SPRING LAKE PARK RESERVE

ECOLOGICAL RESTORATION PLAN FOR SOUTH ARCHERY TRAIL

Prepared for:
Dakota County Parks

Prepared by:
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This Natural Area Management Plan and Work Plan has been reviewed and approved by:

Dakota County

Steve Sullivan_____Date: _____
Parks Director

Bruce Blair _____Date: _____
Manager of Park Development and Natural Resources

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EXECUTIVE SUMMARY

This document was developed at the request of Dakota County Parks, for a portion of the Spring Lake Park Reserve. The specific project area is about 41 acres located at the south archery trail. This portion of the park is located in the City of Rosemount, while much of the park to the east is located in Nininger Township. Although the property contains no known rare plant or animal species, it is part of a much larger habitat complex along the Mississippi River and provides important wildlife habitat and water quality benefits. A mesic oak forest at the site was identified by the Department of Natural Resources (DNR) in 1992 as important for its biodiversity significance. It has been identified as ecologically important by the Dakota County Farmland and Natural Areas Protection Plan, is located in the Mississippi Greenway, and is within the Metro Conservation Corridors, a regional land protection plan of the DNR. It is also located within an Audubon Important Bird Area – a designation given to sites that provide essential habitat for vulnerable or threatened groups or individual species of birds.

Historically, the property was likely dominated by oak savanna and oak forest. After European settlement, the property was used for crops and pasture. The site has been owned by Dakota County Parks since 1975. Most of it is currently non-native dominated grassland with scattered trees, while oak forest still occupies the northwest portion. Black walnut trees were planted in the grassland, and in the absence of regular fire, trees and shrubs have further increased the woody cover. Management has reduced the non-native species, but has not been sufficient to eradicate it and encroachment by both native and non-native woody species has spread over the years. Prairie and oak savanna habitats are some of the most rare habitats in the state and over 99% of these communities have been converted agriculture or other development.

This document describes the recommendations, methods and approximate costs for enhancing the ecological health of this project area and restoring natural communities. The primary proposed restoration involves removing invasive native and non-native shrubs and trees throughout the site, restoring the grassland to prairie and savanna, and enhancing the woodland and forest.

If approved by Dakota County Parks, Friends of the Mississippi River is committed to collaborating on the long-term management and restoration of this site.

INTRODUCTION

This Natural Resource Management Plan presents the site analysis and recommended management and land use activities for the 41-acre project area at the South Archery Trail in Dakota County Spring Lake Park Reserve in Rosemount.

Prior to European settlement, the vegetation at the project area consisted primarily of oak savanna – 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, leading to invasion of woody and non-native invasive species. Similarly, the South Archery Trail has been altered by many decades of pasture and cultivation, lack of natural fire, and invasion of non-native species. Vegetated cover currently consists of about 33 acres of non-native dominated grassland with scattered trees and brush; 6.5 acres of mesic oak forest, and 2.1 acres of woodland.

This plan was developed to:

- Identify the existing condition of natural communities on the property
- Identify target natural communities and restoration goals
- Identify methods for improving the wildlife habitat value of the property

Ecological Management Goals for the Property

The over-arching goal for the property is to restore ecological functions so that, where appropriate, the property approximates conditions and functions that would have been present at the time of European settlement, approximately 1840. Historic conditions are not always appropriate when succession has moved a community too far in one direction, or where there are other desired uses for a site, such as recreation. The existing conditions at the South Archery Trail, however, lend themselves well to full ecological restoration, which would be fully compatible with the recreational uses of the site.

Specific ecological and cultural goals are to:

- Restore a complement of native plant communities
- Improve wildlife habitat
- 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
- Utilize this property to enhance and expand the ecological functions of the property and of the larger Metro Conservation Corridor and Mississippi River Greenway.

SITE INFORMATION

LOCATION AND GOVERNANCE

Size of Project Area: 41 acres

Legal Description: T115N, R18W, Sections 21

Watershed: Vermillion River

Watershed Management Organization: Vermillion River Joint Powers Organization

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

Primary Site Administrator:
Dakota County Parks Department

LANDSCAPE CONTEXT

Proximity to established greenways

Several different greenway corridor-planning efforts have taken place in Dakota County to designate the most important parcels to consider for permanent protection and/or natural resource restoration, based on various ecological criteria. Spring Lake Park falls within the Metro Conservation Corridors, a regional land protection plan of the Department of Natural Resources (DNR) (**Map 1**) and the Mississippi Greenway - a local greenway plan developed for Hastings and surrounding communities. Spring Lake Park is also located within the Mississippi National River and Recreation Area, a 72-mile park established by Congress in 1988 and is within an Important Bird Area, which is a designation of the Audubon Society for sites that provide critical habitat to individuals or groups of vulnerable bird species. In this case, the Mississippi River is a migratory flyway for 40 percent of North American waterfowl, and for dozens of bird species in need of conservation due to population declines.

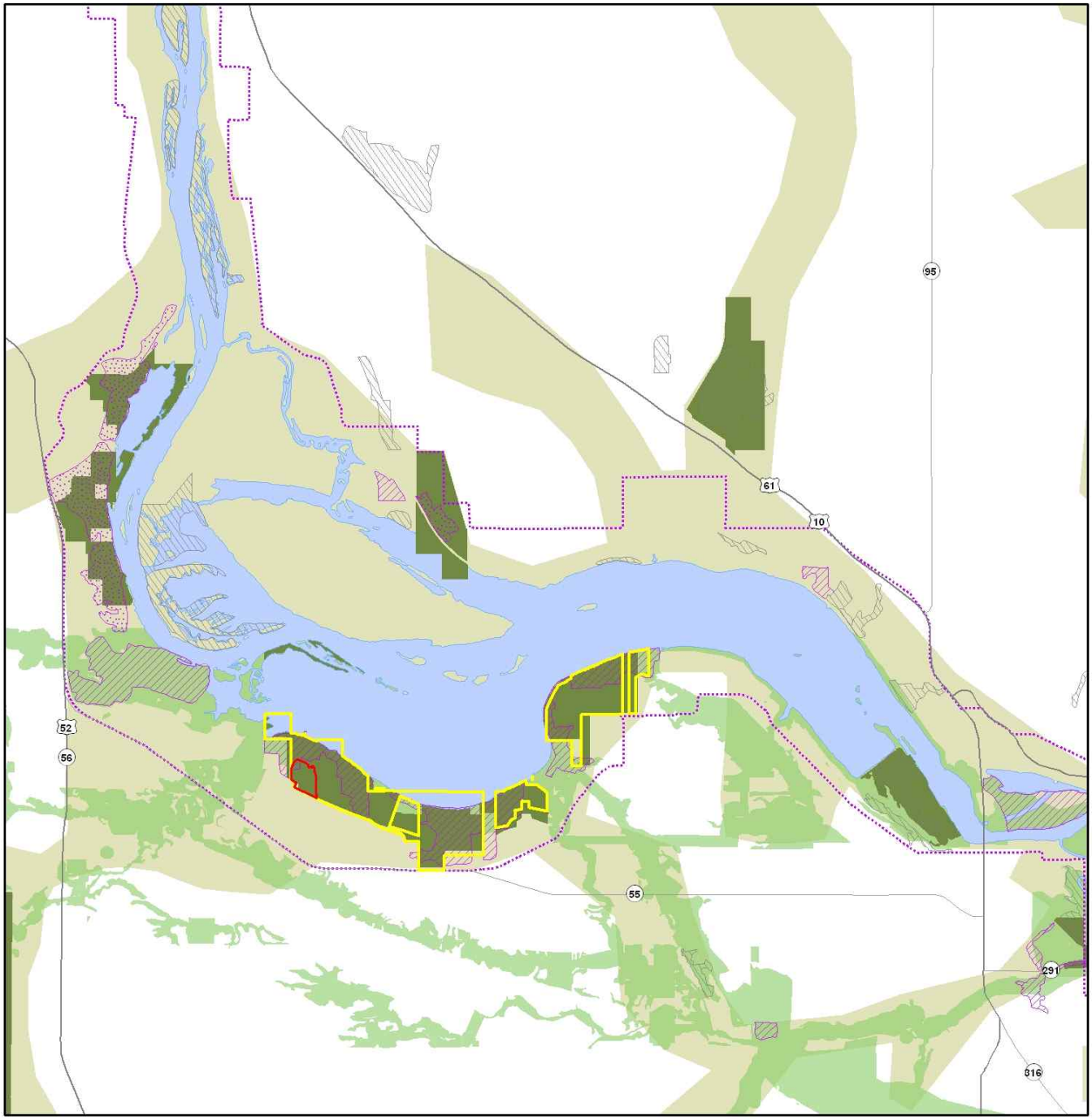
Ecological significance and wildlife value

Spring Lake Park is a significant ecological feature in the landscape due to its location along the Mississippi River, its proximity to other natural areas, and for the diversity and quality of the natural area within the park. The Mississippi River is a globally significant flyway for migratory birds, with 60% of North American species using the corridor. The park provides important 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 downstream from the Pine Bend 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

SNA. A short distance downstream from the park is the Gores Pool WMA, the largest and most diverse bottomland forest in the southern part of the state. And across the river from the park is Grey Cloud Dunes SNA, a high diversity dry prairie on the river terrace. The park serves as a connector between all of these natural areas, and itself contains forested and grassland habitats with very good diversity.

The 41-acre project site is primarily grassland, dominated by non-native grasses, with a fairly abundant woody component. Encroachment by smooth sumac, prickly ash and small trees is pushing the grassland toward woodland. About 7 acres in the northwest corner is part of a much larger mesic oak forest that extends west, north and east of the project site. This forest was designated in the DNR county biological survey as high biodiversity significance (**Map 1**). Several rare plants and animals are found within Spring Lake Park and along the river, though none in the project area.

MAP 1. LANDSCAPE CONTEXT



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1:85,000

0 0.5 1 2 Miles

Project Area (41 ac)
Spring Lake Park
MNRRA corridor
Parks, WMAs, SNAs
Mississippi Greenway
Metro Conservation Corridors

Biological Diversity
Outstanding
High
Moderate

SITE GEOLOGY

Geologic formation and bedrock
The project area is located on the middle of three terraces of the Mississippi River **(Map 2)**, which were formed by riparian deposits from the Glacial River Warren. Located on the terrace plateau, the terrain of the project site is fairly level, with slight knolls and ridges. The elevation varies just 34 feet across the site, from a maximum of 818 feet above sea level at the peaks of small rises at the south end, to 784 feet in the northwest corner. The edge of the terrace, with 25 percent slopes, is just offsite to the north and a ravine passing through the wooded northwest corner of the site feeds into it.

Bedrock at this site consists of the Prairie du Chien group - marine sedimentary rocks formed by ancient shallow seas that covered the area. Prairie du Chien bedrock contains the Prairie du Chien aquifer over much of its expanse. The depth to both is about 51 to 100 feet at this location and groundwater flows toward the northeast. This aquifer underlies most of Dakota County and is a primary source of drinking water. The site is rated "high" for sensitivity of the Prairie du Chien-Jordan aquifer to pollution (Balaban and Hobbs 1990), indicating that the estimated travel time for water-borne contaminants to reach the aquifer is weeks to years.

Soil types

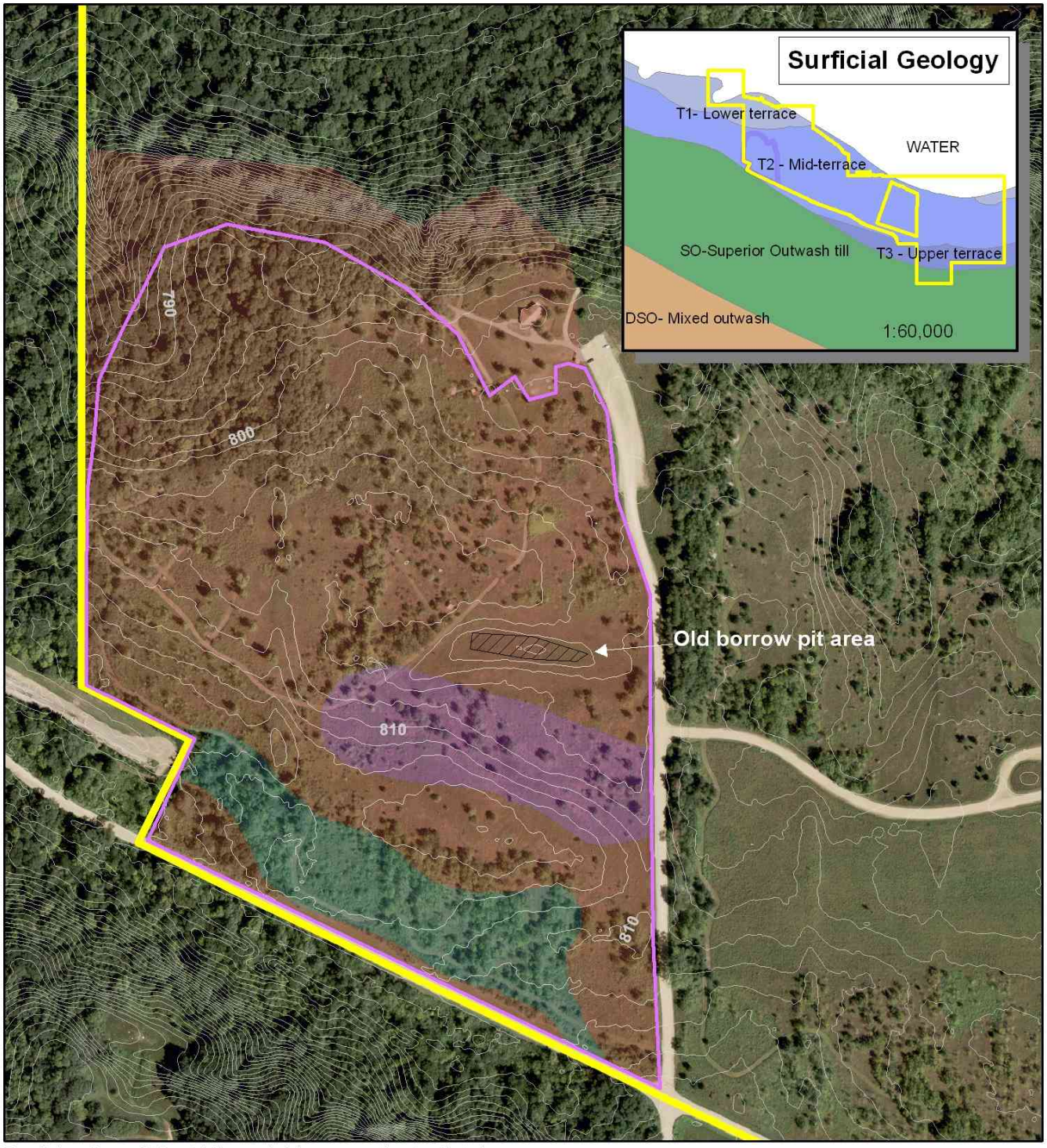
The sandy soils that formed on the site reflect the character of the site as glacial outwash glacial river terrace. Hubbard loamy sand dominates the site, with 4.5 acres of the slightly less arid Dickenson sandy loam at the south end and 4 acres of the drier Sparta loamy fine sand in the center (**Map 2)**.

Hubbard loamy sand (soil type 7B) has very gentle slopes of 1-6%. The dark loamy sand at the surface/subsurface is about 16 inches thick, overlying sand and loamy sand. Permeability of the Hubbard soils is rapid, with low available water capacity, and moderate organic matter. This soil is prone to drought as well as wind erosion. Water erosion can be severe on exposed soil, even on gently sloping land (Johnny Forrest, pers. comm., Dec 2012).

Dickenson sandy loam (soil type 27A) has a finer texture than Hubbard, is lower on the landscape, and has little slope (0-2%). The surface and subsurface layers of about 16 inches of sandy loam overlie about 20 inches of sandy loam. Permeability is moderately rapid and runoff is slow. Available water capacity and organic matter content are both low. Like Hubbard, these soils are prone to drought and wind erosion.

Sparta loamy fine sand (soil type 8B) is the driest of the three soil types, with about 10 inches of loamy fine sand in the surface/subsurface layers, overlying 15 inches of fine sand in the subsoil and 60 inches of sand below that. Permeability of the soil is moderate in the upper part and rapid in the lower part. The available water capacity and organic matter content are both low. This soil is very prone to wind erosion and drought.

MAP 2. Surficial Geology and Soils



From Dakota County: 2006 aerial photograph, 2 ft contours, soils and geologic data.

0 100 200 400 Feet

N

1:3,600

Project area (41 ac)

2ft Contours

Spring Lake Park boundary

Soil Types

27A Dickinson sandy loam 4.5 ac

7B Hubbard loamy sand

8B Sparta loamy fine sand 4 ac

RARE SPECIES

The Natural Heritage Database at the Department of Natural Resources has no records of rare plant or animal occurrences within the project site, but there are a few records within Spring Lake Park and within one mile of the park. Within the park there are three records of kittentails, a state threatened species, and two records of American ginseng, a special concern species. Parks staff report unofficial records of loggerhead shrike sightings as well, though the last time seen was six years ago. In addition, the park contains mesic oak forest, a plant community that is ranked S2, meaning imperiled in the state due to rarity. Most of the oak forest was classified as high biodiversity significance (scale is moderate, high and outstanding) and was rated B for quality (on a scale from A to D). A "B" ranking indicates a mature forest (but not old growth) with an intact canopy that, if logged, was logged long ago or very lightly/selectively, and if grazed it was very lightly.

Although there were no rare species recorded at the property, *Tomorrow's Habitat for the Wild and Rare* (DNR 2006) shows that Spring Lake Park is within an area with 16 to 20 records of species of greatest conservation need (SGCN) – animal species whose populations have declined, primarily due to habitat loss. The key habitats are prairie, savanna and grassland, with forests also important. Bird species are the primary species group for these habitats, with 17 SGCN in grassland, 16 in both savanna and forest, and 15 in prairie (some species are in multiple habitats). It is important to manage the property to increase habitat for these species, which include rose-breasted grosbeak, eastern wood pewee, black-billed cuckoo, and wood thrush. The site may also provide habitat for SGCN reptiles, amphibians, insects, and mammals. Surveys of the animal communities, especially birds, would be valuable for documenting existing conditions. As restorations activities occur, subsequent surveys may show how the changes affect wildlife.

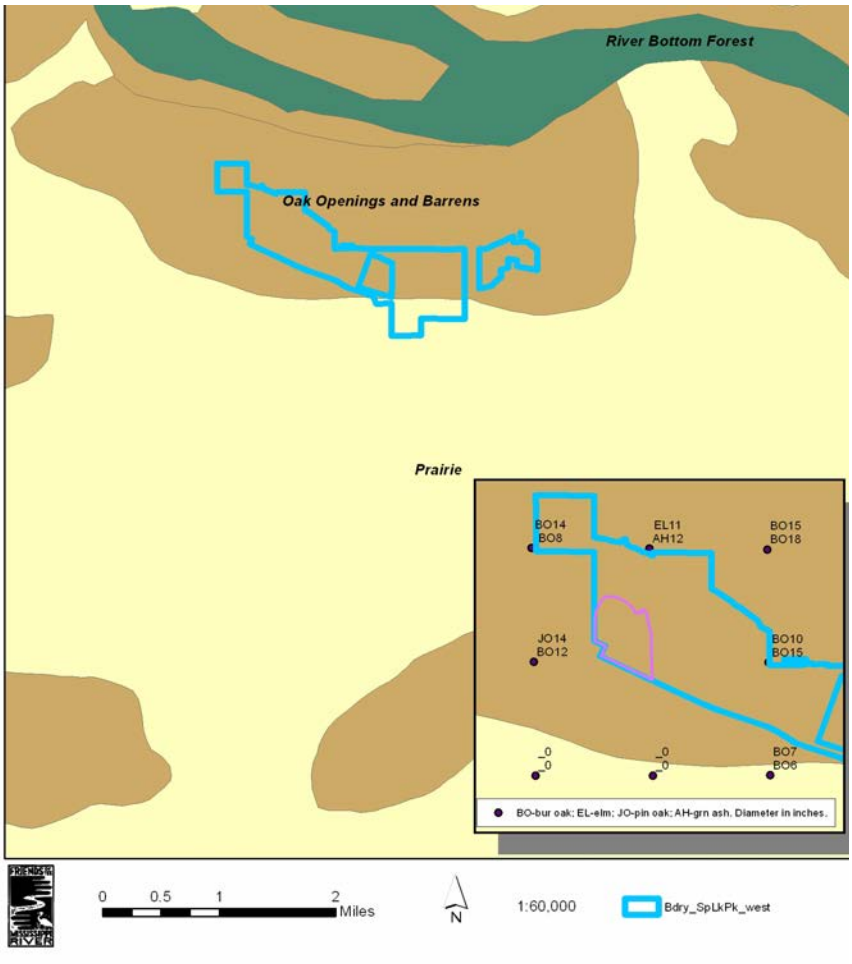
HISTORIC VEGETATION

The best information available on plant communities present at the time of European settlement comes from the 1850's land surveyor notes, which recorded plant species at each one-mile node. This information is in-exact, as there were significant land use alterations prior to the 1850's, including eradication of bison and elk from southeastern Minnesota by 1820. Nevertheless, the surveyor notes provide the most complete picture of the landscape, in a condition that was at least largely unaltered by development. A compilation of those notes into a map indicates that Spring Lake Park Reserve was primarily covered by "oak openings and barren" (Marshner 1974), typically referred to today as oak savanna and brushland (**Map 3**). The dominant trees recorded were bur oak. Prairie was also part of the landscape and would have been intermingled. The data do not show any oak forest, but the map is a generalization and its very possible that oak forest would have developed in some areas, especially in ravines and north or east-facing slopes.

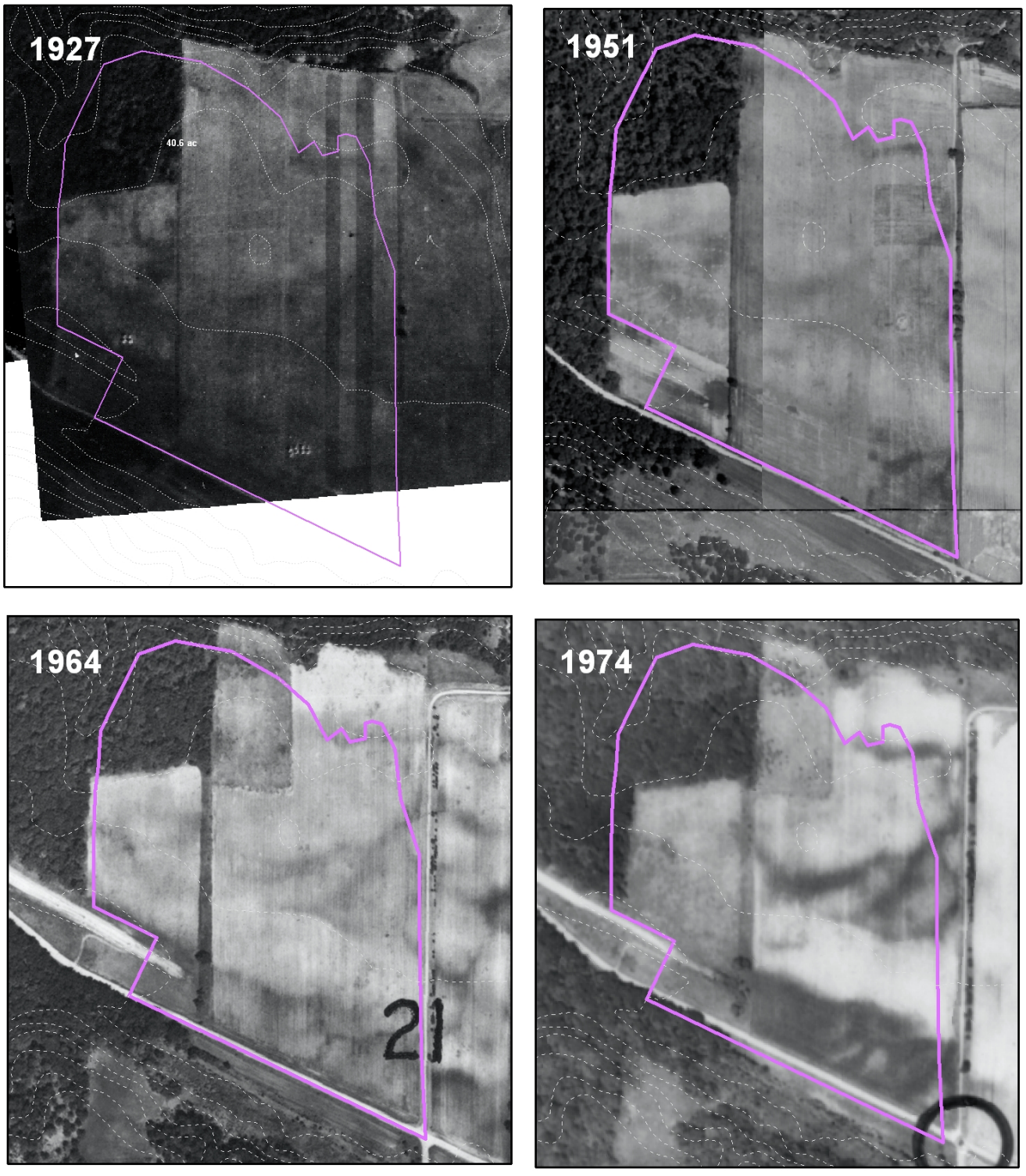
Historic aerial photographs also provide some indication of the previous site conditions and vegetation (**Map 4**). Although even the 1927 photograph was taken many decades after European settlement of the area, it still provides some indications of what site conditions may have been. The northwest corner of the project area seemed to be densely wooded even at that time, though the photo quality is low. That area continued to be wooded until the present. The existing grassland area was farmed in 1927, and continued to be farmed until if was obtained by Dakota County in 1975. Most areas that were converted to cropland had been prairie or open savanna. Overall, land use did not change considerably between 1927 and 1975.

According to the Department of Natural Resources County Biological Survey, only about 2.6 percent of the original native plant communities remained in Dakota County as of the 1997 survey. Urban development since then has undoubtedly reduced that number. Statewide, less than 1% of native prairie remains, where it once covered a third of the state. The situation for oak savanna is even worse, with just a fraction of a percent remaining. Every opportunity to restore these habitats to the landscape is an opportunity to reclaim some of that heritage. Though a restored community cannot fully replicate the historic one that was lost, it is the best means available for recovering some of the historic biodiversity.

Prairie and savanna are considered the most important plant communities to restore in Dakota County, according to *Tomorrow's Habitat for the Wild and Rare* (DNR 2006). There are 41 species of greatest conservation need (SGCNs) that use prairie habitat, 20% of which are habitat specialists. Thirty-six SGCN species use savanna habitat, of which 11% are specialists.



Map 3. Pre-European Settlement Vegetation



MAP 4. HISTORIC AERIAL PHOTOGRAPHS

HISTORIC AND EXISTING LAND USE

According to County notes, Dakota County purchased about 240 acres of the present-day Spring Lake Park site in 1975 from Pine Bend Bluffs Development Company (Johnny Forrest, pers. comm., July 2012).

Historically, the site has been in agricultural use since at least 1927. Historic aerial photos from that and subsequent years (**Map 4**), show most of the site used for cropland (or hay or pasture), with the exception of the northwest quadrant, about 7 acres. That area, as well as adjacent land to the west and north, was and remains, forested. The woods may have been grazed, but the vegetation characteristic of grazing (e.g. raspberry, prickly ash, Pennsylvania sedge) was not strongly prevalent so if grazed it was likely moderate. It is also likely that some selective logging of the area occurred, as an unlogged site would likely have more large-diameter trees.

Long north-south ridges on the restored prairie to the east are believed to be a relic of wind erosion (J. Forrest, pers. comm.). About 30 to 50 feet wide and 6 to 10 feet high, these ridges are believed to have formed when severe droughts in the 1930's and 1950's would have resulted in bare soils. Extremely prone to wind erosion, the loamy sand would have blown across the land, accumulating at the fencelines that can be seen in **Map 4**. Significant amounts of the surface soils probably eroded off the land over the many years it was cultivated.

In 1978, as part of a parks revenue-generating project, black walnut trees were planted over much of the grassland. While the droughty soils are not the most conducive for walnuts, many trees have survived and are now about 8-inches in diameter and 30 feet tall.

Approximately in the center of the project unit, just north of the Sparta soils (**Map 3**) was a borrow-pit area, dug out to elevate the road. As recently as 2000, this area was about 6 feet deep. Today it is hardly noticeable, with a gradual slope to no more than a 3 or 4-foot depth. Presumably it filled in over time with soil carried from water and/or wind erosion. While all that is remains is subsoil, it is vegetated with annual and perennial native short grasses and forbs.

Since the late 1990's, the site has been periodically managed by Dakota County Park, primarily for non-native species control. Non-native woody plants have been cut and treated, thistles and other weeds have been sprayed, and the site has been burned twice. In 1996 a 15-acre area adjacent to the east side of the project site (east of the driveway) was restored to native prairie. In 2010 an additional 10 acres was restored south of the first restoration. The archery course was built in the late 1990's and that is the current primary use of the site, as well as hiking.

WATER RESOURCES

Groundwater recharge or infiltration areas

Due to the relatively porous soils at this site and the relatively shallow depth to bedrock, it is mapped by the DNR as fairly high for groundwater recharge, with an estimated 20-25 cm per year (most of the state is 0-20 cm per yr).

Storm water management issues (erosion, contaminants, buffers)

Surface water runoff at this site is generally in a northerly direction toward the river. As described in the soils section, there is significant erosion potential, with highly erodible soils over much of the site. At the time of the survey, the primary area that appeared to have active erosion was in the woodland at the northwest part of the unit and extending into the forest outside of the project area. Deep ravines have formed, but the extent of erosion and methods to address it are outside the scope of this project. The site should be evaluated in more detail to determine if restoration and /or preventive measures should be taken. An excellent resource to assist with this work is the Dakota County Soil and Water Conservation District.

ECOLOGICAL EVALUATION and RECOMMENDATIONS

EXISTING LAND COVER

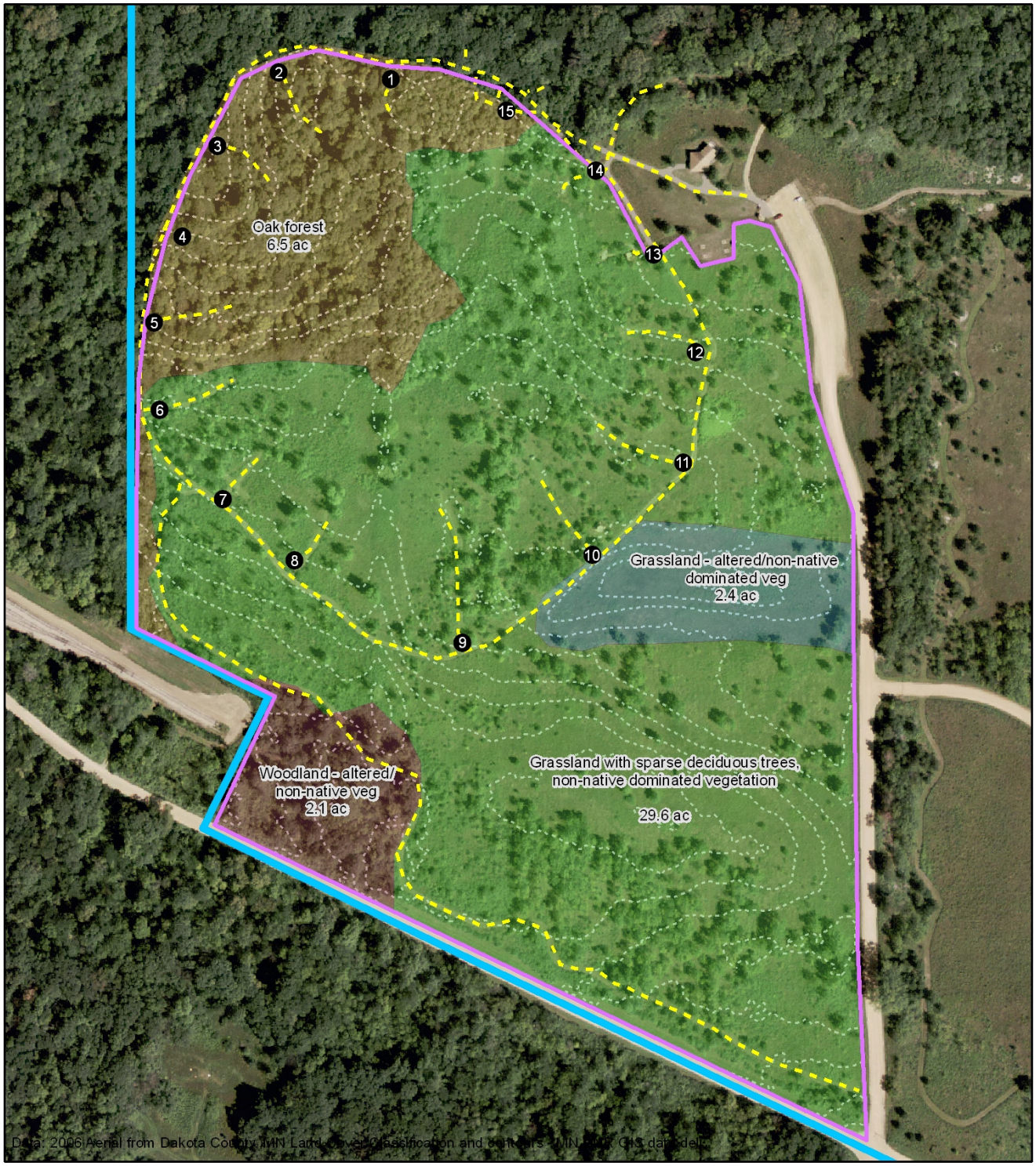
The Department of Natural Resources (DNR) developed a system called the Minnesota Land Cover Classification System (MLCCS), which defines and classifies all types of land cover. Dakota County has been entirely mapped in the MLCCS and this information was used as a basis for the site evaluation, which was conducted by FMR's ecologist in spring and summer 2012. Using the polygons defined by the MLCCS, information for each land cover type was recorded. A primary focus was the existing plant species and their 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 soil types, slopes, animal signs, and ecological concerns, such as erosion, exotic species etc. The field observations then informed the land cover classification, which was modified as needed (**Map 5)**. Each of the land cover units is summarized in **Table 1** and described in the paragraphs below.

The site has numerous ecological threats, primarily due to invasive non-native plant and animal species including earthworms, garlic mustard, common buckthorn, Tartarian honeysuckle and others. Wild turkeys could be considered non-native as they were re-introduced to Minnesota after the native population was extirpated. White-tailed deer are native but their over-abundance has made them a problem species in many areas. Some of the native plant populations have also become skewed, such as sumac, due to lack of the natural disturbance regime, primarily fire. There are also larger threats, e.g. from climate change, that ecologists don't even understand yet. The potential for soil erosion, both wind and water, is also a threat a this site and should be considered for any activities that will disturb the soil.

Table 1. Summary of existing land cover, soils and target restoration.

Existing cover	Acres	Soil type	Target Plant Community
Grassland with sparse trees, non-native dominated	29.6	Hubbard loamy sand	Southern dry prairie UPs13 Southern dry oak savanna UPs14 Southern mesic oak savanna UPs24
Grassland, altered/non-native dominated	2.4	Sparta loamy fine sand	Southern dry prairie UPs13
Woodland, altered/non-native	2.4	Dickensen sandy loam, Hubbard loamy sand	Southern dry-mesic oak (maple) woodland FDs37
Oak forest	6.5	Hubbard loamy sand	Southern mesic oak forest MHs37

Map 5. Existing Land Cover



Grassland with sparse deciduous trees, non-native dominated vegetation

The grassland unit covered nearly 30 acres of the site and was characterized by an overall dominance of grasses, but areas to the northwest and the south had significantly more woody cover, as will be described. Overall, grasses accounted for over 50 percent of the cover of the unit (Photo 1), with non-native grasses, especially quackgrass and Kentucky bluegrass, dominating. Forb cover was also about 30 percent with late goldenrod, red raspberry, and cow vetch some of the most abundant species. Native prairie forbs were not abundant, but included species commonly found in disturbed old fields, such as bergamot, yarrow, flowering spurge, whorled milkweed, stiff goldenrod and black-eyed Susan. A few species, such as dotted blazing star and hoary vervain, were found near the driveway and have apparently migrated from the restored prairie to the east.

Photo 1. View from Tower 10, showing the expanse of grassland with scattered trees and patches of sumac. 7/18/12

Photo 2. Planted in 1978, the black walnuts are stunted, only about 8 inches diameter. 5/2/12

Shrub cover was about 30 percent, dominated by smooth sumac, though Tartarian honeysuckle and prickly ash were also common in some areas. Tree cover was about 20 percent overall with black walnut, green ash and boxelder the dominant species. The black walnuts were planted by Dakota County in about 1978, but have never thrived as the soils are not suitable for this species. Many have died over the years, but quite a few have survived and new trees have also established, though they all appear somewhat stunted (Photo 2).

The entrance to the grassland was marked by a small cluster of Austrian pines that flank either side of the driveway (Photo 3). Though not a natural component of the desired native plant community for the area, these trees serve as entry "sentinels" and can perhaps remain as part of the social history of this site.

Photo 3. Austrian pines mark the entrance to the Archery course at Pine Bend Trail. 7/18/12

As mentioned, the south end of the Grassland

Unit along the road had more tree and shrub cover, especially black walnut, smooth sumac and honeysuckle (Photo 4). Raspberry and blackberry species (*Rubus* spp) were also abundant. Dakota County Parks has done intensive honeysuckle removal in this area in particular, and it is much reduced.

The northwest part of the Grassland Unit (the area within the archery loop) had a much higher woody coverage than the rest of the unit (Photo 5). The tree canopy was much denser than the open grassland, though still had an open coverage. Common trees were black walnut, boxelder, green ash, American elm and black cherry. Smooth sumac dominated the shrub layer, forming a solid cover in some areas, especially toward the north. Other common shrub species were prickly ash and Tartarian honeysuckle.

Photo 4. View of southeast end of grassland, toward the west (Unit III in Map 6). Black walnut, raspberries and sumac are abundant as well as Tartarian honeysuckle. 7/18/12

Photo 5. View of brushy part of grassland inside the archery loop, from tower 10. Smooth sumac forms a solid cover in some areas. 9/20/12

Restoration of the Grassland area is described in the next section, but this land cover type would be divided into three target plant communities, based on soil type. The northwest area within the archery loop would be dry oak savanna (UPs14), the south end of the grassland has more mesic soil and would be mesic oak savanna (UPs24), and the remaining large open grassland would be dry prairie (UPs13).

Grassland – Altered/Non-native Dominated Vegetation

This small, 2.4-acre unit was located within the eastern part of the grassland unit. This area had been excavated in the past (see Land Use History Section). The soil type, Sparta loamy fine sand, probably made it appealing for some other use. What was left behind was probably mostly subsoil, consisting of fine sand overlying sand. Thus, this area is especially dry, which is reflected in the vegetation (Photo 6). Parts of this unit are dominated by very short, drought tolerant species, such as Scribner's panic grass, fall witchgrass, quackgrass, rock spike-moss, wild strawberry, western ragweed and whorled milkweed. Giant goldenrod was also quite abundant, forming large patches and Canada goldenrod was common as well. The shrub layer was about 20 percent, with smooth sumac the primary species, appearing

much shorter here than in other areas. A few black walnut also grew in this area, with a total canopy cover of about 20 percent.

While this area has shorter vegetation than the surrounding grassland, the target native plant community type would be the same for both areas – Dry Prairie (UPs13). A select sub-set of the most drought tolerant species could be set aside for this particular area, but overall the species composition will be quite similar.

Photo 6. View of the Sparta soil unit, from west to east. The dry sandy soils support shorter, drought tolerant grass species. A small rise to the south indicates the past excavation here. 9/20/12

Oak Forest

This 6.5-acre unit in the northwest section of the project area is part of a much larger oak forest that covers the bluffs along the river. A comprehensive evaluation was not completed, but the oak forest unit was surveyed to assess existing conditions and potential management needs. A larger evaluation of the entire oak forest at Spring Lake Park Reserve is needed, especially as much of it was mapped in 1993 by the DNR County Biological Survey as "high biodiversity significance." Non-native woody invasion has certainly altered the site conditions and should be evaluated and managed before the plant community diversity is lost. In the 1993 survey, the oak forest near the project area was given a B/C ranking and described as:

> Mid-aged mesic oak forest dominated by *Tilia americana* and *Quercus rubra* (35-40cm dbh). Typical forest shrubs, herbaceous layer dominated by *Asarum canadense* (wild ginger) and *Hydrophyllum virginiana* (Virginia waterleaf). East part dominated by multi-stemmed *Q. rubra* with *Tilia* (25-35cm dbh) possibly cut in past. Quality will improve if *Rhamnus cathartica* is vigorously controlled. Upslope poorer, former bur oak woodland filled in with misc woodies. Mowed trails for archery park east end. On N-facing slopes of terraces along Mississippi River. In the Mississippi Outwash formation.

Just a little further to the east, about ½ mile from the project area, the oak forest was ranked B quality and described as:

> Mesic oak forest dominated by *Tilia americana* and *Quercus rubra* 40-50cm dbh. All ages of canopy trees, course debris & occasional standing snags. Diverse shrubs and herbs. *Tilia* reproduction common. Upslope drier, more *Zanthoxylem*, also *Q. alba* and *Fraxinus nigra*. Old fence and occasional large old stumps are evidence of past cutting and grazing.
> Threats: small size of area, *Rhamnus cathartica* and *Lonicera tartarica* present.

These descriptions probably are not exactly what the 6.5-acre unit looked like 20 years ago, but they do provide good indications of the overall community, some of the past disturbance (grazing and cutting) and ecological threats (non-native invasive shrubs especially). Due to the dense canopy of the forest, the buckthorn was not as pervasive in 2012 as one would

expect after 20 years. A precursory evaluation of the oak forest unit, in fact, revealed a diverse plant community. The tree canopy was dense, with 11 native species and no non-natives recorded. Pin oak and red oak were dominant, and bur oak, green ash and black cherry were also common. Tree sizes for most species ranged from about 4 inches to 20 in diameter (dbh). One very large 24-inch diameter red oak was found. Most of the canopy species seemed to be reproducing (seedlings were found) except for bur oak, as would be expected since it does not germinate well in dense shade.

Typical of dense canopy forests, the shrub layer was fairly sparse, about 20 percent. Common buckthorn and Tartarian honeysuckle were the dominant shrub layer species, but were mostly abundant along edges and were sparse or absent in the canopy interior.


Photo 7. Oak forest near archery point 1, showing multi-aged trees and fairly open understory. 9/20/12

The ground layer was dense, about 70 percent cover, and had a nice diversity of woodland species, including blue cohosh, rue anemone, bloodroot, wild geranium and honewort.

Garlic mustard was prevalent in many areas. Some studies are now indicating that garlic mustard may be a result of site disturbance, especially by earthworms, and may not actually have a negative impact on native species diversity. Similarly, some studies have shown that a dense cover of native plant species can deter garlic mustard growth. However, under high stress conditions (e.g. drought), native plants can be negatively impacted by garlic mustard. In the short term, our recommendation is to focus on managing the invasive shrub species. Controlling garlic mustard can potentially be considered for targeted areas that have high native plant diversity, but would otherwise not be an immediate priority as it is very difficult to eradicate and requires a long-term commitment.

The target plant community for this area will continue to be Southern Mesic Oak Forest (MHs37).

Woodland – Altered/Non-native Vegetation

Located in the southwest corner of the project area, this 2.4 acre unit has been managed by Dakota County Parks to control invasive woody plants, but was strategically left with more dense woody cover to serve as screening for the rail yard operations that take place on the CF Industries property to the west. The unit contains species typical of a disturbed or young woodland – fairly small diameter trees (4-8 inch dbh), an open canopy with about 65% cover, and a ground layer with both abundant grass cover and woodland forbs.

Red/pin oak are the dominant tree species, with green ash, black cherry, and a few red cedar. The shrub layer is dominated by Tartarian honeysuckle, but the plants are still relatively

small, about 4 feet tall. The ground layer is dominated by non-native grasses and Canada goldenrod, though quite a few other more desirable native species were found including thimbleweed (*Anemone virginiana*), bergamot, American germander (*Teucrium canadense*), large-flowered bellwort, and aster species.

Photo 8. Large-flowered bellwort grows beneath the denser canopy areas of the woodland, while bergamot and other prairie species can be found in openings. 9/20/12

Historically this area was probably oak savanna or oak forest. Turning back to savanna would result in loss of desired screening and would be a lot of material to remove. It can best be left as is and managed for invasive species. It will likely never be an oak forest as it's too small, but will remain woodland. The target plant community for this land cover area will be Southern Dry-Mesic Oak (Maple) Woodland (FDs37).

MANAGEMENT RECOMMENDATIONS

Restoration goals

The primary objective for this site is to recreate and/or improve the composition of the plant communities to better reflect the diversity, composition and structure that would have been present at the time of European settlement and to improve the ecological functions that the historic native plant communities would have 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
- development and enrichment of soils
- local temperature moderation

Though somewhat degraded by past uses, the site presents excellent opportunities for restoring native cover and also retains native plant communities with good diversity that could readily be improved. A complex of healthy and diverse plant communities can provide much greater wildlife value than degraded communities, and tends to be much more stable, and less susceptible to disease, invasive species, and other concerns.

Specific restoration goals identified for the site are to:

- Restore a complement of native dry prairie species to the site, similar to what would have been present historically.
- Increase public awareness and engagement in restoration about prairie and savanna habitat. Potential activities could include:
    - a demonstration garden and/or display near the picnic shelter, showing plant species and prairie community.
    - volunteer events for woody removal, planting etc.
- Enhance wildlife habitat by installing wildlife houses for targeted declining species such as chimney swifts, bats, etc.

For determining target plant communities for restoration, we considered several factors. The historic condition weighs heavily, but must be balanced by the extent to which succession has altered the vegetation, as well as the costs, both monetary and ecological, of restoring the historic community. The existing and planned uses for the site were also primary considerations that determined the restoration targets. We used the *Field Guide to the Native Plant Communities of Minnesota: the Eastern Broadleaf Forest Province* (DNR 2005) as a foundation for the target plant community species.

This property was located near the edge of prairie, savanna, and woodland/forested communities, and may have included all cover types. These plant communities are still

appropriate for the site and were selected as the restoration goals (**Map 6).** Characteristics of intact native plant communities, described below, can be used as guidelines for the long-term management and restoration goals for the site.

Southern Dry Prairie (UPs13) has the following characteristics: trees are absent, other than an occasional a bur oak or red cedar. The shrub layer is sparse, 1 to 5%, and consists of low species such as lead plant, New Jersey Tea, prairie rose, prairie willow and smooth sumac. Graminoid and forbs each have of cover of 5 to 50%, and there may be bare soil visible. Little bluestem is often dominant and other common mid-height species are prairie dropseed, Junegrass, side-oats grama, porcupine grass and Muhly grass. The tallgrasses, e.g. big bluestem, Indiangrass, switchgrass, are present, but less abundant. Common forb species include gray goldenrod, silky aster, dotted blazing star, golden aster, false boneset, flowering spurge, purple prairie clover and stiff sunflower.

Southern dry savanna (UPs14) is characterized sparse tree cover with a grass-dominated herbaceous cover on droughty soils. The topography can be nearly level to steep slopes. One of the most common places it occurs is on terraces along the Mississippi River. Savannas are commonly associated with prairies in a landscape where features such as steep topography or surface waters would have reduced the frequency of fires, providing conditions suitable for savanna species. The plant community is especially adapted to low fertility and drought susceptible soils, conditions that make it more resilient than mesic sites. Fewer species are tolerant of these conditions so there is less competition.

Trees occur as scattered individuals or clusters, with a total cover of 25-50%. Bur oak is the most common, but pin oak is also present. The shrub layer is patchy with a total cover of 25-50%. Common low shrubs are leadplant, prairie rose, poison ivy, while chokecherry, hazelnut, and smooth sumac are important tall shrubs. The forb cover is about 5-50%. Typical species include western ragweed, Virginia ground cherry, hairy puccoon, gray goldenrod, hoary frostweed, and purple prairie clover. The graminoid cover is 25-100%, and dominated by mid-height species such as little bluestem, porcupine grass, and Junegrass. Tall grasses are also important, especially big bluestem and Indiangrass. Purple lovegrass and Muhlenberg's sedge are common short species.

The *Native Plant Communities of Minnesota* (DNR 2006), describes **Southern Dry-Mesic Oak Forest (MHs37)** as: Dry-mesic hardwood forest occurring most often on thin, wind-deposited silt on crests and upper slopes of bedrock bluffs. The ground-layer varies from patchy to continuous. Important species include lady fern, pointed-leaved tick trefoil, Clayton's sweet cicely, enchanter's nightshade, wild geranium, hog peanut, and white snakeroot. Shrub layer cover is patchy to interrupted. Common species include red oak, black cherry, chokecherry, American hazelnut, Missouri gooseberry, and pagoda dogwood. Subcanopy species include basswood, black cherry, red oak, white oak and shagbark hickory. The canopy is interrupted to continuous. The most common species are red oak, white oak, and basswood.

Catastrophic disturbances were rare in this plant community. Analysis of Public Land Survey records indicates that the rotation of catastrophic fires was in excess of 1,000 years

and the roation of catastrophic windthrow was about 390 years. Events that resulted in partial loss of trees, especially light surface fires, were much more common, with an estimated rotation of about 20 years. Based on the historic composition and age structure of these forests, there would be two growth stages separated by a long period of transition.

Southern Dry-Mesic Oak Woodland (FDs37) is described in the *Native Plant Communities of Minnesota* (DNR 2006) as follow: Dry-mesic hardwood forests occurring on undulating sand flats, hummocky moraines, and river bluffs, mostly on fine sand or sand-gravel soils. Historically, fires were common in this community, and many stands are on sites occupied by brushlands 100–150 years ago.

The canopy cover is usually interrupted to continuous (50–100%). Bur oak and northern pin oak are the most common species. Northern red oak, white oak, and red maple are occasionally present. The subcanopy cover is patchy to interrupted (25–75%). The most common species are black cherry, red maple, and bur oak.

Because of the open canopy, the shrub layer is often very dense with patchy to continuous cover (25–100%). Common species include black cherry, red maple, chokecherry (*Prunus virginiana*), American hazelnut (*Corylus americana*), gray dogwood (*Cornus racemosa*), prickly ash (*Zanthoxylum americanum*), Virginia creeper (*Parthenocissus* spp.), and poison ivy (*Toxicodendron rydbergii*).

The ground-layer cover is patchy to continuous (25–100%). Pointed-leaved tick trefoil (*Desmodium glutinosum*), Clayton's sweet cicely (*Osmorhiza claytonii*), hog peanut (*Amphicarpaea bracteata*), Canada mayflower (*Maianthemum canadense*), and wild geranium (*Geranium maculatum*) are commonly present. Pennsylvania sedge (*Carex pensylvanica*) is the most abundant graminoid. Dewey's sedge (*Carex deweyana*) and starry sedge (*Carex rosea*) may also be present.

MAP 6. Restoration Goals

2008 Aerial, 2-ft contours - Dakota County

N

1:3,092

0 100 200 400 Feet

Spring Lake Park Boundary

Management Area 41 ac

Planned Regional Trail (approx)

Guidelines for Restoration

The restoration process can be broken into three overall phases**.** Phase 1 would address the removal of non-native trees and shrubs as well as invasive or undesired native shrubs and trees throughout the project area. Phase 2 would be to restore the herbaceous vegetation to the savanna and prairie. Phase 3 would be to restore oak trees to the savanna, and any other plantings. Details of the work to take place during each phase and each Restoration Unit are described in the sections below.

Specifications for the project tasks should include the following:

- Use the least toxic effective herbicide available, with little or no residual
- Follow best management practices for herbicide use (no wind, no rain forecast etc)
- Minimize herbicide usage as much as possible
- Use only species native to MN for seeding and planting
- Use local genotype seeds and plants as much as possible (genetic origin within 100 miles)
- Conduct woody removal work in oak forest during dormant season to minimize impacts to native herbaceous plants.
- Avoid soil compaction – use heavy equipment only on frozen soils
- For exotic brush work, ensure that all plants cut are treated.

Phase 1 – Woody removal

The first step needed before any other restoration can take place is to remove the invasive woody plants as well as any other undesired plants. If feasible, completing Phase 1 for the entire site may be advantageous, especially if the wood is used for biofuels. Most companies that do take material for biofuels have a very large minimum volume requirement. A larger removal project may also be more cost-effective and would reduce the amount of invasive shrubs that re-seed restored areas. This needs to happen throughout the site, but if it cannot all be completed at one time to funding or other constraints, this task could be split into two sub-phases. It could be divided different ways, but beginning with Units I, II & III would be a good option because the brush, especially sumac, is overtaking some areas and because these units will have a similar process for site preparation and seeding after woody removal. Woody removal in Units IV and V could be completed later.

Tree removal

- For units I and III, remove all tree species except bur oak, red cedar (if any are present), red oak and the small cluster of Austrian pines that are at the SE corner of the Unit III. These can be left standing as they mirror the trees on the other side of the driveway and mark the entrance to the archery area. Although the black walnut were planted trees, they are not a natural component of prairie or savanna. Ideally all would be removed, especially from the prairie. If desired, selected patches or individuals could remain in the savanna, essentially providing some of the functions of bur oaks, until the oaks are a larger size.
- Unit II has a fairly abundant tree cover of American elm, black cherry, green ash, black walnut etc. Most trees are fairly small diameter (up to 10 inch), but the amount of accumulated material may be substantial. For this unit in particular, it will be important

to use the wood for biofuels or some other purpose. It may be possible to do a salvage harvest. The alternative is to chip all the material and haul it off site.

- All trees must be cut level and as close to the ground as possible. Stumps should be no more than four inches tall. Other than cedar, all stumps must be immediately treated with herbicide (e.g. glyphosate). It may be feasible to harvest the trees as a salvage project, which could significantly reduce removal costs.
- After the trees are removed there will be an abundance of tree stumps. These will not impede the prairie restoration and will decay over time. Sometimes stumps are ground up to create a cleaner seeding site. However, the stumps are so numerous that grinding all of them would be cost prohibitive. Waiting for them to decay is another option, but would take years and needlessly delay the restoration. As long as the stumps are cut very low to the ground (4 inches or less), they will not interfere with mowing and other equipment. As they decay, the native species will fill in.

Shrub removal

- For Units I and III, all shrub species except sumac can be cut, stump-treated, stacked and burned (unless they can be taken for biofuels). Except for sumac, work should be done with hand-tools (chainsaws) to minimize impacts to the site. See **Appendix C** for details on control methods for woody species. For all woody species, cut as low as possible to the ground (e.g. 1 inch). Avoid leaving any sharp stems that could puncture tires.
- For Unit II, most of the shrubs can also be removed, but shrub cover is also an important component of oak savannas. Most of the sumac can be mowed, but some patches should be left, about 5 percent total cover. If other native savanna shrub species such as hazelnut are encountered, they should be protected. All shrubs to be protected should be marked prior to removal efforts.
- Sumac is growing in dense stands and it will be most efficient to mow it, rather than hand-cut. Herbicide is not needed for sumac because the mowing and burning regimen for the first three years will serve to reduce it. As the sumac is a natural component of the prairie it not intended to be completely eradicated.
- Follow-up control of resprouted shrubs will likely be needed in the first couple of years after removal and on-going management will be needed every few years to control new plants before they reach maturity.

Phase 2 – Prairie and Savanna Site Preparation and Seeding

The overall process of restoring the herbaceous vegetation at the prairie and savanna units will take approximately one year for the site preparation and installation, followed by three years of establishment management. After woody removal, a sequence of herbicide, mowing, burning in completed to eradicate the herbaceous vegetation and prepare the site for seeding. The exact sequencing or timing may change depending on how the site responds. Species suitable for seeding this unit are provided in **Appendix B**. More details for each step are provided below. Additional savanna characteristics and considerations for restoration are provided in **Appendix D.**

Site preparation

- After woody plants are removed, mow Units 1, II, III to generate new growth – late April/early May.
- After vegetation regrowth to about 6-10 inches, spray entire site with broad-spectrum herbicide (glyphosate) – late May/early June.
- Allow regrowth and spray site once during the summer if needed.
- Burn the site in late summer – early September
- Herbicide any new growth – early October
- Lightly harrow the site – late Oct.
- Broadcast native prairie seed and savanna – early Nov.

Establishment management

- In the first growing season, mow the site 1 to 3 times. As this is a dry site it may not need as many mowings as is typical for other sites or may need only spot-mowing. Vegetation should be mowed when it reaches a height of 10 to 12 inches, and should be mowed to a height of 6 inches. The mower used should be a flail type and should disperse cuttings evenly.
- In the second growing season mow the site once in spring (May). Control noxious weeds during the growing season as needed by spot-mowing/spot spraying.
- In spring of the third year, conduct a prescribed burn. Continue weed control as needed through the growing season.

Phase 3 – Plantings

After the savanna herbaceous species are established (about three years), the oak tree component of the savanna can be introduced. Using acorns from bur oak trees gathered from the on-site oak forest will be the most desirable seed source. Acorns can be seeded directly. Survival rates are low, so planting hundreds of acorns would not be unreasonable. If needed, vegetation can be cleared in small areas to facilitate seeding and germination. The site should then be monitored and a select number of oak seedlings that emerge should be protected from browsing with mesh tree tubes (not solid tubes). The seedlings will also need to be mulched to reduce competition from weeds. Small trees will need to be protected from prescribed burns in until they are large enough to withstand the heat.

After woody removal in Units IV and V, it may also be determined that additional plantings would be beneficial. The native shrub community, in particular, may be depauperate if it has been replaced over the years by buckthorn. Potential planting needs were not specifically determined as part of this document, but suitable plant species and abundances for the forested communities are shown in **Appendix B**.

Habitat enhancement

Other methods to improve the wildlife habitat at the site can also be considered, especially for meeting the needs of species that are declining. Chimney swifts, for example, have declined fifty percent in the last 40 years, primarily due to a loss of nesting and roosting

sites. Many bat populations have declined due to new diseases, and some snake species have declined due to habitat loss. All wildlife houses, however, require a long-term commitment for regular cleaning, maintenance and monitoring.

Long-term management and monitoring

Once established, the prairie should be burned every 3 to 5 years to maintain the vegetation and minimize the woody plants. The timeframe for savanna may be similar or even more frequent, 1 to 4 years. The frequency will depend on site conditions and objectives, with one objective being to keep woody plants reduced. A burn plan should be developed for the whole site to identify specific burn units. Burn units should try to include more than one habitat type. If possible, there should be at least two burn units at this site, and burns should be coordinated with adjacent burn areas as well (across the road), to ensure that no two units of the same habitat type are burned in one year and that adjacent units of the same type are not burned in consecutive years. It is important to leave unburned areas as refugia for plants and animals.

If burning is not feasible due to weather or other circumstances, mowing can be used as a substitute, but should not completely replace burning because it has different impacts on the prairie and does not provide all the functions of burning. However, mowing has different effects and benefits than burning, so occasionally mowing instead of burning can be a good management strategy. Likewise, burning should not always be done in the same season. Spring is often the preferred time because it can set back cool-season non-native species and because it warms the soil and promotes conditions that favor native plant species. But repeatedly burning at the same time of year can favor some species over others. Fall burns, for instance, tend to favor forb species. Late summer burns can also benefit different species.

Follow-up management, primarily in wooded areas, would also include treating resprouting shrubs in the fall for at least two years after initial removal. Once the exotic brush population is reduced and manageable, long-term maintenance will consist of small amounts of cutting or treating every 2 to 4 years. The oak forest is not a fire dependent community, but if a flush of exotic brush seedlings emerges, prescribed burning can considered as a management tool, though it would have to be timed to avoid harming native wildflowers (fall would be best).

The site should be monitored every year to evaluate multiple parameters of the site including: the survival or establishment success of planted species, evaluate and control non-native invasive species, detect and manage erosion issues, and record changes to native plant populations, such as disease, blowdown etc. Any issues should be recorded and mapped to facilitate better tracking over time.

Monitoring animal as well as plant communities is also helpful for evaluating results of the restoration. A comparison of bird populations before and after restoration, for example, would be a valuable tool for quantifying positive impacts on the land.

A schedule of proposed tasks and rough cost estimates is provided in **Table 2** for Phase 1 and Phase 2. Details and associated project costs for Phase 3 will need to be developed after Phase 2 has been initiated and site conditions and needs will be better known.

Undertaking a restoration project of this size is a significant task. Friends of the Mississippi River and will work closely with Dakota County, if desired, to help secure funding and to provide project management and oversight. A partial list of potential professional firms that can conduct management tasks are listed in **Appendix E**.

RESTORATION SCHEDULE AND COST ESTIMATES

An approximation of restoration/management tasks, priorities, and costs is provided in **Table 2,** below. Work units correspond with those shown in **Map 5**. Project cost estimates are not based on actual contractor bids, but on typical costs for similar projects. Actual project costs could be significantly higher or lower, depending on multiple factors. Costs could potentially be decreased by, for example, reducing the diversity of prairie seed costs, contracting for the entire project with one contractor, using volunteers or STS (Sentence to Serve) crew for portions of the labor such as hauling brush. Some activities may also be carried out by the Dakota County Parks. Project tasks and costs may also change over time, as more information is learned about the property and as the site conditions change.

The most important short-term issues to address are erosion control and exotic woody species control at all the units. This should be addressed site-wide prior to any restoration activities to eliminate seed sources of these exotic species.

Cost estimates for Phase 3 were not included as details for that will need to be determined in the future and will depend on the progress of the other two phases. Phase 3 would likely not occur in Units II and III for at least five years.

Additional tasks not included in the tables below will be long-term monitoring activities and any other desired monitoring, such as bird surveys. Costs for potential community volunteer events are also not included, as they will depend on multiple factors, but typically start at about $2,500 per event.

Table 2. Project Schedule and Cost Estimates

PHASE 1: WOODY REMOVAL

YR	Season	Unit	Activity	Ac	Est Cost/ac	Est cost
1	Fall/Wtr	I	Cut & stump-treat all trees & shrubs **except** oaks. Chip wood. Brush-cut sumac (do not treat)	10.4	$900.00	$9,360.00
1	Fall/Wtr	II	Cut & stump-treat all trees **except** oak, hazelnut, selected black walnuts and selected shrubs. Chip wood. Brush-cut sumac (do not treat)	15.1	$1,300.00	$19,630.00
1	Fall/Wtr	III	Cut & stump-treat all trees **except** oaks, hazelnut and selected black walnut, selected shrubs, and pines at entry. Chip wood. Brush-cut sumac (do not treat)	6.5	$1,000.00	$6,500.00
1	Fall/Wtr	IV	Cut & stump-treat non-native trees and shrubs. Chip wood.	2.1	$800.00	$1,680.00
1	Fall/Wtr	V	Cut & stump-treat non-native trees and shrubs. (primarily buckthorn and honeysuckle). Chip wood.	6.5	$900.00	$5,850.00
2&3	Fall	IV, V	Follow-up treatment of resprouts.	8.6	$400.00	$3,440.00
TOTAL ESTIMATE FOR PHASE 1						**$46,460.00**

PHASE 2: PRAIRIE & SAVANNA PREP AND SEEDING

YR	Season	Unit	Activity	Ac	Est Cost/ac	Est cost
2	Approx May	I, II, III	Mow site to stimulate growth	32	$125.00	$4,000.00
2	Late May/early June	I, II, III	Apply broad-spectrum herbicide (glyphosate) to regrowth when 6-10 inches tall.	32	$140.00	$4,480.00
2	Late smr	I, II, III	Rx burn to remove dead vegetation	32	$130.00	$4,160.00
2	Early fall	I, II, III	Herbicide any new growth when it's 6 inches or less	32	$140.00	$4,480.00
2	Late Oct	I, II, III	Lightly harrow to prep for seeding	32	$125.00	$4,000.00
2	Spr/smr	I, II, III	Purchase native seed	32	$600.00	$19,200.00
2	Early Nov	I, II, III	Broadcast native seed	32	$125.00	$4,000.00
			Total Yr 2			**$44,320.00**
3	May	I, II, III	When vegetation reaches 10-12 inches, mow to 6 inches	32	$125.00	$4,000.00
3	July	I, II, III	When vegetation reaches 10-12 inches, mow to 6 inches	32	$125.00	$4,000.00
			Total YR 3			**$8,000.00**
4	May	I, II, III	When vegetation reaches 10-12 inches, mow to 6 inches	32	$125.00	$4,000.00
4	May-Sept	I, II, III	Spot mow/spray weed species	32	$90.00	$2,880.00
			Totall YR 4			**$6,880.00**

YR	Season	Unit	Activity	Ac	Est Cost/ac	Est cost
5	May	I, II, III	Conduct a prescribed burn	32	$140.00	$4,480.00
5	May-Sept	I, II, III	Spot mow/spray weed species	32	$90.00	$2,880.00
			Total YR 5			**$7,360.00**
TOTAL ESTIMATE FOR PHASE 2						**$66,560.00**
TOTAL ESTIMATE FOR PHASE 1 & 2						**$113,020.00**

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Appendix A. Plant Species Recorded at Spring Lake Park

The following plant species were identified at the site by Friends of the Mississippi River in 2012.

Grassland with Sparse Trees Unit

Non-Native	Family	Scientific Name	Common Name	Cov*	Comments
Ground layer 0-2 ft				**3**	
	Herbaceous				
x	Asteraceae	*Achillea millefolium*	yarrow	1	
	Lamiaceae	*Agastache foeniculum*	blue giant hyssop	+	
	Asteraceae	*Ambrosia psilostachya*	western ragweed	1	
	Asteraceae	*Artemisia cf serrata*	toothed sage	+	by driveway
	Asteraceae	*Artemisia ludoviciana*	prairie sage	+	
	Asclepiaceae	*Asclepias syriaca*	common milkweed	+	
	Asclepiaceae	*Asclepias verticillata*	whorled milkweed	1	
	Asteraceae	*Aster oolentangiense*	sky blue aster	1	
	Asteraceae	*Aster sp*	white aster	1	
	Asteraceae	*Cirsium discolor*	field thistle	1	
x	Asteraceae	*Cirsium vulgare*	bull thistle	**1**	
	Fabaceae	*Desmodium canadense*	Showy Tick Trefoil	+	
	Euphorbiaceae	*Euphorbia corollata*	Flowering Spurge	1	
	Rosaceae	*Fragaria virginiana*	wild strawberry	**1**	
	Nyctaginaceae	*Mirabilis nyctaginea*	four o'clock	+	
	Lamiaceae	*Monarda fistulosa*	bergamot	1	
	Lamiaceae	*Monarda punctata*	spotted bee balm	+	by driveway- from restored prairie
	Onagraceae	*Oenothera biennis*	evening primrose	+	
	Solanaceae	*Physalis heterophylla*	clammy ground-cherry	+	
	Roseaceae	*Rubus allegheniensis*	blackberry	1	Esp south end
	Roseaceae	*Rubus ideaus*	raspberry	2	Esp south end
	Asteraceae	*Rudbeckia hirta*	Black-eyed Susan	**+**	
x	Polygonaceae	*Rumex acetosella*	field sorrel	**+**	
	Selaginellaceae	*Selaginella rupestris*	rock spike-moss	2	
	Asteraceae	*Solidago canadensis*	Canada goldenrod	1	
	Asteraceae	*Solidago gigantea*	late goldenrod	3	dominant
	Asteraceae	*Solidago rigida*	Stiff Goldenrod	+	
x	Scrophulariaceae	*Verbascum thapsus*	common mullein	1	
	Verbenaceae	*Verbena stricta*	Hoary Vervain	+	by driveway- from restored prairie
x	Fabaceae	*Vicia cracca*	cow vetch	2	Very abundant when green/flowering.
	Fabaceae	*Vicia villosa*	hairy vetch	1	
	Graminoids			4	
x	Poaceae	*Agropyron (Elytrigia) repens*	quackgrass	4	
	Poaceae	*Andropogon gerardii*	big bluestem	1	
	Poaceae	*Dichanthelium oligosanthes*	Scribner's panic grass	3	Esp abundant in shorter veg areas
	Poaceae	*Digitaria cognatum*	fall witch-grass	1	
	Poaceae	*Paspalum ciliatifolium*	ciliate-leaved paspalum	+	
x	Poaceae	*Poa pratensis*	Kentucky bluegrass	2	
	Poaceae	*Sorghastrum nutans*	Indian Grass	+	
	Woody			2	
	Juglandaceae	*Juglans nigra*	Black walnut	1	
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	1	Scattered, short plants. Abund at south.
	Vitaceae	*Parthenocissus inserta*	Virginia creeper	2	
	Anarcardiaceae	*Rhus glabra*	smooth sumac	2	
x	Ulmaceae	*Ulmus pumila*	Siberian elm	+	seedlings
	Vitaceae	*Vitis riparia*	Wild grape vine	2	
Understory/shrub layer 2-6 ft				**3**	
	Cornaceae	*Cornus sericea*	Red-osier dogwood	**+**	
	Juglandaceae	*Juglans nigra*	Black walnut	+	
	Cupressaceae	*Juniperus virginiana*	red cedar	1	
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	2	10%
	Fagaceae	*Quercus ellipsoidalis*	pin oak	+	Near driveway - diseased.
	Anarcardiaceae	*Rhus glabra*	smooth sumac	3	Large patches at north end
	Rutaceae	*Zanthoxylum americana*	prickly ash	1	5%
Canopy	**6-30 ft**			**2**	
	Aceraceae	*Acer negundo*	boxelder	2	
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	2	
	Juglandaceae	*Juglans nigra*	Black walnut	2	10% cover. Ht=25 ft DBH= 8-inch
	Cupressaceae	*Juniperus virginiana*	red cedar	1	5% cover
	Roseaceae	*Prunus serotina*	black cherry	1	
	Ulmaceae	*Ulmus americana*	American elm	1	

* Relative Cover Classes for individual species and vegetation layers: + (0-1%), 1 (1-5%), 2 (5-25%), 3 (25-50%), 4 (50-75%), 5 (75-100%).

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

Non-Native	Family	Scientific Name	Common Name	Cov*	DBH	Comments
Ground layer 0-2 ft				**3**		
	Herbaceous					
x	Brassicaceae	*Aliaria petiolata*	garlic mustard	2		
	Ranunculaceae	*Anemonella thalictroides*	rue anemone	+		
x	Asteraceae	*Arctium minus*	common burdock	1		
	Araceae	*Arisaema triphyllum*	Jack-in-the-pulpit	+		
	Berberidaceae	*Caulophyllum thalictroides*	blue cohosh	+		
	Onagraceae	*Circaea leutetiana*	enchanter's nightshade	1		
	Umbelliferae	*Cryptotaenia canadensis*	honewort	+		
	Geraniaceae	*Geranium maculatum*	wild geranium	**1**		
	Balsaminaceae	*Impatiens capensis*	Spotted touch-me-not	1		
	Urticaceae	*Laportea canadensis*	wood nettle	2		
x	Lamiaceae	*Leonurus cardiaca*	motherwort	+		
	Verbenaceae	*Phryma leptostachya*	lopseed	+		
	Urticaceae	*Pilea pumila*	clearweed	1		
	Roseaceae	*Rubus ideaus*	raspberry			
	Papaveraceae	*Sanguinaria canadensis*	bloodroot	**+**		
	Liliaceae	*Smilacina racemosa*	false solomon's seal	+		
	Liliaceae	*Uvularia grandiflora*	large flowered bellwort	1		
	Graminoids					
	Cyperaceae	*Carex blanda*	Eastern woodland sedge	**1**		
	Woody, vines					
	Juglandaceae	*Carya cordiformes*	Bitternut hickory			
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle			
	Menispermaceae	*Menispermum canadense*	Moonseed			
	Vitaceae	*Parthenocissus inserta*	Virginia creeper			
	Fagaceae	*Quercus rubra*	Red oak			
	Anarcardiaceae	*Rhus glabra*	smooth sumac			
	Ulmaceae	*Ulmus americana*	American elm			
	Vitaceae	*Vitis riparia*	Wild grape vine			
Understory/shrub layer 2-6 ft				**2**		
	Cornaceae	*Cornus racemosa/foemina*	gray dogwood	1		
	Juglandaceae	*Juglans nigra*	Black walnut	1		
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	2		Mostly edges.
	Fagaceae	*Quercus ellipsoidalis*	pin oak	1		
x	Rhamnaceae	*Rhamnus cathartica*	common buckthorn	2	0.5 to 6"	Mostly edges, some large.
	Saxifragaceae	*Ribes americanum*	currant	1		
	Saxifragaceae	*Ribes cynosbati*	gooseberry	1		
	Rutaceae	*Zanthoxylum americana*	prickly ash	1		
Canopy	**6-30 ft**			**5**		
	Aceraceae	*Acer negundo*	boxelder	1	8	
	Juglandaceae	*Carya cordiformes*	Bitternut hickory			
	Ulumaceae	*Celtis occidentalis*	Hackberry	1	4, 8	
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	2	18, 20	
	Roseaceae	*Prunus serotina*	black cherry	2	4, 15	
	Roseaceae	*Prunus virginiana*	Chokecherry	1		
	Fagaceae	*Quercus ellipsoidalis*	pin oak	2		Co-dominant.
	Fagaceae	*Quercus macrocarpa*	Bur oak	2	8, 12	
	Fagaceae	*Quercus rubra*	Red oak	2	4 to 15	Co-dominant. One giant 24", double trunk.
	Tiliaceae	*Tilia americana*	American basswood	1	4, 12	
	Ulmaceae	*Ulmus americana*	American elm	1		

APPENDIX B. Plant Species For Restoration at the Spring Lake Park South Archery Area.

The following species lists were developed for each unit, based on the DNR Plant Community guide and on direct reference to comparable nearby plant communities. There may be additional species suitable for a site. Not all species listed may be available from nurseries. Detailed species lists and quantities will need to be developed by an ecologist after site preparation and additional evaluation. All seed and plant material used at the property should be of Minnesota origin, ideally from within 100 miles of the site. Nurseries should provide seed/ plant origin information.

Southern Dry Mesic Oak Forest MHs37

The species listed below were taken from the DNR Plant Community guide. The canopy species probably will not need to be planted, but were included as reference.

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Forbs, ferns, graminoids					
Actaea	*rubra*	Red baneberry	60	2	120
Adiantum	*pedatum*	Maidenhair fern	40	3	120
Amphicarpaea	*bracteata*	Hog-peanut	60	4	240
Anemone	*americana*	Round-lobed hepatica	20	3	60
Apocynum	*androsaemifolium*	Spreading dogbane	20	3	60
Aquilegia	*canadensis*	Columbine	20	3	60
Aralia	*nudicaulis*	Wild sarsaparilla	60	6	360
Aralia	*racemosa*	American spikenard	40	2	80
Arisaema	*triphyllum*	Jack-in-the-pulpit	60	4	240
Aster	*sagittifolius*	Tail-leaved aster	20	3	60
Athyrium	*filix-femina*	Lady-fern	100	5	500
Botrychium	*virginianum*	Rattlesnakefern	20	5	100
Carex	*pensylvanica*	Pennsylvania sedge	40	2	80
Caulophyllum	*thalictroides*	Blue cohosh	40	3	120
Circaea	*lutetiana*	Enchanter's nightshade	80	8	640
Cryptotaenia	*canadensis*	Honewort	60	3	180
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	80	18	1440
Dioscorea	*villosa*	Wild yam	20	3	60
Galium	*triflorum*	Three-flowered bedstraw	60	3	180
Geranium	*maculatum*	Wild geranium	100	7	700
Geum	*canadense*	White avens	80	3	240
Hackelia	*spp.*	Stickseed	40	3	120
Hydrophyllum	*virginianum*	Virginia waterleaf	60	4	240
Impatiens	*spp.*	Touch-me-not	40	4	160
Maianthemum	*canadense*	Canada mayflower	60	3	180
Mitella	*diphylla*	Two-leaved miterwort	20	3	60
Osmorhiza	*claytonii*	Clayton's sweet cicely	80	10	800
Osmunda	*claytoniana*	Interrupted fern	40	5	200
Phryma	*leptostachya*	Lopseed	100	6	600
Polygonatum	*pubescens*	Hairy Solomon's-seal	20	3	60
Polygonatum	*biflorum*	Giant Solomon's-seal	40	3	120
Pteridium	*aquilinum*	Bracken	20	5	100
Sanguinaria	*canadensis*	Bloodroot	80	3	240
Sanicula	*marilandica*	Mariland black snakeroot	60	3	180
Smilacina	*racemosa*	false Solomon's-seal	80	3	240
Thalictrum	*dioicum*	Early meadow-rue	100	4	400
Uvularia	*grandiflora*	Yellow bellwort	100	3	300
Uvularia	*sessilifolia*	Pale bellwort	20	3	60
Veronicastrum	*virginicum*	Culver's root	20	3	60
Viola	*Viola sp*	Violet	60	2	120

Southern Dry Mesic Oak Forest MHs37 (continued)

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Shrubs					
Cornus	*alternifolia*	Pagoda dogwood	100	6	600
Cornus	*racemosa*	Gray dogwood	20	1	20
Corylus	*americana*	American hazelnut	40	9	360
Corylus	*cornuta*	Beaked hazelnut	40	2	80
Prunus	*virginiana*	Chokecherry	60	4	240
Rosa	*blanda*	Smooth wild rose	20	1	20
Sambucus	*racemosa*	Red-berried elder	40	3	120
Symphoricarp	cmx	Snowberry	20	3	60
Viburnum	*rafinesquianum*	Downy arrow-wood	40	3	120
Viburnum	*lentago*	Nannyberry	20	1	20
Canopy Trees (>10m)					
Acer	*rubrum*	Red maple	20	88	1760
Acer	*saccharum*	Sugar maple	40	9	360
Betula	*papyrifera*	Paper-birch	20	1	20
Carpinus	*caroliniana*	Blue beech	20	3	60
Carya	*cordiformis*	Bitternut hickory	40	3	120
Celtis	*occidentalis*	Hackberry	60	2	120
Ostrya	*virginiana*	Ironwood	40	9	360
Prunus	*serotina*	Black cherry	100	9	900
Quercus	*rubra*	Northern red oak	100	31	3100
Quercus	*alba*	White oak	60	46	2760
Tilia	*americana*	Basswood	40	4	160

[3]Frequency: Number of releve plots in which species occurs divided by total number of releve plots, multiplied by 100
[4]Abundance: Average percent cover of species within the community. It is most appropriate to interpret each value as a cover class similar to those used for original data collection (see text of report for more details)
[5]Index of Commonness: Frequency multiplied by Abundance

Southern Dry Prairie (UPs13) Species

While restoring a full complement of species for any type of restoration is not feasible, the following guidelines can be used, depending on funding.

Low diversity: 20-30 species (6-8 grasses, 15-20 forbs, 1 low shrub)
Moderate diversity: 35-40 species (9-11 grasses, 25-30 forbs, 2-3 low shrubs)
High diversity: 50-60 species (12-14 grasses, 30-40 forbs, 3-4 low shrubs)

Genus	Species	Common Name	Freq*
Forbs			
Allium	*stellatum*	Prairie wild onion	18
Anemone	*cylindrica*	Long-headed thimbleweed	36
Anemone	*patens*	Pasque-flower	27
Antennaria	*spp.*	Pussytoes	27
Artemisia	*campestris*	Tall wormwood	45
Artemisia	*ludoviciana*	Western mugwort	18
Asclepias	*verticillata*	Whorled milkweed	18
Asclepias	*viridiflora*	Green milkweed	45
Asclepias	*syriaca*	Common milkweed	18
Asclepias	*tuberosa*	Butterfly-weed	27
Aster	*ericoides*	Heath aster	18
Aster	*sericeus*	Silky aster	45
Aster	*oblongifolius*	Aromatic aster	18
Aster	*oolentangiensis*	Sky-blue aster	27
Aster	*prenanthoides*	Crooked-stemmed aster	9
Aster	*laevis*	Smooth aster	9
Astragalus	*crassicarpus*	Buffalo-bean	27
Calylophus	*serrulata*	Toothed evening primrose	27
Campanula	*rotundifolia*	Harebell	27
Chrysopsis	*villosa*	Prairie golden aster	18
Comandra	*umbellata*	Bastard toad-flax	36
Coreopsis	*palmata*	Stiff tickseed	18
Cycloloma	*atriplicifolium*	Winged pigweed	9
Dalea	*purpurea*	Purple prairie-clover	55
Dalea	*villosa*	Silky prairie-clover	9
Dalea	*candida*	White prairie-clover	9
Delphinium	*carolinianum*	Prairie larkspur	18
Desmodium	*illinoense*	Illinois tick-trefoil	9
Euphorbia	*corollata*	Flowering spurge	18
Helianthemum	*bicknellii*	Hoary frostweed	9
Helianthus	*pauciflorus*	Stiff sunflower	36
Kuhnia	*eupatorioides*	False boneset	18
Lathyrus	*venosus*	Veiny pea	9
Lespedeza	*capitata*	Round-headed bush-clover	36
Liatris	*punctata*	Dotted blazing star	45
Liatris	*aspera*	Rough blazing star	18
Linum	*sulcatum*	Grooved yellow flax	18
Lithospermum	*caroliniense*	Hairy puccoon	27
Lithospermum	*incisum*	Narrow-leaved puccoon	27
Mirabilis	*hirsuta*	Hairy four-o'clock	45
Monarda	*fistulosa*	Wild bergamot	27
Oenothera	*biennis*	Common evening-primrose	9
Oenothera	*clelandii*	Cleland's evening-primrose	18
Onosmodium	*molle*	False gromwell	9
Oxalis	cmx.	Wood-sorrel	9
Pediomelum	*argophyllum*	Silvery scurf-pea	9
Pediomelum	*esculentum*	Prairie-turnip	9
Penstemon	*grandiflorus*	Large-flowered beard-	45
Penstemon	*gracilis*	Slender beard-tongue	9
Physalis	*virginiana*	Ground-cherry	36
Physalis	*heterophylla*	Clammy ground-cherry	36
Potentilla	*arguta*	Tall cinquefoil	36
Ratibida	*pinnata*	Gray-headed coneflower	9
Rudbeckia	*hirta*	Black-eyed Susan	9
Senecio	*plattensis*	Prairie ragwort	27
Silene	*antirrhina*	Sleepy catchfly	36
Solidago	*nemoralis*	Gray goldenrod	73
Solidago	*missouriensis*	Missouri goldenrod	18
Solidago	*rigida*	Stiff goldenrod	18
Solidago	*ptarmicoides*	Upland white aster	9
Solidago	*speciosa*	Showy goldenrod	9
Thalictrum	*dasycarpum*	Tall meadow-rue	9
Tradescantia	*occidentalis*	Western spiderwort	36
Verbena	*stricta*	Hoary vervain	27
Veronicastrum	*virginicum*	Culver's root	9
Viola	*pedatifida*	Prairie bird-foot violet	27
Zizia	*aptera*	Heart-leaved alexanders	9
Grasses, Rushes and Sedges			
Andropogon	*gerardii*	Big bluestem	55
Aristida	*basiramea*	Base-branched three-awn	18
Bouteloua	*curtipendula*	Side-oats grama	64
Bouteloua	*hirsuta*	Hairy grama	27
Bromus	*kalmii*	Kalm's brome	9
Calamovilfa	*longifolia*	Sand reed-grass	18
Carex	*pensylvanica*	Pennsylvania sedge	18
Carex	*tenera*	Marsh-straw sedge	9
Carex	*muhlenbergii*	Muhlenberg's sedge	9
Carex	*siccata*	Hay sedge	9
Cyperus	*schweinitzii*	Schweinitz' cyperus	27
Cyperus	*lupulinus*	Hop-like cyperus	27
Elymus	*wiegandii*	Canada wild rye	9
Elymus	*trachycaulus*	Slender wheatgrass	18
Eragrostis	*spectabilis*	Purple lovegrass	27
Koeleria	*pyramidata*	June-grass	73
Muhlenbergia	*cuspidata*	Plains muhly	27
Panicum	*perlongum*	Long-leaved panic grass	18
Panicum	*oligosanthes*	Few-flowered panic grass	45
Panicum	*wilcoxianum*	Wilcox's panic grass	27
Panicum	*virgatum*	Switchgrass	9
Panicum	*leibergii*	Leiberg's panic grass	9
Schizachyrium	*scoparium*	Little bluestem	64
Sorghastrum	*nutans*	Indian grass	36
Sporobolus	*cryptandrus*	Sand dropseed	45
Sporobolus	*heterolepis*	Prairie dropseed	45
Stipa	*spartea*	Porcupine-grass	55
Stipa	*comata*	Needle-and-thread grass	9
Shrubs			
Amorpha	*canescens*	Lead-plant	45
Artemisia	*frigida*	Prairie sagewort	18
Ceanothus	*americanus*	American New Jersey tea	9
Symphoricarpos	*sp*	Snowberry	9

* Freq = percent frequency of occurrence in DNR surveyed communities.

Southern Dry Savanna (UPs14) Species List

Species Lists taken from Terrestrial and Palustrine Native Plant Communities in East-central Minnesota (DNR 2005). Highlighted species are those recommended for the site.

Genus	Species	Common Name	Freq*
Forbs & low shrubs			
Allium	*stellatum*	Prairie wild onion	11
Amorpha	*canescens*	Lead-plant	56
Anaphalis	*margaritacea*	Pearly everlasting	11
Anemone	*cylindrica*	Long-headed thimbleweed	33
Antennaria	*spp.*	Pussytoes	89
Apocynum	*androsaemifolium*	Spreading dogbane	11
Arabis	*divaricarpa*	Spreading rock-cress	11
Arabis	*hirsuta*	Hairy rock-cress	33
Aralia	*nudicaulis*	Wild sarsaparilla	11
Artemisia	*campestris*	Tall wormwood	11
Artemisia	*ludoviciana*	Western mugwort	44
Asclepias	*ovalifolia*	Oval-leaved milkweed	33
Asclepias	*syriaca*	Common milkweed	56
Asclepias	*tuberosa*	Butterfly-weed	11
Aster	*ericoides*	Heath aster	44
Aster	*oolentangiensis*	Sky-blue aster	56
Aster	*sericeus*	Silky aster	33
Campanula	*rotundifolia*	Harebell	56
Chrysopsis	*villosa*	Prairie golden aster	11
Comandra	*umbellata*	Bastard toad-flax	11
Coreopsis	*palmata*	Stiff tickseed	44
Dalea	*candida*	White prairie-clover	44
Dalea	*purpurea*	Purple prairie-clover	78
Delphinium	*carolinianum*	Prairie larkspur	22
Desmodium	*canadense*	Canadian tick-trefoil	11
Euphorbia	*corollata*	Flowering spurge	11
Fragaria	*virginiana*	Common strawberry	11
Galium	*boreale*	Northern bedstraw	33
Geranium	*maculatum*	Wild geranium	11
Geum	*triflorum*	Prairie smoke	44
Helianthemum	*bicknellii*	Hoary frostweed	89
Helianthus	*pauciflorus*	Stiff sunflower	33
Heuchera	*richardsonii*	Alum-root	11
Lechea	*stricta*	Prairie pinweed	67
Lespedeza	*capitata*	Round-headed bush-clover	44
Liatris	*aspera*	Rough blazing star	44
Mirabilis	*hirsuta*	Hairy four-o'clock	22
Monarda	*fistulosa*	Wild bergamot	11
Oenothera	*biennis*	Common evening-primrose	11
Pedicularis	*canadensis*	Wood-betony	11
Penstemon	*gracilis*	Slender beard-tongue	22
Penstemon	*grandiflorus*	Large-flowered beard-tongue	11
Phlox	*pilosa*	Prairie phlox	22
Physalis	*virginiana*	Ground-cherry	100
Potentilla	*arguta*	Tall cinquefoil	67
Prenanthes	*racemosa*	Smooth rattlesnake-root	11
Ranunculus	*rhomboideus*	Prairie buttercup	11
Rudbeckia	*hirta*	Black-eyed Susan	33
Silene	*antirrhina*	Sleepy catchfly	11
Sisyrinchium	*campestre*	Field blue-eyed grass	11
Smilacina	*stellata*	Starry false Solomon's-seal	44
Smilax	cmx.	Carrion-flower	22
Solidago	*missouriensis*	Missouri goldenrod	11
Solidago	*nemoralis*	Gray goldenrod	44
Solidago	*rigida*	Stiff goldenrod	11
Solidago	*speciosa*	Showy goldenrod	22
Thalictrum	*dasycarpum*	Tall meadow-rue	11
Viola	*pedatifida*	Prairie bird-foot violet	67
Grasses, Rushes and Sedges			
Agrostis	*hyemalis*	Rough bent-grass	11
Andropogon	*gerardii*	Big bluestem	100
Aristida	*basiramea*	Base-branched three-awn	11
Bouteloua	*curtipendula*	Side-oats grama	33
Bouteloua	*gracilis*	Blue grama	11
Bouteloua	*hirsuta*	Hairy grama	11
Bromus	*kalmii*	Kalm's brome	11
Calamagrostis	*canadensis*	Bluejoint	11
Calamovilfa	*longifolia*	Sand reed-grass	22
Carex	*brevior*	Short sedge	11
Carex	*pensylvanica*	Pennsylvania sedge	44
Carex	*tenera*	Marsh-straw sedge	11
Carex	*siccata*	Hay sedge	78
Cyperus	*lupulinus*	Hop-like cyperus	67
Elymus	*trachycaulus*	Slender wheatgrass	33
Eragrostis	*spectabilis*	Purple lovegrass	78
Koeleria	*pyramidata*	June-grass	67
Muhlenbergia	*cuspidata*	Plains muhly	11
Panicum	*lanuginosum*	Hairy panic grass	33
Panicum	*linearifolium*	Linnear-leaved panic grass	22
Panicum	*oligosanthes*	Few-flowered panic grass	22
Panicum	*perlongum*	Long-leaved panic grass	44
Schizachyrium	*scoparium*	Little bluestem	78
Sorghastrum	*nutans*	Indian grass	67
Sporobolus	*heterolepis*	Prairie dropseed	67
Stipa	*spartea*	Porcupine-grass	67
Canopy Trees			
Quercus	*macrocarpa*	Bur oak	11

Southern dry-mesic oak woodland (FDs37)

The dry-mesic oak woodland will not be planted or seeded in the near future, but will primarily be managed for non-native species control. The list below shows the composition of the community and can be used to enhance the native plant diversity in the future.

Genus	Species	Common Name	Freq %
Forbs, ferns			
Amphicarpaea	*bracteata*	Hog-peanut	76
Anemone	*quinquefolia*	wood anemone	40
Apocynum	*androsaemifolium*	Spreading dogbane	38
Aquilegia	*canadensis*	Columbine	40
Aralia	*nudicaulis*	Wild sarsaparilla	60
Aster	*macrophyllus*	large-leaved aster	49
Aster	*sagittifolius*	Tail-leaved aster	18
Athyrium	*filix-femina*	Lady-fern	51
Circaea	*lutetiana*	Enchanter's nightshade	60
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	78
Galium	*triflorum*	Three-flowered bedstraw	51
Geranium	*maculatum*	Wild geranium	69
Maianthemum	*canadense*	Canada mayflower	73
Osmorhiza	*claytonii*	Clayton's sweet cicely	78
Osmunda	*claytoniana*	Interrupted fern	20
Phryma	*leptostachya*	Lopseed	60
Polygonatum	*biflorum*	Giant Solomon's-seal	27
Pteridium	*aquilinum*	Bracken	51
Pyrola	*elliptica*	shinleaf	20
Sanicula	*marilandica*	Mariland black snakeroot	36
Smilacina	*racemosa*	false Solomon's-seal	60
Smilacina	*stellata*	starry false solomon's seal	22
Thalictrum	*dioicum*	Early meadow-rue	31
Trientalis	*borealis*	starflower	20
Uvularia	*sessilifolia*	Pale bellwort	60
Graminioids			
Carex	*pensylvanica*	Pennsylvania sedge	84
Elymus	*hystrix*	bottlebrush grass	11
Festuca	*subverticillata*	nodding fescue	11
Oryzopsis	*asperifolia*	mountain rice grass	40
Shrubs			
Amelanchier spp		Juneberry	47
Cornus	*racemosa*	Gray dogwood	67
Cornus	*rugosa*	round-leaved dogwood	16
Corylus	*americana*	American hazelnut	80
Corylus	*cornuta*	Beaked hazelnut	22
Diervilla	*lonicera*	bush honeysuckle	33
Prunus	*virginiana*	Chokecherry	82
Ribes	*cynosbati*	gooseberry	49
Ribes	*missouriense*	Missouri gooseberry	24
Rubus	*ideas*	red raspberry	64
Rubus	*allegheniensis*	blackberry	47
Sambucus	*racemosa*	Red-berried elder	20
Symphoricarpos	cmx	Snowberry	20
Viburnum	*rafinesquianum*	Downy arrow-wood	49
Viburnum	*lentago*	Nannyberry	42
Zanthoxylum	*americanum*	prickly ash	67
Canopy Trees			
Acer	*rubrum*	Red maple	27
Betula	*papyrifera*	Paper-birch	20
Fraxinus	pennsylvanica	green ash	9
Ostrya	*virginiana*	Ironwood	19
Populus	tremuloides	quaking aspen	27
Populus	grandidentata	big-tooth aspen	11
Prunus	*serotina*	Black cherry	29
Quercus	macrocarpa	bur oak	67
Quercus	*rubra*	Northern red oak	33
Quercus	*alba*	White oak	29
Quercus	ellipsoidalis	pin oak	60
Ulmus	americana	American elm	21

APPENDIX C. METHODS FOR CONTROLLING EXOTIC, INVASIVE PLANT SPECIES

TREES AND SHRUBS

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

Siberian elm, native to eastern Asia, readily grows, especially in disturbed and low-nutrient soils with low moisture. Seed germination is high and seedlings establish quickly in sparse vegetation. It can invade and dominate disturbed areas in just a few years. Black locust is native to the southeastern United States and the very southeastern corner of Minnesota. It has been planted outside its natural range, and readily invades disturbed areas. It reproduces vigorously by root suckering and can form a monotypic stand.

Chemical Control

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

In non-freezing temperatures, a glyphosate herbicide such as Roundup can be used for most woody species. It is important to obtain the concentrated formula and dilute it with water to achieve 10% glyphosate concentration. Adding a marker dye can help to make treated stumps more visible. In winter months, an herbicide with the active ingredient triclopyr must be used. Garlon 4 is a common brand name and it must be mixed with a penetrating oil, such as diluent blue. Do not use diesel fuel, as it is much more toxic in the environment and for humans.

Brush removal work can be done at any time of year except during spring sap flow, but late fall is often ideal because buckthorn retains its leaves longer than other species and is more readily identified. Cutting can be accomplished with loppers or handsaws in many cases. Larger shrubs may require brush cutters and chainsaws, used only by properly trained professionals.

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

In the year following initial cutting and stump treatment, there will be a flush of new seedlings as well as resprouting from some of the cut plants. Herbicide can be applied to the foliage of small plants, but foliar application is not as effective for stems ½ inch or more in diameter. Fall is the best time to do this, when desirable native plants are dormant and when the plant is pulling resources from the leaves down into the roots. Glyphosate and Krenite (active ingredient – fosamine ammonium) are the most commonly used herbicides for foliar application. Krenite prevents bud formation so the plants do not grow in the spring. This

herbicide can be effective, but results are highly variable. Glyphosate or a triclopyr herbicide such as Garlon can also be used. Glyphoste is non-specific and will kill anything green, while triclopyr targets broadleaf plants and does not harm graminoids. All herbicides should be applied by licensed applicators and should not be applied on windy days. Care should be taken to avoid application to other plants. "Weed Wands" or other devices that allow dabbing of the product can be used rather than spraying, especially for stump treatment.

Basal bark herbicide treatment is another effective control method. A triclopyr herbicide such as 10% Garlon 4, mixed with a penetrating oil, is applied all around the base of the tree or shrub, taking care so that it does not run off. If the herbicide runs off it can kill other plants nearby. More herbicide is needed for effective treatment of plants that are four inches or more in diameter.

Undesirable trees and shrubs can also be destroyed without cutting them down. Girdling is a method suitable for small numbers of large trees. Bark is removed in a band around the tree, just to the outside of the wood. If girdled too deeply, the tree will respond by resprouting from the roots. Girdled trees die slowly over the course of one to two years. Girdling should be done in late spring to mid-summer when sap is flowing and the bark easily peels away from the sapwood. Herbicide can also be used in combination with girdling for a more effective treatment.

Mechanical Control

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

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

Stems, Seedlings and Resprouts

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

If burning is not feasible, critical cutting in the spring is also effective, though it can impact desirable herbaceous plants as well. Foliar (leaf) application of a bud-inhibitor herbicide

(Krenite) during fall is also effective. This method can also affect non-target species, though most natives will be dormant by that time.

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

Disposal
The easiest and most cost-effective method to handle large amounts of brush is usually to stack it and burn it in winter. In areas where brush is not dense, it can be cut up into smaller pieces and left on the ground where it will decompose in one to three years. This method is especially useful on slopes to reduce erosion potential. Small brush piles can also be left in the woods as wildlife cover. Where there is an abundance of larger trees, cut trees may be hauled and chipped and used for mulch or as a biofuel. Alternatively, the wood can be cut and used for firewood, if a recipient can be found.

FORBS

Canada thistle
While native thistles are not generally problematic, exotics such as Canada thistle are clone-forming perennials that can greatly reduce species diversity in old fields and restoration areas (Hoffman and Kearns 1997). A combination of chemical and mechanical control methods may be needed at the Empire property. 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 would be appropriate for the south grassland (G1), to minimize damage to native grasses. 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.

Sweet clover
White and yellow sweet clover are very aggressive annual species that *increase* with fire. Sweet clover was found in the brome field (G2) and would be eliminated by treatment that eliminates the brome if prairie restoration occurs. However, it is a common plant in agricultural areas, so if restoration is implemented, the area should be surveyed for this

species on an annual basis. Individual plants or small populations can be removed by hand-pulling. If seed production occurs, prodigious amounts of seed could be spread at the site.

APPENDIX D. GENERAL RESTORATION STRATEGIES AND CONSIDERATIONS FOR OAK SAVANNAS IN THE MIDWEST

By Claudia Naninga

There are several ways in which oak savannas in the Midwest can be restored. The longer the savanna has faced fire-suppression, grazing and other stresses the more intensive the restoration efforts that are needed. If an alternate stable state has been reached, several methods have to be combined for an extended amount of time. For example, it might be impossible to get rid of encroached woody species as long as there is not the right understory fuel availability to create large enough fires. Or removing the woody invasive species might not lead to the expected results as after removal of mesophytic species, other mesophytic instead of the required savanna species encroach the site again (Brudvig *et al.* 2007).

The main goals of restoration are the reduction of the overstory tree density and the promotion of oak dominance (Brudvig *et al.* 2011). Specifically this includes the creation of a natural savanna age structure and canopy composition, the reduction of exotics species, and the creation of refugia for oaks and oak-dependent species (Wolf 2006).

A number of restoration approaches have been used in the past: In some cases it might be enough to re-introduce the main natural disturbance, which in case of oak savannas is fire. This approach assumes that the system is already within its natural range of variability and that the re-introduction of a natural disturbance is enough to restore the original system (Nielsen et al. 2003). In other cases the initial removal of selected trees followed by the re-introduction of fire, sometimes referred to as the 'structural manipulation approach', might be necessary. This approach is based on the idea that the reintroduction of a more natural structure before the use of fire will assist the recovery of dynamics much faster and more efficiently than the mere use of the disturbance (Nielsen et al. 2003). It is especially useful if there have been major structural changes, such as canopy closure and the development of a midstory canopy layer (Brudvig *et al.* 2007).

Generally, the use of just one method can be short-sided. For example, Abella *et al.* (2004) and Nielsen *et al.* (2003) were unable to find a change in understory diversity and richness after using fire only. When using the structural manipulation approach, on the other hand, Nielsen *et al.* (2003) achieved increases in species richness. Brudvig *et al.* (2007) did a study in which they didn't use fire and purely removed encroaching species in a savanna. They never got past a threshold and mesophytic species were the dominant invaders after 3 years, while oak was largely unaffected by the treatment. Also shrub-densities returned to pre-treatment levels. They concluded that repeated treatments in combination with fire might be more efficient.

Structural manipulation approach

The first step of regenerating an oak savanna when using the structural manipulation approach is the removal of invasive shrubby species and encroaching trees to create a structure that more resembles a natural system. For example Brudvig (2007) recommends the reduction of the basal area to 30%, the creation of a canopy cover that covers up to 50% of the site, and the removal of all non-oak woody stems that are larger than 150 cm in size. Treatments should be

organized during the winter months when the soil is frozen to reduce negative impacts. There are several ways of removing trees and shrubs, including manual, chain saws, brush cutters. In many cases, especially for exotic invasive species, the use of herbicides will be necessary (Maloney 1997).

After the removal of encroaching exotic species and tree species, fires should be re-introduced. Because of their thick bark and ability to resprout after topkill, most oak species are naturally adapted to fire and fires have been an essential disturbance that keeps savannas from developing into woodland (Wolf 2006). The specific effect of fire in degraded savannas is the reduction of invasive grasses and woody species and to sustain higher levels of habitat and species diversity (Wolf 2004). But fires don't always yield the expected result as all plant species that are part of a savanna respond to fire in an individualistic manner. For example, in study in Minnesota, Tester (1996) found that true prairie grasses and forbs generally were positively related to burn frequency, but that also some introduced grasses, e.g. *Poa pratensis* (C3) and *Setaria lutescens* (C4), reacted to the disturbance with increased growth. On the other hand, *Agropyron repens* (C3) and *Bromus inermis* (C3) and six of seven native non-savanna species that are associated with forests showed decreased growth after fire. This study shows how important it is to understand the response of species to fire.

Knowledge about fire frequency and intensity is also essential. Taking natural fire regimes in a savanna as a reference, the frequency of low-intensity fires was every 4 or 8 years for bur oak or white oak dominated savannas respectively. So even oak trees, whose germination is supported by fires, need fire-free periods for seedlings and saplings to successfully develop (Wolf 2006). Extreme fires, on the other hand, occurred much less frequently, only around every 35-100 years (Apfelbaum *et al.* 1991). There is a range of recommendations concerning the use of prescribed fires in the literature. Generally, fire frequencies that are either too high or too low can shift resource availability and alter species dominance. Some sources say that low-intensity prescribed fires should be used annually or at least every other year (Maloney 1997, Apfelbaum *et al.* 1991). Others say that rather than that, high-intensity fires should be used, because low-intensity fires are not likely to result in the mortality of large overstory stems. Additionally, frequent low-intensity fires have the potential to destroy seed-banks and endangered savanna species (Nielsen *et al.* 2003, Packard 1997), increase the likelihood of invasive species infestation, change resource availability, and prevent the growth of oak seedlings large enough to survive future fires (Wolf 2006).

In many savannas it is necessary to seed and/or plant the site, especially if no viable seed bank is available and no remnants are close enough for seeds to reach the area. It is possible to either collect seeds from functional remnant savanna sites or order them. After the soil type has been determined, a seed mix should be used that is suitable for the microhabitat. The seeds can be applied by broadcasting or with a native seed drill (Maloney 1997). A good time for seeding is spring or fall, after the seeds have ripened (Packard 1997). Several native plant lists for the Midwest are available: Wolf (2004), Maloney (1997), Tester (1996), Brudvig (2008), Packard (1997). After initial treatment it is necessary to monitor the site for some years, continue removing invasive species and potentially interseed. After that, it might be sufficient to regularly burn the site (Maloney 1997).

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APPENDIX E. ECOLOGICAL CONTRACTORS

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

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

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

Bonestroo Natural Resources
2335 West Highway 36
St. Paul, MN 55113
651-604-4812
www.bonestroo.com

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

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

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

Natural Resources Restoration
2013 Walnut Avenue
New Brighton, MN 55112-5365
651-636-3462

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

Wetland Habitat Restorations
1397 Chelmsford St
St. Paul, MN 55108
612-385-9105