Natural Resource Management Plan
for
River Heights Park, Inver Grove Heights

Photo 1. Southwest corner of the park along Inver Grove Trail.

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TABLE OF CONTENTS

List of Tables

List of Figures

Acknowledgements

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EXECUTIVE SUMMARY

This document was developed for the City of Inver Grove Heights to provide assistance in ecological management of River Heights Park, a city-owned 7.7-acre park located on Inver Grove Trail. Although small, the park is ecologically valuable as part of a natural corridor along the Mississippi River and provides important wildlife habitat and water quality benefits, as well as a popular community amenity.

Historically, the property was likely dominated by oak savanna and smaller areas of oak forest. With European colonization, the site was converted to agricultural use. The surrounding landscape was later converted to residential housing while the site became a local park.

With the cessation of agriculture and in the absence of natural fires that occurred prior to colonization, trees and shrubs proliferated across the landscape. The park site first became old field (a weedy grassland) after agriculture ceased, then trees and shrubs gradually moved in. However the woody plants were periodically removed and it has mostly been maintained as grassland. The current land cover is primarily non-native grasses and forbs (flowering plants), with a small woodland dominated by boxelder, a native but generally weedy species. Non-native invasive shrubs proliferated at the park, but about 80 percent of them were removed in 2019.

The site was managed by the city as parkland, but in 2017 the city made plans to sell the three parcels for houses. The local community, however, strongly supported retaining the park and were able to prevail. Friends of the Mississippi River (FMR) was then asked to help with planning and management of the park. As of the time of this document, FMR facilitated removal of most of the invasive woody shrubs, and engaged volunteers with brush hauling and pollinator surveys. The city has assisted with brush disposal and other park maintenance. Neighbors also assist with mowing the trails.

Although the current native plant diversity is low and there are numerous very invasive species at the park, FMR suggests there are good options to improve its ecological value. The primary proposed restoration involves removing invasive, non-native shrubs and plants throughout the site to restore the grassland to savanna and to enhance the woodland. This would be a very intensive process, including additional tree removal in the grassland followed by eradication of most of the existing vegetation, although this would be done in an ecologically sensitive way to retain as many desirable species as possible. Native species would then be seeded and planted. Restoring the woodland canopy would be a secondary phase, to include removing some of the boxelder trees and gradually replacing them with other woodland tree species. Such a full-blown restoration may cost as much as $70,000 or more for a five-year establishment process.

If there is not adequate funding or desire to do the full-scale savanna restoration, there are options for a more moderate approach, targeting treatment of the invasive plants and inter-seeding and inter-planting with native plants. This approach could reduce the costs by half.

This document describes the geological history of the park property, historical and existing vegetation and land uses, and ecological recommendations, methods and approximate costs for enhancing the ecological health of the park.

Most of the invasive plants at the park will never be fully eradicated because they are abundant in the landscape around the park and because some of them can persist in the soil as seeds or rhizomes for many years. On-going long-term management will be therefore be needed to maintain the native cover. Volunteer events, such as brush hauling and plantings, can help offset restoration costs and serve as an opportunity for the community to participate at the site.

Friends of the Mississippi River is committed to collaborating on the long-term management and restoration of this site. FMR has obtained grant funding for initial restoration and enhancement steps that will be adequate for the first two years of work. FMR is also able to help with volunteer activities.

INTRODUCTION

This Natural Resource Management Plan (NRMP) presents the site analysis and recommended management and land use activities for 7.7-acre River Heights Park owned by the City of Inver Grove Heights, Minnesota.

Prior to European colonization, the vegetation at the project area consisted primarily of oak savanna – loosely described as prairie plants with scattered clusters of bur oak trees and brushland. As settlement occurred, both prairie and savanna communities were converted to agricultural and other uses, leaving less than 1% of each of these plant communities on the landscape, where they previously occupied over one-third of the state. What little was left has largely been degraded by lack of fire and invasion of non-native species, leading to a dominance of those species, decline of native species, and succession of savanna and grassland to forest. River Heights Park has been similarly altered, and is currently dominated by boxelder trees in the woods and non-native, invasive grasses and forbs (flowering plants) in the grassland.
This plan was developed to:

- Inventory the existing vegetation at the park
- Identify options to improve the ecological value of the site for native wildlife, including pollinators

The over-arching goal for the property is to increase the diversity and abundance of native plant species, with a particular focus on pollinator plants. This plan also evaluates the feasibility of restoring the site to native plant communities that were historically present, while also considering the existing condition and current desired uses for a site, such as recreation.

Specific ecological and cultural goals are to

- Restore a complement of native plant communities
- Improve habitat for wildlife, including birds and pollinators.
- Provide connectivity with other natural areas in the landscape
- Maintain and manage the property for water quality by avoiding or controlling any erosion that may develop, and retaining continuous ground cover throughout the site
- Increase biological diversity
- Create a model of responsible land stewardship for park visitors
- Provide close-to-home opportunities for people to enjoy and interact with nature
- Utilize this property to enhance and expand the ecological functions of the property and of the larger Metro Conservation Corridor.
- Provide ecological services, including filtering pollutants from soil and water, reducing soil erosion, and absorbing air pollutants and carbon dioxide.

SITE INFORMATION

A. Location and governance

Address: River Heights Park is located on the eastern side of Inver Grove Heights, about 0.3 miles from the Mississippi River, on Inver Grove Trail and River Heights Way (**Figure 2**). The park is approximately 750 feet wide (east-west) and about 450 feet from north to south.

Legal Description: Township 14, Range 27, Section 22

Watershed: Lower Mississippi River

Watershed Organization: Lower Mississippi River Watershed Management Organization

Parcel Identification Numbers (Figure 1):

202570001010
202570001020
202570001030

Total Acres: 7.7

Distance to Mississippi River: 0.34 miles

Ecological Land Classification:
Province: Eastern Broadleaf Forest
Section: Minnesota and Northeast Iowa Morainal
Subsection: St. Paul Baldwin Plains

Primary Site Administrator:
Brian Swoboda, Parks Superintendent
City of Inver Grove Heights
8055 Barbara Avenue East
Inver Grove Heights, MN 55077
651-450-2582 email:
bswoboda@invergroveheights.org

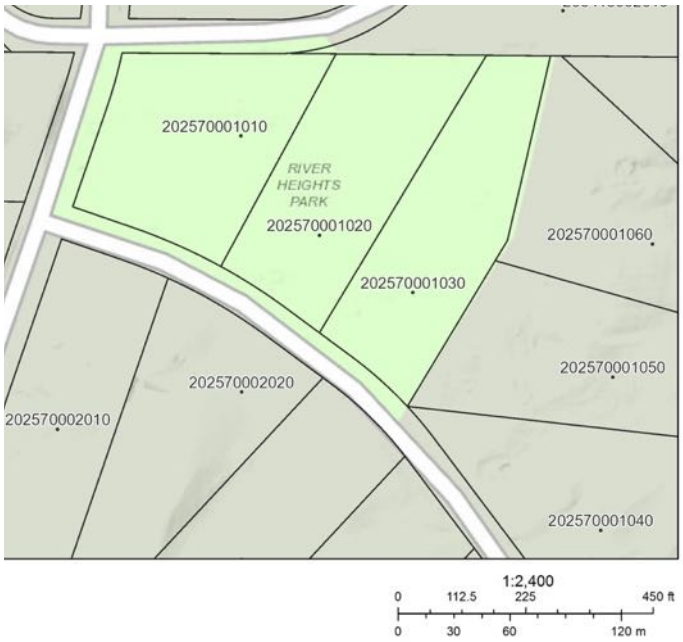
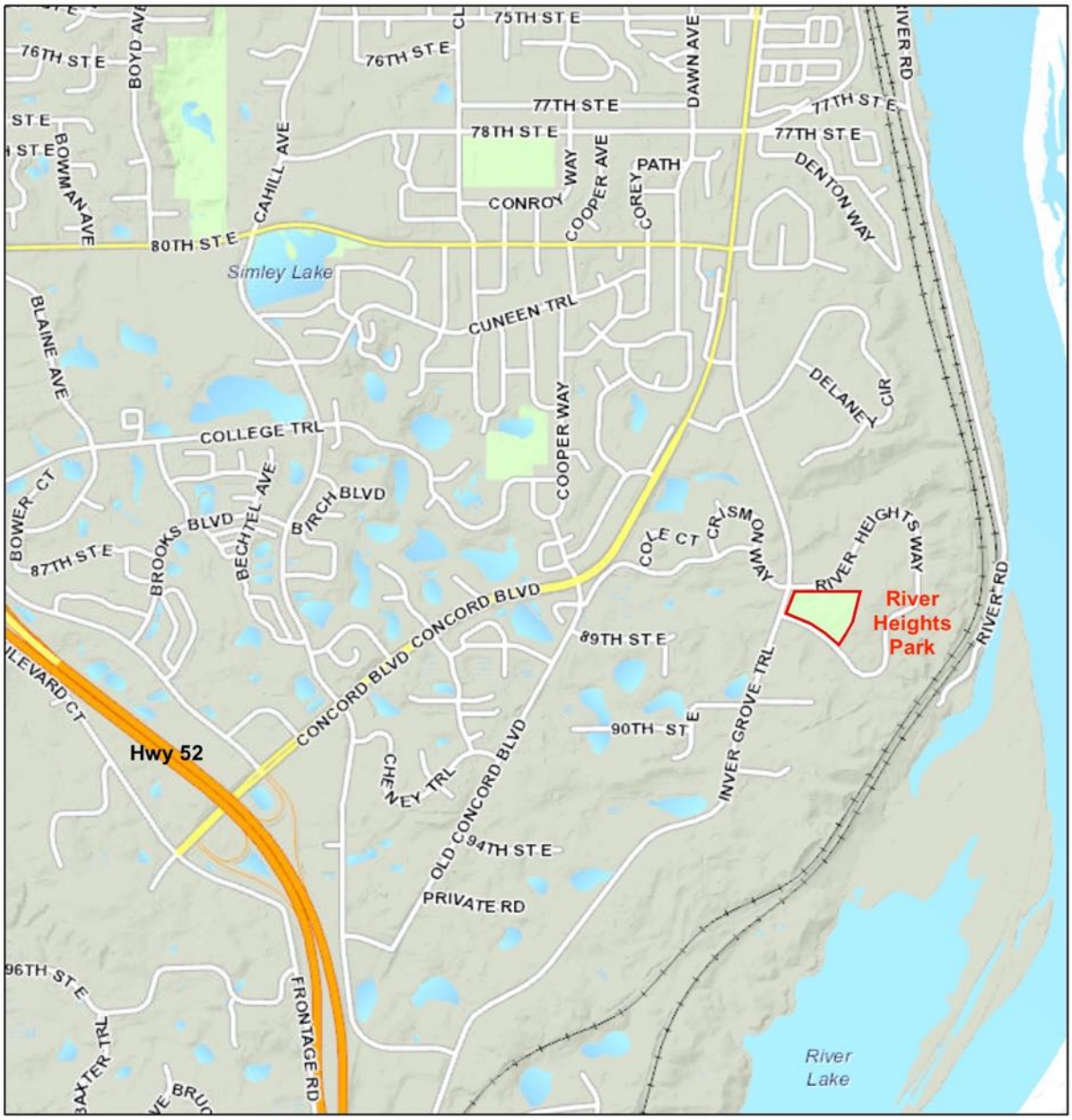


Figure 1. Parcel information

Figure 2. Site Location



February 13, 2019

1:19,200

0 875 1,750 3,500 ft

0 262.5 525 1,050 m

Transportation

Source: http://gis.co.dakota.mn.us/DCGIS/

Disclaimer: Map and parcel data are believed to be accurate, but accuracy is not guaranteed. This is not a legal document and should not be substituted for a title search,appraisal, survey, or for zoning verification.

B. Landscape Context

1. Proximity to established greenways

River Heights Park lies within the Metro Conservation Corridors, a regional land protection plan of the Department of Natural Resources (DNR) (**Figure 3**), which identifies lands that create a network of connectivity across the landscape for movement of wildlife and plants. The park is also located within the Mississippi National River and Recreation Area, a 72-mile park that flanks the river, established by Congress in 1988. River Heights Park is also within the Mississippi River Twin Cities Important Bird Area, a designation of the Audubon Society for sites that provide critical habitat to individuals or groups of vulnerable bird species.

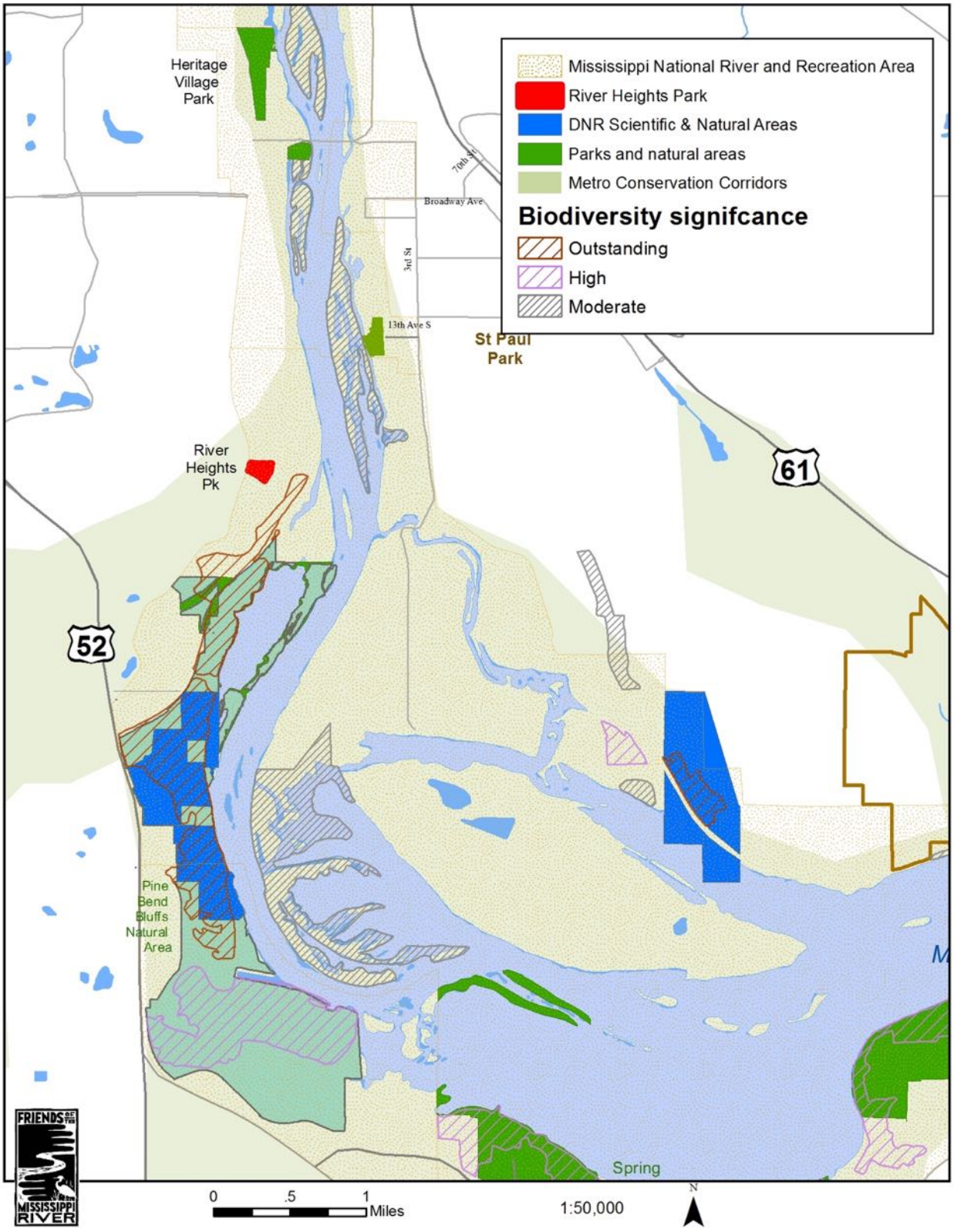
2. Ecological significance

River Heights Park is a significant ecological feature in the landscape due to its proximity to the Mississippi River and other natural areas. The Mississippi River is a globally significant flyway for migratory birds, with 60% of North American species using the corridor. Although the park is small, it potentially provides some habitat for migratory and non-migratory bird species, many of which are declining throughout their range, in part due to habitat loss.

The park is located just half a mile upstream from the Pine Bend Bluffs Natural Area, a 1,300-acre area that is one of the most ecological diverse areas along the Mississippi River in the Twin Cities and which includes Pine Bend Bluffs Scientific and Natural Area (SNA) (**Figure 3**). Grey Cloud Dunes SNA, a very high diversity dry prairie on the river terrace, is located across the river, about 3 miles to the southeast. North of the park the landscape is primarily residential, with some commercial and industrial uses, until Heritage Village Park, a city park with restored prairie vegetation about two miles away.

River Heights Park, along with other small undeveloped lands near the river, serves a role as a small connector between these larger natural areas. The site is currently degraded, dominated by non-native, invasive plants species, many of which are of low value for native wildlife. If restored to native vegetation, however, the site could be very valuable, especially for pollinators. Urban and residential areas are becoming increasingly important for pollinator species, as suitable habitat has decreased in the larger landscape.

Figure 3. Regional Context



C. Land Use

1. Historical and Existing Land Use of the Park

River Heights Park has no known archeological significance, but the Mdewakanton Dakota Sioux long occupied the land in this region until 1854 and likely would have traversed the area of the park. Further back, the Woodland mound-builders (c. 100 BCE to 600 CE), and the people of the Late Mississippian culture around 1000 CE were also known to have lived in the area (Dakota County Historical Society).

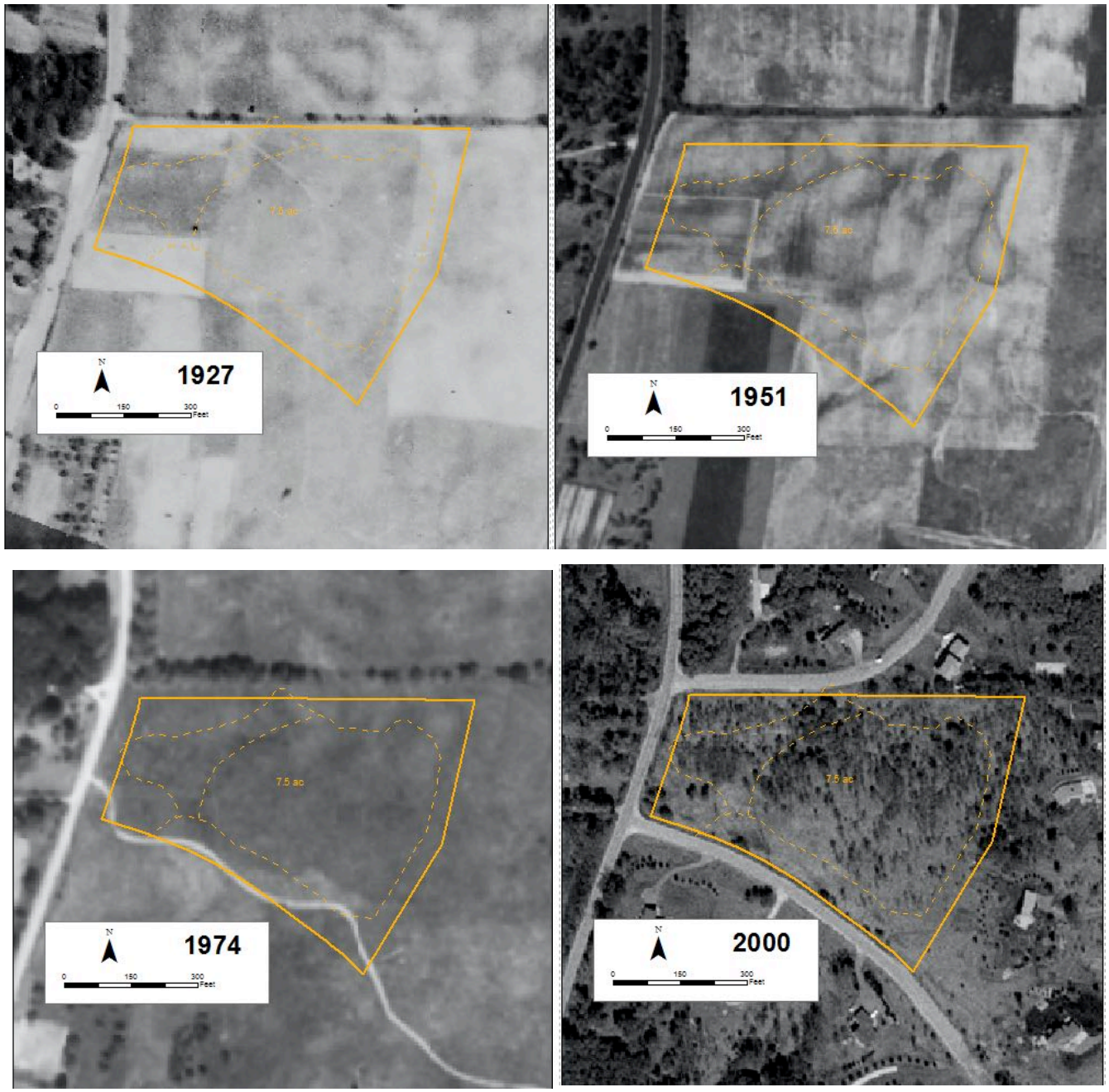
Beginning in the mid-1800's, European colonization dramatically changed the Dakota County landscape. Native prairie that dominated the county was converted to agriculture. Wetlands were drained and much of the Big Woods was also cleared. Fire, which had been a formative feature of the landscape, was suppressed as intense agricultural practices and urban development ensued. In 1990 a biological survey of the County, completed by the Minnesota Department of Natural Resources, showed less than 3% of the native plant communities that had been present in the 1850's remained. Landscape changes continue today in a somewhat different direction, with agricultural lands being converted primarily for residential and commercial uses.

Some of the best evidence of past land use at the Park is depicted in historical aerial photographs (**Figure 4)**. The photos show that the park area was used for cropland and/or pasture until about the 1970's. By 1974 the surrounding rural landscape around the park was being transformed as housing developments were built west of the park. By 1991 the neighborhood around the park was established.

The Park itself apparently shifted from cropland to fallow grassland around 1974. In the absence of fire or bison grazing, the historical processes that shaped the land, the grassland began to fill in with trees and shrubs, which were quite abundant by 2000. The city conducted periodic management of the parcels over the years, with removal of much of the tree and shrub cover in 2008. Additional coniferous trees were also planted, approximately in 2010.

As residential neighborhoods developed around the park, local residents began using the park, creating and maintaining a trail system by the early 2000's. In 2018 the City considered the possibility of selling the parcels for housing. The community strongly supporting keeping it as parkland, and in May 2018 it was officially determined to retain it as a city park.

Figure 4. Historical aerial photographs 1927-2000.



The site was cropland and/or pasture until the 1970's when it became fallow grassland (or possibly hayfield). The local housing development was built in the 1990's; nearby residents used the park and maintained the trails.

Aerial images source: MnGeoSpatial Commons, Dakota County.

2. Adjacent Land Use

Figure 5. Surrounding Landscape 1927 and 2017

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

Since European colonization, the landscape around the park was almost entirely in agricultural use, as seen in the 1927 aerial photograph (**Figure 5**). Residential development gradually expanded from the west and today the park is surrounded by houses. Note also the expansion of forest in the landscape, as agricultural uses ceased and historical wildfires no longer occurred. While the landscape around the park was largely unforested in the past – first as savanna and later as agricultural land – today the park is a pocket of grassland in a largely forested, albeit residential landscape.

The influences of the surrounding lands can be both negative and positive. Seeds from invasive plant species can be brought to the site from adjacent properties by wind, birds, and the fur/clothing and feet of animals and humans. The lack of other grassland in the area means that there will be few other populations of pollinators and other grassland species to support those that may occur at the park. On the positive side, studies now show that urban landscaping can provide critical habitat for pollinators, if homeowners choose to create native plantings for pollinators at their homes. So the local landscape could be a very positive influence for the park.

D. Geology, Soils, Topography, Hydrology

The natural resources at River Heights Park are influenced and in large part determined by numerous physical conditions, especially local bedrock and surficial geology, soils, topography, and local and regional hydrology.

1. Geology

All the bedrock in Dakota County formed from marine sedimentary rock as a result of ancient oceans that covered the area in the Paleozoic age. Sand and clay and marine animals became compressed and formed a variety of sedimentary rock layers with different depths and characteristics.

The bedrock at River Heights Park is the Prairie du Chien Group (Opc in **Figure 6**), which consists primarily of dolostone (a sedimentary carbonate rock with a high amount of dolomite). It is a common outcrop of the bluffland along the Mississippi River and the rock type that is quarried at nearby aggregate facilities. The depth to bedrock at the park is 101 to 150 feet.

Figure 6. Bedrock geology

The Park is located in the OPc unit, which is the Prairie du Chien group

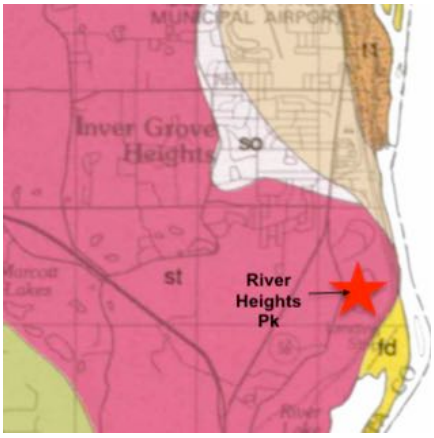


Figure 7. Surficial Geology

The park is located in Unit st, which is glacial till.

Glaciers were the primary force that shaped the landscape in Dakota County. The surficial geology at River Heights Park is glacial till (st) from the Superior Lobe. It consists of sandy loam and poorly sorted sand and gravel (**Figure 7**).

2. Soils

Soil formation is the result of the interaction of five soil-forming factors: parent material (e.g. bedrock), climate, organisms, topographic position or slope, and time (Foth, 1990). Taken collectively, these factors can help determine the dominant plant and animal communities that helped form the soils. The "Soil Survey of Dakota County Minnesota" (1980), provides a generalized depiction and descriptions of soils in Dakota County. Soil types are important because they affect the vegetative and hydrologic features of the property and suggest the most appropriate vegetation type or use of the land.

The dominant soil type at River Heights Park is Kingsley-Mahtomedi-Spencer complex (895C) with 8 to 15 percent slopes (**Figure 8**). This complex is on rolling hills and is moderately to excessively well-drained. It is found on side slopes and ridge crests of end moraines. The surface layer is typically sandy loam, loamy sand, or silt loam. Runoff is rapid, available water capacity ranges from low to high. The soil is considered poor for cultivated crops due to droughtiness and erosion potential. It is well-suited to pasture, and fairly suited to woodland. This later characteristic would tend to indicate the historic condition at River Heights may have been oak savanna or dry oak woodland. The high erosion potential should not present any problem for ecological work, but should be monitored during periods when the site may have little or no vegetative cover as part of the restoration process.

Spencer silt loam (150B) 2 to 6 percent slopes, occupies a small portion of the site toward the northeast. This moderately well-drained soil is found in swales and small depressions. Permeability is moderate, available water capacity is high and runoff is medium. The organic matter content is high. The seasonal high water table is 3 to 6 feet below the surface. This soil type presents little concerns in terms of ecological work.

There is a small are of Spillville loam, occasionally flooded (313) in the northwest part of the site. This is a nearly level, moderately well-drained to somewhat poorly drained soil found in drainageways. It has moderate permeability, high available water capacity, and slow to medium runoff. The seasonal high water table is 3 to 5 feet below the surface. The primary concern with this soil type is occasional flooding, which could impede certain ecological tasks.

3. Topography

Topography and the orientation of slopes (aspect) are important factors in the development and formation of soil, potential for erosion, and the type and stability of vegetation that will grow in a given location. In general, more topographic variation will result in more complexity and diversity of vegetation communities and hydrologic features. South and southwest facing slopes tend to be drier and warmer while north and north-east facing slopes tend to be cooler and moister.

River Heights Park has a fairly simple landscape, with gently rolling terrain throughout (**Figure 8**). The elevation change is about 20 feet, with the highest elevation of about 894 feet, found at several of the hilltops. The lowest elevation is about 874, at the far southeast tip. The overall slope and direction of runoff is from northwest to southeast.

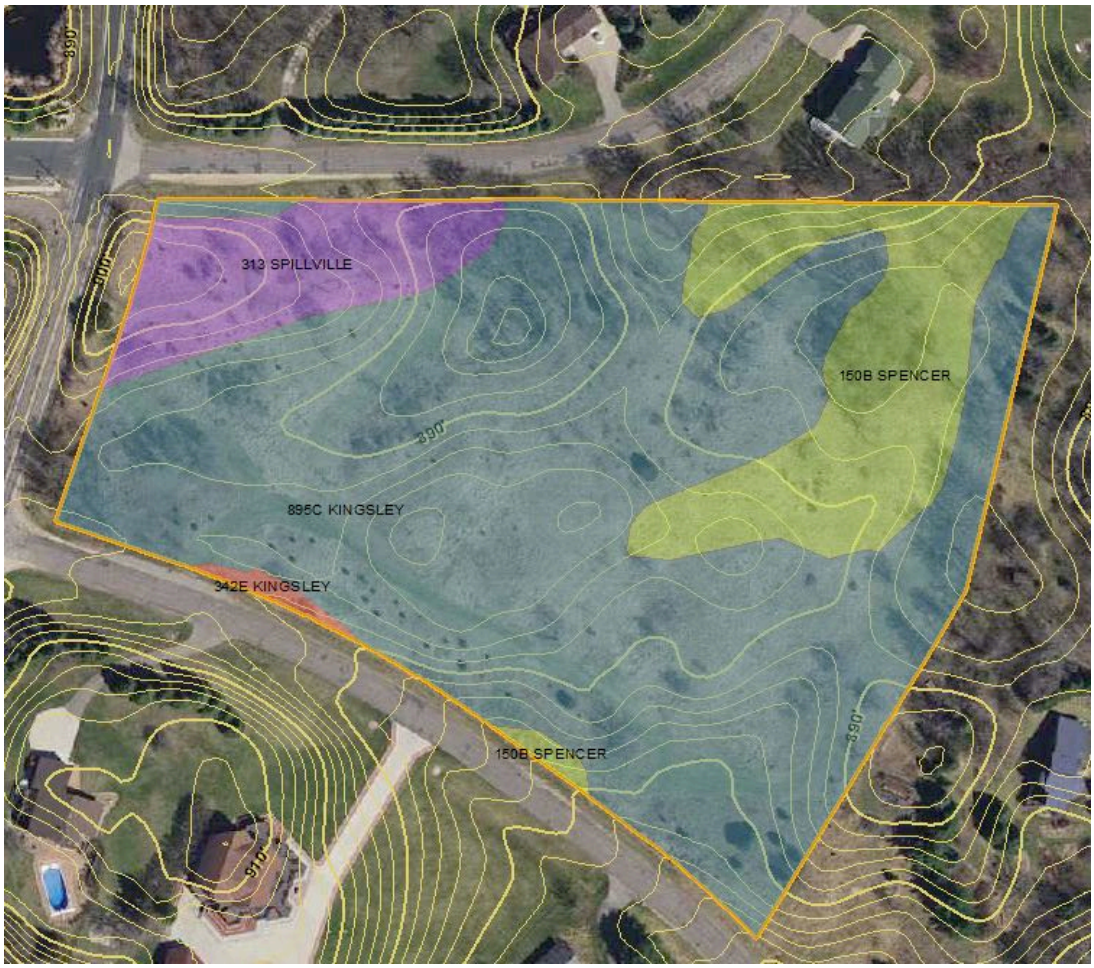


Figure 8. Soils and topography

2-foot contours, Dakota County GIS. 2016 Aerial, MnGeoSpatial Commons.

E. Hydrology

Two key interrelated hydrologic components are groundwater and surface water. There are no standing surface waters at River Heights Park so most of the water from the site either soaks in or flows offsite, but there are areas where the water may collect for short periods of time.

Groundwater accumulates below the surface of the land and is stored in complex, underground geologic layers of sand, gravel and porous rock. Groundwater provides drinking water for most Dakota County, irrigation water for agricultural crops, and process and cooling water used by industrial and manufacturing companies. Most of the County's groundwater is "highly sensitive" to surface contamination. Once an aquifer is polluted, it is very expensive or prohibitive to improve its quality to drinking water standards.

Given its importance and potential vulnerability, it is important to be aware of the potential for groundwater contamination from pesticide and herbicide use. Factors to consider during natural resource management activities are depth to groundwater and the ability of the overlying material to filter pollutants.

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

River Heights Park is located in an area where groundwater sensitivity to contamination is determined to be **moderate** (**Figure 9**); contaminants will reach the groundwater in several years to decades. This classification does not present any concerns in terms of ecological management practices.

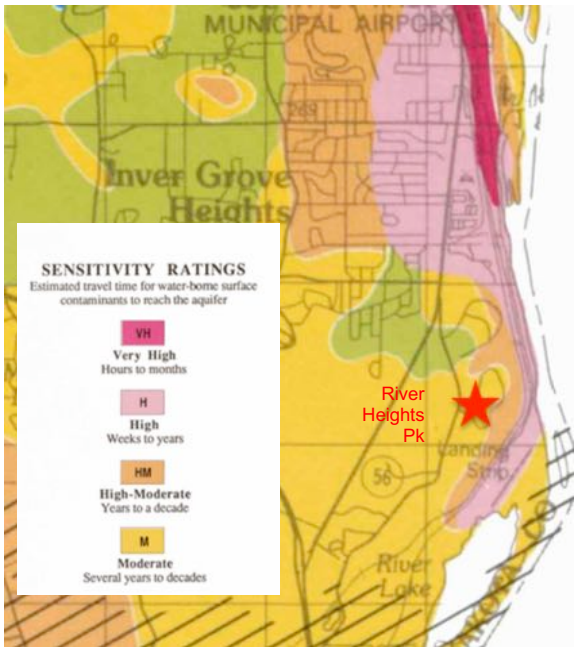


Figure 9. Sensitivity of groundwater to contamination.

River Heights Park is too small of a site to be important for groundwater recharge, but it is located in a part of the state that has fairly high rates of recharge - 6 to 8 inches per year (Setterholm 2014). Most water that infiltrates at the land surface is returned to the atmosphere by plant transpiration and evaporation. Typically only a small fraction of infiltration water reaches the groundwater.

F. Rare Species And Wildlife

1. Rare Species

A search of the DNR Natural Heritage database* revealed no recorded rare plant or animal species at River Heights Park. Twelve organisms were identified within one mile of the site. Six of those were aquatic animals and plants, which could not exist at the Park. The six terrestrial organisms were three animals: Blanding's turtle, North American racer, red-shouldered hawk, and three plants: kittentails, tall nutrush, tubercled rein orchid. The Park does not currently provide suitable conditions for any of these species, but once native vegetation is restored it could conceivably provide suitable habitat for kittentail and tubercled rein orchid.

**State of Minnesota, Department of Natural Resources (DNR). 2017. Rare Features Data included here were provided by the Division of Ecological and Water Resources, Minnesota DNR, and were current (as of June 2017). 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.*

2. Wildlife

A wildlife survey was not completed for the park, but some of bird species noted during site visits are listed below. All the species would be considered potentially breeding at or near the park.

American goldfinch
Baltimore oriole
Black-capped chickadee
Broad-winged hawk (FO)
Chipping sparrow
Eastern bluebird
House wren
Northern cardinal
Red-winged blackbird
Song sparrow

A few other animals noted at the park were gray squirrel and monarch butterfly.

G. Historical Vegetation

One important consideration for developing a natural resources management plan is to understand the types of vegetation found at a property or in the local area prior to European colonization. This information can be a helpful indicator of what plants may thrive on the property. Fortunately, field notes on vegetation were taken during original territorial surveys in the 1840s and compiled by Francis Marschner into a map entitled "The Original Vegetation of Minnesota," published in 1974.

According to Marschner's map, the predominant plant community at River Heights Park in the 1840s was Big Woods, with Oak Openings and Barrens (oak savanna) to the north and south. (**Figure 10**). The plant community assignment is based on data from bearing trees, which were recorded every mile, and the trees closest to them. At River Heights, bur oak trees were the primary species recorded in the area. Some were quite far apart – 70 feet or more – which could indicate more of a savanna habitat than forest.

The mapping was a generalization so it does not always depict exact conditions for a specific site. In the case of River Height Park, it seems quite possible, even likely, that it was in a complex of oak forest and oak savanna. The dominant soil type at the park (Kingsley complex), for example, is a drought-prone soil that is also more suitable to a dry oak forest or oak savanna than to the more mesic Big Woods community.

Oak openings and barrens (or oak savanna) is a transitional area between prairie and forest. It occurs on dry to moderately moist (mesic) sites throughout the deciduous forest-woodland zone and locally in the prairie zone. Although there are few relicts left to inform us what it may have looked like historically, a simple image of savanna is a complex of open grassland areas,

dominated by prairie grasses and forbs, with scattered open grown oak trees, patches of aspens and scrub brush. The principal canopy species are bur, northern pin, northern red, and white oak. Shrub cover is variable but common species are blackberry, raspberry, gooseberry, dogwood, cherry, hazelnut, and prickly ash.

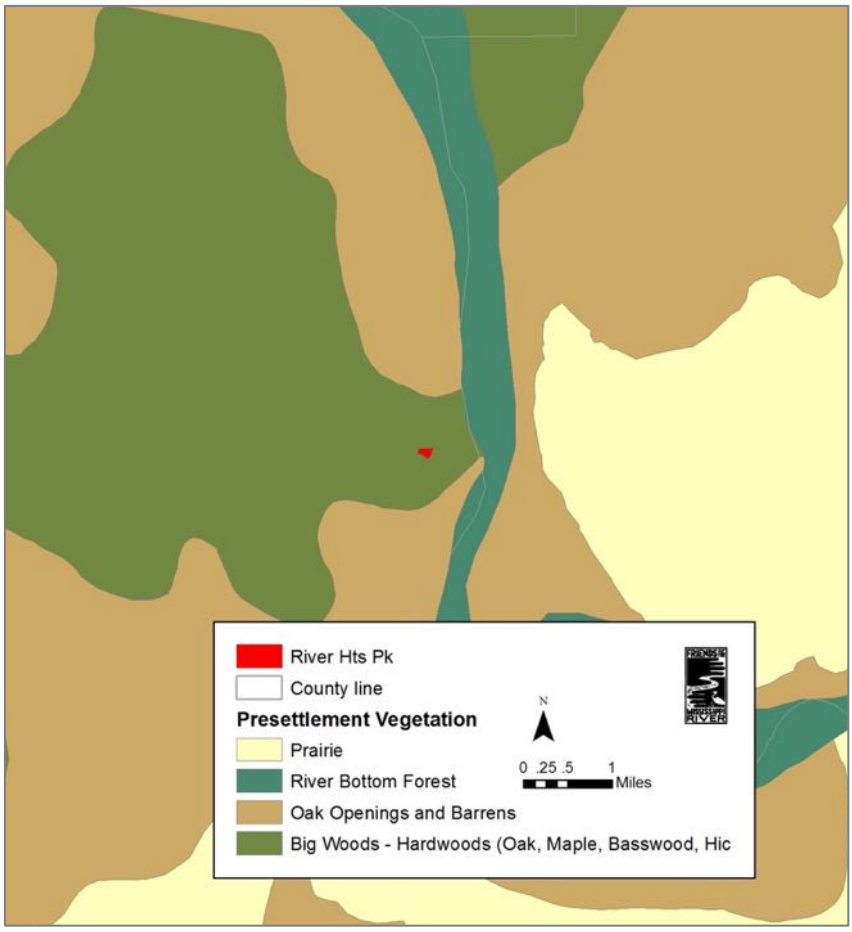


Figure 10. Vegetation at time of European Colonization

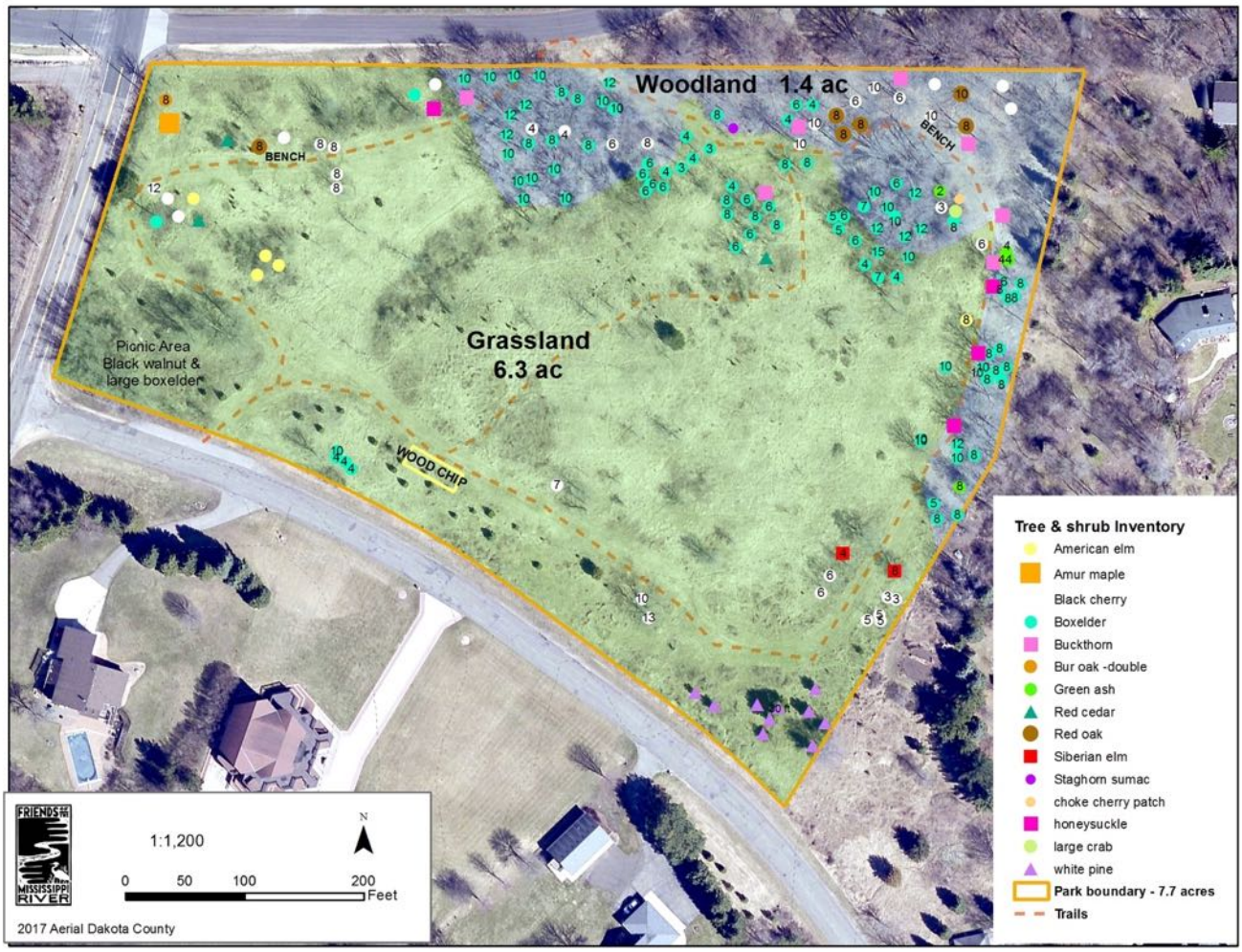
ECOLOGICAL EVALUATION

The Department of Natural Resources (DNR) developed a system called the Minnesota Land Cover Classification System (MLCCS), which defines and classifies all types of land cover, including vegetated, paved, buildings, cropland etc. When applicable, vegetation is defined according to the MN DNR native plant communities system. A native prairie, for example, may be classified as "Southern sand-gravel dry prairie," with the associated code (UPs13). However, where vegetation is not consistent with a native plant community, it is classified in more descriptive terms, such as "Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated vegetation."

Using the polygons defined by the MLCCS as a basis, vegetation and other features for each land cover type were recorded by FMR ecologists in 2019. The vegetation classifications and polygon boundaries were adjusted as needed based on these field observations. The existing plant species were recorded, with an estimated relative percent coverage in each vegetation layer (tree, shrub, and ground layer) (**Appendix A**) [Note that within the text portion of this document, only the common names of plant species are used unless a species is not listed in one of the appendices, in which case the scientific name will also be shown]. Other site features evaluated and recorded were ecological concerns, such as erosion, invasive species, disease, etc.

There were two land cover types at River Heights Park: about 6.3 acres of "Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non- native dominated vegetation (62220)" and about 1.4 acres of "altered non-native deciduous woodland (42130)" (**Figure 11**). These will be respectively referred to as "grassland" and "woodland" for the purposes of this document. While both of these land cover types contain some native plant species, they have been heavily altered over many decades or longer. Both are dominated by non-native plants, and neither has enough native species or other features to be considered a native plant community. They are described in the paragraphs below, with management and restoration recommendations in the next section.

Figure 11. Existing Land Cover



The landcover map shows the park a tree canopy heavily dominated by boxelder, with a few invasive trees and a few desirable native trees (red and bur oak). Moderate amounts of non-native invasive shrubs species.

A. Grassland (62220)

The term "grassland" is applied to upland vegetation with 10-70% cover by trees and ground layer dominated by non-native species, typically smooth brome and Kentucky bluegrass. Common shrubs include sumac, prickly ash, and Tatarian honeysuckle (MLCCS 2005).

Grassland was the dominant land cover at the site, occupying about 6.3 acres - all but the northeast edge. The ground cover was heavily dominated by non-native species, with roughly equal amounts of grasses and forbs (flowering plants). Smooth brome and Kentucky bluegrass were the dominant grasses with some quack grass. Native grasses were very sparse, but included occasional Indiangrass, Canada wild rye (Photo 2) and a species of sedge.

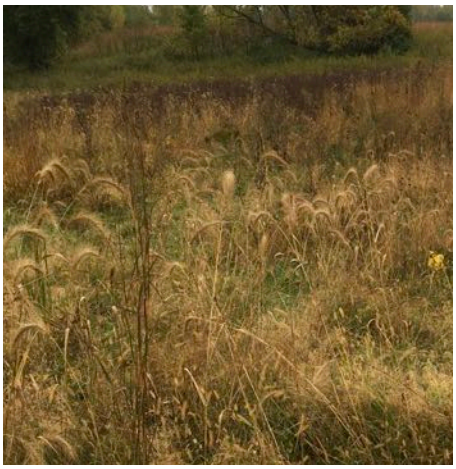


Photo 2. The long seedheads of Canada wild rye are especially noticeable in the fall.

The dominant forbs were the two native goldenrods - Canada and late (Photo 3). While, these species provide important resources for wildlife (especially pollinators), they often become very invasive, forming monocultures where few other species can grow. It will be necessary to reduce the cover of these species to obtain greater habitat diversity at the site, to benefit more species throughout the seasons.

Photo 3. Native goldenrods can become invasive, forming single-species stands (left). The invasive crown vetch (right) is even more invasive and extremely difficult to eradicate.

There were a host of other very invasive non-native forbs at the site, including crown vetch, spotted knapweed, leafy spurge, burdock, curly dock, Canada thistle, white sweet clover and cow vetch. Crown vetch was dominant, forming dense monoculture patches to the exclusion of other species. It spreads by seed and rhizome and is extremely difficult to eradicate. It provides little habitat value of native wildlife. Most of the other invasive species are similarly tenacious and difficult to eradicate.

Besides goldenrods, there were a few native forbs at the site. Yarrow was the most abundant, but thimbleweed, bergamot, common milkweed, stiff goldenrod, daisy fleabane, pussytoes and smooth aster were also present, though not abundant. One particularly notable native plant was cream gentian, of which a few individuals were found on the east side of the park (Photo 4).

Photo 4. Native plants included this swath of bergamot (left), smooth aster (center), and the somewhat uncommon cream gentian (right).

The shrub layer covered about 15% of the grassland, and was most concentrated in the northwest quadrant of the park. The most abundant species was gray dogwood, which is an excellent shrub for wildlife, including pollinators. Other native shrubs included staghorn sumac and red raspberry.

Most of the non-native shrubs have been removed from the site, but there remains some scattered Tatarian honeysuckle and common buckthorn and a few Amur maple in the northwest corner. There were also a few small black locust and Siberian elm trees on the east property line. All of these are very invasive and detrimental to wildlife. While birds may eat the berries of buckthorn and honeysuckle, the nutritional value is much less than berries they eat from most native shrubs. Furthermore, bird nests in the non-native shrubs are more likely to be destroyed by predators than those in native shrubs.

The tree canopy coverage within the interior of the trail loop consisted of mostly scattered small native trees, especially boxelder, black cherries and elms, with a few red cedars. There were also a few small to medium-sized Siberian elm, a very invasive non-native species.

Outside the trail loop, along the south side of the park, were numerous other trees, many of them planted. East of the entrance there were about 16 spruce trees, 5 to 12 feet tall (Photo 5). In the southeast corner was a cluster of 10 white pine trees. Most were about 10 to 15 feet tall, one was about 30 feet. In the southwest corner, at the park entrance, were 4 large boxelder trees, several

small black walnuts, and a few small spruce. These trees create a nicely shaded area for the picnic table and could be retained (Photo 5).

Photo 5. Smooth brome grass dominates much of the park, as seen here (left), east of the entrance. Beyond the grass are the planted spruce trees. West of the entrance is the park sign and mowed picnic area, with large shade trees (right).

The most notable, and desirable, trees in the grassland were a single bur oak and a single red oak (each about 8-inches diameter), in the northwest corner of the grassland, outside the loop.

B. Woodland (42130)

Woodland vegetation is described (MLCCS 2008) as upland vegetation with 10-70% tree cover, of which <25% is by conifers. Boxelder, green ash, and cottonwood are typical canopy dominants, sometimes together and sometimes singly. Aspens are <70% of tree cover, and oaks are <30%. Other species may include elm, hackberry, aspens, oaks, and basswood. The shrub layer is often dominated by buckthorn and Tatarian honeysuckle, but sumacs, gooseberries and elderberries can also be common. The ground layer is also dominated by species tolerant of disturbances, including white snakeroot, motherwort, and garlic mustard.

At River Heights Park, the woodland was about 1.4 acres along the north and east sides of the park. The tree canopy was strongly dominated by boxelder (Photo 6), with over 80 trees counted. Trees ranged in size from about 5 to about 15 inches in diameter, but the vast majority were about 8 to 10 inches. Black cherry was the second most common species, with about 20 trees in the woodland (there were some additional trees in the grassland). There were a handful of green ash and red oak, both of which were also about 8 inches diameter. The overall coverage of the woodland was fairly open, with less than 50 percent coverage.

The subcanopy had smaller trees of the canopy species, as well as a few American elm, choke cherry, one very large crab apple and a large plum.

The shrub layer was moderately dense, and was again dominated by boxelder. European buckthorn was similarly abundant and Tatarian honeysuckle was common. The latter two species were mostly removed from the site in early April 2019 by a crew from the Minnesota Conservation Corps, but some large stems remain, especially on the east and north sides of the park, with a few scattered shrubs in other areas.

Photo 6. A stand of boxelder, the most abundant tree at the park, mostly 8 to 10 inches in diameter.

The ground layer coverage was fairly dense overall, and dominated by non-native invasive plants. Creeping Charlie was dominant and common burdock was also very abundant. Other invasive non-native species present in fairly low abundances were narrow-leaf bittercress, Japanese hedge parsley.

The most abundant woody plants were Virginia creeper, wild grapevine and black cap raspberry. Buckthorn and honeysuckle seedlings were present, along with seedlings of most of the canopy trees.

C. Ecological concerns

The overall ecological concerns for this site are the lack of native plant species diversity, the abundance of non-native invasive plants and the lack of ecological processes, especially fire and ungulate grazing.

Because non-native plants did not evolve within the local ecosystem they do not provide the ecological benefits that native plants do. Native wildlife, especially many pollinators and bird species, are adapted to most efficiently use the nectar, seeds, fruits and other features of native plants. While they may be able to use non-native plants to some extent, native plants provide better nutritional value and better habitat features for their needs. Studies have shown populations of many native wildlife species decline in non-native vegetation.

Fifteen plant species found at the park are listed by the MN Department of Agriculture and the Department of Natural Resources as noxious weeds, as well as two additional species, burdock and curly dock, that should also be managed (**Appendix D**). Of particular concern at the grassland at River Heights Park are crown vetch, spotted knapweed, and leafy spurge. Each of these species is very tenacious, spreads by prolific seeding and/or rhizomes and is extremely difficult to eradicate. The cool-season non-native grasses – smooth brome, Kentucky bluegrass

and quackgrass are also difficult to eradicate entirely but can typically be greatly reduced. Some of the other species are described below.

Common burdock has large leaves that resemble rhubarb, though the two plants are not related. Up to two feet long and a foot wide, the leaves can shade out other plants, especially if the burdock is abundant and forms a carpet. The plant is a biennial, with basal leaves only in the first year and a deep taproot. In the second year the plant sends up a robust stalk, often towering to six feet tall or more. It produces an abundance of long-bristled seed capsules that readily attach to any passerby. Although invasive, this plant is relatively easy to control as long as it is managed annually, and before the seeds have matured.

Common buckthorn can thrive in a wide range of soil and light conditions, enabling it to invade a wide variety of habitats. It forms dense thickets that crowd and shade out native plants, alters nitrogen levels in the soil, hosts fungi that are detrimental to agricultural crops, and contributes to erosion and declining water quality. Recent research suggests it also releases compounds that are toxic to the embryos of native amphibian species. Its fruit is somewhat toxic, with a strong laxative effect on birds and other wildlife. As such, it provides little food value to animals that eat the berries. Studies have shown an increased rate of nest predation and subsequent population declines for birds that nest in buckthorn. Once established, a virtual carpet of buckthorn seedlings radiate outward from each "mother plant," displacing or preventing native plants from re-establishing these areas. Buckthorn can dominate a vulnerable woodland or forest in a matter of 30 to 50 years.

Like buckthorn, **Tatarian honeysuckle** is an upright, deciduous that was brought here from Europe and Asia. It is a very aggressive colonizer that displaces native forest shrubs and herbaceous plants by its invasive nature and early leaf-out. It also invades grassland areas. It has a very robust root system and a multi-stem trunk and is very difficult to eradicate. Birds eat the red or orange berries, spreading the plant to new locations. **Amur maple**, **Siberian elm** and **black locust** are three other woody species that are similarly very invasive. Black locust is native to North America, but is from further south, while the other two species originate in Europe and Asia.

Narrowleaf bittercress is a species in the mustard family that can have significant negative impacts on forest understory. As a biennial, it has a basal rosette of leaves the first year and a flowering stalk the second. It is a cool-season species that gets a competitive advantage in early spring when most native species are still dormant. A prolific seed producer, it spreads very quickly, displacing native species. **Japanese hedge parsley** is an annual in the carrot family. Both species were in low abundances, but need to be managed before they spread. Both can be hand-pulled before seeds form.

The presence of these species is interconnected and the causes of their invasion cannot necessarily be controlled. Earthworms, for instance, play a major role in the establishment of the invasive plant species, by altering the soil structure and consuming seeds of native plants. Buckthorn, in turn, benefits earthworms by providing leaves that are very high in nitrogen. This positive feedback loop ensures that both species continue to thrive at a site. The soil alterations

caused by earthworms also create ideal conditions for many of the other non-native invasive species. There is currently no method for controlling earthworms, so to that extent the site will always be susceptible to invasion of non-native plant species. We can, however, intercept the system. Native plants can co-exist with earthworms, and if there a well-established native plant community, studies have shown it can be quite resistant to invasive plant species. Also, by removing invasive plants, conditions for earthworms decline and their populations also decline.

Lack of fire, a historical component of this landscape, has also altered the composition of the plant community. Fire helps to reduce woody plants and non-native species while cycling nutrients back to the soil. There are also larger threats, especially from climate change, that ecologists don't fully understand yet. The developing trend is for increased precipitation, with more frequent large rain events, warmer temperatures and increased humidity. These trends tend to influence the landscape toward more savanna conditions (**Appendix C**). These climate changes may not directly affect the park, as savanna is the desired plant community type, but plant species composition is likely to be affected in ways that are not yet clear.

ECOLOGICAL MANAGEMENT RECOMMENDATIONS

Ecological restoration is a long-term process. It takes many steps and many years to restore ecosystems to a semblance of their former functionality and diversity. Even under the best circumstances and human abilities, this can only be approximated. It took many decades to degrade the ecosystem and biological communities on the property, so it will not be restored in a short time.

Restoration should be viewed as a process and not as an end point. The ultimate goal is to achieve and maintain a diverse and somewhat self-sustaining natural community at the site, though this will not always proceed in a linear fashion. Using the concept of *adaptive management* will be the key to continual progress at the site. Adaptive management is an iterative process commonly used by land managers, which integrates evaluation and action into the restoration process. While an overall plan is established at the start of a project, as restoration steps are taken, results are monitored and evaluated to determine the next best steps in a constant feedback loop that looks like this: Assess Problem → Design → Implement → Monitor → Evaluate → Adjust → Assess Problem → and so forth. Thus, moving forward with restoration, each round of adaptive management refines and hones the process to better fit the conditions of the site. This strategy should be followed on the property.

A. Management Objectives

The overarching objective for River Heights Park is to improve the wildlife values of the site and to restore the ecological functions that the historical native plant communities provided, including:

- habitat for a diversity of wildlife species
- nutrient and water cycling
- carbon storage
- moderation of water-table levels
- erosion control
- filtration of nutrients, sediments and pollutants

The best way to accomplish those objectives is by restoring and enhancing native plant communities to the site. A robust and diverse native plant community offers the best protection against invasive species, climate change effects and loss of animal species diversity. The historical plant community was most likely oak savanna. Although that would be a suitable goal for this site, it may be difficult to achieve given the existing levels of invasive species.

According to the 2006 State Wildlife Action Plan the suggested management options for grassland areas are to:

- Use mowing, cutting, herbicides and fire to prevent tree and shrub invasion
- Increase native plant species components
- Use light to moderate rotational grazing to benefit SGCN

In addition, DNR recommendations managing habitat for species of greatest conservation need (SGCNs) and monitoring SGCN populations.

B. Target Plant Communities

In determining target plant communities for restoration, we considered the following: historical conditions, existing conditions, and cost/benefits. For cost/benefit we consider the expense and potential ecological detriments of restoring a particular community versus the long-term benefit for wildlife and other habitat values. In some cases, a plant community succession may have advanced too far to warrant restoration to the historical condition. A very overgrown savanna, for example, may be better restored to woodland rather than savanna.

Based on our evaluation, it appears the park was most likely oak savanna and oak woodland historically. Savanna is imperiled in the landscape and given the current open canopy over most of the site, southern dry savanna would be the most suitable target community for the grassland. The target community for the existing woodland would be southern dry-mesic oak woodland (**Table 1**).

We further divided the grassland unit into two units. The goal for the main part of the site, the interior of the trail, would be oak savanna (Sav unit). South of the trail (Unit GRs) was treated somewhat differently due to the presence of numerous large boxelder trees as well as planted coniferous trees, which would make it difficult to restore to savanna. It would be difficult to maneuver equipment around all the trees and herbicide work and burning could damage them. While the trees could be removed to enable a full restoration, they do provide some habitat value and plant diversity, as well as a visual amenity for the park. However, the unit must still be managed to eradicate the invasive forb species, which would otherwise seed into the Sav unit.

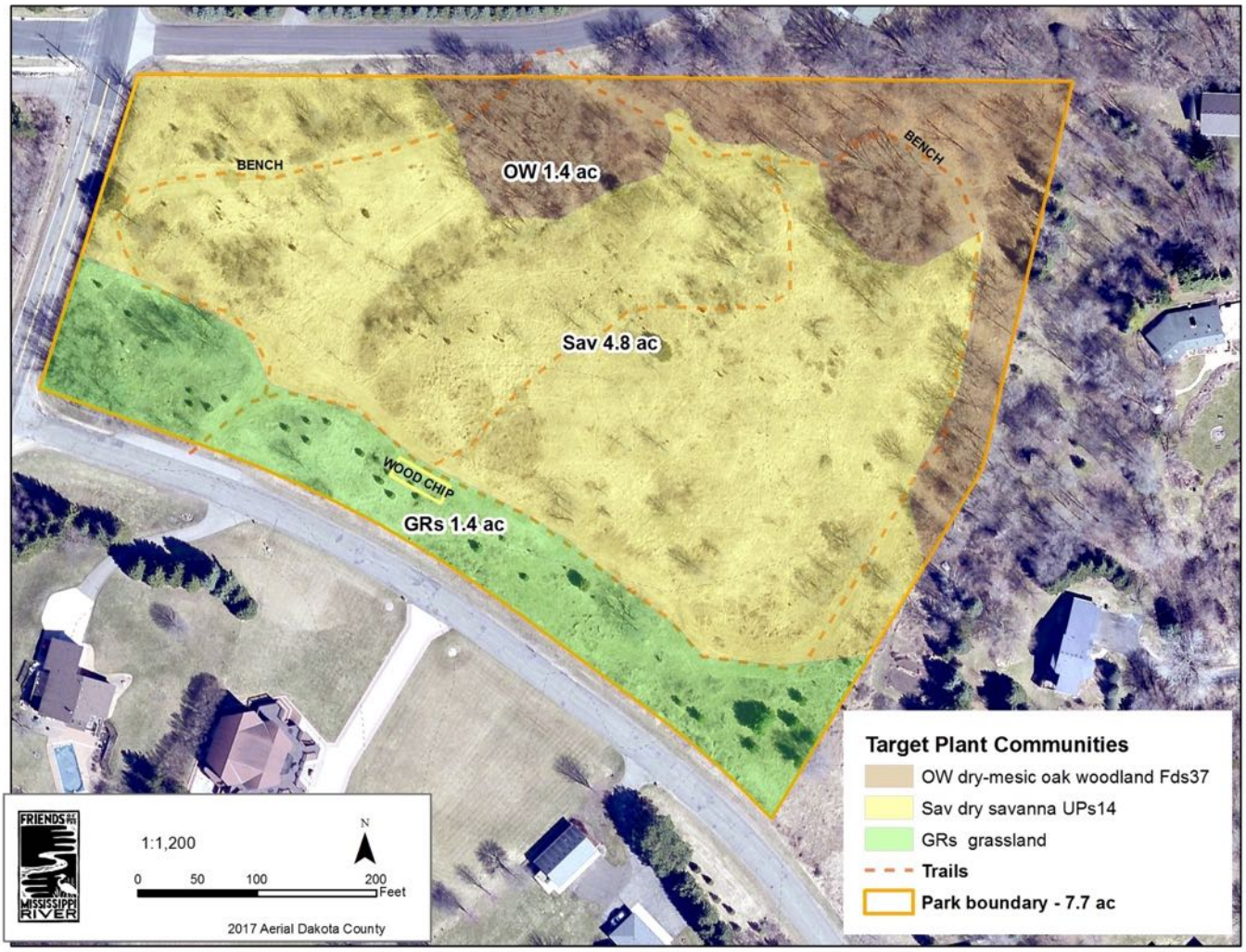
Table 1. Existing land cover and target plant communities

Management Unit	MLCCS Existing cover	Acres	Soil type	Target Plant Community
Sav	Grassland	4.8	Kingsley-Mahtomedi-Spencer complex 8-15% slope	Southern dry savanna UPs14
GRs	Grassland	1.4	Kingsley-Mahtomedi-Spencer complex 8-15% slope	Grassland
OW	Altered/non-native deciduous forest	1.4	Spencer silt loam (150B) 2 to 6 percent slopes	Southern dry-mesic oak woodland FDs37

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

Specific restoration goals and methods are described for each management unit in the next section.

Figure 12. Target Plant Communities for Restoration



C. Ecological Management Recommendations

While the specific restoration and management steps vary somewhat for each of the management units, the basic activities are the same for all units: eradicate non-native woody plants, eradicate non-native grass and forb species, re-establish native plants, and re-establish natural processes such as fire and grazing. The specific tasks for each unit are laid out in the **Restoration Tasks (Table 2).**

For all management activities, best management practices (BMPs) should be followed to minimize negative impacts, including soil compaction, rutting, and other soil disturbances; herbicide drift and non-target impacts; disturbance to nesting birds and other wildlife. BMPs include but are not limited to the following.

1. Management and restoration practices:

- Minimize non-target impacts:
    - Due to groundwater sensitivity, avoid broadcast application of water soluble herbicides.
    - Use foam applicator on cut stumps to eliminate overspray.
    - Protect pollinators –apply herbicide early or late in the day. Do not use neonicotinoid herbicides.
- Minimize herbicide use:
    - Hand-pull weeds where practical, e.g. low abundance of species that can be easily pulled, such as bittercress, hedge parsley, buckthorn seedlings.
    - Use foam applicators for stump treating
- When planting trees and shrubs consider spring and summer floral resources for pollinators, such as example, wild plum, prairie crab apple, elderberry, nannyberry, ninebark, chokecherry, American basswood and serviceberry, where ecologically appropriate.
- 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.
- Prevent soil compaction and rutting – avoid driving heavy equipment on site unless the ground is frozen.
- Conduct before and after vegetation surveys to monitor and evaluate the response of the plant community to the management methods.
- Use local ecotype seed and plant material. Seek genetic material that originated within 100 miles of the site. Favor plant material from the south, to assist with climate change adaptations.

2. Sav Unit – Southern dry savanna UPs14

Management Goals within 6 years:

1. Non-native trees and shrubs larger than ½ inch diameter have been eradicated.
2. Native shrub cover is no more than 25% and native tree cover is less than 10%.
3. Native grasses and forbs are dominant, with at least 75% cover.
4. At least 10 native forb species are present, with blooming plants June through August.
5. Native plugs and bur oak trees have been planted
6. Information on the pollinator populations is tracked over time.
7. Local community members are engaged in site stewardship.

Because the grassland is dominated by grasses and forbs (flowers) that are both non-native and extremely invasive, the best way to restore a diversity of native plants for wildlife habitat would be to essentially "start over." This would consist of eradicating most of the existing grass and flowering plants over a period of one or more growing seasons. To some extent, a few of the native plants could be protected, especially the cream gentian. However the native plant cover is very low and consists of species that are very easy to re-establish, such a bergamot. Some of the native plants – namely goldenrod – would best be reduced as they overtake a site and displace other plants.

The first step toward restoration of the SAV unit would be woody removal. While significant woody removal has already been completed, most of the remaining trees (e.g. Siberian elm, American elm, boxelder) can also be considered for removal (**Figure 13**), other than the red cedars and some of the black cherries. Likewise, any remaining non-native shrubs (buckthorn, honeysuckle, amur maple) should also be removed. There is an abundance of gray dogwood, which is a very good wildlife shrub. It may be getting to be a little too abundant, but some of the management activities like burning will help to keep it in check. Once the native grasses and flowering plants have been established, a few bur oak trees and a few additional native shrubs species, such as hazelnut and American plum, can be planted to complete the composition of the oak savanna.

After woody removal, restoration of the groundcover can begin. Due to the very invasive nature of the non-native species present, is unlikely that they will ever be completely eradicated. However, if native plants are used that are not only vigorous growers, but also resistant to the types of herbicides needed to treat the invasive plants, then the invasive plants can be greatly reduced and the site can support much greater native plant and animal diversity.

Long-term management

Once the restoration project is completed, a process that takes 3 to 5 years, the savanna will need regular monitoring and maintenance. Vegetation surveys should be completed at least annually to spot-treat invasive woody and weedy plants, preventing seed production as much as possible. Savanna habitat is an inherently transitional plant community that will tend toward forest if left unmanaged. It will need period prescribed fire, typically every 3 to 5 years, to reduce woody plants and rejuvenate prairie grasses and forbs. The timing of the burns should be rotated so that it is not always in the same season. Late spring burns are most common, and are most effective at

reducing the cool-season non-native grasses. But they can also be detrimental to native forbs is done repeatedly.

In the event that burning is not feasible, mowing can be used as a substitute, but should not entirely replace burning. Grazing was also an important component of historical savanna communities. Animals such as goats or sheep could be considered periodically for grazing the site.

It would be beneficial to avoid mowing the "sides" of the trails. Repeated mowing beyond the maintained trail tends to result in demise of the native plants that are trying to establish, and instead promotes the non-native invasive plant species. The regular maintenance of the site with prescribed fire and/or prescribed mowing is the best method for maintaining the native vegetation.

3. GRs Unit – Grassland

Management Goals within 6 years:

1. Non-native trees and shrubs larger than ½ inch diameter have been eradicated.
2. Non-native forbs have been eradicated.
3. Native grasses and forbs are present, with at least 40% cover.
4. Pollinator garden at south entrance has at least 10 native plant species and less than 10% weedy cover.

Although the planted coniferous trees in this unit are not native to a savanna plant community, they do provide some wildlife value could be left. Other than some of the smaller boxelder trees, we do not suggest removing trees in this unit. The presence of the trees will limit the degree to which native grasses and forbs can be established, so the goals for this site are primarily to eradicate the invasive plants to prevent them from seeding into the Sav restoration. This unit can be burned along with Sav, but will require protection around the conifers. Likewise, any herbicide use will need be a good distance away to prevent any drift. Ideally, a buffer planting of dense native grasses along the trail could be established, to prevent brome grass seed from reaching the Sav unit.

One option to enhance the south entrance to the park, and create some pollinator habitat, is to install a small demonstration garden. A triangular raised bed, about 28 feet on each side, could be installed at the entrance where the trail splits.

Photo 7. The triangle at the south entrance, about 360 sf, presents an opportunity to create a pollinator garden.

The grass should be sprayed first, then landscape timbers set in, and clean soil added. This would serve not only as an attractive amendment, but would also

benefit pollinators and could be instructive for visitors who may want to do something similar on their own properties.

The southwest corner of this unit is the mowed picnic area, with picnic table and large boxelder shade trees. We suggest that this area could be maintained as it is.

4. OW Unit - Southern dry-mesic oak woodland FDs37

Management Goals within 6 years:

- There are no non-native shrubs larger than 4 feet tall.
- Non-native shrubs less than 4 ft tall are less than 20% coverage.
- The cover of garlic mustard and narrowleaf bittercress throughout the site is less than 5%.
- Native plant ground cover is at least 50%.
- At least 8 new native forb species are present.

The first step at the woodland would be the same as the other units - remove non-native, invasive woody plants (primarily buckthorn). Much of this work has been completed but some remains, especially in the east and northeast. The unit can be burned, along with the Sav unit. Then the invasive woody plants should be treated. Creeping Charlie is not a significant long-term concern so would not need to be targeted, but the other invasive forbs (Appendix A), should be treated or hand-pulled. The unit can then be overseeded in fall with native woodland grasses. Wild rye should especially be used, as it grows quickly and can suppress buckthorn seedlings. A diversity of woodland wildlflowers can be added a few later, once the invasive species are essentially gone.

A second phase for the woodland restoration would be to increase the diversity of canopy tree species. The boxelder trees would be thinned out, starting with the smallest diameter trees. Native trees and shrubs can then be added to the woodland, such as bur oak, white oak, red maple, ironwood, American hazelnut, downy arrowwood, juneberry, red-berried elder, snowberry. Install local ecotype plants should be used, although genetic origin south of the park (e.g. 100-200 miles) could be considered as a step in aiding towards climate change.

Prescribed fire should be used to maintain forest health and regeneration and reduce seedling buckthorn and other invasives. Historically, light surface fires would have occurred occasionally (35-year rotation). Periodic light grazing can also be used (e.g. goats) to restore that function to the landscape.

5. Community Engagement

Involving community volunteers in ecological restoration activities and educational nature outings is very important for promoting a stewardship ethic for natural areas. The more that people learn about and are involved in a natural area the more they will care for it and support the long-term management and protection of it. The local community at River Heights Park has expressed a deep interest in this park, working hard to ensure that it remained a city park and was not developed for housing. As restoration and long-term management of this park continue, we recommend continuing that community engagement in the restoration plans and process. Specific activities community members could participate in include, but are not limited to the list below.

- Hauling woody debris, that has been cut and stump-treated, to a location for the city to remove.
- Cutting small-diameter woody stems (e.g. with loppers or hand-saws), and treating stumps.
- Hand-pulling certain weed species such as bittercress and hedge parsley
- Treating targeted plants such as burdock with a vinegar salt herbicide
- Annually in July lop any burdock that have produced flowers
- Surveying for invasive weeds such a knapweed and leafy spurge
- Pollinator surveys, conducted at least 3 times annually
- Planting native plants in the savanna and woodland
- Breeding bird surveys, annually in June
- Monitoring and tending native plantings
- Planting and maintaining a small pollinator garden at the south entrance

Many of these activities would require some initial training and possibly some follow-up. Friends of the Mississippi River has a long history of community engagement and has recruited thousands of volunteers over the years for these kinds of activities. FMR would be happy to work with the City to develop such a program.

6. Ecological Monitoring

Ecological monitoring of the site is critical to provide baseline data on starting conditions and to evaluate changes over time. Plant and animal surveys can be used to better inform management and to adapt and adjust methods as needed. Vegetation survey plots have not been established but a completed sitewide survey provides some baseline data. Annual surveys should be conducted at approximately the same time each year to provide the best comparative data. Ideally two surveys would be done to capture both early and late season species.

Regular site surveys should be done to monitor and evaluate the response of the plant community to the management methods and to identify new issues. Common buckthorn and honeysuckle are persistent species and new seed will continually be brought to the site from nearby areas. But the site is small, so if managed persistently, and especially with volunteer assistance, the invasive woody plants could be kept at bay.

In addition to vegetation surveys, continued pollinator surveys will serve as a very good means for monitoring the wildlife use and value of the site.

7. Alternative restoration options

The restoration and management tasks laid out in Table 2 would require a considerable commitment of time and funding resources. Friends of the Mississippi River has applied for partial funding from state grants, but at least twice as much will be needed to reach the full goals for the site. There will likely be opportunities for additional funding as the project progresses but there are also options to scale back the project. The invasive tree and shrub removal is mandatory. But the grassland management could be focused on just controlling the invasive forbs, not treating the whole site to also control the invasive grasses. It would also focus on

establishing native shrubs in targeted patches, rather than trying to establish a diversity of native prairie flowers. This method would retain the existing native forbs, and would not era

After a spring burn, Milestone herbicide could be used to only treat the patches of crown vetch, knapweed, spurge etc. Milestone is an aminopyralid herbicide that is very effective on most of the invasive forbs present at River Heights, but does not impact native grasses nor many native prairie forbs, such as milkweeds, carrot family, mint family, and certain asters. The result would still be many areas of dead vegetation, but not the whole site. Native grasses could then be seeded into the cleared areas in the fall. The invasive weeds all have long seed viability so they will continue to recur, but could continue to be treated each year, even as the native grasses are getting established. Plugs of native plants that are resistant to Milestone could also be planted in the gaps to increase the diversity of flowering plants. Selected native shrubs (e.g. hazelnut, rose, plum etc) could also be planted in the grassland to increase food for pollinators.

The non-native grasses could be targeted by applying herbicide in late September, when the native grasses are dormant. A glyphosate herbicide could be used or a grass specific, such as Clethodim. The site could be mowed in early August so that there herbicide would be applied to fresh growth.

This alternative method could reduce the cost by 25 or 30 percent. But, while neither method is likely to result in a “perfect” savanna restoration, the full-blown method would more likely result in a much greater abundance and variety of native plants, especially pollinator species.

D. Restoration Schedule

A five-year Work Plan (**Table 2**) was developed to provide guidelines toward achieving the target communities shown in **Figure 12**. The table shows the work phases, activities, schedules, and estimated costs. A general time frame is shown for each phase. Note that the costs shown are estimates, based on similar work at other sites, but actual costs may be higher or lower, depending on multiple variables. Costs shown also do not include project management or ecological tasks such as vegetation surveys and evaluation.

Table 2. Five Year Restoration Task Table

Year 1 - 2020

	Season	Ecological Task	Acres /Item	IGH	FMR Con-tractor	FMR - Vol-unteers	Detail	Estimated costs: FMR - contractor	IGH cash	IGH In-kind
1	Spr	NRMP updates and Community meeting					FMR staff		$ 650.00	
	Woodland 1.4 ac									
2	Spr-Fall	Invasive woody removal. (IGH staff & CCM crew)	1.4	x			Cut & stump treat non-native shrubs, American elm, green ash. Also approx 30-40 boxelder (less than 10" diam) and a few bl cherry. Forestry mow.			$ 18,000.00
3	Spr	Invasive weed control	1.4	Once in May/June			Spot-spray invasive weeds where forestry mow doesn't reach - burdock, bittercress, hedge parley - before seeds form.		$ 100.00	$ 700.00
4	Jul-Oct	Invasive weed control	1.4		x		Spot-spray invasive weeds - burdock, bittercress, hedge parley - before seeds form. 1-2 visits	$ 1,260.00		
5	Late Sept/earl y Oct.	Follow-up invasive woody control	1.4		x		Foliar spray new seedlings and resprouts. No later than early Oct. Trycera.	$ 420.00		
6	Jul	Purchase woodland grass seed	1.4	x			Grass mix (e.g. Virg wild rye, silky rye, switch grass, bottlebrush grass, Canada wild rye, hairy wood chess, nodding fescue, long-beaked sedge).		$ 840.00	
7	Late fall	Broadcast woodland seed	1.4	x			Broadcast native oak woodland seed mix.			$ 600.00
	Savanna & south Grassland 6.2 ac total									
8	Wntr/spr	Invasive woody removal.	6.2	x			Hand-cut & stump treat non-native shrubs (buckthorn, honeysuckle, Amur maple) plus American elm, green ash, Siberian elm, and targeted native trees (about 45 trees, most small diam). Stumps must be **FLUSH** to ground (opt - forestry mow stumps).			$ 2,000.00
9	Wntr/spr	Limb up conifers to enable Rx burn		x			Limb up conifers to enable Rx burn			$ 500.00
10	May	Invasive weed control	6.2	x			Broadcast spray Sav & GRs for invasive forbs (Milestone), and invasive grasses (Clethodim). FMR will flag areas to protect.		$ 150.00	$ 1,000.00
11	Summer	Pollinator survey - at least 3 times	4.8			x	FMR provides vol training in June.		$ 320.00	
12	Jul/Aug	Rx burn	6.2		x		May need 2nd spray before burn. Protect conifers from fire.	$ 3,500.00		
13	Aug-Oct	Invasive weed control - **twice**	6.2		x		Spray entire unit for invasive forbs (Milestone), and invasive grasses (Clethodim).	$ 3,720.00		
14	late Sept	Seed collection	2			x	FMR and vols			

Year 1, Savanna and South Grassland, continued

15	Jul	Purchase seed	6.2		x		Mostly grasses. Moderate amt of Milestone tolerant forbs - 15 spp	$ 4,340.00		
16	Oct	Drill seed - native grass mix	6.2		x		May be more optimal to drill in spring.	$ 1,860.00		
17	Aug	Install demo garden		x	x	x	28 ft triangle at south entrance, 360 sf. **City site prep:** Site prep: Spray or/or scrape planting area by mid-July. After planting, install weed barrier & mulch along perimeter **FMR**: Add clean soil after site prep. Vols install about 300 plugs. Preen to prevent weeds. Two inches shredded hardwood mulch.		$ 1,075.00	$ 800.00
								$ 15,100.00	**$ 3,135.00**	**$ 23,600.00**

Year 2 - 2021

	Season	Ecological Task	Acres /Item	IGH	FMR Con-tractor	FMR - Vol-unteers	Detail	FMR - contractor	IGH cash	IGH In-kind
	Woodland									
18	Spr-Fall	Invasive weed control	1.4		x		Spot-spray or mow invasive weeds - burdock, bittercress, hedge parley - before seeds form. 2 to 3 visits	$ 1,260.00		
19	Late Sept/earl y Oct.	Follow-up invasive woody control	1.4		x		Foliar spray new seedlings and resprouts. No later than early Oct. Trycera or Krenite	$ 840.00		
	Savanna & south Grassland 6.2 ac total									
20	Spr-Fall	Mowing 2-3X	6.2	x			Flail mow, when vegetation is 12-16", down to minimum height of 6". Prevent weed seed formation.			$ 3,300.00
21	Summer	Pollinator survey - at least 3 times	4.8			x	FMR provides vol training in June.		$ 320.00	
22	May-Oct	Maintain demo garden				x	Weeding/tending every 2 weeks.			
23	late Sept	Seed collection	4.8			x	FMR and vols		$ 315.00	
								$ 2,100.00	**$ 320.00**	**$ 3,300.00**

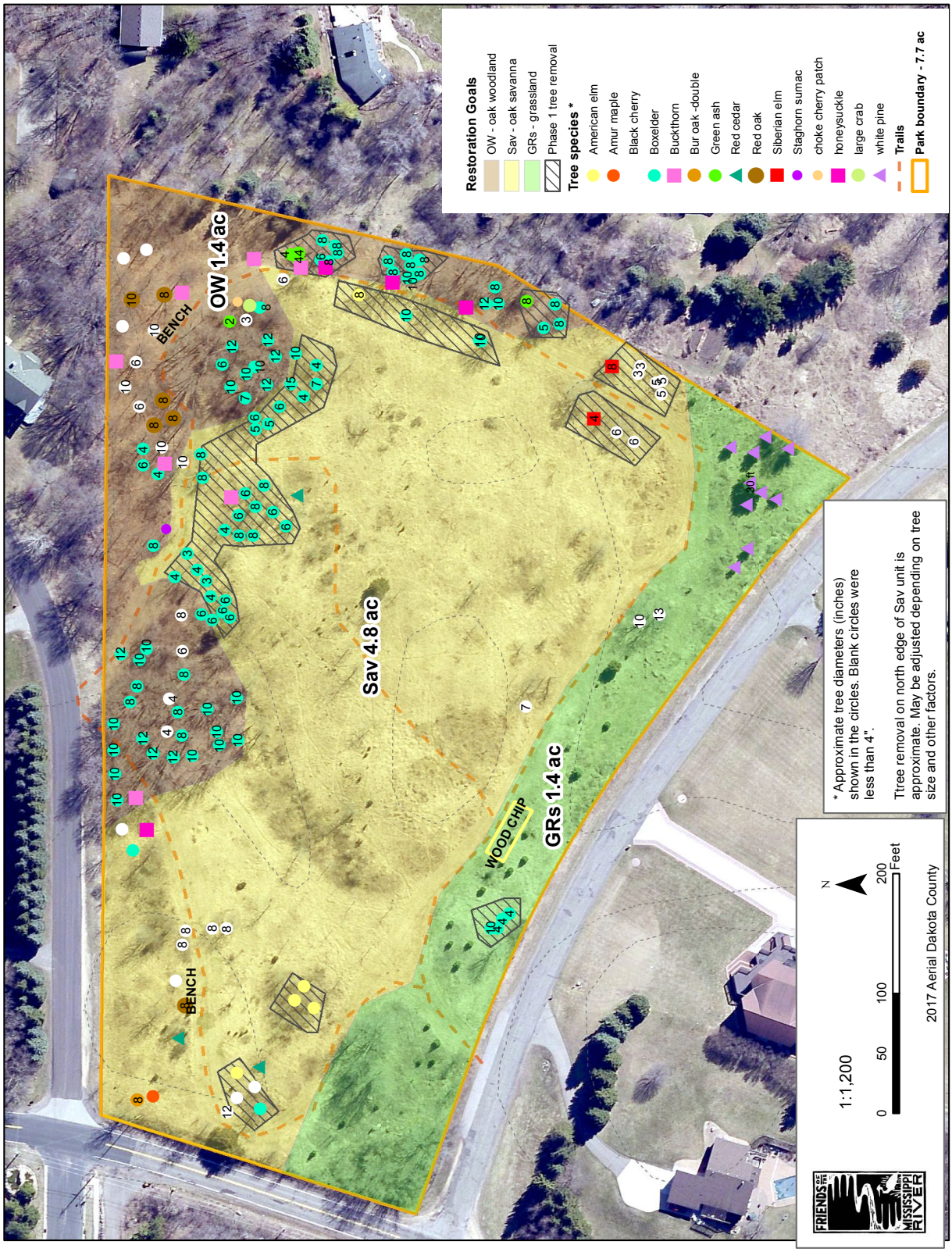
Year 3 - 2022

	Season	Ecological Task	Acres /Item	IGH	FMR Con-tractor	FMR - Vol-unteers	Detail	FMR - contractor	IGH cash	IGH In-kind
	Woodland									
24	Spr-Fall	Invasive weed control	1.4		x		Spot-spray invasive weeds - burdock, bittercress, hedge parley - before seeds form.	$ 700.00		
25	Fall	Follow-up invasive woody control	1.4		x		Foliar spray new seedlings and resprouts. No later than early Oct. Trycera or Krenite	$ 700.00		
	Savanna & south Grassland 6.2 ac total									
26	Spr-Fall	Mowing 1X	6.2	x			Flail mow, when vegetation is 12-16", down to minimum height of 6".			$ 1,100.00
27	Spr-Fall	Invasive weed control	6		x		Spot-spray (spot mow if needed) invasive forbs, prevent seed formation. 3 visits	$ 5,400.00		
28	Summer	Pollinator survey - at least 3 times	4.8			x	FMR provides vol training in June.		$ 350.00	
29	May-Oct	Maintain demo garden				x	Weeding/tending every 2 weeks.		$ 185.00	
30	late Sept	Seed collection	4.8			x	FMR and vols		$ 350.00	
								$ 6,800.00	**$ 885.00**	**$ 1,100.00**

Year 4 - 2023

	Season	Ecological Task	Acres /Item	IGH	FMR Con-tractor	FMR - Vol-unteers	Detail	FMR - contractor	IGH cash	IGH In-kind
	Woodland									
31	Spring	Rx burn	1.4		x		Rx burn along with Savanna	$ 4,000.00		
32	Spr or fall	Purchase woodland trees and shrubs	1.4		x		FMR can likely purchase the plant material	$ 1,000.00		
33	Spr or fall	Woodland planting	1.4			x	Install native trees and shrubs, with mulch & protective fencing.		$ 1,450.00	
34	Spr-Fall	Tending Woodland planting				x	Water, weeding			
35	Spr-Fall	Invasive weed control	1.4		x		Spot-spray invasive weeds - burdock, bittercress, hedge parley - before seeds form.	$ 560.00		
36	Fall	Follow-up invasive woody control	1.4		x		Foliar spray new seedlings and resprouts. No later than early Oct. Trycera or Krenite	$ 700.00		
	Savanna & south Grassland 6.2 ac total									
37	Spring	Rx burn, include woods	7.5		x		Protect conifers	$ 3,700.00		
38	Spr-Fall	Invasive woody and weed control	6.2		x		Spot-spray (spot mow if needed) invasive woody plants and forbs, prevent seed formation. 1 visits	$ 1,860.00		
38	Summer	Pollinator survey - at least 3 times	4.8			x	FMR provides vol training in June.		$ 360.00	
40	May-Oct	Maintain demo garden				x	Weeding/tending every 2 weeks.		$ 185.00	
41	late Sept	Seed collection	4.8			x	FMR and vols		$ 360.00	
								$ 11,820.00	**$ 2,355.00**	**$ -**
							4-YEAR TOTAL	**$ 35,820.00**	**$ 6,695.00**	**$ 28,000.00**

Figure 13. Work Units and Restoration Tasks



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- http://dnr.wi.gov/invasives/index.htm
- http://www.inhs.uiuc.edu/chf/outreach/VMG/lspurge.html
- http://mdc.mo.gov/nathis/exotic/vegman/sixteen.htm
- http://72.57.47.107/plantsincanada/invasive/factsprg.html
- MN Natural Resources (DNR): http://www.dnr.state.mn.us/nr/index.html

Natural history of MN, bibliography (DNR):

http://www.dnr.state.mn.us/snas/naturalhistory_resources.html

Landscaping with Native Plants:

http://www.dnr.state.mn.us/gardens/nativeplants/index.html

Appendix A: Plant Species Recorded at the River Heights Park

The following plant species were identified at River Heights Park by Friends of the Mississippi River in 2019. Species in red font are invasive species that should be eradicated.

Grassland Species

Non-nativ		Scientific Name	Common Name	Rel Cov*	Notes (dbh inches)
	CANOPY >20 ft		**>30 ft**	**2.0**	
		Acer negundo	boxelder	2.0	3-8"
		Fraxinus pensylvanica	green ash		
		Prunus serotina	black cherry	1.0	
		Quercus macrocarpa	bur oak	0.5	double trunk, 8" dbh
		Quercus rubra	red oak	0.5	one 8"
		Ulmus americana	American elm	1.0	One dying 8"
x		*Ulmus pumila*	Siberian elm	1.0	one 8"
	SUBCANOPY 8-20 ft			**1.0**	
		Acer negundo	boxelder	0.5	
		Fraxinus pensylvanica	green ash		
		Juglans nigra	black walnut	1.0	8 trees
		Juniperus virginiana	red cedar	1.0	5 trees
		Malus sp	crab apple		
		Picea sp	Spruce	1.0	16 - south edge
		Pinus strobus	white pine	1.0	10 - SE corner
		Prunus serotina	black cherry	1.0	
		Prunus virginiana	choke cherry		
		Quercus rubra	Red oak	0.5	
		Ulmus americana	American elm	1.0	
x		*Ulmus pumila*	Siberian elm	0.5	1
	SHRUBS 3-8 ft			**1.0**	
x		*Acer ginnala*	amur maple	+	
		Acer negundo	Boxelder	1.0	
		Cornus racemosa	gray dogwood	2.0	
		Juniperus virginiana	red cedar	1.0	
x		*Lonicera tartarica*	Tartarian honeysuckle	1.0	
x		*Rhamnus cathartica*	common buckthorn	1.0	
		Rhus typhina	staghorn sumac	1.0	
x		*Robinia pseudoacacia*	black locust	+	east property line
		Rubus ideaus	red raspberry	2.0	
		Ulmus americana	American elm	0.5	
	GROUND LAYER <3 ft				
		Deciduous		**2.0**	
		Cornus racemosa	gray dogwood	2.0	Abund N & W edges
		Fraxinus pensylvanica	green ash	+	
x		*Lonicera tartarica*	Tartarian honeysuckle	1.0	
		Prunus serotina	black cherry	1.0	
x		*Rhamnus cathartica*	common buckthorn	1.0	
		Rhus glabra	smooth sumac	+	
		Rubus pubescens	dwarf raspberry	+	
		Zanthoxylum americana	prickly ash	1.0	
		Parthenocissus inserta	Virginia creeper	2.0	
		Vitis riparia	Wild grape vine	2.0	
		Graminoids		**4.0**	
x		*Bromus inermis*	smooth brome	2.0	
		Carex sp	sedge	1.0	
		Elymus canadensis	Canada wild rye	1.0	
x		*Elymus repens*	quackgrass	1.0	
x		*Poa pretensis*	Kentucky bluegrass	2.0	
		Sorghastrum nutans	Indiangrass	+	

Grassland (continued)

Non-native	Scientific Name	Common Name	Rel Cov*	Notes (dbh inches)
	Herbaceous cover & ferns		**4.0**	
	Achillea millefolium	yarrow	2.0	
	Anemone cf cylindrica	thimbleweed	1.0	could be A. virginiana
	Antennaria plantaginifolia	plantain-leaved pussytoes	1.0	
x	*Arctium minus*	burdock	1.0	
	Asclepias syriaca	common milkweed	1.0	
x	*Asparagus officinalis*	asparagus	+	
	Athrium felix-femina	lady fern	+	Area recently cleared of buckthorn
	Brassica rapa	field mustard	1.0	
x	*Centaurea stoebe*	spotted knapweed	1.0	
x	*Cirsium canadense*	Canada thistle	1.0	
	Erechtites hieraciifolius	pilewort	+	
	Erigeron strigosus	daisy fleabane	1.0	
x	*Euphorbia virgata*	leafy spurge	1.0	SE corner
	Galium aparine	cleavers	+	
	Gentiana flavida	cream gentian	+	SE corner, inside trail.
x	*Melilotus alba*	white sweet clover	+	
	Monarda fistulosa	bergamot	+	
x	*Potentilla recta*	sulfur cinquefoil	+	
x	*Rumex crispus*	curly dock	+	
x	*Securigera varia*	crown vetch	2.0	dom
x	*Silene latifolia*	white campion	+	
	Solidago canadensis	Canada goldenrod	3.0	dom
	Solidago gigantea	late goldenrod	2.0	dom
	Solidago rigida	stiff goldenrod	1.0	
	Symphyotrichum laeve	smooth aster	1.0	
x	*Taraxacum officinale*	dandelion	1.0	
	Urtica dioica	stinging nettle	1.0	
x	*Verbascum thapsus*	common mullein	1.0	
x	*Vicia cracca*	cow vetch	+	

* Relative Cover: 0.5= <1%, 1 =1-5%, 2=5-25%, 3=25-50%, 4=50-75%, 5=75-100%

Woodland species

Non-native		Scientific name	Common name	Rel Cov*	Note/ diam (inches)
	CANOPY >20 ft			**3**	
		Acer negundo	Boxelder	3	82 trees, median size 8"
		Fraxinus pensylvanica	green ash	1	8 trees 8", 4 trees 4"
		Prunus serotina	Black cherry	2	32 trees, avg 9"
		Quercus rubra	red oak	1	6 trees, mostly 8"
		Ulmus americana	American elm	1	
	SUBCANOPY 8-20 ft				
		Scientific name	**Common name**	**2**	
		Acer negundo	Boxelder	1	20 trees
		Fraxinus pensylvanica	green ash	1	4 trees
		Malus	crab apple	+	1 large
		Prunus sp	plum	1	1 large
		Prunus serotina	black cherry	2	
		Prunus virginiana	choke cherry	1	
		Quercus rubra	red oak	0.5	
		Ulmus americana	American elm	0.5	
	SHRUBS 3-8 ft				
		Scientific name	**Common name**	**3**	
		Acer negundo	Boxelder	2	
		Cornus alternifolia	pagoda dogwood	+	
		Cornus racemosa	gray dogwood	0.5	
x		*Lonicera tatarica*	Tatarian honeysuckle	1	
x		*Rhamnus cathartica*	common buckthorn	2	Large dense stems, up to 3", east side.
		Ulmus americana	American elm	1	
	GROUND LAYER <3 ft				
		Deciduous and vines		**2**	
		Acer negundo	boxelder	1	
x		*Lonicera tatarica*	Tatarian honeysuckle	1	
		Prunus serotina	black cherry	1	
		Quercus rubra	Red oak	+	
x		*Rhamnus cathartica*	common buckthorn	1	
		Ribes missouriensis	Missouri gooseberry	1	
		Rubus occidentalis	blackcap	2	
		Ulmus americana	American elm	1	
		Parthenocissus inserta	Virginia creeper	2	
		Sambucus racemosa	red-berried elder	+	
		Vitis riparia	Wild grape vine	2	
		Herbaceous cover & ferns		**4**	
		Ageratina altissima	white snakeroot	1	
x		*Arctium minus*	burdock	3	
		Asclepias syriaca	common milkweed	1	
		Boehmeria cylindrica	false stinging nettle	+	
x		*Cardamine impatiens*	narrow-leaf bittercress	1	
		Circea lutetiana	enchanter's nightshade	1	
		Galium triflorum	fragrant bedstraw	1	
		Geum canadense	white avens	+	
x		*Glechoma hederacea*	creeping Charlie	4	
		Solidago canadensis	Canada goldenrod	1	
		Solidago gigantea	late goldenrod	1	
x		*Torilis japonica*	Japanese hedge parsley	1	
		* Relative Cover: 0.5= <1%, 1 =1-5%, 2=5-25%, 3=25-50%, 4=50-75%, 5=75-100%			

Appendix B: Plant Species for Restoration

The following lists include species suitable for the plant community restorations at River Heights Park. Not all species may be commercially available and there may be additional appropriate species not listed here. In general, species selected for this site should be very easy to establish species that are strong competitors.

Southern Dry Savanna (UPs14)

	Scientific name	Common name	Milestone tolerant
	Forbs		
1	*Agastache foeniculum*	Anise hyssop	x
2	*Allium stellatum*	Prairie wild onion	x
3	*Amorpha canescens*	leadplant	x
4	*Asclepias syriaca*	Common milkweed	x
5	*Asclepias tuberosa*	Butterflyweed	x
6	*Coreopsis palmata*	Coreopsis	x
7	*Dalea candida*	White prairie clover	x
8	*Dalea purpurea*	Purple prairie clover	x
9	*Desmodium canadense*	Showy tick-trefoil	x
10	*Heliopsis helianthoides*	early sunflower	x
11	*Lespedeza capitata*	Round-headed bush clover	x
12	*Liatris aspera*	Rough blazing star	x
13	*Liatris ligulostylis*	Meadow blazing star	x
14	*Lupinus sericeus*	wild lupine	x
15	*Monarda fistulosa*	Wild bergamot	x
16	*Penstemon grandiflorus*	Large-flowered penstemon	x
17	*Symphyotrichum ericoides*	Heath aster	x
18	*Symphyotricum laeve*	Smooth blue aster	x
19	*Symphyotricum oolentangiense*	Sky-blue aster	x
20	*Verbena stricta*	hoary vervain	x
21	*Zizia aptera (or aurea)*	Heart-leaved Alexanders	x
	Graminoids		
1	*Andropogon gerardii*	big bluestem	**Small amt**
2	*Bouteloua curtipendula*	Sideoats grama	
3	*Schizachyrium scoparium*	Little bluestem	
4	*Sporobolus heterolepis*	Prairie dropseed	
5	*Sorghastrum nutans*	Indian grass	

Southern Dry-Mesic Oak Woodland (FDs37)

	Scientific name	Common Name
	Forbs, ferns	
1	*Amphicarpaea bracteata*	hog-peanut
2	*Anemone quinquefolia*	wood anemone
3	*Aquilegia canadensis*	columbine
4	*Aralia nudicaulis*	wild sarsaparilla
5	*Aster macrophyllus*	large-leaved aster
6	*Athyrium filix-femina*	lady-fern
7	*Circaea lutetiana*	enchanter's nightshade
8	*Desmodium glutinosum*	pointed-leaved tick-trefoil
9	*Galium triflorum*	three-flowered bedstraw
10	*Geranium maculatum*	wild geranium
11	*Maianthemum canadense*	Canada mayflower
12	*Osmorhiza claytonii*	Clayton's sweet cicely
13	*Polygonatum biflorum*	giant Solomon's-seal
14	*Smilacina racemosa*	false Solomon's-seal
15	*Smilacina racemosa*	starry false solomon's seal
16	*Thalictrum dioicum*	early meadow-rue
17	*Uvularia grandiflora*	large-flowered bellwort
	Graminioids	
1	*Carex pensylvanica*	Pennsylvania sedge
2	*Elymus hystrix*	bottlebrush grass
3	*Festuca subverticillata*	nodding fescue
4	*Oryzopsis asperifolia*	mountain rice grass
	Shrubs	
1	*Amelanchier spp*	Juneberry
2	*Cornus racemosa*	gray dogwood
3	*Cornus rugosa*	round-leaved dogwood
4	*Corylus americana*	American hazelnut
5	*Corylus cornuta*	beaked hazelnut
6	*Diervilla lonicera*	bush honeysuckle
7	*Prunus virginiana*	chokecherry
8	*Ribes cynosbati*	gooseberry
9	*Ribes missouriense*	Missouri gooseberry
10	*Sambucus racemosa*	red-berried elder
11	*Symphoricarpos*	snowberry
12	*Viburnum rafinesquianum*	downy arrow-wood
13	*Viburnum lentago*	nannyberry
	Canopy Trees	
1	*Acer rubrum*	Red maple
2	*Ostrya virginiana*	Ironwood
3	*Quercus alba*	white oak
4	*Quercus macrocarpa*	bur oak
5	*Quercus rubra*	northern red oak

Appendix C: 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 the state of Minnesota will not be conducive for 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 that surrounding Oklahoma City. The state 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 able to be mitigated or averted. By promoting healthy oak woodland and oak savanna ecosystems, the potential negative shift from unsustainable land management expectations and serious loss of diversity can occur by focusing on strategies emphasizing resistance and resilience. Appropriate actions could "mimic," assist, or enable ongoing natural adaptive processes such as species dispersal and migration, population mortality and colonization, changes in species dominance and community composition, and changing disturbance regimes.

According to the DNR Wildlife Action Plan 2015-2025, climate change impacts anticipated for forested areas include:

> "Insect damage, larger blowdown areas, droughts, and fire are expected to interact, resulting in many forests, particularly ones on marginal soils, becoming savannas. Invasive species, including earthworms, may limit the establishment and growth of native tree seedlings and other understory plants (Galatowitsch et al. 2009).
>
> Deciduous forests within the prairie-forest border are severely fragmented by agriculture and urban/ suburban sprawl. Should fragmentation increase, thereby creating smaller forest patches and increasing edge habitat, the ability of some plant and animal species to adapt to climate change could become progressively limited. Reasons for this include increased predation on wildlife, the spread of invasive species, and competition from other native species that prefer forest edge."

Appendix D: List of Noxious and Invasive Plants

Numerous annual, biennial or perennial plants have been designated by the Minnesota Commissioner of Agriculture as being injurious to public health and the environment. A few of the most common species are listed below. Bolded species have been found at River Heights Park. The site should be monitored regularly for any other species and control measures taken immediately if any are detected.

- Oriental Bittersweet: a fast-growing vine that overwhelms other plant communities.
- **Common or European Buckthorn**
- Glossy Buckthorn: a great threat to wetlands, where it can form dense stands that cause the growth of other species to be suppressed. It is also an alternative host to fungi that infects oats.
- **Tatarian Honeysuckle**: displace native plants in grassland, savanna, forest edges and open woodland.
- Multi-flora Rose: forms small to large infestations often climbing into trees, invades forest and forest margins.
- Garlic Mustard: significant negative impact on forest understory.

Additional specially regulated plants that have the potential to cause harm in non-controlled environments include:

- Giant Knotweed: forms dense stands where it can crowd out native vegetation.
- Japanese Knotweed: forms dense thickets that exclude native vegetation and greatly alters ecosystems.

The MN DNR also maintains a list of additional invasive, terrestrial plants, below. Bolded species were found at River Heights. All of these species are considered detrimental to native plant communities and should be managed, with the possible exception of creeping Charlie. Unless in a very localized area, this species is too pervasive to be able to control it. However, it does not tend to completely impede native species. Additional species that should also be managed, and were found at River Heights are: burdock, curly dock, and Kentucky bluegrass.

amur maple
amur silver grass
birdsfoot trefoil
black locust
black swallowwort
British yellowhead
bull thistle
butter and eggs
Canada thistle
common tansy
common teasel
cow vetch
creeping Charlie
crown vetch
cut-leaved teasel
dalmation toadflax
giant hogweed
Grecian foxglove
hairy vetch
hoary alyssum
Japanese barberry
Japanese hedge-parsley
Japanese hops
leafy spurge
meadow knapweed
musk thistle
narrowleaf bittercress
phragmites
Norway maple
orange hawkweed
oxeye daisy
perennial sow thistle
poison hemlock
purple loosestrife
Queen Ann's Lace
reed canary grass
Russian olive
Siberian elm
Siberian pea shrub
smooth brome grass
spotted knapweed
tree of heaven
white sweet clover
yellow sweet clover
wild parsnip
yellow iris
yellow star thistle