Natural Resource Management Plan
for the
Hampton Woods WMA

March 2017

Prepared by
Karen Schik & Alex Roth
Friends of the Mississippi River
101 East Fifth St, Suite 2000
St Paul, MN 55101

TABLE OF CONTENTS

List of Tables

List of Figures

I. Acknowledgements

FMR would like to thank the following organizations for funding that made this management plan possible.

Hastings Environmental Protectors
Minnesota Ornithologists' Union
Pheasants Forever
Southern Dakota County Sportsmen's Club
Turkey Federation
Winter Wheat Foundation

II. Executive Summary

Background

Hampton Woods is a forested area located along State Highway 50, about a mile west of the town of Hampton in Dakota County. Approximately 420 acres total, this forested island is surrounded by a matrix of cropland. It was ranked by the Department of Natural Resources (DNR) in the mid-1990's as having outstanding biodiversity significance, due to the exceptional native plant diversity and lack of non-native, invasive species. Invasive woody species have since then begun to encroach on the site, exacerbated by significant logging done circa 2010.

In 2012, Friends of the Mississippi River (FMR) and Dakota County began the process to permanently protect the eastern portion of Hampton Woods, about 190 acres (166.17 acres formerly owned by the Kunz family and 24.4 acres owned by the Uselmann's), through the Dakota County Farmland and Natural Areas Program (FNAP). The County completed purchase of both properties in April and July 2016 and will subsequently convey the entire property to the Minnesota Department of Natural Resources (MNDNR) to be managed as a Wildlife Management Area (WMA).

This Natural Resource Management Plan (NRMP) was developed to provide information on the property's natural resources, current conditions, issues and opportunities, management goals, and implementation options to enable more effective conservation stewardship and protection. An NRMP is typically required for state grant funding that will be used for restoration.

Prior to European settlement, the entire Hampton Woods area was a mix of oak openings and barrens and aspen-oak lands, all surrounded by a larger matrix of prairie types. There has been a long history of agriculture in this area of the County and agriculture continues to dominate the landscape around the property. In fact, Hampton Woods is surrounded by ag lands on all sides, though the south branch of the Vermillion River lies just to the north and west, and the town of Hampton lies to the southeast. The historical prairie land outside of the Hampton Woods area would have been much more amenable for conversion to farmland than the partially wooded Hampton Woods, with its more the erodible soils. Much of the Hampton Woods area has been selectively logged over the decades. The property was most recently logged in 2010/2011.

The property includes a mix of level ground and a steep, northeasterly facing hillside that rises about 60 feet to a plateau on the west, thus created an interesting habitat matrix. The WMA parcels encompass much of the eastern sections of the entire woods, about half of the entire Hampton Woods area.

Natural Resource Inventory and Assessment

A natural resource inventory and assessment was conducted by ecologists from Friends of the Mississippi River in the spring, summer and fall of 2016. The previous property owners managed the land for recreation and hunting, and the property was logged (primarily red and pin oak) in 2010. In contrast to most wooded areas in the Twin Cities Metropolitan area, Hampton Woods

has a relatively low abundance of non-native woody species. Whereas most similar woodlands would be heavily infested with buckthorn, these woods have large areas nearly devoid of it. It is very likely that the relatively isolated nature of these woods, surrounded by agricultural land for many miles, resulted in a much slower invasion by buckthorn. Where it has taken hold is primarily along the edges, especially the north edge where most of the houses are located. Likewise, garlic mustard, another very invasive plant that tends to co-occur with buckthorn, is just showing up at the site in scattered patches.

Logging has also resulted in large openings, some of which have allowed for buckthorn to establish. But in other openings the native trees and shrubs have regenerated, with very little buckthorn present. The north and eastern sides of the property are highly degraded, both in terms of species composition and the presence of non-native invasive species. But pockets of relatively high plant diversity remain, especially at the south end and on the terrace top.

Historically, fire was an important component of the landscape and no doubt would have been an element of the Hampton Woods. The woods may have had slight protection from the South Branch Vermillion River. With development of the land, fires were suppressed. That, in combination with openings in the woods created by logging, allowed non-native woody species to become established. However, the selective logging – when done with low-impact methods - also would have facilitated regeneration of native woody and herbaceous species. Overall the forest exhibits declines in native understory diversity and abundance, with some areas more degraded than others.

Buckthorn is the primary non-native woody plant present throughout much of the property, with Tartarian honeysuckle found primarily along edges. White poplar is also gaining ground in some areas, and non-native herbaceous species (garlic mustard, burdock, motherwort etc) are present, especially along the edges of the large network of maintained trails. There are also areas of overabundant prickly ash.

Maintained hiking/ATV trails have somewhat degraded the woods, as the myriad paths act as unnatural barriers, have led to rutting and soil compaction, and provide edge habitat susceptible to invasion by plants including garlic mustard. Some areas of the trails show evidence of erosion and could benefit from re-vegetation. Rare species, including American ginseng and big-leaved tick trefoil, have been identified within Hampton Woods by MCBS surveys, though not necessarily on the currently purchased property parcels. Without management intervention, the property runs the risk of losing native diversity and transitioning to a degraded, non-native dominated forest.

Final Natural Resource Management Plan Recommendations

Based on the natural resource inventory and assessment, past land uses, and the general goals of the MNDNR for this landscape, this plan recommends removing non-native herbaceous and woody species and restoring native plant communities on the site. Restoration will occur in up to four phases and focuses on removal of non-native woody brush from the entire property. Removal should be conducted in the fall and winter. Minimal impact methods should be used –

primarily cut and stump-treat. Foliar herbicide application should be avoided to prevent non-target impacts. In general, this site is not a good candidate for forestry mowing, however there may be some very degraded areas in the east unit that would qualify. Additional non-native woody control (cut/treat) will be needed every 3-5 years, especially in the most heavily infested areas, edges and canopy gaps, to gradually eradicate the buckthorn. This method may seem slower than forestry mowing and broadcasting herbicide, but is likely to better protect the native floral diversity.

In subsequent years, seeding and shrub planting may be needed in open areas and low diversity areas. Although mesic oak forest is not a fire-dependent community, light surface fires did occur occasionally and may be used to help maintain the community, with burns occurring on a portion of the site once every 20-30 years. Continued maintenance of these areas will involve follow-up herbicide treatments, hand-pulling invasive herbaceous plants, rotating prescribed burns and supplemental seeding. In addition, surveys of orchids, vegetation study plots, breeding birds, and other wildlife surveys are recommended to monitor the site for plant and bird diversity, the measure of which would indicate whether the management activities are successful and wildlife habitat is improving.

Removing non-native invasive woody plants is by far the largest expense for management of this property. The estimated cost for the initial removal for the entire site is about $240,000. It is also the highest priority and should be initiated as soon as possible, according to the four-phase sequence. The four-phase restoration process would take approximately eight years with an estimated cost of $360,000 if all activities were undertaken and contracted. Volunteer events, such as brush hauling and native planting events, may help offset the costs slightly and will serve as a chance to connect the community to the site. FMR has obtained grant funding for initial restoration and enhancement steps that will be adequate for the first two years of work phases one and two. FMR is also able to help with the longer-term coordination and management of restoration activities for the entire site.

III. Purpose of the NRMP

The purpose of the Natural Resource Management Plan (NRMP) is to describe the current and preferred natural resource conditions, goals, and activities for the portion of the Hampton Woods property that will be owned by the MN DNR. The NRMP includes information on the property's location; historic, existing, and adjacent land use; bedrock and surficial geology; soils; topography; hydrology, including groundwater and surface water; historical and existing vegetation cover, including noxious and invasive plants; ecological impacts, both past and present from fire suppression, diseases, wildlife, and climate change; plant community assessment; wildlife; target vegetation communities, including management priorities, methods, five year work plan, and long-term work plan. The Final NRMP also includes plant restoration goals and recommendations, a restoration process, schedule, and cost estimates.

Contacts

MN Department of Natural Resources
Bob Fashingbauer, Area Wildlife Manager
15325 Babcock Ave
Rosemount, MN 55068
651-322-4643
email: Robert.fashingbauer@state.mn.us

Friends of the Mississippi River
Karen Schik, Sr Ecologist
101 East Fifth St, Suite 2000
Saint Paul, MN 55101
651-222-2193 ext 15
email: kschik@fmr.org

IV. Property Information

Address: Approximately 22000 Collier Ct

Section 6, Township 113, Range 18 and
Section 1, Township 113, Range 19

Watershed: Vermillion River Sub-Watershed: South Branch Vermillion River

Watershed Organization: Vermillion River JPO

Parcel Identification Number(s):

170060027012 (28.29 ac)
170060026010 (38.55 ac)
170060051010 (19.3 ac)
170060053010 (9.68 ac)
170060052010 (9.69 ac)
170060055010 (23.83 ac)
070010076011 (31.04 ac)
070010009010 (10.04 ac)
070010008010 (10.04 ac)
070010088010 (10.03 ac)

Total Acres: 190.5

Access to Property:
Public access to the property is from Collier Court, which is located about two miles west of the City of Hampton, on State Highway 50. Turn south off Hwy 50, drive about 1/8 mile to small parking area.

Easement Acquisition Date: July 21, 2016

Funding Sources for Acquisition of the Easement:

Dakota County: $197,000
State of Minnesota Outdoor Heritage Fund: $541,000.

V. Introduction

Most of Dakota County's 400,000 residents live in the highly urbanized northern one-third of the County, a rolling landscape bordered by major rivers on the north and dotted with lakes, forests, wetlands and other natural areas. The southern two-thirds of the County is generally level and open where agriculture is the predominant land use. This portion of the County is dissected by many streams and tributaries, and includes the largest tracts of natural areas.

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

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

- Increase property values and enhance neighborhoods appeal
- Provide close-to-home opportunities for people to enjoy and interact with nature
- Provide critical habitat for plants and animals and preserving critical ecological connections between habitat areas
- Provide environmental services, including filtering pollutants from soil and water, reducing soil erosion, and absorbing air pollutants and carbon dioxide
- Provide natural flood control for area streams and rivers by retaining wetlands and vegetated corridors to absorb flood waters
- Citizen input was used to identify the desired characteristics for natural areas:
- Lands of biological significance
- Lands adjacent to lakes, rivers, and streams to improve water quality
- Lands that provide wildlife habitat
- Lands that provide some level of public access

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

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

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

Strategy 3: Work with owners of large land tracts and agencies to protect natural areas on their properties with conservation easements and natural resource management plans.

The Farmland and Natural Areas Program (FNAP) was developed to implement the Plan and was initially funded through a $20 million bond referendum approved by voters in November 2002. Half of the funds were targeted for protecting highly productive farmland and associated natural areas and half of the funds were focused entirely on natural areas. The first FNAP application round occurred in 2003, with annual application rounds thereafter. The program seeks to work with landowners and a wide variety of partners to protect, restore, and connect threatened natural areas throughout the County to assure that the ecological, social, and financial benefits of these areas can be maintained and enhanced. Currently, County and Dakota County Soil and Water Conservation District staff evaluate and recommend projects for County Board consideration. Projects are funded through a mix of federal, state, County, and local funds.

Building on the concepts in the FNAP, the County Board approved the Vermillion River Corridor Plan in November 2010, which sought the enhanced protection and improvement of water quality and wildlife habitat with increased opportunities for outdoor recreation for the Vermillion River corridor and its major tributaries. In 2012, the County began the ShoreHolders Program to implement the Corridor Plan goals along all the rivers, streams and undeveloped lakeshore throughout the County. In 2015, these programs were merged into the Land Conservation Program. Matching State Environment and Natural Resource Trust Fund and Outdoor Heritage Fund grants have been appropriated to the County to implement its programs.

The Hampton Woods project began with FMR's outreach to private landowners to seek landowners interested in conserving their property. After several years and many discussions with landowners, the DNR and Dakota County, the Dakota County FNAP program stepped forward as a willing agent to help purchase the property and hold it temporarily.

VI. Landscape Context

A. Location

The Hampton Woods parcels are located roughly thirty minutes south of downtown St. Paul in Hampton, MN. From the Twin Cities, take US-52 south to Hampton. Follow signs to exit on Northfield Blvd, and take Northfield into Hampton before turning right on highway 50 (Hampton Blvd). Continue north on MN-50 for just over two miles and turn left on Collier Ct, an inconspicuous gravel road tucked into the treeline. Collier Ct. ends at a gate that serves as the property boundary.

The property is located just east of the south branch of the Vermillion River and northwest of the town of Hampton, MN (**Figure 1**). Agricultural fields and some private residences flank the property's boundaries on all sides. Currently, the property is approximately 4,940 feet long and 2,290 feet wide at its maxima, though these numbers will increase as more parcels are added. On a landscape scale, the property is located within a mosaic of agricultural land, and serves as an oasis of forest in an otherwise disturbed landscape.

The property sits on the western edge of the *Rochester Plateau* ecological subsection, near its boundary with the *Oak Savanna* subsection, as designated by the Minnesota DNR (**Figure 12**). This subsection lies within the *Paleozoic Plateau* section in the *Eastern Broadleaf Forest* province of the state. The property itself is ranked by the Minnesota County Biological Survey as having outstanding biological significance, and is situated near other areas of moderate to low significance as well as near areas of parkland, including the UMN Rosemount research center.

The 1994 evaluation (of the entire Hampton Woods) stated: "Hampton Woods…is one of the largest, diverse natural areas remaining in Dakota County…(it) contains a significant example of a state endangered plant community, mesic oak forest."

The property is also located within an ecological area of regional significance; Hampton Woods is situated within the Metro Conservation Corridors system (**Figure 2**), identified as an important habitat network for both sedentary and migratory plant and animal life in and around the Twin Cities. As a protected area within a matrix of mainly agricultural land, this property has inherent wildlife significance. Rare species on the property include American ginseng and big-leaved tick trefoil, and rare communities exist as well, including multiple variations of mesic oak forest. Flora and fauna depend on these protected areas for habitat, and restoration of these lands will benefit both resident and migratory species. Because of the surrounding agricultural matrix, this is a high priority natural area, both for the species that depend on forest habitat, and for providing access to forested lands for public enjoyment.

B. Historic and Existing Land Use

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

Hampton Woods has had selective logging in the past and also shows signs of grazing. In the 1994 DNR evaluation, "the oak forest east of the plateau is recovering well from these disturbances." That would apparently have been the WMA property, which subsequently underwent significant logging disturbances in 2010.

Some of the best evidence of past land use is depicted in historical aerial photographs. **Figures 3, 4, & 5** are historic aerial photos for the Hampton Woods and surrounding area from 1937 to 2015. The photos show that most the landscape has stayed more or less the same since for the last 80 years or so. As a whole, the Hampton Woods complex has retained the same boundaries, with only minor changes in the amount and size of agricultural fields along its borders. Some expansion of ag fields has occurred at the expense of the forest, but these incursions were minimal and occurred mostly on the southwest side of forest. The surrounding landscape has stayed relatively similar as well, with the largest difference being the number of residences in the surrounding area. Residential density has increased slightly, and the town of Hampton has expanded marginally. However, development is still in keeping with that of an agricultural landscape. Moreover, farming practices seem to have improved in relation to the south branch of the Vermillion River. Historically, there was very little buffer along the river, and tree cover was particularly sparse. By 2015, buffers had expanded and tree cover had increased along much of the river near the property.

The forest within Hampton Woods has changed somewhat since the 1937 aerial photograph. Some observations that can be made based on the photographic evidence include an increase in canopy cover, signaling the maturation of forest vegetation. In the 1937 photo, there was also evidence of previous timber harvesting, as the vegetation has a very blocky and angular appearance and distinct borders exist between forest areas, with areas of older growth visible throughout. In the modern photos, the canopy appears more uniform in nature, signaling a filling out of the forest. However, the 2010 timber harvest is also evident in the photos, as canopy gaps and openings are present, indicative of a selection harvest. Other changes include the loss of small openings that were likely historically maintained throughout the forest, and the location and size of the trails throughout the forest. For example, the main entrance trail on the north side of the property was once further west (and larger) than it is today. Today's entrance is a straight and narrow path, also likely influenced by the need to allow timber harvesting equipment into the site.

C. Adjacent Land Use

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

A number of residences are situated along the periphery of the Hampton Woods complex. These homes are mostly associated with the neighboring agricultural fields, though the eight or so homes on the north side are set into the woods and not clearly associated with any agriculture. Many of the surrounding homes also have associated paths leading into the woods, allowing the residents access to the property.

Hampton Woods is relatively isolated within a matrix of agricultural land, though a number of other smaller forested areas are located nearby. To the east of the property, several forest patches have remained intact throughout the photo record, though their size is a fraction of the Hampton Woods complex. However, these properties can provide stepping stones for species migrating across the agricultural landscape and are important nonetheless. The property is also just east of the South Branch Vermillion River, which serves as an important wildlife corridor. In fact, some of the extensions of the woods connect to the forested areas along the river, though purchasing and protecting some of the intervening properties would go a long way toward ensuring a viable connection between the woods and the river. MN-50 also runs east to west on the northern edge of the property, creating an effective barrier that separates the northern section of the property from the river. Regardless of these barriers, the importance of the property for resident and migratory species cannot be overstated. Finding ways to better link Hampton Woods to other surrounding natural areas could improve landscape connectivity and the ability of species to move across the landscape.

D. Rare Features of the Property

A search of the DNR Natural Heritage database**, revealed several rare features at the property and nearby. Two features within the property were both oak forest (southeast) mesic. While this is an older classification no longer used, the occurrence on the plateau was later classified as red oak-sugar maple-basswood (bitternut hickory) forest which has a state rank of S3, meaning it is vulnerable in Minnesota either because it's rare or uncommon, or found in a restricted range, or because of other factors making it vulnerable to extirpation. In 1993, it was given a quality ranking of B, indicating a good estimated chance for viability. Field notes from the 1993 survey further describe it: "On flat-topped limestone mesa, sandy loam soils, 50-100 ft side slopes of sandy colluvium. Diverse mesic oak forest of *Tilia americana, Ulmus rubra, Quercus rubra, Q. macrocarpa*. Multi-stemmed trees not uncommon. Woody debris on forest floor of various sizes & stages of decay. Deer trails common & several broad horse trails. *Rhamnus cathartica* around edges of site. Evidence of past grazing and cutting."

The other mesic oak forest occurrence was on the east side of the site. It was defined as fair to good estimated viability (B-C rank) and described as "Young, moderately disturbed forest with continuous canopy of *Quercus ellipsoidalis*, *Quercus rubra* 30-40cm dbh, *Prunus serotina*, *Carya cordiformes* 20-30cm dbh. Occasional canopy gaps often with *Populus grandidentata*; natives dominate the herbaceous layer, diversity varies from good to low. *Rhamnus cathartica* scattered throughout. Evidence of human disturbance; openings, paths, past cutting & grazing." This area has since been more significantly altered from logging and buckthorn invasion.

Two rare plants also occur within the Hamptons Woods complex, but were not located within the property: big-leaved tick-trefoil (state threatened, rank S2) and American ginseng (state special concern, rank S3). The S2 rank indicates a species is imperiled in Minnesota because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state.

There were no other rare feature occurrences within one mile of the property.

There were two **Species of Greatest Conservation Need (SGCNs)** identified at this site – red-shouldered hawk and wood thrush (**Appendix F**). These are species identified by the DNR

whose populations are declining due to habitat loss and other factors. Though not considered "threatened", collecting information about these species is important and their presence at a site is a good indicator that the site may provide valuable habitat. (However, presence alone is not definitive as reproductive success is of greater importance; a site may simply be a population "sink" where predation rates are so high that individuals have zero reproductive success).

Upland hardwood forest itself is not considered a Key Habitat for the Rochester Plateau Subsection, because forest was a very small component of the mid-1800's landscape so proportionally less of this habitat type has been lost. Nevertheless, forested sites are important features of the landscape, especially when they are sizable and have good native plant diversity, such as Hampton Woods.

***State of Minnesota, Department of Natural Resources (DNR). 2014. Rare Features Data included here were provided by the Division of Ecological and Water Resources, Minnesota DNR, and were current as of (September 2015). These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.*

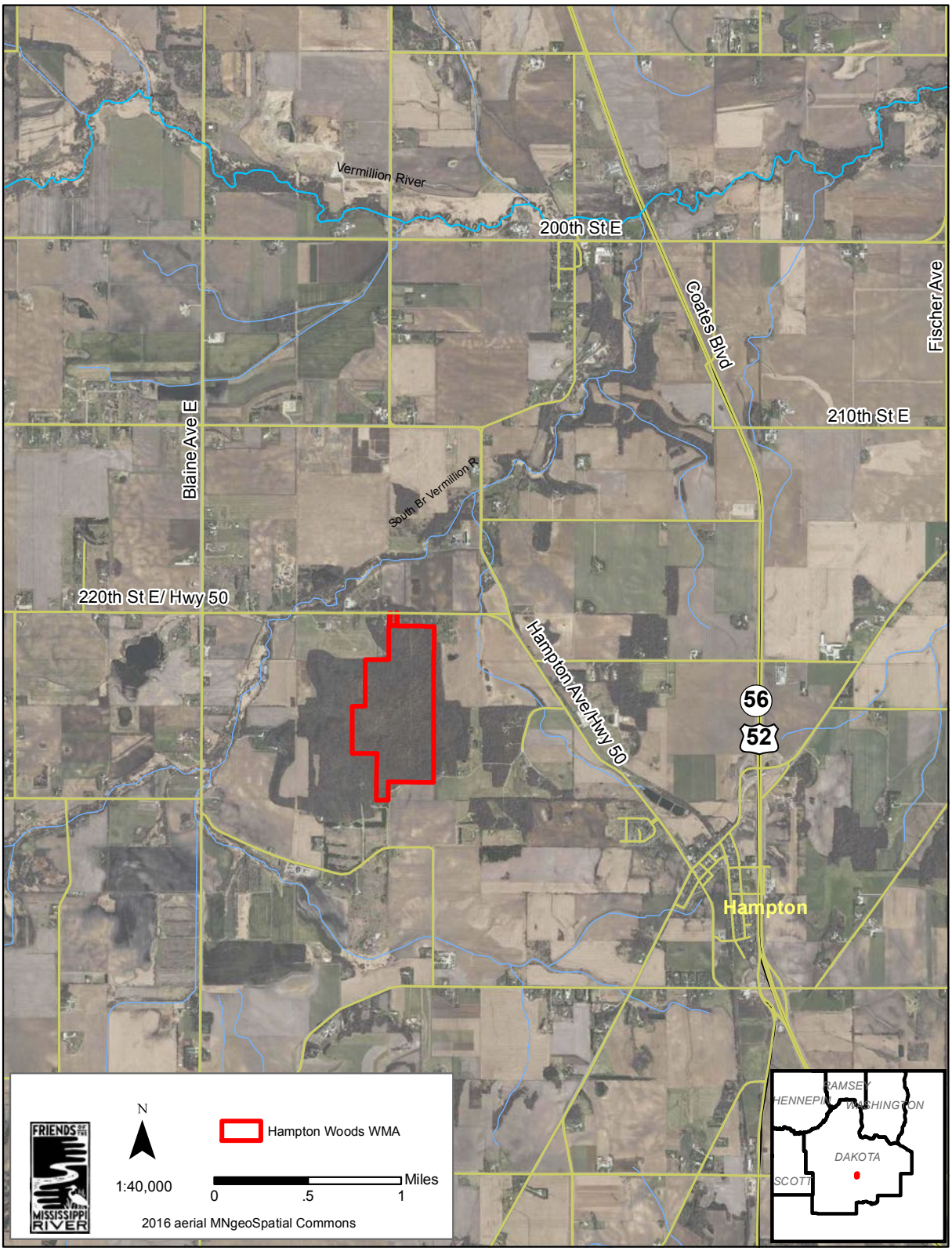

Figure 1. Site Location

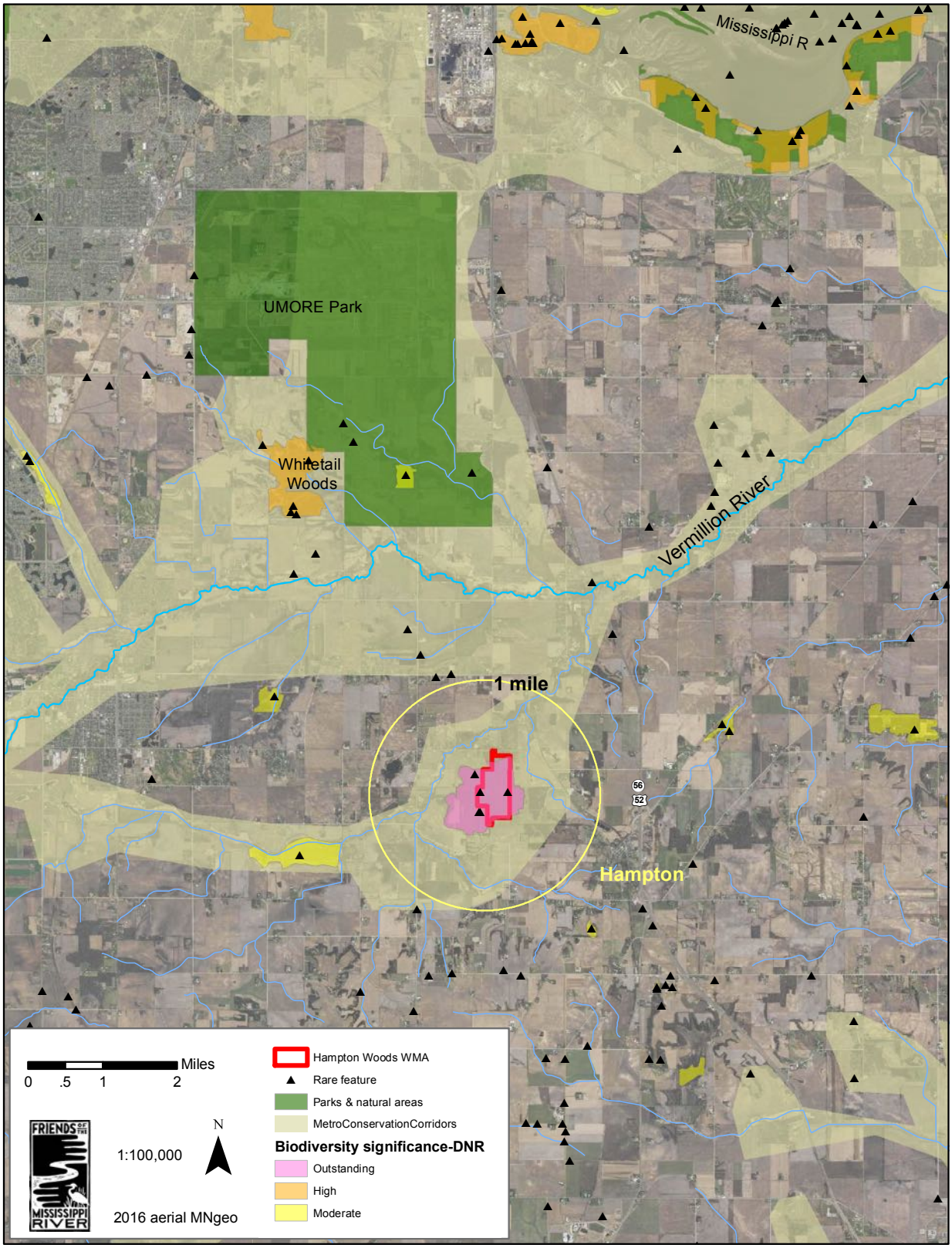

Figure 2. Regional Context

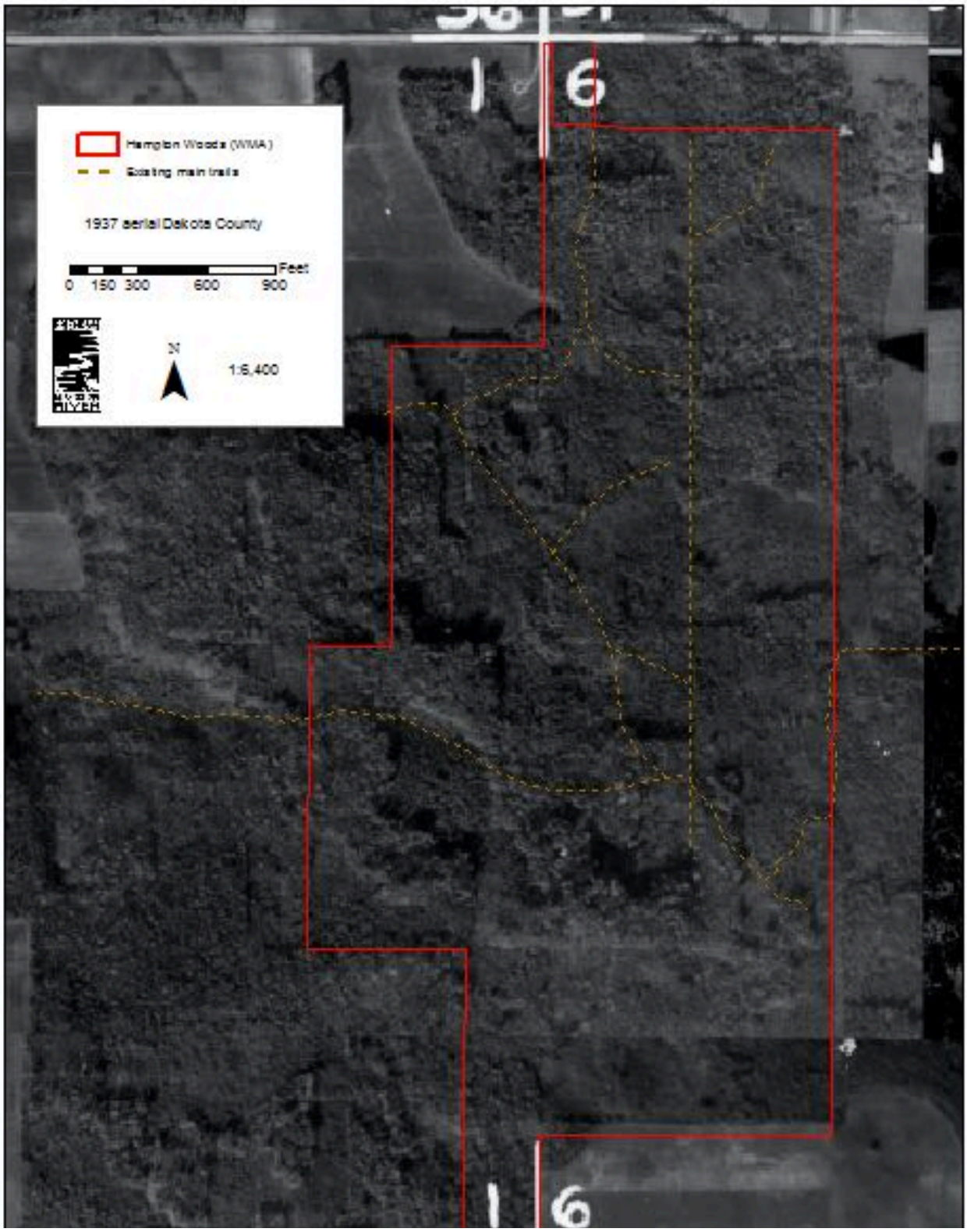

Figure 3. Historical Aerial Photograph 1937

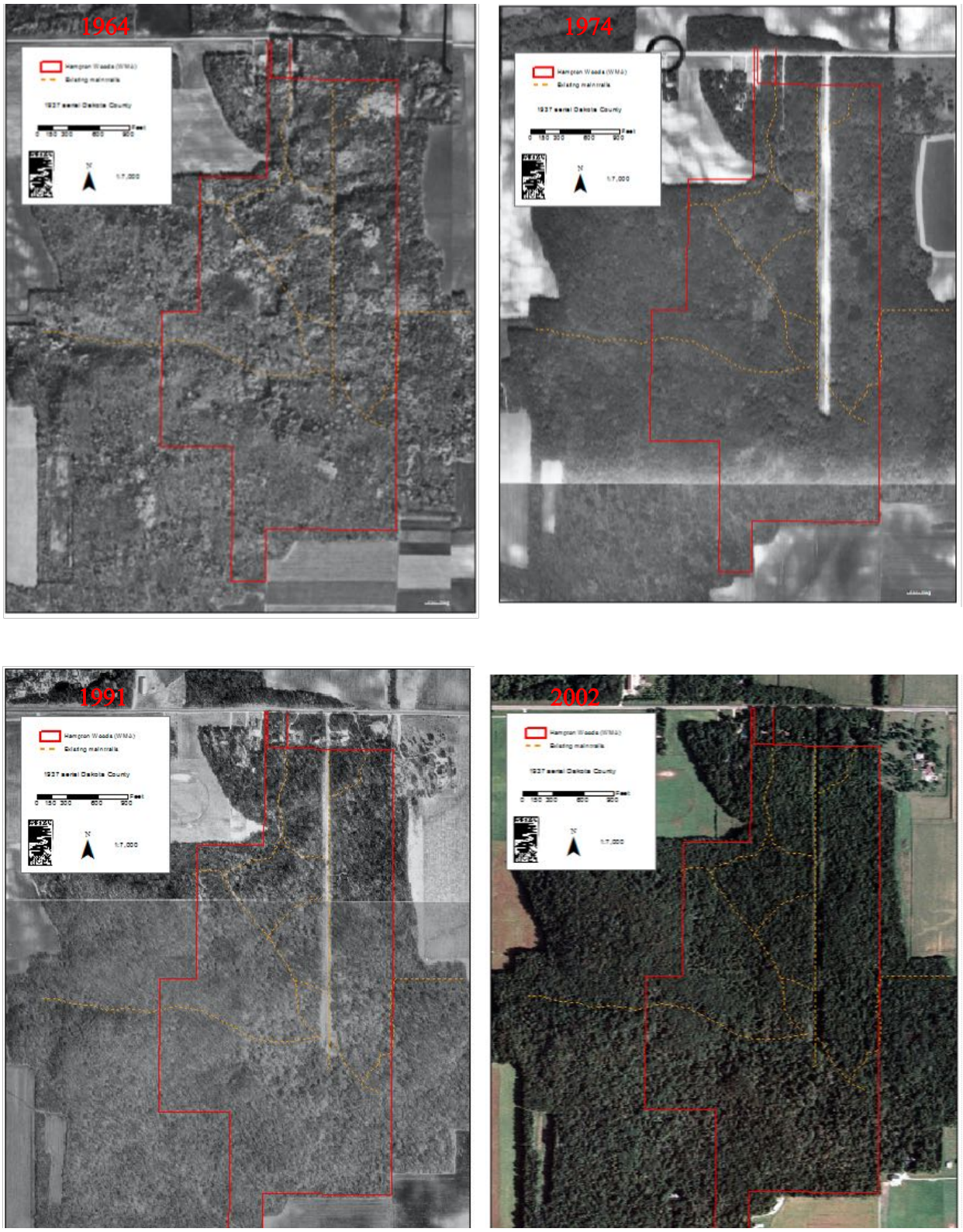

Figure 4. Historical Aerial Photographs 1964-2002

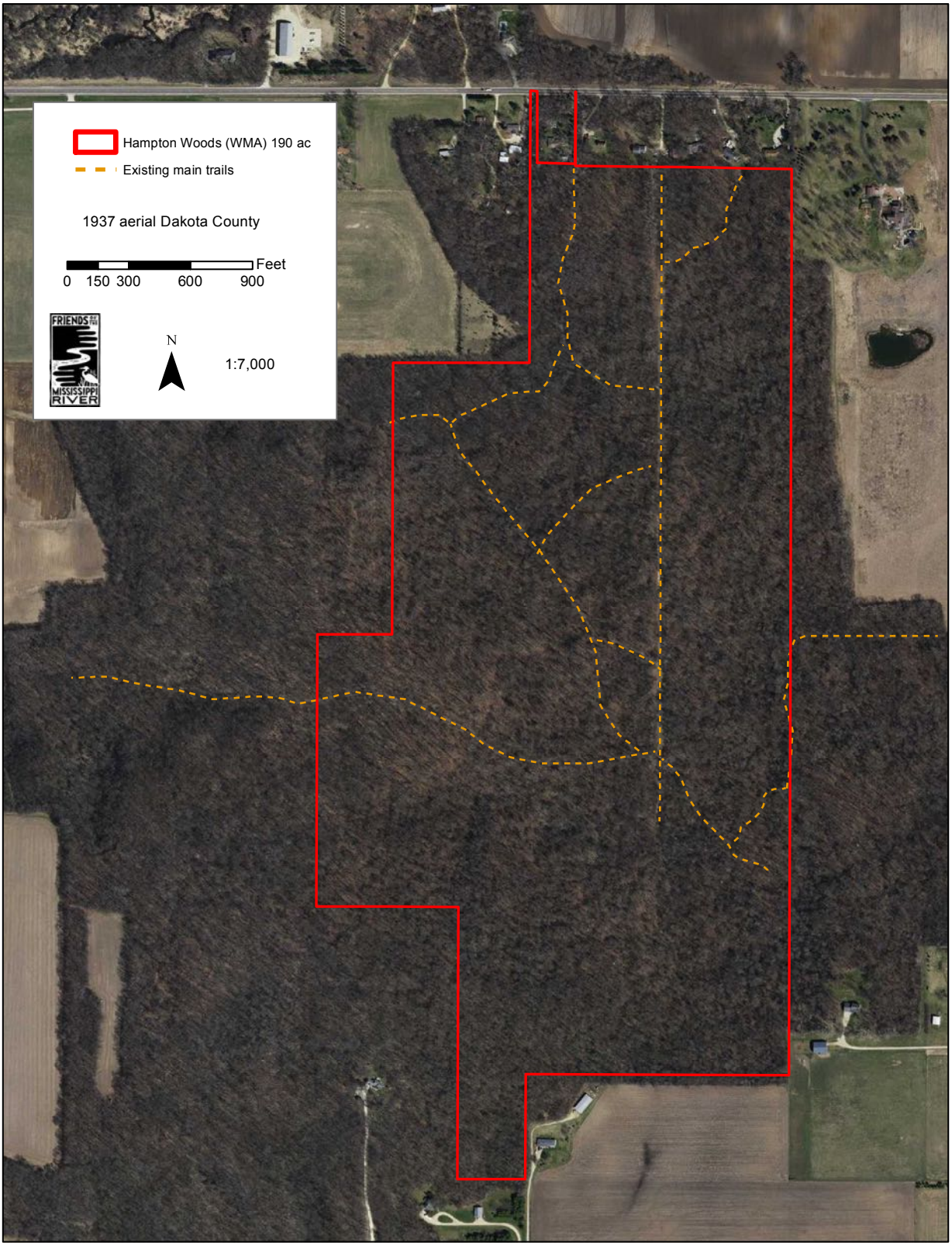

Figure 5. Aerial Photograph 2016

VII. Physical Conditions

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

A. Geology

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

The major bedrock units found in the County include the Decorah, Platteville, Glenwood Sequence, underlain by St. Peter Sandstone, Prairie du Chien Group, Jordan Sandstone, St. Lawrence Formation, and the Franconia Formation. Some of these layers may not exist at a given site because of past geologic events. Bedrock in the County is typically more than 50 feet below the surface in areas north of the Vermillion River and less than 50 feet in areas south of the Vermillion River. In Dakota County, the Prairie du Chien limestone is the most common bedrock first encountered beneath the surface, soil and unconsolidated sediments.

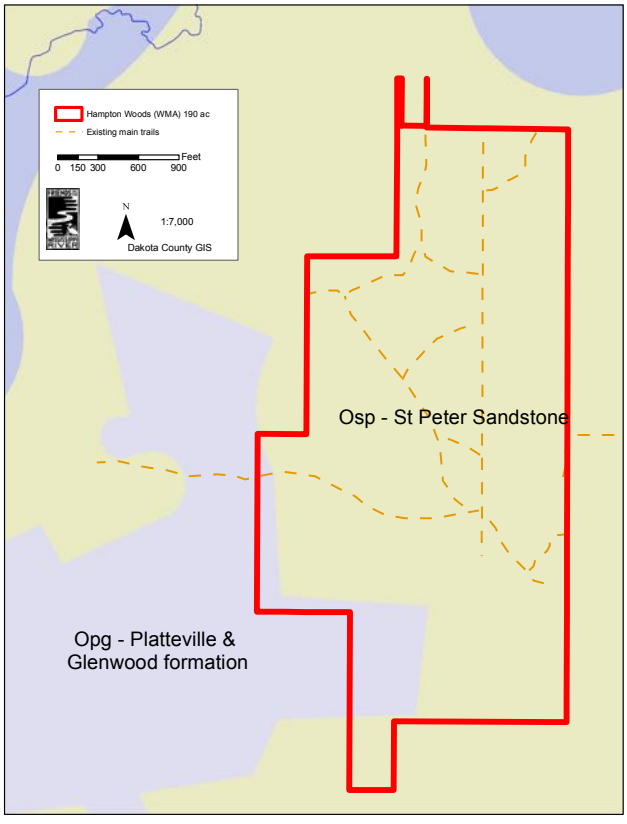

Figure 6. Bedrock geology

Bedrock is important because these layers create the underground aquifers where groundwater is stored. As the primary source of drinking water for County residents, it is critical that the quantity and quality of this water is managed and protected.

Bedrock at Hampton Woods consists of the St Peter Sandstone (**Figure 6**). It is generally within 5 feet of the surface, with some outcropping. Due to the shallow soils, bedrock is the primary influence on the landscape at this site. On the south west part of the site is a mesa where the St. Peter Sandstone is capped by the Platteville formation, consisting of broken flags of Platteville limestone embedded in sand. Wind-blown fine sediment called loess covers this escarpment.

Glaciers were the primary force that shaped the landscape in Dakota County. At Hampton Woods, there are three distinct landscapes features: mesa, hillslopes, and the level land below the mesa. According to the Dakota County Geologic Atlas, the mesa has shallow soils above Platteville Limestone; the hillslopes have loose, unconsolidated sediments above St. Peter Sandstone; and the level land has shallow soils above St. Peter Sandstone. A thin Glenwood Shale layer is between the Platteville Limestone and the St. Peter Sandstone. Prairie du Chien Limestone and Jordan Sandstone are below the St. Peter Sandstone. The low land areas of the site consist of sandy loam and colluvium at the base of the plateau (**Figure 7**).

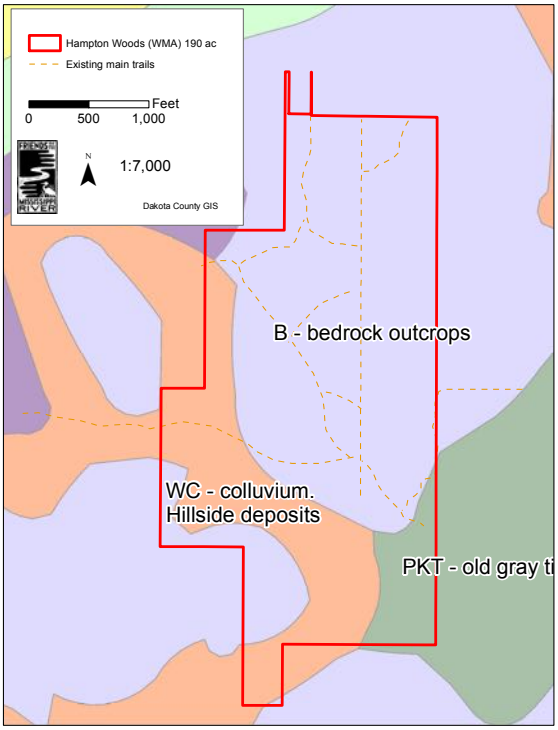

Figure 7. Surficial Geology

B. Soils

Soil formation is the result of the interaction of five soil-forming factors: parent material, climate, organisms, topographic position or slope, and time (Foth, 1990). Taken collectively, these factors can help determine the dominant plant and animal communities that helped form the soils. Identifying and classifying soils is an important component to management and restoration of any site. The "Soil Survey of Dakota County Minnesota," (1983), provides a generalized depiction and descriptions of soils in Dakota County.

There are nine general soil units at the Hampton Woods site (**Figure 8**), based on formation, relief, and drainage. Soil units/types are important because they affect the vegetative and hydrologic features of the property, and suggest the most appropriate use and management of the land.

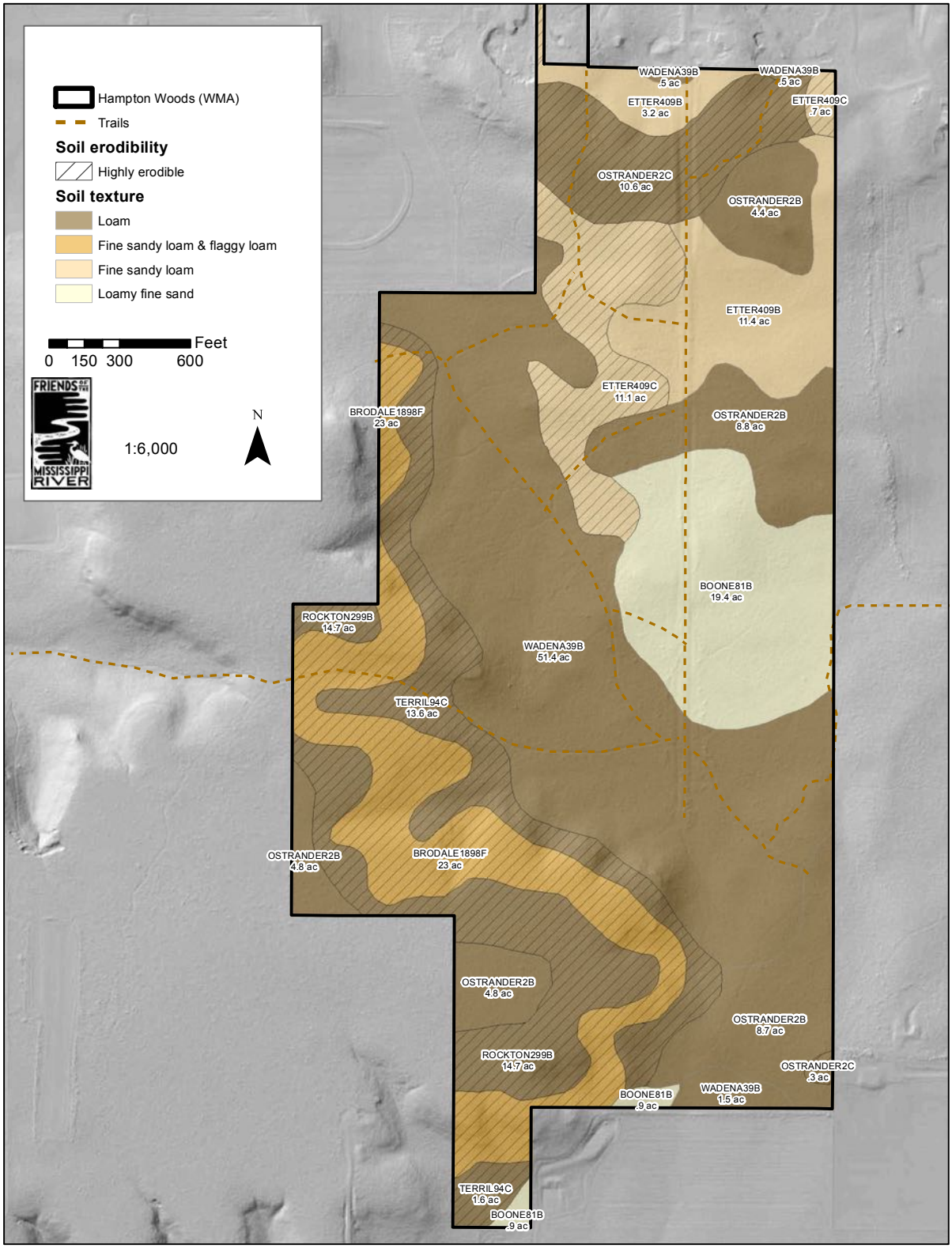

Figure 8. Soil Types

Table 1: Soil Types at the Hampton Woods Property

Soil Code	Soil Name	Percent Slope	Acres	Soil Family	Erodibility (water)	Hydric (yes or no)	Drainage
81B	Boone loamy fine sand	2 to 6	20.3	Mesic, uncoated Typic Quartzipsamments	High	N	Excessively drained
1898F	Brodale fine sandy loam and flaggy loam	25 to 60	23	Loamy-skeletal, carbonatic, mesic Entic Hapludolls	High	N	Excessively drained
409B	Etter fine sandy loam	2 to 6	14.6	Coarse-loamy, mixed, mesic Typic Hapludolls	Medium	N	Well drained
409C	Etter fine sandy loam	6 to 12	11.8	Coarse-loamy, mixed, mesic Typic Hapludolls	High	N	Well drained
2B	Ostrander loam	1 to 6	26.7	Fine-loamy, mixed, mesic Typic Hapludolls	Medium	N	Well drained
2C	Ostrander loam	6 to 12	10.9	Fine-loamy, mixed, mesic Typic Hapludolls	High	N	Well drained
299B	Rockton loam	2 to 6	14.7	Fine-loamy, mixed mesic Typic Agriudolls	Low	N	Well drained
94C	Terril loam	4 to 12	15.2	Fine-loamy, mixed, mesic Cumulic Hapludolls	High	N	Moderately well drained
39B	Wadena loam	2 to 6	53.4	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls	Medium	N	Well drained

The site is primarily dominated by loamy soils, which comprise 63% of the soils or 120 acres (**Table 1**). Wadena and Ostrander are the two main loam soils, accounting for 91 of those acres, and occupying the more level areas both above and below the terrace slope. The terrace slopes are dominated by Brodale loamy find sand and Terril loam, both of which are highly susceptible to water erosion. It will be important for site management to avoid driving equipment on the slopes. This would not be warranted anyway, given the quality of the vegetation, although it could be considered on condition of frozen ground with at least 8 inches of snow cover. The northeastern part of the site is dominated by Etter fine sandy loam, which has medium to high erosion potential, depending on the amount of slope. An “island” of Boone loamy fine sand

occupies a 20-acre pocket near the middle of the eastern side of the property. This excessively drained soil is also highly erodible, but due to the lack of terrain in that area it is not a concern.

According to the Soil Survey of Dakota County, the upland soils (Rockton and Ostrander) provide good potential for herbaceous plants and hardwood trees, and likewise good potential for woodland wildlife habitat. These areas will be good candidates for restoration of diverse understories and provision of wildlife habitat. The narrow band of Brodale soils occurring on the steepest part of the slopes provide only fair potential for herbaceous plants and hardwood trees, and correspondingly poor habitat for woodland wildlife. In the lowland areas, the Wadena, Ostrander and Etter soils provide good to fair potential for herbaceous plants and hardwood trees, while providing good to fair potential habitat for woodland wildlife. Finally, the pockets of Boone soils in the lower areas provide fair habitat for herbaceous plants, but poor potential hardwood tree and woodland wildlife habitat. These areas are likely the lowest priority for restoration of diverse wildlife habitat, though will be important areas for invasive species removal.

C. Topography

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

Topographically, the Hamptons Woods property is relatively simple (**Figure 9**). The eastern portion of the property is mainly flat with slight topographic variation throughout. The western and southwestern sections of the property include mainly east and northeast-facing slopes rising 60 feet to a flat plateau. These areas support slightly different plant communities within the oak forest subtype, and the plateau had been somewhat protected in the most recent logging event. The is highest part of the site is at the southwest, where the top of the plateau is at 1,000 feet above sea level. The lowest part of the site is at the northwest corner, at 900 feet. Most of the water flow at the site moves will tend to exit the property to the northwest, toward the South Branch Vermillion River.

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

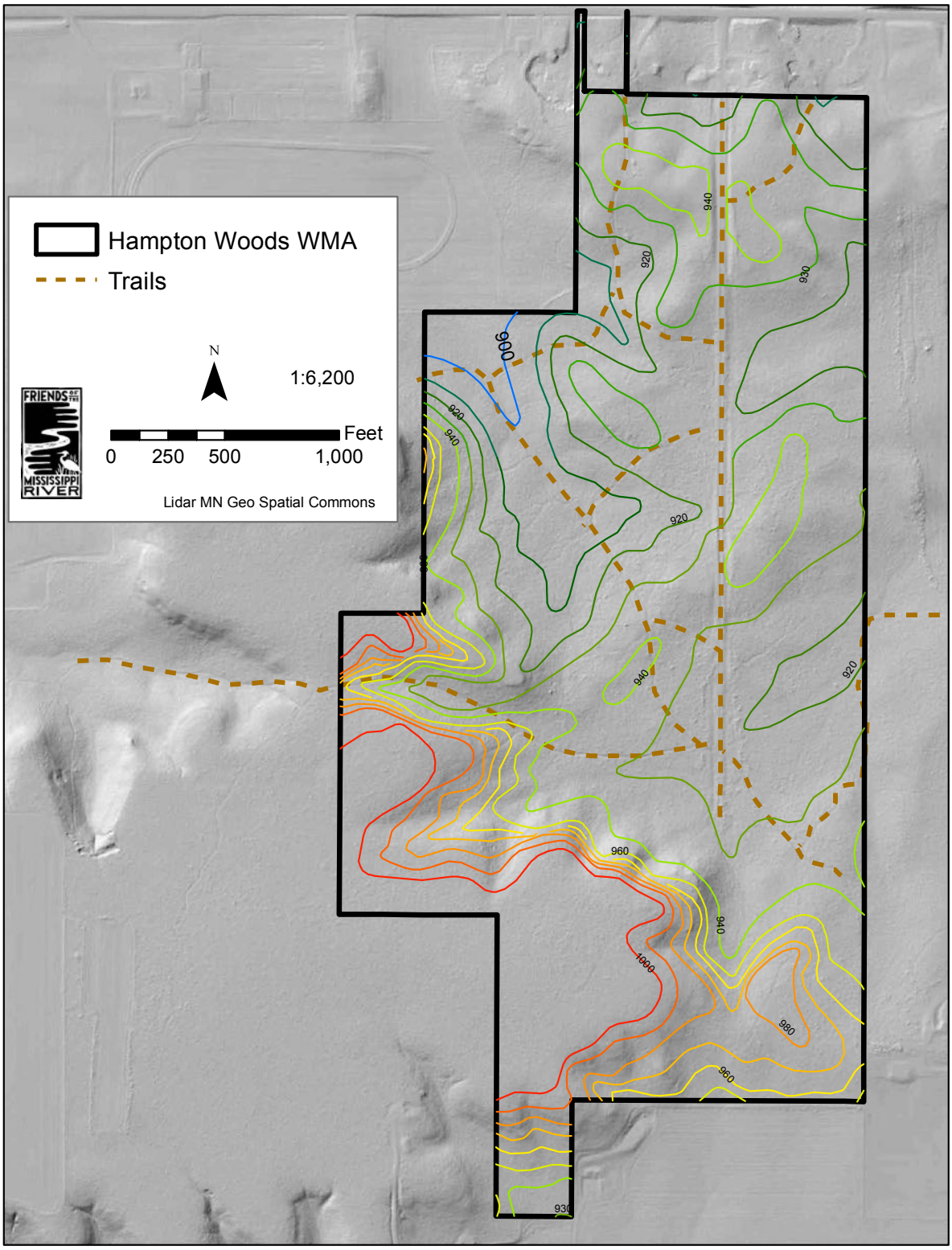

Figure 9. Site Topography

D. Hydrology

There are two key interrelated hydrologic components of the property: groundwater and surface water.

1. Groundwater

Groundwater accumulates below the surface of the land and is stored in complex, underground geologic layers of sand, gravel and porous rock. If groundwater exists in suitable quantity and quality, and can be delivered for human use, it is of great economic value. In the northern portion of the County where the glacial deposits are deep, groundwater is often extracted using drilled wells that end in sand and gravel. In the southern part of the County where the layer of glacial deposits is shallow, most drilled wells extend into the porous bedrock. Most public water supplies obtain water from one of the deeper bedrock aquifers.

Due to its relative abundance, quality and reasonable access, groundwater provides drinking water for most County citizens, irrigation water for agricultural crops (especially on the sandier soils in the eastern part of the County), and process and cooling water used by industrial and manufacturing companies. The amount of available groundwater appears to be stable, but there is growing concern about the supply of groundwater due to increased agricultural irrigation, suburban water use, changing climate, and improved information on the role of groundwater to ecological systems like trout streams. At the same time, most of the County's groundwater is "highly sensitive" to surface contamination. Once an aquifer is polluted, it is very expensive or prohibitive to improve its quality to drinking water standards.

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

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

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

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

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

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

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

Hampton Woods is generally located in an area where **groundwater sensitivity to contamination is determined to be high** due to the shallow depth to bedrock (**Figure 10**). Much of the plateau is only moderately sensitive. Relatively high sensitivity does not mean that water quality has been or will be degraded. If there are no contaminant sources, pollution will not occur. Conversely, low sensitivity does not guarantee protection. Leakage from an unsealed well for example, may bypass the natural protection, allowing contamination to directly enter an aquifer.

High Sensitivity does have management implications when approaching restoration of the property. The use of chemicals (herbicides etc.) should be done with extreme care on this site given the high potential for groundwater contamination. Moreover, the site's proximity to the nearby South Branch Vermillion river is an important consideration. When managing vegetation, glyphosate binds to soil particles and is generally not mobile, so can be a better choice than other herbicides that are more mobile. However, triclopyr-based herbicides like Garlon 3 are generally more effective at preventing resprouting, but should be used with caution. If used, they should be applied with a wick or foam applicator.

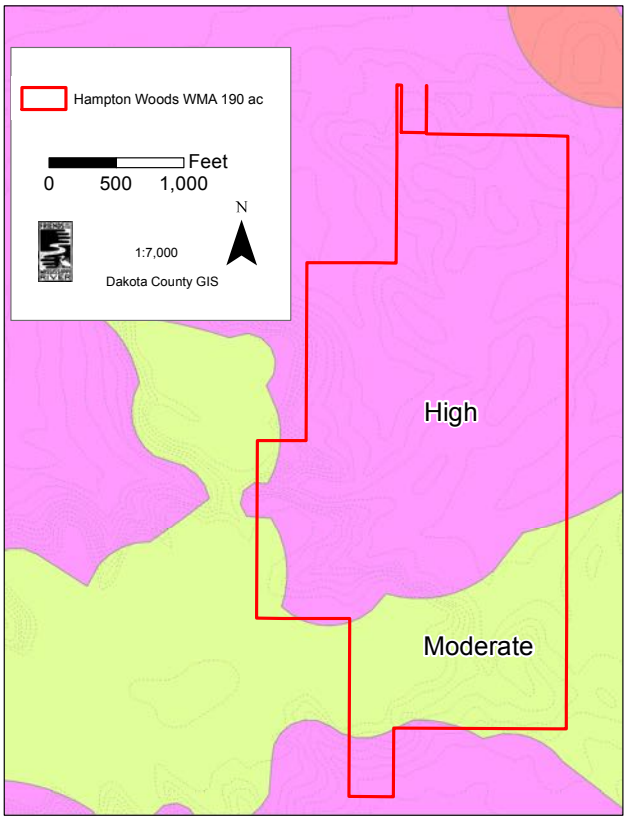

Figure 10. Sensitivity of Groundwater to Contamination

2. Surface Water

One of the unique and attractive features of Dakota County is the amount and diversity of its surface waters. Major riverine systems, including the Mississippi, Minnesota, Cannon, and Vermillion Rivers create the borders or flow within the County. Numerous creeks, streams and brooks are found in the southern portion of the County. Numerous small lakes are found in the northern and western portions of the County, resulting from glaciation. The two largest lakes, Crystal and Marion, are highly desirable for their scenic beauty and recreation. Different types of wetlands are scattered throughout the County and several unique wetlands, known as fens, are found in the Minnesota River Valley.

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

While there are no water bodies or wetlands on the property itself, the property is located close to the south branch of the Vermillion River. The MNDNR designates the Vermillion River, including the south branch, as a trout stream, providing important habitat for trout and other fish species. The stretches of river nearest the property are designated as high and medium quality by the Wetland and Waterway Inventory and Assessment.

VIII. Wildlife

A. Historical

With a diverse landscape and associated plant communities and an abundance of water, Dakota County has historically had a highly diverse wildlife population. Various habitats intersected in Dakota County, including eastern hardwood forests and western prairies. Because fires swept in from the prairies, a savanna community developed in transition zones, and the local riverine community, climate, and soils supported the development of wetlands. It is well-documented that most wildlife species have a preferred habitat. Dakota County's varying habitats provided opportunities for the existence of a large range of species endemic to different eco-systems.

Minnesota's big game species in Dakota County once included bison, elk, and white-tail deer. In the 1800s, early explorers and settlers documented that bison grazed the prairie terraces near Fort Snelling. Nearly all the early explorers from Radisson to Hennepin mention the abundance of the animal. During the drought years in the 1930s, numerous elk antlers were retrieved from shallow lakes in southern Minnesota, though elk were not considered common. Bison and elk were doomed by agriculture in Dakota County, which consumed their grazing areas. The story of white-tail deer is in direct contrast to these animals, though it too suffered from hunting pressure. In 1885, a hunter living near Minnehaha Falls killed seventeen deer in a swamp near Lake Harriet. Deer began to thrive on the fragmented landscape that agricultural operations produced in the country-side. Mountain lions were never common in southern Dakota County, though black bear was a very common mammal a century or two ago.

Fur-bearers also existed in healthy numbers in Minnesota, if not Dakota County. But Fort Snelling was built at the confluence of the Mississippi River in 1819, partially to protect the (English) fur trade, which decimated beaver populations. In the latter half of the 19th century, habitat changes from logging, uncontrolled fires, agricultural development and drainage, along with continued trapping and hunting, further contributed to the decline of the species. From fur traders' records in the 1930s, it is evident that beaver, muskrat, and mink were killed for their fur. Documents show that St. Paul was a regional hub for the buying and selling of pelts. Due to more recent conservation efforts, beaver numbers have rebounded toward more normal levels. Conversely, Minnesota populations of opossum, spotted skunk, and grey fox have seen a definite increase with time.

Populations of amphibians, fish, and mollusks have been sensitive to the presence of pollution in the County's rivers, streams, and wetlands. The advent of suburban development adjacent to water-ways, has led to the introduction of warm water to cool streams, which has resulted in adverse thermal effects and stressed aquatic life. Increased soil erosion from farming operations and intense land use, has increased the sediment loads to rivers and streams, impeding the ability of sight predators to survive, and negatively affecting aquatic ecosystems. Though it is hard at this point to pin-point historical trends because of incomplete data, the introduction of water quality rules at federal and state levels beginning in the 1980s, has improved water quality impacted by point sources (such as waste-water

treatment plants), but is also providing a solid framework to quantity and limit non-point sources (such as stormwater), which should greatly benefit wildlife that relies on clean water.

B. Existing Populations

Two breeding bird surveys were completed on June 2, and June 22, 2016. The point-count method was used, consisting of 5 minute plus 3 minute surveys. All birds seen or heard within 50m were recorded for each time-period. Separate records were also kept for birds detected beyond 50m. In this way, the data collected would be compatible with other studies that use a 5-minute period or and 8-minute. For the purposes of our study, all birds recorded within 8 minutes, within or beyond 50m are included in the totals, as well as birds detected between points, if it was a new species. Points were located at least 250 m apart. Surveys were completed between dawn and 09:00. A total of 7 points were surveyed, with 5 points surveyed each date. For points surveyed more than once, the maximum number of species recorded during the two surveys was used. In addition to 2016, two surveys were completed in 2013 (Appendix F).

A total of 37 species was recorded during the breeding bird survey. Most of the species we would expect to find in a forested habitat were present. Nocturnal species such as owls were naturally missing, and a few others that might have been expected but were not recorded were veery, yellow-throated vireo, and eastern phoebe. Wild turkey was not recorded in the survey but signs of them were observed. Also not recorded in the survey was red-shouldered hawk, though they were detected in a previous site visit.

Of significance at this site was the presence of two species of greatest conservation need (wood thrush and red-shouldered hawk). Although nothing is known about nest success, the presence of these species is a positive sign that the site provides important habitat for them. In both 2013 and 2016, one or two singing mourning warblers were detected. Although not an unusual species, they are uncommon in the Twin Cities during the breeding season. Also of interest was the high number of ovenbirds detected, especially in 2013. Many of those records were to the west of the 2016 survey area, but are another indication of the potential importance of this site. Recent studies by Mark Davis at Macalester College have indicated that nest predation on ovenbird is very high at relatively small forested patches such as this one. Further studies to evaluate ovenbirds nest success at this site would be valuable.

The most abundant species in 2016 were black-capped chickadee, red-eyed vireo, blue jay, and great-crested flycatcher. Ovenbird, house wren, cardinal and blue-gray gnatcatcher were also abundant in 2013. Species such as brown-headed cowbird and indigo bunting were detected along the forested edges and openings. Mourning warblers are also common in early successional forests following logging or fire. It is hoped that cowbirds will decline as the canopy closes and they will be pushed more to the edges.

It seems clear that Hampton Woods is an important natural area in the Twin Cities, retaining a good plant community composition and structure as well as a very good bird community.

According to the NRRI website: In Minnesota, the Mourning Warbler is one of the most abundant birds found in early successional forests following logging or forest fire (Niemi 1977, Niemi and Probst 1990, Probst et al. 1992). They are commonly found in brushy clearings or dense undergrowth of open woodlands. Data collected in the Michigan Breeding Bird Atlas Habitat Survey indicate a preference for wet and mesic habitats (72%), and for young or second-growth vegetation (62%) (Brewer et al. 1991). http://nrri.umn.edu/mnbirds/accounts/MOWAa2.htm It is common in its range, but much more a resident of north-eastern Minnesota, and only occasional in south-eastern.

Further information from the DNR Wildlife Action Plan (2005) provides habitat requirements for some of the SGCNs associated with this community: "Acadian flycatchers, cerulean warblers, hooded warblers, and red-shouldered hawks generally require large areas of contiguous mature to old-growth hardwood forest. Acadian flycatchers favor relatively undisturbed forests and experience high rates of brood parasitism and nest depredation in fragmented landscapes. Cerulean warblers need large, tall trees with horizontal heterogeneity in the canopy, and hooded warblers need mature forests with significant treefall gaps that provide shrubby undergrowth for nesting. Hardwood forests also provide the same important habitat features for wood thrushes.

Few mammals were observed at the site other than gray squirrels, eastern chipmunk and signs of white-tailed deer (scat and tracks) and coyote (scat). Other mammals that are likely present include red fox, raccoon, striped skunk, Virginia opossum, red squirrel, deer mouse, white-tailed mouse, shrews and eastern mole. Other potential species include gray fox, fisher, short and long-tailed weasel, mink, several species of bat, cottontail rabbit, woodchuck, fox squirrel, flying squirrel, and other mice and vole species. One potential SGCN species that could be present is woodland vole. Woodland voles require moist, light soil or humus in forests to construct burrows. Grazing by cattle, which compacts the soil, and the presence of invasive non-native earthworms, which destroy the humus, may make forests within its limited range in southeastern Minnesota unsuitable for this species."

IX. Vegetation

The vegetation that develops at any given site is determined by many factors including, but not limited to: topography; soils and hydrology; historic and current land use; climate; and wildlife. Vegetation is also affected by natural processes such as succession or natural events that create change and variation. Abrupt changes (disturbances), including wildfires, high winds and floods, can change the vegetation structure and composition very quickly and for long time periods. Human-induced changes, such as farming, pasturing and tree cutting, can have the same effects. As various plant species establish at a site, they also act upon the site, ultimately changing site conditions such as water, light and nutrients. These changes in turn benefit new plant species, which then establish at the site. This process of natural succession, or the gradual change in structure and species composition, occurs as the site changes over time. These modifications change the variety of species most adapted to grow, survive and reproduce in an area and create slow and broadly predictable changes in the vegetation.

The effects of disturbance and succession can vary widely. Different areas will be at varying developmental stages due to diverse local histories – particularly since the time of any last major disturbance. These conditions interact with inherent environmental variability (e.g., soils, climate, topography, etc.) to create a mosaic of vegetation in various conditions across the site and the larger landscape.

A. Historical

One major consideration for developing a comprehensive NRMP is to understand the types of vegetation found at a property or in the local area prior to European settlement. This information can be a helpful indicator of what plants may be found or thrive on the property. Fortunately, field notes on vegetation were taken during original territorial surveys in the 1840s and compiled into a valuable information source entitled "The Original Vegetation of Minnesota, compiled from U.S. General Land Office Survey Notes" (Notes) in 1974.

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

The predominant pre-settlement plant community at Hampton Woods was "oak openings and barrens" (**Figure 11),** which was later referred to as oak woodland-brushland.

Oak Woodland-Brushland is the transitional area between prairie and forest, although several species are endemic to both and prefer this type of environment. It occurs on dry to moderately moist (mesic) sites throughout the deciduous forest-woodland zone and locally in the prairie zone. It probably included some more open, savanna-like type areas dominated by prairie grasses and forbs and a few small, gnarly, open grown oak trees, patches of aspens and scrub brush. Larger trees are sometimes more common in moister spots or in heavier soils. The stature and spacing of trees is variable depending on droughtiness and fire frequency. The principal canopy species are bur, northern pin, northern red, and white oak. Shrub cover is variable as well. Oak sprouts and chokecherries are common on all soil types. The brush layer is commonly comprised of blackberry, raspberry, gooseberry, dogwood, cherry, hazelnut, and prickly ash. Prairie willow, New Jersey tea, American hazelnut, sand cherry, and June berry are usually present on sandier soils. Wolf berry can be common on heavier soils. Prairie vegetation, dominated by grasses and forbs, if present, occurred only in small tree and shrub canopy openings.

The historical character of these areas is difficult to judge, and there may have been areas of denser forest, as evidenced by the current presence of pockets of "Big Woods" vegetation – oak, maple, basswood forests. The boundaries of these historical vegetation areas were not hard and fast, and didn't necessarily predict the exact vegetation in each area. Though the 1850's vegetation classification system has limited applicability and is no longer used by ecologists in analyzing vegetation, it is helpful in understanding the historical composition of the site.

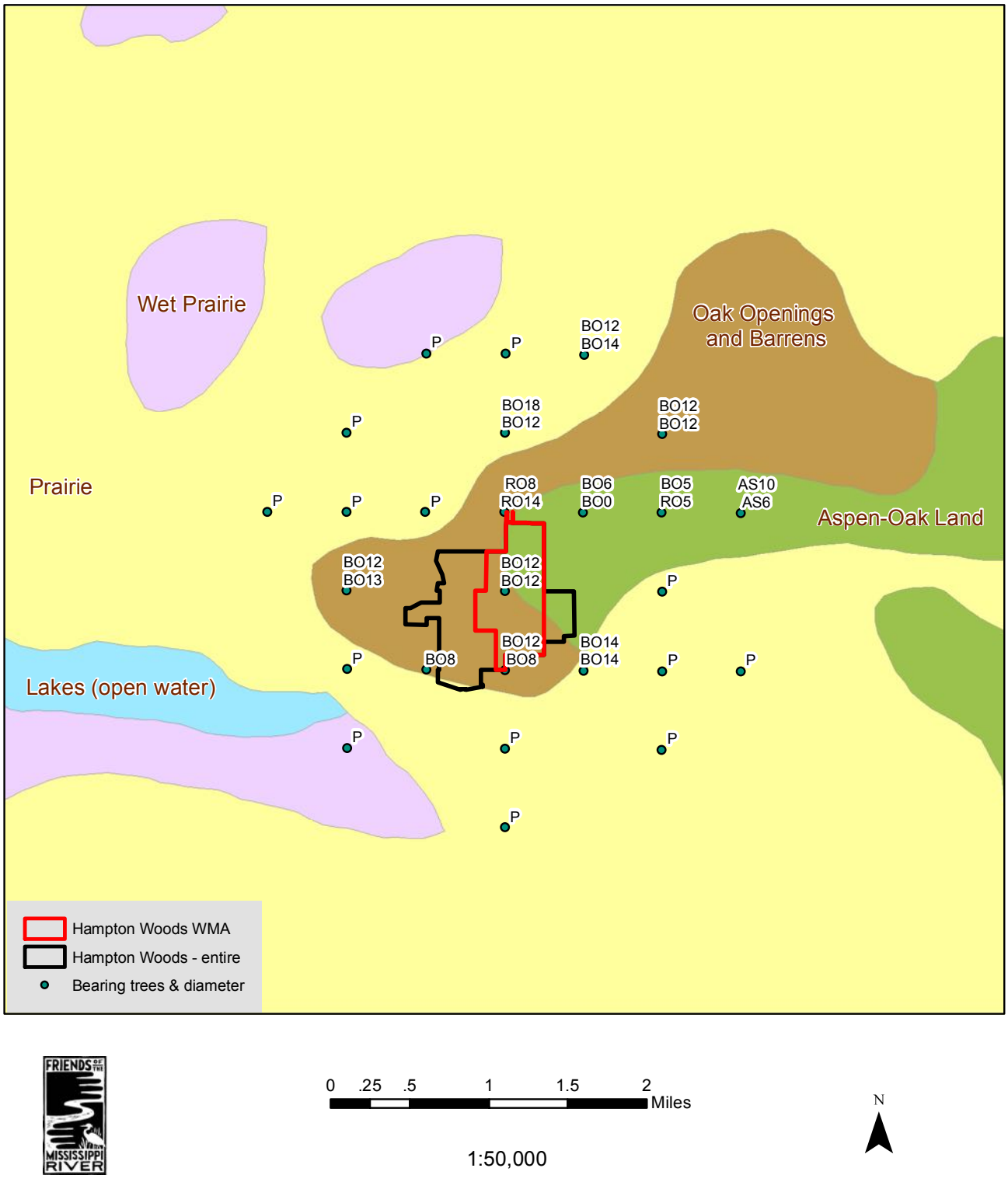

Figure 11. Pre-European Settlement Vegetation

B. Ecological Communities

The Department of Natural Resources (DNR) developed a system called the Minnesota Land Cover Classification System (MLCCS), which integrates cultural and vegetative features of the landscape into one comprehensive land classification system. This information was used as a basis for the site evaluation, which was conducted by Friends of the Mississippi River in the spring and summer of 2016 and is described in the next section of this document.

While the MLCCS classifies **all** land cover, including paved, cropland, lawn etc, the **natural** areas on the landscape are more specifically classified according to the Ecological Classification System developed by the DNR. There are four ecological provinces in Minnesota (prairie parkland, eastern broadleaf forest, Laurentian mixed forest, and tallgrass aspen parkland), ten sections within the provinces, and 26 subsections. The Hampton Woods WMA is classified as follows (**Figure 12**):

Ecological Province: Eastern Broadleaf Forest

Section: Paleozoic Plateau

Subsection: Rochester Plateau

Land type association: Hampton till plain

The Rochester Plateau includes much of the southeastern portion of the County. Prairie and oak savanna were the major plant communities; most the area is now heavily farmed. According to the DNR: "This unit consists of an old plateau covered by loess (windblown silt) along the eastern border and pre-Wisconsin age glacial till in the central and western parts. The western portion is a gently rolling glacial till plain that is covered by loess in places.

This subsection consists of level to gently rolling older till plains. Topography is controlled by underlying glacial till along the western edge of the subsection, where loess is several feet thick. As glacial drift thins to the east, topography is largely bedrock controlled (Dept. of Soil Science, Univ. of Minnesota 1973). Sinkholes are common in the southwestern portion of the subsection.

The eastern boundary with The Blufflands subsection is an area of transition between a level to rolling plateau and dissected landscapes. Another gradient is the depth of wind-blown silts (loess), which grades from thinner deposits in this subsection to much thicker deposits in The Blufflands Subsection. The northern boundary coincides with the northern extent of loess deposits. There is also small outwash plain marking the northern boundary."

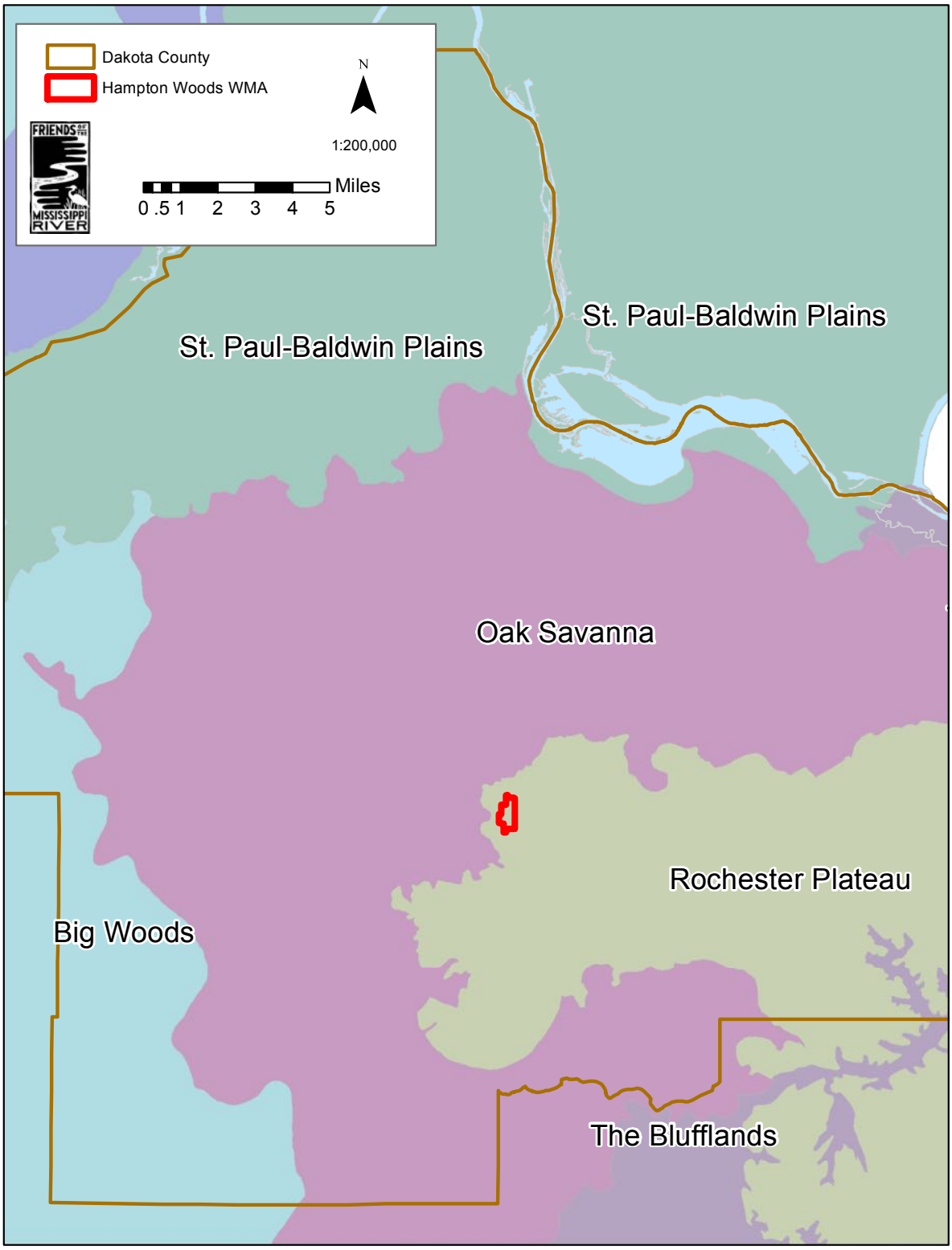

Figure 12. Ecological Subsections

C. Plant Community Assessment

The following are descriptions of the various cover types found at the Hampton Woods WMA. The Minnesota Land Cover Classification System (MLCCS) and DNR Native Plant Communities guide were used as a basis for evaluating the site. Because of the general uniformity of the site, there were just two distinct land cover types: mesic oak forest (Southern Mesic Oak-Basswood forest, MHs38c) over the majority of the site and grassland along the main north-south trail (**Figure 13**). However, there was variation in the vegetation througout the forest, due to variation in site features such as soil types, slope and aspect as well logging disturbances. A sugar maple stand, for example was in the more mesic south end of the site. Red and bur oak were common throughout except at the north end where boxelder, green ash and American elm were more common. Some of the other notable features are reflected in **Figure 14**.

The property was evaluated in spring, summer and fall 2016, by FMR ecologists. Species and observations were recorded during general walk-through surveys. In addition, three vegetation survey plots were established (**Figure 14**) at the north end, the south end and on top of the plateau. Plots were 10m x 10m and the standard releve survey method was used.

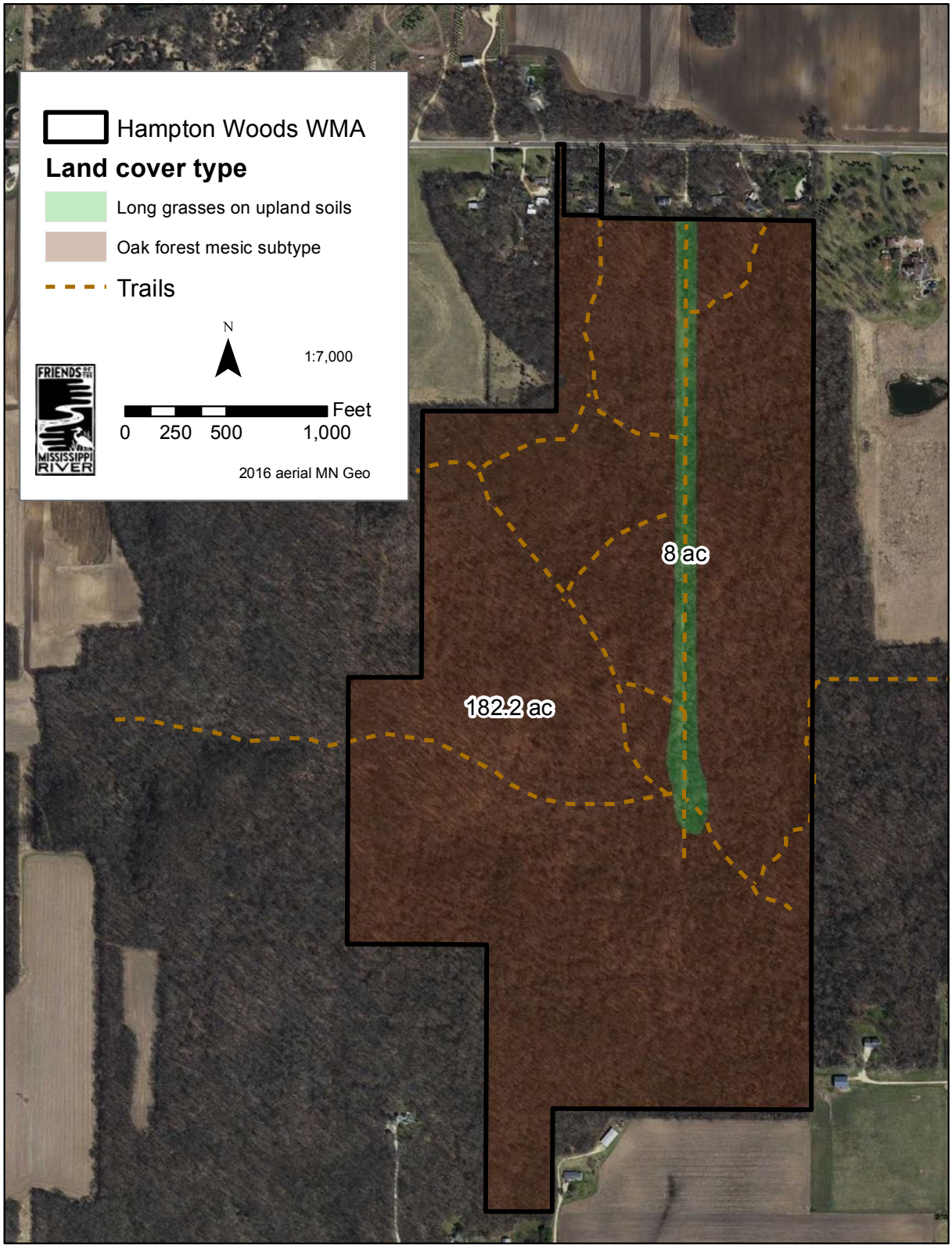

Figure 13. Existing Land Cover

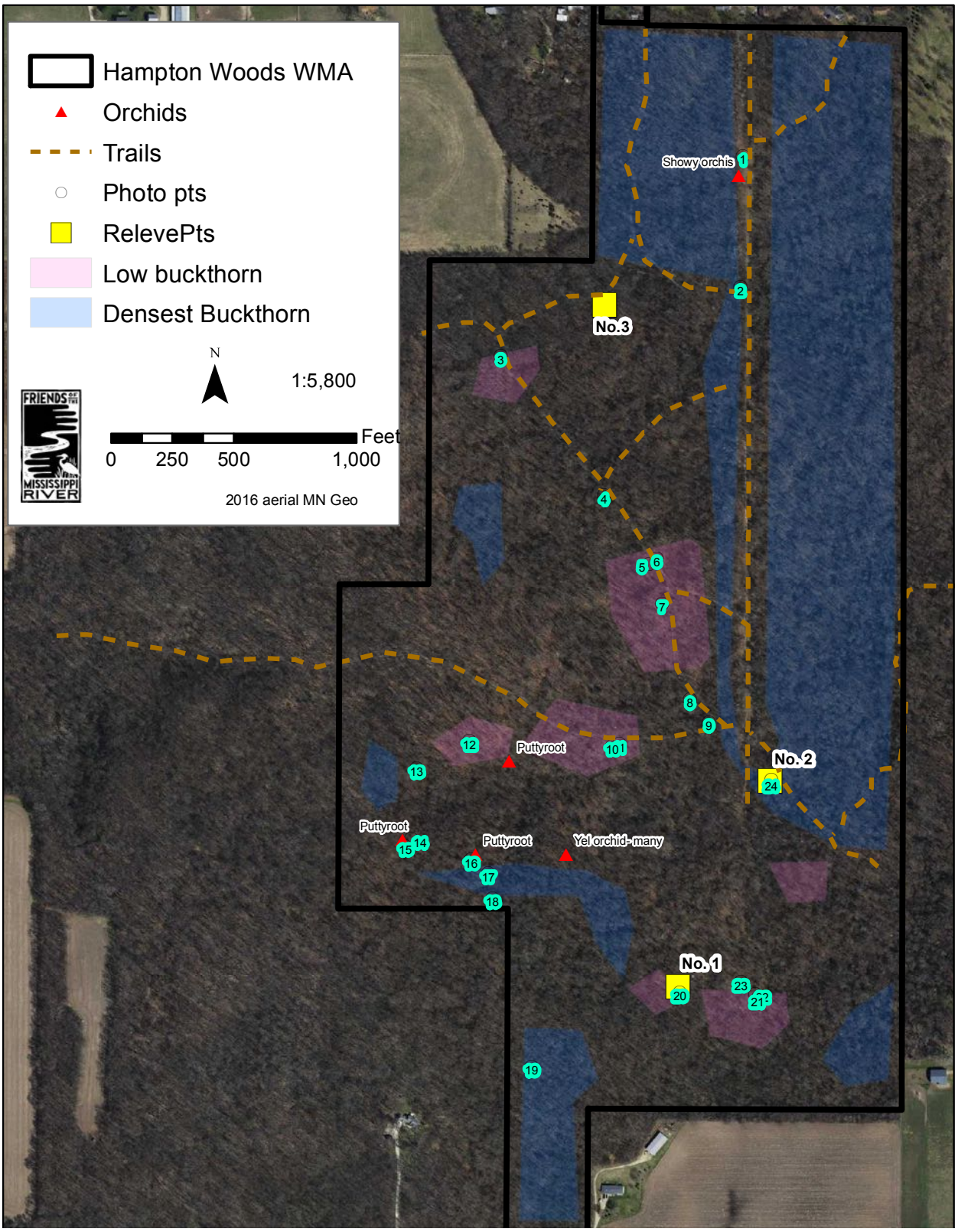

Figure 14. Site Features 2016

1. Mesic Oak Forest

Oak forest encompasses virtually the entire Hampton Woods WMA – about 182 acres. The MLCCS classifies it as Oak Forest, mesic subtype, which is an older name used by the DNR. According to the Plant Communities of Minnesota (2005), the class for this plant community is Southern Mesic Oak-Basswood forest, and the specific plant community type is Red Oak-Sugar Maple-Basswood-(Bitternut Hickory) Forest (MHs38c).

The middle and south parts of the property had been logged in 2010. Logging probably took place in the winter, but the ground was not necessarily frozen and some areas still show the tire ruts. Most of the large oaks are gone and tree stumps abounded (Photo 1). As tree stumps and debris break down the provide habitat for mushrooms and other decomposers (Photo 2). One stump was aged (rings counted) to be 80 years old. In some of the more heavily cut-over areas, hickory was the dominant canopy tree. In areas along logging roads, the following ground species were observed: royal fern, lady fern, black snakeroot, late goldenrod, Canada thistle, cleavers, cinnamon fern.

Photos 1& 2. Relics of recent logging, tree stumps in various stages of decay are common.

In areas that had not been recently logged, tall, scattered, red oaks (20” to 25” dbh) were the dominant species and bur oak was also abundant. Spacing between trees was 12’ to 20’. Oaks were selectively logged from much of the site, however, so American basswood was dominant in many areas, while big-tooth aspen or quaking aspen dominated scattered stands. Bitternut hickory was a sub-dominant tree species in some areas.

The northernmost part of the site had an abundance of boxelder (10”-12”) and American elm (14”), while the southern part of the site was dominated by basswood, with sugar maple at the far south. A total of seventeen tree species were recorded with additional species including eastern cottonwood, black cherry, black walnut, hackberry, green ash, red elm, and a few butternuts, which had cankers, but were still alive.

Canopy cover at the site varied from 60 to 80% in groves, and 20 to 40% outside of groves (logged areas). Many of the bitternut hickories were dying, and nearly all of them were heavily infected with *Phomopsis* galls. Bur oak was also present, but not nearly as abundant as red and pin oak. Red oak was regenerating well in some of the cut areas, and the light gaps had created a flush of growth of native tree saplings and shrubs.

The subcanopy cover was generally about 30 percent, dominated by ironwood, American elm, American basswood and red oak. The selective tree harvesting has probably been beneficial for tree regeneration by bringing more light to the forest floor. Most tree species were represented as seedlings and saplings except for bur oak. No bur oak seedlings were detected, but that is not unusual since bur oak is not shade tolerant. There could be some regeneration in tree gaps and forest edges. Overall there was a good distribution of age classes, except for very large trees, which were absent for most species. Red oak regeneration appears to be occurring very well, especially in some of the cut areas.

The shrub layer included species between 4 to 12-feet tall. Common buckthorn was dominant overall, and was especially dense in the northern quarter of the site (Photos 3 & 4). Most of it was about 8' to 15' tall in the north and smaller in the south but stem size overall tended to be about ½-¾ inch diameter. However, many areas had very little coverage of buckthorn and the south end was especially "clean" (Photo 5). Typically, we expect to see a surge of buckthorn after the canopy is opened. Surprisingly, many such areas, if located in the interior forest, were re-populated by native shrubs and sapling trees (Photo 6 and **Figure 14**). The fact that buckthorn hasn't proliferated is a very positive sign - that buckthorn seeds are not dispersed throughout the site and that it can still likely be controlled. In 1993, the DNR survey found that buckthorn had penetrated the forest along

Photos 2 & 4. Scattered very large buckthorn are common at the north end of the site. The right photo was taken at Pt 2 on Figure 14.

Photo 5. There are numerous large areas where canopy trees have been removed. In interior locations such as this one, native subcanopy trees and shrubs and rebounded. On edges, buckthorn has proliferated. This is Pt 10 on Figure 15.

avenues of disturbance but remained largely absent from the forest interior. Overall, there were not that many large stems, another indicator that the buckthorn invasion is still relatively young, and the seed bank may not be very widespread. It would be very beneficial to initiate buckthorn control as soon as possible to halt the spread and retain the native floral diversity.

Total shrub coverage ranged from 20 to 60%. A total of 22 species were recorded in the shrub layer, including grey and round-leaved dogwood, nannyberry, prickly ash, chokecherry, prickly gooseberry, raspberry, red-berried elder, American hazelnut, and downy arrowwood.

The ground layer was fairly diverse overall with nearly 70 herbaceous species recorded (**Appendix A**). A few species listed were not found at the WMA, but at other parts of Hampton Woods, particularly wild ginseng and big tick trefoil. Species composition and abundance varied with canopy cover and other factors. Overall, the herbaceous cover was dense, with wood nettle and Virginia waterleaf often dominant. Other typical species were sweet cicely, cleavers, wild geranium, snakeroot, false lily of the valley, false Solomon's seal, hairy Solomon's seal, early meadowrue and violet species. Graminoids were sparse, but included long-awned wood grass, Sprengel's sedge, and hairy wood chess, which are fairly conservative grass species. Virginia creeper and wild grapevine were common throughout. Herbaceous cover and diversity was greatest on the plateau, where yellow orchid and puttyroot orchid were found in high numbers, as well as Dutchman's breeches, cut-leaf toothwort, blue cohosh, rattlesnake fern, large-flowered

Photo 6. A very good diversity of native herbaceous species proliferate on the plateau - rattlesnake fern (left), cut-leaf toothwort, and puttyroot orchid are a few.

bellwort and spikenard. Many of these species could be found at other parts of the property as well, but were most abundant on the plateau (Photo 6).

The lowest herbaceous diversity was found at the north end and the eastern side of the site, coinciding with the areas of greatest buckthorn density. These areas tended to be dominated by common generalists, such as raspberry and enchanter's nightshade, but there were also occasional moderate to moderately-high conservative species, including shinleaf, nodding trillium and showy orchis (see cover photo).

Looking in more detail at the vegetation survey plots (releves) reveals further differences at different parts of the site. Plots were established in the buckthorn-dense north end, the buckthorn-sparse the south end, and the top of the plateau. Each plot location was selected to be representative of the surrounding area. At the north vegetation plot (**Photo 7**), the tree canopy was moderately dense. Buckthorn was the primary shrub species. It was abundant with nearly 50% cover, but fairly young and mostly not producing fruit. Herbaceous plants were very sparse, with just 10 species detected and 10% cover. Most of the species found had relatively high conservatism scores, including nodding trillium and early meadowrue, but the total score for the plot was 30, the lowest of the three releves. There was a high abundance of deciduous species in the ground layer – the seedling trees and shrubs – primarily due to an abundance of buckthorn seedlings, but gooseberry was also abundant. Tree regeneration was reflected by seedling boxelder, bitternut hickory, hackberry, red oak and American elm.

Photos 7 & 8. The north releve, top, was dominated by buckthorn with very sparse herbaceous plants. The south releve (bottom) had almost no buckthorn and good herbaceous diversity.

The vegetation survey plot at the south end (**Photo 8**), in contrast, had very dense tree canopy, a very open shrub layer, and a dense ground cover. The ground cover was 50-75%, composed of 20 species, with a total conservatism score of 88, the highest of the three releves. Nodding trillium, blue cohosh and early meadowrue were the most conservative species as well as long-awned wood grass. Bloodroot and other grasses also ranked fairly high. Tree species

regeneration at this plot was seen with seedling and sapling boxelder, bitternut hickory, black cherry, red oak, basswood and American elm.

Photo 9. The west releve, on the plateau, had a dense canopy, low shrub cover, and very dense ground layer.

The west releve (Photo 9), on the plateau, had a very dense tree canopy, a moderate shrub layer, and very dense ground cover, with 15 herbaceous and grass species. Though dense, the herbaceous layer had somewhat low diversity as it was heavily dominated by Virginia waterleaf. A small patch of garlic mustard was present in the plot. This species is appearing in scattered plots and will need to be controlled very soon before it spreads throughout the site. The most conservative species in the plot were blue cohosh and large-flowered bellwort, as well as bloodroot, wild leek, wood nettle, violet, and black snakeroot. The overall conservatism score was 62.

Earthworms were abundant throughout the property, and were scored as stage 5 invasion at each of the releve plots, where 5 is the maximum. Stage 5 is described as: no forest floor humus or fragmented leaves present, mineral soil present, earthworm casting abundant (>50% of forest floor/mineral soil interface covered), middens abundant (>9 in a 5-m radius) (Photo 10). In May, there were large areas nearly devoid of ground cover that would end abruptly with a wall of vegetation. The cause of this is yet to be determined. The earthworms were abundant in all areas. It is notable that overall the herbaceous vegetation was abundant and diverse, in spite of the presence of earthworms. It's possible that the earthworms arrived at the site many decades ago, before non-native invasive species were common in the landscape. Typically, in today's conditions, as worms alter the soil structure and duff layer, they create conditions that favor non-native invasive plants such as buckthorn and garlic mustard, which then invade and prevent native plants from growing. If those invasives were not present when the worms were, then native plants may have had time to gradually adjust to the mineral soil conditions. Nerstrand Woods is another location that seems to affirm this theory, with excellent native woodland diversity and high worm populations. Although controlling earthworm populations is not

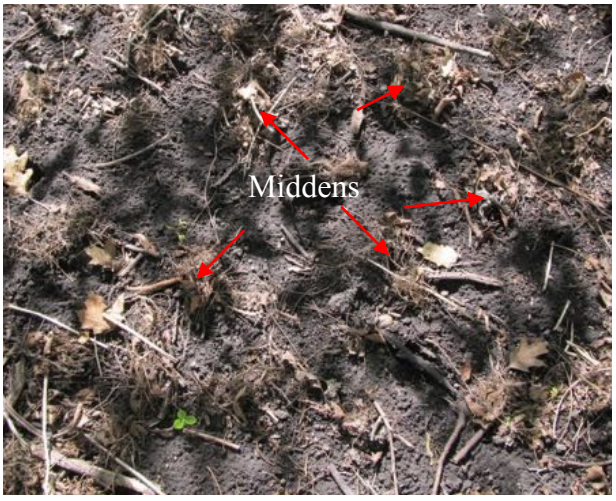

Photo10. Earthworms, none of which are native, were at the highest stage of abundance at the site.

feasible, it would be valuable to survey the population over time in high and low quality areas to evaluate any changes over time that may result from management activities.

Coarse woody debris was abundant throughout the property, in part due to the logging. There did not seem to be an excessive amount, and what is there provides good habitat for many animals and organisms.

The middle section of the property has a slight rise, where soils changed markedly to a fine sand (Photo 11). Here, pin oaks, medium sized (6" to 10") were dominant. Common shrub layer species here were: American hazelnut, quaking aspen whips, pin oak whips, pagoda dogwood, red oak whips, black cherry whips, brambles, and elderberry. Buckthorn was not as abundant here, but ironwood, cottonwood, and oaks were dominant. Poison ivy was present. Basswood was also present, with a large, 4-stemmed individual in an area almost absent of buckthorn, but with buckthorn encroaching from all sides surrounding it. Here, also, smooth sumac was present.

Photo 11. Sandy areas near the center of the property are especially conspicuous on the main trail.

In many of the sandy areas, especially openings and trail edges, Tartarian honeysuckle was found but overall, it was not very abundant at the site.

Overall, the mesic oak forest would be given a DNR ranking of C (**Table 2**). However, a more detailed assessment reflects clear differences in ranking for different parts of the site (**Table 3**). Some of the southern areas and parts of the pleateau had a more intact canopy as well as a good cover and diversity of native herbaceous species, with little buckthorn in the shrub layer, while the north and east sides were much more significantly degraded with a dense cover of buckthorn, sparse ground cover and low native species diversity. The plateau, while it had good native canopy cover, sparse native shrubs and retained the greatest native herbaceous species composition with the most conservative species, also tended to have more buckthorn than the downslope areas to the east. The buckthorn was mostly still small diameter, though fairly tall (over 6 ft), and much of it not yet producing fruit.

Table 2: DNR Element Occurrence Ranking for Oak Forest

A-rank:

- In subtypes that attain old-growth status (120 yrs or more):
  - little or no human-induced disturbance.
  - few or no non-native species.
- In subtypes that do not attain old-growth status and require disturbance for regeneration:
  - typically an older forest of natural origin (regenerating following natural disturbance such as fire or wind-storm).
  - little or no human-induced disturbance (except natural area management such as prescribed burning).
- Shrub layer not composed predominantly of species that follow grazing, but instead is

composed of hazel, chokecherry, gray dogwood and/or blueberry.

- Ground layer composed of native species typical of oak forests.

B-rank EO:

- Typically a mature or nearly mature forest, younger than old-growth, but with intact canopy.
- If logging occurred, it was either long ago (>60 yrs ago), very light selective cutting, or was done as a deliberate management strategy to approximate natural disturbance such as fire.
- At most, very light past grazing.

C-rank EO:

- Often, these sites have been grazed but not heavily enough to destroy groundlayer or result in dominance by armed shrubs that characteristically follow grazing.
- Includes sites that have been logged, if community remains intact and some tree regeneration (including oaks) is occurring.
- Also includes young second-growth (20-60 years old) stands that originated with good regeneration following clearcutting or burning.

D-rank EO:

- heavily cut or heavily grazed forest with a dense shrub layer of prickly ash, *Ribes* spp., or buckthorn.
- ground layer generally low diversity, either packed or very loose soil with few herbaceous plants, or dominated by weedy grasses and sedges or by non-native species.

2. Grassland

Referred to as "Grassland" for lack of a better term, this unit consisted simply of the edges of the main north-south trail that was created for logging access and maintained for recreational use (Photo 12). Adjacent homeowners currently take turns maintaining this and other trails by mowing and clearing fallen trees.

Photo 12. A narrow corridor of grasses and herbaceous plants flank the main trail. Buckthorn borders the woodland edge on most of the trail length.

It probably has more herbaceous plants than grass, and technically would not be classified as a native plant community – because it is too small, linear and does not effectively contain enough features or plant species to qualify as any community.

However, it does have some interesting species and provides some indications of what the historical vegetation may have looked like at the site. In addition to typical open woodland species such as wild geranium, tall thimbleweed, ladyfern, and false Solomon's seal, the unit also has more savanna-type or oak brushland species, such as Canada goldenrod, common yarrow, woodland sunflower, purple giant hyssop, white vervain, and raspberries, plus wild rye and wirestem muhly grass. An unexpected find in the heavier soils was cow parsnip (Photo 13). More typical of wetland edges, this plant indicates the slow drainage or slight ponding that happens in low areas of the site.

Photo13. A somewhat unusual species for this habitat, cow parsnip was at the far south end of the main trail, an indicator of very mesic loamy soils. Just north of here the soils were sand.

Non-native species included red clover, dandelion, plantain, spotted knapweed,

Kentucky bluegrass and smooth brome. Of these, the primary species of concern would be spotted knapweed which is very invasive in prairies. However, since there are no native prairies nearby, this species is not a significant concern at this time.

D. Recommended Target Vegetation Communities

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

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

Based on the property's geology, soils, topography, hydrology, existing land cover and use, current and anticipated ecological conditions and other factors, target plant communities recommended were developed for the site (Table 3, **Figure 15**). Although soil types differ in parts of the site, with some sandy areas within the largely loamy soils, and canopy cover has been altered so that oaks are not dominant throughout, overall one plant community most closely fits the soils, land-type associations, and vegetation features of the site and that is Red Oak - Sugar Maple - Basswood (Bitternut Hickory) Forest (MHs38c), a subtype of the Southern Mesic Oak-Basswood Forest. The target plant community is described below, with descriptions taken directly from the *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest* (DNR 2005).

Red oak - Sugar Maple - Basswood (Bitternut Hickory) Forest (MHs38c)

Mesic hardwood forests on steep, mostly north-facing slopes on thin silt over bedrock and also on till plains with hummocky topography. Northern red oak and sugar maple are the most abundant canopy trees; basswood is also common. Ironwood and sugar maple are the most abundant subcanopy and shrub-layer species; bitternut hickory is common in both the subcanopy and shrub layers.

In the past, catastrophic disturbances were rare in MHs38. Public Land Survey records indicate the rotation of catastrophic fires was in excess of 1,000 years, and the rotation of catastrophic windthrow was about 360 years. Events that resulted in partial loss of trees, especially light surface fires, were much more common, with an estimated rotation of 35 years. Based on the historic composition and age structure of these forests, MHs38 had two growth stages separated by a period of transition.

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

35–75 years—A transition period marked by the gradual decline of northern red oak and its replacement by sugar maple. Basswood, American elm, and ironwood increase during this period, and white oak becomes established.

> 75 years—Mature forests of sugar maple mixed evenly with basswood, American elm, ironwood, northern red oak, and white oak. (Green ash is more common in modern vegetation samples than in the historic records for MHs38.)

Ground-layer cover is patchy to interrupted (25–75%); important species include zigzag goldenrod *(Solidago flexicaulis)*, large- flowered bellwort *(Uvularia grandiflora)*, and Virginia waterleaf *(Hydrophyllum virginianum)*.
Shrub-layer cover is patchy to interrupted (25–75%); common species include sugar maple, ironwood, prickly gooseberry *(Ribes cynosbati)*, and chokecherry *(Prunus virginiana)*.
Subcanopy cover is interrupted to continuous (50–100%); important species include ironwood, sugar maple, and basswood. American elm, red elm, and bitternut hickory are occasionally present, with blue beech occasional in southeastern and east-central Minnesota.
Canopy cover is interrupted to continuous (50–100%); the most common species are basswood, northern red oak, and sugar maple, with bur oak and green ash replacing northern red oak in importance in western Minnesota, especially in the CGP, and white oak abundant in some stands in eastern Minnesota. On rare occasions a supercanopy with abundant white pine is present.

Additional information from the DNR Wildlife Action Plan (2005) states that: "Natural disturbance in this habitat is characterized by the death of individual trees, which occurs at a rather constant rate in older forests. Typical sites are buffered from seasonal drought by fine-textured soils with impermeable soil horizons capable of retaining rainfall or snowmelt below the surface. Usually these soils are well drained and are waterlogged or saturated only after spring snowmelt or heavy, prolonged rains. Essential nutrients, especially nitrogen, are mineralized from decaying organic matter at relatively high rates and quickly become available again for uptake by plants during the spring and early summer months. As a result, nutrients and organic matter accumulate at the soil surface in leaf litter and humus. Like other forest habitats, most maple- basswood habitats in the Eastern Broadleaf Forest Province and southern and western portions of the Laurentian Mixed Forest Province have been fragmented by agriculture and

development. In many locations, the remaining forests typically lack the ecological complexity of pre-European settlement forests because of a number of factors (for example, grazing, invasive plants and animals, edge effects, changes in native animal populations, and consumptive uses)."

Management units were defined (**Figure 16**), based primarily on existing physical boundaries, consisting of the trail system. These corresponded well to the higher and lower quality units of the site, which helped to define the restoration phases. The south unit was selected as the first phase of restoration because it has the most intact plant community, with buckthorn and garlic mustard at very manageable levels. The north unit, though degraded, was also selected for Phase 1, partly due to available funding, but also because it is a very visible location and managing that area will help to generate enthusiasm for additional work at the site.

The West unit was designated as Phase 2, while the East and Middle unit, the most degraded, were designated Phase 3. In reality, these phases apply only to the initial step of non-native brush removal. The non-native brush needs to be removed from the entire site before additional management can begin. Furthermore, management recommendations will need to be re-evaluated after buckthorn is completed; the site will look very different and priorities and methodologies may shift as the site "evolves" in the restoration process.

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

Table 3: Existing Land Cover and Recommended Target Community

Management Unit	Existing land cover	Acres	Quality Index*	Dominant Soil Types	Target Plant Community	Restoration Phase
South	Mesic oak forest	72.3	B-C	Loam (L): Wadena, Ostrander, Terril, Rockton. Brodale flaggy loam	**Southern-Mesic Oak-Basswood Forest:** Red oak-sugar maple-basswood (bitternut hickory) forest MHs38c	1
North		29.5	D	Ostrander L, Etter fine sandy loam (FSL)		2
West		31.5	C	Wadena L, Terril L		3
East		24.2	D	Dom: Boone loamy fine sand (LFS). Also Ostrander L, Etter FSL		4
Middle		21.6	D	Wadena L, Ostrander L, Boone LFS		4

***** The quality index is a ranking system used by the DNR (see Table 2).

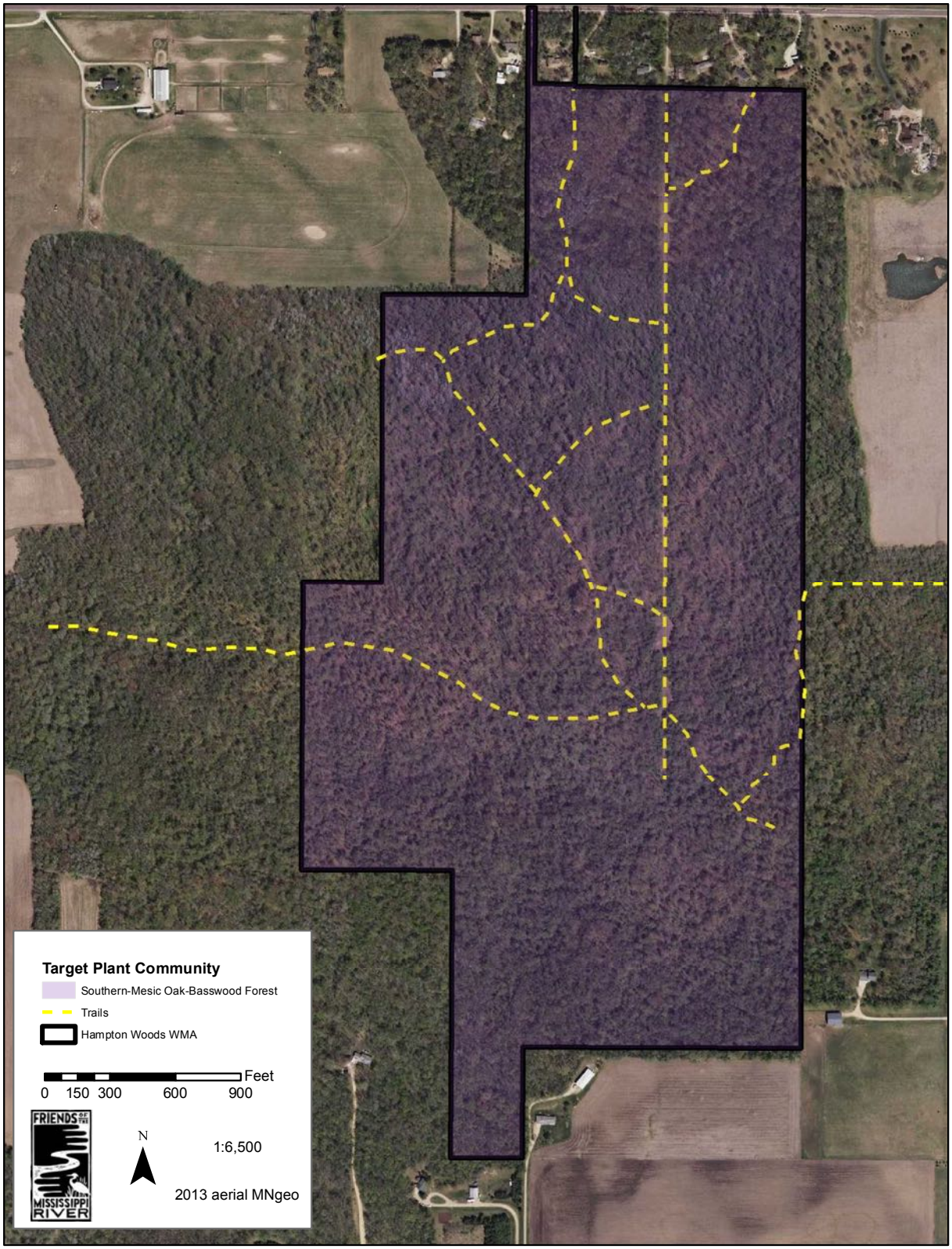

Figure 15. Target Plant Communities for Restoration

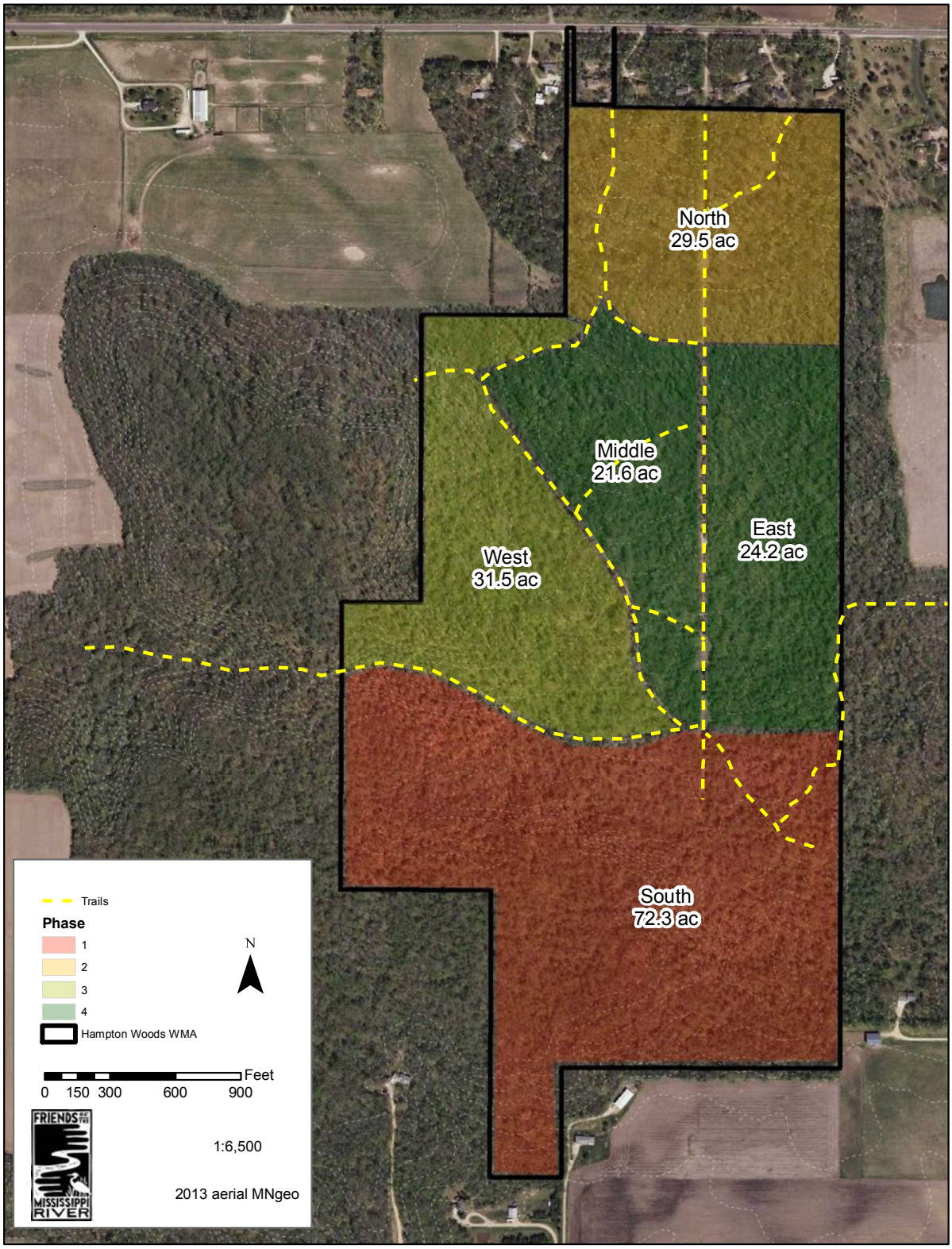

Figure 16. Restoration Management Units and Phases

X. Land Management

A. General Restoration Process

Ecological restoration is a long-term process. It takes time to restore ecosystems to their former functionality and diversity. And even under the best circumstances and human abilities, generally, this can only be approximated. It took many decades to degrade the ecosystem and biological communities on the property, so it will not be restored overnight. Many steps are typically involved in a successful restoration; even deciding when a restoration is complete/successful can be very difficult. Restoration should be viewed as a process and not as an end point. The ultimate goal is to achieve and maintain a diverse natural community at the site, though this will not always proceed in a linear fashion. Using the concept of *adaptive management* will be the key to continual progress at the site. Adaptive management is a strategy commonly used by land managers, which integrates thought and action into the restoration process. It can be described as a strategy that uses evaluation, reflection, communication, and also incorporates learning into planning and management. It is set up like a feedback loop and looks like this: Assess Problem → Design → Implement → Monitor → Evaluate → Adjust → Assess Problem → and so forth. Thus, moving forward with restoration, each round of adaptive management refines and hones the process to better fit the conditions of the site. This strategy should be emphasized on the property.

B. Management Objectives

The overarching objective for the Hampton Woods WMA is to protect and improve the wildlife and water quality values of the site and to restore the ecological functions that the historical native plant communities provided, including:

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

The best way to accomplish those objectives is by restoring and enhancing native plant communities to the site. A robust and diverse native plant community offers the best protection against invasive species, climate change effects and loss of animal species diversity. Although the historical plant community was most likely an oak savanna and oak forest complex, oak savanna would be difficult to restore over most of the site, because it has succeeded too far to oak forest and reversing that would cause more degradation to the site.

Savanna species may be suitable in some areas, but overall maintaining and enhancing the mesic oak forest community will be the best management for this site.

According to the 2005 State Wildlife Action Plan for mesic hardwood forests (**Appendix G**), management practices should be implemented that:

- Use natural disturbance return intervals to guide rotation periods.
- maintain and create large patches of upland forest.
- retain biological legacies (at site level).
- control invasive plants and animals.
- work with Minnesota DNR Division of Fish and Wildlife to determine ecologically and socially desirable deer population levels across the state.
- Collaborate management across ownerships to increase patch size.

In addition, DNR recommendations specify managing habitat for SGCNs and monitoring SGCN populations.

C. Ecological Management Recommendations

The entire Hampton Woods would essentially be managed in the same way, with some modifications among the different units. The management goals and methods are described below, followed by specific details for each of the units.

The target Native Plant Community for all units is **Southern mesic oak-basswood forest** (Red oak-sugar maple-basswood bitternut hickory MHs38c).

Management Goals:

1. Within 6 years, the cover of non-native brush larger than ½ inch diameter has been reduced to less than 10% throughout the site.
2. Within 6 years, the cover of garlic mustard throughout the site is less than 5%.
3. Within 8 years, native tree, shrub species, and/or herbaceous species have been re-introduced to targeted areas most impacted by invasive shrubs.
4. Throughout management, impacts to native plant species are minimized. No net loss of native plant species cover or composition.
5. Within 2 years, all orchid populations are identified, mapped and quantified.
6. Native plant species composition specific to this forest type is maintained during 8 yr period.
7. Native plant community is maintained over long-term – 25 years or more.
8. Information on the breeding bird population is tracked over time.
9. Local community members are engaged in site stewardship.

Management Methods:

- Remove non-native, invasive woody plants (primarily buckthorn)

- Minimize non-target impacts:
    - Do not use oil-based herbicides, which leach through soil and create significant "kill-rings."
    - Due to groundwater sensitivity, do not use water soluble herbicide.
    - Use foam applicator on cut stumps to eliminate overspray.
    - Avoid foliar herbicide application; if needed use foam.
- Re-seed and re-plant suitable native species in targeted areas after non-native plant removal.
- Remove garlic mustard and other non-native herbaceous plants
- Conduct annual ecological monitoring, including targeted plant and animal species surveys, to track effectiveness of management and restoration activities.
- Mimic natural disturbances, if needed, to maintain forest health and regeneration.
- Host annual restoration activities and/or nature hikes to engage community volunteers and site stewards.

D. Other Considerations

Because this site is a State Wildlife Management Area, all visitors must be aware of hunting activities that could be taking place. Hunting and trapping will be allowed at this WMA for any species in the Minnesota Hunting and Trapping Handbook (e.g. including deer, turkey, grouse, woodcock, dove, squirrel, rabbit etc.). The only restriction is for the 200 ft. *No Discharge Zone* along the northern boundary. Hunting should be considered prior to any activities, especially volunteer events. As much as possible, events should be scheduled to avoid hunting season (especially deer hunting), or scheduled to occur during least active hunting hours, such as mid-day. Any persons on-site during hunting season should wear blaze orange and proceed with caution.

E. Work Plan

a. Work Phases

To facilitate management of the property, four work phases were identified (**Figure 16**) based primarily on the ecological condition of the units. If adequate funding were available, all phases could be completed at once. As that is not often the case, these phase designations will help to identify where to start the project and how to progress. It is not, however, necessary to complete all tasks in one phase before starting another. In all likelihood, work could be ongoing in multiple phases in any given year.

Phase 1 of the project is the South unit (72 ac). This is the top priority unit for management because it has the lowest coverage of non-native brush and retains the highest native forb diversity, including the most conservative species at the site.

The North unit (30 ac) was identified as the second priority and **Phase 2**. Although very degraded with dense buckthorn, this unit is the most visible part of the site for visitors, as well as the neighbors to the north. Managing this unit will have a disproportionally larger impact for human visitors, and will make a bigger visual impact, which helps to generate more interest in a site. Much of the buckthorn at this unit is also reaching the fruiting size, so removing it now may be expeditious for stopping the seed load.

The West unit (32 ac) was identified as the third priority and **Phase 3**. This unit is second highest quality after the south unit. **Phase 4** includes both the east unit (24 ac), which is the most degraded, and the middle unit (22 ac) which is somewhat less degraded. These phases should be considered guidelines rather than a firm timeline, as other factors may influence the sequencing. Phase 3, for instance, is less accessible, so Phase 4 might be considered prior to 3, especially if costs were significantly higher for Phase 3.

Project work for each of the work phases will begin with non-native, invasive species control (primarily buckthorn and garlic mustard). After non-native species removal, there will likely be areas that need to be supplemented with native woodland or savanna seed and/or native shrubs.

A five-year Work Plan (**Table 4**) was developed to provide guidelines toward achieving the target communities shown in **Figure 15**. The table shows the work phases, activities, schedules, and estimated costs. A general time frame is shown for each phase, but note that "year 1" for each unit is independent of "year 1" in other units, though they may coincide. Note also that that the costs shown are estimates, based on similar work at other sites, but actual costs may be higher or lower, depending on multiple variables.

b. Ecological Tasks

In general, the ecological tasks below would be completed sequentially for each work phase. Some tasks, however, would necessarily apply to the entire project area, especially the ecological monitoring.

Non-native brush control

Non-native brush control will be the highest priority task for each of the management units (see **Appendix E** for more details). Non-native brush removal can be phased as funding permits, with phases and work units as shown in **Figure 16**. To minimize negative impacts, woody removal work should all be done by hand, i.e. with chainsaws. Forestry mowing is not suitable, even at the north unit, due to the presence of conservative native species and the need to do foliar treatment following forestry mowing. All stems ½ inch or larger should be cut, then stump treated. ONLY foam applicators should be used, which allow chemical to slowly absorb into the stump, and which eliminate overspray. Stems smaller than ½ inch diameter should NOT be cut. They can grow another few years until they reach ½ inch diameter (typically stems are about 5 ft tall at that point). The most effective, least toxic herbicide should be used. Due to groundwater sensitivity, oil-based herbicide should NOT be

used, nor herbicides that translocate with water. Garlon 3a and glyphosate are considered the most suitable. Non-native woody removal should be done in the dormant season – early spring or late fall, and when temperatures are above freezing. Non-native brush control should be scheduled in approximately 3 to 5 year intervals to make a sweep through each unit and address the ½-inch diameter plants. The site should be monitored annually and brush managed before it begins to produce fruit. Do NOT use foliar treatment for follow-up brush control. Foliar treatment often has significant lethal effects on non-target species, resulting in very little native ground cover in the treated areas.

Brush disposal will vary among the units. Where access is good and brush density is high - essentially all units except south – the cut brush can be dragged as much as possible to the trails and chipped. Wood chip can be blown back into the woods, being sure to disperse it so it does not accumulate more than about 1.5 inches deep. Chip could also potentially be used on the trail itself. Where brush is too far to haul, it can be stacked and burned, being sure to locate burn piles away from standing trees, and not on top of high quality native vegetation. Some rot piles can be created, especially in the south unit, but should be limited to one or two per acre. Maximum rot pile size should be about 8 cubic feet.

At the south unit, brush will mostly be either slashed and let lie, or stacked and burned. Slashing can be used where brush is not very large and not very dense. Slash should be cut to about 4-ft lengths so it lies flat on the ground, is easy to walk through, and no more than about 18-inches deep. Burn piles would be made where brush is larger and more abundant. Extreme care must be taken, however, not to locate piles on orchid patches or other high quality vegetation.

The target mesic oak forest plant community (MBs38c) is not a fire-dependent community, but low-level fires did occur. Fire would be especially appropriate and useful in the east unit and possibly the middle unit as well. These are the driest parts of the site that may have been woodland or savanna most recently. The buckthorn is also the most abundant in the east unit, so there will be a flush of seedlings after removal. If adequate fuels for fire are present (primarily oak leaves), it would be very beneficial to burn this unit. The east unit is also a potential candidate for forestry mowing, as the native ground cover diversity was quite low and the buckthorn cover was high.

Garlic mustard control

Garlic mustard is not yet extremely abundant at Hampton Woods. It is still at a level that is manageable, although action must be taken as soon as possible and diligent annual control will be needed to keep it under control. It will likely always be present at the site, needing regular management. But if native vegetation is very robust it will help to prevent the spread. Hand-pulling is the surest way to control this biennial species. In the spring it should be pulled before flowering, typically late April or early May. Pulled at that stage, the pulled plants can be shaken off to remove the dirt and left lying in the woods. If plants are pulled after flowering, the plants should be put in bags, removed from the site and properly disposed where seeds will not mature or be spread. The downside to pulling in spring is that will cause trampling of the native wildflowers. Very late fall can also be an excellent time to hand-pull. In November most native plants have died back but garlic mustard is still green. The plants

are in the basal rosette stage, which is a little more difficult to pull but a dandelion digger is all that is needed. In conjunction with hand-pulling, we suggest contractors also be hired to apply herbicide. The site is very large, so it will be difficult for either contractors or volunteers to cover the whole thing. Herbicide application should ONLY use foam applicators, which provides very targeted application with no overspray that would affect non-target species (see additional control method details in **Appendix E**).

Re-seeding and re-planting

After initial non-native brush removal, each unit should be evaluated to determine what seeding and or plantings may be needed (**Appendix B**). Only local ecotype plant material (genetic origin within 50 miles) should be used. In general, allow at least one growing season after non-native woody removal to see what native species may recover on their own. Large areas with bare soil, however, may need quick-growing species to provide some cover (and to help prevent buckthorn seedling flush). Oats or winter wheat can be used in combination with native grasses and other species. Cover crops and native grasses can also provide fuel for prescribed burns, that will help control buckthorn seedlings.

Seeding is best done just before winter to allow for seed stratification. Shrubs are best planted as bare root, and must be protected from deer browsing (e.g. wire cages). Shrubs should also be well-mulched at the time of installation to retain soil moisture. Allow one to two years after buckthorn removal before installing plant material so as not to interfere with any necessary buckthorn follow up control.

Community Engagement

Involving community volunteers in ecological restoration activities and educational nature outings is critically important for promoting a stewardship ethic for natural areas. The more people learn about and are involved in a natural area the more they will care for it and support the long-term management and protection of it. Hampton Woods provides various opportunities for engagement. Volunteers could be involved in hauling non-native brush from the woods, in searching for and pulling garlic mustard, installing native shrubs, and conducting plant and animal surveys. Friends of the Mississippi River has a long history of community engagement and has recruited thousands of volunteers over the years for these kinds of activities.

Ecological Monitoring

Ecological monitoring of the site is critical to provide baseline data on starting conditions and to evaluate changes over time. Plant and animal surveys can be used to better inform management and to adapt and adjust methods as needed. Vegetation survey plots have already been established and should be surveyed at least once annually. Surveys should be conducted at approximately the same time each year to provide the best comparative data. Ideally two surveys would be done to capture both early and late season species.

The entire orchid population at Hampton should be surveyed and monitored regularly. Populations should be marked with both visual markers and GPS coordinates to alert

contractors to their locations. Visual markers, however, should also be somewhat inconspicuous so as not to be unsightly and to avoid attracting too many human visitors. Orchid surveys should be done annually for 3-5 years, then once every 3 years.

Two breeding bird surveys have already been conducted at Hampton Woods. At least 5 years of annual surveys should be completed, then once every 3 to 4 years. Protocols should follow the established methods.

Earthworm populations should be evaluated in different parts of the site. Locating them within or adjacent to the vegetation survey plots would be beneficial. The surveys would help establish baseline data on populations, and assess changes over time. It would be interesting to begin to try to answer the question of why worms seem to be very abundant in some areas and not others, even when non-native vegetation is sparse. It could be the worms have not yet arrived in the low abundance areas. Since those are the areas with the most orchid species, it will be valuable to track any changes. This is another activity that volunteers could do. An ideal model would be something like the wetland health evaluation program in Dakota County, where the same volunteers would survey each year.

Ecological evaluation must also be completed on a longer time-frame to evaluate canopy health and regeneration. As new tree diseases and insect infestations evolve, it will be important to assess conditions and develop methods to counteract the impacts, such as tree removal and planting tree seedlings. Given the impacts from disease, windthrow and other impacts, the natural disturbance levels are not likely to need “assistance”, but selective tree harvesting should also be considered if needed. Disturbance is an important component of a forest and critical for regenerating both canopy and herbaceous species.

Table 4. Five Year Work Plan

	Phase 1 & 2						
	Year	Season	Units	Ecological Task	Acres	Est Cost/ac	Est cost
1	1	Mar-Apr Oct-Nov	South, North	Cut & stump treat non-native woody plants >1/2 inch diam. Chip and spread in north, plus burn piles. South: slash, burn piles and rot piles.	102	$950.00	$96,900.00
2	1	April-June	All	Orchid survey (volunteer)	179		na
3	1	June	All	Breeding bird survey (2 visits)			$2,200.00
4	1	Nov	All	Volunteer event to hand-pull garlic mustard	179		$3,200.00
5	1	Nov	South	Foliar treat (foam only) garlic mustard.	72	$30.00	$2,160.00
6	1	Fall	North	If needed for large bare ground areas, broadcast cover crop & native woodland seed in targeted areas. Evaluate if additional shrub planting is needed.	6	$500.00	$3,000.00
							$107,460.00
7	2	Apr/May	All	Volunteer event to hand-pull garlic mustard & worm survey.	179		$3,200.00
8	2	April-June	All	Orchid survey (volunteer)	179		na
9	2	June	All	Breeding bird survey (2 visits)	179		$2,200.00
10	2	Nov	North, south, west	Foliar treat (foam only) garlic mustard.	133	$35.00	$4,655.00
11	2	Nov	All	Volunteer event to hand-pull garlic mustard & worm survey.	179		$3,200.00
12	2	Nov	South, North	Follow-up non-native brush control to treat resprouts. Foam application.	102	$100.00	$10,200.00
							$23,455.00
13	3	Apr/May	All	Volunteer event to hand-pull garlic mustard & worm survey.	179		$3,200.00
14	3	April-June	All	Orchid survey (volunteer)	179		na
15	3	June	All	Breeding bird survey (2 visits)	179		$2,200.00
16	3	Nov	North, south, west	Foliar treat (foam only) garlic mustard.	133	$35.00	$4,655.00
							$10,055.00
17	4	April	North	If needed, Vol event to install bareroot shrubs			$5,800.00
18	4	April-June	All	Orchid survey - volunteer	179		na
19	3	Nov	All	Foliar treat (foam only) garlic mustard.	179	$30.00	$5,370.00
20	4	Nov	All	Volunteer event to hand-pull garlic mustard & worm survey.	179		$3,200.00

							$14,370.00
21	5	Nov	All	Volunteer event to hand-pull garlic mustard	179		$3,200.00
22	5	Nov	South, North	Cut/treat non-native woody plants >1/2 inch diam.	102	$450.00	$45,900.00
							$49,100.00
						Total Phase 1 & 2	**$204,440.00**

Phase 3

	Year	Season	Units	Ecological Task	Acres	Est Cost/ac	Est cost
23	1	Oct-Nov	West	Cut & stump treat non-native woody plants	32	$1,600.00	$51,200.00
24	2	Nov	West	Follow-up non-native brush control to treat resprouts. Foam application.	32	$100.00	$3,200.00
25	5	Nov	West	Cut & stump treat non-native woody plants	32	$30.00	$960.00
						Total Phase 3	**$55,360.00**

Phase 4

26	1	Oct, Nov	East, Middle	Cut & stump treat non-native woody plants (forestry mow possibility for East). Chip and haul.	46	$2,000.00	$91,600.00
27	1	Fall	East, Middle	For large bare ground areas, broadcast cover crop & native savanna/woodland seed in targeted areas.	15	$350.00	$5,250.00
28	1	Nov	East, Middle	Foliar treat (foam only) garlic mustard.	46	$30.00	$1,380.00
							$98,230.00
29	2	April	East	Rx burn. Might include Mid unit.	24		$5,800.00
30	2	April	East, Middle	Vol event to install bareroot shrubs	3		$5,800.00
31	2	Nov	East, Middle	Follow-up non-native brush control to treat resprouts. Foam application.	46	$250.00	$11,500.00
32	2	Nov	East, Middle	Foliar treat (foam only) garlic mustard.	46	$30.00	$1,380.00
							$24,480.00
33	5	Nov	East, Middle	Cut & stump treat non-native woody plants	46	$600.00	$27,600.00
							$27,600.00
						Total Phase 4	**$150,310.00**
						GRAND TOTAL	**$410,110.00**

References

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

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

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

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

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

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

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

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

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

Websites:

Invasive species control methods:
http://dnr.wi.gov/invasives/index.htm
http://www.inhs.uiuc.edu/chf/outreach/VMG/lspurge.html
http://mdc.mo.gov/nathis/exotic/vegman/sixteen.htm
http://72.57.47.107/plantsincanada/invasive/factsprg.html
MN Natural Resources (DNR): http://www.dnr.state.mn.us/nr/index.html
Natural history of MN, bibliography (DNR):
http://www.dnr.state.mn.us/snas/naturalhistory_resources.html
Landscaping with Native Plants: http://www.dnr.state.mn.us/gardens/nativeplants/index.html

APPENDICES

Appendix A: Plant Species Recorded at the Property

Oak Forest: MHs38c – Red Oak-Sugar Maple-Basswood- (Bitternut Hickory) Forest

All species recorded throughout the site, excluding the main trail corridor. The following plant species were identified at the site by Karen Schik, Alex Roth, Joe Walton and DNR staff between 2012 and 2016.

	Non-Native	Scientific Name	Common Name	Cover	Diameter (inches)	Comments
	CANOPY		**20-80 ft height**	**20-80%**		
1		*Acer negundo*	boxelder	1		
2		*Acer saccharum*	sugar maple	1		Abundant at the far south
3		Carya cordiformis	bitternut hickory	2	5 to 18	Most had many Phomopsis galls on branches. Many were dead or dying. In cut-over areas, hickory was dominant.
4		*Celtis occidentalis*	hackberry	1	8 to 25	
5		*Fraxinus pennsylvanica*	green ash	1	10 to 35	
6		*Juglans cinerea*	butternut	+	6 to 10	Afflicted with canker. Many dead trees west of main path. 25 ft tall.
7		*Juglans nigra*	black walnut	+	6 to 20	
8		*Populus deltoides*	eastern cottonwood	2		
9		*Populus grandidentata*	big tooth aspen	1		
10		*Populus tremuloides*	quaking aspen	2		
11		*Prunus serotina*	black cherry	1	8 to 20	
12		*Quercus alba*	white oak	+		
13		*Quercus ellipsoidalis*	northern pin oak	1	8 to 20	
14		*Quercus macrocarpa*	bur oak	1	10 to 30	
15		*Quercus rubra*	red oak	2 to 3	20 to 25	Dominant, except in cut-over areas, where hickory was dominant.
16		*Tilia americana*	Ameriican basswood	1	8 to 30	
17		*Ulmus americana*	American elm	1 to 2	8 to 14	
	SUBCANOPY		**12 to 20 ft height**	**Total Cover: 3 to 4**		
1		*Acer negundo*	boxelder	1		
2		*Carya cordiformes*	bitternut hickory	1		
3		*Celtis occidentalis*	hackberry	2		
4		*Fraxinus pennsylvanica*	green ash	2		
5		*Ostrya virginiana*	ironwood	2		
6		*Prunus serotina*	black cherry	2		
7		*Quercus macrocarpa*	bur oak	1 to 2		
8		*Quercus rubra*	red oak	3		Dominant
9		*Tilia americana*	Ameriican basswood	2		
10		*Ulmus americana*	American elm	1 to 2		

	Non-Nati	Scientific Name	Common Name	Cover	Diameter (inches)	Comments
	UNDERSTORY/SHRUB LAYER		**4 to 12 ft height**	**5-50%**		
1		*Acer negundo*	boxelder	+		
2		*Carya cordiformes*	bitternut hickory			
3		*Celtis occidentalis*	hackberry			
4		*Cornus rugosa*	round-leaved	1		
5		*Cornus racemosa*	grey dogwood	1 to 2		
6		*Corylus cornuta*	beaked hazelnut	1		
7	x	*Lonicera tatarica*	Tartarian	1 to 2		More in sandier areas.
8		*Ostrya virginiana*	ironwood	1 to 2		
9		*Prunus serotina*	black cherry	1 to 2		
10		*Prunus virginiana*	choke cherry	1		
11		*Quercus rubra*	red oak	1		Whips
12	x	*Rhamnus cathartica*	common buckthorn	2 to 3	0.5 to 3/4", occ 2-4"	Dominant. Medium density and height throughout. Scattered large 2-4"
13		*Rhus glabra*	smooth sumac	+		openings on trail edge
14		*Ribes cynosbati*	prickly gooseberry	1		
15		*Rubus allegheniensis*	blackberry	2		
16		*Rubus ideaus*	red raspberry	2		
17		*Sambucus pubens*	red berried elder	1		
18		*Tilia americana*	basswood			
19		*Viburnum lentago*	nannyberry	1		
20		*Viburnum rafinesquianum*	downy arrowwood	+		
21		*Zanthoxylum americana*	prickly ash	1		

	GROUND LAYER		**to 4 ft height**	**25-50%**		
	Graminoids					
1		*Carex blanda*	eastern woodland sedge	1		
2		*Carex pensylvanica*	Pennsylvania sedge	2		
3		*Brachyelytrum erectum*	long-awned wood grass	+		
4		*Bromus pubescens*	hairy wood chess	+		
5		*Carex sprengellii*	Sprengel's sedge	+		
6		*Elymus hystrix*	bottlebrush grass	+		
7		*Elymus villosus*	hairy wild rye	+		
8		*Leersia virginica*	whitegrass	+		
	Forbs, ferns					
1		*Actaea rubra*	red baneberry	+		
2		*Ageratina altissima*	white snakeroot	1		
3	x	*Alliaria petiolata*	garlic mustard	1		Widely scattered patches
4		*Allium tricoccum*	wild leek	+		
5		*Amphicarpaea bracteata*	hog peanut	1		
6		*Anemonella quinquefolia*	wood anemone	1		
7		*Aplectrum hyemale*	puttyroot orchid	+		
8		*Aquilegia canadensis*	columbine	+		
9		*Aralia nudicaulis*	wild sarsasparilla	+		
10		*Aralia racemosa*	spikenard	1		Not found at WMA -

	Non-Native	Scientific Name	Common Name	Cover	Diameter (inches)	Comments
11	x	*Arctium minus*	burdock	1		
12		*Arisaema triphyllum*	Jack in the pulpit	1		Abundant in areas, north
13		*Athyrium filix-femina*	lady fern	1		
14		*Botrychium dissectum*	cutleaf grapefern	+		Not found at WMA -
15		*Botrypus virginiana*	rattlesnake fern	+		
16		*Caulophyllum*	blue cohosh	1		
17		*Cardamine concatenata*	cutleaf toothwort	1		
18		*Circea lutetiana*	enchanter's	1		
19		*Cirsium arvense*	Canada thistle	+		
20		*Cypripedium parviflorum*	yellow ladyslipper	+		
21	THR	*Desmodium cuspidatum*	big tick trefoil	+		Not on the WMA, but western parcels. 1994 record
22		*Desmodium glutinosum*	pointed leaved tick trefoil	1		
23		*Dicentra cucullaria*	Dutchman's breeches	1		abundant in spring
24		*Fragaria virginiana*	wild strawberry	+		
25		*Galium aparine*	cleavers	1		
26		*Geranium maculatum*	wild geranium	2		
27		*Geum canadense*	white avens	1		
28		*Geum laciniatum*	rough avens	1		
29		*Heracleum maximum*	cow parsnip	+		Abund at south end of main trail
30		*Hydrophyllum virginianum*	Virginia waterleaf	3		
31		*Impatiens capensis*	spotted touch-me-	1		
32		*Laportea canadensis*	wood nettle	3		
33		*Leersia virgninica*	whitegrass	1		
34	x	*Leonurus cardiaca*	motherwort	+		
35		*Mianthemum canadense*	false lily of the valley	1		
36		*Mianthemum racemosa*	false Solomon's seal	1		
37		*Orchis spectabilis*	showy orchis	+		
38		*Osmorhiza longistylus*	aniseroot	+		
39		*Osmundastrum*	cinnamon fern	+		
40	SPC	*Panax quinquefolius*	wild ginseng	+		NOT at WMA, elsewhere in Hampton Wds. 2012 record
41		*Phryma leptostachya*	lopseed	+		
42		*Pilea pumila*	clearweed	1		
43	x	*Plantago major*	plantain	1		
44		*Polygonatum biflorum*	smooth Solomon's	+		
45		*Polygonatum pubescens*	hairy Solomon's seal	+		
46		*Pyrola cf elliptica*	shinleaf	+		At north part of site
47		*Ranunculus abortivus*	little leaf buttercup	+		
48		*Ranunculus fascicularis*	early buttercup	+		
49		*Sanguinaria canadensis*	bloodroot	1		
50		*Sanicula gregaria*	gregarious snakeroot	1		
51		*Sanicula marilandica*	Maryland black snakeroot	1		
52		*Silene stellata*	starry campion	+		Not found at WMA - western parcels
53		*Smilax herbacea*	carrion plant	+		

	Non-Native	Scientific Name	Common Name	Cover	Diameter (inches)	Comments
54		*Solidago flexicaulis*	zig-zag goldenrod	1		
55		*Solidago gigantea*	late goldenrod	1		
56		*Solidago ulmifolia*	elm-leaved goldenrod	+		
57		*Symphyotrichum cordifolium*	heart-leaved aster	1		
58	x	*Taraxacum officinale*	dandelion	1		
59		*Thalictrum dioicum*	early meadowrue	1		
60		*Toxicodendron radicans*	poison ivy	+		
61		*Trillium cernuum*	nodding trillium	+		
62		*Triosteum perfoliatum*	horse gentian	+		
63		*Urtica dioica*	stinging nettle	+		
64		*Uvularia grandiflora*	large-flowered bellwort	+		
65		*Uvularia sessilfolia*	wild oats	+		
66		*Viola pubescens*	yellow violet	1		
67		*Viola sororia*	common blue violet	1		

Climbers

1		*Menispermum canadense*	moonseed	1		
2		*Parthenocissus quinquefolia*	Virginia creeper	+		
3		*Vitis riparia*	grape vine	1		

Deciduous woody (primarily seedling trees and shrubs)

1		*Acer negundo*	boxelder	+
2		*Acer saccharum*	sugar maple	+
3		*Carya cordiformes*	bitternut hickory	+
4		*Celtis occidentalis*	hackberry	+
5		*Cornus alternifolia*	pagoda dogwood	+
6		*Corylus cornuta*	beaked hazelnut	+
7	x	*Lonicera tartarica*	Tartarian honeysuckle	+
8		*Prunus serotina*	black cherry	1
9		*Prunus virginiana*	choke cherry	1
10		*Quercus rubra*	red oak	+
11	x	*Rhamnus cathartica*	common buckthorn	2
12		*Ribes cynosbati*	gooseberry	1
13		*Tilia americana*	basswood	+
14		*Ulmus americana*	American elm	+
15		*Zanthoxylum americana*	prickly ash	+

Vegetation Survey Plots

10x10 m Releve plots. Releve locations shown on **Figure 14**.

			SOUTHWEST			SOUTHEAST		NORTH	
	Survey dates	5-2-16			5-15-16		5-15-16		
Non-native	**Scientific Name**	**Common Name**	**Cov class**	**DBH (cm)**	**Notes**	**Cov class**	**diam (cm) // Notes**	**Cov class**	**diam cm // Notes**
	CANOPY (decid) 10-35 m	**% cov of ht class**	**80%**			**75-100%**		**50-75%**	
	Acer negundo	boxelder						**2**	26.1, 30.7
	Celtis occidentalis	Hackberry	1		1 tree				
	Juglans cinerea	butternut						2	32.0 // 100 ft tall. No canker!
	Populus tremuloides	quaking aspen							2 // 80-ft trees outside plot. 28, 37.1
	Quercus macrocarpa	bur oak	3	48	3 trees			+	34.3 // leaning out of plot
	Quercus rubra	Red oak	3	48	3 trees				
	Tilia americana	American basswood	4	30, 42.5	3 trees	4	57, 42.5, 27 35.5 cm // snag		
	Ulmus americana	American elm						2	35
	SUBCANOPY (deciduous) 5-10 m		**40%**			**25-50%**		**25-50%**	
	Carya cordiformes	bitternut hickory				2			
	Celtis occidentalis	Hackberry				2			
	Ostrya virginiana	Ironwood				3			
	Quercus rubra	Red oak							
	Tilia americana	American basswood						1	
	Ulmus americana	American elm					Dead	3	
	SHRUB (decid) 1.5-3 m		**20%**			**1-5%**		**25-50%**	
	Acer negundo	boxelder						1	
	Carya cordiformes	bitternut hickory	2		4 trees	+			
	Celtis occidentalis	hackberry	2	5	1 tree			1	
	Corylus cornuta	beaked hazelnut						+	
x	*Lonicera tartarica*	Tartarian honeysuckle							
	Prunus serotina	black cherry				+			
	Prunus virginiana	choke cherry							
x	*Rhamnus cathartica*	common buckthorn	1	5	1 shrub	+		3	
	Ribes cynosbati	gooseberry						1	
	Tilia americana	basswood				+			
	Zanthoxylum americana	prickly ash				+			

Non-native	Scientific Name	Common Name	Cov class	DBH (cm)	Notes		Cov class	diam (cm) // Notes		Cov class	diam cm // Notes
	GROUND LAYER 0-0.5 m		**80%**				**50-75%**			**50-75%**	
	Deciduous		**5-25%**							**25-50%**	
	Acer negundo	boxelder	+				+			+	SD
	Acer saccharum	sugar maple	+								
	Carya cordiformes	bitternut hickory	+				+	seedling		+	
	Celtis occidentalis	hackberry								+	
	Cornus alternifolia	pagoda dogwood					+			+	
	Corylus cornuta	beaked hazelnut								+	
x	*Lonicera tartarica*	Tartarian honeysuckle	+								
	Prunus serotina	black cherry	1				+				
	Prunus virginiana	choke cherry	1				+			1	
	Quercus rubra	Red oak	+				+	seedling		+	SD
x	*Rhamnus cathartica*	common buckthorn	1				+			2	
	Ribes cynosbati	gooseberry	1				2			2	
	Tilia americana	basswood					+	seedling			
	Ulmus americana	American elm					+	seedling		1	SD & knee high
	Zanthoxylum americana	prickly ash					+				
	GROUND LAYER										
	Herbaceous cover & ferns		**50-75%**		**CC-WI ****		**50-75%**	**CC-WI ****		**~ 10%**	**CC-WI ****
	Alliaria petiolata	garlic mustard	1								
	Allium tricoccum	wild leek	+		6						
	Arisaema triphyllum	Jack in the pulpit					1	5		1	5
	Athrium felix-femina	lady fern					1			+	
	Caulophyllum thalictroides	blue cohosh	1		8		1	8			
	Circea lutetiana	enchanter's nightshade					2			1	
	Galium aparine	cleavers	1		2		+	2			
	Geranium maculatum	wild geranium	+		4		2	4			
	Geum laciniatum	rough avens					2	5		+	5
	Heracleum lanatum	cow parsnip					1	3			
	Hydrophyllum virginianum	Virginia waterleaf	4		4		+	4			
	Impatiens capensis	Spotted touch-me-not					1				
	Laportea canadensis	wood nettle	1		4						
	Mianthemum canadense	false lily of the valley								+	
	Mianthemum racemosa	false Solomon's seal	1				+			+	
	Osmorhiza longistylus	aniseroot	+		4						
	Polygonatum sp						+	5		+	5
	Rubus ideaus	red raspberry								+	
	Sanguinaria canadense	bloodroot	1		6		+	6			
	Sanicula gregaria	black snakeroot	1		3						
	Solidago flexicaulis	zigzag goldenrod					+	6			
x	*Taraxacum officinale*	dandelion					+				
	Thalictrum dioicum	early meadowrue					1	7		+	7
	Thalictrum sp	rue sp					+				
	Trillium cernuum	Nodding trillium					+	8		+	8

Uvularia grandiflora	large-flowered bellwort	+		7				
Viola pubescens	yellow violet	1		5				
Viola sororia	common blue violet	1		3	+	3		
Viola sp	Violet				+			
Graminoids		**<5%**			**<5%**		**<5%**	
Brachyelytrum erectum	long-awned wood grass				1	7		
Bromus pubescens	hairy wood chess	+		6				
Carex blanda	Carex blanda				+	3		
Carex pennsylvanica	Pennsylvania sedge						+	
Carex sprengellii	Sprengel's sedge				+	6		
Elymus vilosus	silky wild rye				+	6		
Climbers								
Menispermum canadense	Moonseed				1		+	
Parthenocissus inserta	Virginia creeper	**1**			1		1	
Vitis riparia	Wild grape vine				+		+	
Bare ground					**3**		**2**	
CoefConser-WI-total				**62**		**88**		**30**

** The Coefficient of Conservatism is a quality ranking system (0-10) where 10 indicates the most conservative species, 0 the most common. MN does not have a ranking at this time, so the WI ranks were used.

NOTES:	**Southwest**	**Southeast**	**North**
Dead wood:	1 snag. Some coarse woody.	Red oak tree stump (cut)	Abundant coarse woody debris.
Earthworms:	Stage 5	Stage 5	Stage 5
Leaf litter:	Oak litter present.	None	Much less basswood than south. Very depauperate ground cover.
General:	Relatively healthy, but low forb diversity.		Cooper's hawk pair, tree frogs, gray squirrel, animal hole (chipmunk)

MHs38 Southern Mesic Oak-Basswood Forest — Species Frequency and Cover

	freq%	cover
Forbs, Ferns & Fern Allies		
Zigzag goldenrod *(Solidago flexicaulis)*	84	●●
Clayton's sweet cicely *(Osmorhiza claytonii)*	81	●
Bloodroot *(Sanguinaria canadensis)*	77	●
Large-flowered bellwort *(Uvularia grandiflora)*	73	●●
Lopseed *(Phryma leptostachya)*	65	●
Common enchanter's nightshade *(Circaea lutetiana)*	64	●
Early meadow-rue *(Thalictrum dioicum)*	63	●
Virginia waterleaf *(Hydrophyllum virginianum)*	63	●●●
Jack-in-the-pulpit *(Arisaema triphyllum)*	56	●
Erect, Smooth, or Illinois carrion-flower*	55	●
Wild geranium *(Geranium maculatum)*	55	●
Honewort *(Cryptotaenia canadensis)*	54	●
Wild sarsaparilla *(Aralia nudicaulis)*	54	●
Blue cohosh *(Caulophyllum thalictroides)*	53	●
Rattlesnake fern *(Botrychium virginianum)*	50	●
Lady fern *(Athyrium filix-femina)*	50	●
Yellow violet *(Viola pubescens)*	50	●
Common false Solomon's seal *(Smilacina racemosa)*	48	●
Maryland black snakeroot *(Sanicula marilandica)*	48	●
Pointed-leaved tick trefoil *(Desmodium glutinosum)*	47	●
Red baneberry *(Actaea rubra)*	46	●
Maidenhair fern *(Adiantum pedatum)*	44	●
Hog peanut *(Amphicarpaea bracteata)*	44	●
Wild ginger *(Asarum canadense)*	43	●●
Wood anemone *(Anemone quinquefolia)*	41	●
Sweet-scented bedstraw *(Galium triflorum)*	41	●
Sharp-lobed hepatica *(Anemone acutiloba)*	38	●
White avens *(Geum canadense)*	37	●
Canada mayflower *(Maianthemum canadense)*	37	●
Cleavers *(Galium aparine)*	34	●
Shining bedstraw *(Galium concinnum)*	31	●
Grasses & Sedges		
Pennsylvania sedge *(Carex pensylvanica)*	57	●●●
Starry sedge *(Carex rosea)*	41	●
Bland sedge *(Carex blanda)*	31	●
Bottlebrush grass *(Elymus hystrix)*	28	●
Long-stalked sedge *(Carex pedunculata)*	27	●●
Nodding fescue *(Festuca subverticillata)*	20	●
Bearded shorthusk *(Brachyelytrum erectum)*	19	●
Woody Vines		
Virginia creeper *(Parthenocissus* spp.)	80	●
Wild grape *(Vitis riparia)*	39	●
Shrubs		
Prickly gooseberry *(Ribes cynosbati)*	71	●
Chokecherry *(Prunus virginiana)*	64	●
Prickly ash *(Zanthoxylum americanum)*	57	●●
Poison ivy *(Toxicodendron rydbergii)*	57	●
Pagoda dogwood *(Cornus alternifolia)*	53	●
Missouri gooseberry *(Ribes missouriense)*	30	●●
Nannyberry *(Viburnum lentago)*	23	●
Downy arrowwood *(Viburnum rafinesquianum)*	22	●
American hazelnut *(Corylus americana)*	21	●●

*Erect, Smooth, or Illinois carrion-flower *(Smilax ecirrata*, *S. herbacea*, or *S. illinoensis)*

Trees	Canopy		Subcanopy		Shrub Layer	
	freq%	cover	freq%	cover	freq%	cover
Basswood	82	●●●	52	●●	73	●
Northern red oak	60	●●●●	11	●	52	●
Sugar maple	59	●●●●	60	●●●	65	●●●
Ironwood	42	●●●	84	●●●	70	●●
Green ash	36	●●●	16	●	38	●
Bur oak	33	●●●	-	-	18	●
White oak	30	●●●	-	-	9	●
American elm	27	●●	21	●●	32	●
Paper birch	20	●	-	-	-	-
Bitternut hickory	18	●●	26	●●	46	●
Red elm	16	●	19	●	34	●
White pine	12	●●●●	-	-	-	-
Black cherry	9	●	9	●	34	●
Blue beech	-	-	20	●●●	19	●

Appendix C: Potential Ecological Impacts

Disease

While there are multiple diseases that could impact the Hampton Woods forest, the most significant are likely to be those that impact the oak trees, the dominant species at the site.

1. Oak Wilt

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

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

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

When oak trees are wounded, they are more susceptible to oak wilt since beetles, which carry fungal spores on their bodies, are attracted to the scent of fresh wounds and become vectors of the disease. Storm damage can also result in potential infestations.

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

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

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

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

2. Bur Oak Blight

Bur Oak Blight (BOB) is a relatively new fungal disease in Minnesota that was recently discovered. This disease has been confirmed in several counties in Minnesota, including Ramsey and Hennepin, so it could potentially occur in Dakota County. This disease kills trees, but moves much more slowly than does Oak Wilt. It only affects bur oaks, which is a concern in areas containing valuable bur oaks. BOB seems to be influenced by the frequency of rainfall, with more rainfall resulting in conditions more suitable for the disease. Symptoms occur on leaves during July and August, with large, brown, wedge-shaped

necrotic lesions forming. Sometimes leaf veins also turn brown. One of the best ways to diagnose the presence of this disease is by examining bur oaks during the winter. Normal bur oaks drop all their leaves during the winter. If the leaves are retained (even a few), this may indicate that the tree is infected with BOB. The disease overwinters in leaf petioles and spreads throughout the crown of the tree and potentially into other nearby trees over the span of several years. Mortality can result, but often trees that die are located next to ones that are unaffected, so the rate of spread is relatively slow. Control of this disease cannot be attained through raking and burning of fallen leaves, since many leaves remain attached to the tree over winter. However, periodic site-wide burning would reduce the spore load, since many fallen leaves bear fungal spores. Researchers are supporting the use of fungicide injections since the protection provided by a single injection seems to last for several years.

Non-native and Over Populated Native Animals

A. Earthworms

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

B. White-tail Deer

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

Today, browsing by deer, not grazing, has a more significant negative impact on woodlands. Deer populations in the metropolitan area have greatly increased over the last century due to both direct and indirect causes. The conversion of native forest, woodland, savanna, and prairie first to agricultural land and then to more "suburbanized landscapes" have favored deer. Fragmentation of forests and managing for large gaps and residential lots with linear

woodlands has greatly increased the suburban "edge effect." Deer prefer areas with large amounts of long, linear forest/woodland edge that can be used both as open areas to feed and wooded areas for cover. Active management for deer hunting by wildlife managers has also had a direct increase in deer abundance. Deer prefer to feed on many of the native forbs, shrubs, and tree seedlings. Although deer will eat buckthorn and honeysuckle, they do not prefer them if given the choice. This combination of factors greatly increases the browsing pressure on the few natives that can survive earthworm and buckthorn. The lack of oak regeneration, typical of such woodlands, is one result of these conditions.

The synergistic effect of the three factors, fire suppression, earthworm infestation, buckthorn/honeysuckle invasion, and high deer browsing pressure has resulted in a situation of oak woodland decline. Although difficult to turn around, this decline can be ameliorated and possibly reversed, under appropriate management activities.

C. Climate Change

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

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

According to the DNR Wildlife Action Plan 2015-2025:
Climate change impacts anticipated for forested areas include: "Insect damage, larger blowdown areas, droughts, and fire are expected to interact, resulting in many forests, particularly ones on marginal soils, becoming savannas. Invasive species, including earthworms, may limit the establishment and growth of native tree seedlings and other understory plants (Galatowitsch et al. 2009).

Deciduous forests within the prairie-forest border are severely fragmented by agriculture and urban/ suburban sprawl. Should fragmentation increase, thereby creating smaller forest patches and increasing edge habitat, the ability of some plant and animal species to adapt to climate change could become progressively limited. Reasons for this include increased predation on wildlife, the spread of invasive species, and competition from other native species that prefer forest edge."

Appendix D: List of Noxious and Invasive Plants

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

- Oriental Bittersweet was NOT found at the WMA but has been detected at other sites in the Twin Cities. It is a fast-growing vine that overwhelms other plant communities.
- **Common or European Buckthorn** can thrive in a wide range of soil and light conditions, enabling it to invade a wide variety of habitats. It forms dense thickets that crowd and shade out native plants, alters nitrogen levels in the soil, hosts funguses detrimental to agricultural crops, contributes to erosion and declining water quality. Recent research suggests it also releases compounds that are toxic to the embryos of native amphibian species. Its fruit is somewhat toxic, with a strong laxative effect on birds and other wildlife. As such, it provides little food value to animals that eat the berries. Once established, a virtual carpet of buckthorn seedlings will radiate outward from each "mother plant," displacing or preventing native plants from re-establishing these areas. The berries are dispersed by birds throughout the woodland. Trees that offer perches for birds are typically choked with buckthorn plants growing under their crowns. Buckthorn can dominate a vulnerable woodland or forest in a matter of 30 to 50 years.
- Glossy Buckthorn is a great threat to wetlands, where it can form dense stands that cause the growth of other species to be suppressed. It is also an alternative host to fungi that infects oats.
- **Tartarian Honeysuckle** is an upright, deciduous shrub with red or orange berries that replaces native forest shrubs and herbaceous plants by their invasive nature and early leaf-out.
- Multi-flora Rose- forms small to large infestations often climbing into trees, invades forest and forest margins
- **Garlic Mustard** has had a significant impact on forest understory. Due to its ability to aggressively spread, out-compete important native understory species and create large monocultures, many ecologically important plant communities are displaced.

Specially Regulated Plants that have the potential to cause harm in non-controlled environments include:

- Giant Knotweed forms dense stands where it can crowd out native vegetation.
- Japanese Knotweed forms dense thickets that exclude native vegetation and greatly alters ecosystems.
- The DNR also maintains a list of invasive, terrestrial plants: amur maple, amur silver grass, birdsfoot trefoil, black locust, black swallowwort, British yellowhead, buckthorn, bill thistle, butter and eggs, Canada thistle, common tansy, common teasel, cow and hairy vetch, creeping charlie, crown vetch, cut-leaved teasel, dalmation toadflax, exotic honeysuckles, garlic mustard, giant hogweed, Grecian foxglove, hoary alyssum, Japanese barberry, Japanese hedge parsley, Japanese hops, Japanese knotweed, leafy spurge, meadow knapweed, multi-flora rose, musk or nodding thistle, narrowleaf bittercress, non-native phragmites, Norway maple, orange hawkweed, oriental bittersweet, oxeye daisy, perennial sow thistle, poison hemlock, purple loosestrife, Queen Ann's Lace, reed canary grass, Russian olive, Siberian elm, Siberian peashrub, smooth brome grass, spotted knapweed, tree of Heaven, white and yellow sweet clover, wild parsnip, yellow iris, and yellow star thistle.

Appendix E: Methods for Controlling Non-native Invasive Woody Plant Species

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.

C***hemical 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 10% glyphosate herbicide (e.g Roundup) can be used for most woody species, or triclopyr herbicide such as Garlon 3a. Adding a marker dye (diluent blue) is best to make treated stumps more visible. In winter months, Garlon 4 is typically used, mixed with a penetrating oil. Diesel fuel should never be use as it is more toxic in the environment and for humans. Garlon 4 will cause a “kill-ring” and should only be used at very degraded sites. Garlon 4 should NOT be use at Hampton Woods due to the sensitivity of the groundwater to contamination and the high quality herbaceous plants. 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.

At Hampton Woods, herbicide should ONLY be applied with a foam applicator. The foam sits on top of the stump and gradually soaks in. This method eliminates overspray, reduces chemical use, and increases the chemical efficacy and more chemical goes into the plant.

Ideal weather conditions for herbicide work are during the growing season (when the plants are biologically active) and especially when soil moisture levels are low. Some studies have shown that when soil moisture is high, herbicide is more likely to move out of the roots of the treated plant into the soil, potentially having lethal effects on nearby plants and simultaneously sub-lethal effects on the treated plant (Dornbos & Pruim 2012). Fall is the best time for work at the southern parts of Hampton and the terrace because the buckthorn is somewhat scattered and easiest to find in late fall (early Nov) when leaves have dropped from most plants.

Most material will be cut with brush cutters and chainsaws, used only by properly trained professionals.

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. A foliar application of herbicide is a common treatment approach, typically done in fall, when desirable native plants are dormant and when the plant is pulling resources from the leaves down into the roots. However, this method will affect native herbaceous plants

and may cause significant mortality. It should **NOT** be used in high quality locations (such as Hampton Woods) unless specific methodology is approved, such as foam application on very dense stands or use of a wick applicator. Krenite (active ingredient – fosamine ammonium) is an herbicide used in fall to prevents bud formation in the spring. This herbicide can be effective, but results are highly variable. Glyphosate or a triclopyr herbicide such as Garlon can also be used. Glyphosate is non-specific and will kill anything green and should not be used for foliar treatment at Hampton. 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.

Undesirable trees and shrubs can also be destroyed without cutting them down. Girdling is a method suitable when there are 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.

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. This method typically causes a significant "kill ring" and should NOT be used at Hampton.

Mechanical Control

Mechanical methods for woody plant removal include hand-pulling, weed wrenching, forestry mowing, repeated cutting and browsing.

Hand-pulling are similar, except hand-pulling require no tools (optional use of a pliers) and is suitable for seedlings or very small saplings (less than 3 ft tall), whereas weed wrenches involve use of a weed extracting tool and is used on larger plants, up to about 2-inches diameter. Both methods can be done any time when the soil is moist and not frozen. Disadvantages to both methods they are time-consuming and require that the dirt be shaken off each plant that is pulled. They also, especially weed wrenching, create 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 best used in areas that have very little desirable native plant cover. It could be used at Hampton for seedling plants in disturbed areas.

Forestry mowers are large machines that essentially grind everything in their path. The mower can be set at different heights, and can cut just below the surface of the soil. The latter method is most effective for controlling buckthorn and it gets to the root collar where resprouting occurs. But even at high cutting heights, the mower tends to shatter the stems and can be a very effective tool for significantly reducing buckthorn levels. The mulch from mowing also serves to suppress new buckthorn seedlings and can dramatically reduce the seedling "carpet" that typically happens after large plants are removed. The mower can be used on frozen soils to reduce impacts. At Hampton, we do not recommend use of the mower, due to the presence of high quality native plants. Even in the most degraded areas there were interesting plants. Use of the mower typically requires follow-up foliar application, which would not be suitable at Hampton.

Repeated cutting is another potential control method. It consists of cutting the plants (by hand or with a brush cutter) at critical stages in the growth cycle. Cutting in mid spring (late May) intercepts the flow of nutrients from the roots to the leaves. Re-cutting in fall (about late September) intercepts the flow of nutrients from the leaves to the roots. Depending on the size of the stem and other factors such as weather

conditions and the amount of available light, many plants may die within a few years, with two cuttings per year.

Using of browsing animals, especially goats, is another means of control. This is best used on small stems – 4 ft or less. Goats primarily defoliate the stems, weakening the plant. If the plants are small and this is done repeatedly (ideally twice a year), this method can significantly reduce the invasive plant over time. However, there are several limitations to the use of goats, including the fact that they will eat do not discriminate between desirable native plants and undesirable non-native plants; they eat everything in sight. For that reason, this method is not suitable at Hampton Woods.

Stems, Seedlings and Re-sprouts

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. Burning will primarily kill small seedling – first year plants. It will top-kill larger plants, but also weakens them, making them easier to control with other methods, such as follow-up mow or foliar herbicide.

If burning is not feasible, critical cutting and/or foliar application are alternatives. Or do nothing and re-cut/treat new growth in 3-5 years.

Disposal

Stack and burn: The easiest and most cost-effective method to handle large amounts of brush is usually to stack it and burn it in winter.

Cut and let lie: 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.

Rot piles: Small brush piles (e.g. 8 ft tall or less, similar length & width) can also be left in the woods as wildlife cover. This should be used as a supplement to other methods, and there should not be more than a 2-3 piles per acre.

Biofuels: Where there is an abundance of larger trees, cut trees may be hauled and chipped and used for mulch or as a biofuel.

Chip on-site: Brush can be chipped on-site and blown back into the woods. The chip should be spread around so it's not more than 1-2 inches thick. This allows native plants to push through, but is very effective as suppressing buckthorn seedlings from germinating.

Appendix F. Breeding Bird Surveys

Species of Greatest Conservation Need (Minnesota Department of Natural Resources 2015) in red.
Maximum of 2 breeding bird surveys conducted in June each year.
Survey method was point count. Seven points were surveyed each year, but necessarily the same points.

			2013	2016
	Common name	**Code**	All Spp Observed	All Spp Observed
1	American Crow	AMCR	2	2
2	American Redstart	AMRE	1	0
3	American Robin	AMRO	0	2
4	Baltimore oriole	BAOR	6	3
5	Black-capped Chickadee	BCCH	6	9
6	Blue Jay	BLJA	6	8
7	Blue-gray Gnatcatcher	BGGN	5	1
8	Blue-headed vireo	BHVI	1	0
9	Blue-winged warbler	BWWA	1	2
10	Brown-headed Cowbird	BHCO	2	2
11	Cedar Waxwing	CEWA	0	2
12	Common grackle	COYE	0	2
13	Cooper's hawk	COHA	1	0
14	Downy Woodpecker	DOWO	2	3
15	Eastern wood pewee	EWPE	9	5
16	Gray Catbird	GRCA	0	1
17	Great-crested Flycatcher	GCFL	11	9
18	Hairy woodpecker	HAWO	2	1
19	House Wren	HOWR	9	2
20	Indigo Bunting	INBU	5	2
21	Least Flycatcher	LEFL	0	1
22	Mourning Warbler	MOWA	1	1
23	Northern cardinal	NOCA	6	3
24	Northern Flicker	NOFL	3	0
25	Ovenbird	OVEN	10	2
26	Pileated Woodpecker	PIWO	0	1
27	Red-bellied woodpecker	RBWO	4	2
28	Red-eyed Vireo	REVI	9	10
29	Rose-breasted Grosbeak	RBGR	4	2
30	Ruby-throated Hummingbird	RTHU	0	1
31	Scarlet tanager	SCTA	1	2
32	Tree Swallow	TRES	0	1
33	Warbling vireo	WAVI	1	0
34	White-breasted Nuthatch	WBNU	2	3
35	**Wood thrush**	**WOTH**	**1**	**2**
36	Yellow-bellied Sapsucker	YBSA	1	2
	No birds		112	89
	No. species		28	31
	No. SGCNs*		2	1

*Red-shouldered hawk, a SGCN and special concern species, was recorded during visits outside the bird survey, but during the breeding season in 2013.