Bismarck Hill

Vegetation, Wildlife Assessment and Restoration Plan

Prepared For:

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SMITHGROUP JJR

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Introduction

SmithGroupJJR (SGJJR) was retained by the Michigan City Parks and Recreation Department (Parks Department) to complete a Vegetation, Wildlife Assessment and Restoration Plan (Plan) for Bismarck Hill in Michigan City. It is the intent that this Plan be used as a tool by the Parks Department and the Parks and Recreation Board to objectively inform future land use and land management decisions within the project area.

Study Area

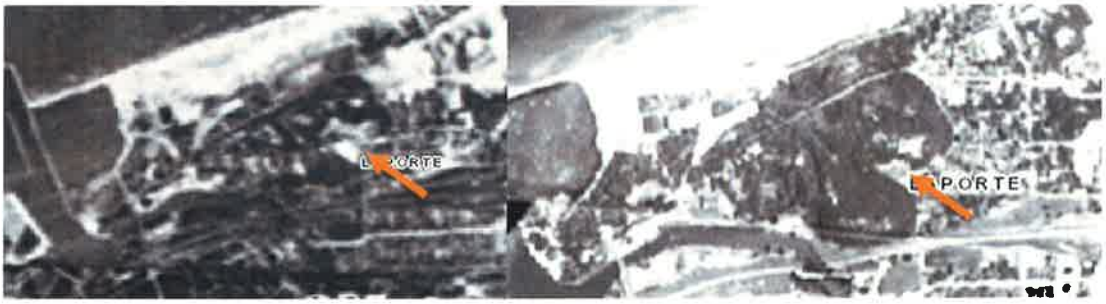
The project area consists of a 26 acre portion of Bismarck Hill (Hill), a wooded sand dune bound approximately by Lake Shore Drive to the northwest, Krueger Avenue and Center Street to the east, and a railroad to the south per Exhibit A. Canada Park is a small out-of-project area on the eastern side of the Hill.

The base map of the project area used for all exhibits within this report was generated using readily-available digital data provided by the Parks Department.

Ecological and Historical Context

Bismarck Hill occurs within the Lake Michigan Border of the Northwestern Morainal natural region. Prior to settlement by Europeans, it is likely that this region succeeded from grass-dominated sand dunes to conifers, to an oak / hickory forest with interspersed dry prairie. Dominant woody vegetation historically consisted of northern red oak, white oak, green ash, bur oak, pin oak, eastern white pine, wild black cherry, red maple, slippery elm, shagbark hickory, tulip poplar and black walnut.

Bismarck Hill likely has been at least partially wooded for the last 150 years or more. Aerial photographs from 1939 show that the dune was heavily wooded during 1939 with a few clearings particularly on the south facing slope above Canada Park, which is indicated with an arrow below. By 1954, the clearings had mostly filled in with trees. While the clearings could have been dry prairie openings, the proximity of the clearings to roads and Canada Park, as well as the abundance of weeds in areas that were formerly clear of vegetation, suggest that the clearings were anthropogenic in nature.



1939 (Indiana State Geologic Survey) **1954 (Indiana State Geologic Survey)**

Soils were sandy throughout with a thin (≤6") layer of organic duff in areas where vegetation was present.

Principles

This Plan is based on Guiding Principles and Metrics as described below. These guidelines shape the formation of the restoration plan and provide associated metrics that can be used as a gauge for evaluating the success of future plan implementation. The principles are organized by the four tenets of sustainability:

A. Ecological – Sustaining the ability of the landscape to perform ecological functions such as building soil, recharging and cleaning water, cycling nutrients, and enabling biological systems to remain diverse and productive.
B. Economic – Encouraging reinvestment in the community and providing cost effective solutions that preserve or wisely use scarce resources.
C. Social – Providing equitable access to natural resources for the benefit of all community residents and preserving cultural connections between people and place.
D. Human Spirit – Inspiring a deeper, spiritual connection with nature.

The following Guiding Principles and Metrics have been established for Bismarck Hill:

A. ECOLOGICAL
- Identify, protect, connect and restore sensitive resources.
- Work toward a sustainable, maintainable natural landscape.
- Control invasive weeds.
- Honor natural processes.
- Maximize native plant cover and minimize bare sand cover.

Metrics:
- Reduce abundance of Oriental bittersweet, honeysuckle, and buckthorn by 90%.
- Maintain palette of 100% indigenous plants to be used for restoration.
- Consolidate the number of volunteer trails by 25% by improving and consolidating remaining trails.

B. ECONOMIC
- Structure restoration and access improvements so that they are fundable and easily phased.
- Minimize maintenance costs for infrastructure as well as natural areas.

Metric:
- Implement the first phase of restoration within two years of plan adoption.

C. SOCIAL
- Enhance wayfinding and access.

Metrics:
- Improve at least one access point and trail throughout the dune.
- Provide additional wayfinding signage to clearly designate every public access point.
- Develop and enforce trail access regulations that support these principles.

D. HUMAN SPIRIT

- Identify, enhance and protect viewsheds.
- Honor and enhance the native dune landscape (i.e. do not make it into something it is not).
- Provide opportunities for quiet contemplation.
- Respect privacy of neighbors, as well as opportunities for the public to experience quiet, unbroken access to open space.

Metric:

- Provide two intentional and additional opportunities for quiet contemplation.

Ecological Assessment Methods

Ecological Communities

Ecological communities including Black Oak woodland (1); Black-Scarlet oak / Sassafras woodland (1a); Basswood woodland (2); Red Pine / Basswood / Black Locust woodland (3); Black Oak/Witch Hazel woodland (4); and wooded scrub edge (5) were delineated on an aerial photograph in the field during June 22 to June 23 and July 5 to August 12, 2015 (Exhibit B). The boundaries were identified in the field based on physiognomic patterns including dominant plant species and topography.

Vascular Flora

Vascular plants were identified to species during the same period of time. Summary statistics (Native Mean C, Native FQI, Relative Importance Value, etc.) are per Wilhelm and Masters (2006). It should be noted that it is likely that some of the spring ephemerals and late summer flora (particularly Asteracea) were missed during the inventory due to the timing of our field work.

Tree Data

A tree survey was conducted for Bismarck Hill from August 6 through August 10, 2015. All trees ≥8" diameter at breast height (DBH; 4.59' above the ground) were identified by species, measured for DBH on the uphill side of the tree, rated for quality and tagged with an aluminum tree tag on the north side of the tree. For leaning trees, the DBH was measured from the ground 4.59' along the length of the stem. Each trunk of a multi-stemmed tree ≥8" DBH was tagged and treated as an individual tree if the division of the trunk was below 4.59' from the ground.

For each tree that was tagged, the condition of the individual was estimated on a scale of 1 through 5 as defined below:

1. Dead. Tree in severe decline. Dieback of scaffold branches and/or trunk. Most foliage from epicormics. Extensive structural defects that cannot be abated.
2. Poor. Tree in decline. Epicormic growth. Extensive dieback of medium to large branches. Significant structural defects that cannot be abated.
3. Fair. Tree with moderate vigor, moderate twig and small branch dieback, thinning of crown, poor leaf color, moderate structural defects that might be mitigated with regular care.
4. Good. Tree with slight decline in vigor, small amount of twig dieback, minor structural defects that could be corrected.

5. Excellent. A healthy, vigorous tree, reasonably free of signs and symptoms of disease with good structure and form typical of species.

A total of 2,807 trees were tagged. The data for six tags were later found to be unidentifiable, leaving a total of 2,801 total trees that were identified and tagged in the final data set.

Wildlife

Incidental wildlife observed during field work was identified to species. A concerted effort to inventory the fauna was outside the scope of this study.

Invasive Plant Species

An invasive species is a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (ISAC 2006). For purposes of this study, we have also included native species of poison ivy, box elder and black locust which otherwise meet the ISAC definition.

All invasive plant species observed were identified to species and qualitatively assessed as to abundance. The location and extent of specific infestation areas were drawn on an aerial photograph. The relative abundance of specific species was approximated in terms of individuals, or using relative abundance measures per White 2009:

Rare (R):	Few (≤ 4) individuals observed. Rare species likely are observed after prolonged, diligent searching, or by returning to a known location where individuals have been observed in the past.
Occasional (O):	Species that were scattered throughout the site and not immediately located, but were encountered before the entire project area was entirely searched.
Common (C):	Species easily found throughout the project area with no real effort, but not a dominant species.
Very Common (VC):	Occurs in large numbers throughout most or all of an area, but not a dominant species.
Abundant (A):	Predominant and ubiquitous species.

State or Federally Threatened and Endangered Species

Rare, state or federally threatened endangered species were searched for during the mapping of ecological communities, plant inventories, and during the tree survey. Individuals or groups of individuals were noted and are documented in text below.

Results

Ecological Communities

Six ecological communities were identified per Exhibit B: 1). Black Oak woodland; 1a) Black-Scarlet Oak / Sassafras woodland; 2). Basswood woodland; 3) Red pine / Basswood / Black Locust woodland; 4). Black Oak / Witch Hazel woodland; 5). Scrub edge.

1. **Black Oak Woodland**: This community was located on the south facing slope of the northern lobe of Bismarck Hill, and on the largely undisturbed nobs on the northern lobe. Characteristic trees included Black Oak (*Quercus velutina*), White Oak (*Quercus alba*), Red Oak (*Quercus rubra*), Scarlet Oak (*Quercus coccinea*), and Basswood (*Tilia americana*). Characteristic shrubs included Witch Hazel (*Hamamelis virginiana*), Flowering Dogwood (*Cornus florida*), Early Low Blueberry (*Vaccinium angustifolium*), and Late Low Blueberry (*V. pallidum*). Most of the high quality forb diversity occurred within this community including Big-leaved Aster (*Eurybia macrophylla*), Canada Mayflower (*Maianthemum canadense*), False Boneset (*Brickellia eupatorioides*), Bedstraws (*Galium circaezans* and *G. pilosum*), Rough Blazing Star (*Liatris aspera*), Feathery False Solomon Seal (*Maianthemum racemosum*), Bluestem Goldenrod (*Solidago caesia*) and Bastard toadflax (*Comandra umbellata*).

1. (a) **Black-Scarlet Oak / Sassafras Woodland:** This community dominated the south lobe of Bismarck Hill. The assemblage of trees is virtually the same as the Black Oak Woodland above (hence the 1a designation), but the overall diversity is much lower. Characteristic trees include Black Oak, Scarlet Oak and Sassafras (*Sassafras albidum*). The most dominant shrub which was nearly ubiquitous was witch hazel. The herbaceous ground layer was largely absent, but when present was characterized by Pennsylvania sedge (*Carex pensylvanica*), bedstraws and bluestem goldenrod.

2. **Basswood Woodland:** This community occurred in the north lobe of Bismarck Hill along the north facing side slope and within the low valleys of the Black Oak Woodland. Characteristic tree species included Basswood, White Oak, Red Oak, Sassafras, Black Oak, Catalpa (*Catalpa speciosa*), Red Mulberry (*Morus rubra*), and Black Locust (*Robinia pseudoacacia*) particularly near the edges of this community with the Red Pine / Basswood / Black Locust (3) community. Characteristic shrubs included Witch Hazel. Characteristic forbs, where present, included rich mesic woodland species including Feathery False Solomon Seal, Canada Mayflower, Wild Sarsaparilla (Aralia nudicaulis), Sweet Cicely (*Osmorhiza claytonii*) and Pennsylvania sedge.

3. **Red Pine / Basswood / Black Locust Woodland:** This was a highly degraded, weedy area along the north end of the northerly lobe. Characteristic tree species included Red Pine (*Pinus resinosa*), Basswood, Black Locust, Box Elder (*Acer negundo*) and Catalpa. Characteristic shrubs included Common Buckthorn (*Rhamnus cathartica*), Winged Euonymus (*Euonymus alatus*) and Jetbead (*Rhodotypos scandens*). Oriental Bittersweet (*Celastrus orbiculatus*) was abundant throughout this community. The herbaceous layer was absent.

4. **Black Oak / Witch Hazel Woodland**. This community occurs between the higher quality Black Oak Woodland and Basswood Woodland to the west, and the degraded Scrub Edge on the east. In general, Black Oaks occurred higher up on the slopes; Red Oaks and White Oaks occurred further down the slope;

and basswoods occurred closer to the bottom of the slope. Witch Hazel was common throughout. Oriental Bittersweet was abundant particularly in the transition zone between this community and the Scrub Edge community to the east. The herbaceous layer was largely absent.

5. **Scrub Edge**. This was a highly degraded community that formed the perimeter of the study area. While specimen sized oaks were scattered throughout this community, the most abundant species consisted of Oriental Bittersweet, Green Briars (Smilax sp.), and weedy shrubs including Common Buckthorn, Jetbead, Privett (*Ligustrum vulgare*) and Black Locust.

Vascular Flora

In the project area, 99 species of vascular plants were identified including 75 native species per Appendix 1. The Total Native Mean C was 4.2. The Native Floristic Quality Index (FQI) was 36.1. Wilhelm and Masters (2006) indicate that in the Chicago Region, sites with a Total Native Mean C of at least 3.5 and an FQI of 35 or more, *one can be fairly confident that the site has sufficient floristic quality to be at least of marginal natural area quality.*

Trees

A total of 2,807 trees ≥8" DBH were tagged, identified and assessed as to condition. Twenty-five species were identified.

The number of tree species and percent of the total number of species are summarized in Table 1. The largest percentage of tagged trees was comprised of Black Oak, including over 40% of the total. Black Oak typically dominated the xeric conditions on the south and west facing slopes of the dune complex, and the vast majority of the land area comprising the southern lobe of the dune. Many of these trees were quite large as documented by the average DBH in Table 1. However, those found on the steeper slopes were of lower condition due to the low quality habitat and soil profile.

Basswood was the second most common tree species and comprised just over 20% of the total. Basswood was common on the northern lobe of the dune, especially were the dune leveled off, became more sheltered and increased in moisture. Basswood was also frequent in the transition zone at the top of the slopes along Lake Shore Drive. Here, the more disturbed forest of Black Locust, Catalpa and Red Pine transitioned into Basswood and Oaks at the top of the slope.

White Oak was the third most common tree species at just over 9% of the total. White Oak was found in the transition zone from the Black Oak-dominated slopes to the more level areas of dry upland forests, as a co-dominate with Basswood in areas of concentration where they dominated on the dune plateau. Noteworthy is the higher condition estimates for White Oak. There were a number of excellent White Oaks as the habitat conditions improved in the northern sections of the dune complex.

Similar to White Oak, Red Oak was found mainly as a transitional species and co-dominate in the upland forests with Basswood, White Oak and Black Oak. Red Oaks represented approximately 9% of the total. Noteworthy for the Red Oaks was the average DBH measurements and higher than average condition rankings.

Though smaller in occurrence, Scarlet Oak was an important transitional species at the top of the dune slopes. These trees were usually very large and dominant in this rather narrow transition zone. The largest tree recorded was a Scarlet Oak (tag # 2806) with greater than 33" DBH. It should be noted that while typical specimens of Black and Scarlet Oak are distinct, these two species are known to hybridize. Identification was also complicated in cases where leaves, acorns and buds were out of reach of the investigators.

Sassafras was typically an intermediate tree in the upland areas near the slopes or the dry upland woodlands of Basswood, White Oak and Red Oak. Sassafras was a frequent understory tree in the upland woodlands, but was dominant in some areas. While these trees are often contorted in shape, there were a number of excellent specimens with above average DBH and condition measurements.

The remaining dominant species included Black Locust and Catalpa. These were scattered throughout the northern lobe, within steep slopes, and particularly concentrated along the northern and northwestern slopes facing Lake Michigan. As shade-intolerant, fast-growing and short-lived trees, they typically dominated in areas that appear to have experienced greater disturbance, whether human or wind-related, and have overall poorer quality condition rankings. However, like the Sassafras, there were a number of trees of exceptional size and condition for both species.

The average DBH of species observed also is summarized in Table 1. Scarlet, Black and Red Oaks have the highest average DBH for the most frequent species observed. The largest 20 trees recorded are shown in Table 2 and are dominated, as expected, by the oak species, including Black, Red and Scarlet. In addition to these species, there were a number of other tree species with excellent specimens including Basswood at 25.6", American Elm (*Ulmus americana*) at 23.1", Black Locust at 22.9", Red Mulberry at 22.0" and Siberian Elm (*Ulmus pumila*) at 22.0".

Table 1: Summary of Tree Species Observed at Bismarck Hill

Row Labels	# of Trees	% of Total	Avg. DBH	Avg. Condition
Quercus velutina	1,129	40.22%	14.6	2.9
Tilia americana	566	20.16%	12.1	3.3
Quercus alba	262	9.33%	12.6	3.7
Quercus rubra	257	9.16%	14.5	3.4
Robinia pseudoacacia	139	4.95%	11.0	2.2
Sassafras albidum	133	4.74%	9.8	3.2
Pinus resinosa	76	2.71%	11.0	2.6
Catalpa speciosa	67	2.39%	10.4	2.4
Quercus coccinea	66	2.35%	14.9	3.5
Morus rubra	24	0.86%	10.6	2.2
Ailanthus altissima	15	0.53%	9.9	2.6
Ulmus pumila	12	0.43%	14.0	3.2
Ulmus americana	10	0.36%	12.9	2.5
Populus deltoides	7	0.25%	16.1	2.3
(blank)	6	0.21%	15.0	3.3
Prunus serotina	6	0.21%	10.7	3.5
Fraxinus americana	5	0.18%	9.6	1.6
Pinus sylvestris	5	0.18%	10.2	2.8
Fraxinus pennsylvanica	4	0.14%	13.7	1.3
Acer saccharum	4	0.14%	11.6	4.3
Pinus strobus	3	0.11%	13.7	3.0
Rhamnus cathartica	3	0.11%	10.0	3.3
Acer rubrum	3	0.11%	9.0	4.0
Ulmus rubra	1	0.04%	11.1	3.0
Ostrya virginiana	1	0.04%	9.1	5.0
Celtis occidentalis	1	0.04%	14.2	3.0
Liriodendron tulipfera	1	0.04%	8.1	4.0
Grand Total	**2,807**	**100.00%**	**13.2**	**3.0**

Table 2: Top 20 trees with the Largest DBH (Diameter at Breast Height).

Tag #	Scientific Name	Common Name	DBH	Condition	Notes
2806	*Quercus coccinea*	Scarlet oak	33.3	4	
1210	*Quercus velutina*	Black oak	29.6	3	
2108	*Quercus coccinea*	Scarlet oak	29.5	4	
2129	*Quercus velutina*	Black oak	29.4	1	
2809	*Quercus coccinea*	Scarlet oak	29.1	4	
2737	*Quercus velutina*	Black oak	29.0	1	
2818	*Quercus coccinea*	Scarlet oak	28.2	4	
2340	*Quercus velutina*	Black oak	28.2	4	
163	*Quercus velutina*	Black oak	28.0	4	
2571	*Quercus rubra*	Red oak	27.9	4	
1399	*Quercus velutina*	Black oak	27.5	2	
2137	*Quercus velutina*	Black oak	27.3	3	
2279	*Quercus velutina*	Black oak	27.2	3	
2564	*Quercus velutina*	Black oak	27.0	3	
2684	*Quercus velutina*	Black oak	27.0	4	
2825	*Quercus coccinea*	Scarlet oak	26.9	3	
1	*Quercus rubra*	Red oak	26.2	5	Multiple stem
2332	*Quercus alba*	White oak	26.1	3	
2446	*Quercus rubra*	Red oak	26.1	5	
1230	*Quercus velutina*	Black oak	25.9	4	

Tree Condition Estimates

For each tree that was tagged, the condition of the specimen was estimated on a scale of 1 through 5, defined below.

1. Dead. Tree in severe decline. Dieback of scaffold branches and/or trunk. Most foliage from epicormics. Extensive structural defects that cannot be abated.
2. Poor. Tree in decline. Epicormic growth. Extensive dieback of medium to large branches. Significant structural defects that cannot be abated.
3. Fair. Tree with moderate vigor, moderate twig and small branch dieback, thinning of crown, poor leaf color, moderate structural defects that might be mitigated with regular care.
4. Good. Tree with slight decline in vigor, small amount of twig dieback, minor structural defects that could be corrected.
5. Excellent. A healthy, vigorous tree, reasonably free of signs and symptoms of disease with good structure and form typical of species.

The average condition for each tree species is included in Table 1. Table 3 shows the total number of specimens in their condition category for each species. The percentage is the percentage within each species. Of the dominant

species, Black Oak was the largest percentage of Condition 1 trees at 21% of the species total number, and the smallest percentage of Condition 5 trees at 4%. Conversely, White Oak and Red Oak had the lowest percentage of Condition 1 specimens (5% and 8% respectively) and the largest percentage of Condition 5 specimens (17% and 11% respectively). Black Locust and Catalpa both had large percentages of Condition 1 specimens, as expected.

Table 3: Number of Specimens in Each Condition Category

Row Labels	No. of Trees	% of Total
Acer rubrum	**3**	
3	1	33%
4	1	33%
5	1	33%
Acer saccharum	**4**	
3	1	25%
4	1	25%
5	2	50%
Ailanthus altissima	**15**	
1	4	27%
2	4	27%
3	2	13%
4	4	27%
5	1	7%
Catalpa speciosa	**67**	
1	19	28%
2	17	25%
3	20	30%
4	8	12%
5	3	4%
Celtis occidentalis	**1**	
3	1	100%
Fraxinus americana	**5**	
1	2	40%
2	3	60%
Fraxinus pennsylvanica	**4**	
1	3	75%
2	1	25%
Gleditsia triacanthos	**1**	
3	1	100%
Liriodendron tulipifera	**1**	
4	1	100%

Morus rubra	**24**	
1	7	29%
2	10	42%
3	3	13%
4	4	17%
Ostrya virginiana	**1**	
5	1	100%
Pinus resinosa	**76**	
1	6	8%
2	37	49%
3	22	29%
4	5	7%
5	6	8%
Pinus strobus	**3**	
3	3	100%
Pinus sylvestris	**5**	
2	1	20%
3	4	80%
Populus deltoides	**7**	
1	4	57%
4	3	43%
Prunus serotina	**6**	
2	1	17%
3	2	33%
4	2	33%
5	1	17%
Quercus alba	**262**	
1	14	5%
2	11	4%
3	69	26%
4	124	47%
5	44	17%
Quercus coccinea	**66**	
1	1	2%
2	6	9%
3	23	35%
4	33	50%
5	3	5%

Quercus rubra	**257**	
1	21	8%
2	24	9%
3	85	33%
4	98	38%
5	29	11%
Quercus velutina	**1128**	
1	241	21%
2	95	8%
3	408	36%
4	335	30%
5	49	4%
Rhamnus cathartica	**3**	
2	1	33%
3	1	33%
5	1	33%
Robinia pseudoacacia	**139**	
1	56	40%
2	32	23%
3	18	13%
4	27	19%
5	6	4%
Sassafras albidum	**133**	
1	27	20%
2	13	10%
3	26	20%
4	47	35%
5	20	15%
Tilia americana	**564**	
1	75	13%
2	51	9%
3	150	27%
4	230	41%
5	58	10%
Ulmus americana	**10**	
1	4	40%
3	3	30%
4	3	30%

Ulmus pumila	**12**	
2	4	33%
3	4	33%
4	2	17%
5	2	17%
Ulmus rubra	**1**	
3	1	100%
Grand Total	**2801**	**100%**

Some of the best quality specimens for each species are summarized in Table 4 below, with the count of specimens for each species estimated to be of Condition 5 (Excellent), and the percentage of the total number of Category 5 specimens for all tagged trees (227 trees).

Not surprisingly, Basswood and Oaks have the greatest number of specimens with an excellent overall condition rating. This is to be expected, given the greater number of these species overall, and the dominate role they play in their particular habitat. The species at the bottom of the table had very few specimens overall, but a few that were in excellent overall condition.

Table 4: Tree Species with Condition Rating of 5

Row Labels	No. of trees ranked Condition 5	% of all Condition 5
Tilia americana	58	25.4%
Quercus velutina	49	21.5%
Quercus alba	44	19.3%
Quercus rubra	29	12.7%
Sassafras albidum	20	8.8%
Robinia pseudoacacia	6	2.6%
Pinus resinosa	6	2.6%
Catalpa speciosa	3	1.3%
Quercus coccinea	3	1.3%
Acer saccharum	2	0.9%
Ulmus pumila	2	0.9%
Acer rubrum	1	0.4%
Ailanthus altissima	1	0.4%
(blank)	1	0.4%
Rhamnus cathartica	1	0.4%
Ostrya virginiana	1	0.4%
Prunus serotina	1	0.4%
Grand Total	**228**	**100.0%**

Wildlife

Five mammals and 16 birds were observed during field visits. These are all rather common animals that one might expect to find in similar habitats in the region. Please note that a concerted inventory of wildlife on site is outside the scope of this study.

Table 5. Wildlife Species Observed

Mammals
Chipmunk
Gray Squirrel
Red Fox
White-tailed Deer
Woodchuck

Birds
Tufted Titmouse
Northern Cardinal
Cedar Waxwing
Downy Woodpecker
House Wren
Indigo Bunting
Northern Flicker
Red-eyed Vireo
Eastern Wood-pewee
Black-capped Chickadee
Blue Jay
White-breasted Nuthatch
Eastern Towhee
Song Sparrow
Wild Turkey
Warbling Vireo

Invasive Plants

Nineteen species of vascular plants encountered within the project area were classified as invasive plants. The most abundant invasive species based on visual estimates and the number of management zones in which they appear are: Oriental bittersweet, honeysuckle, black locust, black bead, and winged euonymus.

The greatest abundance of invasive species occurred in Management Zones D, E and F, which are on the edges of the project area.

Table 6. Invasive Plant Data

Scientific Name	Common Name	Frequency in Management Zones					
		A	B	C	D	E	F
Acer negundo	Box Elder					VC	C
Ailanthus altissima	Tree of Heaven		O				C
Alliaria petiolata	Garlic Mustard	O	O	O	O	O	O
Berberis thunbergii	Japanese Barberry	O	O	O	O	O	O
Celastrus orbiculatus	Oriental Bittersweet	C	C	C	A	A	A
Convallaria majalis	Lily of the Valley	O					
Euonymus alatus	Winged Euonymus			C	C	C	C
Hesperis matronalis	Dame's Rocket	O	O				
Ligustrum vulgare	Common Privet						A
Lonicera maackii	Amur Honeysuckle	O	C	C	C	C	C
Melilotus alba	Sweet Clover	O					
Pinus resinosa	Red Pine				VC		
Pinus sylvestris	Scotch Pine				R		
Rhamnus cathartica	Common Buckthorn	C	O	C	C	C	C
Robinia pseudoacacia	Black Locust	O	C	C	VC	VC	VC
Rhodotypos scandens	Jetbead				VC		VC
Rosa multiflora	Japanese Rose				C	C	C
Saponaria officinalis	Bouncing Bet	O	O	O	O	O	O
Ulmus pumila	Siberian Elm				O		
Vinca minor	Vinca	O					
R = Rare							
O = Occasional							
C = Common							
VC = Very Common							
A = Abundant							

The following is a summary of invasive species encountered in each management zone (**Exhibit C**):

Zone A. While 11 of the 20 invasive species observed occurred in this management zone, only Common Buckthorn and Oriental Bittersweet were common. The Bittersweet was most evident in an opening on the south side of this community contiguous with Canada Park. Buckthorn was most often observed in the transitional area with Community 2 (Basswood Woodland) with a denser tree canopy.

Zone B. Eight of 20 invasive species were observed in this management zone which aligned with the Black-Scarlet Oak / Sassafras Woodland community. Common species included Oriental Bittersweet, which was most abundant in the transitional areas contiguous with the Scrub Edge (Community 5) and in canopy openings. Buckthorn and Honeysuckle were most abundant in areas with a denser tree canopy, in in areas contiguous with Zone F and the off-site Zoo.

Zone C. Eight of 20 invasive species were observed in this management zone which aligned with the Black Oak / Witch Hazel community. Common species included Oriental Bittersweet, which was most abundant in the transitional areas contiguous with the Scrub Edge (Community 5) and in canopy openings. Buckthorn and Honeysuckle were most abundant in areas with a denser tree canopy. Jetbead was observed at the north end of this zone in the transitional area with Zone D described below.

Zone D. 13 of 20 invasive species were observed in this management zone which aligned with the Red Pine/Basswood/Black Locust Woodland community. Common weeds included Red Pine and Black Locust in the westerly two thirds of Zone D, and Jetbead and Oriental Bittersweet in the easterly third of Zone D.

Zone E. 10 of 20 invasive species were observed in this management zone including Box Elder, Oriental Bittersweet and Black Locust. The remainder of the management zone was similar to Zones D (above) and F (below). The primary reason we did not include this Zone E with Zone F is because there were virtually no high quality trees or herbaceous cover.

Zone F. 13 of 20 invasive species were observed in this management zone. Oriental Bittersweet was by far the most abundant weed. Black Locust was distributed throughout this zone. Privet and Jetbead were most evident in the section of Zone F on the edge of the northerly lobe of the study area.

State or Federal Endangered, or Threatened Species

Investigators searched for state or federally endangered flora and fauna during the mapping of ecological communities, plant species inventory and tree survey. Dozens of sea rocket (*Cakile edentula var. lacustris*), a plant of special concern on the Indiana Department of Natural Resources Watch List, were observed in the sand piles at the end of Amphitheatre Road which is just outside of the 26 acre study area. Sea rocket occurs naturally on sand beaches along Lake Michigan. It is likely that the source of this colony is from beach sand that blew onto the parking lot at Washington Park that was later hauled off and dumped at the top of Bismarck Hill.

It is likely that at least one Sticky Goldenrod (*Solidago simplex var. gillmanii*) individual, a State Threatened species, was observed on the south facing lobe of the Black Oak Woodland (Ecological Community 1). Positive identification was not possible since the individual was not flowering during the field visit. We did, however, include this species in the total floristic inventory for the study area.

Both sea rocket and sticky goldenrod were documented at Sheridan Beach and the Esplanade during an ecological assessment in 2012 (SmithGroupJJR).

Discussion

Ecological Communities

The study area consisted of a degraded remnant black oak savanna and woodland that maintained characteristic and even sensitive native species. We measured a Native Mean C value of 4.2 and an FQI of 36.1 which qualifies it per Wilhelm and Masters (2006) as *at least of marginal natural area quality*. These statistics likely would have been slightly higher had we completed additional floristic surveys during the spring when spring ephemerals are in bloom, and late summer when many species in the Asteracea family bloom. Primary ecological stressors we observed were encroachment by invasive weeds; the absence of fire; eroded areas of bare sand caused by pedestrian traffic; past clearing as evidenced in historic aerial photographs; and the planting of red pines.

The diversity and abundance of non-native and invasive species was high, but not unexpected for this region. About a fifth of the species observed were classified as invasive weeds, and about a quarter of the species observed were not indigenous.

In general, woodland health, as measured by the abundance of invasive plants, decreases moving toward the edges of the study area. The northerly third of the northerly lobe of the study area was particularly weedy probably due to aforementioned land clearing discussed above.

In general, the potential to restore diverse and stable ecological communities is high. The matrix of characteristic species persists, and plant diversity would increase dramatically with the management of shade-suppressing woody invasive species. Following the completion of remedial restoration activities – in which the most pernicious invasive species are brought under control through selective woody brush removal, the use of herbicide, and supplemental seeding and planting – prescribed fire would provide the most effective and economical tool to maintain and enhance the health of native ecological communities.

Sensitive Resources

We encountered two plant species of special interest: American sea rocket, which is on Indiana's Watch List, and sticky goldenrod, or dune goldenrod, which is an Indiana State Threatened Plant. The presence of Sea Rocket in the bare area at the end of Amphitheater Drive is likely an artifact of transporting beach sand to the top of Bismarck Hill. Sticky goldenrod occurred on the south facing slope of the northerly lobe which was where all of the dry prairie / sand savanna herbaceous species were observed such as flowering spurge (*Euphorbia corolata*), rough blazing star (*Liatris aspera*), and sand reed.

Areas mapped and specifically called out as Sensitive on the Opportunities and Constraints drawing (Exhibit D) consisted of Black Oak Woodland and Savanna. This sensitive area has a very high restoration potential due to the presence of specimen sized oaks and basswood; a sub-canopy layer usually dominated by sassafras; and a very abundant shrub layer. Interestingly, the sensitive area in the northerly lobe contained a diversity of shrubs including Witch Hazel, Flowering Dogwood (*Cornus florida*), Blueberry (*Vaccinium sp*), and Maple-leafed Arrowwood (*Viburnum acerifolium*), as well as a diverse herbaceous layer as described above. In the southerly lobe, Witch Hazel

was by far the most abundant shrub, and the herbaceous layer was largely absent. We speculate that higher floristic diversity of the northerly lobe was driven by a more southerly aspect that perhaps favored a more xeric assemblage of open savanna and woodland species, while the high quality areas in the southerly lobe created a shadier, more mesophytic environment.

Regardless of the differences in overall plant diversity, it is remarkable that most of the sensitive areas maintained a healthy canopy, sub-canopy and shrub layer of native species as compared to most regional woodlands where the sub-canopy tends to be absent, and the shrub layer tends to be dominated by invasive honeysuckles and buckthorns.

Nonetheless, these sensitive, high quality areas will not persist without the re-introduction of prescribed fire that helps create and maintain openings in the canopy required for oak reproduction (which was virtually non-existent), and a greater diversity of native herbaceous species.

It should be noted on Exhibit D that at least half of the area mapped as Sensitive is also mapped as Highly Erodible and Sensitive. These are areas with steep slopes where pedestrian traffic should be avoided unless a hardened trail such as an at-grade boardwalk is installed.

Wildlife

The diversity and abundance of observed wildlife was low. This is largely because a detailed and comprehensive quantitative assessment of wildlife was beyond the scope of this study. A quantitative ecological assessment focused on wildlife likely would have resulted in greater wildlife abundance and diversity than was observed, particularly in avifauna.

Opportunities and Constraints

Bismarck Hill offers remarkable opportunities for ecological restoration and enhancement, passive recreational uses, education and interpretation, and views per the Opportunities and Constraints Diagram (Exhibit D).

Sensitive Resources. Sensitive resources indicated on Exhibit D are discussed above. With restoration, primarily through weed management and the re-introduction of fire, the sensitive zone (Exhibit D) could be restored to a highly functioning natural area. While trails could be introduced into this area, the trails should be sited along low gradient ridges. Trails on steeper areas, if allowed, should be constructed of a hardened surface such as a gradient boardwalk or steps.

Access and Viewsheds. There is currently no good access into the study area. Volunteer trails into the woodland from Canada Park are present, but they are straight up very steep slopes. In addition to causing erosion, these trails are very hard to traverse due to the loose sand and steep slopes. We recommend closing the volunteer trails per Exhibit D, and creating a trailhead at the west end of Canada Park. Access can also be obtained from the road on the south side of the zoo, and from Amphitheatre Drive. We also recommend creating a viewing platform on the nob in the northerly lobe per Exhibit D to provide residents and tourists with a remarkable view of Washington Park and Lake Michigan. Restoration below and around this nob would be necessary to see through the vegetation.

Lower Quality Areas. Management Zones D and E have largely lost their natural character due to past disturbances and invasive weeds. While this area could be restored, land managers would largely be starting from scratch. There

are greater opportunities for restoration in parts of Zone F. Several specimen sized trees persist in the jungle of Oriental Bittersweet which at least provides a structure for savanna restoration. We also believe there is a higher likelihood that a remnant native herbaceous seedbank persists in these areas.

Zip Lines and Cabins. We understand the Parks Department has considered siting cabins and a zip line within the study area. We believe cabins could be situated in any of the non-sensitive zones if they could be sited and constructed in a way that does not cause erosion. Perhaps the best place for cabins would be in the open area at the end of Amphitheater Drive. We believe zip lines could be carefully sited in any of the non-sensitive zones if they could be constructed in a way that does not cause erosion. We also believe zip lines could be carefully sited in the sensitive zone if pathways to get to zip line platforms were hardened with an at-grade boardwalk.

Amphitheater Drive. We understand the open space at the end Amphitheater Drive is constructed of a variety of materials including construction debris and sand fill. We recommend that the sand fill in the south east corner be removed to the natural grade. Several black oaks persist in this area suggesting that the native grade is not very deep. We also observed that sand pushed into the swale at the far east end of the open area has piled around several large oaks. We recommend pulling back the sand in this area to a 4:1 slope to protect the trees, and to provide a buffer between this degraded open area and the sensitive areas within the study area.

Restoration and Management

Adaptive Management

Dunes are dynamic systems that change in response to natural (lake levels, precipitation, wind, natural disturbances, succession, fire, etc.) and anthropogenic (soil disturbance, weeds, etc.) disturbances. Cowels (1899) wrote foundational papers on the natural succession of plants by observing the tension between plant communities associated with dunes on the south and eastern shores of Lake Michigan, and plant communities associated with the ever encroaching or submitting woodlands landward to the dunes.

It is thus appropriate that the management of dune resources for ecological health and use by residents be in accordance with adaptive management principles (Williams et al. 2009):

> *Adaptive management is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a trial and error process, but rather emphasizes learning while doing . . . . Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.*

While adaptive management is a powerful management tool and strategy, in order to be successful:

- Leadership must support the needed changes;
- Stakeholders must work collaboratively to plan courses of action;
- Leadership and stakeholders must agree with and support goals and objectives.

Adaptive management is not appropriate:

- For single-time decision making;
- If base data is not available;
- If there are irresolvable conflicts between stakeholders as to goals, objectives and strategies;
- If appropriate management is not possible;
- If there is not a commitment to sustained funding, monitoring and assessment.

It will be important to implement adaptive management principles to maintain the long term viability and health of this dune system, for ecological communities including people.

Restoration and Management

Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability (SER 2004).

The attributes of a restored ecological system include (SER 2004):

1. The predominance of characteristic species and structure that align with a reference ecosystem;
2. Indigenous species;
3. Appropriate functional groups;
4. Sustainable, reproducing populations of target communities and structure;
5. Normal ecological processes (wind, fire, waves, etc.) are functioning;
6. Contiguity with the larger ecological matrix;
7. Potential ecological stressors have been eliminated or reduced;
8. Resiliency to normal environmental stresses;
9. The ability to sustain itself similar to that of a reference community.

As noted above, managing invasive species is one of the fundamental stressors that must be addressed to restore the health of ecological communities within the project area. The following criteria developed by the National Park Service (NPS 2006) are helpful in guiding the management of specific invasive species:

- Control is prudent and feasible;
- The species interferes with natural processes and the perpetuation of natural features, native species or habitats;
- Disrupts the genetic integrity of native species;
- Disrupts the accurate presentation of cultural landscape;
- Damages cultural resources;
- Significantly hampers management of the park or adjacent lands;
- Poses a public health hazard;
- Creates a hazard to public safety.

Exhibit C indicates management zones where invasive plants or other management activities are proposed. Table 6 provides a summary of the species and relative abundance of invasive species per management zone. Appendix B provides specific management recommendations for each invasive species.

Ecological restoration typically occurs during two phases: a **remedial phase** and **maintenance phase**. The remedial phase is the most intensive and expensive in that invasive species are largely controlled; ecological stressors are removed or reduced; native species and structure are reintroduced as appropriate; and ecological systems (wind, fire, etc.) are restored such that they can maintain community resilience with minimal effort. During the maintenance phase, the focus is on maintaining ecological systems that will sustain ecological communities restored during the remediation phase.

At Bismarck Hill, Zones A and B per Exhibit C require maintenance level restoration work through the use of prescribed fire; minor repair and replanting of erosion areas; and the monitoring and quick removal of invasive weeds as they appear. Zone C will require the same treatments, but with greater intensity. Zone F will require the same treatments, but with a very intensive initial effort. Areas D and E will require extensive remedial work including clearing, herbicide, and the replanting of woody and herbaceous seeds and plants.

Recommendations

We recommend the following activities to address the principles set forth in the introduction, and to reestablish the attributes of a restored ecological system as described above.

1. **Protect and Expand Healthiest Areas First**. Management Zones A and B are the healthiest in that they most closely meet attributes described above. It is much less effort to maintain and geographically expand a healthy community than it is to conduct remedial restoration work. Therefore, we recommend that the Parks Department maintain and enhance healthy communities as a first priority.

2. **Use Prescribed Fire**. Fire is a natural system that controls woody vegetation and cool season invasive weeds, and stimulates the germination and productivity of native, warm season flora. The use of prescribed fire is the least expensive management tool to restore and maintain healthy communities. We recommend burning on a three to five year cycle across Bismarck Hill. Given the steep, dry conditions, prescribed fire will be productive in even some of the weediest areas in setting back and controlling invasive weeds.

3. **Contain and Remove Weeds**. Weeds within management zones should as a first priority be contained, and as a second priority be eradicated. Weed management should be implemented using the following priorities: Zones A and B, C, F, and D/E. Please see Appendix B for profiles and management techniques of invasive plant species.

4. **Reintroduce Native Species**. The native seed bank is largely intact in Zones A. It may persist in Zones B and C. It has probably been exhausted in Zone F, and is even more probable that it has been exhausted in Zones D and E. The seed bank will be stimulated by proposed management activities in Zones A, B and perhaps C. Installing a simple seed mix in areas where severe infestations of weeds have been eradicated will help native species out compete weeds in the future. Please see Appendix C for a list of representative species per zone for restoration seeding and planting.

5. **Improve and Consolidate Access Paths**. Existing access points provide vectors for weeds, and have resulted in several volunteer paths. Improving and consolidating access will reduce invasive weeds, and stabilize the side slope.

6. **Education and Interpretation**. Creating well-sited trails, interpretive signage and viewing platforms will provide Michigan City with an opportunity to expose residents and tourists to what could be a magnificently restored black oak savanna.

7. **Minimize Exposed Sand**. Minimizing exposed sand will reduce erosion. This can be achieved by creating properly sited trails and access points, and restoring erosion areas.

8. **Amphitheater Drive**.

    a. Excavate fill sand down to the natural grade around remnant oaks per Exhibit D.
    b. Excavate to create a 4:1 slope and revegetate fill sand at the east side of the opening.
    c. Salvage sea rocket individuals and re-plant at the base of the foredunes within Sheridan Beach and the Esplanade, and north of Fedders Alley.

9. **Monitor**. While the implementation of proposed management strategies will result in a dune system that is more maintainable, regular monitoring will ensure that future stressors do not become management issues that require remedial action.

Performance Standards

Performance standards provide managers with a target toward which to work, and signify progress when milestones are reached. Basic performance standards are described below. These can and should be reviewed as part of an adaptive management strategy.

Standard 1: Invasive Weeds – Total cover by invasive weeds should not exceed 10%.

Standard 2: Total Wood Cover – Total cover by trees and shrubs should not exceed:

- 50% on south and southwest facing slopes;
- 75% within the remainder of the site.

Standard 3: Importance Values – the 10 most important herbaceous species in terms of abundance in all zones should be non-weedy native species.

Standard 4: Bare Soil – Areas of bare soil outside of a prescribed path that are ≥ 0.25 square meters should be stabilized with native plant material.

Management Schedule

The following management activities for a three year implementation period are suggested during the Remedial Phase of restoration, as scheduled by quarter of the year:

Table 7. Management Schedule.

	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Selective woody brush removal	x			x								
Herbicide woody re-sprouts				x		x	x			x	x	
Herbicide herbaceous weeds		x	x			x	x			x	x	
Supplemental planting					x			x	x			x
Prescribed Burning	x				x				x			

The following management activities are suggested during the Maintenance Phase of restoration:

- Annual monitoring for infestations of weeds
- Prescribed burn every three years
- Supplemental seeding/planting as necessary
- Supplemental herbiciding, brushing, etc., as necessary

An opinion of probable cost for restoration activities is included in Appendix D, which shows costs per task listed above. Years 1 through 3 are the remedial phase of restoration, while the maintenance phase activities are listed in Years 6 and 10.

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Bismarck Hill

Vegetation, Wildlife Assessment and Restoration Plan

EXHIBIT A

Project Limits

Area of Interest

Parcel Boundary

Note: Parcel data and aerial photography based on existing data sources from local and state agencies and has not been field verified for accuracy.

Exhibit A: Project Limits

Bismarck Hill Ecological Assessment Michigan City, Indiana September 12, 2015

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Vegetation, Wildlife Assessment and Restoration Plan

EXHIBIT B

Ecological Communities and Transect Locations

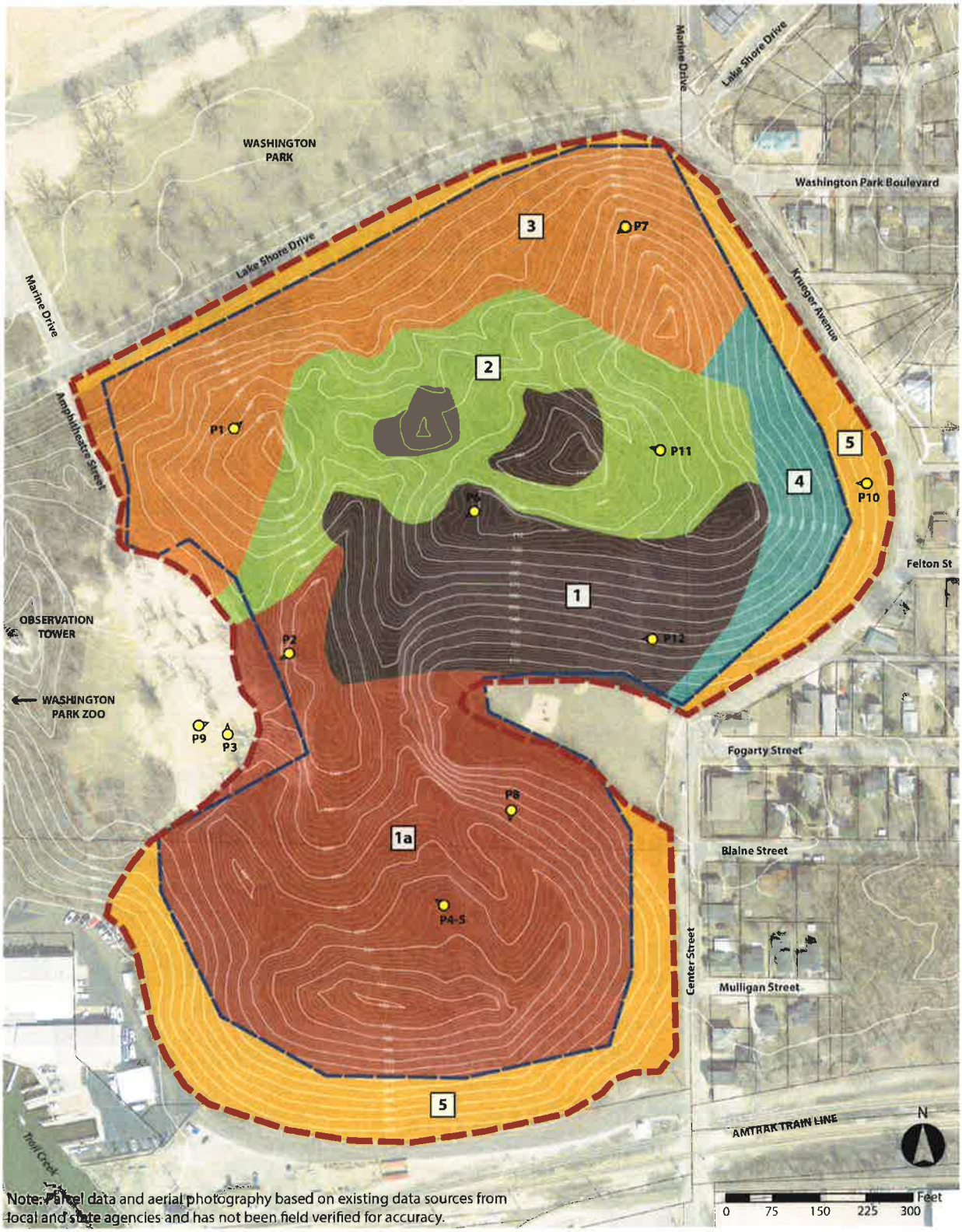

Exhibit B: Ecological Communities and Transect Locations

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Vegetation, Wildlife Assessment and Restoration Plan

EXHIBIT C

Restoration Management Units

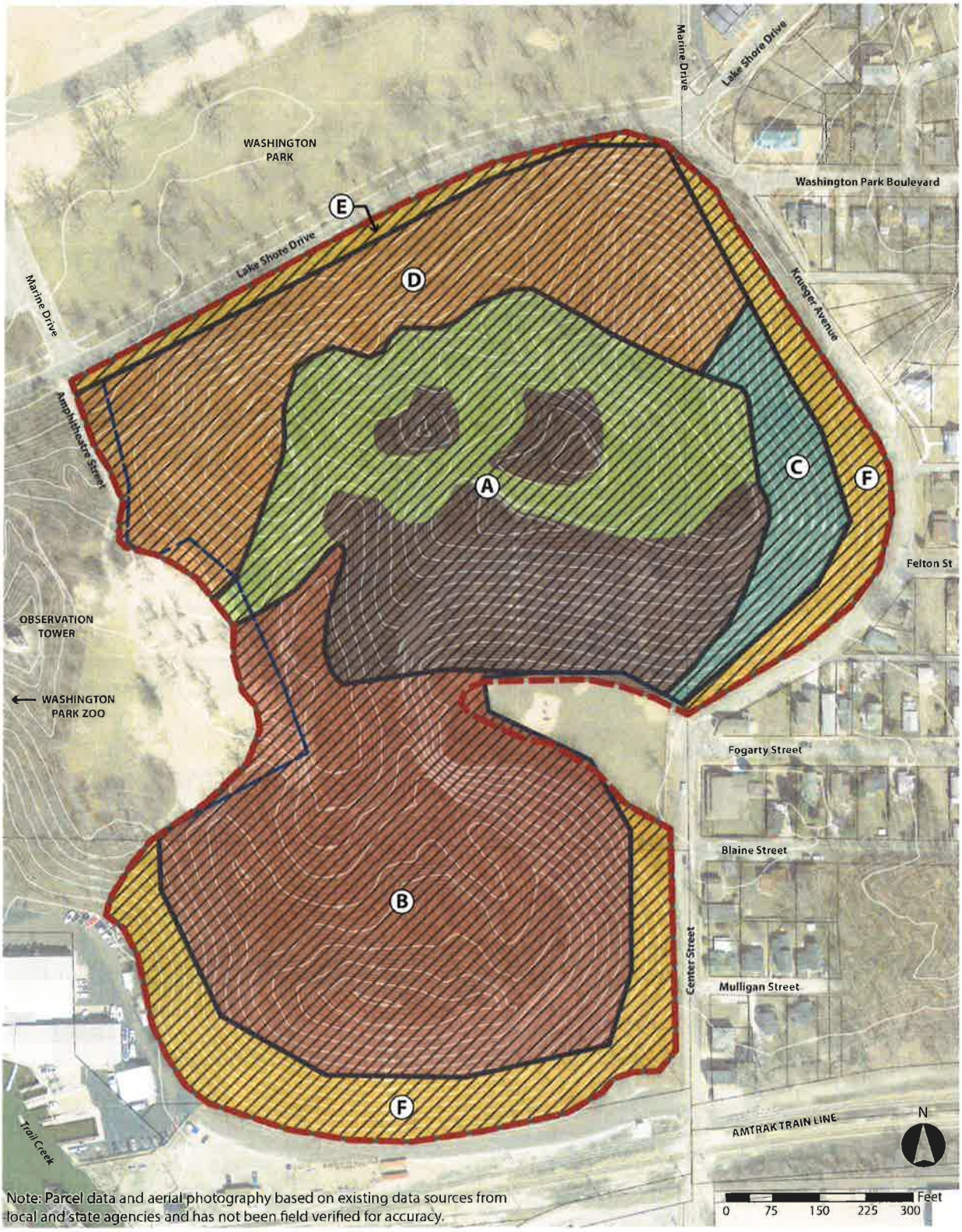

Exhibit C: Restoration Management Units

Bismarck Hill Ecological Assessment Michigan City, Indiana September 12, 2015

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Vegetation, Wildlife Assessment and Restoration Plan

EXHIBIT D

Opportunities and Constraints

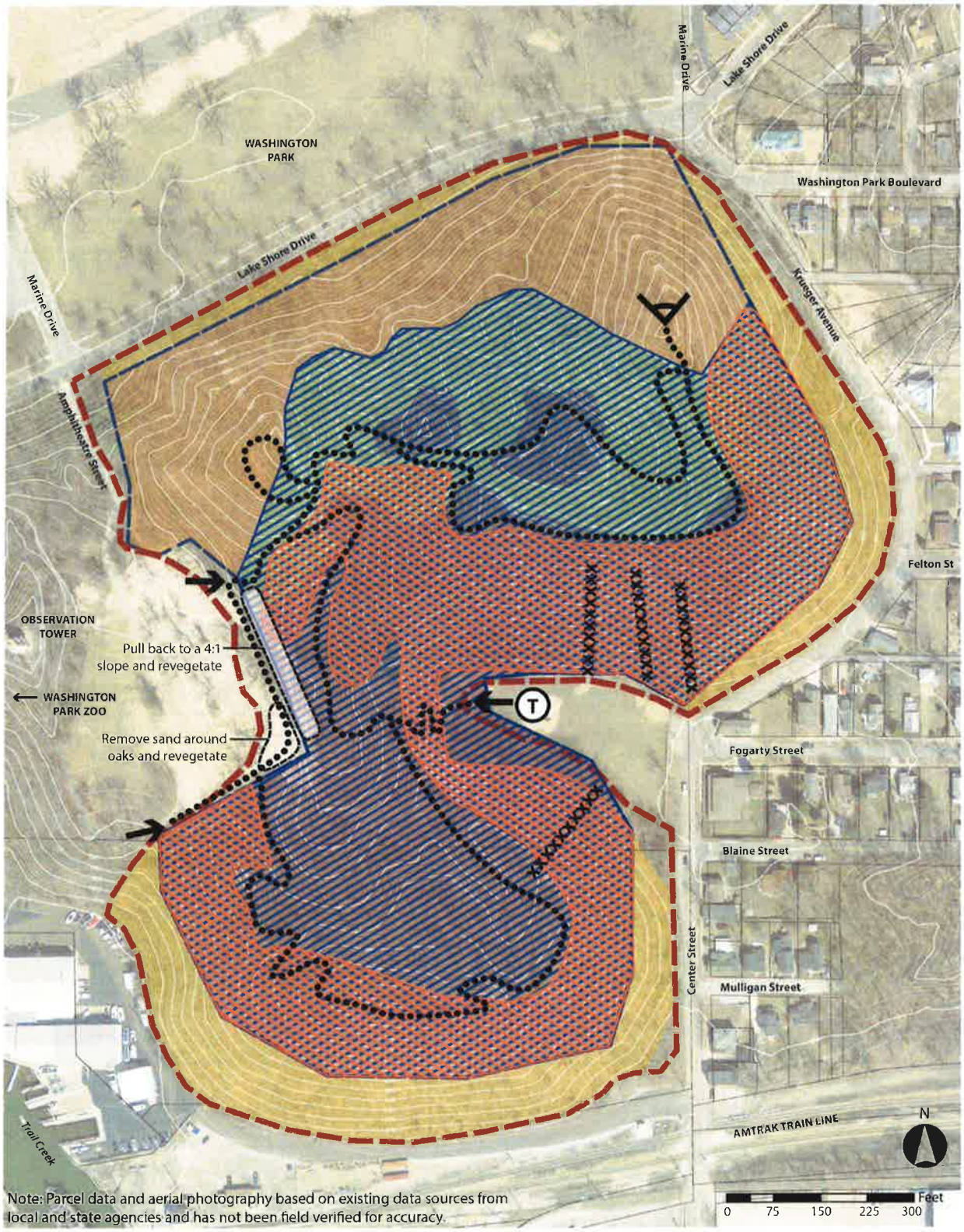

Exhibit D: Opportunities and Constraints

Bismarck Hill Ecological Assessment Michigan City, Indiana September 12, 2015

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Vegetation, Wildlife Assessment and Restoration Plan

REPRESENTATIVE PHOTOGRAPHS

Photo P1: Red Pine / Basswood / Black Locust Woodland

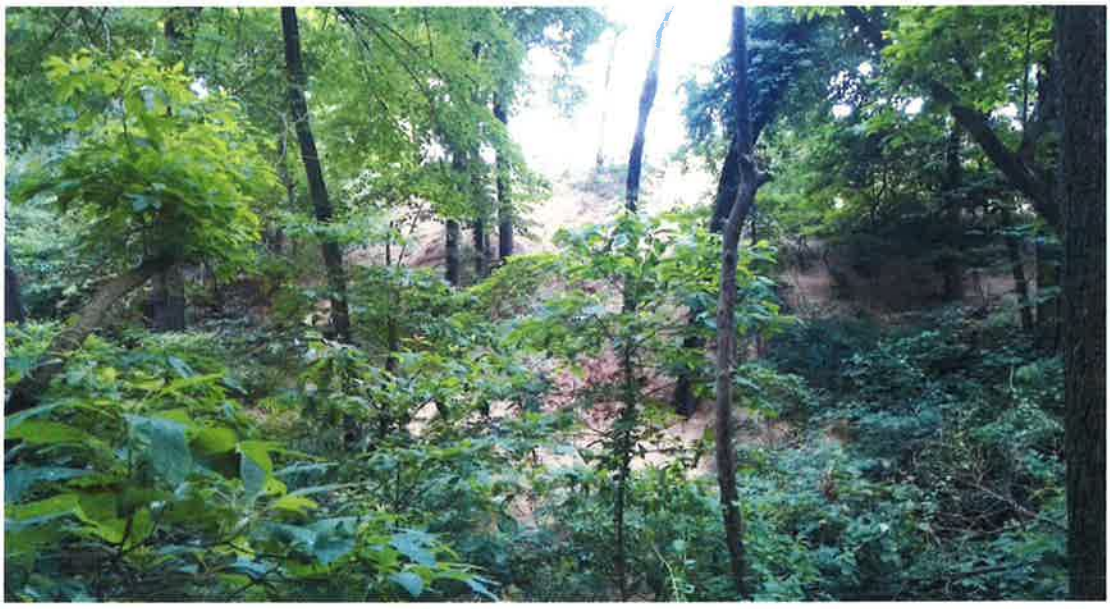

Photo P2: Black-Scarlet Oak / Sassafras Woodland

Photo P3: Sand Spoil Pile at End of Amphitheatre Drive

Photo P4: Witch Hazel Understory in Black-Scarlet Oak Woodland

Photo P5: Black-Scarlet Oak Woodland

Photo P6: Witch Hazel

Photo P7: Jetbead in Management Unit D

Photo P8: Healthy Specimen Oak in Black-Scarlet Oak Woodland

Photo P9: Sea Rocket in Sand Spoil Pile at End of Amphitheatre Drive

Photo P10: Abundant Growth of Invasive Oriental Bittersweet

Photo P11: Basswood Woodland

Photo P12: South Facing Slope in Black Oak Woodland

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Bismarck Hill

Vegetation, Wildlife Assessment and Restoration Plan

APPENDIX A

Vascular Plant Inventory Data

SMITHGROUP JJR

Study Information

Site: Bismarck Hill

Locale: Michigan City, Indiana

By: M. O'Leary

FLORISTIC QUALITY DATA

75 NATIVE SPECIES
99 TOTAL SPECIES
4.2 NATIVE MEAN C
3.2 W/ADVENTIVES
36.1 NATIVE FQI
31.5 W/ADVENTIVES
2.8 NATIVE MEAN W
3.1 W/ADVENTIVES
AVG: FAC. UPLAND

NATIVE	75	75.8%	ADVENTIVE	24	24.2%
TREE	26	26.3%	TREE	3	3.0%
SHRUB	9	9.1%	SHRUB	8	8.1%
W-VINE	4	4.0%	W-VINE	1	1.0%
H-VINE	1	1.0%	H-VINE	0	0.0%
P-FORB	26	26.3%	P-FORB	4	4.0%
B-FORB	0	0.0%	B-FORB	3	3.0%
A-FORB	2	2.0%	A-FORB	4	4.0%
P-GRASS	4	4.0%	P-GRASS	0	0.0%
A-GRASS	1	1.0%	A-GRASS	1	1.0%
P-SEDGE	1	1.0%	P-SEDGE	0	0.0%
A-SEDGE	0	0.0%	A-SEDGE	0	0.0%
FERN	1	1.0%	FERN	0	0.0%

ACRONYM	C	SCIENTIFIC NAME	W	WETNESS	PHYSIOGNOMY	COMMON NAME
ACARHO	0	Acalypha rhomboidea	3	FACU	NT A-FORB	Three-Seeded Mercury
ACENEG	1	Acer negundo	-2	FACW-	NT TREE	Boxelder
ACESAN	6	Acer saccharum s. nigrum	5	UPL	NT TREE	Black Maple
AILALT	0	Ailanthus altissima	5	UPL	AD TREE	Tree-Of-Heaven
ALLPET	0	Alliaria petiolata	0	FAC	AD B-FORB	Garlic Mustard
AMEARB	6	Amelanchier arborea	3	FACU	NT TREE	Juneberry
AMMBRE	10	Ammophila breviligulata	5	UPL	NT P-GRASS	Beach Grass
ANEAME	8	Anemone americana	5	UPL	NT P-FORB	Round-Leaved Hepatica
APOCAN	2	Apocynum cannabinum	0	FAC	NT P-FORB	Dogbane
AQUCAN	5	Aquilegia canadensis	1	FAC-	NT P-FORB	Columbine

ARANUD	7	Aralia nudicaulis	3	FACU	NT SHRUB	Wild Sarsaparilla
ARTANN	0	Artemisia annua	3	FACU	AD A-FORB	Annual Wormwood
ASCSYR	1	Asclepias syriaca	5	UPL	NT P-FORB	Common Milkweed
BERTHU	0	Berberis thunbergii	4	FACU-	AD SHRUB	Japanese Barberry
BRIEUP	8	Brickellia eupatorioides	5	UPL	NT P-FORB	False Boneset
CAKEDE	0	Cakile edentula v. edentula	5	UPL	AD A-FORB	Eastern Sea Rocket
CALLOM	9	Calamovilfa longifolia v. magna	5	UPL	NT P-GRASS	Prairie Sand Reed
CXPENP	5	Carex pensylvanica	5	UPL	NT P-SEDGE	Pennsylvania Oak Sedge
CARPCA	5	Carpinus caroliniana s. virginiana	0	FAC	NT TREE	Blue Beech
CATSPE	0	Catalpa speciosa	3	FACU	NT TREE	Cigar Tree
CELORB	0	Celastrus orbiculata	5	UPL	AD W-VINE	Oriental Bittersweet
CELOCC	3	Celtis occidentalis	1	FAC-	NT TREE	Hackberry
CENLON	0	Cenchrus longispinus	5	UPL	NT A-GRASS	Mat Sandbur
CHEALB	0	Chenopodium album	1	FAC-	AD A-FORB	Lamb's Quarters
CIRLUC	2	Circaea lutetiana s. canadensis	3	FACU	NT P-FORB	Enchanter's Nightshade
COMUMB	7	Comandra umbellata	3	FACU	NT P-FORB	Bastard Toadflax
CONMAJ	0	Convallaria majalis	5	UPL	AD P-FORB	Lily-Of-The-Valley
CORALT	8	Cornus alternifolia	5	UPL	NT TREE	Pagoda Dogwood
CORFLO	4	Cornus florida	4	FACU-	NT TREE	Flowering Dogwood
DICLAT	6	Dichanthelium latifolium	3	FACU	NT P-GRASS	Broad-Leaved Panic Grass
DICPSE	6	Dichanthelium ovale s. pseudopubescens	5	UPL	NT P-GRASS	False White-Haired Panic Grass
DIOVIL	4	Dioscorea villosa	1	FAC-	NT H-VINE	Common Wild Yam
EQUARV	1	Equisetum arvense	0	FAC	NT FERN	Common Horsetail
EUOALA	0	Euonymus alata	5	UPL	AD SHRUB	Winged Euonymus
EUPCOR	4	Euphorbia corollata	5	UPL	NT P-FORB	Flowering Spurge
EURMAC	7	Eurybia macrophylla	5	UPL	NT P-FORB	Big-Leaved Aster
EUTGRA	3	Euthamia graminifolia	-2	FACW-	NT P-FORB	Grass-Leaved Goldenrod
FRAAME	4	Fraxinus americana	3	FACU	NT TREE	White Ash

FRAPEL	1	Fraxinus pennsylvanica v. lanceolata	0	FAC	NT TREE	Green Ash
GALAPA	1	Galium aparine	3	FACU	NT A-FORB	Annual Bedstraw
GALCIC	7	Galium circaezans v. circaezans	4	FACU-	NT P-FORB	Smooth Wild Licorice
GALPIL	5	Galium pilosum	5	UPL	NT P-FORB	Hairy Bedstraw
HACVIR	0	Hackelia virginiana	1	FAC-	NT P-FORB	Stickseed
HAMVIR	5	Hamamelis virginiana	3	FACU	NT SHRUB	Witch Hazel
HELDIV	5	Helianthus divaricatus	5	UPL	NT P-FORB	Woodland Sunflower
HESMAT	0	Hesperis matronalis	5	UPL	AD P-FORB	Dame's Rocket
JUGNIG	2	Juglans nigra	3	FACU	NT TREE	Black Walnut
LEOCAR	0	Leonurus cardiaca	5	UPL	AD P-FORB	Motherwort
LIAASP	8	Liatris aspera	5	UPL	NT P-FORB	Rough Blazing Star
LIGVUL	0	Ligustrum vulgare	5	UPL	AD SHRUB	Common Privet
LIRTUL	4	Liriodendron tulipifera	2	FACU+	NT TREE	Tulip Poplar
LONMAA	0	Lonicera maackii	5	UPL	AD SHRUB	Amur Honeysuckle
MAICAN	8	Maianthemum canadense	0	FAC	NT P-FORB	Canada Mayflower
MAIRAC	4	Maianthemum racemosum	3	FACU	NT P-FORB	Feathery False Solomon Seal
MELALB	0	Melilotus alba	3	FACU	AD B-FORB	White Sweet Clover
MELOFC	0	Melilotus officinalis	3	FACU	AD B-FORB	Yellow Sweet Clover
MORRUB	4	Morus rubra	1	FAC-	NT TREE	Red Mulberry
OSMCLI	3	Osmorhiza claytonii	4	FACU-	NT P-FORB	Hairy Sweet Cicely
OSTVIR	5	Ostrya virginiana	4	FACU-	NT TREE	Hop Hornbeam
OXASTR	0	Oxalis stricta	3	FACU	NT P-FORB	Tall Wood Sorrel
PARQUI	2	Parthenocissus quinquefolia	1	FAC-	NT W-VINE	Virginia Creeper
PHYAME	0	Phytolacca americana	1	FAC-	NT P-FORB	Pokeweed
PINSTR	5	Pinus strobus	0	FAC	NT TREE	White Pine
PINSYL	0	Pinus sylvestris	5	UPL	AD TREE	Scotch Pine
POLAVA	0	Polygonum aviculare v. aviculare	1	FAC-	AD A-FORB	Common Knotweed
POPDEL	1	Populus deltoides	-1	FAC+	NT TREE	Eastern Cottonwood
PREALB	5	Prenanthes alba	3	FACU	NT P-FORB	Lion's Foot
PRUSER	1	Prunus serotina	3	FACU	NT TREE	Wild Black Cherry

PRUVIR	3	Prunus virginiana	1	FAC-	NT SHRUB	Common Choke Cherry
PTETRT	4	Ptelea trifoliata v. trifoliata	2	FACU+	NT SHRUB	Smooth Wafer Ash
QUEALB	5	Quercus alba	3	FACU	NT TREE	White Oak
QUECOC	7	Quercus coccinea	5	UPL	NT TREE	Scarlet Oak
QUERUB	4	Quercus rubra	3	FACU	NT TREE	Northern Red Oak
QUEVEL	4	Quercus velutina	5	UPL	NT TREE	Black Oak
RHACAT	0	Rhamnus cathartica	3	FACU	AD SHRUB	Common Buckthorn
RHOSCA	0	Rhodotypos scandens	5	UPL	AD SHRUB	Jetbead
ROBPSE	1	Robinia pseudoacacia	4	FACU-	NT TREE	Black Locust
ROSMUL	0	Rosa multiflora	3	FACU	AD SHRUB	Japanese Rose
RUBENS	5	Rubus enslenii	5	UPL	NT SHRUB	Arching Dewberry
SAPOFF	0	Saponaria officinalis	3	FACU	AD P-FORB	Bouncing Bet
SASALB	1	Sassafras albidum	3	FACU	NT TREE	Sassafras
SECCER	0	Secale cereale	5	UPL	AD A-GRASS	Rye
SMIROT	4	Smilax rotundifolia	0	FAC	NT W-VINE	Cat Brier
SOLCAE	7	Solidago caesia	3	FACU	NT P-FORB	Bluestem Goldenrod
SOLSIG	10	Solidago simplex v. gillmanii	5	UPL	NT P-FORB	Dune Goldenrod
SYMSHO	6	Symphyotrichum shortii	5	UPL	NT P-FORB	Short's Aster
TILAMA	5	Tilia americana v. americana	3	FACU	NT TREE	American Linden
TOXRAR	1	Toxicodendron radicans s. radicans	3	FACU	NT W-VINE	Poison Ivy
TRAOHI	3	Tradescantia ohiensis	2	FACU+	NT P-FORB	Common Spiderwort
ULMAME	3	Ulmus americana	-2	FACW-	NT TREE	American Elm
ULMPUM	0	Ulmus pumila	5	UPL	AD TREE	Siberian Elm
ULMRUB	3	Ulmus rubra	0	FAC	NT TREE	Slippery Elm
UVUGRA	7	Uvularia grandiflora	5	UPL	NT P-FORB	Large-Flower Bellwort
VACANG	5	Vaccinium angustifolium	3	FACU	NT SHRUB	Early Low Blueberry
VACPAL	5	Vaccinium pallidum	5	UPL	NT SHRUB	Late Low Blueberry
VIBACE	8	Viburnum acerifolium	5	UPL	NT SHRUB	Maple-Leaved Arrowwood
VINMIN	0	Vinca minor	5	UPL	AD SHRUB	Common Periwinkle
VITRIP	1	Vitis riparia	-2	FACW-	NT W-VINE	Riverbank Grape
ZANAME	3	Zanthoxylum americanum	5	UPL	NT SHRUB	Prickly Ash

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Bismarck Hill

Vegetation, Wildlife Assessment and Restoration Plan

APPENDIX B

Invasive Plant Profiles and Management Techniques

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Vegetation, Wildlife Assessment and Restoration Plan

APPENDIX C

Recommended Species

TREES AND SHRUBS

Amelanchier arborea	Juneberry
Cornus florida	Flowering Dogwood
Corylus americana	Hazelnut
Hamamelis virginiana	Witch Hazel
Ostrya virginiana	Hop Hornbeam
Ptelea trifoliata	Smooth Wafer Ash
Quercus alba	White Oak
Quercus coccinea	Scarlet Oak
Quercus rubra	Red Oak
Quercus velutina	Black Oak
Sassafras albidum	Sassafras
Tilia americana	Basswood

FORBS

Amorpha canescens	Lead Plant
Asclepias syriaca	Common Milkweed
Asclepias tuberosa	Butterfly Milkweed
Calamovilfa longifolia v. magna	Prairie Sand Reed
Castilleja coccinea	Indian Paintbrush
Chamaecrista fasciculata	Golden Cassia
Coreopsis lanceolata	Sand Coreopsis
Dichanthelium ovale s. pseudopubescens	False White-Haired Panic Grass
Elymus canadensis	Canada Wild Rye
Euphorbia corollata	Flowering Spurge
Eurybia macrophylla	Big-Leaved Aster
Koeleria macrantha	June Grass
Lespedeza capitata	Round-Headed Bush Clover
Lupinus perennis	Wild Lupine
Monarda punctata v. villicaulis	Horsemint
Panicum virgatum	Prairie Switch Grass
Pedicularis canadensis	Wood Betony
Rudbeckia hirta v. hirta	Black-Eyed Susan
Schizachyrium scoparium	Little Bluestem Grass
Solidago caesia	Bluestem Goldenrod
Solidago speciosa	Showy Goldenrod
Symphyotrichum shortii	Short's Aster
Verbascum virgatum	Wand Mullein
Verbena stricta	Hoary Vervain

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APPENDIX D

Opinion of Probable Restoration Cost

Restoration Activity	Year 1				Year 2				Year 3			
	unit	units	$/unit	$	unit	units	$/unit	$	unit	units	$/unit	$
Selective Woody Brush Removal, Zones A and B	acre	18.4	$ 2,000	$ 36,760	acre	18.4	$ 1,000	$ 18,380	acre	18.4		
Selective Woody Brush Removal, Zone C	acre	1.4	$ 4,000	$ 5,560	acre	1.4	$ 1,200	$ 1,668	acre	1.4		
Selective Woody Brush Removal, Zones D and E	acre	6.3	$ 8,000	$ 50,400	acre	6.3	$ 3,000	$ 18,900	acre	6.3		
Selective Woody Brush Removal, Zone F	acre	4.2	$ 7,000	$ 29,330	acre	4.2	$ 1,200	$ 5,028	acre	4.2		
Herbaceous Weed Control, Zones A and B	acre	18.4	$ 750	$ 13,785	acre	18.4	$ 500	$ 9,190	acre	18.4	$ 400	$ 7,352
Herbaceous Weed Control, Zone C	acre	1.4	$ 750	$ 1,043	acre	1.4	$ 500	$ 695	acre	1.4	$ 400	$ 556
Herbaceous Weed Control, Zones D and E	acre	6.3	$ 1,000	$ 6,300	acre	6.3	$ 500	$ 3,150	acre	6.3	$ 400	$ 2,520
Herbaceous Weed Control, Zone F	acre	4.2	$ 1,000	$ 4,190	acre	4.2	$ 500	$ 2,095	acre	4.2	$ 400	$ 1,676
Black Oak Savanna Seeding, Zones C, D, E and F	acre	11.9	$ 2,000	$ 23,800	acre	11.9			acre	11.9		
Tree Planting, Zones D and E (1" Cal. #5; 100/acre)	acre	6.3	$ 10,000	$ 63,000	acre	6.3			acre	6.3		
Shrub Planting, Zones D, E and F (3-5' Ht. #5; 100/acre)	acre	10.5	$ 5,000	$ 52,500	acre	10.5			acre	10.5		
Prescribed Burn	each	1	$ 20,000	$ 20,000	each	1	$ 20,000	$ 20,000	each	1	$ 20,000	$ 20,000
Subtotal				$ 306,668				$ 79,106				$ 32,104
15% Contingency				$ 46,000				$ 11,866				$ 4,816
TOTAL				**$ 352,668**				**$ 90,972**				**$ 36,920**

Restoration Activity	Year 6				Year 10			
	unit	units	$/unit	$	unit	units	$/unit	$
Selective Woody Brush Removal, Zones A and B	acre	18.4			acre	18.4		
Selective Woody Brush Removal, Zone C	acre	1.4			acre	1.4		
Selective Woody Brush Removal, Zones D and E	acre	6.3			acre	6.3		
Selective Woody Brush Removal, Zone F	acre	4.2			acre	4.2		
Herbaceous Weed Control, Zones A and B	acre	18.4			acre	18.4		
Herbaceous Weed Control, Zone C	acre	1.4			acre	1.4		
Herbaceous Weed Control, Zones D and E	acre	6.3	$ 300	$ 1,890	acre	6.3	$ 300	$ 1,890
Herbaceous Weed Control, Zone F	acre	4.2	$ 300	$ 1,257	acre	4.2	$ 300	$ 1,257
Black Oak Savanna Seeding, Zones C, D, E and F	acre	11.9			acre	11.9		
Tree Planting, Zones D and E (1" Cal. #5; 100/acre)	acre	6.3			acre	6.3		
Shrub Planting, Zones D, E and F (3-5' Ht. #5; 100/acre)	acre	10.5			acre	10.5		
Prescribed Burn	each	1	$ 20,000	$ 20,000	each	1	$ 20,000	$ 20,000
Subtotal				$ 23,147				$ 23,147
15% Contingency				$ 3,472				$ 3,472
TOTAL				**$ 26,619**				**$ 26,619**