Vermillion River Greenway

Natural Resource Management Plan

2023

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Executive Summary

The Vermillion River Greenway Natural Resource Management Plan (NRMP) is a guidance document for implementation of natural resource protection, conservation, and restoration within lands surrounding the Vermillion River in Dakota County, Minnesota. The corridor encompasses the rich floodplain of the Vermillion River, a refugia for rare species in the Vermillion River gorge, Vermillion Falls, and several recreational assets. Guidance for management of these resources has been informed by detailed natural resource assessments of these lands, research regarding the corridor's geologic history, soils, waterbodies, and historic and present land use, and consultation with Dakota County and the City of Hastings, Minnesota. Recommendations for protection and restoration consider resource condition, past investment, establishment of habitat corridors, the presence of rare species and unique features, landowner priorities, and community values. This NRMP details immediate conservation and restoration actions, as well as longer-term management with projected costs.

Background

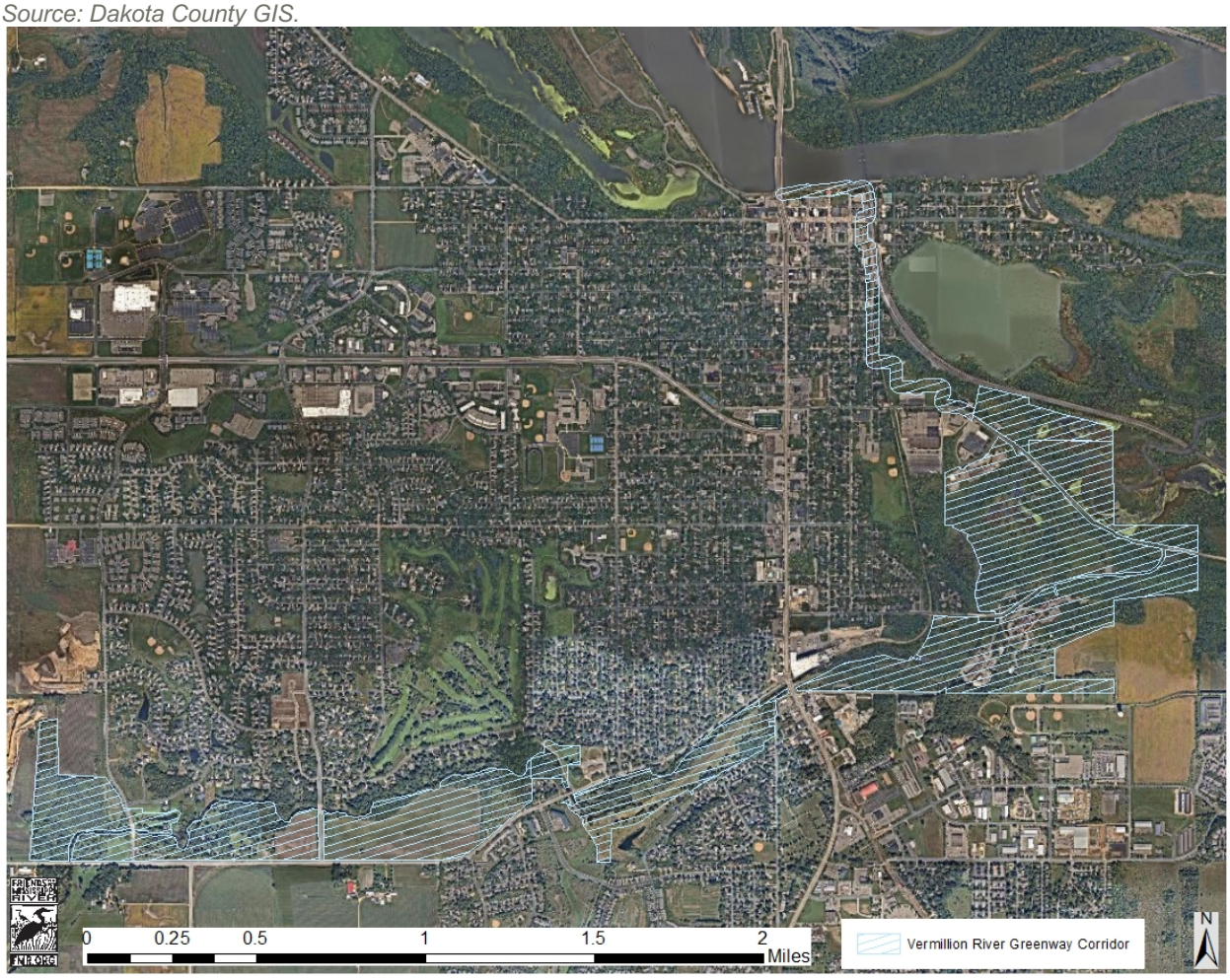
The Vermillion River Greenway in Hastings (Greenway) (Figure 1) is an approximately 5-mile stretch of paved bike/hike trail with a 10-foot trail width and mowed swaths on each side of the trail within a 30-foot-wide right-of-way. The width of the Greenway, however, occasionally widens to 100 to 300 feet, depending on the surrounding landscape and encompasses approximately 545 acres. Generally, the Greenway stretches east and west within southern Hastings and then north to the Mississippi River and downtown Hastings. More specifically, the Greenway will connect from the City of Hastings-owned parcel PID 198323900040 just west of General Sieben Drive in southwest Hastings and traverse the south and east sides of the City to Levee Park in northern Hastings along the Mississippi River. There are parks and/or places owned by either the City of Hastings or that are privately owned that will form "natural area nodes" along the Greenway, even though they may not be owned by the County. Parks along the Greenway include the following: Lake Rebecca Park (City of Hastings), River Falls Park (City of Hastings), Jaycee Park (City of Hastings), Levee Park (City of Hastings), Rivertown Dog Park (City of Hastings), C.P. Adams Park (City of Hastings), Old Mill Park (City of Hastings), Vermillion Falls Park (City of Hastings/Con Agra), and Vermillion River Linear Park (City of Hastings). Several private properties along the Vermillion River east of General Sieben Drive and the former Wallin Property (Dakota County Park Conservation Area) make up the western extent of the Greenway. Also along the Greenway are nearby semi-natural lands under both public and private ownership that more or less follow the course of the Vermillion River.

The Greenway currently connects 291 acres of existing public land, and opportunities exist to increase that acreage through easement or fee acquisition within the south and western portions of the corridor. Public natural areas, in addition to the Greenway, provide tangible benefits to residents and visitors as an opportunity to spend time in nature whether by using the trails directly or observing nature from a

vehicle. Natural areas also provide vital environmental benefits related to water quality, flood storage, climate change attenuation, carbon sequestration, and wildlife habitat.

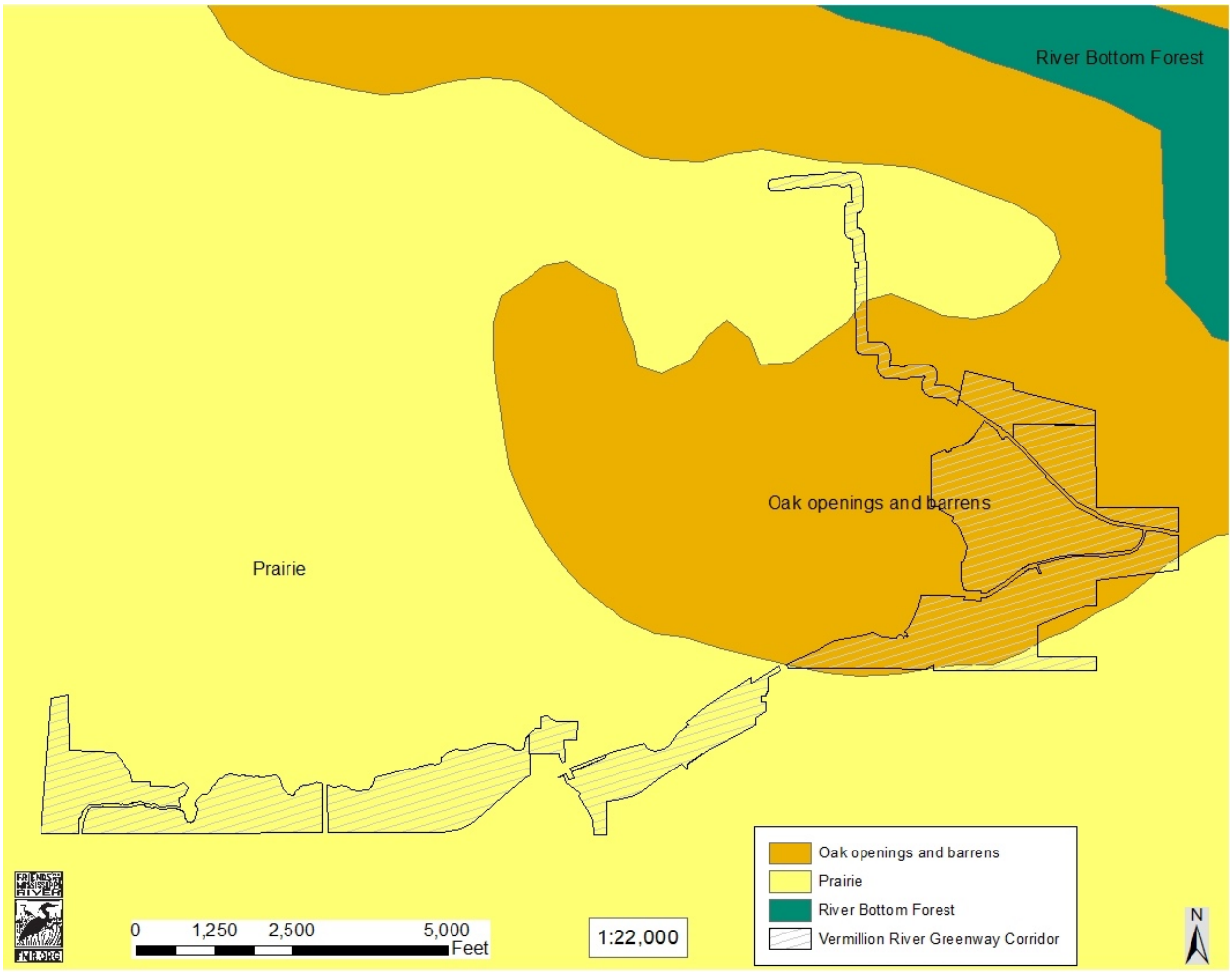
Figure 1: Vermillion River Greenway Corridor, Aerial imagery 2021

Source: Dakota County GIS.



Prior to European colonization, the Vermillion River corridor within Dakota County was covered by forests, oak savanna, prairies, and wetlands occupying depressions on the landscape and within the floodplain of the river (Figure 2). Remnants of these native plant communities and water resources remain today fragmented between urban and suburban land uses. While there are existing prairie restorations and native planting areas of high to moderately- high quality in the corridor, most of the remaining native plant cover is of low to poor quality and in discrete areas with the exception of Hastings SNA. However, Dakota County is optimistic about the future of the natural areas adjacent to the Greenway. With management and restoration, the quality of these areas can be enhanced, leading to improved conditions for wildlife and more enriching human experiences. This Natural Resource Management Plan (NRMP) sets the course for restoration and conservation of these important areas for the next 20 years.

Figure 2: Historical vegetation communities in the Vermillion River Greenway corridor
Source: MNDNR.



While the NRMP does not seek to recreate pre-European colonization landcover patterns explicitly, it does aim to make forward progress in terms of applying current knowledge about establishing and maintaining native plantings, being responsive to the effects of climate change including altered temperature and precipitation patterns and staying abreast of planned land use in adjacent undeveloped areas. This Plan includes many exciting projects that the public will be able to see and appreciate, including reducing canopy cover in fire-suppressed and overgrown woodlands, establishing native vegetation, creating new demonstration plantings in higher traffic areas, restoring eroding shorelines, and creating opportunities for the public to engage in habitat restoration.

Planning Process

Recommended projects represent priorities put forth by the City of Hastings Parks Department and Dakota County Parks staff within their respective jurisdictions. A stakeholder meeting was held with the project team, Dakota County staff, and Hastings Parks Department staff. The product of this meeting

was a summary of issues, concerns, and interests related to the management of natural resources within the corridor and how this management would best be implemented in consideration of existing parks master plans, terms of existing easements over privately held property within the corridor, potential for future acquisition in fee or easement, and knowledge changing land use patterns. This information, in addition to the 2019 Vermillion Greenway Master Plan, [link] guided project staff to develop background data and informed their collaboration with additional partners. Individual projects included in the NRMP were guided and vetted by the City of Hastings Parks Department. Dakota County completed a final review of each recommendation. The final plan was adopted by the Dakota County Board of Commissioners on _____,2023.

Natural Resource Management Plan Recommendations

Plan recommendations address plant communities, wildlife habitat, water resources, and public use in and near the Greenway. Restoration projects within public lands along the Vermillion River Greenway corridor will touch nearly 300 acres of public land in Dakota County and traverse several natural areas that are privately held. The Plan addresses the following priorities:

- Removal of invasive plants within the Vermillion River Greenway generally
- Removal of both native and non-native invasive trees and shrubs from oak woodlands and former grasslands where woody encroachment has diminished herbaceous vegetation
- Restoring prairie habitat in degraded or remnant grasslands
- Minimizing mown lawn areas where feasible by establishing small prairie restoration and pollinator planting demonstrations
- Stabilizing streambanks by removing invasive shrubs and establishing deep-rooted native vegetation
- Further enhancing existing high-quality habitat

Purpose of the Natural Resource Management Plan

The purpose of this Natural Resource Management Plan (NRMP) is to describe the existing natural resource conditions of the land within the Vermillion River Greenway and the natural resource goals for the land in consideration of all external influences such as ownership, other uses within the property, and adjacent land use. The NRMP includes information on the Greenway'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, presence of noxious and invasive plants; land cover; past and present ecological impacts from fire, disease, wildlife, and climate change; plant community assessment; wildlife, and target vegetation communities, including management priorities, methods, a five-year workplan, and a long-term workplan. The NRMP also includes plant community restoration 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 (Dakota County or the City of Hastings), 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.

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 landholdings and easements. Dakota County also sees opportunities to partner with other interested organizations to build larger corridors of conservation land.

Goals

- **Maximize Native Plant Diversity and Increase Plant Community Resilience**. A major goal of ecological restoration is to establish native plant communities that support high-quality and resilient habitat and to work toward the highest numbers of plant species that adapted to the physical conditions of each site. High plant species diversity and robust numbers of individuals ensure that multiple species can 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 habitat continues to provide the necessary ecological functions that keep the system intact. This redundancy results in greater resilience to change due to climate or the influx of invasive 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 Minnesota's Wildlife Action Plan for 2015-2025 (MNDNR 2015). This list includes species on Federal and State Endangered, Threatened, and Special Concern Species lists. Additionally, the Wildlife Action Plan identifies 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 and some invasive species in that their roots penetrate 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. Deep-rooted native plants within erodible areas also provide soil stabilization and prevent soil loss and waterbody pollution and sedimentation.
- **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 and the effects of conversion to agricultural or residential uses. Returning 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 be considered symptoms of broader land use change: lack of land management and disturbance due to agriculture and urban development. Management of invasive species including initial removal and ongoing management to prevent reestablishment is a significant piece in returning these landscapes to functioning plant communities that are resilient and support improved wildlife habitat.

Approach

The overarching goal is to return and maintain a diverse native plant community within a site, though this will not always follow a linear progression. Using the concept of adaptive management will be the key to continual progress. Adaptive management integrates thought and action into the restoration process and can be described as a process that uses evaluation, reflection, and communication to incorporate learning and responsiveness into planning and management.

Introduction

Most of Dakota County's 440,000 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, proximity, and easy transportation access to St. Paul and Minneapolis, the combination of agricultural use and development has resulted in the loss of most historic 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 for future residential development. Despite being relatively small and few, some of these natural areas include

important plant and animal communities and are prime candidates for conservation. Residential surveys consistently indicate that most community members think it is important that the county has an active role in protecting these areas.

To address the community'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" in 2002. This protection 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 protection 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.

Community 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.

Natural History and Current Conditions

Landscape Context

The Vermillion River Greenway is a 5-mile regional trail and open space corridor that will provide a link between the north and east extents of Hastings to the south and west reaches of the city while also connecting the Mississippi River Greenway in eastern Dakota County to the new Point Douglas Regional Trail between Hastings and Prescott, Wisconsin. A 1-mile portion of the trail corridor will be newly designed and constructed in southwest Hastings and connect to Marshan Township. The Greenway connects 291 acres of public land (shown in white) within the corridor including Hastings SNA (Figure 3), and links regions designated as Metro Conservation Corridors (MeCC, a regional land protection plan of the MNDNR). This designation highlights the importance these greenspaces play in facilitating wildlife movement and providing contiguous habitat for pollinators and other wildlife (Figure 4).

Figure 3: 2020 Land Use

Park, recreational, and preserve lands are shown in white. Source: Metropolitan Council.

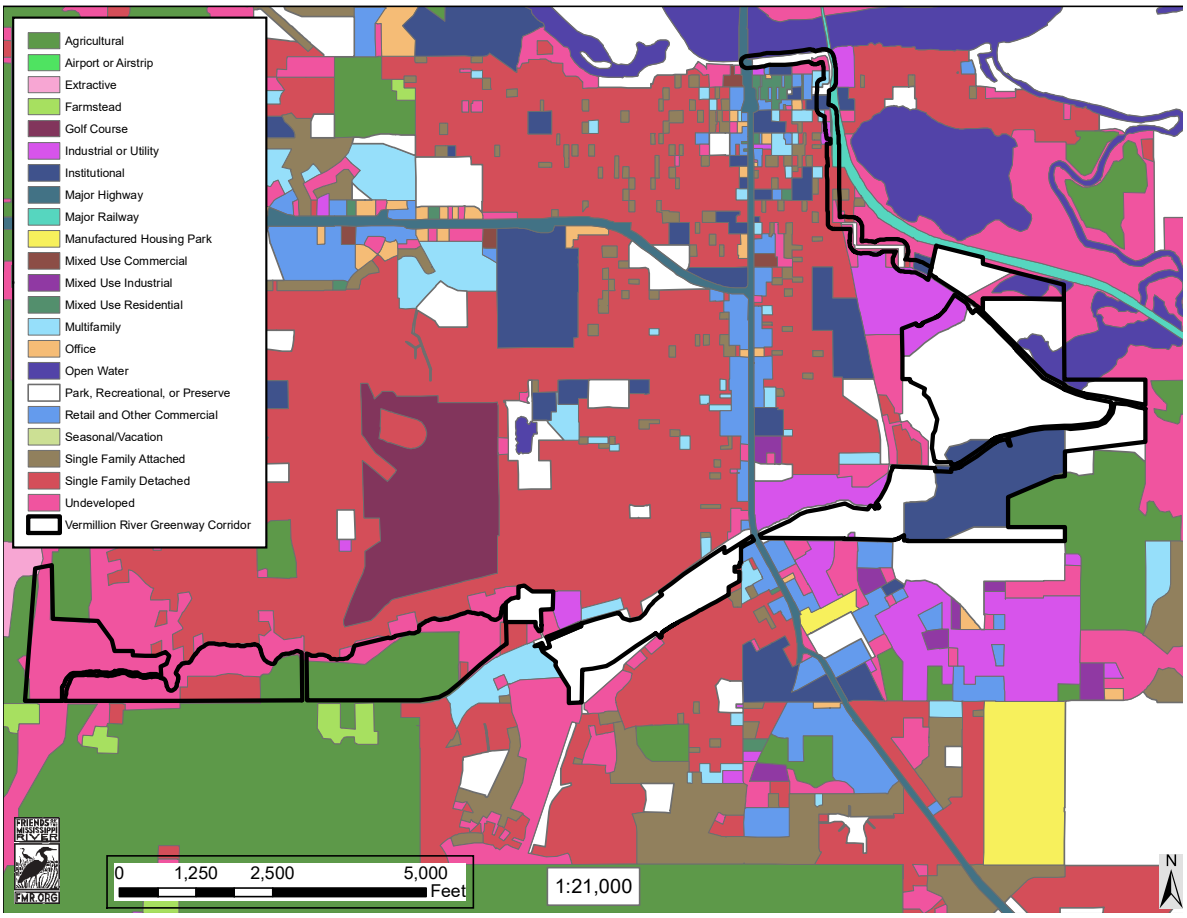
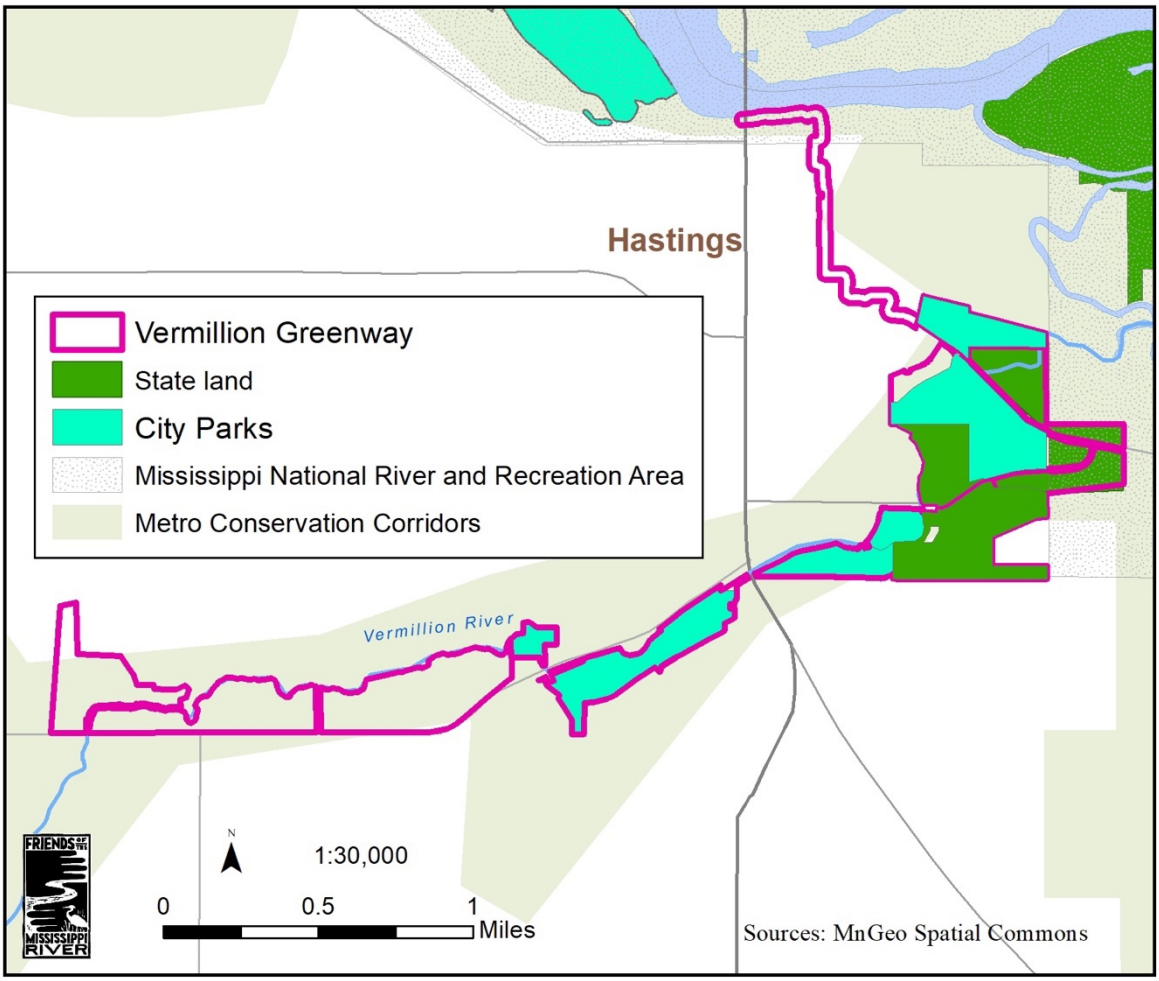


Figure 4: Landscape context



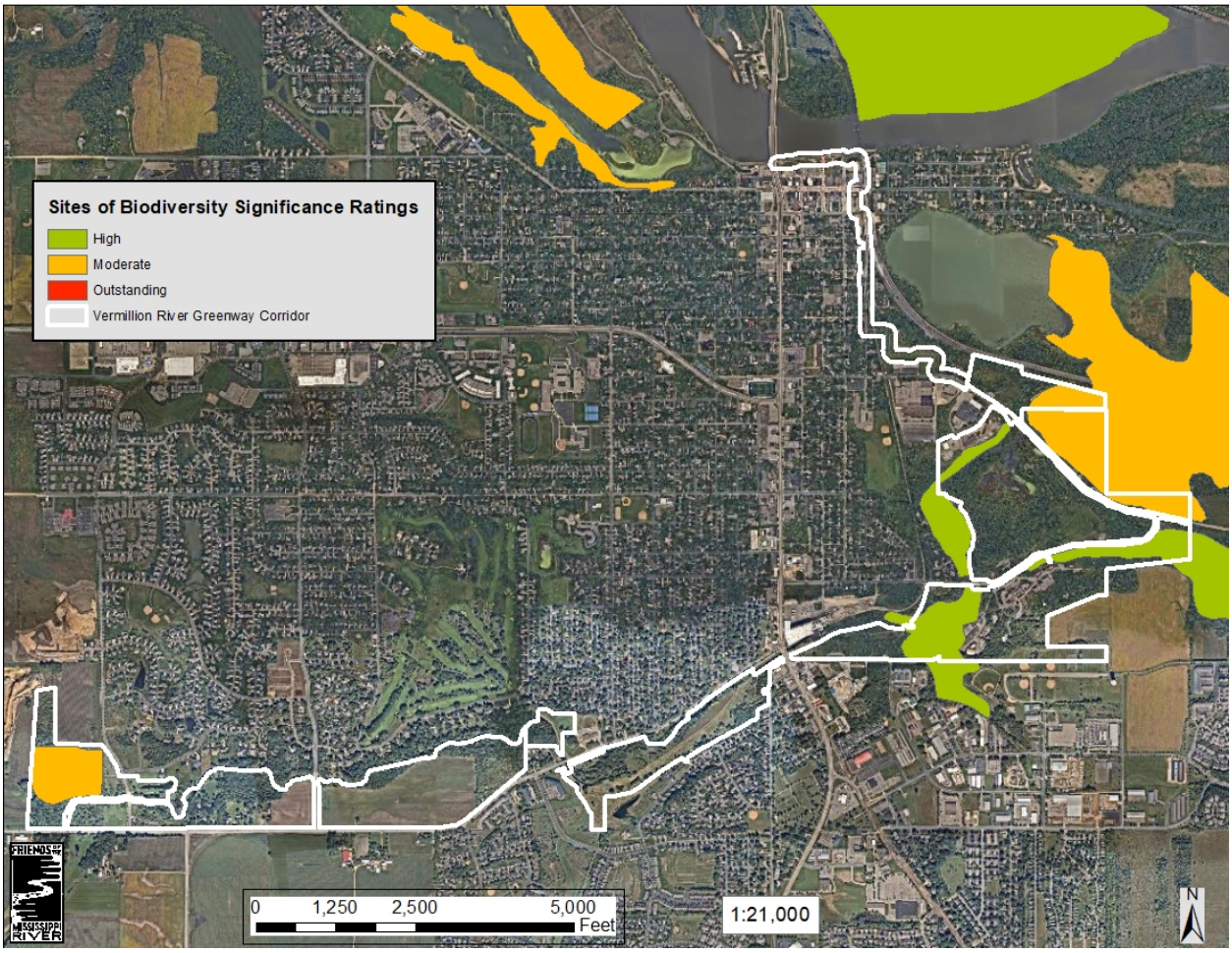
The parks and greenspaces connected by the Vermillion River Greenway vary in size from small neighborhood parks to 60-acre parks and a state Scientific and Natural Area. Taken together, they form semi-contiguous linear corridors of natural land that range from just 20 feet to over 5,500 feet in width. Some city park lands accommodate recreational uses such as picnic areas, disc golf, and athletic fields. In addition to city parks and public spaces, the Hastings Co-op Creamery Dairy, LeDuc Mansion, and Kennedy Elementary School are all connected to or near the Vermillion River Greenway and provide adjacent points of interest for entry to the greenway proper.

There are linear tracts of the Vermillion River Greenway that pass through contiguous habitat up to a mile long, and within the Hastings SNA, the Greenway's habitat width is up to 1 mile, however, many of the greenspaces within the corridor are dissected by roads and highways. U.S. Highway 61 bisects the corridor near its midpoint, and the portion of the corridor in downtown Hastings (Levee Park) has very minimal greenspace. Roads, other smaller crossings, and areas of infrastructure create barriers to the

movement of wildlife and fragment areas of existing or potential native plant cover. This fragmentation affects the movement of wildlife and impacts hydrological conditions in the surrounding natural areas.

In addition to connectivity, the corridor protects several areas of high biodiversity significance, as defined by the MN Department of Natural Resources. High biodiversity areas are found at Vermillion Falls Park, Old Mill Park, and Hastings SNA. Moderate biodiversity areas are found at Hastings SNA and the far west end of the corridor (Figure 5).

Figure 5: Sites of Biodiversity Significance within the Vermillion River Greenway Corridor
Source: MNDNR.



Historical Vegetation

A significant element to development of a comprehensive NRMP is to identify vegetation cover found in the local area prior to European colonization. This information can indicate which habitat types might be found as remnants or can inform which species might be used to restore plant communities. Fortunately, vegetation field notes were recorded during land surveys in the 1840s and compiled into

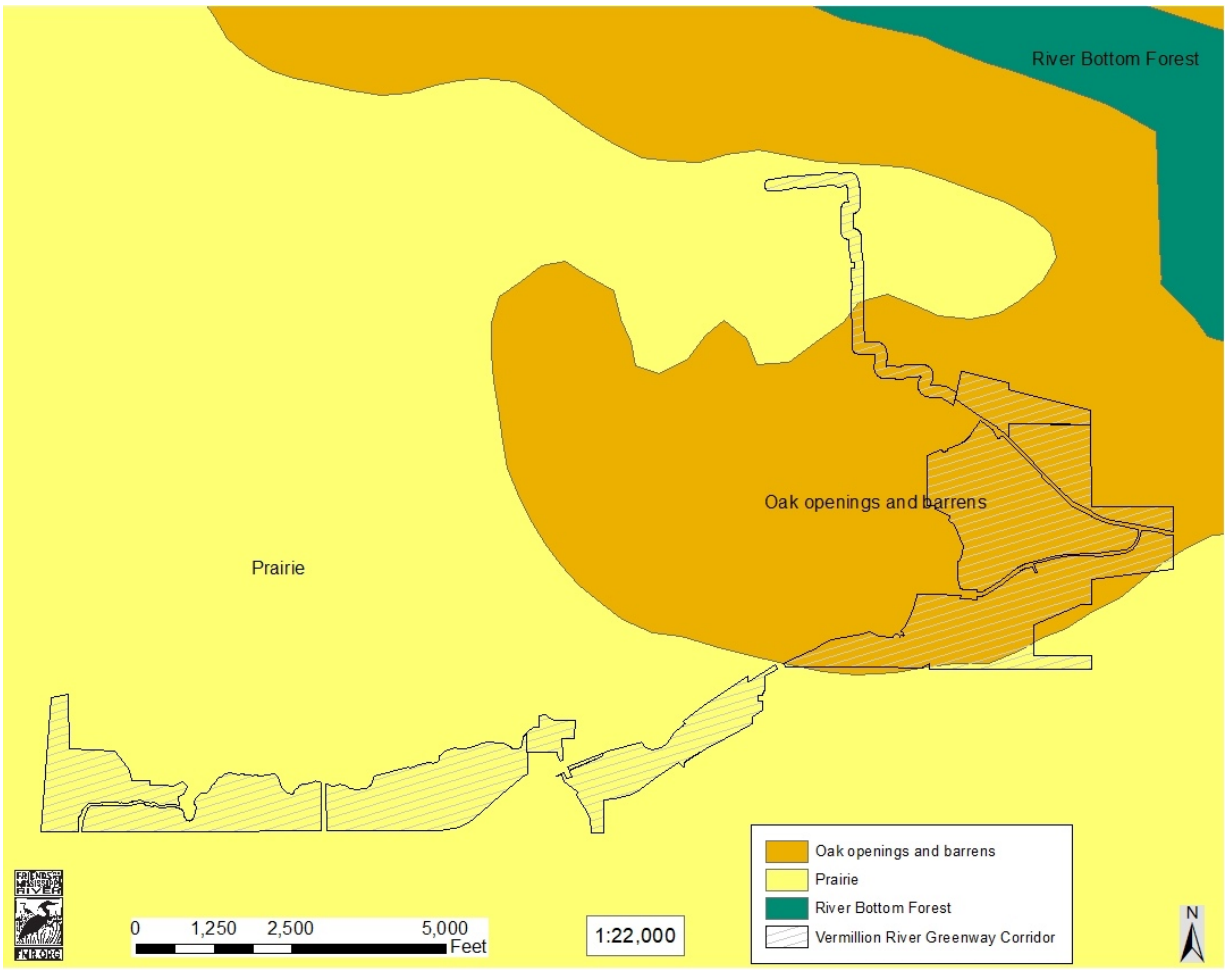
“The Original Vegetation of Minnesota.” This reference was developed from U.S. General Land Office Survey Notes and eventually published in 1974. These records provide information about the pattern of plant communities across Minnesota at the time of European colonization and are used in this NRMP to inform potential restoration goals.

Based on “The Original Vegetation of Minnesota,” the portion of Dakota County in which the Vermillion River corridor lies was primarily prairie in the western half, and a swath of oak openings and barrens covered the central and eastern portions of the corridor. A line of river bottom forest was present on the extreme eastern end nearing the Mississippi River. The varied nature of the corridor would have supported a variety of habitat types depending on fire frequency and topography, including dry sand-gravel prairies, mesic tallgrass prairies, dry and mesic oak savannas and brushlands, wet prairie, and fire-dependent oak woodlands.

Of the four bearing trees recorded within the corridor in the Natural Heritage Information System Bearing tree database, two were American basswood and one was an American elm. In addition to these species, sugar maple, red oak, and an understory of shade tolerant forbs made up the “Big Woods” in areas of higher soil moisture that were protected from fire. A bur oak was the other bearing tree recorded, and white oak, aspen and black cherry were the other dominant tree species in the drier upland areas within the western end of the corridor with primarily prairie and savanna cover. Fire was a key disturbance that maintained the open structure of these savannas and kept woody vegetation from encroaching and causing succession to forests.

Forested floodplains with cottonwood, silver maple, willow, and American elm were found in the wider floodplains near the Mississippi River. Near the Vermillion River, prairie or savanna would often be found up to the water’s edge. Wetlands were once plentiful throughout the corridor and provided critical habitat for wildlife. 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). Precolonial vegetation patterns are shown in Figure 6.

Figure 6: Historical Vegetation
Source: MNDNR.



Historical and Existing Land Use

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

Past land use is best studied by the review of historic aerial photographs. Figures 7-18 are historic aerial photos for the segments of the Vermillion River Greenway and surrounding area in 1937, 1964, 1997, and 2020. These photos and very recent imagery show extensive urbanization and development of diverse cropped farm fields into predominantly single-family homes and commercial spaces over the last 85 years. In areas where development did not occur within the eastern portion of the Greenway, 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 remnants of these cover types have persisted to the present day.

The following comments address these conditions in more detail:

- Within the western portion of the corridor between the county-owned parcel at the northeast corner of General Sieben Drive and CR 46 and present-day Vermillion River Linear Park, the riparian area of the Vermillion was sparsely treed in 1937. The county-owned parcel now referred to as Dakota County Park Conservation Area exhibits savanna cover type in 1937 with widely spaced oaks and an open, herbaceous ground layer. This vegetation condition extends eastward to the location of present-day Vermillion River Linear Park with large open areas abutting the river corridor. Occasional small clumps of overstory trees as well as farmsteads were also present in non-cropped dry areas, and savanna patches held their form mostly through the late 1950's when tract housing developed. Upland areas directly west of the park were quickly converted to single-family residential use between 1964 and 1991, but 20 to 40-acre farms have persisted on the south side of the river to present day. Additional large-lot residential development is currently occurring north of the river between Pleasant Drive and General Sieben Drive, and the oak savannas historically present here are diminishing.
- The alignment of the Vermillion River in the corridor is largely unchanged over the last 85 years—unusual for a stream in a relatively developed area. One exception is the river channel south of Louis Lane and west of the Dakota County Highway Department. Here the alignment of the river was moved south approximately 350 feet in the 1940s cutting off two historic oxbows from the river to protect farmsteads north of the river from periodic flood flows. The river has not been channelized, but it has become separated from its floodplain in several areas due to both progressive sediment deposition and erosive high flows. The streambanks have also been highly impacted by increased flow rates, increased water volume in the channel, and specific areas of erosion at the location of stormsewer outfalls.
- In 1937, row cropped landcover is dominant within the corridor west and south of downtown Hastings and east of downtown out of the floodplain of the Vermillion and Mississippi Rivers. Perennial herbaceous cover persisted in wetter areas near the rivers. The land within present day Vermillion River Linear Park was historically prairie that was farmed until the 1960s when the property became under the ownership of the City of Hastings. In response to a flood of record in 1965, a meander was removed north of the park, and a levee was constructed to protect new residential development north of the river. Additional flood abatement was undertaken in 1979 when a 24-acre area south of the channel was excavated to store flood flows and mitigate the floodplain loss to the north of the park.
- In the earliest aerial photos from 1937, wetland areas were consistently in some form of perennial herbaceous cover, and row cropped land surrounded these wetter areas. New techniques in agricultural drainage allowed expanded row-cropped production by the 1950s in all areas of the corridor but particularly in the western extent of the corridor where planted areas expanded and there were fewer previously wet areas in perennial cover. Drastic

reductions in diverse row-cropped land are noticeable in Hastings Township by 1964 with woody encroachment advancing into formerly open areas and tree plantings present.

- Herbaceous perennial cover enclosed the meander belt for the Vermillion River in 1937 aerial photos, with a 500-700' width in many areas. From present-day Vermillion River Linear Park to the east end of the corridor, the floodplain had an open canopy and minimal shrub layer from 1937 to 1957, but fire suppression and the expansion of invasive shrubs such as common buckthorn quickly changed the riparian corridor from the late 1950s to the early 1990s such that the canopy became closed with secondary growth forest (box elder and cottonwood) and the shrub layer of buckthorn filled in most canopy gaps.
- The primary changes to the central section of the corridor (between Hwy 61 and the dog park) since the earliest aerial photographs of 1937 has been increased woody cover. Old Mill Park and Vermillion Falls Park had a much more open tree canopy, indicative of savanna, with wooded along the gorges. Woody cover gradually increased at these sites, but with recent management they are now becoming more similar to the 1997 levels of coverage. The Veterans Home and C.P. Adams Park were all part of the former Hastings hospital and asylum, which opened in 1900. The north leg of the current VH and the western side of the current CP Adams Park persisted largely untouched over the decades, remaining as forested and wetland. As the hospital transitioned to other uses, the wooded areas of the southern section have gradually increased and the northern portion that was converted to park has also grown in. The SNA also remained largely untouched and mostly forested since 1937, with the open lowland areas gradually becoming more forested.

Figure 7: 1937 Aerial photograph of the Vermillion Greenway (west)

Source: Dakota County GIS.

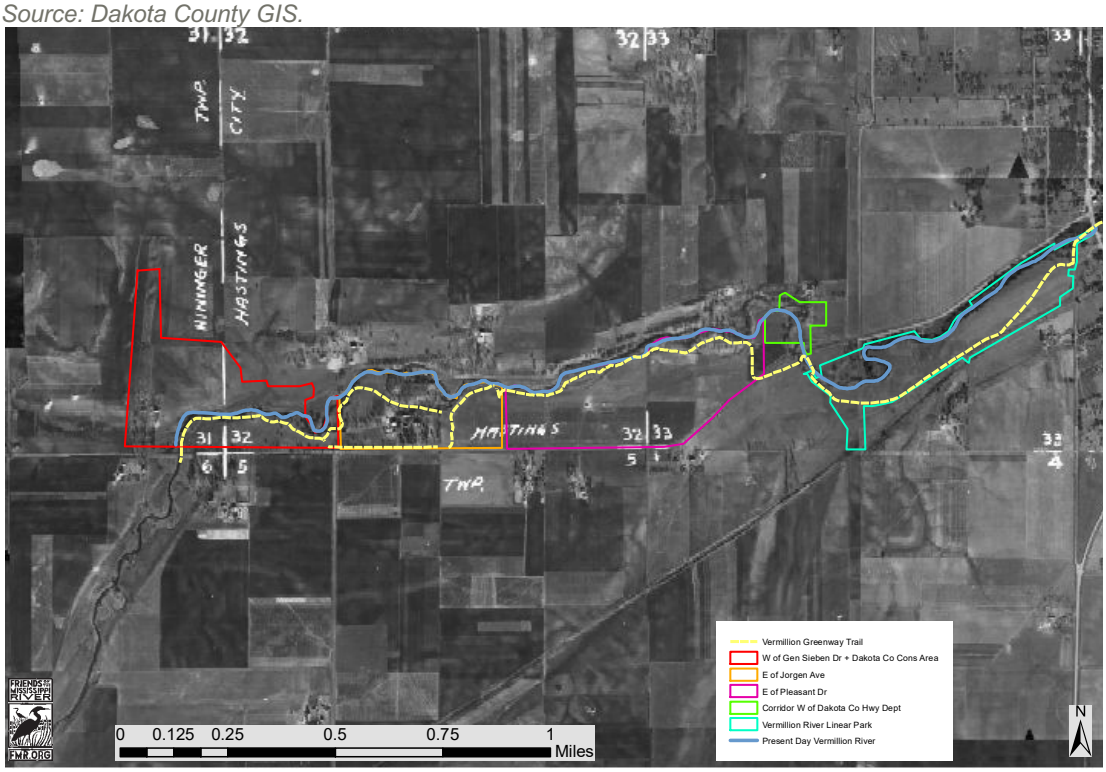


Figure 8: 1964 Aerial photograph of the Vermillion Greenway (west)

Source: Dakota County GIS.

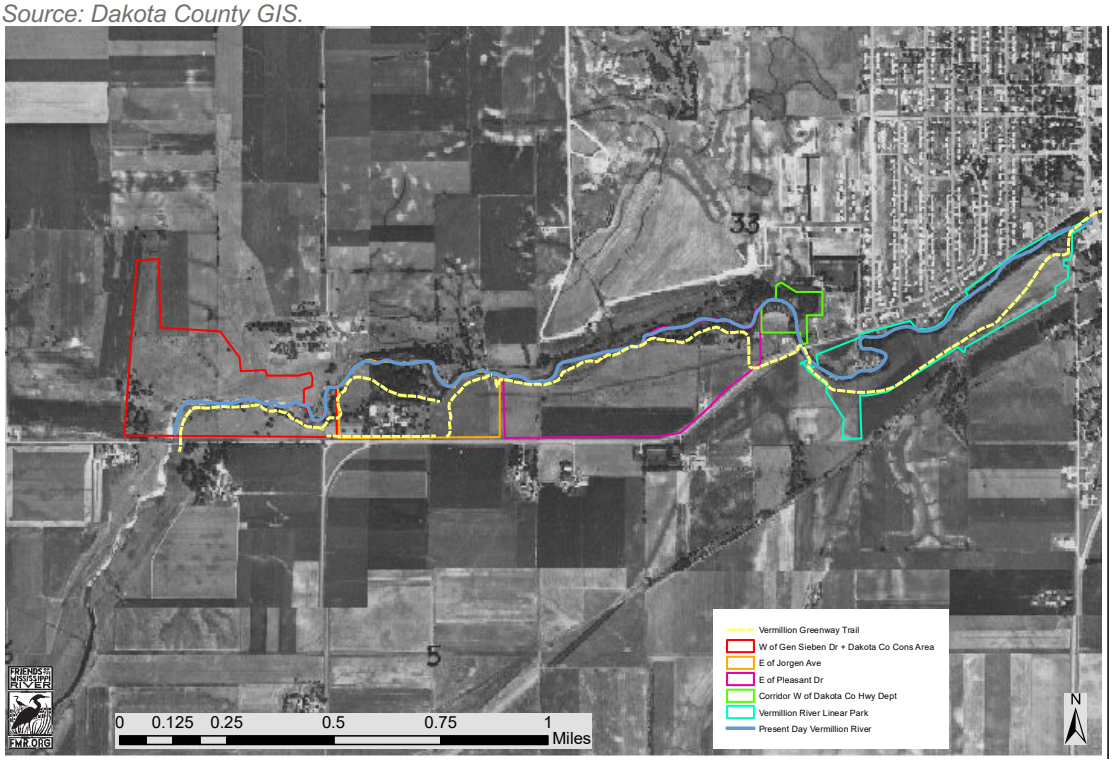


Figure 9: 1997 Aerial photograph of Vermillion Greenway (west)
Source: Dakota County GIS.

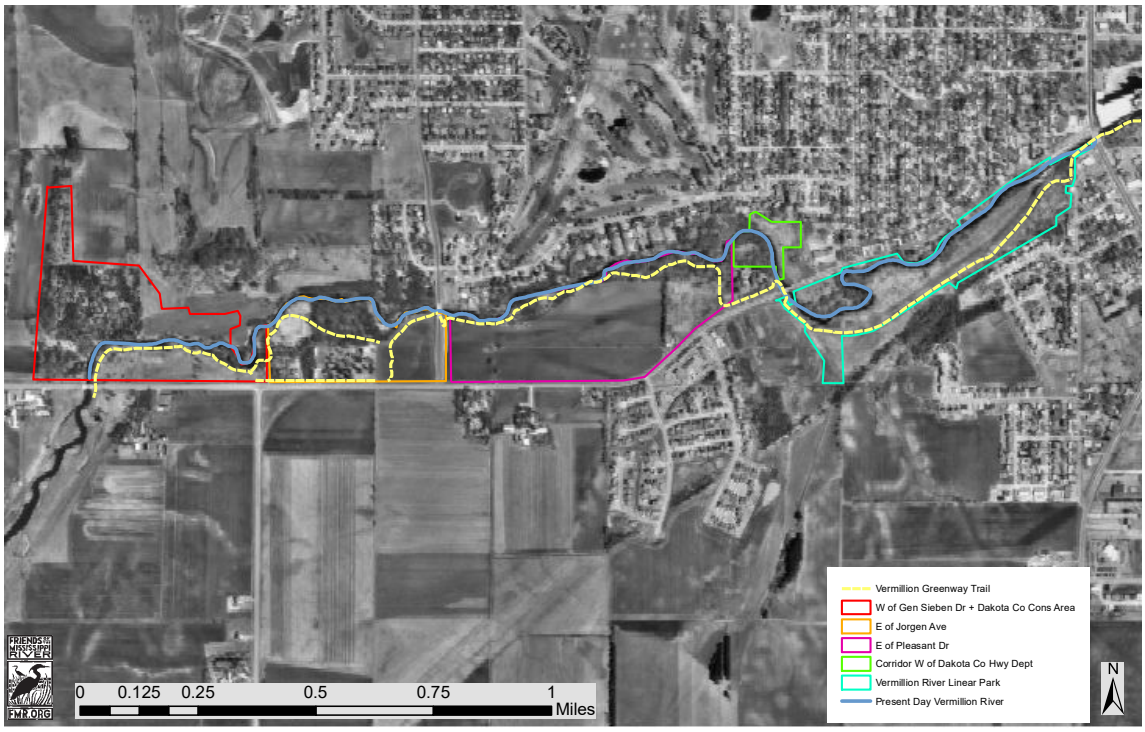


Figure 10: 2020 Aerial photograph of the Vermillion Greenway (west)
Source: Dakota County GIS.

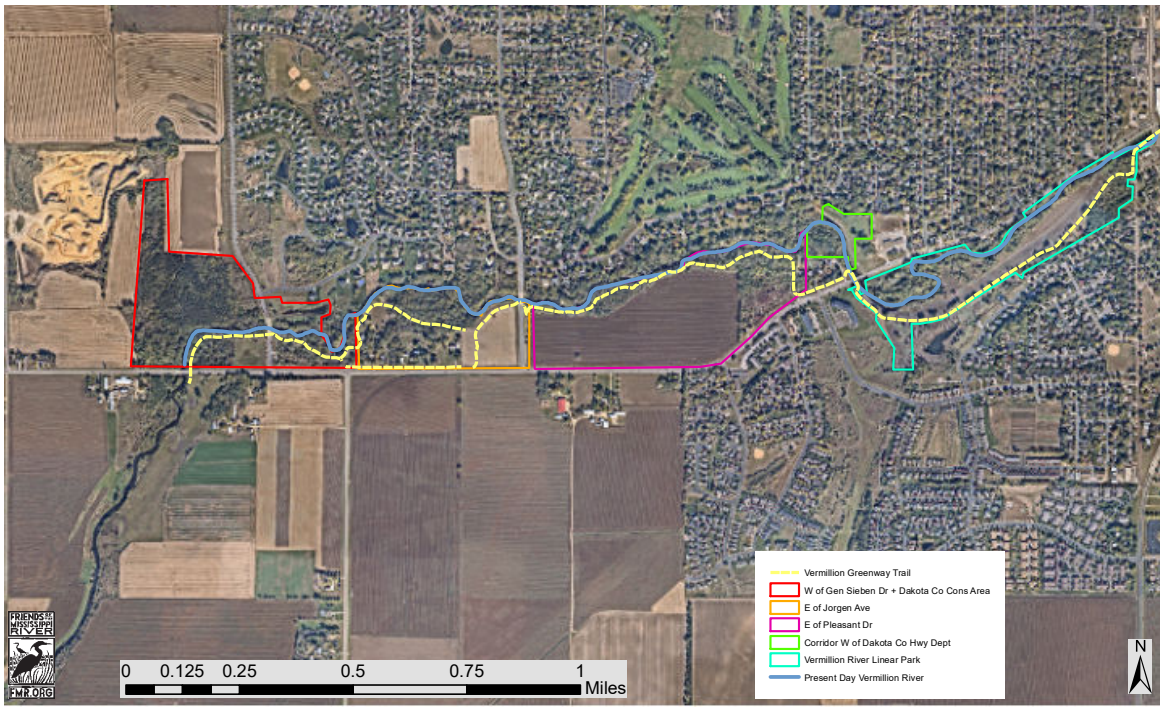


Figure 11. 1937 Aerial photograph of the Vermillion Greenway (central)
Source: Dakota County GIS.

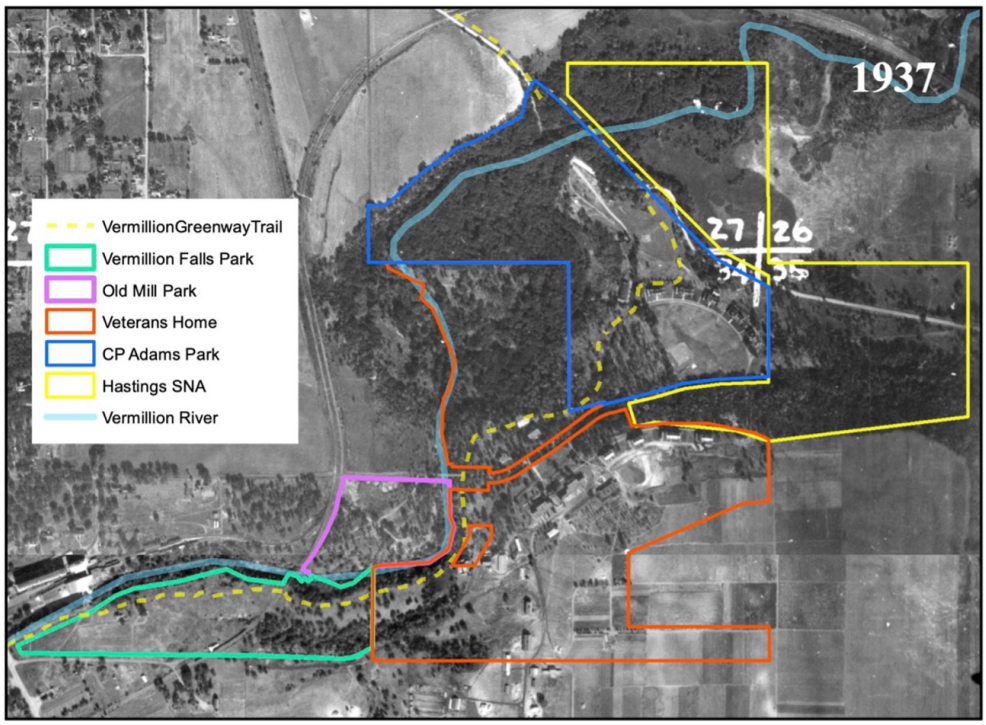


Figure 12: 1964 Aerial photograph of the Vermillion Greenway (central).
Source: Dakota County GIS.

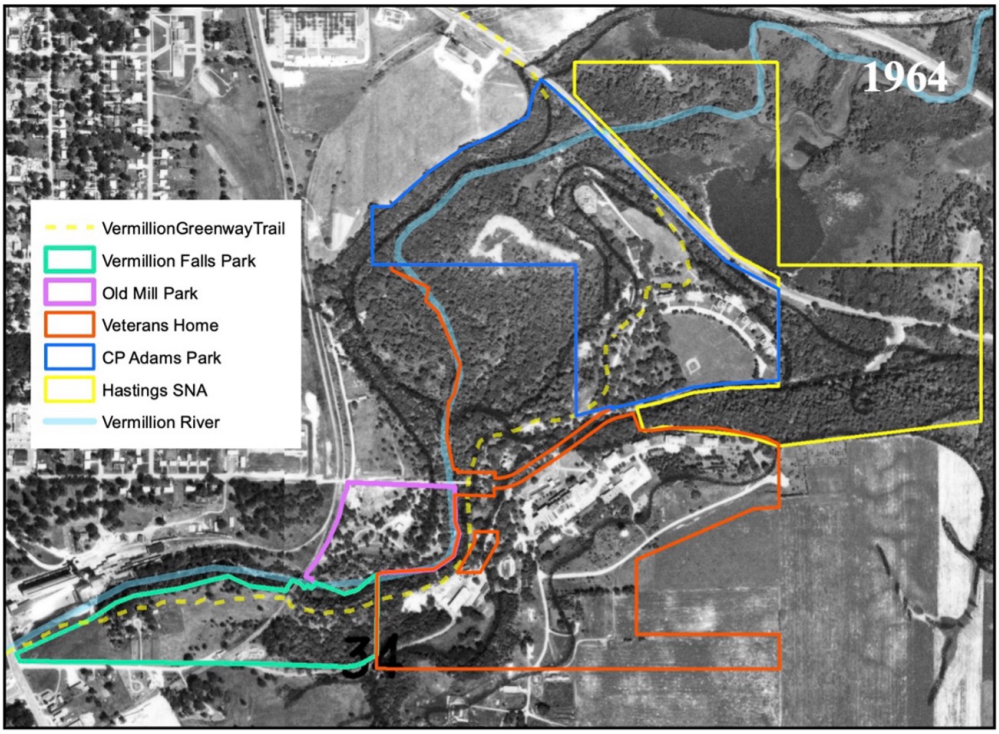


Figure 13: 1997 Aerial photograph of the Vermillion Greenway (central).
Source: Dakota County GIS.

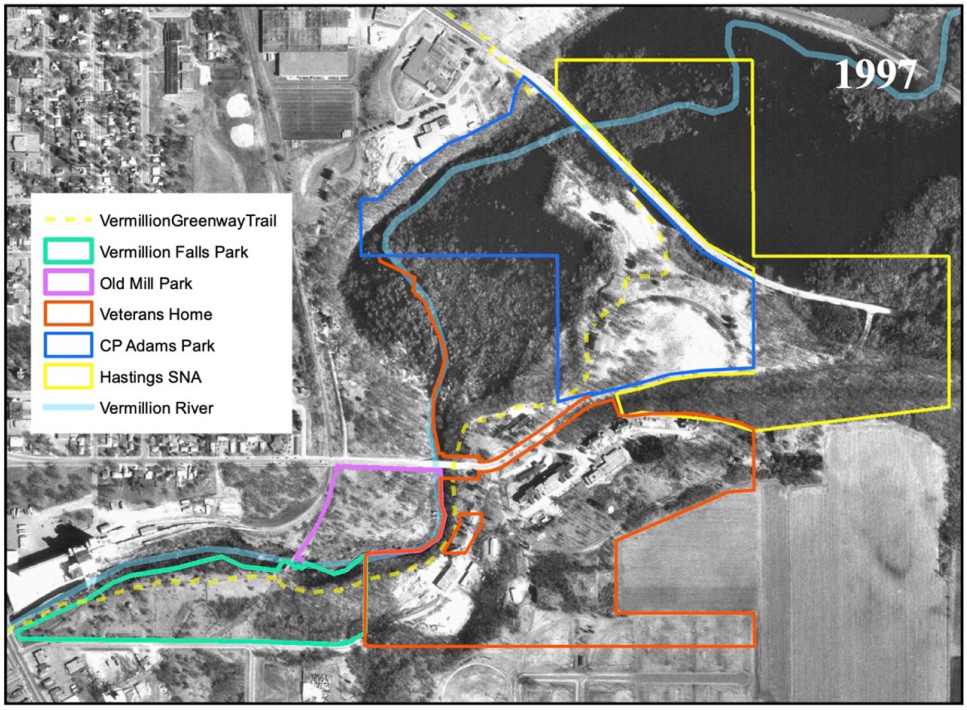


Figure 14: 2020 Aerial photograph of the Vermillion Greenway (central).
Source: Dakota County GIS.

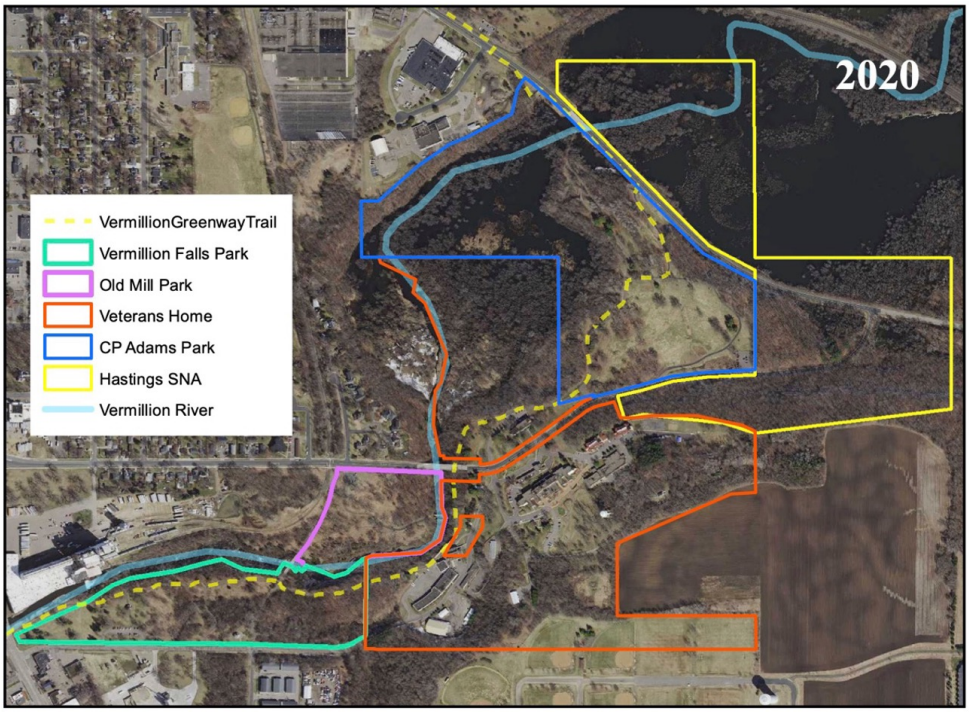


Figure 15: 1937 Aerial photograph of the Vermillion Greenway (north).
Source: Dakota County GIS.

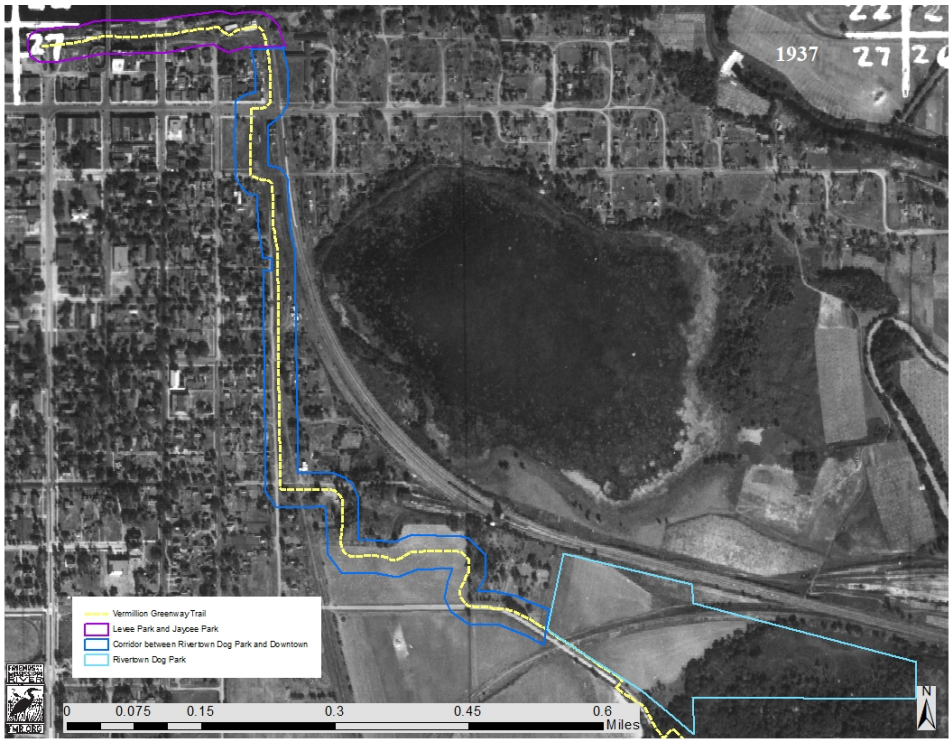


Figure 16: 1964 Aerial photograph of the Vermillion Greenway (north).
Source: Dakota County GIS.

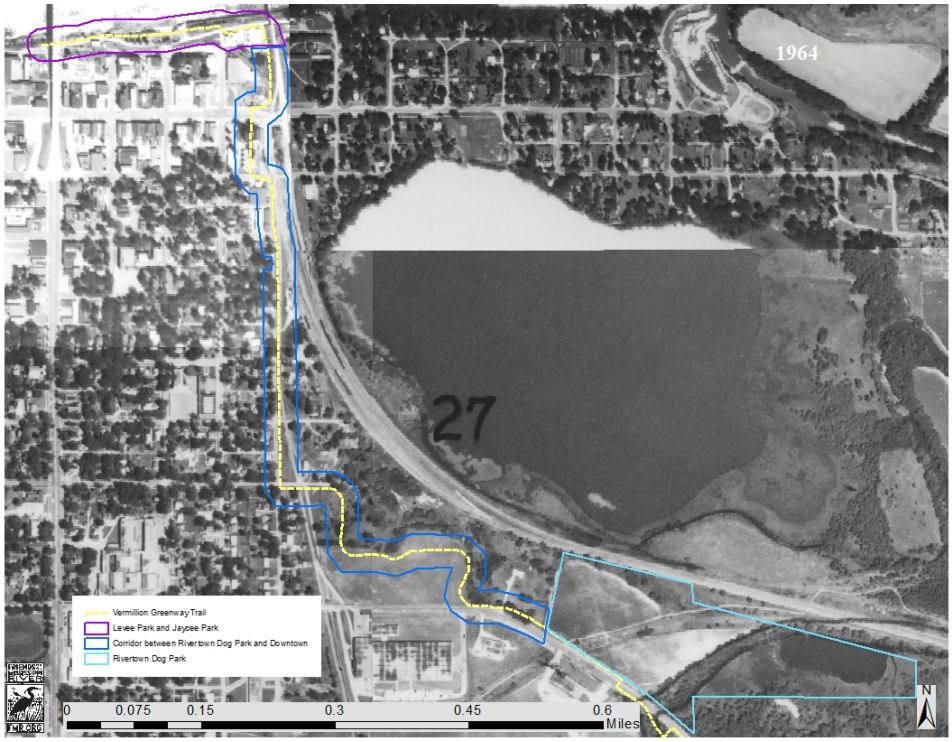


Figure 17: 1997 Aerial photograph of the Vermillion Greenway (north).
Source: Dakota County GIS.

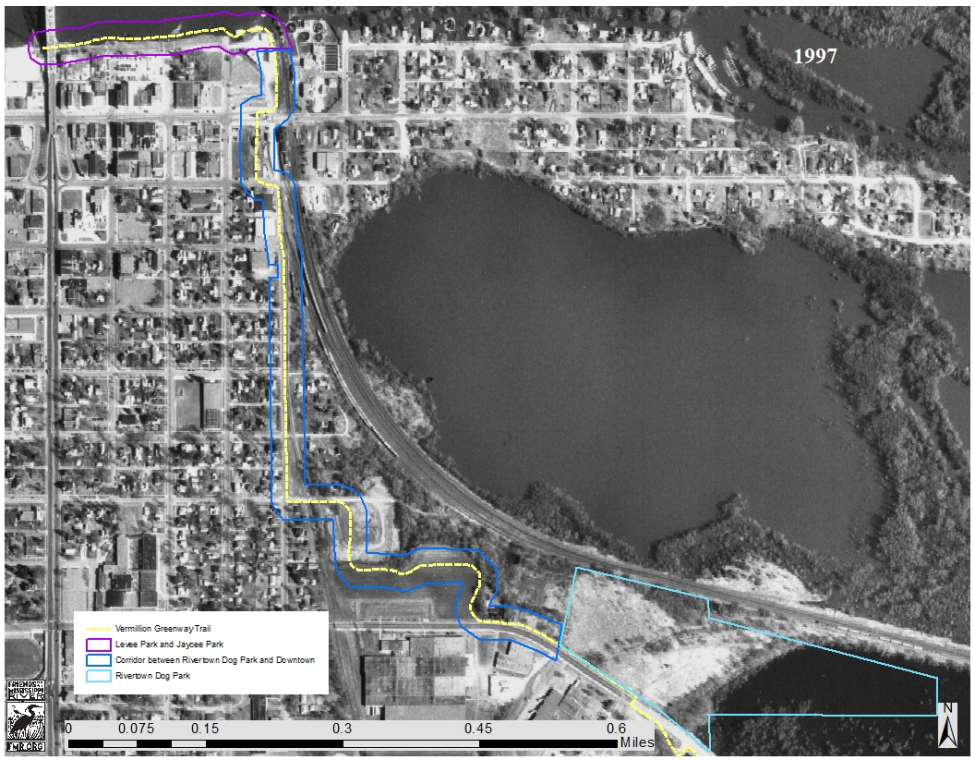
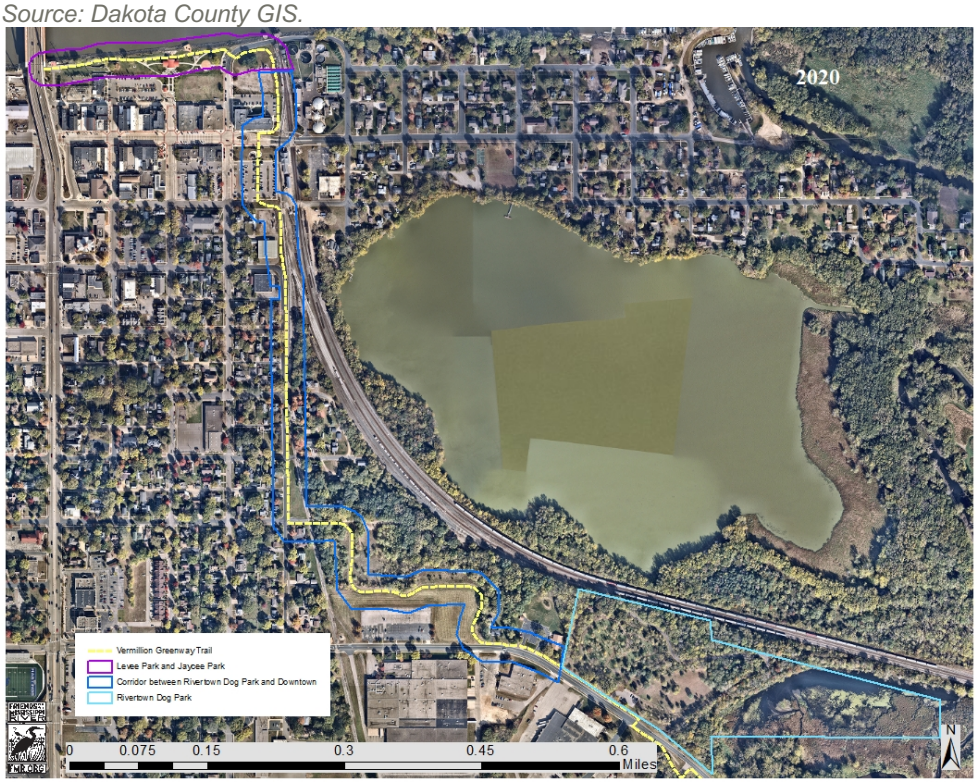


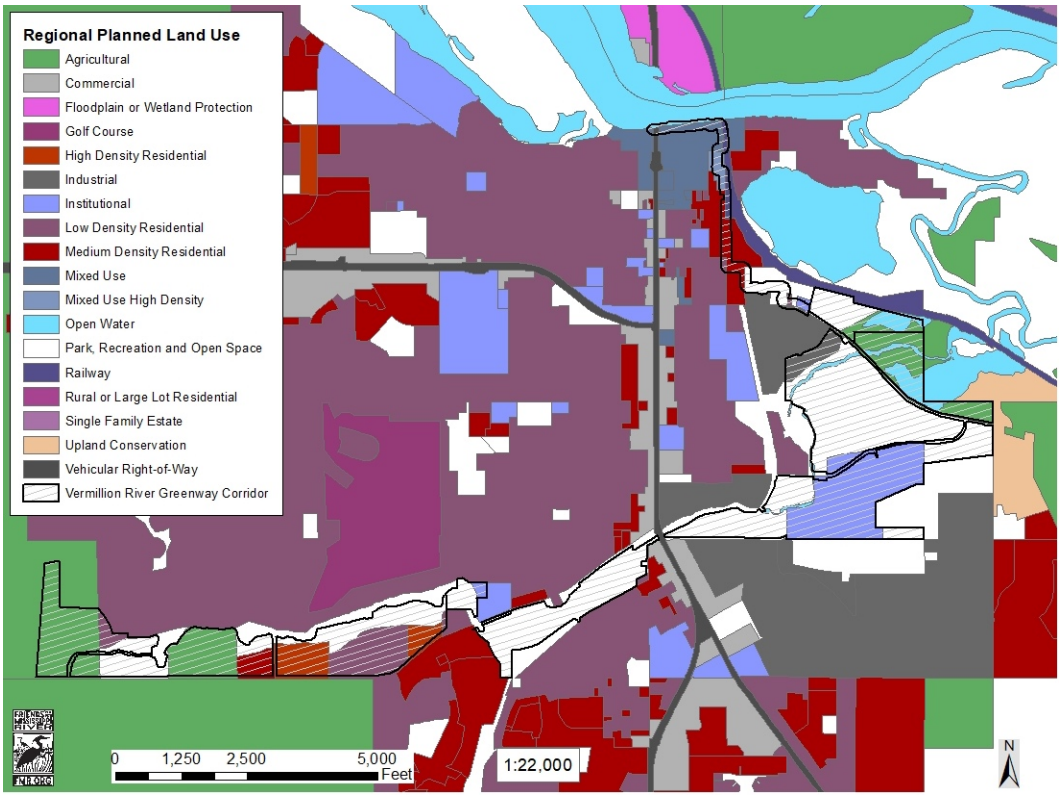
Figure 18: 2020 Aerial photograph of the Vermillion Greenway (north).
Source: Dakota County GIS.



Adjacent Land Use

The adjacency of parkland, agricultural land, open areas, and residential and commercial uses can impact 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 (Figure 19). Today, the relatively high percentage of impervious surfaces within the central section of the corridor significantly increases stormwater runoff rates and changes hydrological conditions of wetlands, streams and ponds within the corridor Additionally, successful management of invasive species can be considerably affected by the presence of invasive plants on adjacent parcels and the likelihood and ease with which reinvasion can occur. While natural resource management objectives focus on the corridor itself, adjacent land use, both current and planned, should be considered in restoration prioritization and cost estimation. Smaller and discrete natural areas within the central portion of the corridor (Vermillion Falls Park, Old Mill Park, Levee Park, and Rivertown Dog Park) are subject to increased invasive species threats. Small natural areas with high degrees of edge compared to their contiguous habitat and frequent exposure to weed propagules due to high foot traffic and roads are more vulnerable to the establishment of introduced species. Also, surrounding residential areas with legacy invasive plants such as common buckthorn, non-native honeysuckles, Amur maple, burning bush and other species can impact the ecological integrity of the corridor even after non-native species have been controlled on the corridor parcels themselves.

Figure 19: Planned land use within the Vermillion River Greenway corridor.
Source: Metropolitan Council.



Rare Features

The Minnesota Department of Natural Resources (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.

The MN DNR Natural Heritage Information System Biotics database was reviewed for occurrences of rare species within one mile of the Vermillion River Greenway study area. These data are presented in Table 1 (Copyright 2021, State of Minnesota DNR, License Agreement #204662). Rare Features Data included here were provided by the Division of Ecological and Water Resources and were current as of May 2022. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

Table 1. Rare Features Within 1 Mile of the Vermillion River Greenway Corridor. Source: MNDNR.

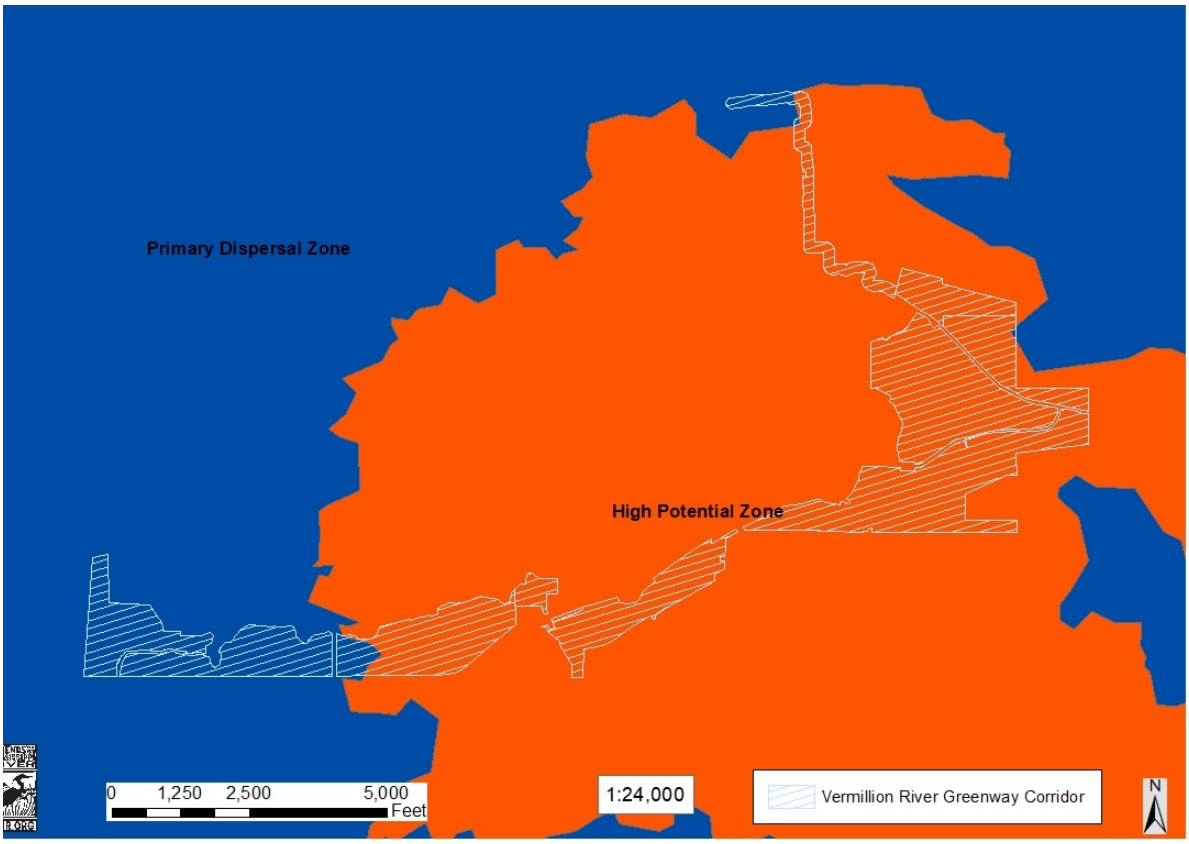
Taxon	Scientific Name	Common Name	State Status	Federal Status
Amphibian	Necturus maculosus	Mudpuppy	Special Concern	Not Listed
Bat	Myotis lucifugus	Little Brown Myotis	Special Concern	Not Listed
Bird	Buteo lineatus	Red-shouldered Hawk	Special Concern	Not Listed
Bird	Chondestes grammacus	Lark Sparrow	Special Concern	Not Listed
Bird	Falco peregrinus	Peregrine Falcon	Special Concern	Not Listed
Bird	Vireo bellii	Bell's Vireo	Special Concern	Not Listed
Fish	Anguilla rostrata	American Eel	Special Concern	Not Listed
Fish	Cycleptus elongatus	Blue Sucker	Special Concern	Not Listed
Insect	Bombus affinis	Rusty-patched Bumble Bee	Watchlist	Endangered
Mussel	Actinonaias ligamentina	Mucket	Threatened	Not Listed
Mussel	Alasmidonta marginata	Elktoe	Threatened	Not Listed
Mussel	Arcidens confragosus	Rock Pocketbook	Endangered	Not Listed
Mussel	Cumberlandia monodonta	Spectaclecase	Endangered	Endangered
Mussel	Ellipsaria lineolata	Butterfly	Threatened	Not Listed
Mussel	Elliptio crassidens	Elephant-ear	Endangered	Not Listed
Mussel	Epioblasma triquetra	Snuffbox	Endangered	Endangered
Mussel	Eurynia dilatata	Spike	Threatened	Not Listed
Mussel	Lampsilis higginsii	Higgins Eye	Endangered	Endangered
Mussel	Lampsilis teres	Yellow Sandshell	Endangered	Not Listed
Mussel	Lasmigona costata	Fluted-shell	Threatened	Not Listed
Mussel	Ligumia recta	Black Sandshell	Special Concern	Not Listed
Mussel	Megalonaias nervosa	Washboard	Endangered	Not Listed
Mussel	Plethobasus cyphyus	Sheepnose	Endangered	Endangered
Mussel	Pleurobema sintoxia	Round Pigtoe	Special Concern	Not Listed

Taxon	Scientific Name	Common Name	State Status	Federal Status
Mussel	Quadrula fragosa	Winged Mapleleaf	Endangered	Endangered
Mussel	Quadrula nodulata	Wartyback	Threatened	Not Listed
Mussel	Reginaia ebenus	Ebonyshell	Endangered	Not Listed
Mussel	Simpsonaias ambigua	Salamander Mussel	Endangered	Not Listed
Mussel	Theliderma metanevra	Monkeyface	Threatened	Not Listed
Mussel	Tritogonia verrucosa	Pistolgrip	Endangered	Not Listed
Mussel	Truncilla donaciformis	Fawnsfoot	Threatened	Not Listed
Mussel	Venustaconcha ellipsiformis	Ellipse	Threatened	Not Listed
Reptile	Acris blanchardi	Blanchard's Cricket Frog	Endangered	Not Listed
Reptile	Emydoidea blandingii	Blanding's Turtle	Threatened	Not Listed
Vascular Plant	Besseya bullii	Kitten-tails	Threatened	Not Listed
Vascular Plant	Cirsium pumilum var. hillii	Hill's Thistle	Special Concern	Not Listed
Vascular Plant	Gymnocladus dioica	Kentucky Coffee Tree	Special Concern	Not Listed
Vascular Plant	Panax quinquefolius	American Ginseng	Special Concern	Not Listed
Vascular Plant	Trillium nivale	Snow Trillium	Special Concern	Not Listed

Rusty-patched Bumble Bee. The rusty-patched bumble bee (*Bombus affinis*, also RPBB) 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 midwestern 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 Minnesota-Wisconsin US Fish and Wildlife Service Field Office has adapted a habitat connectivity model that considers the likelihood of RPBB movement based on the most recent National Land Cover Database maps. The model was built using typical bumble bee foraging distances from the locations of known records. As such, the model suggests the areas with the highest potential for RPBB to be present based on availability of suitable habitat. A large portion of the Vermillion River Greenway Corridor occurs within the High Potential Zone of the rusty-patched bumble bee (Figure 20) and has been documented at Old Mill Park.

Figure 20: Rusty Patched Bumblebee Potential Zones within the Greenway corridor.
Source: USFWS, MN-WI Ecological Services Field Office.



Blanding's Turtle. The Blanding's turtle (*Emydoidea blandingii)* was once widespread in the eastern and central U.S. but is now restricted to a small handful of states and provinces in the Upper Midwest, New England, and southeastern Canada. Populations face many threats including habitat loss and fragmentation, predation, and mortality on roadways. Blanding's turtles are long lived and don't reach sexual maturity until after 12 years. They breed during spring and early summer in wetlands where there are abundant food sources of invertebrates and small amphibians with nesting sites in sandy upland areas with sparse vegetation up to a mile away from their resident marshes. Turtle nests are generally raided by predators to a high degree, and Blanding's turtles have been documented to experience extremely high nest predation rates. For those nests that succeed, the hatchlings that emerge in August and September must face hazards such as predation and road mortality as they move to seek shelter in wetland habitats. Their low reproduction and high juvenile mortality 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. The Blanding's turtle was classified as a threatened species in Minnesota in 1984.

Kitten-tails. Minnesota is an important population center for kitten-tails (*Besseya bullii),* a midwestern endemic species, which is considered rare or threatened wherever it occurs. Although there are many known occurrences kitten-tails in the southern half of the state, there has been a precipitous decline in recent decades. Many populations have been reduced to perilously low numbers, and others have been lost all together. The cause is loss or degradation of savanna habitat. In most cases, the habitats were small to begin with, usually no more than a few acres in size. They were typically inclusions in otherwise forested habitats, which were kept in a semi-open state by periodic wildfires. With the suppression of wildfires, many of these openings have grown into forests. Other losses have been attributed to urbanization within the expanding metropolitan area of Minneapolis-St. Paul and surrounding suburbs. Kitten-tails was reclassified as a threatened species in Minnesota in 1996.

Kitten-tails is primarily a species of oak savanna communities, though it also occurs in dry prairies and oak woodlands including dry-mesic oak and maple woodlands. Minnesota populations are largely restricted to the bluffs and terraces of the St. Croix, Mississippi, and Minnesota River valleys, with many populations occurring in the greater Twin Cities area. Plants show a preference for partial shade to full sunlight and upper slopes, and the known population of kitten-tails in the Vermillion River Greenway corridor fits this habitat type. As kitten-tails habitat has diminished due to woody encroachment, appropriate management tools may include fire, which can be effective in reducing woody vegetation and encouraging flowering. However, careful timing of prescribed fires is critical. Fire should only be used in early spring before plants appear above ground, usually during late March or early April. Once the plants appear above ground, even 2.5-5.1 cm (1-2 in.), they can be severely damaged by fire. Sizable populations of kitten-tails have been documented at Old Mill Park and Vermillion Falls Park.

Physical Conditions

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

Geology

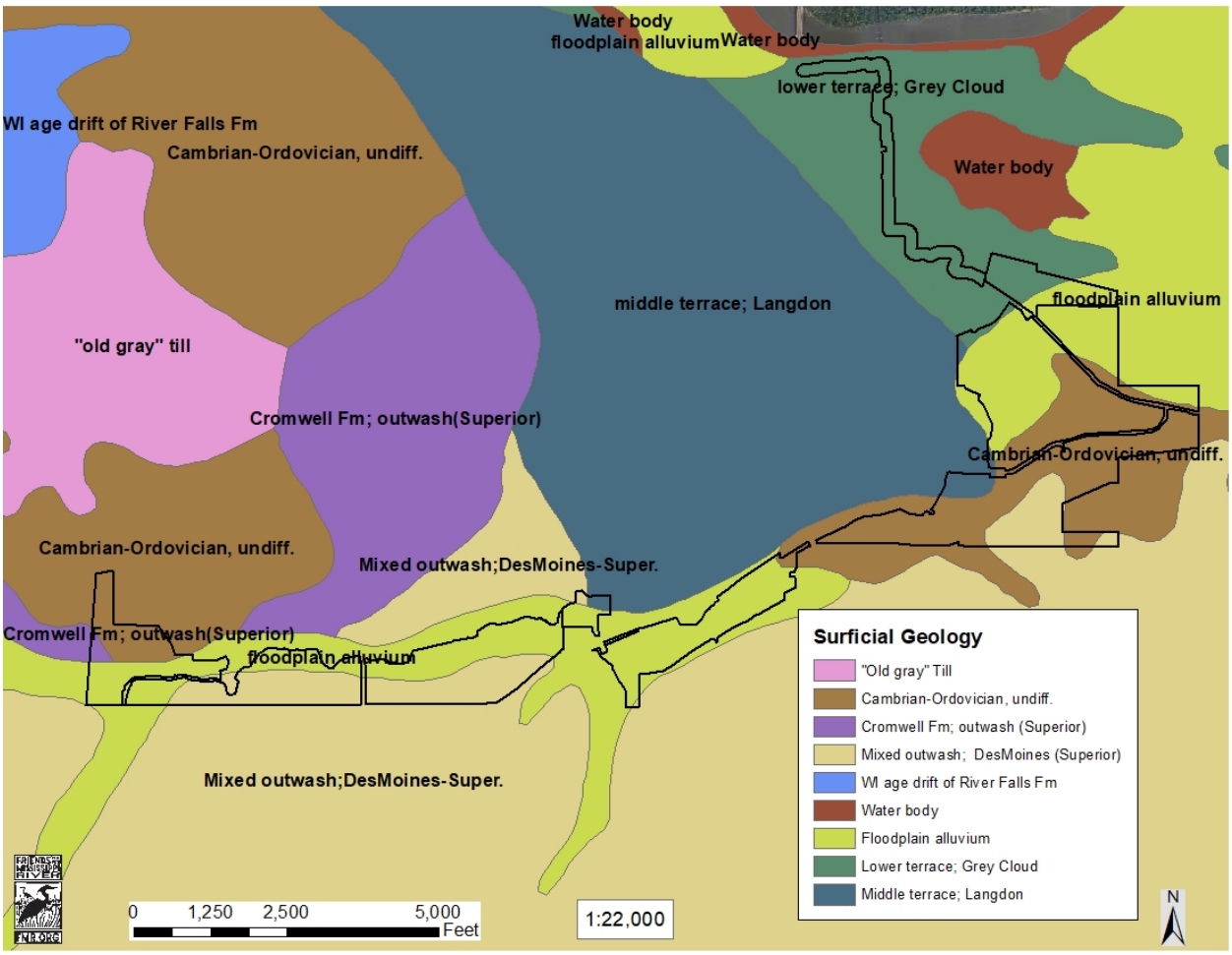
The bedrock of Dakota County formed from ancient oceans, beaches, reefs, and mudflats. Sand, clay, and marine animals were buried and compressed and formed a variety of sedimentary rock layers with varying depths and character. The position and substrate types of underlying rock determine the location and size of underground aquifers. 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 Vermillion Greenway Corridor include St. Lawrence Formation 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 and Oneota Dolomite of the Prairie du Chien Group form an aquifer due to their capacity for groundwater storage.

Dakota County's surficial geology (Figure 21) is very diverse and translates to an ecologically diverse landscape. The most recent glacial retreat (10-12,000 years ago) extended south into the northern portion of the county, and the resulting terminal moraines developed typical "knoll and basin" topography. South of these moraines, the surficial geology is quite irregular. In some areas, softer rock was worn down and is much lower in elevation than the more resistant rock layers. This process has created isolated, mesa-like uplands, 100-200 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 Dakota County.

Surficial geology greatly influences topography, soil type, and soil pore space, and these characteristics influence the resulting plant communities. The Vermillion River Greenway in Dakota County is located largely within a collapsed outwash plain landform. Within the river channel, the surficial geology is Floodplain Alluvium, or the sediment of modern rivers which is typically coarser-grained in the channels, and finer-grained on the floodplains. Sand is chiefly present within the floodplain of the Vermillion River and is commonly overlain by about 5 feet of sandy loam to loamy sand, with interbeds of organic-rich layers and gravelly in some places. The floodplain of the river to the east as the Vermillion approaches its confluence with the Mississippi is outwash consisting of sand, gravelly sand, and gravel. This material was deposited by glacial meltwater issuing from the ice margin. At the Vermillion's confluence with the Mississippi around the Hastings SNA, the surficial geology is Oolitic sandy dolostone and sandstone of the Shakopee Formation which overlies massive dolostone of the Oneota Dolomite. This material is exposed in areas and is often quarried.

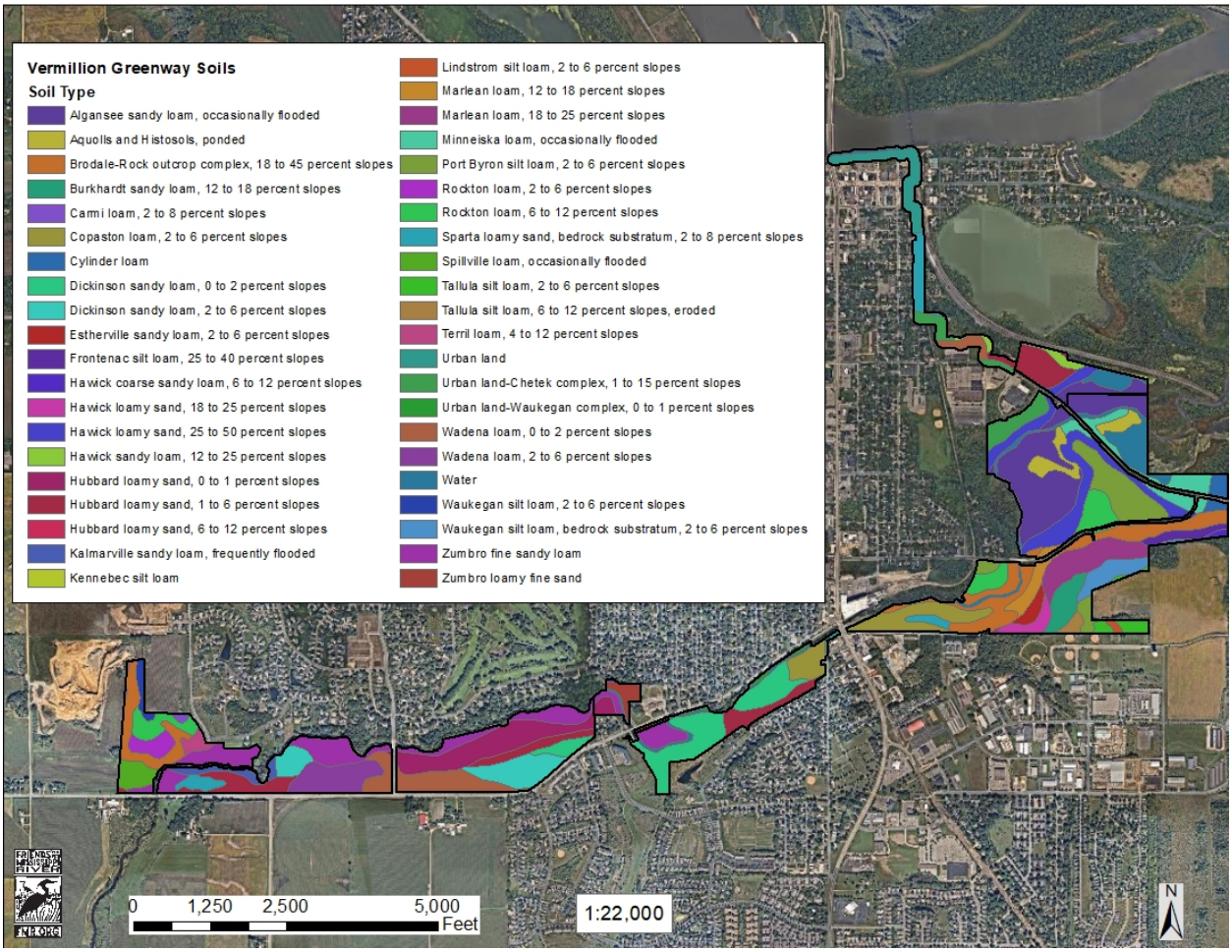
Figure 21: Surficial geology of the Vermillion River Greenway corridor.
Source: Dakota County GIS.



Soils

Soils are formed from the interaction of the parent material, climatic conditions, organisms, relative topography or slope, and time. Collectively, these factors can be referenced to determine the plant and animal communities that formed the soils. Identification and classification of soils within the Vermillion River Greenway corridor informs the management and restoration by both indicating the likely historical plant communities and pointing to target plant communities. 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 and types affect the vegetative and hydrologic features of the corridor and suggest the most appropriate use and management of the land. Soil types within the Vermillion River Greenway corridor are shown in Figure 22.

Figure 22: Vermillion River Greenway soils.
Source: Dakota County GIS.



Drainage classification is one of the more important soil characteristics in consideration of land management. as it relates to land management in the Greenway Corridor. In the western half of the corridor, the most common soil types are Zumbro fine sandy loam (well drained to moderately well drained), Urban land Waukegan complex (well drained), Hubbard loamy sand (excessively drained), and Dickinson sandy loam (well drained to excessively drained) are the most common soils. In the eastern half of the corridor, the north-south segment of the greenway within the US Highway 61 corridor has soils of the Urban land Waukegan complex or Chetek complex, which are well drained and excessively drained, respectively. The easternmost section of the greenway as the Vermillion nears the Mississippi is primarily Algansee sandy loam that can be occasionally flooded and Port Byron silt that is well drained.

A summary of soil types and their drainage classifications in the Corridor study area is included in Appendix A.

Topography

Topography and the slope orientation (aspect) relative to north, south, east, and west, are important determinants of soil formation and development, erosion potential, and the plant communities that will establish. Generally, more topographic variation will result in more complex and diverse vegetation communities and hydrologic features. Given their sun and wind exposure, south- and southwest-facing slopes will be drier and support less vegetation than north- and northeast-facing slopes. The greatest topographic relief in the corridor is between the falls and the dog park, with some significant slopes also at the far west end (Figure 23). Light detection Ranging (LiDAR) imaging further reveals the landscape relief of the corridor (Figure 24).

Figure 23. 10-foot elevation contours in the Vermillion River Greenway corridor.

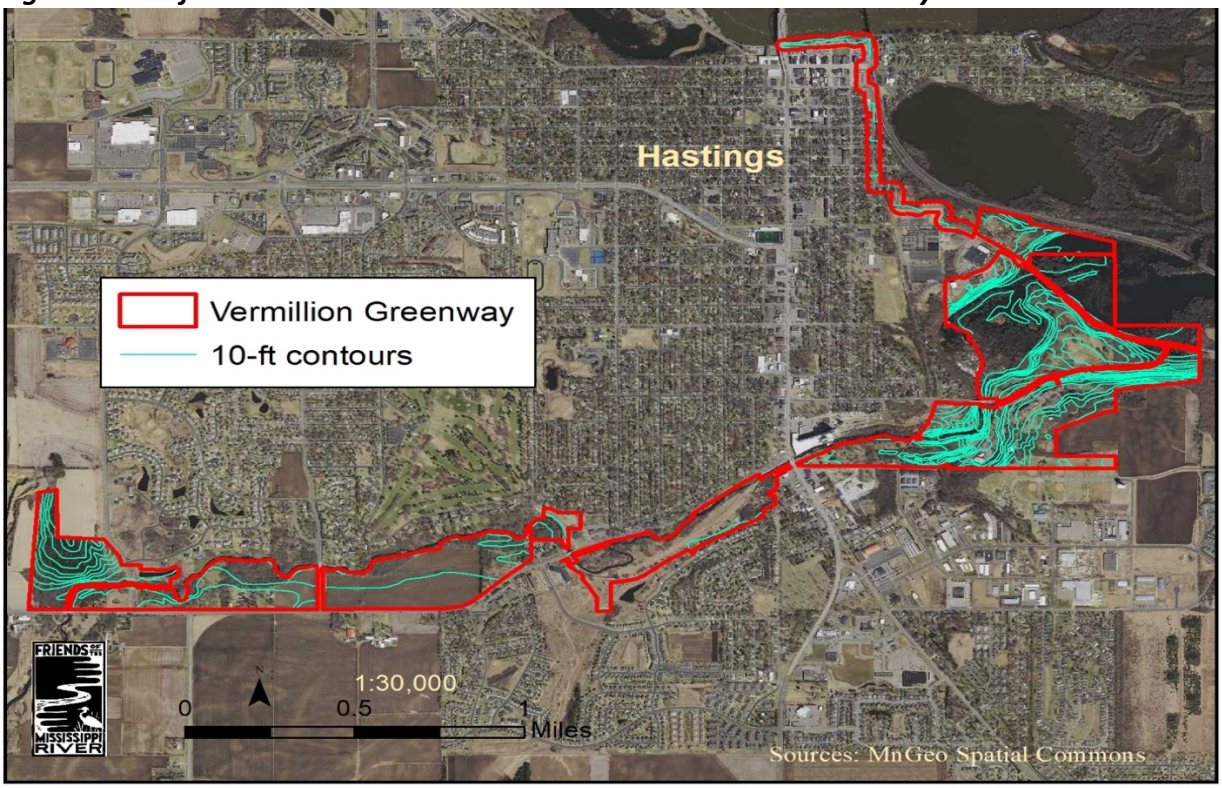
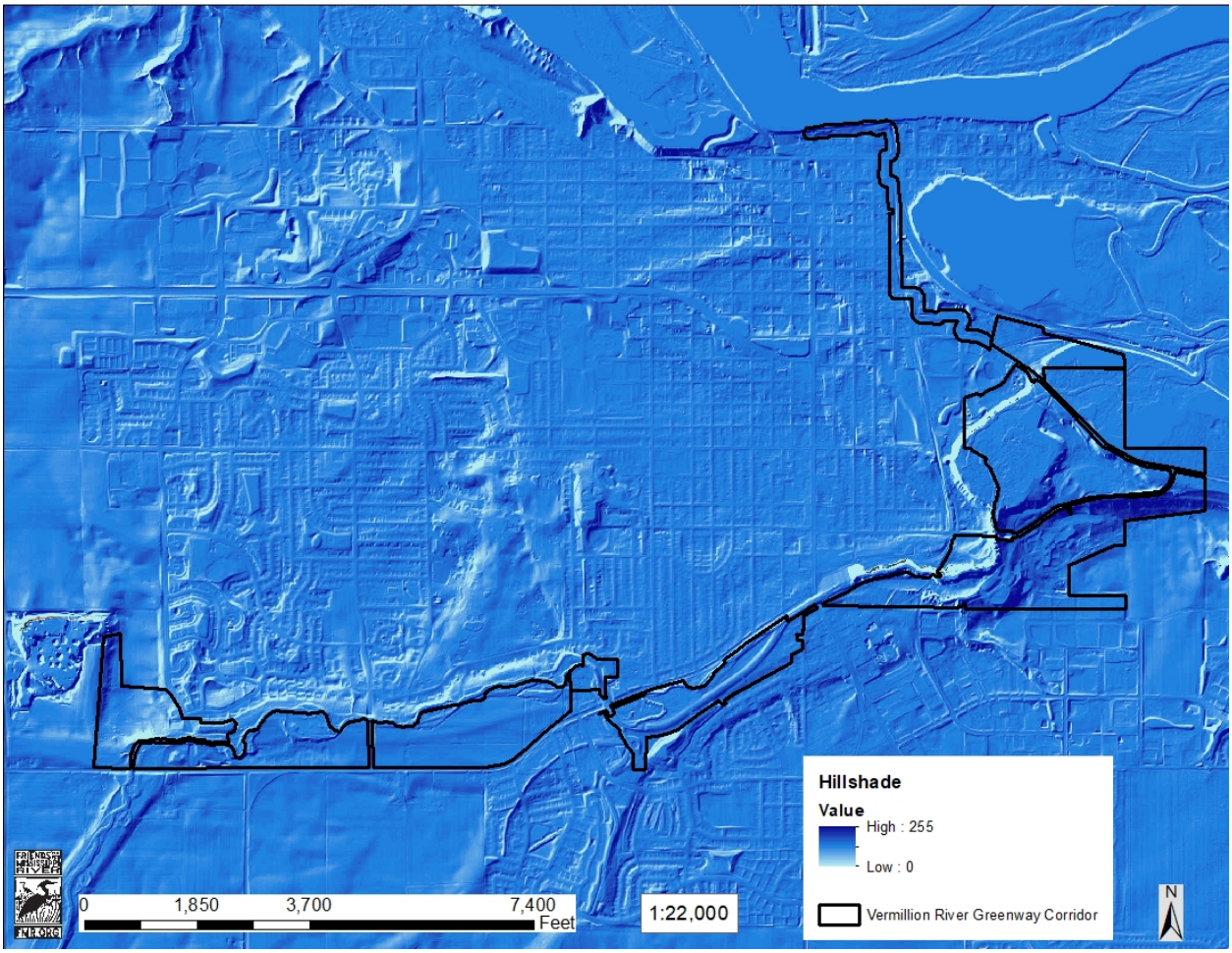


Figure 24: Digital orthophoto of hillshade within the Greenway corridor.
Source: MN Geospatial Information Office



Aspect or orientation also strongly influences soil temperature and moisture. In the northern hemisphere, north-facing slopes are often shaded by the earth itself, while south-facing slopes receive more solar radiation for a given surface area because the slope is tilted toward the sun. The slope aspect can also significantly influence locational climate (microclimate). Soil temperatures and soil moisture on south-facing slopes are typically warmer and drier than those of 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 has significant impacts on species distribution and community associations of vegetation on the landscape.

Hydrology

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

Groundwater

Groundwater accumulates below the land's surface 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.

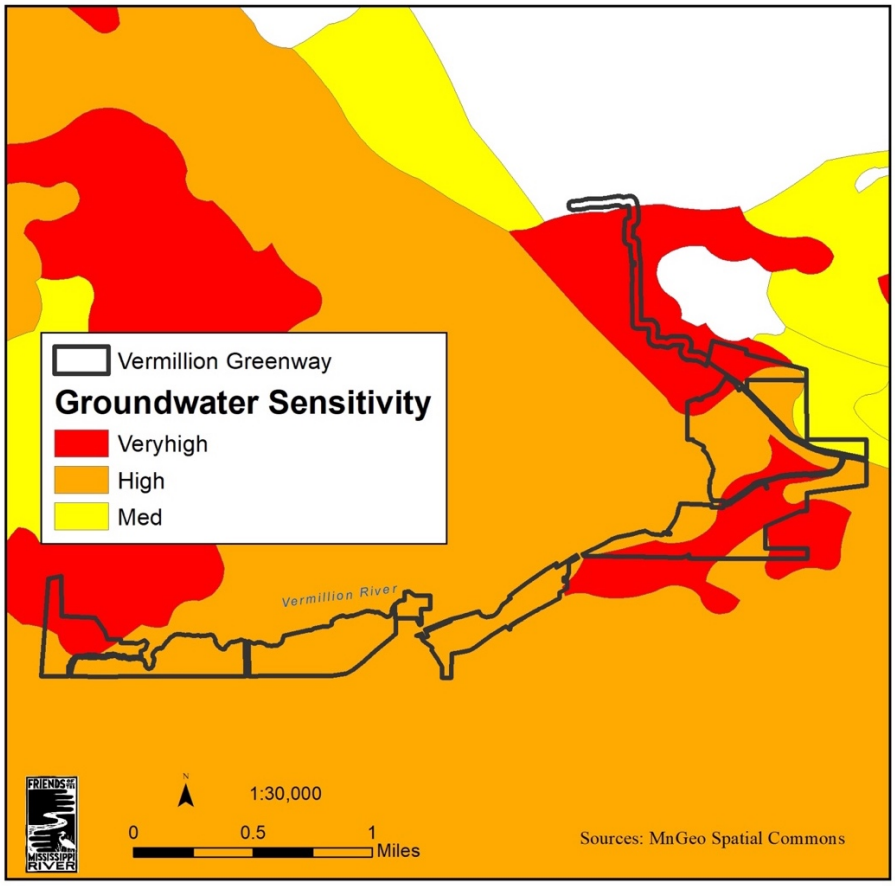
Within Dakota County, groundwater's relative abundance, quality, and reasonable access allows it to provide drinking water for most of the community. Groundwater is also used for agricultural irrigation (especially on the sandier soils in the eastern part of the County) and for cooling uses in industry and manufacturing. 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. The Vermillion River upstream of the corridor is a designated trout stream. Furthermore, most of the county's groundwater is "highly sensitive" to surface contamination. Once an aquifer is polluted, it is very expensive or cost-prohibitive to return its quality to drinking water standards.

Given groundwater's importance and vulnerability, awareness of the potential for contamination is essential, and steps must be taken to prevent contaminating activities at the ground's surface. In rural parts of Dakota County, the greatest risks to drinking water health are pesticides and nitrates as nitrogen contamination. Naturally occurring manganese and arsenic are also concerning 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 MNDNR 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 that contaminants move conservatively with water, flow paths are vertical, and the permeability of the sediment is the controlling factor.

Infiltration rates are based on the soil type and the texture of surficial geology and travel time can vary from hours to approximately one year. 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 25 illustrates the sensitivity of groundwater to pollution in the Vermillion River corridor. 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. This figure also indicates areas known to have karst topography. Karst is a terrain with distinctive landforms and hydrology created primarily from the dissolution of soluble rocks. It is characterized by sinkholes, caves, springs, and underground drainage dominated by rapid conduit flow.

Figure 25: Groundwater sensitivity.



Approximately 4 miles of the 5-mile Vermillion River greenway has Karst topography. Karst features are the result of water dissolving bedrock, which creates conduits, sinkholes, and caves that can rapidly move water. This rapid movement makes groundwater in karst areas especially vulnerable to activities on the land's surface. As such, knowing where these features exist is essential to understanding where contaminant transport will be high due to the interaction between surface and groundwater systems. The 4 miles of the corridor with karst topography are mapped as high sensitivity to groundwater pollution. The exception in the greenway is the 1-mile section of the corridor from roughly Pleasant Drive to the eastern end of Vermillion River Linear Park, which is mapped as moderately sensitive to groundwater pollution.

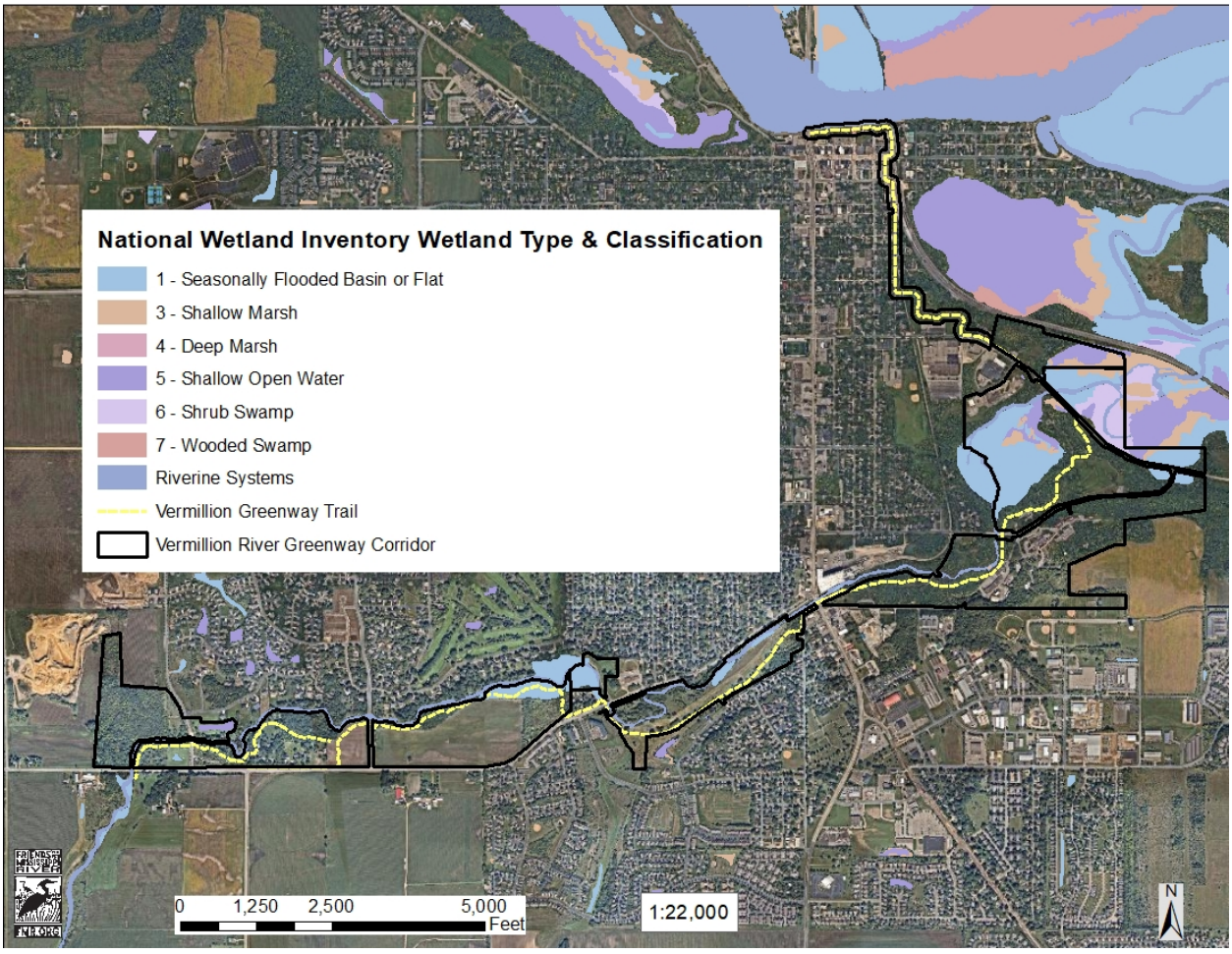
High sensitivity does not mean that water quality has been or will be degraded. If there are no contaminant sources, pollution will not occur. This designation is cautionary. Likewise, low sensitivity does not guarantee protection. Leakage from an unsealed well for example, may bypass the natural protection,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

Surface Water: Streams, Lakes, Ponds, and Wetlands

Dakota County is valued for the number and diversity of its waterbodies. The Mississippi, Minnesota, Cannon, and Vermillion rivers all delineate major watersheds within the county. Glaciation left many small lakes are found in the northern portions of the county, and different types of wetlands are scattered throughout the county.

Within the corridor, the wetlands as classified by the National Wetland Inventory (2010-2013) are freshwater forested wetland, freshwater emergent wetland, freshwater pond, or freshwater forested or shrub. Freshwater forested wetland is the dominant wetland type along the Vermillion west of Vermillion Linear Park and the large wetland complex west of C.P. Adams Park (Figure 26). Freshwater emergent wetland is the next most common in deeper water to the interior of the forested wetlands along Ravenna Trail.

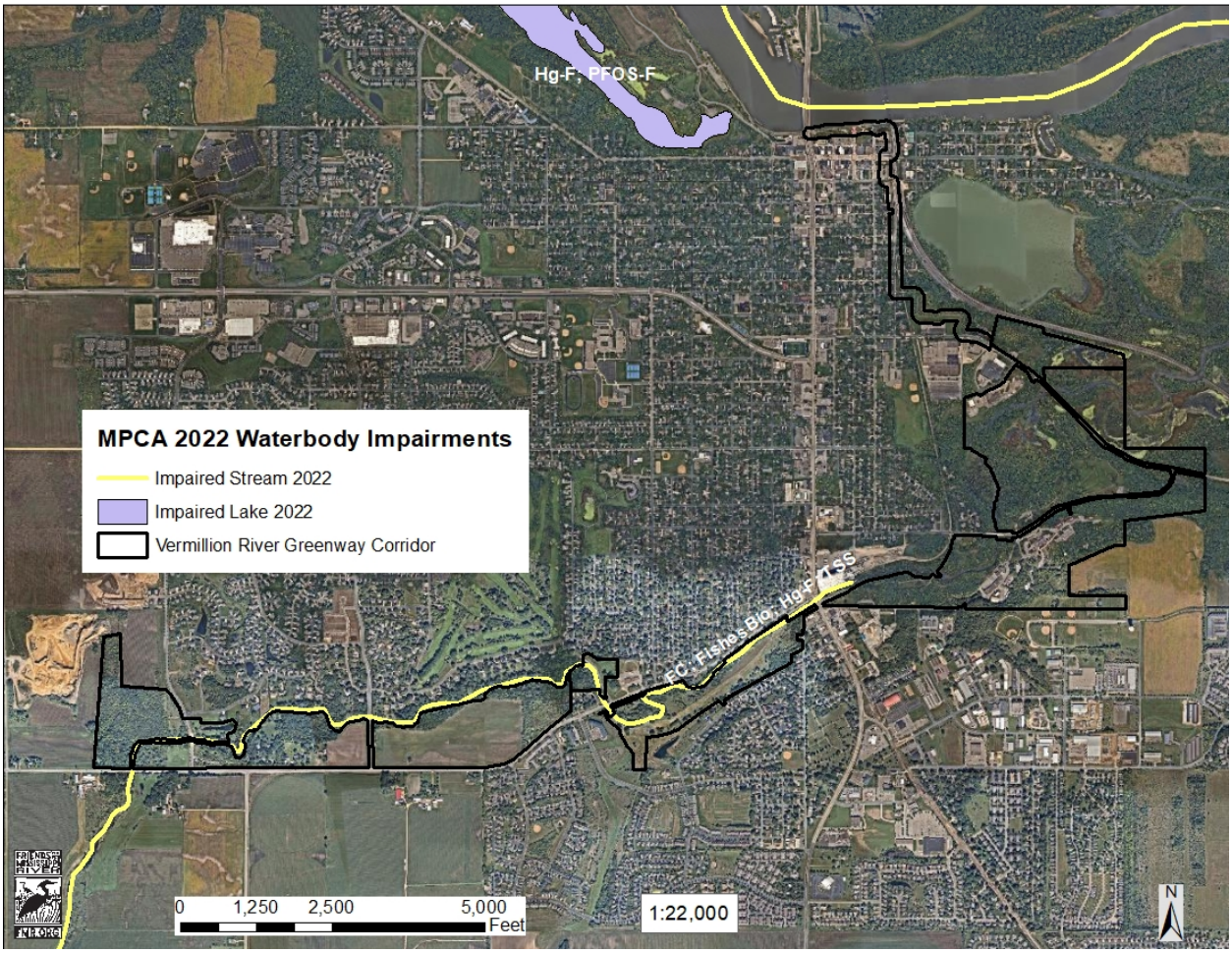
Figure 26: National Wetland Inventory wetlands within the Vermillion Greenway corridor.
Source: MNDNR.



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 27 depicts public waters (streams, lakes, and wetlands) that are included on Minnesota's 2022 Impaired Waters List. Within the region of the Vermillion River Greenway, the western portion of the Vermillion River is impaired for fecal coliform, fish bioassessments, mercury in fish tissue, and total suspended solids. Lake Rebecca, just to the northwest of the Greenway is impaired for mercury and perfluoro-octane sulfonate (PFOS) in fish tissue.

Figure 27: Impaired waterbodies within Vermillion River Greenway corridor.

Source: MN Pollution Control Agency.

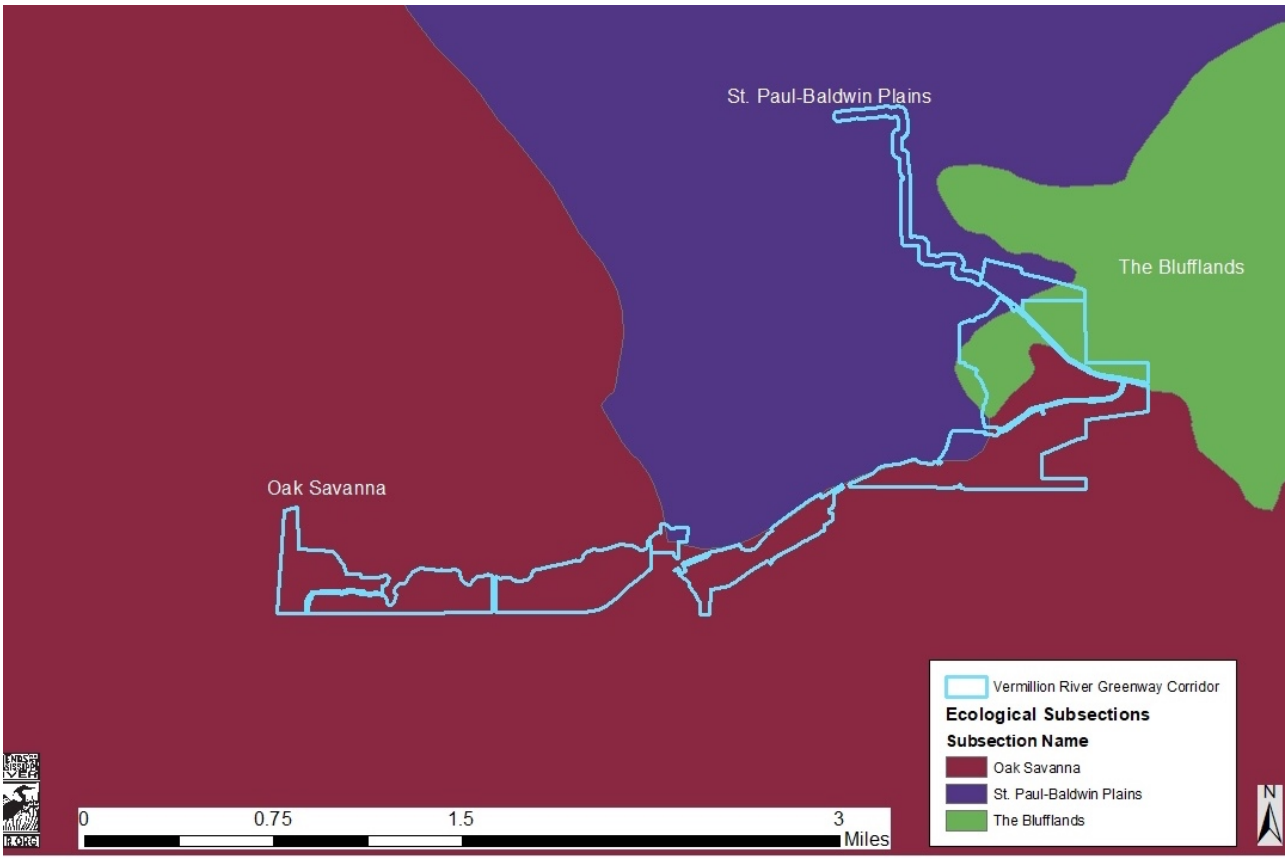


Ecological Communities

Minnesota contains three major biomes. Generally, from northeast to southwest across the state, the coniferous forest lies in the northeast; the deciduous forest creates a band across the middle; and the prairie/grassland biome is in the southwest. While these biomes still exist, they have been greatly altered in physical character and extent due to human activity since the mid-1800s. The metropolitan region of Minnesota, including Dakota County, falls within the deciduous forest biome. There was, and still is, significant plant community diversity within each biome, and the county has historically had mostly tallgrass prairie and oak savanna plant communities. Oak and maple-basswood forests are also present and restricted to areas sheltered from fires, such as steep ravine slopes.

In addition to the major biomes, there are four ecological provinces in Minnesota: prairie parkland, eastern broadleaf forest, Laurentian mixed forest, and tallgrass aspen parkland. There are ten sections within the each of the provinces, and 26 subsections identified by the MNDNR. The Vermillion River Greenway Corridor is within three subsections: St Paul Baldwin Plains, Oak Savanna, and The Blufflands (Figure 28).

Figure 28: Ecological subsections of the Vermillion Greenway.
Source: MNDNR.



The Saint Paul Baldwin Plains Subsection covers the northern extent of the Vermillion River Greenway and was historically comprised of a mosaic of tallgrass prairie and oak savanna with small clusters of Big Woods forest throughout. 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 form in depressions within the prairie and oak savannas, and thus populating the open landscape with more heavily wooded areas that was otherwise kept open by periodic fire disturbance.

The Blufflands Subsection within the greenway is located along north and west boundaries of the subsection. The north boundary marks the northern extent of loess deposits (windblown silt) which has been extensively eroded along rivers and streams. The western boundary is quite complex and follows major river valleys. Bluffs of up to 600 feet and river bottom forests indicative of this ecological class are common near the Mississippi River. There are no lakes in this subsection, and the drainage network is well developed and dendritic in nature. Tallgrass prairie and bur oak savanna were the major vegetation types on ridge tops and dry upper slopes prior to European colonization. Red oak-white oak-shagbark hickory-basswood forests were present on wetter slopes, and red oak-basswood-black walnut forests in protected valleys. Presently, most of the Blufflands within the greenway are within the developed core of Hastings apart from land within Vermillion Falls and Old Mill Parks and Rivertown Dog Park.

The Oak Savanna Subsection within the greenway covers the roughly three-quarters of the land in the west and central areas of the corridor. Most of the Oak Savanna Subsection generally is characterized by rolling plains of loess-mantled ridges over sandstone and carbonate bedrock and till which has given rise to a well-developed drainage network. The plains resulted from a series of end moraines that disrupted the spread of fires from the west but did not provide sufficient protection for hardwood forests to become established. Tornados and high wind events also created significant disturbance within oak savannas. In the present day, most of the oak savanna within the greenway is in agricultural use except for dedicated park space at Old Mill Park and Vermillion Linear Park.

Existing Vegetation

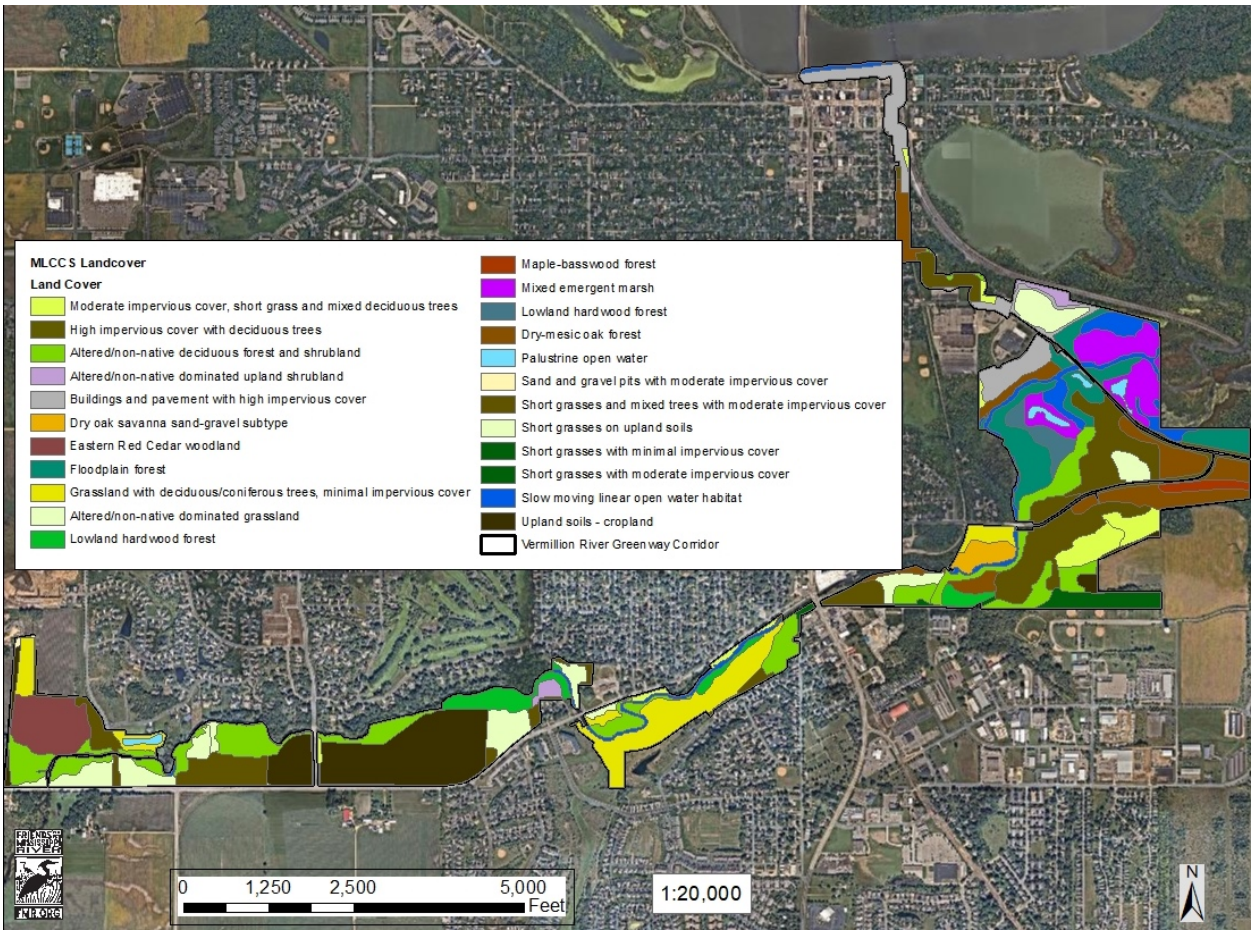
The vegetation characteristics within the Vermillion River Greenway Corridor are determined by several factors including physical site conditions such as topography, soils, hydrology, historic and present land use, climate, invasive species effects, and wildlife. Vegetation is also affected by natural processes like succession or natural events that create change and variation. Abrupt and disruptive changes, including wildfires, high winds, and floods, can change the vegetation structure and composition very quickly and for long periods of time. 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 like 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.

Plant Communities and Cover Types

The plant communities and cover types within the Vermillion River Greenway Corridor can be categorized using the MNDNR's Land Cover Classification (MLCCS) system (Figure 29). This system integrates cultural and vegetative features of the landscape into one comprehensive land cover classification system.

Figure 29: MN Landcover Classifications within the Vermillion Greenway.
Source: MNDNR.



MLCCS consists of five hierarchical levels that are reflected in five-digit classification codes:

- 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, mesic prairie, etc.)

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. Existing landcover is summarized in Table 2.

Table 2. Summary of Land Cover in the Corridor. Source: MNDNR.

SITE	MLCCS LAND COVER	MLCCS CODE	ACRES	TARGET PLANT COMM
W OF GEN SIEB + DAKOTA CONS AREA				
	Long grasses on upland soils	23212	10.9	Southern dry savanna
	Upland soils - cropland	24110	10.6	Southern mesic prairie
	Upland soils - cropland	24110	8.8	Southern mesic prairie
	Eastern Red Cedar woodland	41130	20.1	Southern dry-mesic pine-oak woodland
	Altered/non-native deciduous woodland	42130	13.8	Southern dry-mesic oak forest
	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	62220	4.6	Southern mesic prairie
	Slow moving linear open water habitat	91100	6.0	Southern terrace forest or Southern floodplain forest
E OF JORGEN				
	Short grasses and mixed trees with 11-25% impervious cover	13124	12.2	Southern dry savanna
	Short grasses on upland soils	23211	2.3	Southern mesic prairie
	Upland soils - cropland	24110	9.3	Southern mesic prairie
	Altered/non-native deciduous woodland	42130	11.1	Southern dry-mesic oak woodland
	Medium-tall grass altered/non-native dominated grassland	61220	1.8	Southern mesic prairie
E OF PLEASANT				
	Short grasses and mixed trees with 11-25% impervious cover	13124	1.2	Southern dry savanna
	Short grasses and mixed trees with 51-75% impervious cover	13144	0.8	Southern dry savanna
	Non-native dominated long grasses with 26-50% impervious cover	13232	1.3	Southern mesic prairie
	Upland soils - cropland	24110	45.7	Southern mesic prairie
	Lowland hardwood forest	32220	9.5	Southern terrace forest
	Altered/non-native deciduous woodland	42130	5.7	Southern dry-mesic oak woodland
	Medium-tall grass altered/non-native dominated grassland	61220	7.2	Southern mesic prairie
CORR W OF DAKOTA CO HWY DEPT				
	Short grasses and mixed trees with 26-50% impervious cover	13134	1.2	Southern dry savanna

SITE	MLCCS LAND COVER	MLCCS CODE	ACRES	TARGET PLANT COMM
	Short grasses on upland soils	23211	2.7	Southern mesic prairie
	Lowland hardwood forest	32220	0.3	Southern terrace forest
	Altered/non-native dominated upland shrubland	52130	2.1	Southern dry savanna
VERMILLION LINEAR PARK				
	Short grasses and mixed trees with 26-50% impervious cover	13134	1.1	Southern mesic prairie
	Short grasses with sparse tree cover on upland soils	23111	2.1	Southern mesic prairie
	Lowland hardwood forest	32220	2.2	Southern terrace forest or Southern floodplain forest
	Altered/non-native deciduous woodland	42130	11.4	Southern terrace forest
	Medium-tall grass altered/non-native dominated grassland	61220	29.8	Southern mesic prairie
	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	62140	1.4	Southern mesic prairie
VERMILLION FALLS PARK				
	Short grasses and mixed trees with 4-10% impervious cover	13114	7.0	Southern dry savanna
	Oak forest mesic subtype	32112	3.3	Southern dry-mesic oak forest
	Oak forest dry subtype	32113	1.2	Southern dry-mesic oak woodland
	Maple-Basswood forest	32150	1.7	Southern mesic maple-basswood forest
	Altered/non-native deciduous woodland	32170	2.7	Southern dry-mesic oak woodland
	Oak woodland-brushland	42120	0.5	Southern dry-mesic oak woodland
	Altered/non-native deciduous woodland	42130	4.0	Southern dry-mesic oak woodland
	Medium-tall grass altered/non-native dominated grassland	61220	4.0	Southern dry savanna
OLD MILL PARK				
	100% impervious cover	11210	0.5	None-trail
	Mowed turf	13115	4.2	none
	Oak woodland-brushland	42120	4.0	Southern dry-mesic oak woodland
	Restored dry prairie	61210	1.1	Southern dry prairie
	Dry oak savanna sand-gravel subtype	62123	4.8	Southern dry savanna
VETERANS HOME				
	4% to 10% impervious cover with perennial grasses and sparse trees (mowed turf with scattered trees)	13110	4.2	none

SITE	MLCCS LAND COVER	MLCCS CODE	ACRES	TARGET PLANT COMM
	Short grasses and mixed trees with 51-75% impervious cover (VH Buildings)	13144	27.9	none
	Short grasses with 4-10% impervious cover (Ballfield)	13211	7.8	none
	Upland soils (cropland)	24110	2.3	none
	Oak forest mesic subtype	32112	1.9	Southern dry-mesic oak forest
	Oak forest dry subtype	32113	1.4	Southern dry-mesic oak forest
	Maple-basswood Forest	32150	2.6	Southern mesic maple-basswood forest
	Altered/non-native deciduous forest	32170	22.1	Southern dry-mesic oak woodland
	Floodplain forest	32210	11.3	Southern floodplain forest
	Lowland hardwood forest	32220	0.5	Southern terrace forest
	Mixed hardwood swamp - seasonally flooded	32420	4.5	Southern wet ash swamp
	Mixed emergent marsh	61620	0.5	Mixed emergent marsh
CP ADAMS PARK				
	Short grasses and mixed trees with 4-10% impervious cover	13114	19.9	None – disc golf
	Short grasses on upland soils	23211	4.1	None – disc golf
	Oak forest mesic subtype	32112	7.1	Southern dry-mesic oak forest
	Maple-basswood Forest	32150	1.8	Southern mesic maple-basswood forest
	Altered/non-native deciduous forest	32170	2	Southern dry-mesic oak forest
	Floodplain forest	32210	11	Southern floodplain forest
	Mixed hardwood swamp - seasonally flooded	32420	2.6	Southern wet ash swamp
	Mixed emergent marsh	61620	6.3	Mixed emergent marsh
	Palustrine open water	93300	5.5	Palustrine open water
HASTINGS SNA				
	51% to 75% impervious cover with deciduous trees	11240	6.7	None-roads and roadsides
	Oak forest mesic subtype	32112	20.6	Southern dry-mesic oak forest
	Maple-basswood Forest	32150	4.0	Southern mesic maple-basswood forest
	Floodplain forest	32210	9.9	Southern floodplain forest
	Mixed emergent marsh	61620	16.6	Mixed emergent marsh
	Palustrine open water	93300	7.3	Palustrine open water
RIVERTOWN DOG PARK				

SITE	MLCCS LAND COVER	MLCCS CODE	ACRES	TARGET PLANT COMM
	Long grasses and mixed trees with 11-25% impervious cover	13125	11.9	Southern dry-mesic oak forest
	Altered/non-native dominated upland shrubland	52130	2.0	Southern dry savanna
CORRIDOR BETWEEN RIVERTOWN DOG PARK & DOWNTOWN				
	4% to 10% impervious cover with deciduous trees	11210	0.8	Southern mesic maple-basswood forest
	Medium-tall grass altered/non-native dominated grassland	61220	4.1	Southern mesic prairie
	Short grasses and mixed trees with 4-10% impervious cover	13114	1.1	Southern dry savanna
	Buildings and pavement with 76-90% impervious cover	14113	7.1	None-paved trails and infrastructure
	Non-native dominated long grasses with 26-50% impervious cover	13232	0.3	None-paved trails and infrastructure
LEVEE PARK/JAYCEE PARK				
	Slow moving linear open water habitat	91100	1.6	None-Mississippi Riverfront
	Short grasses and mixed trees with 4-10% impervious cover	13114	1.0	None-paved trails and infrastructure
	Buildings and pavement with 76-90% impervious cover	14113	5.5	None-paved trails and infrastructure
	Non-native dominated long grasses with 26-50% impervious cover	13232	0.1	None-paved trails and infrastructure

Plant Community Assessments

On-site plant community assessments were conducted within the parks and publicly owned parcels of the Vermillion River Greenway following an approximate 300-foot-wide corridor. Sections of the corridor within private properties were visually surveyed from the trail or nearby roads and were defined by property boundaries or logical divisions using cross-streets. Publicly owned units were surveyed using a meander survey, noting general species abundance in each stratum, and privately owned units received more generalized inspections. The surveys were conducted by FMR ecologists in September 2022. Summaries of these assessments follow.

West of General Sieben Drive:

Photo 1. Riparian area near General Sieben Drive

The 4-acre parcel at the northwest corner of General Sieben Drive and 160th Street East is owned by the City of Hastings and has approximately 385 feet of frontage on the Vermillion River. The MLCCS cover types are listed as Long grasses on upland soils in the upland areas and altered/non-native deciduous woodland along the river. The upland is a fallow field in recent production, and the stream corridor is forested and dominated by bur oak, green ash, eastern cottonwood, and box elder (Photo 1). The shrub layer is dominated by common buckthorn, but some oak regeneration is present in canopy gaps. Smooth brome has moved from the upland/old field area into the perimeter of the woodland. The open character of the parcel indicates that it could be easily converted to oak savanna or native prairie, if canopy thinning were to take place.

Dakota County Conservation Area:

Photo 2. Dakota Co Conservation Area

The open character of the previous parcel continues across General Sieben Drive to the south half of the county-owned Dakota County Conservation Area. Again, MLCCS categorizes most of the parcel as *Long grasses on upland soils.* This cover type is more evident on the south half of this parcel, but more closely resembles a *Grassland with sparse conifer or mixed deciduous*. Large bur oaks with wide canopies and limbs reaching the ground (Photo 2) indicate that this area was historically oak savanna. A remnant prairie plant community is present with hoary vervain, Scribner's panic grass, plantain-leaved pussytoes, and Scribner's panic grass in general abundance in open areas. Hill's thistle has also been recorded in the area. In 2022, a trail alignment through this parcel was staked to route trail users through the remnant oak savanna, but this alignment needs

to be adjusted slightly to avoid the drip line/root zone of the bur oaks. As is common in prairies and savannas where fire or other disturbance has been excluded, ruderal woody species are well-established. Siberian elm seedlings are plentiful, and eastern red cedar is abundant. Within the northern half of the parcel, the grade drops slightly toward the river and a moderately-wide floodplain is present. Bur oaks reach into the transition area between upland and lowland, and very large green ash and black cherry are present with smaller hackberry in the understory. Bur oaks are also regenerating in this transition area with most in the 4-6" diameter size class, but large, mature common buckthorn are also present. Within the river corridor, the streambanks are stable, but reed canary grass is dominant along the stream channel and in the floodplain, and common buckthorn and Tatarian honeysuckle fill the shrub layer.

East of Jorgen Avenue:

Nine privately-owned residential parcels comprise the greenway section between the Dakota County Conservation Area and Pleasant Drive to the east. There is no existing public access through these parcels, and the Vermillion River Trail follows local roads north of these parcels. Because the parcels are not publicly accessible, a general assessment of plant communities was done from the roadway. Continuous native tree cover lines the riverbank within these parcels with silver maple, green ash, black walnut, white oak, and red oak all present. There is regeneration of these species in the subcanopy with light- to moderate common buckthorn in the shrub layer. Smooth brome dominates the grassy field edge of the cultivated field (soybeans) at the northwest corner of Pleasant Drive and 160th Street East (Photo 3). The MLCCS cover type map indicates a lobe of *Medium-tall grass altered/non-native dominated grassland* along the streambank; this may indicate a small remnant prairie. Recent aerial imagery shows an open area on this parcel that may be presently mowed. The other parcels have closed canopies, and given the abundance of buckthorn on nearby properties, it can be assumed that these woodlands also have buckthorn unless they have been managed to prevent invasion.

Photo 3. East of Jorgen Avenue

East of Pleasant Drive:

Four privately-owned parcels totaling approximately 67 acres comprise the section of greenway east of Pleasant Drive before the Vermillion River turns south and travels under County Road 47. The Vermillion River Trail traverses these parcels within an easement conveyed to the City of Hastings, but the trail typically closes from December 15 to March 15 as no maintenance occurs through the winter. The three western parcels are row cropped, and the fourth parcel is a homestead with a mix of short- and medium-grasses that are non-native according to the MCLLS cover map. The eastern edge of this parcel has both jack pine and short grasses and may have remnant plant communities. A wide *Lowland hardwood forest* is present within the floodplain of the Vermillion. The floodplain here is quite wide (150-200 feet) in some areas with very large eastern cottonwood (Photo 4) and silver maple present and hackberry and Siberian elm in the understory. Several culverts run under the trail allowing for flood flows to reach the wide floodplain, and for water stored in the floodplain to reach the river when lower flows occur. On higher ground at the edge of the cultivated fields, black walnut is very abundant. The shrub layer is dominated by buckthorn, but management is planned by the City of Hastings. Several social trails (unofficial footpaths) run from the paved trail to the river where people attempt to access the river despite private property postings. This is likely contributing to weediness in the herbaceous layer: garlic mustard is abundant in this unit.

Photo 4. Large cottonwood east of Pleasant Drive

Corridor west of Dakota County Highway Department:

Photo 5. Very dense, mature buckthorn west of Hwy Dept.

The Vermillion River Trail traverses this area within a narrow easement and is thus flanked by private property with dense, mature buckthorn (Photo 5). Several social trails run from the paved trail to the river and contribute to bare ground, eroded streambanks, and weed pressure. The woodland is very degraded through this unit. Siberian elm and box elder dominate the canopy, and dense buckthorn and Tatarian honeysuckle fill the shrub layer. Garlic mustard is prevalent in the herbaceous layer. The stream corridor within this area has

changed considerably over the last century. The river was moved south from its original alignment in a flood diversion project in the 1940s, and approximately 1000 feet of streambank at the outside bend of the river is currently hard armored with riprap. The City of Hastings owns approximately 4 acres on the south side of the river, but this land is surrounded by private properties that prevent access. Four of these private properties line the paved trail that runs parallel to County Road 47, and their residential landscaping spills over beyond the private parcel boundaries including a dense stand of silver feather grass *(Miscanthus sinensis)* as shown in Photo 6.

Photo 6. Paved Corridor West of Highway Dept.

The trail follows a below-grade crossing under County Road 47. Reed canary grass is dominant along the riverbank, and dense cheatgrass *(Bromus tectorum)* was treated with herbicide before the time of the plant community assessment. Heavy silt on the trail indicates that flood flows reach the trail during times of high water.

<u>Vermillion River Linear Park:</u>

This 60-acre park is a long, linear property managed by the City of Hastings. In coordination with Friends of the Mississippi River (FMR), three phases of restoration have been undertaken on the property following priorities of a natural resources management plan developed by FMR ecologists in 2012. These priorities include restoration of the riverbanks, managing invasive species, and establishing native plant communities appropriate for the present-day hydrology of the site. Specific restoration has included conversion of most of the upland to dry or mesic native prairie, management of invasive species in the floodplain forest along the Vermillion, cedar revetment

Photo 7. Spillway at Vermillion River Linear Park

Photo 8. Dotted mint at Vermillion River Linear Park

stabilization of the streambanks, and native plant establishment in the spillway or bypass channel at the center of the park (Photo 7). Some invasive woody shrub management has also been completed on the periphery of the park.

Conversion to native plant communities is in process as of late 2022 and will continue for at least 5-10 years. Side oats grama, big bluestem, and gray-headed coneflower are plentiful in the upland prairie areas, which is typical of early establishment restored grasslands. Native wild lupine, dotted mint (Photo 8), and porcupine grass are also present which indicates some remnant seed bank. Native spring ephemerals are also present in the floodplain forest including Virginia bluebells and bloodroot. Vegetation community issues specific to this site include an established population of spotted knapweed on the western portion of the prairie which has been managed with mowing, spot herbicide application, and biocontrol (root-boring and flower-boring weevils); Siberian elm in the restored prairie which has been managed with mowing, and an afforested floodplain which may benefit from targeted canopy thinning.

<u>Vermillion Falls Park:</u>

Vermillion Falls Park is a 25-acre city park located along the south side of the Vermillion River east of Highway 61. The Vermillion Greenway Trail follows the river bluff through the park for about 0.5 miles between Hwy 61 and the Veterans Home property.

Friends of the Mississippi River completed a Natural Resource Management Plan for the park in 2019 and has been implementing habitat restoration activities at 20 acres of the park since then to restore oak forest, maple-basswood forest, and oak savanna.

Photo 9. Maple-basswood forest after invasive woody removal. Note the formation of unofficial trails.

Wooded areas cover about 16 acres of the park, including maple-basswood forest (Photo 9), mesic oak forest, dry oak forest, and very degraded oak woodland. Non-native grassland with scattered trees and shrubs occupies about four acres and about five acres is mowed turf with scattered trees, at the west

end of the park. The eastern oak forest and maple-basswood forest were ranked high biodiversity by the DNR (though invasive woody plants had degraded them by the time management began).

Photo 10. Degraded woodland after forestry mowing to restore native plant community.

Ecological restoration is well underway at the park, with invasive woody removal completed on the north and eastern wooded areas (Photo 10) and seeding with native species completed. The degraded woodlands in the central part of the site (Photo 11) will be managed for invasive woody plants in winter 2023 and the conversion of the non-native grasslands (Photo 12) to oak savanna will also begin in 2023.

The cliff walls along the Vermillion River and very steep portions of the dry gorge have not been managed and have an abundance of large buckthorn. These plants will continue to provide a seed source to the surrounding restored lands. The buckthorn also can cause significant erosion issues as ground layer vegetation is reduced from shading.

Another opportunity to improve the ecological conditions at the park would be to convert some of the mowed turf at the far west end of the park to native prairie plantings.

Photo 11. Very degraded woodland prior to restoration.

There are also significant concerns for the native plant diversity at the park due to unmanaged park visitor uses. The lower riverbank below the falls is one of the highest quality areas in the park, with unusual species including Canada yew, walking fern, and native spring wildflowers. There is currently an old trail to the river, about midway between the bridge and the falls, which has fallen into disrepair. These stairs could be improved for safer access. One of the beautiful things of this park, however, is the natural features and lack of built structures. Keeping this area as “wild” as possible with only modest stairs like the original, will retain its charm. Any additional stairs to the river should be

Photo 12. Non-native grassland before restoration to savanna.

avoided due to the significant impacts to the gorge walls and the plants located there. Increased access to the river will also likely result in loss of the native plants that make it special. The existing somewhat difficult access helps to keep the foot traffic in check so that the entire area does not get trampled.

The cliff walls along the river are being degraded by unauthorized trails. As people scramble up and down the steep slopes, they have become denuded of vegetation, causing erosion, and creating safety risks. Similarly, there are unauthorized trails crisscrossing the park in the bluff areas and the dry gorge that have erupted since invasive woody plants removal made the park more accessible. It is important to address these areas, but doing so will be costly and will require specialized crews that are trained to work on cliff sides.

The newly opened woods have also attracted mountain bikers. The trails are not designed or suited for bikes, which cause trail erosion and are destructive to the wildflowers such as Dutchmen's breeches, wild ginger, large-flowered bellwort, blue cohosh, which are still present with abundance in some areas, but others where they are struggling to hang on. Trails are also how invasive species are moved around, so the more trails there are, the more invasives are likely and the fewer native plants. The diverse native wildflowers are special to this park and should be protected. Official trails need to be established, signed, and maintained so it's clear where the designated trails are. Interpretive signs can help visitors understand the importance of staying on trails.

One rare (state-threatened) plant species, kittentails (*Besseya bullii*), is found at the park. Kittentails has been found north of the main trail, especially between the falls and the bridge. A survey is planned to map the plants before any future plans for the park are enacted.

Vegetation management and ecological restoration at the park is otherwise being conducted by Friends of the Mississippi, but plans should be in place to continue the maintenance after the initial restoration is complete in a few years.

Old Mill Park:

Old Mill Park is a 10-acre city park located along the north and west sides of the Vermillion River as it bends to the north. The Vermillion Greenway Trail does not intersect the park but is just across the river at Vermillion Falls Park.

Photo 13. Remnant oak savanna that has been managed and maintained for over 10 years.

Friends of the Mississippi River completed a Natural Resource Management Plan for the park in 2012 and has been implementing habitat restoration activities at the park since then to restore oak savanna and oak forest.

Present ecological conditions of the park are very good, with the oak savanna and oak woodland well-established and diverse native plant communities generally sustaining (Photo 13). The park needs regular monitoring to manage for invasive woody and weedy plants. Prescribed burns should be completed on over the entire park 3 to 6 years, with no more than half of the park burned in any given year.

One area that has not been addressed for invasive woody plants is the steep walls along the river. As with Vermillion Falls Park, it is important to address these areas, but doing so will be costly and will require specialized crews that are trained to work on cliff sides.

In addition to invasive species, other concerns are the prevalence of unauthorized trails that crop up and tend to multiply and deepen and widen. These trails in the prairie have become entrenched, then resulting in new trails being created. As the trails spread out, they threaten the native plants in the prairie, especially kittentails, the state endangered species which is directly adjacent to the trails. In addition to threatening the kittentail plants the entrenched trails become eroded.

Old Mill Park has a fairly abundant population of kittentails, most of which are located along the bluff between the bridge and the ruins. Any future trail or overlook development plans for the park should include a detailed survey for kittentails and should avoid the bluff areas. The trails at the park need to be repaired and need better signage to designate official trails and to close unofficial trails.

Veterans Home:

The Veterans Home (VH), about 88 acres, is divided by 18th St East, with a third of the property to the north and two thirds to the south. About 0.4 miles of the Vermillion Greenway Trail pass through the

property, paralleling the Vermillion River along the southwest side, then following along on the north side of the north housing units.

The VH includes about 28 acres of campus buildings and facilities, mostly on the south side of 18th St, along with about 12 more acres that include ballfield, turfgrass, cropland and other uses.

Photo 14. Invasive shrubs dominate most of the wooded areas.

About half of the property (44 acres) is forested, half of which is mixed deciduous/oak forest that is degraded by invasive woody plants, especially buckthorn (Photo 14) but also occasional black locust trees. Other forest acres include a couple acres each of maple-basswood forest, dry oak forest and mesic oak forest, 11 acres of floodplain forest, and five acres of hardwood swamp.

Overall, bur oak, red oak, sugar maple and basswood are the primary tree species, with large trees of over 22-inches diameter in the more intact wooded areas. Trees were generally younger/smaller diameter in the degraded woods. Other tree species noted were pin oak, cottonwood, quaking aspen, black cherry, and paper birch.

Invasive woody removal is the primary management needed in all the wooded acres, though it was most abundant in the degraded woods, with some large shrubs up to four-inches diameter. The floodplain forest had widely scattered but very large buckthorn, in the maple-basswood forest it was primarily along the trailside edge (Photo 15), and in the dry oak forest it dominated the ground layer up to two feet with a dense cover of small stems.

Along the river the buckthorn was very large, often obliterating the view of the river and the Old Mill Ruins on the other side (Photo 16). Much of the terrain there is quite steep and would require ropes and skilled experts to remove it.

Black locust was most commonly found along the river trail, especially at the 18th St underpass where there were several

Photo 15. Maple-basswood forest with few invasive species except along edges.

Photo 16. Buckthorn along the Vermillion River obscures views of the mill ruins.

large diameter trees. A few other notable trees along the trail were several large white pines, possible relicts from the past, and one catalpa.

Other opportunities for improved habitat would be in many of the mowed turf areas near the buildings, including along some stretches of the Greenway Trail, which could be converted to prairie or savanna plantings. Reducing the acres of mowing and converting to native plantings would reduce carbon emissions, increase water infiltration, reduce runoff, provide habitat for pollinators, birds, and other wildlife. Such plantings would also provide an aesthetic experience for residents and an opportunity for residents to engage with the restoration process and future nature observation.

C.P. Adams Park:

CP Adams Park is a 60-acre City of Hastings Park consisting of about 24 acres of mowed grassland with scattered trees, 22 acres wooded areas, and 14 acres wetland and open water. The Vermillion Greenway trail passes through or along the edges of the park for about 0.6 miles, more than any other single property. The trail follows the forest-grassland edge and roadsides on a generally north-south course through the park. The primary recreational attraction at the park is the disc golf course situated in the grassland and extending into the woods on all sides.

Photo 17. The disc golf course occupies much of the mowed turf areas of the park, with scattered individual and patches of trees.

The **mowed grassland** has about a 50% tree canopy overall. The majority of the unit has scattered large trees in the turf area (Photo 17), but there are also narrow wooded corridors that serve to divide the disc golf fairways. Scattered tree species include red oak, bur oak (24" diameter at breast height, or dsh), cottonwood (up to 34" dsh), green ash (24-30" dsh), red cedar, basswood (32" dsh) and catalpa. Additional species in the wooded corridors include black walnut, quaking aspen, white pine (up to 24" dsh), silver maple, and bitternut hickory.

The shrub layer in the grassland is primarily present only in the wooded fairway dividers and includes sapling canopy trees as well as a moderately low abundance of common buckthorn (1" or less dsh) and non-native honeysuckle. The ground layer in those areas is a somewhat weedy but mostly native composition of seedling trees, white snakeroot, Virginia creeper, zigzag goldenrod and moonseed with some burdock present as well.

The **wooded portions** occupy about a third of the park on the west, north and northeast sides of the park. Maple-basswood and altered deciduous forests are on the west; oak forest, floodplain forest, mixed hardwood swamps are in the far northwest; and floodplain forests and mesic oak forests are in the northeast.

The 2-acre maple-basswood forest is largely intact (Photo 18), but there is abundant buckthorn along the top edge in places. This unit transitions to a 2-acre altered deciduous forest and both units are on a steep west to northwest slope.

Photo 18. The interior maple-basswood forest was largely devoid of invasive species.

The altered woods harbors remnants of past uses, such as piles of rubble (fencing, concrete) and had some apparent soil disturbances. The canopy trees tended to be smaller diameter than other wooded areas, indicating these woods grew up more recently. Tree species include green ash, hackberry, cottonwood, basswood and occasional small Siberian elm. Invasive shrubs are fairly low abundance but common along the edge (Photo 19). The ground layer is fairly beat up, with large areas unvegetated, possibly due to foot traffic.

Creeping Charlie and burdock are abundant, but native species present included patches of wild ginger, zigzag goldenrod, clearweed, eastern woodland sedge, white snakeroot and Virginia creeper.

The mesic oak forest was about 7 acres. The patch on the east side has an intact canopy and low abundance of non-native shrubs. The ground layer has good native cover including Jack in the pulpit, zigzag goldenrod and false Solomon's seal. Buckthorn is larger and more abundant at

Photo 19. Buckthorn dominated the understory of altered woodlands.

the north oak forest, with 1 to 2-inch diameter at standard height (dsh). However, that unit is on a very steep south-facing slope that will make access difficult.

There are several floodplain forest units, totaling about 11 acres, which tend to have a dense tree canopy dominated by cottonwood (up to 3 feet or more dsh, including one enormous tree north of the bridge) (Photo 20) and silver maple (20-inch dsh) as well as basswood and green ash. The shrub layer is sparse but included patches of buckthorn, up to 3-inch dsh.

Photo 20. Several very large cottonwood trees were found in the floodplain forests. Invasive woody plants were most abundant along edges.

The wooded units generally have dense tree canopies, a diversity of tree sizes, and a fairly sparse shrub layer with moderate amounts of common buckthorn and lesser amounts of Tatarian honeysuckle. While buckthorn stems can be up to three inches diameter, most are less than one inch. Both species are most abundant along woodland edges. Large portions of interior woods do not have any buckthorn, but it is fairly abundant in the northern wooded units. Ground cover vegetation was fairly dense in general but was sparse on northly slopes and under dense canopies. The ground cover consisted mostly of native species, but diversity was fairly low.

Photo 21. The hardwood swamp was mostly native species.

Besides floodplain forest, the other wetland areas consist of open water ponds, mixed emergent marsh, and mixed hardwood swamp. The latter had a canopy of scattered silver maple, 4-10” dsh, no shrub layer, and a ground cover dominated by rice cut grass, and abundance of *Bidens* spp., jewelweed *(Impatiens capensis),* and clearweed *(Pilea pumila)* (Photo 21). The emergent marsh was dominated by hybrid cattail (*Typha* spp.) There was also a stormwater wetland in the southeast corner of the grassland by the parking lot, composed of a variety of native wetland plants. The wetland units did not need any management.

The management priority for the entire CP Adams Park is invasive woody removal in the wooded areas. Invasive weeds (primarily burdock) should also be managed in all the wooded areas, though abundance

is low. Some of the wooded corridors that separate the disc fairways could be enhanced with native shrubs that are beneficial for pollinators. The altered woodland unit needs to be treated for invasive weeds and overseeded to establish some ground cover. The trash and rubble could also be removed. Invasive woody plants in the oak forest units should be cut and stump-treated only, not foliar treated, to protect native ground cover species.

Hastings Scientific and Natural Area (SNA):

Hastings SNA is a 65-acre nature preserve located on the east and northeast sides of C.P. Adams Park. The Vermillion Greenway Trail does not transect the SNA but is across the road (Ravenna Trail) and parallels it for about 0.14 miles.

Friends of the Mississippi River completed an Adaptive Management Plan for the SNA in 2012 and has implemented habitat management activities at the site since then. The most recent management was invasive woody control in 2017.

The SNA consists of a northwest parcel (26 acres) and a southeast parcel (39 ac), joined at their corners. The Vermillion River bisects the northwest parcel while the southeast parcel is divided into three sections by two roads (Ravenna trail and 18th Ave E).

Photo 22. Invasive woody plants were most common in lowland forests and roadsides.

The parts of the SNA north of Ravenna trail are mostly emergent marsh, floodplain forest and open water. Silver maple dominates the floodplain forest, with green ash and small diameter American elm. These areas are largely devoid of invasive species except along the roadsides and edges (Photo 22), where buckthorn and honeysuckle have re-established, and some are quite large. There are a few interior areas, especially the eastern section, with patches of small buckthorn have regenerated.

Photo 23. The interior of the mesic oak forest was a largely intact native plant community.

The southwest and southeast sections of the SNA are mostly mesic oak-basswood forest, with maple-basswood forest on the north-facing slope and wet ash (seepage) swamp and ponds at the base of the terraces. Old growth red oak, sugar maple, and basswood are found on the steep north-facing bluffs and bluff tops (Photo 23). Most of the SNA is ranked moderate to high biodiversity significance by the DNR.

A wide array of plant species occurs on this site, including the rare snow trillium. Talus slopes and

steep escarpments of dolomitic limestone provide habitat for specialized plants, such as mosses, lichens, and liverworts and those areas are ranked high biodiversity significance. The terrain drops 170 feet from the high points on the south to the lowest areas at the north.

Most of the native plant communities are relatively intact, but non-native invasive woody species are again encroaching in the woodlands (Photo 24). Buckthorn is the primary concern, and non-native honeysuckle was also present, primarily along roadsides and other edges. In addition to the roadsides, small buckthorn was fairly abundant in the southeast section, occupying several acres east of the Veteran's Home property. The shrubs present are generally small - seedling to six feet tall - and up to one-inch diameter.

Photo 24. Buckthorn seedlings were regenerating in previous removal areas of the south woods.

Invasive woody control is the top priority management need at the SNA. To provide maximum protection to native plants, the method of buckthorn control should only be cut and stump-treated (with dauber applicators). Foliar application should not be done. Very small plants will not get treated, so a repeat cut-and-treat will be needed in five or six years to address plants that have matured to a larger size.

<u>Rivertown Dog Park:</u>

The Rivertown Dog Park is Hastings' most visited city park, and its 14 acres of park-like vegetation structure is suited to walking and exercising dogs.

Approximately two-thirds of the park at its center is mowed turf with scattered trees which allows dogs to run and play among several internal footpaths. The remaining third is a perimeter of woods with a paved path encircling the park. The canopy is predominantly green ash and black walnut with several green ash marked for emerald ash borer monitoring. Several red oak dot the perimeter of the park, and the understory in the perimeter contains small amounts of buckthorn.

Photo 25. Woodland at Rivertown Dog Park

The eastern end of the woodland has a higher density of buckthorn (Photo 25), and these plants are mature and senescing. The canopy trees in the eastern woodland include red and pin oak, black walnut, American basswood, and green ash. Some regeneration of these native species is present, but the understory is largely dominated by buckthorn.

Corridor between Rivertown Dog Park and Downtown Hastings:

Photo 26. Corridor between Rivertown Dog Park and Downtown Hastings

The greenway section between the Rivertown Dog Park and the parks along the Mississippi River is a narrow corridor of trail along Ravenna Trail which connects through the neighborhoods south of downtown. The trail edges are primarily mowed turf (Photo 26) and have been planted with swamp white oak in sections. The trail's crossing of the Smead property skirts the edge of a possible remnant prairie that has been degraded by invasive species such as spotted knapweed and Siberian elm. The trail's alignment through the neighborhoods west of Lake Isabelle follows the edge of the Canadian Pacific railyard, and the vegetation quality is very poor owing to the degree of disturbance. Yard waste dumping has introduced day lilies and snapdragons through this area of the corridor, and a large stormsewer outfall between 5th and 6th Streets on Bailly Street has created a deep gully between the railroad tracks and the trail.

Levee Park/Jaycee Park:

Photo 27. Levee Park prairie restoration project.

The downtown Hastings parks, Levee Park and Jaycee Park, at the northern extent of the greenway, are highly maintained public spaces which accommodate gatherings, events, and concerts. Large areas of mowed turf are present along the hillsides above the Mississippi River along with small ornamental plantings in planter boxes and beds. At Levee Park, a significant area of hard armoring is present along the riverbanks upstream and

downstream of the railroad bridge. A native prairie planting on the slope between the Rotary Club Pavilion and the parking lot east of Sibley Street was initiated but is weedy with common ragweed, alfalfa, and turf grasses (Photo 27). Little tree cover is present, and the hillside is in nearly full sun. At Jaycee Park, large areas of mowed turf are also present, but the trail corridor is somewhat screened from roadways by trees and shrubs.

Photo 28. Levee Park trail

Invasive Species

In considering the habitat quality and potential restoration of natural areas, a significant factor in level of difficulty, cost, likelihood of success, and persistence of habitat is the presence of invasive or introduced species, the spatial extent of the invasive species, and the length of time the site has been affected by invasive species. As such, invasive species management is often the initial consideration in planning and implementing habitat restoration.

Table 3 summarizes the presence or understood absence of common invasive species identified within each site. Other invasive species may be present at each site, and these specifics are noted in the Plant Community Assessments above. It should also be noted that new invasive species can quickly become established at a site and frequent inspection and monitoring is necessary to prevent establishment or reinvasion after initial management.

Table 3. Invasive Species Identified in the Corridor by FMR ecologists.

Scientific name	Common name	Seib	Jorg> East	Pleas >East	Hstg PW	VLP	VFP	OMP	VH	CPA	SNA	RDP	B/T - Dwntn	Levee/ Jaycee
Alliaria petiolata	garlic mustard			M	H	H						M		
Arctium minus	common burdock					L	L	L	L	L		L		
Berberis thunbergii	Japanese Barberry								L		L			
Bromus inermis	smooth brome	M	M				M	L	L	M		M		M
Centaurea stoebe	spotted knapweed	L			M	H	L							
Cirsium arvense	Canada thistle						L	L						L
Cirsium vulgare	bull thistle													

Euphorbia virgata	leafy spurge														
Frangula alnus	glossy buckthorn														
Hemerocallis fulva	daylily						L				L				
Linaria vulgaris	butter and eggs						L								
Lonicera tatarica	Invasive honeysuckle	M			M		L	L	M	M	L		M		
Lotus corniculatus	bird's foot trefoil					M						L		L	
Lythrum salicaria	purple loosestrife														
Morus alba	white mulberry										L	M			
Phalaris arundinacea	reed canary grass	L			H						L				
Rhamnus cathartica	common buckthorn	M	H	M		L	L	L	H	M	M	M	M		
Robinia pseudoacacia	black locust				H		L		L						
Saponaria officinalis	soapwort										L				
Securigera varia	crown vetch											L		M	
Typhus angustifolia	narrow-leaved cattail									L					
Ulmus pumila	Siberian elm	M		M	L	L		L		L		M	H		

Site name abbreviations: Sieb = W Of Gen Sieben Dr + Dakota Co Cons Area, Jorg>East=East of Jorgen Ave, Pleas>East Of Pleasant Drive, Hstg PW=Corridor Near Hastings Public Works, VLP=Vermillion Linear Park, VFP=Vermillion Falls Park, OMP=Old Mill Park, VH=Veterans Home, SNA=Hastings SNA, RDP=Rivertown Dog Park, B/T Dwntn= Between Rivertown Dog Park & Downtown, Levee /Jaycee=Levee Park and Jaycee Park

Abundance codes: H=High, M=Medium, L=Low

Wildlife

Dakota County encompasses a variety of ecological subsections as noted above, and 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.

Table 4 lists relatively common species that are known or likely to occur within the Greenway Corridor. Not all species would be expected at any given site. Presence/absence can depend on multiple factors, including size and shape of habitat and proximity to other habitat types, degree of isolation, and structural and species diversity.

Table 4. Wildlife Species Observed in Dakota County with Statuses. Source: MNDNR.

Common Name	*Scientific Name*	Endangered	Threatened	Special Concern	SGCN
Mammals					
American badger	*Taxidea taxus*				X
Prairie vole	*Microtus ochrogaster*			X	X
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

Common Name	*Scientific Name*	Endangered	Threatened	Special Concern	SGCN
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
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					
Bull snake	*Pituophis catenifer sayi*			X	X
Plains (western) hognose snake	*Heterodon nasicus*			X	X
Prairie skink	*Plestiodon septentrionalis*				
Smooth green snake	*Opheodrys vernalis*				X
Insects					
Monarch butterfly	*Danaus plexippus*				X
Rusty-patched bumble bee	*Bombus affinis*	FE			X

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

Ecological Recommendations

Priorities identified in this plan focus attention on the preservation, restoration, or enhancement of particular species, plant communities, water resources, or ecosystem processes. Restoration or conservation objectives are listed for each target plant community within each site below.

Oak Savanna

Sites: West of General Sieben Drive (upland), Dakota County Conservation Area (upland), Vermillion Falls Park, Old Mill Park

- **Eliminate cover of all invasive shrubs.** Invasive common buckthorn and honeysuckle species exhibit the greatest extent of shrub layer cover of many woodlands and oak savanna remnants within the Vermillion River Greenway corridor. Removing these species, performing follow-up

maintenance, and establishing a diverse, native shrub and herbaceous plant layer appropriate for the native plant community target is necessary to protect these remnants or to restore lost habitat. Ongoing maintenance of these restorations, including prescribed fire, is needed.

- **Remove secondary growth or ruderal trees and shrubs.** Native tree species such as box elder, Eastern cottonwood, green ash and black walnut have afforested oak savannas due to fire suppression. To re-establish savanna plant communities, these species, in addition to any non-native (Siberian elm, black locust) trees should be removed to reduce the tree density to between 10 and 20 percent canopy cover, with a preference towards retaining bur oaks.
- **Establish savanna grasses and forbs as the dominant ground cover.** Native grasses, and forbs to a somewhat lesser extent, comprise the dominant vegetative cover within intact oak savannas. In areas where extensive tree and shrub removal is necessary, there is little likelihood of native seedbank presence or viability. Following canopy thinning, site preparation including repeated mowing and selective herbicide application will limit woody regrowth and suppress the initial flush of weedy vegetation expressing itself from the seedbank. Urban and agricultural sites typified by the areas identified in the corridor have a long history of human-caused disturbance, such that weed pressure will be high and prioritizing initial weed control with prolonged site preparation will support better establishment and persistence of planted native species. With time, the herbaceous layer will be competitive against weedy species.
- **Utilize fire as a management tool to control woody encroachment.** Senesced native grasses accumulate biomass over time and provide fine fuels which will carry prescribed fire through restored oak savannas. The reintroduction of burning in these fire-dependent systems will diminish 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, will allow for some oak recruitment and ensure continued regeneration of oak savanna.
- **Manage areas adjacent to the oak savanna.** Savannas are vulnerable to invasive species reestablishment and the movement of shade-tolerant species from nearby woodlands. Care should be taken to limit the effects of properties surrounding remnant or restored habitat by ensuring management of adjacent parcels.

Oak Woodlands

Sites: Vermillion Falls Park, Old Mill Park

- **Eliminate cover of all invasive 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 diverse canopy composition.** Tree species indicative of secondary growth such as box elder, Eastern cottonwood, green ash and black walnut 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 vary 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.

- **Incorporation of climate resilient and adaptive tree species.** Minnesota's climate is changed and continues to change which has affected the suitability, regeneration, and long-term viability of some native trees. In managing the canopy for resiliency to climate change and higher diversity, the addition of climate-adapted and climate-resilient tree species should be considered, as well. Emerging data documenting the resiliency of native tree species, the potential viability of these same species grown in USDA zones to the south, and the suitability of species native to zones south of Minnesota are emerging and should be referenced in reforestation planning.
- **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

Sites: West of General Sieben Drive, East of Jorgen Avenue, East of Pleasant Drive, Corridor west of Dakota County Highway Department, Vermillion Falls Park, Old Mill Park, Veterans Home, C.P. Adams Park, Hastings SNA, Rivertown Dog Park

- **Eliminate cover of all invasive 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 extent to which invasive shrubs are problematic. If resources are limited, sites with minimal invasion (Vermillion Falls Park, Old Mill Park, CP Adams Park) should be prioritized for maintenance and removal of invasive shrubs with management of more degraded sites coming as resources are more available. Protection of remnant and more intact restored habitats is necessary to allow the plant communities to persist over time. Restoration of areas with invasive shrub pressure can be undertaken progressively.
- **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 invasive shrubs, and provides enhanced wildlife habitat value.

- **Diversify canopy species.** While some of the mesic hardwood forests within the corridor are the result of afforestation within the last 75 years, large scale removal of native trees in public parks is generally opposed by the community. For sites that would require significant canopy removal or a high degree of input to convert an existing altered woodland 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, green ash and black walnut can be transitioned to other forest types by selectively removing tree species. 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 should 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.
- **Incorporation of climate resilient and adaptive tree species.** As previously noted, Minnesota's changed climate requires an understanding of which Minnesota-native tree species are resilient to the effects of climate change, which are not, and which species common in ranges to the south may be suitable additions to mesic hardwood forests of the future.
- **Establish native ground cover.** Planting woodland sedges, grasses, and forbs (especially spring ephemerals) will create opportunities for reducing erosion, controlling invasive species with competition and the reintroduction of fire, and adding pollinator resources to these altered forests. Continued management to remove weedy biennials such as garlic mustard and lesser celandine will aid the reestablishment of herbaceous species composition on the forest floor.
- **Be responsive to the impacts of invasive earthworms.** The destructive effects of invasive earthworms in the woodlands of the upper Midwest can be seen within the Vermillion Greenway corridor. The lack of organic material on the forest floor, as well as middens left behind by earthworms, at Vermillion Falls Park and the woodlands surrounding Rivertown Dog Park indicate the need to reestablish herbaceous vegetation that is more resistant to earthworms such as Pennsylvania sedge, zig-zag goldenrod, wild columbine, and jack-in-the-pulpit.

Altered deciduous forest

Sites: West of General Sieben Drive, East of Jorgen Avenue, East of Pleasant Drive, Corridor west of Dakota County Highway Department, Vermillion Falls Park, Old Mill Park, Veterans Home, C.P. Adams Park, Hastings SNA, Rivertown Dog Park

- **Invasive shrub removal.** This is the single greatest threat and first step in the restoration process in altered deciduous forests. Some of the hardwood forests found in the Greenway Corridor differ in the extent to which invasive shrubs are problematic. As previously mentioned, if resources are limited, sites with minimal invasion (West of General Sieben Drive, Vermillion

Falls Park, Old Mill Park, CP Adams Park) should be prioritized for maintenance and removal of invasive shrubs with management of more degraded sites (East of Pleasant Drive, Corridor West of Dakota County Highway Department, and Rivertown Dog Park) undertaken as resources are more available. Restoration of areas with invasive shrub pressure can be undertaken progressively in this way.

-
- **Selective thinning of afforested areas.** In addition to woody encroachment by invasive species, some altered deciduous forests are also afforested whereby the lack of disturbance and other abiotic factors have allowed for the establishment of dense tree cover of especially shade-tolerant species. These woodlands lack species and structural diversity in the canopy, subcanopy, and shrub layer and can lack diversity in herbaceous cover. Selective thinning of species such as green ash, box elder, black walnut, and black cherry throughout a range of size classes will create canopy gaps and allow for planting of more diverse tree and shrub species which will improve habitat.
- **Native graminoid seeding to establish vegetative cover.** Following removal of invasive tree and shrub species, the establishment of vegetative cover is key to preventing reinvasion of those same invasive species and the germination of weed seeds held in the seed bank. Immediate seeding with a simple graminoid mix should be done in the growing season following initial removal. Any necessary follow-up broadleaf herbicide application to resprouted woody invasives will not damage the grasses germinating from seeding.
- **Native tree and shrub planting to diversify the canopy and shrub layer, where appropriate.** The addition of native trees and shrubs in areas where sufficient canopy gaps are created by invasive woody removal should be undertaken. Plantings should be prioritized in locations where trees and shrubs can be watered, protected from wildlife browse, and can be used to protect bare ground and steeper slopes from soil erosion. Species such as black chokeberry *(Aronia melanocarpa),* gray dogwood *(Cornus racemosa),* American hazelnut *(Corylus americana),* ninebark *(Physocarpus opulifolius),* chokecherry *(Prunus virginiana),* and nannyberry *(Viburnum lentago)* are suitable for the woodlands.
- **Native plug planting of shade-tolerant, earthworm-resistant graminoids and forbs.** Minnesota's hardwood forests developed in the absence of earthworms. Without worms, fallen leaves decompose slowly, creating a spongy layer of organic "duff." This duff layer is the natural growing environment for native woodland wildflowers. It also provides habitat for ground-dwelling animals and helps prevent soil erosion. A common condition in many of Minnesota's altered deciduous forests is invasion of earthworms and the detrimental effects. Earthworms eat the leaves that create the duff layer and are capable of consuming it completely. Canopy trees survive, but seedlings of these trees do not, and many woodland ferns and forbs are lost, as well. In areas of heavy earthworm infestation such as the forests East of Pleasant Drive, in the Corridor West of Dakota County Highway Department, in Vermillion Falls Park, and in Rivertown Dog Park, soil erosion and leaching of nutrients reduces the productivity of forests and ultimately degrade wildlife habitat. Few species are known to be more resistant to the effects of earthworms, but Pennsylvania sedge *(Carex pensylvanica),* ramps or wild leeks *(Allium*

tricoccum), Jack in the pulpit (*Arisaema triphyllum),* wild columbine *(Aquilegia canadensis),* and zigzag goldenrod *(Solidago flexicaulis)* have been shown to have some resistance, and the planting of these species could be prioritized.

Prairies

West of General Sieben Drive, East of Jorgen Avenue, Vermillion Linear Park, Veteran's Home, C.P. Adams Park, Corridor between Rivertown Dog Park and Downtown Hastings, Levee Park, Jaycee Park

- **Convert turf and altered grasslands to native prairies.** Underutilized park areas with maintained turf cover, trail corridors with extensive mowed grass, or former pastured lands dominated by non-native, cool season grasses can be converted to native shortgrass or tallgrass prairies, depending on soil type and hydrological conditions. Even moderately sized areas of mowed turf can be enhanced with prairie/pollinator plantings. The purpose and importance of these "pocket prairies" (primarily for community enjoyment and to create habitat corridors) must be clearly communicated to the public and to staff maintaining the parks so that errant mowing does not disturb establishing plants. One year of herbicide site preparation is recommended to exhaust the weed seed bank prior to seeding with native prairie vegetation, and a limited species palate compatible with park uses should be used.
- **Remove encroaching woody species.** Prairie/woodland margins succeed to wooded secondary forest, thus shading out prairie grasses and forbs. Reestablishing 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 should be explored.

Floodplain Forests

Sites: All sites adjacent to the Vermillion River, C.P. Adams Park, Hastings SNA

Management activities recommended for wet forests are similar to those of more mesic and dry woodlands including reducing invasive tree and shrub cover, diversifying the canopy, and reestablishing a diverse and resilient herbaceous layer. Canopy species composition differs, however, and tends to be dominated by tree species such as Eastern cottonwood and silver maple. Maintenance by fire is less effective due to minimal fine fuels or continuous fuels such that these forests will continuously need to be managed to avoid encroachment of invasive shrubs. Additionally, these forests are not fire adapted and disturbance regimes are tied to periodic flooding and canopy gaps with the loss of short-lived

floodplain tree species. Regeneration of Eastern cottonwood in floodplain forests of the Upper Midwest has been steadily decreasing and is being tied to the climate change effects of prolonged spring flooding followed by prolonged summer drought. As the floodplain forests of the Vermillion River are restored, consideration should be given to establishing a more diverse and climate-resilient tree canopy by planting species such as hackberry, American sycamore, red oak, white oak, and black walnut.

Wetlands and Shorelines

Sites: All sites within the floodplain of the Vermillion River, C.P. Adams Park, Hastings SNA

Manage invasive species. The wetlands within the corridor primarily fall into two types: the seasonally flooded basins that make up the floodplain of the Vermillion River and the more diverse wetland mosaic within Hastings SNA that includes shallow open water, shallow and deep marsh, and shrub swamp.

Within the Vermillion floodplain, the degree to which water level fluctuates with precipitation events is dependent upon upstream watershed connectivity (lower fluctuation) and degree of impervious surfaces (higher fluctuation). Increases in impervious surfaces within the watershed have given rise to higher levels of disturbance in the floodplain wetlands which has allowed a shrub layer of invasive shrubs to dominate. A significant effort would be necessary to convert these wetlands to native plant communities after a long period being dominated by invasive shrubs. Once initial removal is undertaken, it is likely that some remnant wetland seedbank has persisted, and the potential to establish a native herbaceous layer is high. Where a native seedbank is not present, reestablishment of a floodplain plant community is better served by targeted plug planting as seed is often swept away during flood events. Adjacent upland areas currently dominated by reed canary grass can be restored to native cover by way of repeated mowing in mid-spring and fall followed by judicious herbicide application that avoids off-target damage to cool season sedges and rushes. Follow-up maintenance is necessary to treat resprouts and eventually exhaust the substantial seedbank.

The relatively high-quality wetland mosaic within Hastings SNA should be protected by targeted management of buckthorn that was noted in a few interior areas, especially the eastern section and roadsides.

Target Plant Communities

Existing land cover and use, current and anticipated ecological conditions, geology, soils, topography, and hydrology are all considered when identifying target plant communities for existing land cover types and recommending restoration activities to reach those targets (Table 5). The likelihood of achieving target plant communities and the relative effort versus anticipated benefit is also weighed when setting restoration goals. These considerations govern the optimal and most suitable goals for restoration.

Target plant communities listed here are consistent with the *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province* (MNDNR 2005), and detailed

descriptions of these communities can be found in the referenced guide. Figures 30-32 indicate the target plant communities within each site.

Table 5. Recommended Target Plant Community by Site and Restoration Steps

Existing Plant Community: Sites	**Target Plant Community**	**Restoration Steps**
Oak Savanna: West of General Sieben Drive (upland), Dakota County Conservation Area (upland), Vermillion Falls Park, Old Mill Park	Southern Dry and Mesic Savanna (UPs14 and UPs24)	- Invasive shrub removal - Ash, boxelder, cottonwood, hackberry, walnut thinning - Protection of rare/sensitive species - Native seeding/plug planting of savanna graminoids and forbs - Prescribed fire
Oak Woodland: Vermillion Falls Park, Old Mill Park	Southern Dry-Mesic Oak Woodland (FDs37)	- Invasive shrub removal - Ash, boxelder, cottonwood, hackberry, walnut thinning - Oak sapling planting where necessary - Native shrub planting - Native seeding/plug planting of shade-tolerant, earthworm-resistant graminoids and forbs
Altered Deciduous Forest: West of General Sieben Drive, East of Jorgen Avenue, East of Pleasant Drive, Corridor west of Dakota County Highway Department, Vermillion Falls Park, Old Mill Park, Veterans Home, C.P. Adams Park, Hastings SNA, Rivertown Dog Park	Southern Dry-Mesic Oak Forest (MHs37), Southern Mesic Maple-Basswood Forest (MHs39), or Southern Wet-Mesic Hardwood Forest (MHs49)	- Invasive shrub removal - Native tree and shrub planting to diversify canopy/shrub layer, where appropriate - Native seeding/plug planting of shade-tolerant, earthworm-resistant graminoids and forbs
Altered Floodplain Forest: All sites adjacent to the Vermillion River, C.P. Adams Park, Hastings SNA	Southern Terrace Forest (FFs59) or Southern Floodplain Forest (FFs68)	- Invasive shrub removal - Native tree and shrub planting to diversify canopy/shrub layer where appropriate - Native seeding/plug planting of shade-tolerant, earthworm-resistant graminoids and forbs
Freshwater Emergent Wetland: C.P. Adams Park, Hastings SNA	Northern Spikerush-Bur Reed Marsh Northern (MRn93b), Southern Seepage Meadow Carr (WMs83) and Southern Wet Prairie (WPs54)	- Invasive shrub removal - Herbicide application in combination with mechanical removal (mowing, scraping, hydrological manipulations) - Native tree and shrub planting to diversify shrub layer where appropriate - Native plug planting of floodplain graminoids and forbs

Existing Plant Community: Sites	**Target Plant Community**	**Restoration Steps**
Altered Grasslands/Prairie: West of General Sieben Drive, East of Jorgen Avenue, Vermillion Linear Park, Veteran's Home, C.P. Adams Park, Corridor between Rivertown Dog Park and Downtown Hastings, Levee Park, Jaycee Park	Southern Dry Prairie (UPs13) or Southern Mesic Prairie (UPs23)	- Eliminate woody encroachment/invasive shrubs - Control invasives in the herbaceous layer - Native seeding - Prescribe burning/mowing/haying

Figure 30: Target plant communities of the west Vermillion River Greenway

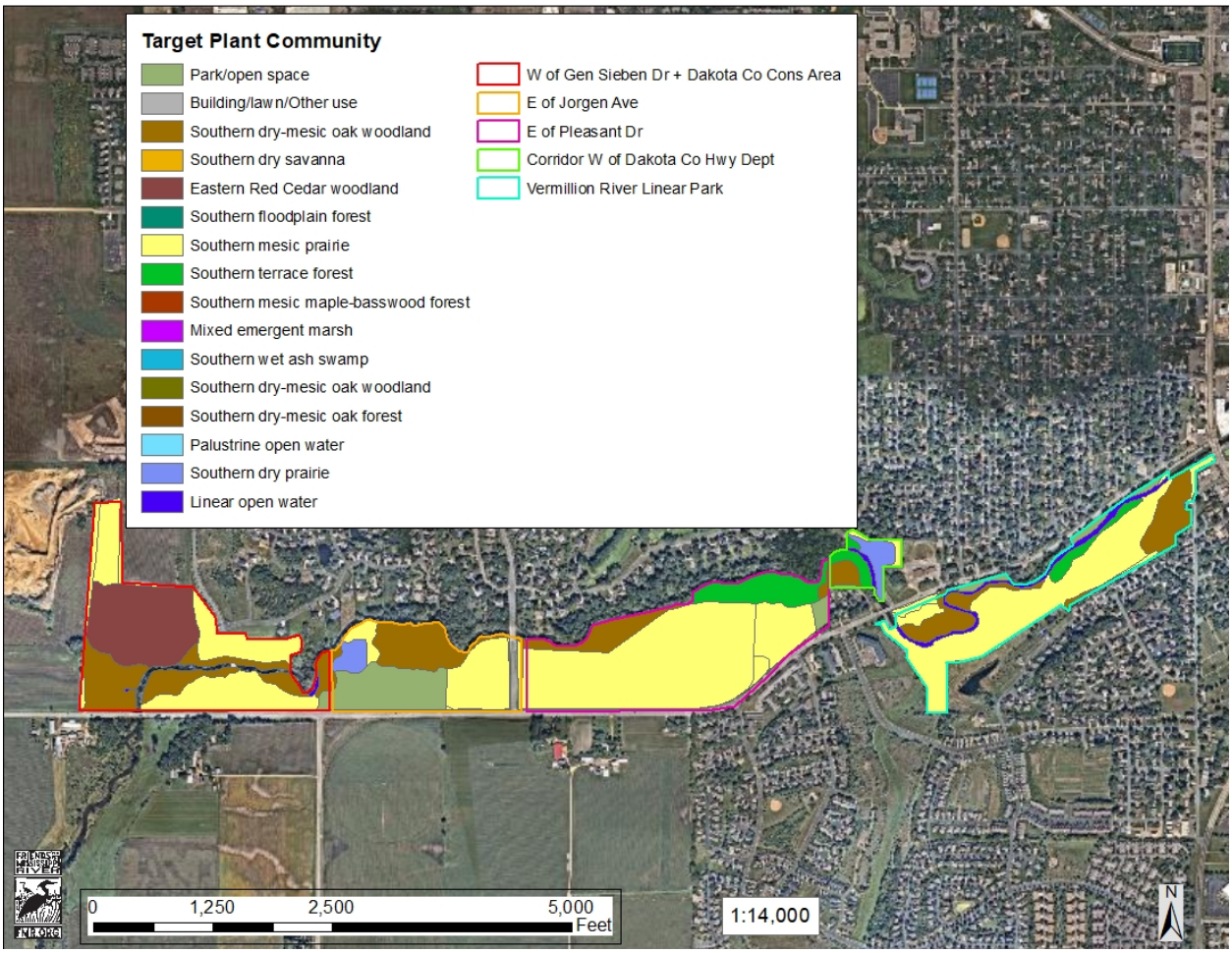


Figure 31: Target plant communities of the central Vermillion River Greenway

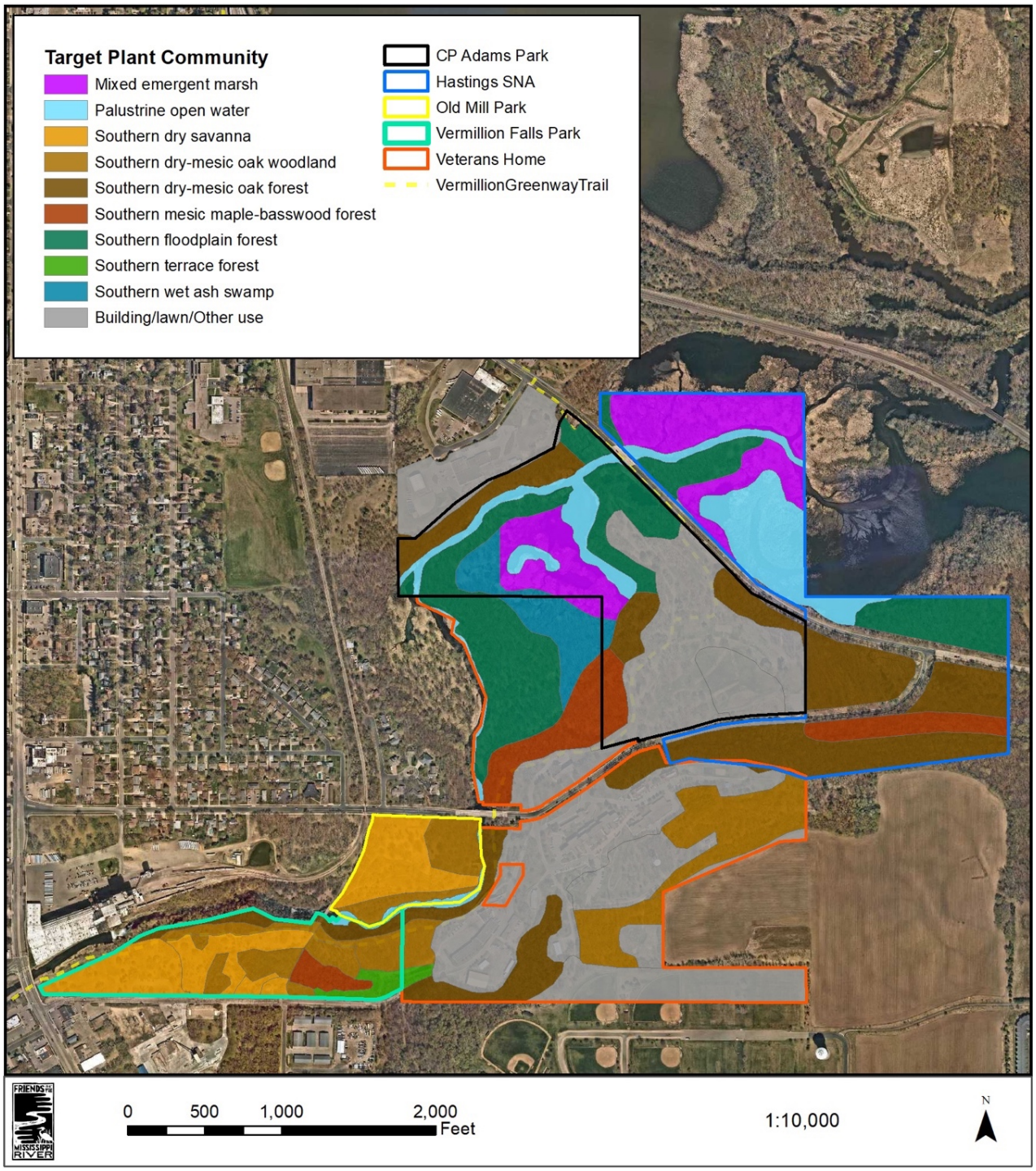
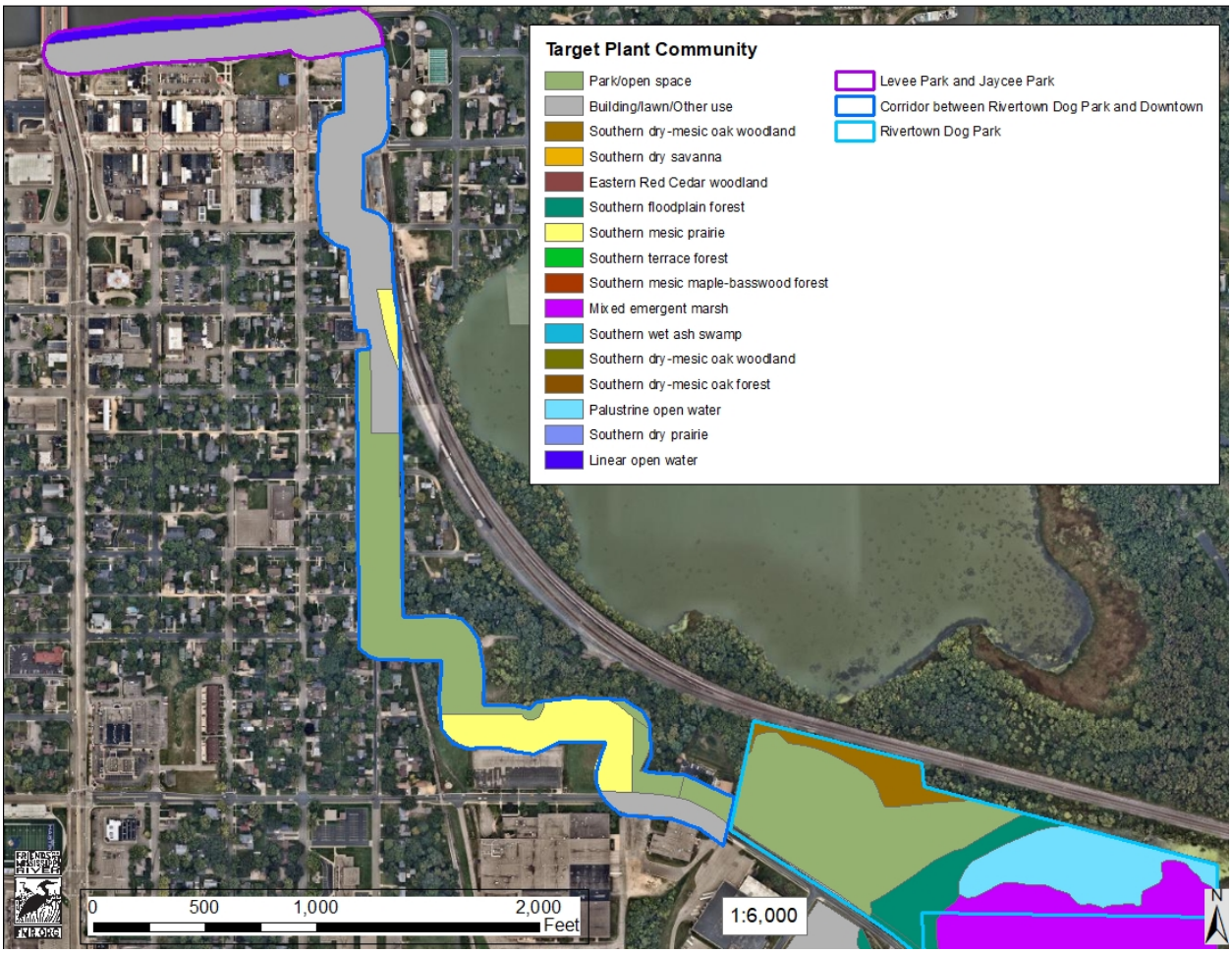


Figure 32: Target plant communities of the north Vermillion River Greenway



Implementation

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

Previous and Ongoing Restoration Efforts

In 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. Vegetation restoration efforts are listed in Table 6.

Table 6. Past and Current Vegetation Restoration

Greenway Segment	Plant Community	Activity	Year Initiated
Vermillion Linear Park	Mesic Prairie	Restoration: Invasive plant control, seeding, prescribed burning	2016
	Floodplain Forest	Restoration: Invasive plant control, streambank revetment, seeding	2018
Vermillion Falls Park	Oak Savanna	Restoration: Invasive plant control, seeding	2022
	Woodland	Restoration & enhancement: Invasive woody control, prescribed burning, seeding	2019
Old Mill Park	Oak Savanna	Restoration & enhancement: invasive plant control, seeding, Rx burn	2013
	Oak Woodland	Enhancement: invasive woody control	2013
Hastings SNA	Forest (all)	Enhancement: invasive woody control	2012

Work Plans

Restoration Sequence Work Plan

Table 7 details Restoration Sequence work plans for vegetation management at each management unit included in this NRMP. These work plans were developed to provide guidelines toward achieving the target communities shown in Table 5. 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. 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 as a shared understanding by County or City staff and FMR ecologists, on a scale of 1 to 3, with 1 being the highest.

Table 7. Restoration Sequence Work Plan for Natural Resource Projects

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Site: West of General Sieben Drive Owner: City of Hastings and private ownership									
Wooded areas near river and in adjacent uplands	1	1	F, W	Initial cut/treat invasive shrubs	1		$6,000		$6,000
Subtotal									$6,000
Wooded areas maintenance	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	1		$900		$900
Wooded areas maintenance	1	2	Sp, Su, F	Follow up treatment of invasive forbs	1		$350		$350
Wooded areas maintenance	1	3	F	Supplemental seeding if needed	1		$300		$300
Subtotal									$1,550
Upland old field	2	1	Sp, Su, F	Site preparation herbicide spray out (3x)	3		$800		$2,400
Upland old field	2	2	F	Seed and seeding	3		$1,500		$4,500
Upland old field	2	3-5	Sp, Su, F	Establishment mowing 2 years, Rx burn	3		$1,100		$3,300
Subtotal									$10,200
SITE TOTAL									***$17,750***
Site: Dakota County Conservation Property and private ownership Owner: Dakota County and private ownership									
Wooded areas near river and in adjacent uplands	1	1	F, W	Initial cut/treat invasive shrubs	4		$6,000		$24,000
Subtotal									**$24,000**
Wooded areas maintenance	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	4		$900		$3,600
Wooded areas maintenance	1	2	Sp, Su, F	Follow up treatment of invasive forbs	4		$350		$1,400

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Wooded areas maintenance	1	3	F	Supplemental seeding if needed	4		$300		$1,200
Subtotal									**$6,200**
Oak savanna	1	1	F, W	Initial cut/treat invasive shrubs	2		$6,000		$12,000
Oak savanna	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	2		$900		$1,800
Oak savanna	1	3	F	Rx burn	2		$800		$1,600
Subtotal									**$15,400**
SITE TOTAL									***$45,600***
Site: East of Jorgen Avenue Owner: Private ownership									
Wooded areas near river and in adjacent uplands	1	1	Sp, Su, F	Initial cut/treat invasive shrubs	11		$6,000		$66,000
Wooded areas maintenance	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	11		$900		$9,900
Wooded areas maintenance	1	2	Sp, Sum, F	Follow up treatment of invasive forbs	11		$350		$3,850
Wooded areas maintenance	1	3	F	Supplemental seeding, if needed	11		$300		$3,300
Subtotal									**$17,050**
Upland old field	2	1	Sp, Su, F	Site preparation herbicide spray out (3x)	3		$800		$2,400
Upland old field	2	2	F	Seed and seeding	3		$1,500		$4,500
Upland old field	2	3-5	Sp, Su, F	Establishment mowing 2 years, Rx burn	3		$1,100		$3,300
Subtotal									**$17,050**
SITE TOTAL									***$93,250***
Site: East of Pleasant Avenue Owner: Private ownership									

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Wooded areas near river and in adjacent uplands	1	1	Sp, Su, F	Initial cut/treat invasive shrubs	12		$6,000		$72,000
Subtotal									**$72,000**
Wooded areas maintenance	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	12		$900		$10,800
Wooded areas maintenance	1	2	Sp, Sum, F	Follow up treatment of invasive forbs	12		$350		$4,200
Wooded areas maintenance	1	3	F	Supplemental seeding, if needed	12		$300		$3,600
Subtotal									**$18,600**
SITE TOTAL									***$90,600***
Site: Corridor west of Dakota Co Hwy Dept Owner: Dakota County and private ownership									
Wooded areas near river	1	1	S, F	Establish dedicated trail rests and signage to reduce vegetation trampling and erosion.	3		$500		$1,500
Subtotal									**$1,500**
Wooded areas	1	1	Sp, Su, F	Initial cut/treat invasive shrubs	12		$500		$6,000
Subtotal									**$6,000**
Wooded areas maintenance	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	12		$900		$10,800
Wooded areas maintenance	1	2	Sp, Su, F	Follow up treatment of invasive forbs	12		$350		$4,200
Wooded areas maintenance	1	3	F	Supplemental seeding if needed	12		$300		$3,600
Subtotal									**$18,600**
SITE TOTAL									***$26,100***
Site: Vermillion River Linear Park Owner: City of Hastings									

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Floodplain forest	1	1	S, F	Selective thinning of canopy trees	7		$1,000		$7,000
Subtotal									**$7,000**
Wooded areas maintenance	1	1,2	Sp, Su, F	Follow up treatment of invasive forbs	7		$350		$2,450
Wooded areas maintenance	1	1, 2	Su, F	Follow up foliar herbicide on invasive shrub resprouts	7		$900		$3,600
Subtotal									**$6,000**
Upland mesic prairie	1	1	F, W	Cut/treat invasive shrubs	26		$450		$11,700
Upland mesic prairie	1	1,2	Su, F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	26		$300		$7,800
Upland mesic prairie	2	2	F	Prescribed burn across 1/3 of site	9		$800		$7,200
Upland mesic prairie	2	2	F	Seed and seeding following burn	9		$1,500		$13,500
Upland mesic prairie	2	3	Sp, Su, F	Spot mowing or spot spraying	26		$1,100		$28,600
Subtotal									**$49,300**
SITE TOTAL									***$80,350***
Site: Vermillion Falls Park Owner: City of Hastings									
Wooded areas	1	1	Sp, Su, F	Establish dedicated trails to reduce vegetation trampling and erosion.	10		$500		$5,000
Subtotal									**$5,000**
All forest and savanna units (not steep slopes)-maintenance	1	5	Sp, Su, F	Follow up treatment of invasive forbs	12		$350		$4,200

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
All forest and savanna units (not steep slopes)-maintenance	1	5	Su, F	Follow up foliar herbicide on invasive shrub resprouts	12		$900		$10,800
All forest and savanna units (not steep slopes)-maintenance	1	5	F	Supplemental seeding, if needed	12		$300		$3,600
Subtotal									**$18,600**
Mesic oak forest, maple-basswood forest- Cliff wall and very steep slopes	2	1	F, W	Initial cut/treat invasive shrubs		5.5		$6,000	$33,000
Mesic oak forest, maple-basswood forest- Cliff wall and very steep slopes	2	1,2	Su, F	Follow up foliar herbicide on invasive shrub resprouts (2 years)		5.5		$6,000	$33,000
Subtotal									**$66,000**
Turf grass	3	2	Sp, Su, F	Site preparation herbicide spray out (3x)	6		$800		$4,800
Turf grass	3	2	F	Seed and seeding	6		$1,500		$9,000
Turf grass	3	3-5	Sp, Su, F	Establishment mowing every 2 years, Rx burn	6		$1,100		$6,600
Subtotal									**$20,400**
SITE TOTAL									***$110,000***

Site: Old Mill Park **Owner: City of Hastings**									
All units except steep slopes: Oak Savanna, Prairie, Oak Woodland	1	1	Sp, Su, F	Establish dedicated trails and signage to reduce vegetation trampling and erosion.	3	$500			$1,500
All units except steep slopes: Oak Savanna, Prairie, Oak Woodland	1	1,3	F	Prescribe burn or mow 1/2 each year. Include woods.	8	$500			$4,000

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
All units except steep slopes: Oak Savanna, Prairie, Oak Woodland	1	1,2	Sp, Su, F	Spot spray/mow herbaceous invasives and woody plants	8	$800			$6,400
All units except steep slopes: Oak Savanna, Prairie, Oak Woodland	1	2	F	Hand seed native savanna and woodland species as needed	8	$300			$2,400
Subtotal									**$14,300**
Oak woodland - *Cliff wall and very steep slopes*	2	1	F, W	Initial cut/treat invasive shrubs		2.5		$6,000	$15,000
Oak woodland - *Cliff wall and very steep slopes*	2	1,2	Su, F	Follow up foliar herbicide on invasive shrub resprouts (2 years)		2.5		$6,000	$15,000
Subtotal									**$30,000**
SITE TOTAL									***$44,300***
Site: C.P Adams Park Owner: City of Hastings									
Oak forest, Maple-Basswood, Floodplain Forest	1	1	F, W	Cut/treat invasive shrubs	20	7	$2,000	$3,000	$61,000
Oak forest, Maple-Basswood, Floodplain Forest	1	1,2	F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	20	7	$800	$1,000	$23,000
Oak forest, Maple-Basswood, Floodplain Forest	1	1,2	Sp, Su, F	Spot spray/mow herbaceous invasives	20		$200		$4,000
Subtotal									**$88,000**
Altered/non-native deciduous forest	1	1	F	Remove trash	5		$800		$4,000

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Altered/non-native deciduous forest	1	1	F, W	Cut/treat invasive shrubs	2	5	$2,500	$3,500	$22,500
Altered/non-native deciduous forest	1	2,3	Sp, Su, F	Spot spray/mow herbaceous invasives	2	5	$600	$800	$5,200
Altered/non-native deciduous forest	1	2,3	F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	2	5	$800	$1,000	$6,600
Altered/non-native deciduous forest	1	2	Sp, F	Heavily seed with native woodland species, especially graminoids, in first growing season after removal.	2	5	$800	$800	$5,600
Subtotal									**$43,900**
Fairway: Short grasses and mixed trees with 4-10% impervious cover	1	1	F, W	Cut/treat invasive shrubs	20		$250		$5,000
Fairway: Short grasses and mixed trees with 4-10% impervious cover	1	1,2	F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	20		$100		$2,000
Fairway: Short grasses and mixed trees with 4-10% impervious cover	3	1,2	Sp, Su, F	Spot spray/mow herbaceous invasives	20		$150		$3,000
Fairway: Short grasses and mixed trees with 4-10% impervious cover	3	2	Sp	Install native pollinator shrubs	1		$2,000		$2,000
Subtotal									**$12,000**
SITE TOTAL									***$143,900***
Site: Veteran's Home **Owner: State of Minnesota**									

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1	F, W	Cut/treat invasive shrubs	29	11	$2,000	$4,000	$102,000
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1,2	F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	29	11	$800	$1,000	$34,200
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1,2	Sp, Su, F	Spot spray/mow herbaceous invasives	29		$600		$17,400
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	2	Sp	Enrichment seeding where needed	15		$650		$9,750
Subtotal									**$163,350**
Turf grass	3	1	Sp, Su, F	Site preparation for pollinator planting-spray, removed dead vegetation	1		$1,200		$1,200
Turf grass	3	2	F	Seed and seeding or plug planting	1		$2,500		$2,500
Turf grass	3	3-5	Sp, Su, F	Establishment mowing every 2 years, Rx burn, spot treat weeds	1		$1,800		$1,800
Subtotal									**$5,500**
SITE TOTAL									***$168,850***
Site: Rivertown Dog Park **Owner: City of Hastings**									

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1	F, W	Cut/treat invasive shrubs	6.5		$2,000		$13,000
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1,2	F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	6.5		$800		$5,200
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1,2	Sp, Su, F	Spot spray/mow herbaceous invasives	6.5		$600		$3,900
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	2	Sp	Enrichment native seeding where needed	6.5		$650		$4,225
Subtotal									**$26,325**
Turf grass	3	1	Sp, Su, F	Site preparation for pollinator planting-spray, removed dead vegetation	7.4		$1,200		$8,880
Turf grass	3	2	F	Seed and seeding or plug planting	7.4		$2,500		$18,500
Turf grass	3	3-5	Sp, Su, F	Establishment mowing every 2 years, spot treat weeds	7.4		$1,800		$13,320
Subtotal									**$40,700**
SITE TOTAL									***$67,025***
Site: Levee Park & Corridor between Rivertown Dog Park and Downtown Hastings **Owner: City of Hastings and private ownership**									

PLANT COMMUNITY	PRIORITY	YEAR	SEASON	ACTIVITY	SLOPE <30% ACRES	SLOPE >30% ACRES	COST/AC SLOPE <30%	COST/AC SLOPE >30%	COST PER TASK
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1	F, W	Cut/treat invasive shrubs	4		$2,000		$8,000
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1,2	F	Follow up foliar herbicide on invasive shrub resprouts (2 years)	4		$800		$3,200
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	1,2	Sp, Su, F	Spot spray/mow herbaceous invasives	4		$600		$2,400
Oak forest, Maple-Basswood, Altered deciduous forest, Floodplain Forest, Lowland hardwood forest	1	2	Sp	Enrichment native seeding where needed	4		$650		$2,600
Subtotal									**$16,200**
Turf grass	3	1	Sp, Su, F	Site preparation for pollinator planting-spray, removed dead vegetation	2		$1,200		$2,400
Turf grass	3	2	F	Seed and seeding or plug planting	2		$2,500		$5,000
Turf grass	3	3-5	Sp, Su, F	Establishment mow for 2 years, spot treat weeds	2		$1,800		$3,600
Subtotal									**$11,000**
SITE TOTAL									***$27,200***
CORRIDOR TOTAL									**$914,925**

References

Balaban, N.H. and H.C. Hobbs, eds. 1990. Geologic Atlas Dakota County, Minnesota. Minnesota Geologic Survey. University of Minnesota, St. Paul.

Hobbs, H.C., S. Aronow, and C.J. Patterson. 1990. Surficial Geology *in:* Geologic Atlas Dakota County, Minnesota. University of Minnesota, St. Paul.

David L. Dornbos Jr. and Randall Pruim. 2012. Moist Soils Reduce the Effectiveness of Glyphosate on Cut Stumps of Buckthorn. Natural Areas Journal Jul 2012: Vol. 32, Issue 3, pg(s) 240-246.

Foth, H.D., 1990. Fundamentals of soil science. New York: Wiley

Gardner, Ron. Cornell University Cooperative Extension. https://pesticidestewardship.org/water/leaching/

Hartzler, Bob. Extension weed management specialist, Iowa State University. https://crops.extension.iastate.edu/absorption-soil-applied-herbicides

Marschner, F.J., 1974. The Original Vegetation of Minnesota. Map compiled from U.S. General Land Office survey notes. U.S. Forest Service, North Central Forest Experiment Station, St. Paul.

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

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

_____. 2006. *Tomorrow's habitat for the wild and rare: an action plan for Minnesota Wildlife.* Comprehensive Wildlife Conservation Strategy. Division of Ecological Services, Minnesota Department of Natural Resources, St Paul, MN.

_____. 2016. Minnesota's Wildlife Action Plan 2015-2025. Division of Ecological and Water Services, Minnesota Department of Natural Resources.

Mossler, J.H. 1990. Bedrock Geology *in:* Geologic Atlas Dakota County, Minnesota. University of Minnesota, St. Paul.

Setterholm, D. 2014. Geologic Atlas User's Guide: Using Geologic Maps and Databases for Resource Management and Planning. Minnesota Geological Survey Open-File Report OFR-12-1, St Paul, MN.

Soil Conservation Service. 1983. Soil Survey of Dakota County Minnesota. United States Department of Agriculture.

Websites:

- Invasive species control methods:
  - Wisconsin DNR https://dnr.wi.gov/topic/invasives/
  - MN Natural Resources (DNR): http://www.dnr.state.mn.us/nr/index.html
  - Missouri Dept of Conservation: https://nature.mdc.mo.gov/status/invasive

Hastings Geology Historical Marker Project, 1998. https://historicalmarkerproject.com/markers/HMSAW_geology-of-the-dakota-county-region_Hastings-MN.html

Pesticide Environmental Stewardship https://pesticidestewardship.org/

Dakota County GIS: http://gis.co.dakota.mn.us/DCGIS/

Appendix A. Soils in the Vermillion River Greenway Corridor

Soil Type	Drainage Class	Acres of Type within Greenway	Map Unit Symbol
Algansee sandy loam, occasionally flooded	Somewhat poorly drained	47.78	1821
Brodale-Rock outcrop complex, 18 to 45 percent slopes	Excessively well drained	40.84	880F
Zumbro fine sandy loam	Well drained to moderately well drained	38.13	495
Hubbard loamy sand, 1 to 6 percent slopes	Excessively well drained	33.01	7B
Dickinson sandy loam, 0 to 2 percent slopes	Somewhat excessively drained	30.53	27A
Hawick loamy sand, 25 to 50 percent slopes	Excessively well drained	26.80	611F
Hubbard loamy sand, 0 to 1 percent slopes	Excessively well drained	26.23	7A
Port Byron silt loam, 2 to 6 percent slopes	Well drained	22.09	285B
Copaston loam, 2 to 6 percent slopes	Well drained	21.28	100B
Wadena loam, 0 to 2 percent slopes	Well drained	21.20	39A
Rockton loam, 6 to 12 percent slopes	Well drained	18.48	299C
Dickinson sandy loam, 2 to 6 percent slopes	Well drained to excessively drained	18.23	27B
Marlean loam, 18 to 25 percent slopes	Well drained	16.49	251E
Minneiska loam, occasionally flooded	Moderately well drained	14.73	463
Wadena loam, 2 to 6 percent slopes	Well drained	13.99	39B
Urban land-Chetek complex, 1 to 15 percent slopes	Excessively well drained	12.46	858C
Urban land		12.39	1039
Sparta loamy sand, bedrock substratum, 2 to 8 percent slopes	Excessively well drained	11.56	1848B
Aquolls and Histosols, ponded	Very poorly drained	8.63	1055
Waukegan silt loam, bedrock substratum, 2 to 6 percent slopes	Well drained	8.12	1827B
Burkhardt sandy loam, 12 to 18 percent slopes	Somewhat excessively drained	7.85	151D
Marlean loam, 12 to 18 percent slopes	Well drained	5.77	251D
Spillville loam, occasionally flooded	Moderately well drained to somewhat poorly drained	5.58	313
Rockton loam, 2 to 6 percent slopes	Well drained	4.96	299B
Frontenac silt loam, 25 to 40 percent slopes	Well drained	4.51	173F
Hawick loamy sand, 18 to 25 percent slopes	Excessively well drained	4.47	611E
Tallula silt loam, 2 to 6 percent slopes	Well drained	4.35	320B
Zumbro loamy fine sand	Well drained to moderately well drained	4.18	1815
Cylinder loam	Somewhat poorly drained	4.03	129
Kalmarville sandy loam, frequently flooded	Poorly drained to very poorly drained	4.03	465
Hawick sandy loam, 12 to 25 percent slopes	Excessively well drained	3.42	611D
Estherville sandy loam, 2 to 6 percent slopes	Somewhat excessively drained	3.05	41B

Soil Type	Drainage Class	Acres of Type within Greenway	Map Unit Symbol
Waukegan silt loam, 2 to 6 percent slopes	Well drained	2.94	411B
Terril loam, 4 to 12 percent slopes	Moderately well drained	2.91	94C
Tallula silt loam, 6 to 12 percent slopes, eroded	Well drained	2.18	320C2
Urban land-Waukegan complex, 0 to 1 percent slopes	Well drained	1.66	857A
Hawick coarse sandy loam, 6 to 12 percent slopes	Excessively well drained	0.94	611C
Lindstrom silt loam, 2 to 6 percent slopes	Well drained	0.84	301B
Carmi loam, 2 to 8 percent slopes	Well drained	0.72	1895B
Hubbard loamy sand, 6 to 12 percent slopes	Excessively well drained	0.02	7C
Kennebec silt loam	Moderately well drained	0.02	250

Appendix B. Recommended plants species for restoration

CULTURALLY IMPORTANT SPECIES

Listed below are some of the species culturally significant to the Dakota people, who stewarded this region prior to colonization. These should be incorporated into planting plans wherever possible.

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

Appendix C. Methods for Controlling Non-native Invasive Plant Species

Crown vetch *(Securigera varia)*

Mechanical control can be done by pulling the plant by hand or with equipment such as a shovel. Plants can resprout from root fragments, so try to remove as much of the plant as possible. Additional control methods may be necessary. Follow Minnesota Department of Agriculture noxious weed disposal (link is external) guidance. Mowing several times a year can reduce the population but will likely not eliminate it. Mow repeatedly from May to October to prevent flowering. Do not mow if the plants have produced seeds as mowing will spread the seeds. In areas with native grasses, prescribed burning in late spring for several successive years can encourage the native grasses and increase their ability to compete with crown vetch. Crown vetch can resprout after burns so continue to monitor the population.

Herbicide control can be done using systemic herbicides which are taken up by plants and move within the plant, which can kill leaves, stems, and roots. Spot spray with aminopyralid before the plant begins to flower. Spot spray with clopyralid from May to October while the plant is actively growing. Spot spraying during the growing season with herbicides containing 2,4-D, glyphosate, or triclopyr can also be effective. https://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/crownvetch.html

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

Mugwort *(Artemisia vulgaris)*

Mugwort is a perennial with an extensive rhizome system. Shoots emerge during the spring, and flowering occurs from July to late September. A single plant can, depending on its environment, produce up to 200,000 seeds. The small seeds (~1mm in diameter) are largely wind dispersed. Seed production does not seem to be a major factor in the spread of mugwort populations, however, and some biotypes do not produce viable seed. Instead, mugwort spreads largely through vegetative expansion and the anthropogenic dispersal of root propagules.

Pulling is ineffective and may even promote growth by leaving residual rhizome fragments in the soil. Mugwort tolerates mowing, and even sustained mowing over two years will not fully eradicate mugwort stands but can significantly reduce it.

Glyphosate applied in late summer or early fall will suppress mugwort the following year but generally not eradicate it. **Triclopyr** and **clopyralid** are more selective herbicides that effectively control mugwort.

Mowing in combination with spot-spraying may provide the best control, whereby plants are mowed before they flower, then spot-sprayed in late summer.

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

Birdsfoot trefoil (*Lotus corniculatus*)

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

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

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

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

Trefoil species can also be reduced by grazing.

References: http://mipncontroldatabase.wisc.edu/Default.aspx,
http://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/birdsfoottrefoil.html

https://www.techlinenews.com/articles/2013/managing-birdsfoot-trefoil-lotus-corniculatus?rq=trefoil

Canada thistle (*Cirsium arvense*)

While native thistles are not generally problematic, exotics such as Canada thistle are clone-forming perennials that can greatly reduce species diversity in old fields and restoration areas (Hoffman and Kearns 1997). A combination of chemical and mechanical control methods may be needed. Chemical control is most effective when the plants are in the rosette stage and least effective when the plants are flowering. A broadleaf herbicide such as 2,4-D can be used if native grasses are present. It is most effective when applied 10-14 days before the flowering stems bolt. It is applied at rate of 2-4 lb/acre using a backpack or tractor-mounted sprayer or in granular form. Dicamba could also be used, with the advantages that it can be applied earlier in the spring at a rate of 1 lb/acre. Plants that do not respond to treatment or that are more widely dispersed could be controlled mechanically.

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

Common Burdock (*Arctium minus)*

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

Spotted knapweed (*Centaurea stoebe*)

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

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

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

Garlic mustard (*Alliaria petiolata)*

Garlic mustard is a non-native biennial forb of woodlands and woodland edges that is very invasive and aggressive. Following the introduction of just a few plants, populations can rapidly increase, and a dramatic

“explosion” of garlic mustard plants can occur. In some areas it can form monotypic stands that crowd out other species, while recent studies have shown that in other locations it may simply occupy open ecological niches. Nevertheless, garlic mustard can be very invasive in woodlands, and it is recommended to monitor and remove it as soon as it is detected (early detection and rapid response). Garlic mustard also produces a flavonoid (root exudate) that suppresses mycorrhizal inoculation. Thus, species that are mycorrhizae dependent, like oaks, will become stunted and easily outcompeted by garlic mustard. The flavonoid persists in the soil years after garlic mustard plants are removed, which is a good reason to keep woodlands garlic mustard-free.

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

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

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

Non-native cool season grasses

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

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

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

Appendix D. Recommended work specifications for restoration activities

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

Herbicide and Applicators

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

   a) consistent with labeling

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

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

6. All treatment sites will be posted as specified by the pesticide label, and as required by state guidelines.
7. Records of pesticide application must be completed for each use and records maintained according to state guidelines. Records must be submitted at the time of invoicing.
8. Conduct spot treatments rather than broadcast applications whenever possible.
9. Choose biocontrol over pesticides when available.
10. Spray in **early morning or evening** when bees and other pollinators are less active.
11. Avoid windy days (wind speeds less than 10 mph) and ensure a rain-free period of at least 3 hrs after application.
12. Monitor pesticides for dispersal by drift, erosion, or runoff.
13. Prevent herbicide drift to non-target plants. Use wick application or physical barriers where needed.
14. **Follow DNR Operational Order 59 (Pesticides and Pest Control) and other appropriate state guidelines.**

Tree & Shrub Control

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

Forest management practices to protect pollinators & control erosion

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

Appendix E. Future Considerations and Ecological Impacts

Fire Suppression

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

Disease

Oak wilt 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."

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

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

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

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

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

Bur Oak Blight

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

Dutch Elm Disease

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

Non-native and over-populated native animals

Earthworms

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

White-tail deer

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

Today, deer browsing, not grazing, has a more significant negative impact on woodlands. Deer populations in the Metropolitan Area have significantly increased over the last century, due to direct and indirect causes. The

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

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

Emerald Ash Borer

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

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

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

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

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Climate Change

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

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