	spring, summer, fall	Spot spray herbaceous invasives		0.5		$300	$150
		8.2	spring	Enrichment native seeding where needed and plug planting along shoreline		0.5		$1,600	$800
								Subtotal	$1,700
9. Native Planting - Stormwater	3	9.1	fall, winter	Treat invasive shrubs including sandbar willow		1.9		$1,500	$2,850

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
Basin - Wet Meadow		9.1 to 9.5	spring, summer, fall	Spot spray herbaceous invasives		1.9		$300	$570
		9.2	spring	Enrichment native seeding where needed and plug planting along shoreline		1.9		$1,600	$3,040
								Subtotal	$6,460
Pheasant Run Stormwater Pond									
10. Native Planting - Stormwater Basin Buffer - Emergent Marsh, Mesic Prairie and Woodland	2	10.1 - 10.3	spring, fall	Treat hybrid cattail		1.4		$1,000	$1,400
		10.1 - 10.3	spring, fall	Treat reed canary grass		6		$1,000	$6,000
		10.1	fall, winter	Treat invasive shrubs around edges of wetland and in wooded area		6		$3,500	$21,000
		10.2 to 10.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts		6		$900	$5,400
		10.2	spring	Plant native seed and install plug plantings along shoreline		8		$1,600	$12,800
								Subtotal	$46,600
Owner: Lakeville									
Site: North Creek PCA									
11. Mesic Prairie	2	11.1 and 11.4	spring	Prescribe burn or mow		2.9		$3500/unit	$3,500
		11.1 to 11.5	spring, summer, fall	Spot spray herbaceous invasives		2.9		$300	$870
		11.2	spring	Enrichment native seeding where needed		2.9		$650	$1,885

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
								Subtotal	$6,255
East Lake Community Park									
12. Floodplain Forest	3	12.1	fall, winter	Treat invasive shrubs		2.7		$3,500	$9,450
		12.2 to 12.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts		2.7		$900	$2,430
		12.2	spring	Plant native groundlayer species via seed and/or plugs		2.7		$1,600	$4,320
								Subtotal	$16,200
13. Pollinator Prairie Plantings	2	13.1	summer	Site preparation herbicide sprayout, drill seed natives		2.2		$2,000	$4,400
		13.2 to 13.5	spring, summer, fall	Establishment maintenance: continue invasive Treat, mowing, burn year 5		2.2		$1,200	$2,640
								Subtotal	$7,040
14. Dry Prairie	2	14.1	spring	Prescribe burn or mow		1.2		$3500/unit	$3,500
		14.1	fall, winter	Treat invasive shrubs and other woody encroachment		1.2		$3,500	$4,200
		14.2 to 14.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts		1.2		$900	$1,080
		14.2	spring	Enrichment native seeding where needed		1.2		$650	$780
								Subtotal	$9,560
15. Oak Woodland	1	15.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	0.5	11.1	$5,000	$3,500	$41,350
		15.2 to 15.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	0.5	11.1	$1,300	$900	$10,640

PLANT COMMUNITY	PRIO RITY	RESTORA TION SEQUENC E[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ ACSLO PE >30%	COST/A C SLOPE <30%	COST PER TASK
		15.2	spring	Hand seed/broadcast seed native ground layer mix with emphasis on grasses	0.5	11.1	$1,800	$1,600	$18,660
		15.3 or 15.4	spring, fall	Prescribe burn, timing dependent on development of fine fuels	0.5	11.1		$6000/u nit	$6,000
								Subtotal	$76,650
16. Native Planting - Stormwater Basin Buffer - Mesic Prairie and Shoreline	2	16.1 - 16.3	spring, fall	Spot spray herbaceous invasive species	0.1	1.2		$300	$360
		16.1	fall, winter	Treat invasive shrubs and Siberian elms around shoreline	0.1	1.2		$2,000	$2,400
		16.2 to 16.5	summer , fall	Follow up foliar herbicide on invasive shrub resprouts	0.1	1.2	$1,300	$900	$1,210
		16.2	spring	Enrichment native seeding where needed and plug planting along shoreline	0.1	1.2	$1,800	$1,600	$2,100
								Subtotal	$6,070
Owner: Apple Valley									
Site: Cobblestone Lake Park									
17. Native Planting – Maintenance on Lake Shoreline and Buffer Area and Rain Garden	3	17.1 to 17.5	spring, summer	Spot spray herbaceous invasive species		6.3		$300	$1,890
		17.1 to 17.5	fall, winter	Treat woody invasives including sandbar willow		0.5		$2,000	$1,000
		17.2	spring	Enrichment native seeding where needed		6.3		$650	$4,095
								Subtotal	$6,985
Quarry Park									
18. Low Mow Demonstration Area	4	18.1	summer , fall	Site preparation: herbicide sprayout. Seed in fine fescue or other low mow species		0.2		$800 this site	$800

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
		18.2	spring	Spot spray any invasive herbaceous species that came in when area was disturbed		0.2		$350 this site	$350
								Subtotal	$1,150
Moeller Park									
19. Oak Forest	2	19.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	0.2	2.2	$5,000	$3,500	$8,700
		19.2 to 19.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	0.2	2.2	$1,300	$900	$2,240
		19.2	spring	Hand seed/Broadcast seed native ground layer mix with emphasis on grasses	0.2	2.2	$1,800	$1,600	$3,880
								Subtotal	$14,820
20. Deciduous Woodland	4	20.1	fall, winter	Treat invasive shrubs		0.9		$3,500	$3,150
		20.2 to 20.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts		0.9		$900	$810
		20.2	spring	Plant native ground layer species via seed		0.9		$1,600	$1,440
								Subtotal	$5,400
Site: Findlay Park									
21. Oak Forest	3	21.1 to 21.5	fall, winter	General maintenance: monitor and treat for invasives	0.3	1.7		$1,000	$1,700
		21.2	spring	Hand seed/Broadcast seed native ground layer mix	0.3	1.7	$1,800	$1,600	$3,260
								Subtotal	$4,960
22. Deciduous Woodland	2	22.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	1.6	9.2	$5,000	$3,500	$40,200

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
		22.2 to 22.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	1.6	9.2	$1,300	$900	$10,360
		22.2	spring	Hand seed/Broadcast seed native ground layer mix with emphasis on grasses	1.6	9.2	$1,800	$1,600	$17,600
								Subtotal	$68,160
Minnesota Zoo									
23. Oak Savanna	1	23.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	2.2	21.2	$5,000	$3,500	$85,200
		23.2 to 23.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	2.2	21.2	$1,300	$900	$21,940
		23.2	spring	Hand seed/broadcast seed native ground layer mix with emphasis on grasses	2.2	21.2	$1,800	$1,600	$37,880
		23.3 or 23.4	spring, fall	Prescribed burn, timing dependent on development of fine fuels	2.2	21.2		$8000/unit	$64,000
								Subtotal	$209,020
24. Oak Forest	1	24.1	fall, winter	Treat invasive shrubs, thin ash, cottonwood, and walnut trees	0.6	5.9	$5,000	$3,500	$23,650
		24.2 to 24.5	summer, fall	Follow up foliar herbicide on invasive shrub resprouts	0.6	5.9	$1,300	$900	$6,090
		24.2	spring	Hand seed/Broadcast seed native ground layer mix with emphasis on grasses	0.6	5.9	$1,800	$1,600	$10,520
								Subtotal	$40,260
	2	25.1 and 25.4	spring	Prescribed burn or mow	0.1	2.8		$2500/unit	$10,000

PLANT COMMUNITY	PRIORITY	RESTORATION SEQUENCE[Site #].[Year]	SEASON	ACTIVITY	Slope >30% Acres	Slope <30% Acres	COST/ACSLOPE >30%	COST/AC SLOPE <30%	COST PER TASK
25. Pollinator Planting - Maintenance		25.2 to 25.5	spring, summer, fall	Spot spray herbaceous invasives	0.1	2.8		$300	$840
		25.2	spring	Enrichment native seeding	0.1	2.8	$900	$650	$1,910
								Subtotal	$12,750
GRAND TOTAL RESTORATION COST $1,151,270									

Twenty-Year Work Plan

A 20-year work plan (see **Table 12**) 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 initial years of intensive ecological restoration, and these costs will generally decrease after intense, initial restoration activities are completed.

Table 12: Twenty-Year Work Plan for Long-Term Maintenance

PLANT COMMUNITY	RESPON-SIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/ TASK/ YEAR*
Farmington								
Rambling River Park								
1. Shrub Carr and Floodplain Forest		spring, summer, fall	Annual spot treatment of invasives	34.9	0.5	$250	$300	$8,875
		fall, winter	Survey and remove invasive shrubs every 3 years	34.9	0.5	$900	$1,300	$32,060
							Subtotal	$40,935
Fairhill Park								
2. Native Planting - Stormwater Basin Buffer - Mesic Prairie		summer, fall	Annual spot treatment of invasives	2.3		$250		$575
		fall, winter	Prescribe burn every 3 to 5 years	2.3		$2500/unit		$2,500
							Subtotal	$3,075
Jim Bell Preserve								
2. Native Planting - Stormwater Basin Buffer - Mesic Prairie		summer, fall	Annual spot treatment of invasives	3.9	0.2	$250		$975
		fall, winter	Prescribe burn every 3 to 5 years	3.9	0.2	$2500/unit		$2,500
							Subtotal	$3,475
4. Lowland Hardwood Forest		spring, summer, fall	Annual spot treatment of invasives	47.9		$250	$300	$11,975
		fall, winter	Survey and remove invasive shrubs every 3 years	47.9		$900	$1,300	$43,110
							Subtotal	$55,085

PLANT COMMUNITY	RESPON-SIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/ TASK/ YEAR*
5. Wet Meadow		spring, summer, fall	Annual spot treatment of invasives	5.6		$250		$1,400
		fall, winter	Prescribe burn every 5 to 8 years	2		$2500/unit		$2,500
							Subtotal	$3,900
Distad Park								
2. Native Planting - Stormwater Basin Buffer		spring, summer, fall	Annual spot treatment of invasives	13.8		$250		$3,450
		fall, winter	Prescribe burn every 3 to 5 years	13.8		$2500/unit		$7,500
							Subtotal	$10,950
7. Mesic Prairie		summer, fall	Annual spot treatment of invasives	2.2		$250		$550
		fall, winter	Prescribe burn every 3 to 5 years	2.2		$2500/unit		$2,500
							Subtotal	$3,050
8. Wet Meadow		spring, summer, fall	Annual spot treatment of invasives	0.5		$250		$125
		fall, winter	Prescribe burn or mow every 5 years	0.5		$2500/unit		$2,500
							Subtotal	$2,625
2. Native Planting - Stormwater Basin - Wet Meadow		spring, summer, fall	Annual spot treatment of invasives	1.9		$250		$475
		fall, winter	Prescribe burn or mow every 5 years	1.9		$2500/unit		$7,500
							Subtotal	$7,975
Pheasant Run Stormwater Pond								

PLANT COMMUNITY	RESPON-SIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/ TASK/ YEAR*
10. Native Planting - Stormwater Basin Buffer - Emergent Marsh, Mesic Prairie and Woodland		spring, summer, fall	Annual spot treatment of invasives	1.4		$250		$350
		fall, winter	Prescribe burn or mow every 5 years	6		$2500/unit		$2,500
							Subtotal	$2,850
Lakeville								
North Creek PCA (Site 6)								
11. Mesic Prairie		summer, fall	Annual spot treatment of invasives	2.9		$250		$725
		fall, winter	Prescribe burn every 3 to 5 years	2.9		$2500/unit		$2,500
							Subtotal	$3,225
East Lake Community Park								
12. Floodplain Forest		spring, summer, fall	Annual spot treatment of invasives	2.7		$250		$675
		fall, winter	Survey and remove invasive shrubs every 3 years	2.7		$900		$2,430
							Subtotal	$3,105
13. Pollinator Prairie Plantings		summer, fall	Annual spot treatment of invasives	2.2		$250		$550
		fall, winter	Prescribe burn every 3 to 5 years	2.2		$2500/unit		$4,000
							Subtotal	$4,550
14. Dry Prairie		summer, fall	Annual spot treatment of invasives	1.2		$250		$300
		fall, winter	Prescribe burn every 3 to 5 years	1.2		$2500/unit		$2,500
							Subtotal	$2,800

PLANT COMMUNITY	RESPON-SIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/ TASK/ YEAR*
15. Oak Woodland		spring, summer, fall	Annual spot treatment of invasives	11.1	0.5	$250	$300	$2,925
		fall, winter	Survey and remove invasive shrubs every 3 years	11.1	0.5	$900	$1,300	$10,640
		spring, fall	Prescribe burn, timing dependent on development of fine fuels, every 3 to 8 years	11.1	0.5	$2500/unit		$2,500
							Subtotal	$16,065
16. Native Planting - Stormwater Basin Buffer - Mesic Prairie and Shoreline		spring, summer, fall	Annual spot treatment of invasives	1.2	0.1	$250		$300
		fall, winter	Prescribe burn or mow every 5 years	1.2	0.1	$2500/unit		$2,000
							Subtotal	$2,300
Partner: Apple Valley								
Site: Cobblestone Lake Park								
17. Native Planting - Lake Shoreline and Buffer Area and Rain Garden		spring, summer, fall	Annual spot treatment of invasives	6.3		$250		$1,575
		fall, winter	Prescribe burn or mow every 5 years	0.5		$2500/unit		$2,000
							Subtotal	$3,575
Site: Quarry Park								
18. Low Mow Demonstration Area		spring, summer, fall	Survey and treat any invasive herbaceous species	0.2		$250		$50
							Subtotal	$50
Site: Moeller Park								

PLANT COMMUNITY	RESPON-SIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/ TASK/ YEAR*
19. Oak Forest		spring, summer, fall	Annual spot treatment of invasives	2.2	0.2	$250	$300	$610
		fall, winter	Survey and remove invasive shrubs every 3 years	2.2	0.2	$900	$1,300	$2,240
							Subtotal	$2,850
20. Deciduous Woodland		spring, summer, fall	Annual spot treatment of invasives	0.9		$250	$300	$225
		fall, winter	Survey and remove invasive shrubs every 3 years	0.9		$900	$1,300	$810
							Subtotal	$1,035
Site: Findlay Park								
21. Oak Forest		fall, winter	General maintenance: monitor and control for invasives	1.7	0.3	$250		$425
							Subtotal	$425
22. Deciduous Woodland		spring, summer, fall	Annual spot treatment of invasives	9.2	1.6	$250	$300.00	$2,780
		fall, winter	Survey and remove invasive shrubs every 3 years	9.2	1.6	$900	$1,300.00	$10,360
							Subtotal	$13,140
Minnesota Zoo								
23. Oak Savanna		spring, summer, fall	Annual spot treatment of invasives	21.2	2.2	$250	$300	$5,960
		fall, winter	Survey and remove invasive shrubs every 3 years	21.2	2.2	$900	$1,300	$21,940
		spring, fall	Prescribe burn, timing dependent on development of fine fuels, every 3 to 8 years	21.2	2.2	2500/unit		$20,000

PLANT COMMUNITY	RESPON-SIBILITY	SEASON	ACTIVITY	ACRES SLOPE < 30%	ACRES SLOPE >30%	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST ESTIMATE/ TASK/ YEAR*
							Subtotal	$47,900
24. Oak Forest		spring, summer, fall	Annual spot treatment of invasives	5.9	0.6	$250	$300	$1,655
		fall, winter	Survey and remove invasive shrubs every 3 years	5.9	0.6	$900	$1,300	$6,090
							Subtotal	$7,745
25. Pollinator Planting		summer, fall	Annual spot treatment of invasives	2.8	0.1	$250		$700
		fall, winter	Prescribe burn every 3 to 5 years	2.8	0.1	$2500/unit		$12,500
							Subtotal	$13,200
						GENERAL RESTORATION COST/YEAR		**$255,885**

*Yearly cost estimate calculated on year that burn occurs.

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 12**, 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.

Table 13: 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.

Strategic Partnerships for Implementing Greenway Natural Resource Projects

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 19** and **20**). 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 19: Greenway Corridor Scenarios. Taken from Greenway Guidebook, page 22.

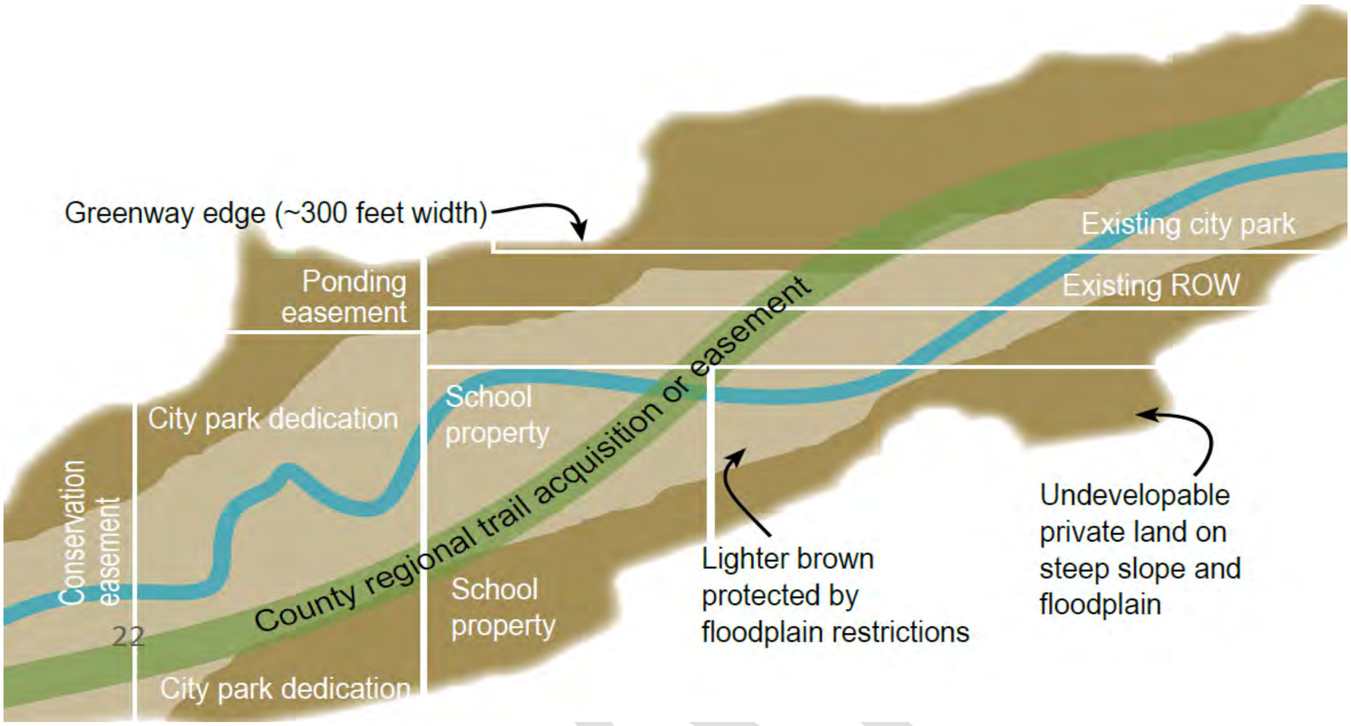
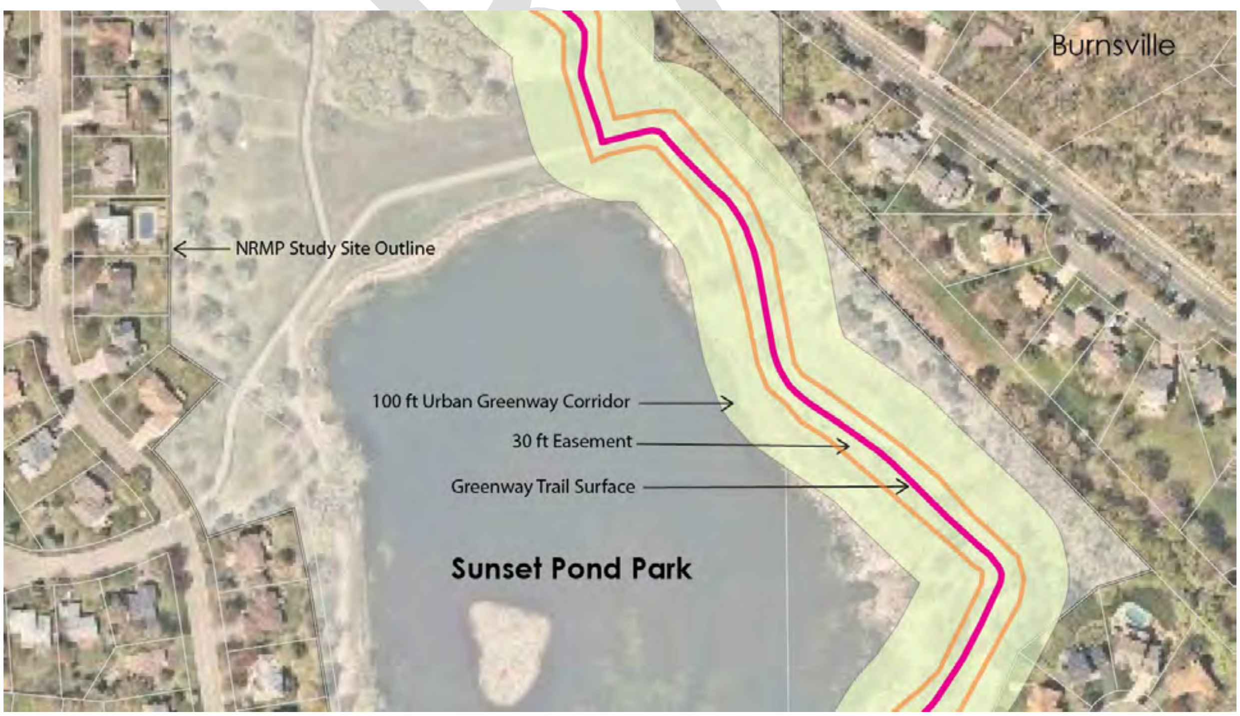


FIGURE 20: A Local Greenway Corridor Example on the Lake Marion Greenway



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.

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 12** outlines the Roles and Responsibilities of Dakota County and Landowner Partner organizations for each of the consideration areas discussed above.

Table 12: 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.

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 title 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 (JPA) 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.

Continued Natural Resource Management

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 10)** 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).

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 ecological restoration contractors that specialize 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 of Minnesota & Iowa 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

Monitoring

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.

As mentioned earlier, Dakota County embraces the Adaptive Management approach in land management. 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 learning into planning and management. It is set up like a feedback loop as illustrated in Executive Figure 1. 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.

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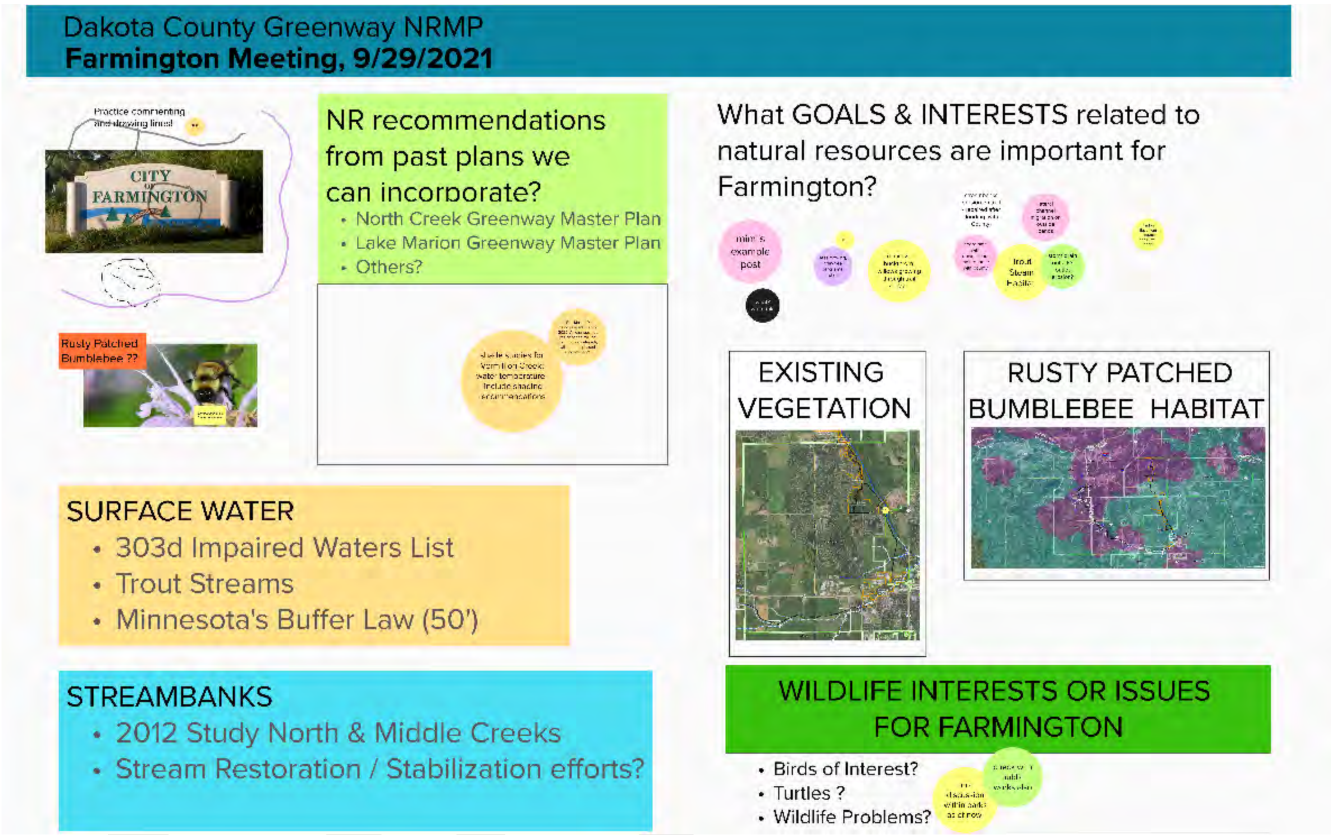
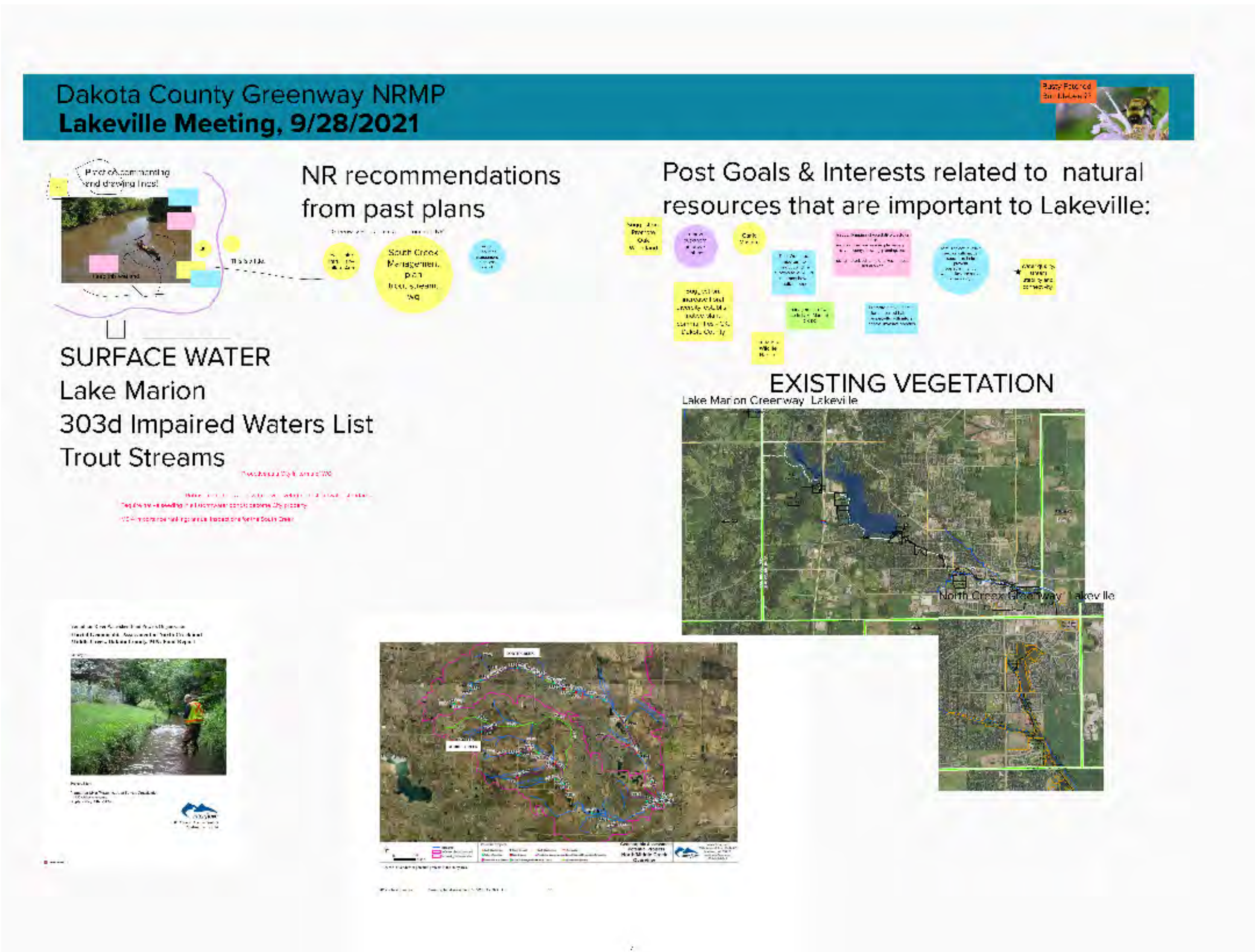
Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Farmington



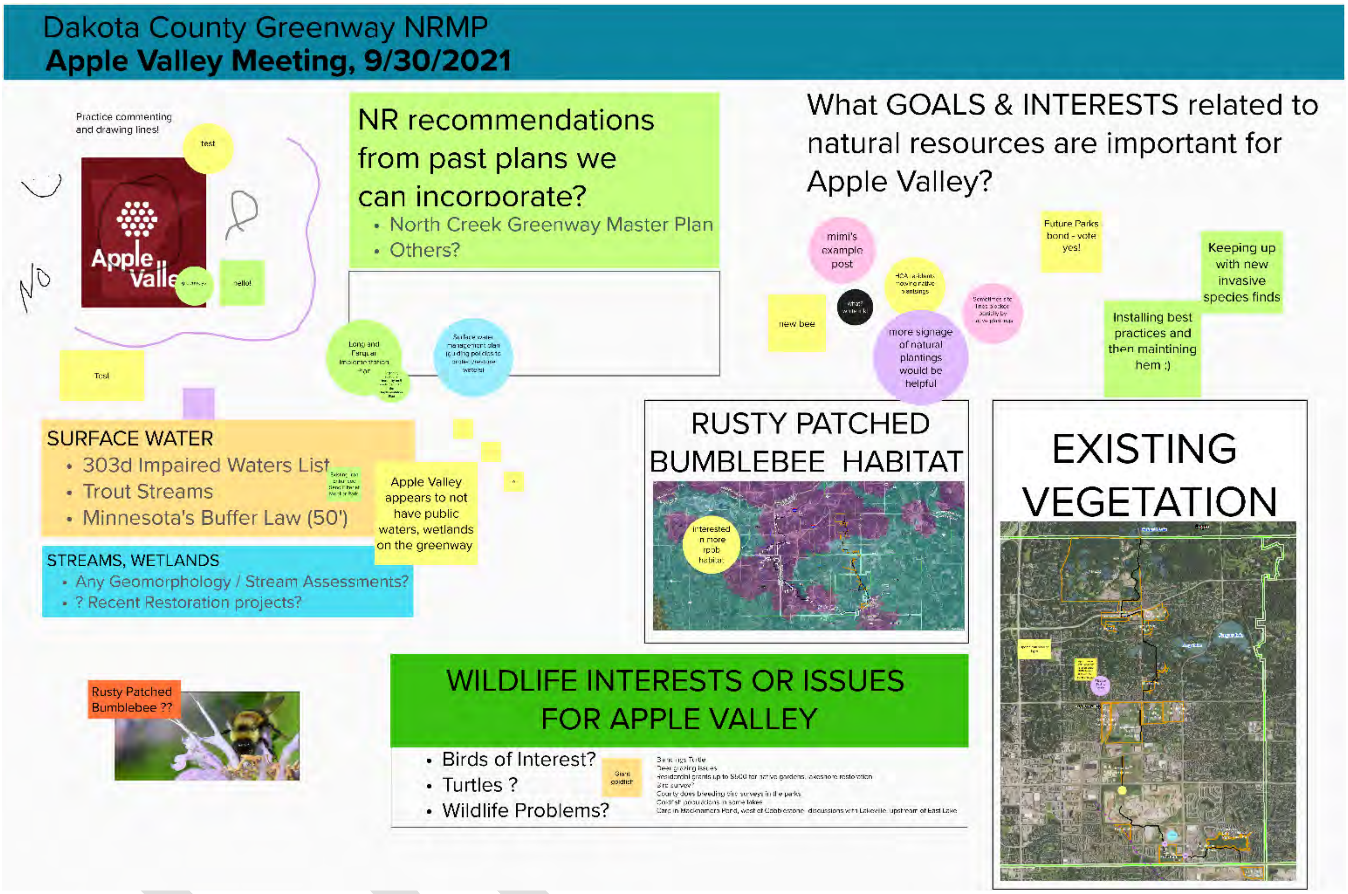
Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Lakeville



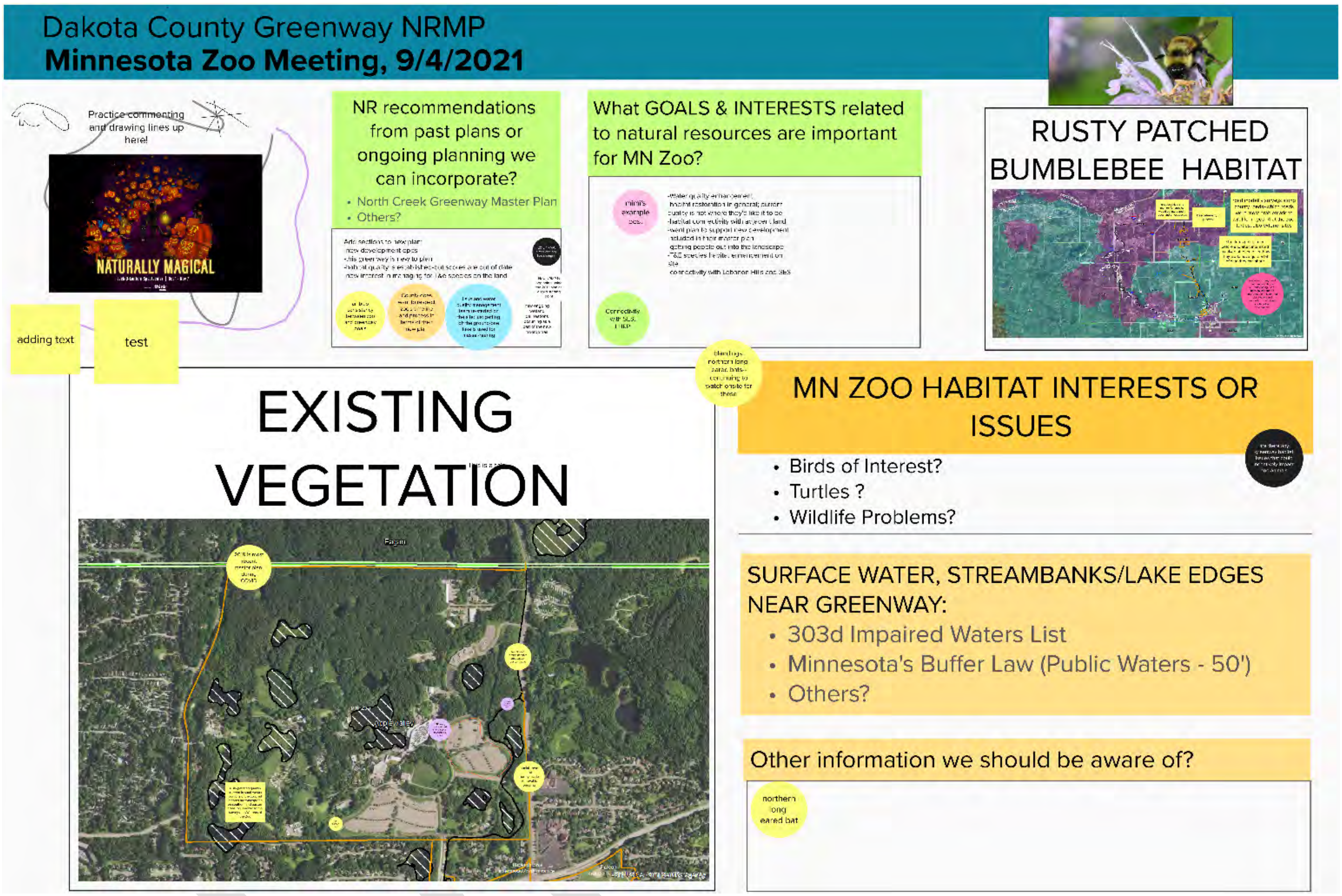
Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Apple Valley



Appendix A. Greenway Partner's Summary of Issues, Concerns, Interests

Minnesota Zoo



Appendix B. Soils in the Greenway Study Area

MUSYM	MUName	Drainage Class	Area (ac)
129	Cylinder loam, 0 to 2 percent slopes	Somewhat poorly drained	34.5
208	Kato silty clay loam	Poorly drained	98.7
250	Kennebec silt loam	Moderately well drained	8
252	Marshan silty clay loam	Poorly drained	196.3
318	Mayer loam, swales	Very poorly drained	13.4
344	Quam silt loam	Very poorly drained	1.6
539	Klossner muck, 0 to 1 percent slopes	Very poorly drained	27.8
540	Seelyeville muck	Very poorly drained	26.4
1027	Udorthents, wet	<Null>	18.2
1030	Pits, sand and gravel	Excessively drained	22.2
1055	Aquolls and Histosols, ponded	Very poorly drained	3.5
1078	Anthroportic Udorthents, 2 to 9 percent slopes	Moderately well drained	54.9
1816	Kennebec variant silt loam	Moderately well drained	8.3
1824	Quam silt loam, ponded	Very poorly drained	6.3
301B	Lindstrom silt loam, 1 to 4 percent slopes	Well drained	6.3
342B	Kingsley sandy loam, 3 to 8 percent slopes	Well drained	4
342C	Kingsley sandy loam, 8 to 15 percent slopes	Well drained	265.2
342E	Kingsley sandy loam, 15 to 25 percent slopes	Well drained	41

342F	Kingsley sandy loam, 25 to 40 percent slopes	Well drained	1.2
39A	Wadena loam, 0 to 2 percent slopes	Well drained	5.2
39B	Wadena loam, 2 to 6 percent slopes	Well drained	30.3
39C	Wadena loam, 6 to 12 percent slopes	Well drained	16.1
411A	Waukegan silt loam, 0 to 1 percent slopes	Well drained	173.9
411B	Waukegan silt loam, 1 to 6 percent slopes	Well drained	71.8
411C	Waukegan silt loam, 6 to 12 percent slopes	Well drained	8.2
415A	Kanaranzi loam, 0 to 2 percent slopes	Well drained	12.9
415B	Kanaranzi loam, 2 to 6 percent slopes	Well drained	18.7
415C	Kanaranzi loam, 6 to 12 percent slopes	Well drained	14.2
41B	Estherville sandy loam, 2 to 6 percent slopes	Somewhat excessively drained	5
42C	Salida gravelly coarse sandy loam, 2 to 12 percent slopes	Excessively drained	4.6
611D	Hawick gravelly sandy loam, 12 to 20 percent slopes	Excessively drained	14.2
611F	Hawick loamy sand, 20 to 40 percent slopes	Excessively drained	6.6
857A	Urban land-Waukegan complex, 0 to 1 percent slopes	<Null>	5.9
858C	Urban land-Chetek complex, 1 to 15 percent slopes	<Null>	1.5
861C	Urban land-Kingsley complex, 3 to 15 percent slopes	<Null>	71.6
865B	Urban land-Hubbard complex, 0 to 6 percent slopes	<Null>	20.9

895C	Kingsley-Mahtomedi-Spencer complex, 8 to 15 percent slopes	Well drained	44.2
896F	Kingsley-Mahtomedi complex, 25 to 40 percent slopes	Well drained	73.4
W	Water	<Null>	31.9
		Total:	1434.4

Appendix C. Potential Ecological Impacts

Fire Suppression

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

Disease

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 throughthe 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 shouldinclude 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 areof 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

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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 nativegenotype, DED-resistant elms become commercially available.

Exotic and Over Populated Animals

4. 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 arevery invasive in our native woodlands and forests. These species move into new areas in waves, one speciesfollowing 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.

5. 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. Theconversion 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 notedthat 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 managementactivities.

6. 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 degreesF, 7 percent at -20 degrees F, and 98 percent at -30 degrees F. However, since the larvae overwinter under thebark and are insulated, air temperatures need to be slightly colder to have the measured effect, and larvae need to be exposed for prolonged periods of time for mortality to occur.

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

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

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

Climate Change

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

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 throughthe 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 shouldinclude 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 areof 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.

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Appendix D. List of Noxious and Invasive Plants

Plant	MD 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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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				
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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			savanna habit.	
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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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 riparian habitat. It	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.

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			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	MD andMN DNR Status	Mode of Introduction	Ecological Impact	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.	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

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			It out-competes native species. Reed canary grass is a major threat to natural wetlands.	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				
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	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

Plant	MD andMN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			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.	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. According to the USDA Plant database, this species is not present or with a limited distribution in Minnesota	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.
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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			such as pastures, roadsides, and ditch banks, but also in hayfields and disturbed prairies.	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	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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			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.	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 Early Detection Species and	Native to Europe and temperate Asia. Common teasel may have been introduced to North America as early as the 1700s, and was likely cultivated for producing wool or as an ornamental.	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 waterways. It occupies sunny and open sites such as riparian areas, meadows, grassland, savannas, forest openings, 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. 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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			disturbed sites.	
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.	Teasels produce massive amounts of seed that can remain viable in the soil for several years and have germination	Mechanical: Individual rosettes can be removed using a dandelion digger; removal of the entire root is essential to eliminate re-sprouting. Flowering stalks

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
		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.	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.	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 Early Detection Species; it is reported in Minnesota	A plant native from central Europe east to central Asia; originally introduced into North America as an ornamental plant.	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 plant species and decrease plant species diversity. It is typically found along disturbed sites, road-sites, clear-cuts, railroad right-of-ways, fences,	Manual: Hand pulling, mowing, and tillage can be effective in preventing seed production and starving toadflax roots, thereby controlling infestation under certain 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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			croplands, pastures, and rangelands	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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 prairies and sand blow-outs where vegetation is sparse. It is most abundant in dry areas, fields, and waste places.	Mechanical: Mowing and pulling Thermal: Prescribed burning
apanese 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	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			disturbed areas.	
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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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 (Eradicate List)	Native to Europe and likely a fertile hybrid between black and brown knapweeds. It may have been introduces to western North America for forage, but is not palatable and has low nutritional value	Grows aggressively and forms dense patches of vegetation. Out-competes other plants in pastures, hayfields, meadows, riparian areas, forest margins, and rights-of-way.	Mechanical: Combination of hand-pulling and digging is an option for small infestations 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	It is distasteful to grazing animals, giving it a competitive edge. It generally does not pose a threat to high	Mechanical: Pulling or mowing in early bud or bloom stage, then dispose off-site Chemical: Spot spraying with glyphosate, triclopyr or

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
		agricultural pest.	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.	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	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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
			effect on neighboring plants. It invades northern moist prairies, forest openings, abandoned fields, clear-cuts, and roadsides.	
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 plants, especially under grazing pressure.	Mechanical: Repeated pulling of small infestations is effective.
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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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.

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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

Plant	MD and MN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
				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.

Plant	MD andMN DNR Status	Mode of Introduction	Ecological Impact	Control Methods
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				
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 E. Methods for Controlling Exotic, Invasive Plant Species

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. Theyare 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 closeto 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. Itis 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, andReclaim.

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 fromthe 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 licensedapplicators 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 thebark 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% Garlon4, mixed with a penetrating oil, is applied all around the base of the tree or shrub, taking care so that it doesnot 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 forweed 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 ofthe 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 whereit 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.

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 controlis 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 maynot be as dense.

2. Wild Parsnip

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

- 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 removeChemical
- Use sparingly in quality habitats
- Spot application with glyphosate or selective metsulfuron after a prescribed burn; parsnip is one of thefirst 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.

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.

4. 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 weedyperennial 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 overtime, 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 andlater as this application timing maximizes translocation of the herbicide to the rhizomes, ensuring maximumrhizome mortality, which is crucial to control of RCG. Two herbicide applications can be implemented duringthis 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 andfrom 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 thistime 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.

5. 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.

6. 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 propagulesources, 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 F. Suggested Native Shrubs for Replacing Common Buckthorn

Dry Upland Areas					
CommonName	**ScientificName**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
New Jersey tea	*Ceanothus americanus*	2 to 3	Full sun	High: butterflies andhummingbirds	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 to 12	Sun/part shade	highly valued by mammalsand birds	Spreads, but slowly; forms very deep roots
Beaked hazelnut	*Corylus cornuta*	6 to 12	Sun/shade	high	Spreads, but slowly. More northern range thanAmerican hazelnut.
Eastern red cedar	*Juniperus virginiana*	20	Sun	high	Invades prairies in absence of fire. Important birdcover in winter and summer heat.
Pin cherry	*Prunus pensylvanica*	10 to 30	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; redberries 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					
CommonName	**ScientificName**	**Height [feet]**	**Light**	**Wildlife Value**	**Comments**
Allegheny serviceberry	*Amelanchierlaevis*	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 earlysummer.
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	*Viburnumtrilobum*	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 swallowtailbutterfly	Foliage open form in shade, dense in sun.
Flood Tolerant Areas					
CommonName	**ScientificName**	**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 inlate summer
False Indigo	*Amorphafruticosa*	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 bloomlate 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 andmammals	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 G. 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.

Southern Seepage Meadow/Carr (WMs83)

Open wetlands dominated by a dense cover of hummock-forming broadleaved sedges or tall shrubs. Present in areas of groundwater seepage along streams and drainage ways, on sloping terraces, and at bases of slopes. Vegetation Structure & Composition Description is based on summary of vegetation data from 63 plots (relevés).

• Moss cover is typically absent, although brown mosses may be present.

• Graminoid cover is interrupted to continuous (50–100%); typically dominated by tussock sedge (Carex stricta) or aquatic sedge (C. aquatilis) with bluejoint (Calamagrostis canadensis), lake sedge (C. lacustris), prairie sedge (C. prairea), woolly sedge (C. pellita), and fowl manna grass (Glyceria striata) common. Hairy-fruited sedge (Carex trichocarpa) is dominant on some sites.

• Forb cover is variable (5–75%); common species include spotted Joe pye weed (Eupatorium maculatum), great water dock (Rumex orbiculatus), common boneset (Eupatorium perfoliatum), marsh bellflower (Campanula aparinoides), red-stemmed aster (Aster puniceus), swamp milkweed (Asclepias incarnata), northern and cut-leaved bugleweeds (Lycopus uniflorus and L. americanus), common marsh marigold (Caltha palustris), giant sunflower (Helianthus giganteus), and touch-me-nots (Impatiens spp.)

• Shrub cover is variable. Tall shrubs, if present, include red-osier dogwood (Cornus sericea), pussy willow (Salix discolor), slender willow (S. petiolaris), and Bebb's willow (S. bebbiana).

Landscape Setting & Soils

WMs83 is typically associated with groundwater seepage areas at bases of river terraces or beach ridges, on gentle slopes, or on bottomlands between steep bluffs. It also can occur in level wetlands dissected by streams and rivers that may be fed by groundwater discharge. Surface water is derived primarily from groundwater sources and has neutral to basic pH, reflecting the surrounding calcareous till and bedrock substrate. Soils range from mineral or muck soil to sapric peat. Organic sediments range from very shallow to greater than 36in (100cm) in depth.

Natural History

WMs83 is associated with wetlands influenced by lateral groundwater flow, in contrast to the gravitational water of basins of other wet meadow communities. WMs83 may experience moderate inundation following spring runoff and heavy rains, and periodic drawdowns during summer or as a result of fluctuations in groundwater seepage related to precipitation trends. Water levels are high and persistent enough to prevent trees (and often shrubs) from becoming established, although standing water may be absent by the end of the growing season. Because of water-level fluctuations, surface substrates alternate between aerobic and anaerobic conditions. Organic matter that accumulates over time on the substrate surface is usually oxidized during drought influenced drawdowns or is removed by fire during periods of severe drought. In basins where water flow becomes stabilized, accumulation of peat may cause succession of WMs83 to rich fen; otherwise, the constant inputs of minerals from groundwater flow that typically influence the community, along with warm climatic conditions and frequent drawdown, prevent succession of WMs83 to rich fen. WMs83 WET MEADOW/CARR SYSTEM Southern Floristic Region Frequent fires in the surrounding landscape may be an important factor in reducing the presence of shrubs or accumulation of peat in the community. The lack of a distinct shade-tolerant flora in occurrences of WMs83 dominated by shrubs may be due to historically high fire frequency, which prevents shrubs from becoming established in any one place for very long. It is possible that shrub-dominated areas are more frequent now than in the past because of fire suppression over the past 100–150 years.

Native Plant Community Types in Class

• WMs83a Seepage Meadow/Carr WMs83a is the only community type recognized in this class at present; it is divided into three subtypes, based on dominant species. WMs83a1 is the most abundant of the three subtypes; WMs83a3 is not well documented and appears to be uncommon. WMs83a has been documented in the PPL, MIM, LAP, CGP, RRV, and WSU.

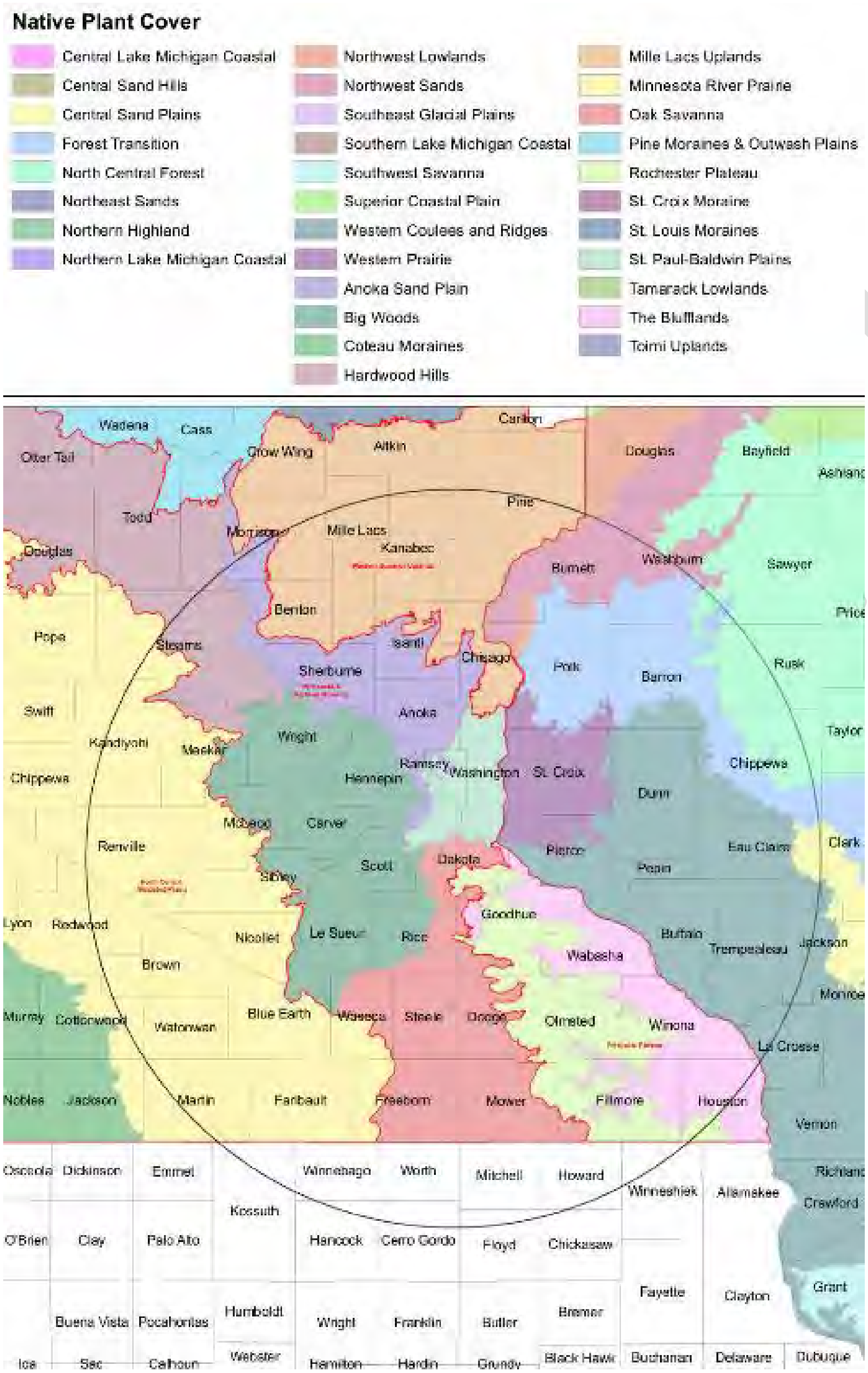
• WMs83a1 Tussock Sedge Subtype Open, graminoid-dominated meadows. WMs83a1 differs from the other subtypes in WMs83a by the dominance of tussock sedge (Carex stricta) or, rarely, hairy-fruited sedge (C. trichocarpa). WMs83a1 is present throughout the EBF Province, although uncommon in some areas. Description is based on summary of vegetation data from 48 plots.

• WMs83a2 Aquatic Sedge Subtype Open, graminoid-dominated meadows, often associated with calcareous fens (OPp93). WMs83a2 differs from the other subtypes in WMs83a by the dominance of aquatic sedge (Carex aquatilis), with interior sedge (C. interior), Sartwell's sedge (C. sartwellii), and hardstem bulrush (Scirpus acutus) also typical in the graminoid layer. Shrub cover is low with pussy willow and red-osier dogwood common, and sage-leaved willow and bog birch occasional. Common forbs include bog aster (Aster borealis), common marsh marigold, and bulb-bearing water hemlock (Cicuta bulbifera). WMs83a2b is present throughout the MIM and also present in the CGP, RRV, and very locally in the PPL. Description is based on summary of vegetation data from 13 plots.

• WMs83a3 Impatiens Subtype Small, open, forb-dominated meadows in forested settings. WMs83a3 often differs from the other subtypes in WMs83a by being dominated by forbs and having low cover of sedges and other graminoids. WMs83a3 is often associated with Southern Wet Ash Swamps (WFs57), developing where areas of strong groundwater seepage create large gaps in the tree canopy and favor the presence of shade-intolerant species. WMs83a3 has been documented in seepage areas on terraces along streams and rivers in the MIM and PPL. Description is based on summary of vegetation data from 2 plots

Appendix H. 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 I. Public Engagement

Public engagement for this project consisted of reaching out to the general public via one online public meeting at the Final 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 30-day public review period.

Phase I Research and Findings

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Phase II Vision, Goals, Recommendations

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Phase III Draft Final Plan

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DAKOTA COUNTY PLANNING COMMISSION

February 24, 2022 AGENDA ITEM: Veterans Memorial Greenway Update

PURPOSE

Provide Planning Commission:

1. An overview and update on alignment, design, and engineering activities on the Veteran's Memorial Greenway project.
2. An overview and update on the memorial nodes along the Greenway

BACKGROUND

The Veteran's Memorial Greenway is a five-mile greenway in Eagan and Inver Grove Heights that will link Lebanon Hills Regional Park and the Mississippi River Greenway, with neighborhood access points and local park connections. The County Board renamed and repurposed the Rich Valley Greenway as the Veterans Memorial Greenway in 2020. The greenway also is being planned to include ten interpretive memorials to honor the service and sacrifice made by County veterans. The greenway interpretive memorial plan is being developed in consultation with a 13-member Veterans Advisory Group formed in late 2020 and through outreach to a diverse range of Veterans through interviews and potential focus sessions.

A greenway feasibility study was prepared in early 2020. Design/engineering is the next step, involving a three-phase multi-year project, anticipated to be fully completed by 2024. Project challenges include crossing of two state highways (TH 3 and US 52) and two railroad lines. Project implementation is dependent upon successful negotiations with landowners, approval by the County Board, and the availability of funds. Approximately $10M in funding has been secured.

The Planning Commission will be periodically engaged throughout the project, primarily on the overall public involvement process and the preliminary and final design of the greenway corridor. Following completion of the project, staff will request Planning Commission's recommendation to the County Board on submittal of the amended master plan to the Metropolitan Council.

ATTACHMENTS

Attachment A: Project Alignment Map

QUESTIONS

The following questions are intended to help assist in review of the packet materials.

1. Do you have any questions on the design/engineering components of the project?

2. Do you have any suggestions on the memorial node designs?

3. Do you have any suggestions for how to address challenges of the Greenway?

Veterans Memorial Greenway - Alignment Options