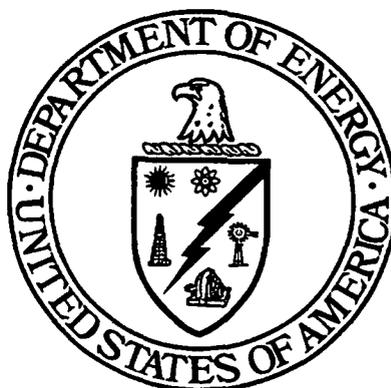


**2001 CONSOLIDATED MONITORING REPORT
FOR RESTORED AREAS AT THE FERNALD
ENVIRONMENTAL MANAGEMENT PROJECT**

**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO**



FOR INFORMATION ONLY

DECEMBER 2001

**U.S. DEPARTMENT OF ENERGY
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LIST OF ACRONYMS AND ABBREVIATIONS

A1PI	Area 1, Phase I
A8PI	Area 8, Phase I
A8PII	Area 8, Phase II
CC	coefficient of conservatism
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COE	U.S. Army Corp of Engineers
dbh	diameter at breast height
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEMP	Fernald Environmental Management Project
FQAI	Floristic Quality Assessment Index
FWS	U.S. Fish and Wildlife Service
m ²	square meter
mg/L	milligrams per liter
mS/cm	microSiemens per centimeter
MSI	Modified Simpson's Index of Diversity
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Agency
NRIA	Natural Resource Impact Assessment
NRRDP	Natural Resource Restoration Design Plan
NRRP	Natural Resource Restoration Plan
NRT	Natural Resource Trustee
NTU	Nephelometric Turbidity Units
OEPA	Ohio Environmental Protection Agency
PVC	polyvinyl chloride
ROD	Record of Decision
USDA	U.S. Department of Agriculture

1.0 INTRODUCTION

The purpose of this report is to summarize and present data associated with monitoring, maintenance, and management of ecologically restored areas at the Fernald Environmental Management Project (FEMP) for Calendar Year 2001. This report is required as part of an overall restored area monitoring and maintenance strategy set forth in the FEMP Natural Resource Restoration Plan (NRRP, DOE 2001a).

The NRRP specifies the submittal of an annual monitoring report at the end of each calendar year, starting in 2001.

1.1 BACKGROUND

The 1,050-acre FEMP site is undergoing large-scale environmental remediation pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Section 107 of CERCLA imposes responsible party liability for injury to natural resources resulting from the release of a hazardous substance. CERCLA and the National Contingency Plan (NCP) establish certain state and federal agencies as trustees for natural resources. The Natural Resource Trustee (NRT) representatives for the FEMP include the Ohio Environmental Protection Agency (OEPA) and the U.S. Fish and Wildlife Service (FWS). The U.S. Department of Energy (DOE) has a dual role as both a trustee and a potentially responsible party. In 1986, the State of Ohio filed a \$206 million lawsuit against DOE as compensation for natural resource damages resulting from releases of hazardous substances at the FEMP. Action on the natural resource damage claim was stayed until the completion of all site Records of Decision (RODs). Since the signing of the Operable Unit 5 ROD in 1996, DOE has been in negotiations with the other NRTs. A summary of these NRT negotiations is provided below.

As stated above, NRT negotiations were underway by 1996. DOE actually identified the other FEMP NRTs and made initial contact in 1994. The NRTs agreed to meet and discuss resolution of the Ohio 1986 natural resource damage claim. From these discussions, the NRTs tentatively agreed to avoid further litigation and seek compensation for natural resource injuries through the implementation of on-property ecological restoration projects. In 1997, the NRTs signed a tri-party letter that was sent to the U.S. Environmental Protection Agency (EPA) stating this intent. The NRTs then developed a conceptual restoration plan for the FEMP site. This document, entitled the NRRP, was preceded by the Natural Resource Impact Assessment (NRIA, DOE 2001b). The NRIA used existing site data to quantify the extent of past and anticipated future natural resource injuries at the FEMP. The NRTs used this information to quantify compensatory restoration acreage through a process called Habitat Equivalency

1 Analysis. These processes are explained in greater detail within the NRRP. A draft final NRRP was
2 produced in 1998, and DOE began implementation of several ecological restoration projects.
3 Negotiations continued with the NRTs regarding the scope of restoration, compensation for groundwater
4 injury, and the extent of monitoring. In 2001, the NRTs signed a Memorandum of Understanding that
5 formalized the agreement to use on-property ecological restoration as the primary means of
6 compensation. The NRTs also sought to compensate for groundwater injury through a cash settlement,
7 which would be used to develop a series of groundwater education programs and possibly fund an on-site
8 educational facility. The NRTs are currently finalizing the NRRP, with the goal of reaching final
9 settlement by Spring 2002.

10
11 The approach for site ecological restoration developed by the NRTs and set forth in the NRRP involves
12 integration of ecological restoration projects into site remediation activities. This will result in the
13 implementation of a series of projects across the site following remediation. In general, site restoration
14 will involve grading to maximize the formation of wetlands or expanded floodplain, amending soil where
15 topsoil is removed, and the establishment of native vegetation. Restoration projects will usually involve
16 forest restoration, wetland construction, or seeding with native grasses and forbs. Further detail regarding
17 the sitewide ecological restoration approach is provided in the NRRP.

18
19 The NRTs have agreed to implement the concept of "adaptive management" during the field
20 implementation, monitoring, and maintenance of restoration projects at the FEMP. Adaptive
21 management is defined pursuant to the final NRRP as a continuing process of planning, monitoring, and
22 adjusting, with the objective of improving the project implementation and outcomes (Lessard 1998). The
23 NRTs realize that flexibility is needed to successfully implement restoration and management. The field
24 of ecological restoration is relatively new, and innovative techniques and approaches are being developed
25 all the time. Also, ecological systems are dynamic and dependant on a variety of factors that are difficult
26 to control, such as climate, predation, etc. Because of this, results presented in annual monitoring reports
27 will be used to adjust implementation, maintenance, and monitoring approaches as needed, in order to
28 optimize the progress of restored areas at the FEMP. It is important to note that implementation and
29 management of restored areas will be bounded by the scope of work defined in the NRRP.

30 31 1.2 RESTORED AREA MONITORING REQUIREMENTS

32 Monitoring of restored areas will involve two phases. First, Implementation Phase monitoring will be
33 conducted to ensure that restoration projects are completed pursuant to their Natural Resource Restoration

1 Design Plans (NRRDPs). The second phase of monitoring is termed the Functional Phase. This effort
2 will consider projects in terms of their system-specific contribution to sitewide ecological communities.
3 The NRRP provides a thorough overview of both Implementation and Functional Phase monitoring. The
4 text below describes the specific requirements that will be evaluated for each phase.

6 1.2.1 Implementation Phase Monitoring

7 The main focus of Implementation Phase monitoring usually involves vegetation survival. The NRTs
8 have negotiated that 80 percent survival of all planted vegetation must be achieved. In addition, seeded
9 areas must obtain 90 percent cover. Plant survival rates will usually be calculated on an individual "patch
10 by patch" basis. A patch is a planting unit about 0.25 acre in size that consists of a specific habitat
11 template. This design approach will be used for most of the NRRDPs developed at the FEMP.

12
13 To determine vegetation survival, mortality counts will be conducted at the end of each growing season.
14 Each balled and burlap or container-grown tree and shrub will be inspected and assigned one of three
15 categories: alive, resprout, or dead. Trees and shrubs will be considered "alive" when their main stem
16 and/or greater than 50 percent of the lateral stems are viable. "Resprout" trees and shrubs will have a
17 dead main stem, with one or more new shoots growing from the stem or the root mass. Plants will also be
18 categorized as "resprout" when less than 50 percent of its lateral branches are alive. Dead trees will have
19 no signs of vitality at all.

20
21 Herbaceous cover will be estimated for all seeded areas within a restored area. Instead of the
22 patch-specific approach used for planted vegetation, the restored area will be divided into specific
23 seeded-area subsections. These subsections will generally be delineated by area and habitat-specific
24 boundaries. In each subsection, at least three one-meter square quadrats will be randomly distributed and
25 surveyed. Cover estimates for each quadrat will then be averaged to calculate herbaceous cover.

26
27 Specific NRRDPs may impose additional implementation phase monitoring requirements. For instance,
28 water levels and the formation of hydric soils must be evaluated for wetland mitigation projects. The
29 duration of implementation phase monitoring is also variable. Vegetation survival will generally be
30 evaluated for two growing seasons following installation, while wetland mitigation requirements must be
31 evaluated for three to five years. The NRRP provides a monitoring schedule based on these requirements
32 in relation to anticipated project completion dates.

1 1.2.2 Functional Phase Monitoring

2 Functional Phase monitoring is not a pass/fail determination like Implementation Phase monitoring.
3 Instead, functional monitoring will evaluate the progress of the restored community against
4 pre-restoration baseline conditions and an ideal reference site. Vegetation indices will be used for
5 comparisons, as well as several wildlife-based evaluations. The Ecological Restoration Functional Phase
6 Monitoring Plan is provided as Appendix E of this report. This monitoring plan details the field methods
7 and data analyses that will be used to implement Functional Phase monitoring at the FEMP. A summary
8 of the specific parameters to be evaluated is discussed below.
9

10 The vegetation indices that will be used to assess restored areas include Floristic Quality Assessment
11 Index (FQAI) and a modified Simpson's Index of Diversity (MSI). In general, FQAI provides a measure
12 of the quality of vegetation inhabiting a particular area, while Simpson's Index quantifies the diversity of
13 the vegetative community. FQAI is determined from species richness values and predetermined rankings
14 of native species. Species richness and abundance measurements would typically be required for
15 calculating Simpson's Index. For herbaceous vegetation, a modified approach will be utilized that
16 calculates Simpson's Index using cover estimates instead of abundance values. The monitoring plan in
17 Appendix E provides detail regarding the calculation of these parameters.
18

19 Several wildlife evaluations will be conducted in addition to vegetation surveys. These include breeding
20 bird surveys, amphibian and macroinvertebrate sampling, and migratory waterfowl observations. Casual
21 wildlife observations will also be recorded in each study area. The collection and treatment of these
22 parameters is detailed in Appendix E.
23

24 The schedule for Functional Phase monitoring is provided in Appendix E and the NRRP. The schedule is
25 set up so that only one type of ecological community will be evaluated in any given year. The first couple
26 of years will be devoted to establishing baseline conditions and surveying ecological reference sites.
27 Therefore, this year's consolidated monitoring report includes only baseline data. The baseline systems
28 that were evaluated include grazed pasture, riparian forest, successional woodlot, pine plantation, and
29 open water.
30

31 1.3 PROJECT SUMMARIES

32 The ecological restoration projects evaluated in this year's consolidated monitoring report include
33 Implementation Phase monitoring of the Area 1, Phase I (A1PI) Wetland Mitigation Project and the

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1 Area 8, Phase II (A8PII) Forest Demonstration Project. Section 4.1 of the NRRP includes a summary of
2 these projects. Additional detail regarding the wetland mitigation project can be found in Sections 2.2
3 and 2.3 of the Wetland Monitoring Report for the Year 2000 (DOE 2001c). This consolidated monitoring
4 report also describes the baseline ecological monitoring program as part of Functional Phase monitoring.
5 Lastly, this report summarizes data collected as part of the Area 8, Phase I (A8PI) Revegetation Research
6 Plots.

8 1.4 METEOROLOGICAL CONDITIONS

9 Site meteorological conditions effect several major components of ecological restoration projects.
10 Precipitation irrigates planted and seeded vegetation, and charges water features. Because of this, site
11 precipitation data is presented on Table 1-1. In general, the first half of 2001 received below-average
12 rainfall, while the second half received above average precipitation. The Palmer drought Severity Index
13 for southwest Ohio remained at the "near normal" level for most of the year (NOAA 2001). Therefore,
14 The FEMP site received adequate rainfall to support ecological restoration in 2001, and supplemental
15 irrigation was not required for most of the year. It should be noted that water was introduced into the
16 wetland mitigation project, in an effort to control invasive species. More information regarding this
17 management activity is provided in Section 2.1.4.

**TABLE 1-1
 2001 PRECIPITATION DATA**

Month	Average Site Precipitation (in.)	Actual Site Precipitation (in.)	Monthly Departure from Normal (in.)	Cumulative Departure from Normal (in.)	Palmer Drought Severity Index (as a function of cumulative precipitation)
January	3.14	1.40	-1.74	-1.74	Near Normal
February	2.80	1.69	-1.11	-2.85	Near Normal
March	3.90	1.41	-2.49	-5.43	Near Normal
April	3.80	3.54	-0.26	-5.60	Near Normal
May	4.23	6.05	+1.82	-3.78	Moderate Drought
June	4.06	3.66	-0.40	-4.18	Near Normal
July	4.03	6.09	+2.06	-2.12	Near Normal
August	3.20	3.73	+0.53	-1.59	Near Normal
September	2.79	4.10	+1.31	-0.28	Near Normal
October	2.68	6.65	+3.97	+3.69	Unusual Moist Spell
November	3.33	3.51	+0.18	+3.87	Unusual Moist Spell
December	3.12	tbd	tbd	tbd	tbd

2.0 IMPLEMENTATION PHASE MONITORING

This section presents the project-specific requirements, results, and corrective measures for Implementation Phase monitoring at the FEMP. In 2001, the A1PI Wetland Mitigation Project and the A8PII Forest Demonstration Project are the only two projects undergoing Implementation Phase monitoring. This section also summarizes all maintenance and adaptive management activities conducted within these projects during 2001, and provides a discussion regarding lessons learned for each project.

2.1 A1PI WETLAND MITIGATION PROJECT

The wetland mitigation project involved the planting of 3,327 trees and shrubs within 86 different patches across the 12-acre project area (DOE 1999). Field implementation was conducted in several phases from 1999 to 2000. Also, a replanting effort was undertaken between 2000 and 2001, in order to address vegetation survival counts following the first growing season (DOE 2001c). The NRTs agreed to adjust the replanting strategy by focusing on wetland patches and buffer patches along the western side of the project area. As a result of these various planting efforts, the actual number of plants within a given patch is often different from the original design. Because of this, any discussion regarding patch-specific vegetation survival can become very confusing. Also, evaluating individual patches may not accurately reflect impacts to its corresponding community. Therefore, the Implementation Phase requirements and results for the wetland mitigation project will be discussed in terms of distinct communities instead of individual patches. The communities in the wetland mitigation project include the eight interconnected basins (Figure 2-1). All upland areas were also grouped into a single separate community. Patch-specific information is included in Appendix A.

2.1.1 Requirements

The wetland mitigation design called for several Implementation Phase monitoring requirements. These requirements include planted vegetation survival, herbaceous cover estimates, measurements of water elevations and water quality, soil sampling, and documentation of wildlife observations. Unless otherwise noted, all monitoring was conducted pursuant to the methods set forth in the Wetland Monitoring Report for the Year 2000 (DOE 2001c). Each of these requirements is discussed in more detail below.

1 2.1.1.1 Vegetation Survival

2 Planted vegetation must meet 80 percent survival pursuant to the wetland mitigation design (DOE 1999).
3 As discussed above, there are numerous differences between design quantities and field implementation
4 quantities. The NRTs have agreed to compare survival numbers to the original design amounts instead of
5 the actual amounts. Table A-1 in Appendix A provides both the actual survival percentages and the
6 percentages based on the design quantities. The actual patch quantities are termed the "2001 Baseline"
7 quantities, and were determined by adding the total number of individuals that were alive to the number
8 of plants installed in 2001.

9
10 2.1.1.2 Herbaceous Cover

11 The wetland mitigation design called for 80 percent herbaceous cover following the first or second
12 growing season (DOE 2001c). DOE will report the extent of herbaceous cover in terms of both total
13 cover and native species cover.

14
15 The method for determining herbaceous cover has been modified from the original design. Instead of a
16 patch-specific walkover survey, DOE used randomized quadrats to determine basin-specific cover
17 estimates, similar to the approach used for Functional Phase herbaceous surveys described in Appendix E.
18 The original approach proved difficult to implement, because individual seeding patches could not be
19 distinguished (DOE 2001c). Quadrat locations across the wetland mitigation project are shown on
20 Figure 2-1.

21
22 DOE also made a determination regarding the presence of hydrophytic vegetation for each quadrat,
23 pursuant to the methods established by the U.S. Army Corp of Engineers (COE) for delineating
24 jurisdictional wetlands (COE 1987). A quadrat was designated as having hydrophytic vegetation present
25 if greater than 50 percent of the dominant plant species observed were hydrophytic. The U.S. Fish and
26 Wildlife Service Region 1 Wetland Indicator Status list was used to determine the extent of hydrophytic
27 vegetation (USDA 2001). A basin was considered hydrophytic if the majority of its quadrats were
28 hydrophytic.

29
30 2.1.1.3 Water Level and Water Quality Measurements

31 Adequate hydrology is the most important determinant of a successful wetland mitigation project
32 (DOE 1999). The wetland mitigation design established several processes for measuring hydrology.
33 First, shallow monitoring wells were installed in each basin. Next, staff gauge locations were established

1 to determine the water depth of several ponds. Water depth measurements were taken in several drainage
2 swales as well. All water level monitoring points are identified on Figure 2-1. Pursuant to the monitoring
3 schedule in the original design, measurements were taken twice in 2001.

4
5 Water quality samples were taken in Basins 1, 2, 4, 5, and 6, where ponding is expected (Figure 2-1). For
6 each sample, the color, odor, temperature, pH, specific conductivity, turbidity, and dissolved oxygen were
7 recorded. The intent of the water quality sampling is to status the health of the aquatic systems.

8 Imbalances or other stresses to a system could result in measurement extremes. Water quality sampling
9 was conducted twice in 2001.

11 2.1.1.4 Other Requirements

12 Several other requirements were specified in the wetland mitigation design. Soil samples were taken in
13 several locations in order to determine the presence of hydric conditions (Figure 2-1). The design called
14 for samples to be taken one year after construction. However, samples were not collected in 2000
15 because of an extremely hard ground surface. Therefore, soil sampling was rescheduled for 2001
16 (DOE 2001c). The color, moisture content, and soil type were recorded for each sample. Samples were
17 compared to Munsell Soil Color Charts to determine hydric conditions, pursuant to the COE Wetland
18 Delineation Manual (COE 1987).

19
20 Wildlife observations were recorded pursuant to the wetland mitigation design. Casual observations have
21 been conducted during field activities in 2001. In addition, several amphibian sampling efforts were
22 conducted by OEPA.

24 2.1.2 Results and Discussion

25 The results of the A1PI Wetland Mitigation Project monitoring requirements are presented in Tables 2-1
26 through 2-6, and in Appendix A. Tables 2-1 and 2-2 provide basin-specific summary information, while
27 Tables A-1 and A-2 in Appendix A provide patch-specific data. A discussion of the specific requirements
28 are presented in Sections 2.1.2.1 to 2.1.2.4. A summary of findings is provided below.

29
30 The monitoring requirements established in the wetland mitigation design are intended to answer six
31 questions (DOE 1999). Responses to these questions are provided below, based on the second year of
32 Implementation Phase monitoring of the A1PI Wetland Mitigation Project.

1 1. Have the requirements of the reviewing agencies been met?

2
3 Yes. Design, construction, and adaptive management of the A1PI Wetland Mitigation Project
4 have resulted in a diverse and improving wetland ecosystem. Wetland experts from OEPA have
5 noted that, as a mitigation project, the A1PI wetland system is very diverse (Mack 2001). DOE
6 will continue to implement adaptive management principles in conjunction with the agencies and
7 the NRTs, with the intent of improving the wetland system and maximizing the jurisdictional
8 wetland acreage created.
9

10 2. Have sufficiently dense wetland plant communities been established?

11
12 No. The wetland basins have not reached sufficient native cover. However, each basin has
13 shown much improvement over 2000. Management activities, coupled with maturation of the
14 system as a whole, have resulted in steady improvement across the wetland mitigation project.
15

16 3. Do surface and groundwater levels support wetland conditions?

17
18 Yes. Water level measurements, herbaceous cover estimates, and soil samples demonstrate that
19 surface and groundwater levels are sufficient. Further maintenance of several water control
20 structures was initiated in 2001. These actions will be monitored closely to determine what
21 additional activities (if any) will be required.
22

23 4. Do surface and groundwater quality fall within parameters indicative of a comparatively healthy
24 system?

25
26 Yes. The second year of monitoring demonstrates that water quality is normal, and that there is
27 an abundance of aquatic life in the system.
28

29 5. Have animal populations adapted to wetland systems successfully colonized the site?

30
31 Yes. Wildlife use of the wetland system has met or exceeded expectations.
32

33 6. Have wetland soils been created?

34
35 Yes, in part. At least one hydric soil sample was collected in Basins 1, 2, 3, 6 and 7. However,
36 the majority of samples collected across the project did not demonstrate hydric characteristics.
37

38 As stated above, further detail regarding the specific monitoring requirements used to answer these
39 questions are provided in Sections 2.1.2.1 to 2.1.2.4 below.
40

41 2.1.2.1 Vegetation Survival Results

42 The survival rates presented in Table 2-1 show that Basins 1, 3, 6 and 8 achieved 80 percent survival
43 in 2001. Several other basins almost met the 80 percent survival requirement (Basins 2, 4 and 7). As
44 discussed in Section 2.1.1.1, the survival rates were determined according to the design quantities instead
45 of the actual number planted. Therefore, the percent survival for Basin 3 is actually greater than

1 100 percent, since several patches within this basin were replanted with additional vegetation as part of
2 the Fall 2000 replant effort (Table A-1). It appears that the precipitation levels in 2001, coupled with the
3 maturation of amended soils and continued deer control efforts, have resulted in much better growing
4 conditions than what was encountered in 1999.

5
6 Despite the improved growing conditions, survival rates in Basins 2, 4, 5 and 7, and the upland
7 community, fall below 80 percent. Because of the reduced survival in several locations, DOE has
8 proposed a replanting strategy, which is described in Section 2.1.3. Further discussion on survival rates
9 in the wetland mitigation project is provided below.

10
11 It is suspected that the wetland vegetation planted in several basins is adjusting to the hydrologic
12 conditions that have developed. Some of the wetland plants, particularly in Basins 2, 4 and 7, may have
13 been installed in areas that are now either too dry or too wet. Basin 5 had the lowest survival rate of any
14 community within the wetland mitigation project. Field observations over time have revealed that water
15 levels in this basin fluctuate more than any other basin within the project area. Basin 5 receives runoff
16 directly from the adjacent North Access Road, and is totally inundated following significant rain events.
17 During this time, Basin 5 acts as a sediment trap, receiving a high amount of sediment carried from the
18 road. It then slowly drains into Basin 1 via a pole drain, causing water levels to recede. As a result, much
19 of Basin 5 acts almost as a mud flat, with little vegetation able to withstand the periodic high sediment
20 loading and the wide fluctuations in water levels.

21
22 Deer impacts are also a concern. The FEMP Deer Management Plan (DOE 2001d) showed that deer have
23 damaged almost 1,000 plants within the wetland mitigation project. Deer pressure is one of the primary
24 reasons for reduced survival in the upland community.

25 26 2.1.2.2 Herbaceous Cover Results

27 Herbaceous cover estimates for each basin and the upland community are presented in Table 2-2. The
28 80 percent cover requirement was met for all but one basin (Basins 5). However, the NRTs are also
29 concerned with estimates of native cover in addition to total cover. When only native species are
30 considered, none of the project area communities exceed 80 percent cover. However, much improvement
31 was observed over the previous year. In 2000, native cover estimates did not exceed 25 percent in any
32 basin (DOE 2001c). Table 2-2 demonstrates that every basin except one exceeded 25 percent native
33 cover. Basins 1 and 6 both exceeded 50 percent native cover. It should be noted that different methods

1 were used to determine percent native cover in 2000 and 2001, so only qualitative comparisons can be
2 made. Nevertheless, these results demonstrate that the percent native cover in the wetland mitigation
3 project is improving steadily.

4
5 Improvement is also demonstrated by evaluating the extent of hydrophytic vegetation present in the
6 wetland project. Based on the quadrats sampled, Table 2-2 shows that Basins 1, 4 and 6 met the
7 hydrophytic vegetation requirement established by COE (1987). Note that the extent of data collection
8 was too limited to characterize the entire basin. However, the results on Table 2-2 and Table A-2 in
9 Appendix A further demonstrate that native herbaceous vegetation, and more importantly wetland
10 vegetation, is expanding in the wetland mitigation project.

11
12 Several basins within the project area have high percentages of non-native vegetation (Table 2-2). Like
13 the woody vegetation discussed in Section 2.1.2.1, the herbaceous vegetation is adjusting to the
14 hydrologic regime that has developed within each basin. Many areas seeded with a wetland seed mix
15 and/or planted with wetland plugs do not receive adequate moisture to support such vegetation. Invasive
16 non-native vegetation quickly moves in to fill the void. The importance of water elevations was
17 illustrated in Basin 6. For 2000, the percent native cover in Basin 6 was estimated at 5 to 25 percent
18 (DOE 2001c). Water levels were subsequently manipulated to increase the amount of water in the basin.
19 As a result, the percentage of native species increased to approximately 57 percent (Table 2-2).
20 Section 2.1.4 provides additional detail regarding the manipulation of water levels within certain basins.

21 22 2.1.2.3 Water Level and Water Quality Measurement Results

23 Water levels of shallow wells, ponds, and swales are presented in Table 2-3. The shallow well water
24 depths show a general trend towards increasing hydrological conditions. The fall water column depths
25 were greater at every location except Basin 5. The shallow well measurements are also comparable to
26 data collected in 2000 (DOE 2001c). It should be noted that the fall measurements may have been
27 influenced by recent precipitation, as 0.42 inches of rain was recorded at the FEMP on the day before
28 sampling. Water depths in the ponds and swales also indicate sustained water holding capacity in the
29 system.

30
31 Water quality analyses are presented in Table 2-4. In general, the results show a balanced system, with
32 no issues needing immediate attention. The relatively high turbidity measurement in Basin 5 is attributed
33 to the high amount of runoff received from the North Access Road, as discussed in Section 2.1.2.1.

2.1.2.4 Other Results

Results from soil sampling are provided in Table 2-5. Several samples exhibited hydric characteristics. In fact, hydric soils were delineated in at least one sample from Basins 1, 2, 3, 6 and 7. While not hydric, several additional samples were characterized as moist or damp. These findings correspond with the water elevation results discussed above where Basin 8 does not appear to be receiving much surface water runoff. Sample locations were randomized within each basin (Figure 2-1), so it is suspected that a more systematic sampling approach would reveal further development of hydric soils.

Wildlife observations are summarized in Table 2-6. Observations from 2001 demonstrate increased use of the wetland mitigation project by wildlife. In 2000, 32 species of birds, four species of amphibians and reptiles, and five species of mammals were observed (DOE 2001c). All three wildlife categories increased in 2001. Forty-three species of birds were observed, along with seven species of herpetofauna and 12 species of mammals. The use of the wetland mitigation project by migratory waterfowl was particularly encouraging. Several clutches of wood duck fledged. In addition, a hooded merganser nested in Basin 4. The first county nesting record for this species was recorded several years earlier at Miami Whitewater Forest (Styer 2001). The adult did not survive, but one of the young successfully fledged.

2.1.3 Replanting Strategy

A replanting strategy is required to address reduced survival and native herbaceous cover in the wetland mitigation basins. Overall, DOE is pleased with the progress of vegetation in the A1PI Wetland Mitigation Project, especially within the shrub and herbaceous patches. As discussed above, DOE contends that some of the excessive mortality can be attributed to shifting hydrological conditions and extreme deer browse and rub impacts, as well as the severe drought conditions that were experienced during the initial planting.

For several reasons, the NRTs have agreed not to establish additional woody vegetation in the wetland mitigation project. First, the NRTs have decided that additional plantings in areas of heavy deer pressure should be avoided. Also, the shifting hydrological conditions makes planting within the wetland basins risky. DOE should adjust the replant strategy to take advantage of these changing conditions by improving the herbaceous layer within the wetland basins. Therefore, herbaceous vegetation will be planted in several basins in order to increase the percentage of native vegetation. The approach for herbaceous planting in the wetland mitigation project is described below.

1 Areas selected for planting in Spring 2002 are limited to portions of Basins 2, 4 and 7 (Figure 2-1). The
2 areas to be planted have a low percent of native cover (Table 2-2) and contain areas that have not been
3 previously planted with wetland plugs. Table 2-7 lists the grass and wildflower species to be included in
4 the plantings. Areas to be planted will be delineated on the ground and herbaceous stock will be planted
5 on approximately 3-foot centers within these areas to augment existing wetland vegetation.

6
7 Basins 2, 4 and 7 were chosen as replant areas for several reasons. Basins 3 and 5 were planted with
8 herbaceous plugs in 2001 along with a portion of Basin 2; therefore these areas were not considered.
9 The 2001 plantings in Basins 3 and 5, along with a portion of Basin 2, will be re-evaluated in the 2002
10 growing season to determine if the Spring 2001 plantings were successful. Significant improvements are
11 expected in these areas for 2002. Basin 8 does not contain any areas that are favorable for wetland
12 species. Surface water runoff in this basin is faster than was planned; therefore, soils are too well drained.
13 Basins 1 and 6 have the highest percent of native cover. The conditions in these basins showed
14 significant improvement in the last year and are expected to continue to improve over the next few years.

15
16 As stated above, the proposed replant strategy will not attempt to restore area-specific woody plant
17 survival within the wetland mitigation project. Instead, the NRTs have negotiated to develop shrub
18 patches within the radium hot spot, where woody vegetation is limited (Figure 2-2). In 2000, a portion of
19 Area 2, Phase III was excavated to address radium contamination. Following remediation, this "radium
20 hot spot" was graded to hold water. The area was seeded with a wetland grass/forb mix, and inoculated
21 with wetland donor soil and clumps of bur reed (*Sparganium spp.*). However, large portions of the
22 project remain sparsely vegetated. Therefore, a planting strategy has been developed for the radium hot
23 spot that will expand the coverage of vegetation within the project area. The area will also be developed
24 as a plant source for future restoration projects at the FEMP. This approach is described in more detail
25 below.

26
27 Planting within the radium hot spot will consist of a series of single-species wetland shrub patches,
28 installed pursuant to Figure 2-2. The species and quantities specified for each patch are presented in
29 Table 2-8. Species were chosen so that they can provide live cuttings and/or seeds for future restoration
30 projects. Also, most of these species have experienced limited deer damage on site. In addition, the
31 patches are laid out so that the species that are less appealing to deer are placed on the outside patches,
32 protecting the more palatable species. The plants will consist of seedlings and live dormant cuttings.
33 Seedling plugs will be installed using dibble bars, while cuttings will be pushed or driven into the ground

1 with a hammer. Fertilizer tablets that contain a systemic deer repellent will be used with each plant. An
2 evaluation of the performance of this product will be reported in the next Consolidated Monitoring
3 Report.

4 5 2.1.4 Maintenance and Management Summary

6 The A1PI Wetland is a developing wetland that is subject to ongoing management and maintenance to
7 optimize wetland function. Monitoring revealed several areas where maintenance was needed to retain
8 the integrity of the area. Invasive and aggressive plant species were identified encroaching upon native
9 communities. Plant damage by wildlife was recognized during various walk-throughs of the wetland
10 project, demonstrating the need for preventive action. Maintenance of structures and safety equipment
11 around the ponds was also found to be needed in 2001. Opportunities were discovered for improvement
12 of wildlife habitat, quicker establishment of native plant communities, and improvement of the
13 monitoring process.

14
15 Needs or concerns identified during monitoring were addressed in a timely manner. Maintenance actions
16 were planned and implemented utilizing maintenance labor force for the FEMP. Activities included
17 control, repair, and improvement of the wetland plants, structures, habitat, and processes.

18
19 Attempts were made to control invasive and aggressive plant species such as thistle (*Cirsium spp.*), giant
20 reed (*Phragmites australis*), and cattail (*Typha latifolia*) through mowing, cutting, and herbicide
21 application. Another control effort included adjustment of water levels in some basins to flood a greater
22 area within the basins to drown some of the non-native species and create additional habitat for hydric
23 native species. To lessen the affects of deer and other wildlife upon the wetlands, deer repellent and
24 garlic sticks were applied to plants to deter deer from browsing upon planted native species. Protective
25 tree tubes were wrapped around saplings to prevent damage from deer rubs. Goose fence was erected to
26 protect newly planted grasses and forbs from foraging geese. Each of these actions was taken to control
27 problems identified during monitoring in the wetlands.

28
29 The affects from weather, water, and wildlife took their toll on some structures in the wetlands. Action
30 was taken to repair a leaking headwall, to check erosion through spillways and drainage ways, to move
31 native plant species in the footprint of a monitoring well that have to be elevated above standing water, to
32 re-hang fallen signs and ring buoys around ponds, and to replace a rotted wren box post.

1 Every effort is made to improve the infrastructure and conditions within the wetland mitigation project.
2 Brush piles were enlarged to improve wildlife use capabilities. Minnows were stocked in Basin 4 pond to
3 provide food for ducks. Plugs were purchased for installation in basins lacking sufficient cover. The
4 plugs were found to accelerate the establishment of grasses and forbs within the basins over seeding.
5 Monitoring practices in the wetlands saw a couple of improvements. The monitoring of water levels in
6 ponds was expedited by the installation of staff gauges. Percent vegetative cover determinations were
7 formalized with random quadrat sampling within basins and upland areas of the project.
8

9 2.1.5 Lessons Learned

10 Efforts were made to control some of the cattails in wetland swales. They were clipped below the water
11 level, which allows water to infiltrate into the center stem of the cattail. Extended inundation with water
12 will drown the plant. However, due to falling water levels in swales from transpiration, evaporation, and
13 water outflow; efforts to drown the cattails in the wetlands were not very successful. Water levels were
14 dropping sufficiently each day to expose that day's cut stems. More success was achieved after water was
15 introduced into the swales from the water line running through the wetlands. This not only maintained
16 water levels but also flooded the swales and some of the surrounding basins.
17

18 Another benefit was discovered during the flooding of basins. Non-native clover (*Trifolium spp.*) began
19 to disappear from the flooded areas. These were replaced in part by seeded and planted native grasses
20 and rushes. The native plant species were then able to maintain their establishment even after the water
21 levels receded. Short term flooding in late spring to early summer was found to help control undesirable
22 non-native species and to promote the establishment of desirable wetland species.
23

24 2.2 A8PII FOREST DEMONSTRATION PROJECT

25 The A8PII Forest Demonstration Project completed its second growing season in 2001. Most planting
26 was completed in Spring 2000. Shrubs and most seedlings were planted in Fall 2000. Some remaining
27 seedlings were planted in Spring 2001. As with the wetland mitigation project, monitoring results will be
28 presented in terms of both system-specific and patch-specific quantities.
29

30 2.2.1 Requirements

31 Since this project does not satisfy regulatory-driven mitigation requirements, the Implementation Phase
32 monitoring program is less involved than the wetland mitigation project. The forest demonstration
33 project NRRDP established monitoring requirements for vegetation survival and herbaceous cover, as

1 well as and evaluation of invasive species within the project area. These requirements are discussed in
2 more detail below.

3 4 2.2.1.1 Vegetation Survival

5 The A8PII NRRDP calls for 80 percent survival of all planted vegetation, with the exception of seedlings
6 (DOE 2000). Mortality counts were conducted at the end of the growing season in 2001. All sapling
7 trees and shrubs installed in A8PII were evaluated and assigned a viability category pursuant to the
8 approach discussed in Section 1.2.1. Results of this effort are provided in Section 2.2.2.1 below.

9 10 2.2.1.2 Herbaceous Cover

11 Seeded areas within the forest demonstration project must meet 90 percent cover. Like the wetland
12 mitigation project, the A8PII NRRDP did not specify that native cover must reach 90 percent. However,
13 the NRTs agreed to manage restored areas to maximize native cover.

14
15 Cover estimates were conducted pursuant to the process for Functional Phase monitoring set forth in
16 Appendix E. This approach utilizes broad cover class estimates instead of specific cover percentages.
17 Therefore, percent cover and percent native cover is presented in Tables 2-10 and B-2 in terms of cover
18 classes instead of percentages. These results are discussed in Section 2.2.2.2 below.

19 20 2.2.1.3 Other Requirements

21 The only other requirement for the A8PII Forest Demonstration Project specified in the NRRDP was a
22 report on the status of invasive species across the project area. The status is provided in Section 2.2.2.3
23 below.

24 25 2.2.2 Results and Discussion

26 The results of Implementation Phase monitoring for the forest demonstration project are presented in
27 Tables 2-9 and 2-10, and in Appendix B. Tables 2-9 and 2-10 provide summary information organized
28 by vegetative communities, while Tables B-1 and B-2 provide more detailed patch-specific and
29 quadrat-specific data. These monitoring results are discussed in greater detail below.

30 31 2.2.2.1 Vegetation Survival Results

32 Table 2-9 demonstrates that 24 of 39 patches met the 80 percent vegetation survival requirement. When
33 the project is viewed on a system basis, the only stressed community is the tallgrass savanna. Two factors

1 seemed to control woody plant mortality. First, most of the non-savanna patches that did not reach
2 80 percent survival experienced heavy deer damage. Patches RP3, RP4, MM22, and BS30 are located in
3 the southeastern portion of the project area, where some of the most severe deer damage was observed
4 (DOE 2001d). Several saplings were literally snapped in two by rubbing bucks.

5
6 The second factor appeared to be simply a matter of not locating planted vegetation. Table B-1 shows
7 that a number of individuals were unable to be located. Stringent quality control was maintained during
8 field implementation, so it is not possible that the vegetation was never planted (DOE 2001e). Instead,
9 the plants were not located during several round of field monitoring. There are several possible
10 explanations for this. First, unlike the wetland mitigation project, many of the patches in A8PII are very
11 large. Also, seeded areas and existing herbaceous vegetation grew tall, obscuring the view of many
12 shrubs and hickory seedlings. The hickory seedlings were tabulated as part of the vegetation survival
13 counts, because they were substituted for NRRDP-specified saplings that were commercially unavailable.
14 Lastly, some shrubs planted in the savanna may have been mowed during tallgrass maintenance activities.
15 Aside from the difficulties associated with conducting the mortality counts, most vegetative communities
16 established in A8PII appear to be progressing well.

17 18 2.2.2.2 Herbaceous Cover Results

19 As stated in Section 2.2.1.2 above, herbaceous cover estimates were presented in terms of cover class
20 instead of actual percentages. Cover classes represent a range of percentages that are easier to assign in
21 the field. Cover class 5 represents a percent cover of 75 of 100 percent. Table B-2 illustrates that all
22 sample points were assigned a cover class of five, with the exception of one quadrat in the material
23 handling area. Pursuant to the A8PII NRRDP, the material handling area does not need to meet the
24 90 percent cover requirement. It should be noted that additional notes on the herbaceous cover field
25 forms indicated that total cover exceeded 90 percent in all but two quadrats. The two quadrats that did
26 not exceed 90 percent cover were again located in the material handling area. In summary, field data
27 indirectly demonstrate that total herbaceous cover exceeded 90 percent in all seeded areas except the
28 material handling area.

29
30 A walk-through of A8PII leaves the observer with a general impression that seeded areas are progressing
31 extremely well. Many native grasses grew quickly and went to seed in the first growing season. Also, a
32 variety of forbs have been established, including black-eye Susan (*Rudbeckia hirta*), bergamot (*Monarda*
33 *fistulosa*), purple coneflower (*Echinacea purpurea*), ox-eye sunflower (*Heliopsis helianthoides*), and

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1 butterfly weed (*Asclepias tuberosa*). However, native cover did not exceed 60 percent in any seeded area
2 (Table 2-10). Nevertheless, as stated above, most seeded areas within A8P2 appear to be progressing
3 well. Therefore, corrective actions will focus on expanding the extent of native vegetation in the tallgrass
4 savanna, which had the second lowest percent native cover (44 percent, Table 2-10). This approach is
5 described in Section 2.2.3 below.

6 7 2.2.2.3 Other Results

8 Invasive species across the forest demonstration project area have been reduced. FEMP maintenance
9 personnel have conducted an "invasives sweep" across A8P2 several times in both 2000 and 2001.
10 Pursuant to the NRRDP, amur honeysuckle (*Lonicera mackii*) and multiflora rose (*Rosa multiflora*) are
11 mechanically removed or sprayed with Roundup herbicide in the spring and fall of each year. During the
12 most recent sweep in Fall 2001, the amount of non-native species present within the project area was
13 noticeably reduced. One problem area remained, along the northern drainage that separates the
14 Beech-Maple forest type from the Savanna habitat type. A large patch of multiflora rose, amur
15 honeysuckle, and Russian olive (*Elaeagnus angustifolia*) could not be sprayed with Roundup herbicide
16 because of their proximity to water. These plants will be mechanically removed in the Spring 2002
17 invasives sweep.

18 19 2.2.3 Replanting Strategy

20 As Section 2.2.2.1 described, 15 of 39 patches did not reach 80 percent survival. Because of this, a
21 replant strategy is required to compensate for the reduced survival. The replanting effort must, to the
22 extent feasible, meet the following criteria; replace lost species, maximize the chance for survival, and
23 minimize impacts to existing restored areas. The replanting strategy described below addresses these
24 criteria.

25
26 The first step is to determine the number of plants that need to be installed. Table B-1 calculates the
27 number of plants required to raise failed patches to 85 percent survival. A total of 83 plants must be
28 replanted within A8P2. Next, planting locations need to be determined. The majority of planted areas
29 within A8P2 are progressing very well. Most of the forest patches that failed are difficult to access.
30 Also, in order to maximize future survival, additional plantings in some areas should be avoided.
31 Therefore, instead of installing new trees and shrubs into failed patches, DOE proposes the formation of
32 three new planting areas (Figure 2-4). Replant Areas 1 and 2 will be treated as independent patches
33 during Implementation Phase monitoring in 2002. The siting of each replant area is discussed below.

1 Replant Area 1 will address plantings needed for patch OS1. Planting within OS1 should be avoided,
2 because the high nutrient content of the soil is suspected of reducing overall survival within the patch.
3 The location of Replant Area 1 is at the end of a mowed path, so the area is very accessible.
4

5 Replant Area 2 will combine the plantings needed for RP3, RP4, MM22, and BS30. This additional
6 planting area provides several benefits. First, it avoids some of the heaviest deer damage areas in the
7 southeast corner of the project area. Second, it expands the overall coverage of forest restoration in
8 A8P11. Lastly, it results in a single point of access and disturbance into the southern reaches of A8P11.
9 An additional access will be needed to reach this area, but impacts to the surrounding patches should be
10 minimal.
11

12 Replant Area 3 is the entire savanna habitat type. The area is level, open, and surrounded by a mowed
13 buffer strip, so access is not an issue. Shrubs only will be used to restore patch quantities. By using
14 shrubs, the density of trees species within the savanna is kept low.
15

16 The plant list for each replant patch is provided in Table 2-11. Species were selected based on the
17 species-specific mortality within each patch, as well as the overall survival of the species within A8P11.
18 All trees and shrubs used during replanting efforts will be container grown from local suppliers, if
19 available. Appropriate deer controls will be implemented on all vegetation. Additional deer control
20 measures may be implemented based on recommendations from local deer management experts, as called
21 for in the FEMP Deer Management Plan (DOE 2001d). Also, extra-wide mulch rings will be used,
22 especially around shrubs within the savanna patches, so that later field location is possible.
23

24 The approach for addressing native herbaceous cover will focus on further development of the tallgrass
25 savanna. This area will be sprayed with a selective herbicide in Spring 2002, and then interseeded with a
26 native grass and forb mix, if needed. Mowing of the area will also continue in order to reduce
27 competition from non-native species. Intensive management (aside from mowing) of other seeded areas
28 within A8P11 would probably be counter-productive at this point.
29

30 2.2.4 Maintenance and Management Summary

31 Maintenance and management activities within the forest demonstration project focused on weed control,
32 establishment of the tallgrass savanna, and deer protection. Invasive weeds were cut and/or sprayed on
33 several occasions in 2001. Several patches of thistle (*Cirsium spp.*) were removed from the beech-maple

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1 area and the tallgrass savanna. The tallgrass savanna was also mowed several times, in an attempt to
2 establish the native grasses and forbs seeded into the area in 2000. Deer tubes were replaced on several
3 saplings across A8PII, and deer repellent was sprayed on all trees and shrubs susceptible to browsing. All
4 of these efforts will require continued attention in 2002.

5
6 2.2.5 Lessons Learned

7 The first year of Implementation Phase monitoring for the forest demonstration project revealed two
8 points that need to be addressed. First, the impact of deer on planted vegetation requires continued
9 vigilance and new approaches. Despite protection of virtually all saplings with deer tubing and repellent
10 sprays, deer significantly reduced survival in several patches. The tubes were usually successful in
11 protecting the trunk of planted saplings, but the deer would snap off limbs above the tubing. On several
12 occasions, tubes were scrunched down or completely ripped off the tree. As stated above, several trees
13 were literally snapped in two. It is anticipated that approaches described in the FEMP Deer Management
14 Plan will reduce deer impacts to A8PII and other restoration projects across the site.

15
16 Second, the inability to locate some planted vegetation requires a revised approach to marking vegetation.
17 Several field visits were conducted across the project area. On each occasion, additional plants would be
18 found. It is possible that more plants would have been found during additional searches. However, the
19 search effort became too time consuming, and it was decided to record individuals as missing and assume
20 that they were dead for the purposes of calculating survival percentages. In the future, planted vegetation
21 will receive a 4-foot diameter mulch ring. This size ring was specified in the A8PII NRRDP, but it was
22 not always correctly installed in the field. This requirement will be scrutinized more closely during future
23 restoration projects. Also, shrubs and small trees that are planted in areas of high grass will be flagged for
24 easier identification from heavy equipment. It is suspected that some shrubs were mowed over as part of
25 maintenance activities in the tallgrass savanna.

TABLE 2-1
A1PI WETLAND MITIGATION PROJECT
VEGETATION SURVIVAL SUMMARY

Basin	Survival Rate Based on No. Planned (%)
1	81%
2	78%
3	105%
4	75%
5	49%
6	93%
7	79%
8	93%
upland	62%

TABLE 2-2
A1PI WETLAND MITIGATION PROJECT
HERBACEOUS COVER SUMMARY

Basin	Average Percent Cover	Average Percent Native Cover	Hydrophytic Vegetation Present?
1	90	72	Yes
2	88	33	No
3	87	22	No
4	97	40	Yes
5	28	33	No
6	91	57	Yes
7	98	39	No
8	97	26	No
upland	94	27	No

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**TABLE 2-3
 AIPI WETLAND MITIGATION PROJECT
 WATER LEVELS**

All values measured in feet

Basin No.	Spring Sample Date: 5/15/01			Fall Sample Date: 11/20/01			Pond Sample Date: 5/8/01			Swale Sample Date: 5/8/01		
	Well Depth	Depth to Water	Water Column Height	Well Depth	Depth to Water	Water Column Height	Water Elevation	Floor Elevation	Depth	Water Elevation	Floor Elevation	Depth
1	1.45	0.95	0.50	1.52	0.40	1.12	600.36	598.46	1.9	600.36	598.46	1.9
2	1.57	1.24	0.33	1.56	0.58	0.98	606.01	604.27	1.74	605.36	604.64	0.72
3	1.47	0.9	0.57	1.54	0.60	0.94	NA	NA	NA	610.18	609.2	0.98
4	1.46	0.12	1.34	Underwater		NA	612.4	611.1	1.3	612.17	611.05	1.12
5	1.46	0.73	0.73	1.54	1.20	0.34	NA	NA	NA	NA	NA	NA
6	1.45	Dry	0	1.54	0.82	0.72	NA	NA	NA	Dry	Dry	Dry
7	1.46	Dry	0	1.54	0.99	0.55	NA	NA	NA	Dry	Dry	Dry
8	1.18	Dry	0	1.25	1.25	0	NA	NA	NA	NA	NA	NA

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**TABLE 2-4
 A1PI WETLAND MITIGATION PROJECT
 WATER QUALITY RESULTS**

Location	Date	Color	Odor	Temperature (Celcius)	pH	Specific Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)
Basin 1 Pond	5/22/01	clear	none	20.7	8.11	0.833	1	7.58
	10/27/01	clear	none	10.8	7.95	0.411	3	10.32
Basin 2 Pond	5/22/01	clear brown	none	21.0	7.91	0.272	1	5.79
	10/27/01	clear	none	11.9	8.64	0.288	0	11.52
Basin 4 Pond	5/22/01	clear brown	none	20.8	8.02	0.238	11	6.39
	10/27/01	clear	none	11.3	8.08	0.302	9	10.58
Basin 5 Pond	5/22/01	stained	none	20.6	7.63	0.496	28	4.31
	10/27/01	clay brown	none	11.3	7.78	0.397	258	4.95
Basin 6 Pond	5/22/01	clear orange	none	20.6	7.36	0.950	3	2.74
	10/27/01	clear	none	9.6	7.99	0.686	3	11.65

NTU – Nephelometric Turbidity Units

Note – Time and weather conditions for sampling events: 5/22/01 = 10:45am – 11:15am, sunny, 62
 10/27/01 = 1:30pm – 2:00pm, sunny, 65

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**TABLE 2-5
 A1PI WETLAND MITIGATION PROJECT
 SOIL SAMPLING RESULTS**

Sample Date: 6/28/01

Sample ID	Basin	Sample length	Color	Hydric?	Moisture Content	Soil Type
W1-1	1	4"	2" 10YR 4/2, brown 2" 10YR 3/2, brown	No	Damp	1" Silty, sandy clay 3" Silty clay
W1-2	1	5"	2.5Y 4/2, light olive, mottled	yes	Moist to wet	Silty clay, roots
W1-3	1	Crumbled	Top 10YR 5/3, light brown Bottom 10YR 4/2, brown	No	Top Dry Bottom Damp	Silty clay
W1-4	1	3"	10YR 4/2, brown	No	Dry to damp	Silty, sandy clay with mulch
W2-1	2	3"	10YR 4/3, brown	No	Dry to damp	Silty clay
W2-2	2	4"	10YR 4/3, brown, mottled	No	Damp to moist	Silty clay
W2-3	2	3"	10YR 4/2, brown	No	1" Damp 2" Damp to moist	1" Silty clay 2" Clay
W2-4	2	3"	10YR 4/3, brown	No	Dry	1.5" Silty clay 1.5" Clay
W2-5	2	Crumbled	Top 10YR 4/3, brown Bottom 10YR 3/1, very, very dark brown (almost black)	Yes	NA	NA
W3-1	3	4"	1" 10YR 6/3, light brown 3" 10YR 4/2, brown	No	1" Dry 3" Damp	1" Silty clay 3" Clay
W3-2	3	4"	1" 2.5Y 6/3, light gray-brown 3" 2.5Y 5/2, light olive	No	1" Dry 3" Damp	1" Silty clay 3" Clay
W3-3	3	3"	10YR 4/2, dark brown, mottled	Yes	Moist	Clay
W3-4	3	4"	2.5YR 5/2, light olive, mottled	Yes	Moist to wet	Clay with mulch
W4-1	4	4"	2" 10YR 4/2, brown 2" 10YR 5/3, light brown Mottled	No	2" Moist to wet 2" Damp	Clay
W4-2	4	3"	10YR 5/3, light brown	No	Dry	Clay
W4-3	4	4"	10YR 5/3, light brown, mottled	No	Damp	Clay
W4-4	4	4"	10YR 3/3, dark brown	No	Damp	Clay
W5-1	5	NA	10YR 4/2, brown	No	Damp	Silty, sandy clay with mulch
W5-2	5	NA	10YR 4/2, brown	No	Moist	Clay with mulch
W6-1	6	5"	10YR 3/2, dark brown	No	Damp	Top silty clay Bottom clay

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TABLE 2-5
A1PI WETLAND MITIGATION PROJECT
SOIL SAMPLING RESULTS
(Continued)

Sample ID	Basin	Sample length	Color	Hydric?	Moisture Content	Soil Type
W6-2	6	2"	10YR 4/2, brown	No	Dry to damp	Clay
W6-3	6	Crumbled	10YR 5/3, light brown	No	Dry	Silty, sandy, clay
W6-4	6	Crumbled	<i>Top</i> 10YR 4/3, brown <i>Bottom</i> 10YR 3/1 very, very, dark brown (almost black)	Yes	NA	Silty clay to clay
W7-1	7	Crumbled	10YR 3/2, dark brown	No	Dry to damp	Silty clay
W7-2	7	3"	2.5Y 3/1, very dark olive gray	Yes	Moist to wet	Clay
W7-3	7	Crumbled	10YR 4/2, brown	No	Dry to damp	Silty clay to clay
W8-1	8	Crumbled	10YR 4/3, brown	No	Dry to damp	Silty clay
W8-2	8	Crumbled	10YR 3/2, dark brown	No	Dry to damp	Clay

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TABLE 2-6
A1PI WETLAND MITIGATION PROJECT
WILDLIFE OBSERVATIONS

Birds:

Agelaius phoeniceus (Red-Winged Blackbird)
Aix sponsa (Wood Duck)
Anas discors (Blue-winged Teal)
Anas platyrhynchos (Mallard)
Ardea herodias (Great Blue Heron)
Branta canadensis (Canada Goose)
Bucephala albeola (Bufflehead)
Buteo jamaicensis (Red Tailed Hawk)
Butorides striates (Green Heron)
Cardullis tristis (American Goldfinch)
Carnialis cardinalis (Northern Cardinal)
Cathartes aura (Turkey Vulture)
Ceryle alcyon (Belted Kingfisher)
Charodrius vociferu (Killdeer)
Corus brachyrhynchos (American Crow)
Cyanocarax cristata (Blue Jay)
Falco sparverius (Kestrel)
Fulica americana (American Coot)
Gallinago gallinago (Common Snipe)
Hirundo rustic (Barn Swallow)
Lophodytes cucullatus (Hooded Merganser)
Meleagnes gallopavo (North American Turkey)
Meleagris gallopavo (Wild Turkey)
Mimus polyglottos (Northern Mockingbird)
Molothrus ater (Brown-Headed Cowbird)
Nycticorax nycticorax (Black Crowned Night Heron)
Passer domesticus (House Sparrow)
Passerina cyanea (Indigo Bunting)
Porzana carolina (Sora)
Progne subis (Purple Martin)
Quiscalus quiscula (Common Grackle)
Sialia sialis (Eastern Bluebird)
Sturnella magna (Eastern Meadowlark)
Sturnus vulgaris (European Starling)
Tachycineta bicolor (Tree Swallow)
Toxostoma rufum (Brown Thrasher)
Tringa flavipes (Lesser Yellowlegs)
Tringa melanoleuca (Greater Yellowlegs)
Tringa solitaria (Solitary Sandpiper)
Troglodytes aedon (House Wren)
Turdus migratorius (American Robin)
Tyrannus tyrannus (Eastern Kingbird)
Zenaida macroura (Mourning Dove)

Herpetofauna:

Acris crepitans (Cricketfrog)
Ambystoma opacum (Marbled Salamander)
Bufo americanus (American Toad)
Nerodia spiedon (Northern Watersnake)
Pseudacris crucifer (Spring Peeper)
Rana catesbeina (Bullfrog)
Rana clamitans (Green Frog)

Mammals:

Apodemus sp. (Field Mouse)
Canis latrans (Coyote)
Mephitis mephitis (Striped Skunk)
Microtus pennsylvanicus (Meadow Vole)
Mustela vison (Mink)
Odocoileus virginianus (White-Tailed Deer)
Procyon lotor (North American Raccoon)
Sciurus carolinensis (Gray Squirrel)
Sciurus niger (Fox Squirrel)
Sylvilagus floridanus (Cottontail Rabbit)
Urocyon cinereoarlentus (Gray Fox)
Vulpes vulpes (Red Fox)

Other:

Crayfish species

TABLE 2-7
A1PI WETLAND MITIGATION PROJECT
HERBACEOUS LAYER REPLANT STRATEGY

Plugs for Spring 2002 Planting	No. of Plugs
Grasses/Sedges	
Woolgrass (<i>Scirpus cyperinus</i>)	128
Blue Joint Grass (<i>Calamagrostis canadensis</i>)	128
Bottlebrush Sedge (<i>Carex lurida</i>)	128
Fox Sedge (<i>Carex stipata</i>)	128
Dark Green Bulrush (<i>Scirpus atrovirens</i>)	128
Prairie Cordgrass (<i>Spartina pectinata</i>)	128
Wildflowers	
Red Milkweed (<i>Asclepias incarnata</i>)	96
Wild Senna (<i>Cassia hebecarpa</i>)	72
Great Blue Lobelia (<i>Lobelia siphilitica</i>)	96
Cardinal Flower (<i>Lobelia cardinalis</i>)	72
Bergamot (<i>Monarda fistulosa</i>)	72
Sweet Joe-Pye Weed (<i>Eupatorium maculatum</i>)	96

TABLE 2-8
A1PI WETLAND MITIGATION PROJECT
REPLANT STRATEGY FOR THE RADIUM HOT SPOT

Patch No.	Common Name	Scientific Name	Propigation Method	Size	Plants
1	False Indigo Bush	<i>Amorpha fruticosa</i>	Root suckers	0.06 ac.	276
2	Buttonbush	<i>Cephalanthus occidentalis</i>	Seed	0.08 ac.	368
3	Silky Dogwood	<i>Cornus amomum</i>	Cuttings	0.02 ac.	92
4	Red-Osier Dogwood	<i>Cornus stolonifera</i>	Cuttings	0.02 ac.	92
5	Water Willow	<i>Decondon verticillatus</i>	Cuttings	0.02 ac.	92
6	Shrubby St. John's Wort	<i>Hypericum spathulatum</i>	Root suckers	0.03 ac.	138
7	Winterberry	<i>Ilex verticulata</i>	Cuttings	0.01 ac.	46
8	Swamp Rose	<i>Rosa palustris</i>	Root suckers	0.02 ac.	92
9	Pussy Willow	<i>Salix discolor</i>	Cuttings	0.045 ac.	207
10	Heart-Leaf Willow	<i>Salix eriocephala</i>	Cuttings	0.025 ac.	115
11	Black Willow	<i>Salix nigra</i>	Cuttings	0.025 ac.	115
12	Silky Willow	<i>Salix sericea</i>	Cuttings	0.035 ac.	161
13	Elderberry	<i>Sambucus canadensis</i>	Cuttings	0.025 ac.	115
14	Coralberry	<i>Sympnoricarpos orbiculatis</i>	Root suckers	0.045 ac.	207

**TABLE 2-9
A8PII FOREST DEMONSTRATION PROJECT
VEGETATION SURVIVAL SUMMARY**

A8PI ECOLOGICAL RESTORATION VEGETATION SURVIVAL**Patch-Specific Survival:**

Existing Riparian		Mesophytic		Beech Maple		Oak Maple		Savanna		Buffer Area	
Patch	% Surv.	Patch	% Surv.	Patch	% Surv.	Patch	% Surv.	Patch	% Surv.	Patch	% Surv.
RP1	83	MM8	93	BS23	90	OS1	71	SV1	58	BF31	83
RP2	82	MM9	88	BS24	83	OS2	82	SV2	50		
RP3	63	MM10	85	BS25	83	OS3	84	SV3	25		
RP4	44	MM11	88	BS26	82	OS4	84	SV4	78		
RP5	89	MM12	80	BS27	86			SV5	60		
		MM13	80	BS28	86			SV6	59		
		MM14	83	BS29	82			SV7	50		
		MM19	84	BS30	75			SV8	77		
		MM20	83					SV9	56		
		MM21	81					SV10	31		
		MM22	73								
Totals =	78%		83%		84%		80%		54%		83%

**TABLE 2-10
A8PI FOREST DEMONSTRATION PROJECT
HERBACEOUS COVER SUMMARY**

Area	Average Cover Class	Percent Native Cover
Oak-Maple Habitat Type	5	38
Savanna Habitat Type	5	44
Wetland Area	5	51
Drainage Swales, Berms, and the Materials Handling Area	4.75	59

Note: Cover classes were used instead of percent cover estimates. However, percent cover was noted on the field data forms. In all instances except for two, percent cover met or exceeded 90 percent.

TABLE 2-11
A8PII FOREST DEMONSTRATION PROJECT
REPLANT STRATEGY

Replant Area 1

Scientific Name	Common Name	Type	Size	Qty.	Addresses
<i>Acer saccharum</i>	sugar maple	tree	2 gal.	1	OS1
<i>Carya ovata</i>	shagbark hickory	tree	2 gal.	2	OS1
<i>Quercus imbricaria</i>	shingle oak	tree	2 gal.	2	OS1
<i>Quercus muhlenbergii</i>	chinquapin oak	tree	2 gal.	2	OS1
<i>Rhus glabra</i>	smooth sumac	shrub	1 gal.	2	OS1
<i>Symphiocarpus orbiculatus</i>	corralberry	shrub	1 gal.	2	OS1

Total = 11

Replant Area 2

Scientific Name	Common Name	Type	Size	Qty.	Addresses
<i>Acer rubrum</i>	red maple	tree	2 gal.	4	RP3, MM22
<i>Acer saccharum</i>	sugar maple	tree	2 gal.	2	BS30
<i>Aesculus glabra</i>	Ohio buckeye	tree	2 gal.	2	MM22
<i>Asima triloba</i>	paw paw	tree	2 gal.	3	RP3, RP4
<i>Carya ovata</i>	shagbark hickory	tree	2 gal.	5	RP3, RP4, BS30
<i>Cercis canadensis</i>	redbud	tree	2 gal.	4	RP3, RP4
<i>Cornus florida</i>	flowering dogwood	tree	2 gal.	4	RP3, RP4
<i>Tilia americana</i>	American basswood	tree	2 gal.	2	MM22

Total = 26

Replant Area 3

Scientific Name	Common Name	Type	Size	Qty.	Addresses
<i>Corylus americana</i>	hazel	shrub	1 gal.	1	SV1
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	1	SV1
<i>Corylus americana</i>	hazel	shrub	1 gal.	2	SV2
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	3	SV2
<i>Prunus virginiana</i>	choke cherry	shrub	1 gal.	3	SV3
<i>Rhus glabra</i>	smooth sumac	shrub	1 gal.	3	SV3
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	2	SV3
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	1	SV4
<i>Rhus glabra</i>	smooth sumac	shrub	1 gal.	3	SV5
<i>Corylus americana</i>	hazel	shrub	1 gal.	2	SV6
<i>Prunus virginiana</i>	choke cherry	shrub	1 gal.	2	SV6
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	2	SV6
<i>Corylus americana</i>	hazel	shrub	1 gal.	1	SV7
<i>Rhus glabra</i>	smooth sumac	shrub	1 gal.	3	SV7
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	2	SV7
<i>Rubus occidentalis</i>	black raspberry	shrub	1 gal.	2	SV7
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	1	SV8
<i>Corylus americana</i>	hazel	shrub	1 gal.	2	SV9
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	3	SV9
<i>Rhus glabra</i>	smooth sumac	shrub	1 gal.	3	SV10
<i>Rosa setigera</i>	prairie rose	shrub	1 gal.	2	SV10
<i>Rubus occidentalis</i>	black raspberry	shrub	1 gal.	2	SV10

Total = 46

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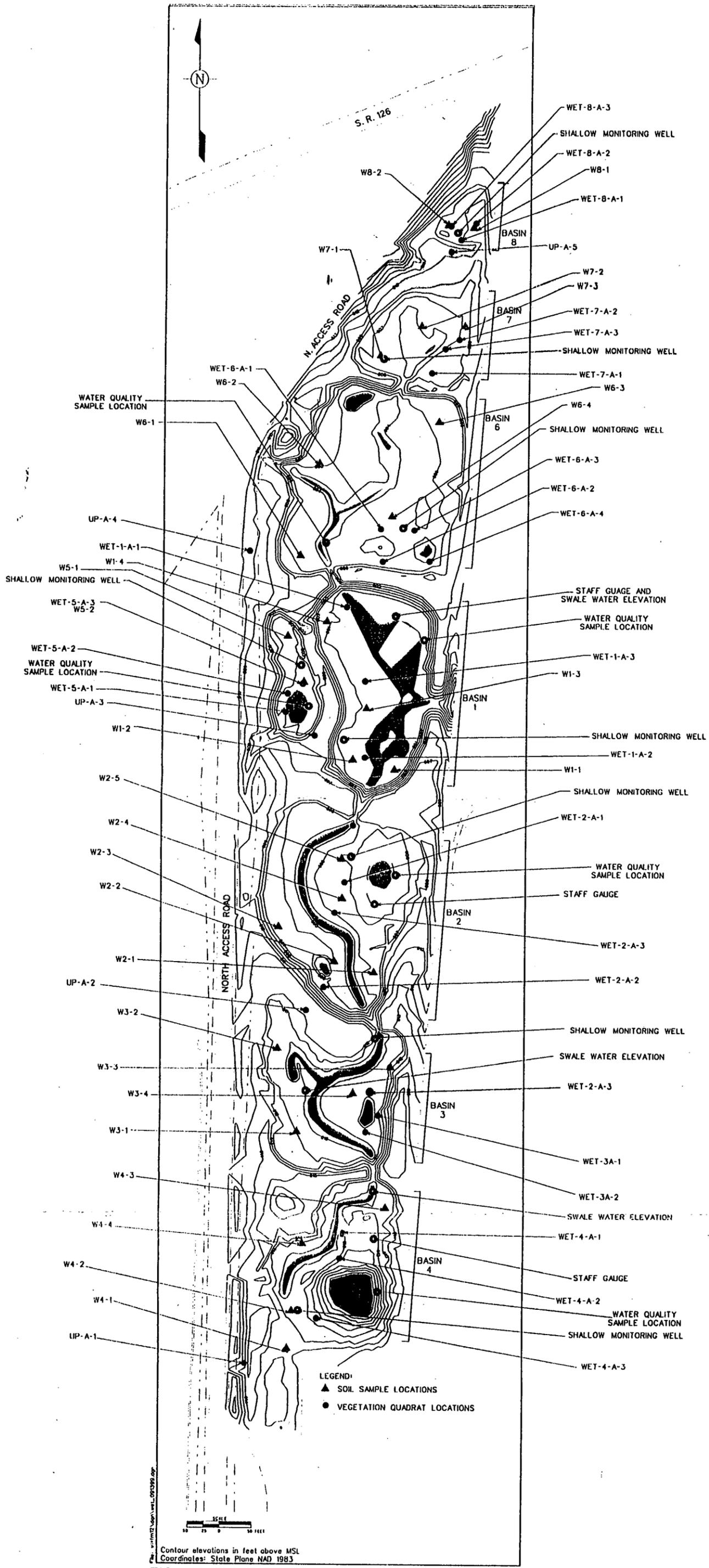
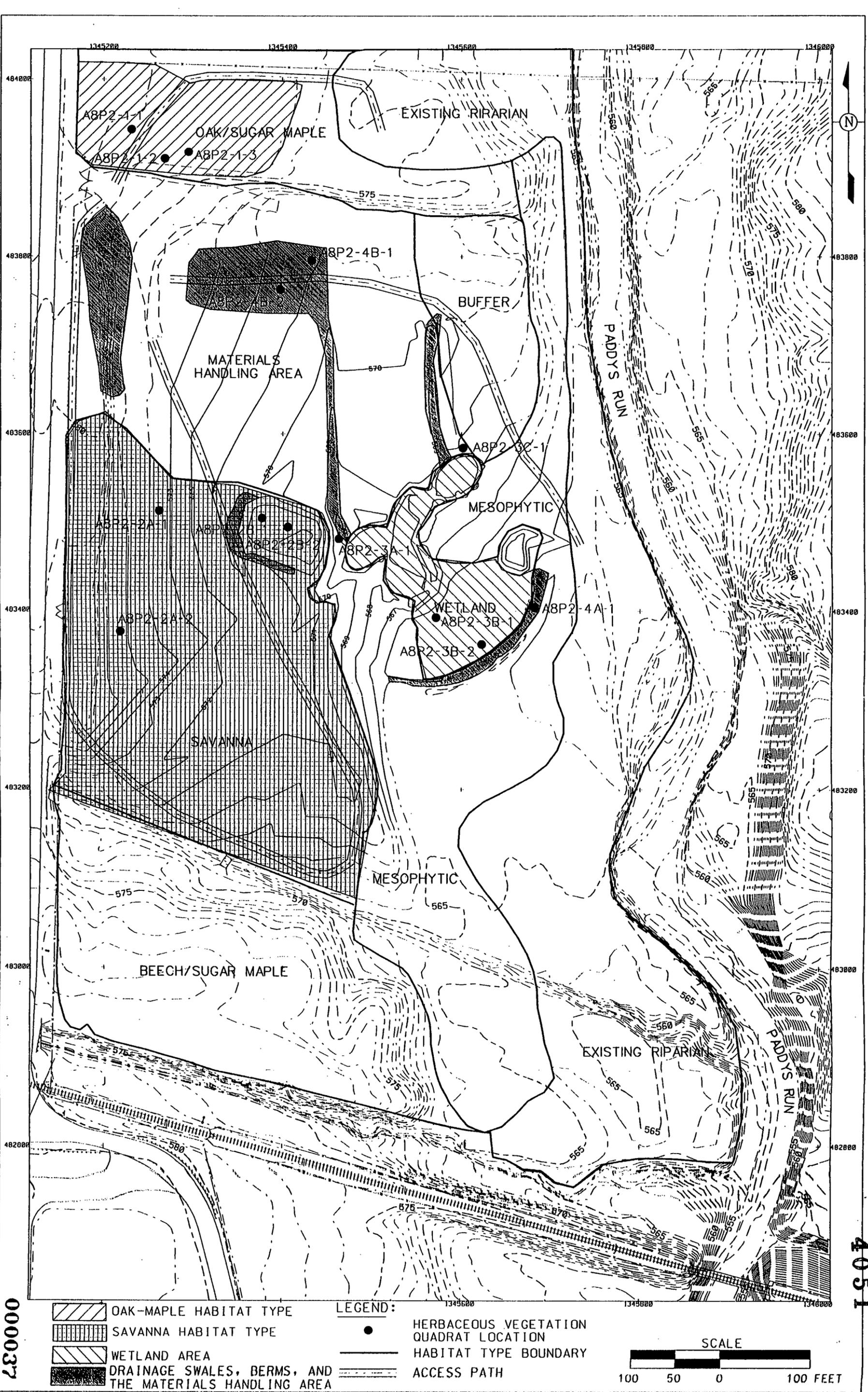


FIGURE 2-1. A1PI WETLAND MITIGATION PROJECT

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FIGURE 2-3. AREA 8, PHASE II FOREST DEMONSTRATION PROJECT

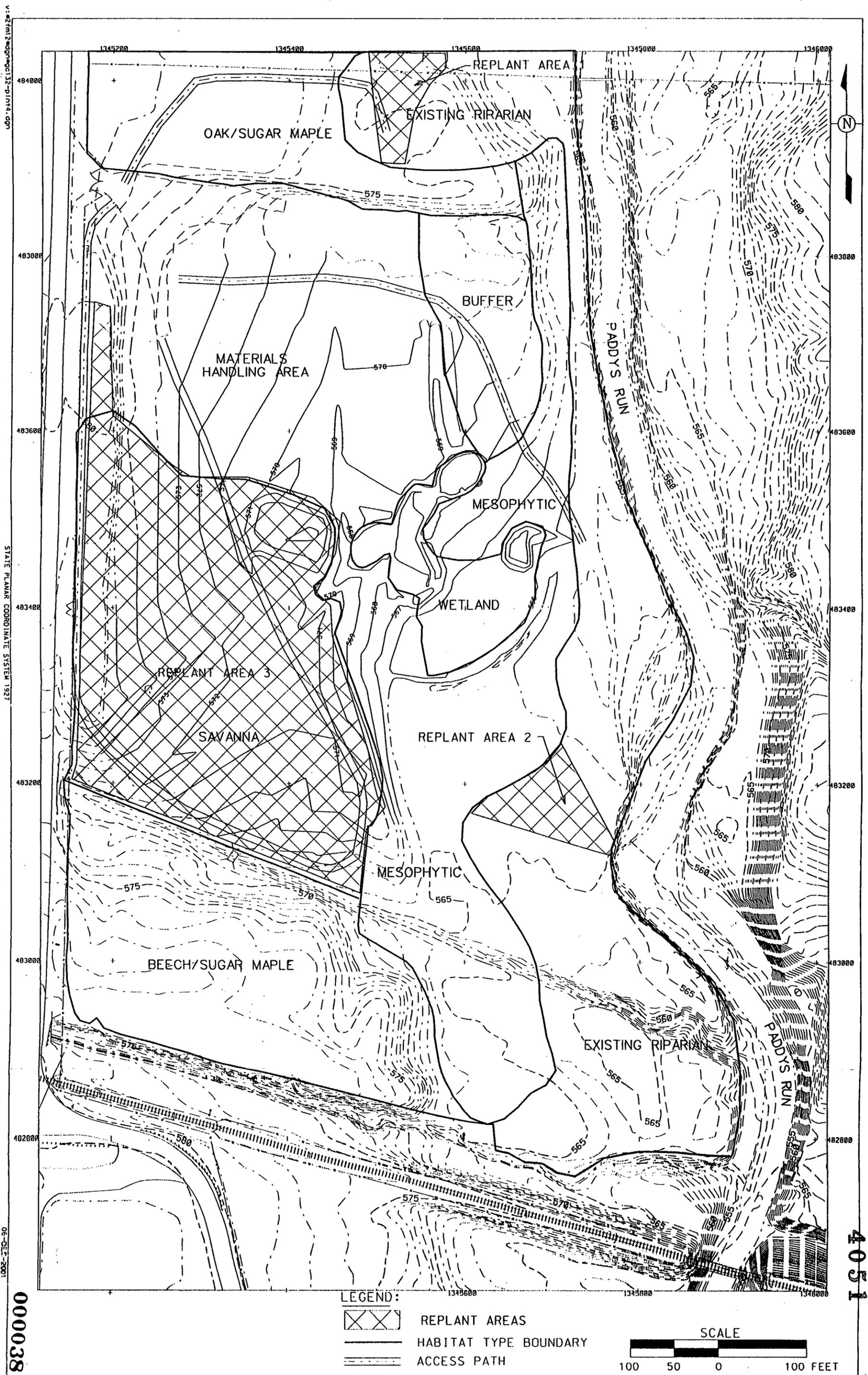


FIGURE 2-4. AREA 8, PHASE II REPLANT STRATEGY

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3.0 FUNCTIONAL PHASE MONITORING

The approach and methodology for Functional Phase monitoring is discussed in Section 1.2.2 and in Appendix E. As stated in Section 1.2.2, functional monitoring activities in 2001 consisted of establishing the baseline ecological conditions for representative communities at the FEMP. The interim results of the baseline monitoring effort are discussed below. An additional baseline survey will be conducted in the spring of 2002, so final baseline conditions will be presented in the 2002 monitoring report, along with an evaluation of ecological reference sites.

Summary calculations for each baseline community are presented in Table 3-1. Species lists for each area are provided in Appendix C. The herbaceous data and woody data in Table 3-1 are presented separately. For the herbaceous layer, the FQAI and Simpson's Index calculations fell generally as expected, with a few exceptions. The successional woodlot had the highest FQAI value and second highest diversity, while the grazed pasture had the lowest FQAI score. Non-native grasses and forbs dominate the grazed pasture, which results in a low floristic quality value (Table C-1).

The FQAI value and diversity for the open water was unexpectedly high. This area was seeded with native grasses and forbs following excavation, so big bluestem (*Andropogon gerardi*), switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and partridge pea (*Cassia fasciculata*) were all identified within the open water area (Table C-5). These species would not normally pioneer into recently disturbed subsoil, so their presence artificially inflates the vegetation indices for the open water system. If they were removed, the FQAI value would drop to 7.09, and diversity would be recalculated as 19.28. Since the intent of baseline characterization is to determine site conditions absent of any restoration activities, DOE proposes to adjust the final open water vegetation indices by removing seeded species. This approach is more efficient than developing a new open water baseline location, and will more accurately reflect what baseline conditions should be.

Several interesting herbaceous species were found in 2001, including a ragged fringed orchid (*Habenaria lacera*) in the pine plantation (Table C-4). Wild ginger (*Asarum canadense*) and showy tick trefoil (*Desmodium canadense*) were located in the riparian habitat (Table C-2).

Woody vegetation data was as expected, with the pine plantation showing a lower floristic quality and diversity than the riparian or woodlot systems (Table 3-1). The FQAI score would be even lower if the

1 non-native white pine (*Pinus strobus*) was given a zero score. Currently, white pine has a coefficient of
2 conservatism (CC) value of six (Table C-4). Since it is not native to southwest Ohio, white pine should
3 receive a value of zero. However, the CC values used for calculating FQAI scores are applicable to
4 northeast Ohio instead of southwest Ohio. Statewide CC values have been developed and will be
5 published soon (Mack 2001). Once statewide CC values are available, site FQAI scores will be
6 recalculated and presented in the next consolidated monitoring report. The adjusted CC values will be
7 more representative of ecological communities in southwest Ohio.

8
9 Results from breeding bird surveys and migratory waterfowl observations are presented in Tables 3-2
10 and 3-3, respectively. These results are also as expected. The successional woodlot had the highest
11 number of species and individuals observed. Migratory waterfowl observations within the open water
12 baseline location revealed that only Canada geese and mallards used the system.

13
14 Other parameters used to characterize baseline ecological systems at the FEMP include amphibian
15 surveys, macroinvertebrate sampling, and butterfly surveys. These activities are controlled by OEPA, so
16 they will not be reported on within this document.

17
18 In 2002, a spring survey will be conducted to complete the characterization of baseline conditions at the
19 FEMP. Reference sites will also be established and characterized in 2002. As stated in Section 1.2.2,
20 ecological systems within restored areas will be compared to appropriate reference sites. Specific
21 reference sites need to be determined, but the communities to be characterized include upland
22 beech-maple/oak hickory forest complex, wet forest, riparian forest, emergent wetlands with some open
23 water, wet meadow/freshwater marsh, and tallgrass prairie. Further information regarding the selection
24 and characterization of reference sites is provided in Appendix E.

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**TABLE 3-1
BASELINE ECOLOGICAL MONITORING INTERIM DATA SUMMARY**

Herbaceous Data

Area	Average CC	Total Spp.	FQAI	Total Cover	MSI
Open Water	1.67	36	10.00	167	25.53
Grazed Pasture	0.42	33	2.41	305	12.27
Riparian	2.12	31	11.80	233	11.94
Pinelot	2.07	32	11.70	174	15.16
Woodlot	2.00	42	12.96	248	22.21

Woody Data

Area	Average CC	Total Spp.	FQAI	Total Abundance	MSI
Riparian	3.50	20	15.65	330	6.27
Woodlot	3.18	20	14.21	538	4.91
Pinelot	3.00	14	11.22	264	4.75

**TABLE 3-2
BASELINE BREEDING BIRD SURVEY SUMMARY**

Grazed Pasture		Riparian		Successional Woodlot		Pine Plantation	
Species	Qty.	Species	Qty.	Species	Qty.	Species	Qty.
red winged blackbird	36	Carolina chickadee	11	American robin	32	American goldfinch	40
eastern meadowlark	21	Acadian flycatcher	8	northern cardinal	32	northern cardinal	31
song sparrow	10	northern cardinal	8	rufous-sided towhee	29	house wren	22
Barn swallow	8	Red-eyed vireo	8	brown-headed cowbird	19	Carolina chickadee	18
mourning dove	8	Carolina wren	7	song sparrow	18	yellow-throated warbler	13
American robin	6	wood thrush	7	indigo bunting	16	indigo bunting	12
American goldfinch	5	American robin	5	field sparrow	13	rufous-sided towhee	11
brown-headed cowbird	5	tufted titmouse	5	American goldfinch	12	blue-gray gnatcatcher	10
eastern kingbird	5	blue-gray gnatcatcher	4	white-eyed vireo	12	Gray catbird	9
rough-winged swallow	5	common flicker	4	Carolina chickadee	11	chipping sparrow	6
common grackle	3	Great crested flycatcher	3	blue-gray gnatcatcher	10	American crow	4
common yellowthroat	2	eastern wood-peewee	2	common yellowthroat	9	white-eyed vireo	4
indigo bunting	2	red-bellied woodpecker	2	cedar waxwing	7	Brown-headed cowbird	3
Northern flicker	2	downy woodpecker	1	European starling	7	Carolina wren	3
red-tailed hawk	2	house wren	1	house wren	6	Cedar waxwing	3
American crow	1	indigo bunting	1	gray catbird	5	American robin	2
belted kingfisher	1	Scarlet tanager	1	mourning dove	5	song sparrow	2
blue jay	1	White breasted nuthatch	1	blue jay	4	Downy woodpecker	1
bobwhite quail	1	yellow-throated warbler	1	yellow-breasted chat	4	tufted titmouse	1
Carolina chickadee	1			American crow	3		
Carolina wren	1			Carolina wren	3		
eastern bluebird	1			downy woodpecker	3		
Field sparrow	1			eastern kingbird	3		
Great blue heron	1			scarlet tanager	3		
House finch	1			yellow-throated warbler	3		
Killdeer	1			bobwhite quail	2		
northern mockingbird	1			common grackle	2		
Red-bellied woodpecker	1			Cooper's hawk	2		
red-eyed vireo	1			eastern-wood peewee	2		
				red-bellied woodpecker	2		
				red-eyed vireo	2		
				acadian flycatcher	1		
				brown thrasher	1		
				common flicker	1		
				eastern bluebird	1		
				killdeer	1		
				orchard oriole	1		
				pileated woodpecker	1		
				red-tailed hawk	1		
				ruby-throated hummingbird	1		
				tufted titmouse	1		
				wood thrush	1		

**TABLE 3-3
BASELINE OPEN WATER
MIGRATORY WATERFOWL OBSERVATIONS**

Date	Species	Sex	No.
3/22/01	Canada goose	M	1
	Canada goose	F	1
	mallard	M	1
3/26/01	Canada goose	nd	24
	mallard	M	4
	mallard	F	4
3/27/01	Canada goose	nd	9
	mallard	M	1
	mallard	F	1
3/28/01	Canada goose	nd	3
	mallard	M	1
	mallard	F	1
3/29/01	(no waterfowl present)		

4.0 RESTORATION RESEARCH PROJECTS

This section provides data collected in support of the A8PI Revegetation Research Plots. This research effort was required as part of a dispute resolution between DOE and the regulatory agencies for missed milestones associated with Operable Unit 4. Miami University submitted a research plan that sought to determine the most effective density of saplings and seedlings for forest restoration at the FEMP site (DOE 1998). Since the initiation of the project, planting densities were negotiated between the NRTs. Also, the sapling trees planted within the research plots began to experience heavy deer pressure. Therefore, DOE decided to protect the saplings and close the research contract with Miami University. DOE committed to collecting sapling survival data, and to evaluate the effectiveness of deer control efforts within the research area. Vegetation survival was assessed in Fall 2001. These results are presented in Tables 4-1, 4-2 and Appendix D. A discussion of the results is provided below.

Table 4-1 shows the percent survival per plot. Sapling survival continues to remain high in all plots, with all plots exceeding 70 percent survival (excluding resprouts). Overall sapling survival was 73 percent. This is 5 percent lower than what was reported last year (DOE 2001f). However, given the extent of deer damage observed across the project area in 1999 and 2000, some increased mortality would be expected. It should be noted that many of the trees still showed signs of stress (i.e., early leaf drop), so future reductions may still occur.

Percent survival by species is presented in Table 4-2. Survival rates ranged from 88 percent for chinquapin oak (*Quercus muehlenbergii*) to 47 percent for green ash (*Fraxinus pennsylvanicum*). The low survival of green ash saplings within the research plots is due to the heavy deer pressure they received. Green ash saplings were more frequently and more severely rubbed than any other species within the research plots (Table D-1). It is suspected that rubbing deer preferred the light-colored, relatively smooth bark characteristics of green ash saplings.

Trunk diameters of all living saplings show that Ohio buckeye (*Aesculus glabra*) is experiencing the fastest rate of growth within the project area (Table 4-2). A number of buckeyes can be found in adjacent wooded areas, so it appears that this species is well suited for the location of the project. Also, during field installation of the saplings in 1999, 11 smaller, container-grown buckeyes were procured. All of these plants were installed in Plot H. These container-grown plants have generally grown at a faster rate than the balled and burlapped saplings (Table D-1). This is perhaps due to the fact that the

1 container-grown species are placed in the ground with an intact root mass, so energy can immediately be
2 used to develop the aboveground portion of the plant. Balled and burlapped trees must expend resources
3 to restore a root system during the first several growing seasons.

4
5 Seedling survival and volunteer recruitment were not quantified within the research plots. As stated
6 above, planting densities were negotiated independently of this effort, so the focus of research shifted to
7 sapling survival. Field observations revealed that a number of seedlings were surviving, and that
8 volunteer recruits were populating both the control and research plots.

TABLE 4-1
ASPI REVEGETATION RESEARCH PLOTS
SAPLING SURVIVAL SUMMARY

Plot	No. Planted	No. Alive	No. Resprout	No. Dead	Percent Survival	Average Growth (mm)
A	100	75	11	14	75%	2.0
D	50	36	9	5	72%	1.4
E	50	36	6	8	72%	1.8
H	100	72	11	17	72%	2.8

TABLE 4-2
ASPI REVEGETATION RESEARCH PLOTS
SPECIES-SPECIFIC SURVIVAL SUMMARY

Species	Common Name	No. Planted	No. Alive	No. Resprout	Percent Survival	Average Growth (mm)
<i>Aesculus glabra</i>	Ohio buckeye	60	52	2	87%	3.4
<i>Celtis occidentalis</i>	hackberry	60	47	3	78%	1.5
<i>Fraxinus pennsylvanicum</i>	green ash	60	28	14	47%	2.1
<i>Juglans nigra</i>	black walnut	60	39	13	65%	1.7
<i>Quercus muehlenbergii</i>	chinquapin oak	60	53	5	88%	1.7

- 1 U.S. Department of Energy, 2001d, "Fernald Environmental Management Project Site Deer Management
2 Plan," Draft, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.
3
- 4 U.S. Department of Energy, 2001e, "Area 8, Phase II Natural Resource Restoration Project Completion
5 and Lessons Learned Report," Final, Fernald Environmental Management Project, DOE, Fernald Area
6 Office, Cincinnati, OH.
7
- 8 U.S. Department of Energy, 2001f, "2000 Annual Report for Area 8, Phase I Revegetation Research
9 Plots," Final, Miami University Task Order 12, Fernald Environmental Management Project, DOE,
10 Fernald Area Office, Cincinnati, OH.

APPENDIX A

A1PI WETLAND MITIGATION PROJECT DATA

**TABLE A-1
AIFI WETLAND MITIGATION PROJECT VEGETATION SURVIVAL DATA**

Location		Initial Planting		2000 Counts					Replant Data			2001 Counts					
Patch	Basin	No. Individuals Planned	No. Individuals Planted in 1999	No. Alive	No. Dead	No. Resprout	Survival Rate Based on No. Planted (%)	Survival Rate Based on No. Planned (%)	Total Individuals Planted in Fall 2000	Total Individuals Planted and Alive 1999-2000	Total Individuals Planted in Spring 2001	2001 Baseline	No. Alive	No. Dead	No. Resprout	Survival Rate Based on 2001 Baseline(%)	Survival Rate Based on # Planned (%)
UF2	upland	48	36	10	26	6	28	21		10		10	11	4	5	110	23
UF3	upland	35	19	8	11	6	42	23	16	24		24	21	7	4	88	60
UF4	upland	13	13	11	2	0	85	85	5	16		16	7	5	3	44	54
UF5	upland	26	27	16	11	5	59	62	5	21		21	22	1	1	105	85
UF6	upland	26	26	22	4	3	85	85		22		22	14	5	3	64	54
UF7	upland	52	56	41	15	5	73	79	3	44		44	25	15	4	57	48
UF8	upland	39	39	28	11	2	72	72		28		28	24	4	1	86	62
UF9	upland	78	79	56	23	6	71	72		56		56	47	12	5	84	60
UF10	upland	13	13	3	10	1	23	23	8	11		11	11	1	1	100	85
UF11	upland	61	63	37	26	9	59	61	27	64		64	61	7	3	95	100
UF12	upland	70	68	39	29	13	57	56		39		39	38	6	0	97	54
UF13	upland	57	50	31	19	2	62	54		31		31	28	3	1	90	49
UF14	upland	52	54	15	39	9	28	29	30	45		45	46	2	3	102	88
UF15	upland	35	24	20	4	0	83	57		20		20	19	1	0	95	54
UF16	upland	9	6	3	3	0	50	33	5	8		8	8	0	0	100	89
US1	upland	14	14	13	1	0	93	93		13		13	11	2	0	85	79
US2	upland	41	35	18	17	3	51	44		18		18	16	4	1	89	39
US3	upland	135	116	64	52	6	55	47		64		64	55	8	11	86	41
US4	upland	14	15	12	3	1	80	86		12		12	12	2	0	100	86
US5	upland	27	27	16	11	5	59	59		16		16	11	5	3	69	41
US6	upland	14	10	9	1	0	90	64		9		9	5	2	2	56	36
US7	upland	27	21	10	11	2	48	37	13	23	4	27	15	4	5	56	56
US8	upland	27	25	14	11	7	56	52	16	30		30	22	2	5	73	81
US9	upland	14	14	6	8	0	43	43		6		6	3	2	1	50	21
US10	upland	14	14	4	10	3	29	29		4		4	2	--	2	50	14
US11	upland	81	57	29	28	7	51	36	25	54		54	46	6	3	85	57
US12	upland	54	44	30	14	2	68	56		30		30	23	4	2	77	43
US13	upland	54	43	21	22	3	49	39	16	37	3	40	36	7	3	90	67
US14	upland	54	41	18	23	3	44	33	11	29	5	34	22	7	3	65	41
US15	upland	27	16	13	3	2	81	48		13		13	10	1	3	77	37
US16	upland	27	26	24	2	2	92	89		24		24	22	3	1	92	81
US17	upland	81	63	44	19	4	70	54	9	53	5	58	51	4	5	88	63
US18	upland	81	59	44	15	3	75	54	16	60	9	69	53	17	3	77	65
US19	upland	27	20	18	2	1	90	67		18		18	16	1	2	89	59
US20	upland	68	65	54	11	6	83	79		54		54	37	15	7	69	54
US21	upland	54	52	39	13	7	75	72		39		39	35	8	2	90	65
US22	upland	54	54	47	7	2	87	87		47		47	37	10	2	79	69
US23	upland	41	37	31	6	2	84	76		31		31	29	3	2	94	71
US24	upland	27	23	19	4	1	83	70		19		19	16	1	2	84	59

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**TABLE A-1
A1PI WETLAND MITIGATION PROJECT VEGETATION SURVIVAL DATA**

Location		Initial Planting		2000 Counts					Replant Data			2001 Counts					
Patch	Basin	No. Individuals Planned	No. Individuals Planted in 1999	No. Alive	No. Dead	No. Resprout	Survival Rate Based on No. Planted (%)	Survival Rate Based on No. Planned (%)	Total Individuals Planted in Fall 2000	Total Individuals Planted and Alive 1999-2000	Total Individuals Planted in Spring 2001	2001 Baseline	No. Alive	No. Dead	No. Resprout	Survival Rate Based on 2001 Baseline(%)	Survival Rate Based on # Planned (%)
US25	upland	54	51	34	17	6	67	63	8	42	3	45	42	3	0	93	78
US26	upland	41	34	23	11	6	68	56	6	29	6	35	27	9	0	77	66
US27	upland	54	51	35	16	6	69	65	9	44	2	46	52	4	0	113	96
US28	upland	108	90	51	39	6	57	47	29	80	11	91	82	12	5	90	76
US29	upland	27	21	19	2	0	90	70	17	36	14	50	36	6	0	72	133
US30	upland	54	47	23	24	2	49	43	21	44		44	41	6	2	93	76
US31	upland	54	31	16	15	5	52	30	0	16		16	16	11	4	100	30
US32	upland	41	40	38	2	0	95	93		38		38	38	6	0	100	93
US33	upland	27	25	23	2	1	92	85		23		23	22	1	2	96	81
WF1	7	22	19	9	10	2	47	41	10	19		19	14	0	4	74	64
WF2	7	17	17	10	7	3	59	59	4	14		14	15	1	1	107	88
WF3	6	35	25	10	15	3	40	29	19	29		29	28	3	4	97	80
WF4	6	35	32	22	10	2	69	63	8	30		30	25	1	5	83	71
WF5	6	30	27	17	10	3	63	57	10	27		27	25	1	4	93	83
WF6	1	26	23	17	6	2	74	65		17		17	16	1	2	94	62
WF7	2	39	35	26	9	7	74	67	7	33		33	33	3	0	100	85
WF8	2	30	31	28	3	1	90	93		28		28	25	2	2	89	83
WF9	2	39	39	28	11	8	72	72	4	32		32	31	2	4	97	79
WF10	3	30	29	23	6	0	79	77	39	62		62	59	5	0	95	197
WS1	8	27	24	16	8	6	67	59	7	23	1	24	25	2	2	104	93
WS2	7	41	21	18	3	1	86	44	16	34		34	30	4	2	88	73
WS3	7	27	27	26	1		96	96		26		26	25	25	2	96	93
WS4	6	27	26	11	15	11	42	41	18	29		29	27	2	13	93	100
WS5	6	54	54	53	1	0	98	98		53		53	53	--	--	100	98
WS6	6	27	27	27	0	0	100	100		27		27	21	2	4	78	78
WS7	6	27	25	7	18	8	28	26	17	24		24	39	7	0	163	144
WS8-A	1	14	14	14	0		100	100		14		14	14	0	--	100	100
WS9	1	162	171	118	53	19	69	73	17	135	1	136	115	17	34	85	71
WS10	1	54	56	35	21	10	63	65	12	47		47	56	4	4	119	104
WS11	1	14	14	14	0		100	100		14		14	14	0	--	100	100
WS12-A	1	27	27	27	0		100	100		27		27	27	--	--	100	100
WS13	5	41	35	18	17	6	51	44	19	37		37	20	13	6	54	49
WS14	5	41	39	19	20	8	49	46	14	33	3	36	20	16	5	56	49
WS15	2	28	27	25	2	0	93	89		25		25	20	5	0	80	71
WS16-A	2	41	41	41	0		100	100		41		41	40	1	--	98	98
WS17	2	149	147	100	47	16	68	67	23	123	5	128	106	13	23	83	71
WS18	3	41	38	29	9	6	76	71	9	38		38	35	0	8	92	85
WS19	3	95	75	51	24	17	68	54	50	101	5	106	102	9	15	96	107
WS20	3	41	33	30	3	2	91	73		30		30	26	7	0	87	63
WS21	3	27	27	27	0	0	100	100		27		27	27	0	0	100	100

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**TABLE A-1
A1PI WETLAND MITIGATION PROJECT VEGETATION SURVIVAL DATA**

Location		Initial Planting		2000 Counts					Replant Data			2001 Counts					
Patch	Basin	No. Individuals Planned	No. Individuals Planted in 1999	No. Alive	No. Dead	No. Resprout	Survival Rate Based on No. Planted (%)	Survival Rate Based on No. Planned (%)	Total Individuals Planted in Fall 2000	Total Individuals Planted and Alive 1999-2000	Total Individuals Planted in Spring 2001	2001 Baseline	No. Alive	No. Dead	No. Resprout	Survival Rate Based on 2001 Baseline(%)	Survival Rate Based on # Planned (%)
WS23	4	81	67	55	12	3	82	68		55		55	57	1	0	104	70
WS24	4	68	57	51	6	2	89	75		51		51	52	1	0	102	76
WS25	4	41	30	28	2	1	93	68		28		28	22	1	7	79	54
WS26	4	27	27	26	1	0	96	96		26		26	26	0	0	100	96
WS27	4	54	44	31	13	0	70	57	12	43	2	45	45	2	2	100	83
Total		3737	3327	2306	1021	318	69	62	615	2921	79	3000	2659	401	275	89	71

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**TABLE A-2
A1PI WETLAND MITIGATION PROJECT HERBACEOUS COVER DATA**

Basin	Quadrat	Survey Date	Percent Cover	Percent Native Cover	Cover Class Total	Species Total	Hydrophytic Vegetation Present?	Modified Simpson's Index	Average CC	FQAI
1	Wet-1-A-1	07/23/2001	85	85	16	11	yes	17.14	2.64	8.74
1	Wet-1-A-2	07/23/2001	85	100	14	8	yes	9.10	2.38	6.72
1	Wet-1-A-3	07/23/2001	100	40	20	14	no	27.14	1.23	4.61
2	Wet-2-A-1	07/23/2001	95	23	16	10	no	12.00	0.50	1.58
2	Wet-2-A-2	07/24/2001	70	25	17	10	no	15.11	1.00	3.16
2	Wet-2-A-3	07/24/2001	100	44	22	16	no	28.88	2.21	8.86
3	Wet-3-A-1	07/25/2001	80	11	10	6	no	4.50	1.00	2.45
3	Wet-3-A-2	07/25/2001	80	27	14	9	no	13.00	1.13	3.38
3	Wet-3-A-3	07/25/2001	100	25	15	9	no	8.75	1.00	3.00
4	Wet-4-A-1	07/25/2001	95	11	11	7	no	7.86	0.29	0.76
4	Wet-4-A-2	07/25/2001	95	67	18	12	yes	25.50	2.91	10.08
4	Wet-4-A-3	07/25/2001	100	36	19	12	yes	19.00	2.00	6.93
5	Wet-5-A-1	07/25/2001	5	0	1	1	no	0.00	0.00	0.00
5	Wet-5-A-2	07/25/2001	10	50	2	2	no	0.00	2.00	2.83
5	Wet-5-A-3	07/25/2001	70	33	12	8	yes	13.20	2.40	6.79
6	Wet-6-A-1	07/25/2001	80	62	18	10	yes	13.91	2.50	7.91
6	Wet-6-A-2	07/25/2001	90	33	22	14	no	25.67	1.15	4.32
6	Wet-6-A-3	07/25/2001	100	64	19	12	yes	14.00	1.91	6.61
6	Wet-6-A-4	07/25/2001	95	78	13	7	yes	8.67	2.67	7.06
7	Wet-7-A-1	07/25/2001	100	18	17	9	no	12.36	0.63	1.88
7	Wet-7-A-2	07/25/2001	100	40	21	15	no	26.25	2.00	7.75
7	Wet-7-A-3	07/26/2001	95	60	15	9	yes	15.00	2.63	7.88
8	Wet-8-A-1	07/26/2001	95	25	17	10	no	10.46	1.25	3.95
8	Wet-8-A-2	07/26/2001	95	27	20	15	no	38.00	0.62	2.38
8	Wet-8-A-3	07/26/2001	100	25	18	14	no	13.91	1.31	4.89
upland	UP-A-1	08/20/2001	75	47	18	14	no	30.60	2.00	7.48
upland	UP-A-2	08/20/2001	95	15	17	10	no	10.46	1.25	3.95
upland	UP-A-3	08/20/2001	100	33	18	12	no	12.75	1.75	6.06
upland	UP-A-4	08/20/2001	100	33	16	9	no	17.14	1.75	5.25
upland	UP-A-5	08/20/2001	100	7	20	11	no	14.62	0.55	1.81

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APPENDIX B

A8PII FOREST DEMONSTRATION PROJECT DATA

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TABLE B-1
A8PII FOREST DEMONSTRATION PROJECT
VEGETATION SURVIVAL AND REPLANT DATA

Patch	No. Planted	No. Alive	No. Resprout	No. Dead	No. Missing	Percent Survival	Replant Amount
RP1	30	25	4	1	0	83%	
RP2	106	87	9	7	3	82%	
RP3	43	27	5	2	9	63%	10
RP4	16	7	3	6	0	44%	7
RP5	46	41	2	3	0	89%	
MM8	67	62	3	2	0	93%	
MM9	48	42	2	4	0	88%	
MM10	79	67	4	2	6	85%	
MM11	49	43	0	3	3	88%	
MM12	69	55	6	3	5	80%	
MM13	50	40	3	5	2	80%	
MM14	70	58	5	2	5	83%	
MM19	64	54	5	1	4	84%	
MM20	40	33	2	5	0	83%	
MM21	74	60	6	7	1	81%	
MM22	48	35	8	2	3	73%	6
BS23	70	63	0	3	4	90%	
BS24	42	35	2	3	2	83%	
BS25	75	62	4	6	3	83%	
BS26	38	31	3	3	1	82%	
BS27	63	54	2	3	4	86%	
BS28	35	30	3	1	1	86%	
BS29	50	41	4	1	4	82%	
BS30	36	27	1	1	7	75%	3
OS1	69	49	5	9	6	71%	11
OS2	62	51	4	3	4	82%	
OS3	79	66	1	10	2	84%	
OS4	58	49	2	5	2	84%	
SV1	12	7	0	0	5	58%	2
SV2	16	8	0	2	6	50%	5
SV3	16	4	1	1	10	25%	8
SV4	18	14	0	4	0	78%	1
SV5	10	6	1	2	1	60%	3
SV6	22	13	1	2	6	59%	6
SV7	22	11	3	4	4	50%	8
SV8	13	10	0	1	2	77%	1
SV9	16	9	0	3	4	56%	5
SV10	13	4	2	2	5	31%	7
BF31	60	50	0	8	2	83%	
Totals =	1,794	1,430	106	132	126	80%	83

**TABLE B-2
A8P11 FOREST DEMONSTRATION PROJECT
HERBACEOUS COVER DATA**

Area	Quadrat	Survey Date	Cover Class	Percent Native Cover	Species Total	Modified Simpson's Index	Average CC	FQAI
Oak-Maple Habitat Type	A8P2-1-1	07/17/2001	5	27	14	25.3	0.62	2.3
	A8P2-1-2	07/17/2001	5	0	9	9.23	0	0
	A8P2-1-3	07/17/2001	5	67	14	17.25	3	11.22
	A8P2-1-4	07/18/2001	5	44	17	34.5	1.63	6.7
Savanna Habitat Type	A8P2-2a-1	07/18/2001	5	33	3	2.1	1.67	2.89
	A8P2-2a-2	07/18/2001	5	54	12	21.38	1.27	4.41
	A8P2-2b-1	07/18/2001	5	50	18	57.75	1.71	7.24
	A8P2-2b-2	07/18/2001	5	27	11	26.25	2	6.63
Wetland Area	A8P2-3a-1	07/18/2001	5	50	13	25.5	1.85	6.66
	A8P2-3b-1	07/18/2001	5	47	11	11.4	1.5	4.97
	A8P2-3b-2	07/18/2001	5	46	10	12	1.11	3.51
	A8P2-3c-1	07/18/2001	5	53	14	34	1.93	7.22
Drainage Swales, Berms, and the Materials Handling Area	A8P2-4c-1	07/18/2001	5	59	13	13.57	3.67	13.22
	A8P2-4a-1	07/18/2001	5	86	11	11.83	4.78	15.85
	A8P2-4b-1	07/18/2001	5	43	20	30	2.42	10.81
	A8P2-4b-2	07/18/2001	4	45	10	17.14	2.11	6.68

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APPENDIX C

FUNCTIONAL PHASE MONITORING DATA

TABLE C-1
GRAZED PASTURE SPECIES LIST

Species	Common Name	Type	CC	Avg. Cover
<i>Acalypha rhomboidea</i>	three-seeded mercury	Forb	0	0.15
<i>Acer negundo</i>	box elder	Tree	3	0.2
<i>Achillea millefolium</i>	yarrow	Forb	0	0.1
<i>Agrostis alba</i>	redtop	Grass	na	0.6
<i>Ambrosia artemisiifolia</i>	common ragweed	Forb	0	0.05
<i>Capsella bursa-pastoris</i>	shepard's purse	Forb	0	0.3
<i>Cerastium vulgatum</i>	mouse-ear chickweed	Forb	0	0.3
<i>Ceratum arvense</i>	field chickweed	Forb	2	0.05
<i>Echinochloa crusgalli</i>	barnyardgrass	Grass	0	0.05
<i>Erigeron philadelphicus</i>	fleabane	Forb	2	0.05
<i>Festuca rubra</i>	red fescue	Grass	0	1.8
<i>Glechoma hederacea</i>	ground ivy	Vine	0	0.6
<i>Juncus tenuis</i>	slender rush	Sedge	1	0.3
<i>Lactuca scariola</i>	prickly lettuce	Forb	0	0.05
<i>Lobelia inflata</i>	Indian tobacco	Forb	1	0.05
<i>Lysimachia nummularia</i>	moneywort	Forb	0	0.05
<i>Medicago lupulina</i>	black medic	Forb	0	0.25
<i>Muhlenbergia schreberi</i>	nimblewill	Grass	1	0.05
<i>Oxalis stricta</i>	yellow woodsorrel	Forb	0	0.1
<i>Phleum pratense</i>	timothy grass	Grass	0	0.55
<i>Plantago lanceolata</i>	English plantain	Forb	0	1.2
<i>Plantago major</i>	common plantain	Forb	0	0.1
<i>Plantago rugelli</i>	red-stemmed plantain	Forb	0	0.05
<i>Poa spp.</i>	bluegrass	Grass	0	0.7
<i>Schizachyrium scoparius</i>	little blue stem	Grass	na	0.05
<i>Setaria glauca</i>	yellow foxtail	Grass	0	0.05
<i>Sida spinosa</i>	prickly mallow	Forb	0	0.05
<i>Solanum carolinense</i>	horse nettle	Forb	0	0.4
<i>Taraxacum officinale</i>	dandelion	Forb	0	1.6
<i>Trifolium pratense</i>	red clover	Forb	0	0.2
<i>Trifolium repens</i>	white clover	Forb	0	2.15
<i>Veronia gigantea</i>	giant ironweed	Forb	3	0.75
<i>Viola sororia</i>	common blue violet	Forb	na	0.05
	grasses (mowed)	Grass	0	2.25

**TABLE C-2
RIPARIAN BASELINE SPECIES LIST**

Species	Common Name	Type	CC	Avg.Cover	Avg. dbh	Abundance
<i>Acer negundo</i>	box elder	seedling	3	0.3		
<i>Acer negundo</i>	box elder	tree	3		10.1	91
<i>Aesculus glabra</i>	Ohio buckeye	tree	6		6.1	33
<i>Allaria petiolata</i>	garlic mustard	forb	0	0.6		
<i>Ambrosia artemisifolia</i>	common ragweed	forb	0	0.05		
<i>Asarum canadense</i>	wild ginger	forb	7	0.15		
<i>Asimina triloba</i>	pawpaw	tree	6			2
<i>Boehmeria cylindrica</i>	false nettle	forb	4	1.25		
<i>Celtis occidentalis</i>	hackberry	tree	6		10.9	17
<i>Cercis canadensis</i>	redbud	tree	0		15.55	2
<i>Cryptotaenia canadensis</i>	honestwort	forb	3	0.35		
<i>Desmodium canadense</i>	panicked tick trefoil	forb	5	0.05		
<i>Eupatorium rugosum</i>	white snakeroot	forb	4	2.3		
<i>Fraxinus pennsylvanica</i>	green ash	tree	6		4.85	12
<i>Fraxinus quadrangulata</i>	blue ash	tree	8		4.4	4
<i>Fraxinus spp.</i>	ash spp.	seedling		0.1		
<i>Geum vernum</i>	spring avens	forb	4	0.05		
<i>Glechoma hederacea</i>	ground Ivy	vine	0	1.45		
<i>Gleditsia triacanthos</i>	honey locust	tree	1		31.45	3
<i>Juglans nigra</i>	black walnut	tree	5		21.7	16
<i>Lonicera japonica</i>	vine honeysuckle	vine	0	0.05		
<i>Lonicera maackii</i>	honeysuckle	seedling	0	0.3		
<i>Lonicera maackii</i>	amur honeysuckle	shrub	0			79
<i>Lysimachia nummularia</i>	moneywort	vine	0	0.4		
<i>Maclura pomifera</i>	osage orange	tree	0		12.0	5
<i>Mikania scandens</i>	climbing hempweed	vine	na	0.05		
<i>Parthenocissus quinquefolia</i>	Virginia creeper	vine	3	0.2		
<i>Pilea pumila</i>	clearweed	forb	4	0.4		
<i>Plantanus occidentalis</i>	sycamore	tree	7		16.8	32
<i>Platanus occidentalis</i>	sycamore	seedling	7	0.05		
<i>Polygonum persicaria</i>	spotted lady's thumb	forb	0	0.4		
<i>Populus deltoides</i>	cottonwood	tree	5		13.50	1
<i>Prunus serotina</i>	black cherry seedling	tree	3	0.05		
<i>Prunus serotina</i>	black cherry	tree	3		9.8	9
<i>Quercus macrocarpa</i>	bur oak	tree	5		19.7	4
<i>Robinia pseudoacacia</i>	black locust	tree	0		18.6	10
<i>Rosa multiflora</i>	multiflora rose	seedling	0	0.05		
<i>Rosa multiflora</i>	multiflora rose	shrub	0			1
<i>Sanicula canadensis</i>	short-styled black snakeroot	forb	4	0.65		
<i>Saponaria officinalis</i>	bouncing bet	forb	0	0.1		
<i>Sida spiniosa</i>	prickly mallow	forb	0	0.05		
<i>Smilax tamnoides</i>	bristly greenbrier	forb		0.1		
<i>Tilia americana</i>	American basswood	tree	6		32.0	1
<i>Toxicodendron radicans</i>	poison ivy	vine	1	0.4		
<i>Triticum aestivum</i>	wheat	grass	0	0.8		
<i>Ulmus americana</i>	american elm	seedling	1	0.05		
<i>Ulmus americana</i>	American elm	tree	1		19.5	7
<i>Ulmus rubra</i>	slippery elm	tree	2		2.5	1
<i>Ulmus spp.</i>	elm spp.	seedling		0.05		
<i>Viola sororia</i>	common blue violet	forb		0.65		
	unknown grass	grass		0.2		

TABLE C-3
 SUCCESSIONAL WOODLOT BASELINE SPECIES LIST

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Species	Common Name	Type	CC	Avg. Cover	Avg. dbh	Abundance
<i>Acer negundo</i>	box elder	seedling	3	0.6		
<i>Acer negundo</i>	box elder	tree	3		11.85	17
<i>Acer nigrum</i>	black maple	seedling	na	0.1		
<i>Acer nigrum</i>	black maple	tree	na		14.52	19
<i>Acer saccharinum</i>	sugar maple	seedling	3	0.05		
<i>Acer saccharum</i>	sugar maple	tree	3		13.94	80
<i>Actinomeris alternifolia</i>	common wing stem	forb	na	0.15		
<i>Agrimonia parriflora</i>	harvest lice	forb	2	0.05		
<i>Agrostis alba</i>	red top	grass	na	0.05		
<i>Allaria petiolata</i>	garlic mustard	forb	0	0.25		
<i>Aster pilosus</i>	heath aster	forb	1	0.15		
<i>Bidens bipinnata</i>	Spanish needles	forb	3	0.05		
<i>Campsis radicans</i>	trumpet creeper	vine	0	0.05		
<i>Carya cordiformis</i>	bitternut hickory	seedling	4	0.1		
<i>Carya cordiformis</i>	bitternut hickory	tree	4		4.55	2
<i>Carya laciniosa</i>	shellbark hickory	tree	7		6.5	3
<i>Celtis occidentalis</i>	hackberry	tree	6		7.46	15
<i>Cercis canadensis</i>	red bud	tree	0		11.5	1
<i>Chenopodium album</i>	lambquarter	forb	0	0.3		
<i>Cornus racemosa</i>	gray dogwood	seedling	2	0.05		
<i>Cornus racemosa</i>	gray dogwood	tree	2		3.7	11
<i>Cryptotaenia canadensis</i>	honewort	forb	3	0.35		
<i>Eupatorium rugosum</i>	white snakeroot	forb	4	1.45		
<i>Festuca spp.</i>	red fescue	grass	0	0.05		
<i>Fraxinus americana</i>	white ash	seedling	4	0.1		
<i>Fraxinus americana</i>	white ash	tree	4		11.06	5
<i>Fraxinus pennsylvanica</i>	green ash	tree	6		38.8	1
<i>Fraxinus spp.</i>	ash spp.	seedling		0.4		
<i>Fraxinus spp.</i>	ash spp.	tree			17.48	4
<i>Galium triflorum</i>	three-petal bedstraw	forb	5	0.2		
<i>Galium triflorum</i>	three-petal bedstraw	forb	5	0.3		
<i>Geum vernum</i>	spring avens	forb	4	0.45		
<i>Glechoma hederacea</i>	ground ivy	vine	0	0.55		
<i>Impatiens capensis</i>	touch-me-not	forb	2	0.1		
<i>Juglans nigra</i>	black walnut	tree	5		18.27	7
<i>Leersia virginica</i>	whitegrass	grass	3	0.4		
<i>Lonicera japonica</i>	vine honeysuckle	vine	0	0.05		
<i>Lonicera maackii</i>	amur honeysuckle	seedling	0	1.05		
<i>Lonicera maackii</i>	amur honeysuckle	shrub	0			162 (est.)
<i>Lysimachia nummularia</i>	moneywort	forb	0	0.45		
<i>Oxalis stricta</i>	yellowwood sorrel	forb	0	0.1		
<i>Panicum clandestinum</i>	deer tongue	grass	3	0.05		
<i>Parthenocissus quinquefolia</i>	Virginia creeper	vine	3	0.5		
<i>Pilea pumila</i>	clearweed	forb	4	0.3		
<i>Polygonum persicaria</i>	spotted ladythumb	forb	0	0.3		
<i>Polygonum punctatum</i>	dotted smartweed	forb	6	0.15		
<i>Prunus serotina</i>	black cherry	seedling	3	0.25		
<i>Prunus serotina</i>	black cherry	tree	3		28.63	14
<i>Quercus rubra</i>	red oak	tree	7		20	1
<i>Quercus shumardii</i>	shumard oak	tree	na		39.4	1
<i>Rosa multiflora</i>	multiflora rose	seedling	0	0.45		
<i>Rosa multiflora</i>	multiflora rose	seedling	0	1		
<i>Rosa multiflora</i>	multiflora rose	shrub	0			157 (est.)
<i>Rubus occidentalis</i>	black raspberry	seedling	1	0.1		
<i>Rubus occidentalis</i>	black raspberry	shrub	1			2
<i>Sanicula canadensis</i>	short-styled black snakeroot	forb	4	0.75		
<i>Taraxacum officinalis</i>	dandelion	forb	0	0.05		
<i>Toxicodendron radicans</i>	poison ivy	vine	1	0.15		
<i>Ulmus americana</i>	american elm seedling	seedling	1	0.15		
<i>Ulmus americana</i>	american elm	tree	1		13.63	25
<i>Ulmus rubra</i>	slippery elm	tree	2		14.09	11
<i>Viola sororia</i>	common blue violet	forb	2	0.25		

**TABLE C-4
PINE PLANTATION BASELINE SPECIES LIST**

Species	Common Name	Type	CC	Avg.Cover	Avg. dbh	Abundance
<i>Acer negundo</i>	box elder	seedling	3	0.25		
<i>Acer negundo</i>	box elder	tree	3		9.81	7
<i>Allaria officinalis</i>	garlic mustard	forb	0	0.85		
<i>Apocynum cannabinum</i>	Indian hemp	forb	3	0.1		
<i>Calystegia sepium</i>	hedge false bindweed	vine	1	0.15		
<i>Campsis radicans</i>	trumpet creeper	vine	0	0.15		
<i>Celtis occidentalis</i>	hackberry seedling	seedling	6	0.1		
<i>Celtis occidentalis</i>	hackberry	tree	6		2.3	2
<i>Digitaria spp.</i>	crabgrass spp.	grass	0	0.85		
<i>Eupatorium rugosum</i>	white snakeroot	forb	4	1.5		
<i>Festuca spp.</i>	fescue spp.	grass	0	0.25		
<i>Fraxinus american</i>	white ash seedling	seedling	4	0.15		
<i>Fraxinus americana</i>	white ash	tree	4		2	2
<i>Fraxinus spp.</i>	ash spp.	tree			2	1
<i>Glechoma hederacea</i>	ground ivy	forb	0	0.05		
<i>Habenana lacera</i>	ragged fringed orchid	forb	6	0.05		
<i>Hackelia virginia</i>	Virginia stickseed	forb	2	0.05		
<i>Juglans nigra</i>	black walnut	tree	5		20.9	1
<i>Lonicera maackii</i>	amur honeysuckle	seedling	0	0.05		
<i>Lonicera maackii</i>	amur honeysuckle	shrub	0			65
<i>Lonicera japonica</i>	vine honeysuckle	vine	0	0.05		
<i>Mikania scandens</i>	climbing hempweed	vine	na	0.1		
<i>Morus rubra</i>	red mulberry	tree	6		7.53	4
<i>Oxalis stricta</i>	yellowwood sorrel	forb	0	0.2		
<i>Partenocissus quinquefolia</i>	Virginia creeper	vine	3	0.65		
<i>Phytolacca americana</i>	pokeweed	forb	2	0.35		
<i>Pilea pumila</i>	clearweed	forb	4	0.4		
<i>Pinus nigra</i>	Austrian pine	tree	0		23.95	48
<i>Pinus strobus</i>	white pine	tree	6		22.96	86
<i>Polygonum pensylvanicum</i>	knotweed	forb	1	0.05		
<i>Polygonum persicaria</i>	spotted ladythumb	forb	0	0.35		
<i>Polygonum punctatum</i>	dotted smartweed	forb	6	0.4		
<i>Prunus serotina</i>	black cherry seedling	seedling	3	0.05		
<i>Prunus serotina</i>	black cherry seedling	seedling	3	0.15		
<i>Prunus serotina</i>	black cherry	tree	3		4.79	26
<i>Quercus shumardii</i>	shumard oak sapling	tree			2.2	1
<i>Rosa multiflora</i>	multiflora rose	seedling	0	0.15		
<i>Rosa multiflora</i>	multiflora rose	shrub	0			7
<i>Rubus occidentalis</i>	black raspberry	seedling	1	0.35		
<i>Rubus occidentalis</i>	black raspberry	shrub	1			13
<i>Toxicodendron radicans</i>	poison ivy	forb	1	0.45		
<i>Ulmus rubra</i>	slippery elm	tree	2		3.5	1
<i>Ulmus spp.</i>	elm seedling	seedling		0.05		
<i>Vernonia gigantea</i>	giant ironweed	forb	3	0.15		
<i>Viola sororia</i>	common blue violet	forb	na	0.2		
<i>Vitis riparia</i>	riverbank grape	vine	4	0.05		

TABLE C-5
OPEN WATER BASELINE SPECIES LIST

Species	Common Name	Type	CC	Avg.Cover
<i>Ambrosia artemisfolia</i>	common ragweed	forb	0	0.25
<i>Andropogon gerardi</i>	big bluestem	grass	6	0.6
<i>Aster pilosus</i>	heath aster	forb	4	0.15
<i>Bidens connata</i>	swamp beggarticks	forb	0	0.05
<i>Bromus ciliatus</i>	fringed brome	grass	7	0.1
<i>Carduus nutans</i>	nodding thistle	forb	0	0.05
<i>Cassia fasciculata</i>	partridge pea	forb	na	0.3
<i>Cerastium vulgatum</i>	mouse-ear chickweed (1 ind.)	forb	0	0.05
<i>Cirsium discolor</i>	field thistle	forb	6	0.2
<i>Cyperus esculentus</i>	yellow nutsedge	sedge	2	0.25
<i>Daucus carota</i>	Queen Anne's lace	forb	0	0.15
<i>Echinochloa crusgalli</i>	barnyardgrass	grass	0	1
<i>Erigeron annuus</i>	daisy fleabane*	forb	1	0.05
<i>Erigeron canadensis</i>	horseweed	forb	na	0.15
<i>Festuca spp.</i>	fescue spp.	grass	0	0.2
<i>Lactuca scariola</i>	prickly lettuce	forb	0	0.1
<i>Medicago lupulina</i>	black medic	forb	0	0.35
<i>Mikania scandens</i>	climbing hempweed*	vine	na	0.05
<i>Panicum clandestinum</i>	deer tonge	grass	3	0.05
<i>Panicum virgatum</i>	switchgrass	grass	4	0.3
<i>Plantago lanceolata</i>	English plantain	forb	0	0.55
<i>Plantago major</i>	common plantain	forb	0	0.1
<i>Polygonum hydropiper</i>	common smartweed	forb	3	0.25
<i>Polygonum persicaria</i>	spotted ladysthumb	forb	0	0.15
<i>Populus deltoides</i>	cottonwood	seedling	5	0.1
<i>Potentilla canadensis</i>	Dwarf cinquefoil*	forb	3	0.05
<i>Rumex crispus</i>	curled dock*	forb	0	0.05
<i>salix nigra</i>	black willow	shrub	3	0.25
<i>Setaria glauca</i>	yellow foxtail	grass	0	0.2
<i>Sida spinosa</i>	prickly mallow	forb	0	0.4
<i>Sorghastrum nutans</i>	Indian grass	grass	6	0.1
<i>Taraxacum officinale</i>	dandelion	forb	0	0.15
<i>Trifolium pratense</i>	red clover	forb	0	0.3
<i>Trifolium repens</i>	white clover	forb	0	0.75
<i>Triticum aestivum</i>	wheat	grass	0	0.15
<i>Typha latifolia</i>	common cattail	forb	2	0.4

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APPENDIX D

ASPI REVEGETATION RESEARCH PLOTS DATA

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**TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAPLING DATA**

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present
A	54	<i>Aesculus glabra</i>	26.4	A		1	3	A	A	27.1				X	A	28.4			3	
A	59	<i>Aesculus glabra</i>	32.9	A				A	A	34.0					A	36.4				
A	77	<i>Aesculus glabra</i>	27.7	A		1	1	A	A	27.9				X	A	30.4				
A	78	<i>Aesculus glabra</i>	30.0	A				A	A	31.5					A	38.5				
A	79	<i>Aesculus glabra</i>	21.7	A		3	3	A	A	21.8					A	30.6			3	
A	81	<i>Aesculus glabra</i>	23.0	A		2		A	A	26.2					A	28.2			2	
A	90	<i>Aesculus glabra</i>	20.3	A		1		A	A	23.3					A	27.0				
A	92	<i>Aesculus glabra</i>	26.5	A		1	2	A	A	30.9					A	37.5			3	
A	96	<i>Aesculus glabra</i>	31.6	A		1		A	A	34.1					A	44.5			3	
A	97	<i>Aesculus glabra</i>	33.0	A				A	A	33.9					A	38.0			1	
A	98	<i>Aesculus glabra</i>	27.1	A		1		A	A	27.5					A	31.9				
A	101	<i>Aesculus glabra</i>	39.9	A				A	A	45.8					A	46.1				
A	103	<i>Aesculus glabra</i>	21.7	A	2			A	A	22.9					A	23.1				X
A	105	<i>Aesculus glabra</i>	23.3	A		1		A	A	32.6					A	33.7				
A	110	<i>Aesculus glabra</i>	36.4	A				A	A	36.8				X	A	38.1			1	
A	115	<i>Aesculus glabra</i>	22.9	A				A	A	26.2					A	27.1			2	
A	118	<i>Aesculus glabra</i>	34.8	A				A	A	35.6					A	35.7				
A	138	<i>Aesculus glabra</i>	21.6	A				A	A	27.4				X	A	32.7				
A	142	<i>Aesculus glabra</i>	20.3	A		1		A	A	23.3					A	23.7				
A	145	<i>Aesculus glabra</i>	29.7	A				A	A	29.8					A	34.6				
A	57	<i>Celtis occidentalis</i>	34.6	A				A	A	38.4				X	A	38.9				
A	65	<i>Celtis occidentalis</i>	32.8	A				A	A	34.6					A	37.0				
A	67	<i>Celtis occidentalis</i>	31.6	A				A	A	32.6					A	33.5				
A	68	<i>Celtis occidentalis</i>	34.6	A				A	A	36.9				X	A	40.3				
A	82	<i>Celtis occidentalis</i>	40.0	A				A	A	41.2					A	39.8				
A	85	<i>Celtis occidentalis</i>	43.2	D				D	D					D						
A	94	<i>Celtis occidentalis</i>	29.9	D				D	D					D						
A	100	<i>Celtis occidentalis</i>	30.9	A				A	A	39.6				X	A	38.8				
A	104	<i>Celtis occidentalis</i>	38.3	A				A	A	38.5					A	38.5				
A	112	<i>Celtis occidentalis</i>	34.8	A				A	A	34.8				X	A	35.5				X

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TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAPLING DATA

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present
A	119	<i>Celtis occidentalis</i>	34.6	A				A	A	35.3					A	35.1				
A	122	<i>Celtis occidentalis</i>	40.0	A				A	A	41.7					A	41.8				
A	126	<i>Celtis occidentalis</i>	36.4	A				A	A	38.9				X	A	42.3				
A	130	<i>Celtis occidentalis</i>	39.3	A				A	A	39.6					A					
A	133	<i>Celtis occidentalis</i>	29.7	D				RS	RS	29.7					RS					
A	135	<i>Celtis occidentalis</i>	34.5	A				A	A	37.2					A	38.1				
A	136	<i>Celtis occidentalis</i>	34.5	A				A	A	34.5					A	35.7				
A	146	<i>Celtis occidentalis</i>	39.8	A				A	A	40.1					A	40.6				
A	147	<i>Celtis occidentalis</i>	30.2	A				A	A	32.4					A	32.8				
A	150	<i>Celtis occidentalis</i>	35.0	A				A	A	36.4				X	A					
A	52	<i>Fraxinus pennsylvanicum</i>	34.6	A			1	RS	RS						D				4	
A	53	<i>Fraxinus pennsylvanicum</i>	35.0	A			4	RS	RS			3			D				4	
A	64	<i>Fraxinus pennsylvanicum</i>	48.0	A				RS				4			D				4	
A	70	<i>Fraxinus pennsylvanicum</i>	36.1	A			2	A	A	36.5					D				4	
A	74	<i>Fraxinus pennsylvanicum</i>	38.0	A	3			RS	D						D					
A	76	<i>Fraxinus pennsylvanicum</i>	39.5	A	3		1	A	A	39.8					A				3	
A	80	<i>Fraxinus pennsylvanicum</i>	41.3	A			2	A	A	43.1					D				3	
A	84	<i>Fraxinus pennsylvanicum</i>	35.9	A			3	A	RS						RS					
A	89	<i>Fraxinus pennsylvanicum</i>	37.9	A				RS	D						D					
A	95	<i>Fraxinus pennsylvanicum</i>	36.6	A				A	A	39.4			3		A	41.4			3	
A	102	<i>Fraxinus pennsylvanicum</i>	48.0	A	3			D	D						RS					
A	107	<i>Fraxinus pennsylvanicum</i>	36.2	A	2			RS	D						D					
A	111	<i>Fraxinus pennsylvanicum</i>	34.8	A	3			A	A	36.8					D					
A	113	<i>Fraxinus pennsylvanicum</i>	31.8	A	4			A	RS	31.8					RS		2			
A	123	<i>Fraxinus pennsylvanicum</i>	49.3	A			2	A	A	49.7					A					
A	124	<i>Fraxinus pennsylvanicum</i>	39.6	A			1	A	A	40.3					RS					
A	127	<i>Fraxinus pennsylvanicum</i>	36.7	A			2	A	A	40.7					A	40.3			3	
A	134	<i>Fraxinus pennsylvanicum</i>	34.9	A			2	A	A	37.1			1		A	37.4			2	
A	144	<i>Fraxinus pennsylvanicum</i>	37.8	A			2	A	A	39.4				X	A	40.6			3	
A	148	<i>Fraxinus pennsylvanicum</i>	41.5	A			2	A	A	41.5					A	44.2			3	

**TABLE D-1
AIFI REVEGETATION RESEARCH PLOTS
SAMPLING DATA**

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present
A	56	<i>Juglans nigra</i>	32.9	A				A	A	36.4					A	36.4				
A	58	<i>Juglans nigra</i>	40.0	A				A	RS						A	42.2				
A	62	<i>Juglans nigra</i>	35.0	A				A	RS				3		A	35.4			3	
A	69	<i>Juglans nigra</i>	31.4	A				A	RS				4		D				4	
A	71	<i>Juglans nigra</i>	34.6	D				A	RS				2		RS				2	
A	72	<i>Juglans nigra</i>	37.7	A				A	RS					X	D					X
A	86	<i>Juglans nigra</i>	33.0	A				A	A	35.5					A	37.1				
A	88	<i>Juglans nigra</i>	34.8	D				A	A	34.8					RS					X
A	91	<i>Juglans nigra</i>	31.6	A				A	A	32.0			2		RS				2	
A	93	<i>Juglans nigra</i>	36.5	D				A	D						D					
A	99	<i>Juglans nigra</i>	37.9	A				A	A	37.9					X	A	41.8			X
A	108	<i>Juglans nigra</i>	35.2	A				A	A	37.5					A	39.2				X
A	114	<i>Juglans nigra</i>	26.6	A				A	A	28.7					A	30.0				X
A	121	<i>Juglans nigra</i>	31.4	A				A	A	33.2					A	36.2				X
A	125	<i>Juglans nigra</i>	39.5	A				A	A	40.6					A	45.6				
A	128	<i>Juglans nigra</i>	36.6	A				A	A	38.1					A	40.2				
A	132	<i>Juglans nigra</i>	33.3	A				A	A	36.1					X	A	38.2			X
A	137	<i>Juglans nigra</i>	36.2	A				A	A	36.5					X	A	37.1			X
A	139	<i>Juglans nigra</i>	29.5	A				A	A	30.3					A	30.6				X
A	149	<i>Juglans nigra</i>	36.4	A				A	A	39.7					A	40.1				
A	51	<i>Quercus muehlenbergii</i>	26.2	A			1	3	RS	RS					RS				4	
A	55	<i>Quercus muehlenbergii</i>	26.5	A			2	3	RS	RS			2		RS				4	
A	60	<i>Quercus muehlenbergii</i>	21.5	A			2	3	A	A	28.1				X	A	29.7			3
A	61	<i>Quercus muehlenbergii</i>	18.5	A			2	1	A	A	20.6				X	A	19.8			2
A	63	<i>Quercus muehlenbergii</i>	24.7	A				1	A	A	26.0				X	A	26.9			1
A	66	<i>Quercus muehlenbergii</i>	18.3	A			2		A	A	21.5				X	A	21.8		2	2
A	73	<i>Quercus muehlenbergii</i>	20.3	A			2		A	A	22.1					A	24.1		1	
A	75	<i>Quercus muehlenbergii</i>	18.3	A			2		A	A	19.8			1		RS			2	3
A	83	<i>Quercus muehlenbergii</i>	23.1	A			2		A	A	24.1			3		A	29.2			2
A	87	<i>Quercus muehlenbergii</i>	19.9	A			3		A	A	23.6					A	24.8			2

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TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAPLING DATA

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01						
			Diam. (mm)	Dead, Alive, or Resprout	Damage Severity (1 to 4)			Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Dead, Alive, or Resprout	Damage Severity (1 to 4)			Dead, Alive, or Resprout	Diam. (mm)	Dead, Alive, or Resprout	Damage Severity (1 to 4)			
					Vole	Deer	Rub					Vole	Deer	Rub	Fungus Present			Vole	Deer	Rub	Fungus Present
A	106	<i>Quercus muehlenbergii</i>	20.1	A		2			A	A	20.5				X	A	24.0				
A	109	<i>Quercus muehlenbergii</i>	23.1	A		1			A	A	25.9					A	27.1		1		
A	116	<i>Quercus muehlenbergii</i>	18.3	A		2			A	A	20.0				X	A	22.3			2	X
A	117	<i>Quercus muehlenbergii</i>	21.6	A		2	2		A	A	27.3					A	28.6			4	
A	120	<i>Quercus muehlenbergii</i>	23.1	A		2			A	A	24.1					A	27.4				X
A	129	<i>Quercus muehlenbergii</i>	21.8	A		1			A	A	25.6					A	26.2			2	
A	131	<i>Quercus muehlenbergii</i>	18.4	A		1	1		A	A	24.4					A	22.1			2	
A	140	<i>Quercus muehlenbergii</i>	24.6	A		2			A	A	25.9				X	A	29.2				
A	141	<i>Quercus muehlenbergii</i>	24.6	A		1			A	A	25.4					A	29.2		3		
A	143	<i>Quercus muehlenbergii</i>	23.5	A		2	2		A	RS	25.7				X	A	27.8		3	3	
D	5	<i>Aesculus glabra</i>	27.8	A					A	A	31.2					A	36.3				
D	12	<i>Aesculus glabra</i>	31.5	A					A	A	31.9					A	34.7				
D	20	<i>Aesculus glabra</i>	23.3	A					A	A	23.7			2		A	24.2			3	
D	25	<i>Aesculus glabra</i>	33.0	A					A	A	23.4	2				A	23.9			2	X
D	26	<i>Aesculus glabra</i>	32.9	A					A	A	33.8					A	39.3				
D	27	<i>Aesculus glabra</i>	24.4	A					A	A	24.8					A	24.5				
D	28	<i>Aesculus glabra</i>	27.9	A		1			A	A	28.5			3		A	34.1			3	
D	30	<i>Aesculus glabra</i>	30.9	A					A	A	31.2				X	A	32.2			1	
D	31	<i>Aesculus glabra</i>	21.6	A		1			A	A	22.8					A	23.2			1	
D	42	<i>Aesculus glabra</i>	21.4	D			2		A	A	21.7					RS				3	
D	49	<i>Aesculus glabra</i>	21.6	A		1			A	A	21.9					A	24.6			1	
D	1	<i>Celtis occidentalis</i>	36.1	D					A	A	36.9					A	37.8				
D	2	<i>Celtis occidentalis</i>	38.8	A					A	A	39.6					A	39.6				
D	3	<i>Celtis occidentalis</i>	38.2	A					A	A	39.5					A	32.9				
D	13	<i>Celtis occidentalis</i>	36.4	D					A	A	37.2				X	A	38.6				
D	24	<i>Celtis occidentalis</i>	35.9	A					A	A	36.2					A	39.7				
D	33	<i>Celtis occidentalis</i>	33.3	D					A	A	35.6					A	36.8				
D	37	<i>Celtis occidentalis</i>	33.1	D					A	A	32.1				X	RS					
D	41	<i>Celtis occidentalis</i>	34.7	D					A	A	37.4				X	A	39.2				
D	43	<i>Celtis occidentalis</i>	34.7	D					A	A	35.3					A	36.4				

**TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAPLING DATA**

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present
D	45	<i>Celtis occidentalis</i>	41.5	D				A	D						D					
D	6	<i>Fraxinus pennsylvanicum</i>	54.3	A	3			RS	RS						RS				4	
D	9	<i>Fraxinus pennsylvanicum</i>	40.6	A				A	A	41.6					RS				4	
D	10	<i>Fraxinus pennsylvanicum</i>	36.0	A				A	A	36.9					A	38.2			3	
D	22	<i>Fraxinus pennsylvanicum</i>	36.1	A	2		3	A	A	37.5					A	39.4	2		4	
D	29	<i>Fraxinus pennsylvanicum</i>	38.0	A				A	A	38.8					A	38.7	2			
D	32	<i>Fraxinus pennsylvanicum</i>	43.0	A		1	2	A	A	44.1					A	45.3			2	
D	34	<i>Fraxinus pennsylvanicum</i>	34.6	A				A	A	36.1					A	37.7				
D	38	<i>Fraxinus pennsylvanicum</i>	42.8	A				A	A	44.0					A	46.9				
D	39	<i>Fraxinus pennsylvanicum</i>	37.3	A				A	A	40.1					A	43.9				
D	47	<i>Fraxinus pennsylvanicum</i>	44.5	D				A	RS			4			D					
D	4	<i>Juglans nigra</i>	31.2	A		1		A	A	31.6					A	33.1				
D	8	<i>Juglans nigra</i>	38.9	D		2		A	A	39.5					A	38.3				
D	11	<i>Juglans nigra</i>	34.6	A				RS	RS			2			RS					X
D	15	<i>Juglans nigra</i>	39.6	D				D	D						DR					
D	17	<i>Juglans nigra</i>	40.8	A				RS	RS			3			RS					X
D	23	<i>Juglans nigra</i>	35.8	D				A	A	36.4					RS					X
D	35	<i>Juglans nigra</i>	33.1	D				D	D						D					X
D	40	<i>Juglans nigra</i>	33.4	A				A	RS						RS					
D	44	<i>Juglans nigra</i>	35.1	A				RS	RS			2			RS					
D	48	<i>Juglans nigra</i>	41.0	D				A	A	43.0		4			D					
D	7	<i>Quercus muehlenbergii</i>	29.4	A		2		A	A	31.2		1			A	33.0		1		
D	14	<i>Quercus muehlenbergii</i>	26.2	A		2		A	A	28.0					A	28.6		1	1	
D	16	<i>Quercus muehlenbergii</i>	29.5	A		2		A	A	30.3					A	30.7				
D	18	<i>Quercus muehlenbergii</i>	27.7	A		2		A	A	29.7					A	30.7				
D	19	<i>Quercus muehlenbergii</i>	31.1	A		2		A	A	33.0					A	34.0		1		
D	21	<i>Quercus muehlenbergii</i>	26.5	A		2		A	A	26.9					A	28.8		2		
D	36	<i>Quercus muehlenbergii</i>	26.7	A		2		A	A	28.1					A	28.4			2	
D	46	<i>Quercus muehlenbergii</i>	27.9	A		2		A	A	31.1					A	32.2		1		
D	50	<i>Quercus muehlenbergii</i>	24.9	A		2	1	A	A	26.4					A	27.0		1	1	

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TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAPLING DATA

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01						
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	
E	152	<i>Aesculus glabra</i>	20.1	A		1			A	A	22.6					A	21.6				
E	167	<i>Aesculus glabra</i>	19.9	A		1			A	A	20.1					A	22.2				
E	171	<i>Aesculus glabra</i>	20.1	A		1			A	A	21.3					A	21.8			2	
E	173	<i>Aesculus glabra</i>	23.2	A					A	A	25.8			1		A	28.0				
E	175	<i>Aesculus glabra</i>	26.7	A		1	1		A	A	27.8					A	31.1			1	
E	177	<i>Aesculus glabra</i>	21.3	A	2				A	A	24.4					A	28.6			2	
E	178	<i>Aesculus glabra</i>	21.7	A					A	A	24.8					A	33.7				
E	187	<i>Aesculus glabra</i>	16.8	A					A	A	17.5					A	26.3				
E	189	<i>Aesculus glabra</i>	18.2	A					A	A	18.6			1		A	22.4			1	
E	199	<i>Aesculus glabra</i>	22.9	A		1			A	A	23.0				X	A	32.1			1	X
E	156	<i>Celtis occidentalis</i>	39.7	A					A	A	40.3					A	41.5				
E	157	<i>Celtis occidentalis</i>	37.9	A					A	A	38.5					A	38.8				
E	160	<i>Celtis occidentalis</i>	41.0	D					A	A	41.9				X	A	38.4				
E	162	<i>Celtis occidentalis</i>	33.4	D					A	A	38.9					A	34.7				
E	168	<i>Celtis occidentalis</i>	33.3	A					A	A	35.4				X	A	36.1				
E	172	<i>Celtis occidentalis</i>	33.4	A					A	A	33.7					A	33.3				
E	184	<i>Celtis occidentalis</i>	34.7	D					A	A	34.9				X	A	33.8	1			
E	196	<i>Celtis occidentalis</i>	38.1	A					A	A	38.1					A	39.8				
E	198	<i>Celtis occidentalis</i>	33.0	D					RS	D						D					
E	200	<i>Celtis occidentalis</i>	38.0	A					A	A	38.9					A	41.4				
E	154	<i>Fraxinus pennsylvanicum</i>	38.1	A	2				RS	RS			3			D		2			
E	161	<i>Fraxinus pennsylvanicum</i>	39.3	A					A	A	39.8					A	41.6				
E	166	<i>Fraxinus pennsylvanicum</i>	40.9	A					A	A	41.4					A	44.0				
E	169	<i>Fraxinus pennsylvanicum</i>	37.8	A	1		4		A	A	47.2			1		A	50.4				
E	170	<i>Fraxinus pennsylvanicum</i>	37.9	A	1		4		RS	RS						RS				4	
E	176	<i>Fraxinus pennsylvanicum</i>	41.2	A					RS	RS						D		1	2	4	
E	186	<i>Fraxinus pennsylvanicum</i>	40.9	A					A	A	41.3					D				4	
E	190	<i>Fraxinus pennsylvanicum</i>	43.2	A			3		A	A	44.2					D					
E	192	<i>Fraxinus pennsylvanicum</i>	40.0	A					A	A	42.3					A				4	
E	197	<i>Fraxinus pennsylvanicum</i>	41.5	A			3		A	RS				1		RS					

**TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAPLING DATA**

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present
E	153	<i>Juglans nigra</i>	36.4	A				A	A	36.5					A	38.0				
E	159	<i>Juglans nigra</i>	36.5	A				A	A	37.7		3			A					
E	163	<i>Juglans nigra</i>	36.2	A				A	A	37.8					A	38.4		1		
E	165	<i>Juglans nigra</i>	38.0	A				A	RS				1		RS					
E	180	<i>Juglans nigra</i>	39.6	A				A	RS	39.6					A	35.5				
E	182	<i>Juglans nigra</i>	35.1	A				D	D						D					
E	185	<i>Juglans nigra</i>	36.2	A				A	RS						RS					
E	193	<i>Juglans nigra</i>	35.0	D				A	RS						RS					
E	194	<i>Juglans nigra</i>	38.1	A				A	A	40.2					A	42.9	1			
E	195	<i>Juglans nigra</i>	37.9	A				A	RS			1			RS					
E	151	<i>Quercus muehlenbergii</i>	28.1	A		2		A	A	30.0				X	A	30.6			2	
E	155	<i>Quercus muehlenbergii</i>	24.9	A				A	D						D					
E	158	<i>Quercus muehlenbergii</i>	29.8	A		2		A	A	30.5					A	31.3	3		1	
E	164	<i>Quercus muehlenbergii</i>	34.7	A		1		A	A	34.8				X	A	34.9				
E	174	<i>Quercus muehlenbergii</i>	20.2	A		2		A	A	21.2					A	23.9			2	
E	179	<i>Quercus muehlenbergii</i>	25.2	A		1		A	A	27.2				X	A	27.4				
E	181	<i>Quercus muehlenbergii</i>	23.4	A		2		A	A	27.4	2				A	25.6			1	
E	183	<i>Quercus muehlenbergii</i>	24.6	A		1		A	A	25.5	3				A	27.8			1	
E	188	<i>Quercus muehlenbergii</i>	23.2	A		2		A	A	24.3				3	A	32.0			3	
E	191	<i>Quercus muehlenbergii</i>	20.0	A		1		A	A	20.0				3	D			4		
H	214	<i>Aesculus glabra</i>	5.0	D				D	D											
H	226	<i>Aesculus glabra</i>	8.3	D			4	D	D											
H	230	<i>Aesculus glabra</i>	6.5	A				A	A	9.5					A	11.3				
H	234	<i>Aesculus glabra</i>	5.3	A				A	A	6.2					A	7.7				
H	242	<i>Aesculus glabra</i>	4.9	A				A	A	5.2					D					
H	250	<i>Aesculus glabra</i>	18.4	A				A	A	20.8					A	24.3				
H	252	<i>Aesculus glabra</i>	33.1	A				A	A	35.6					A	35.3				
H	253	<i>Aesculus glabra</i>	16.7	A		1		A	A	18.3					A	25.3			1	
H	255	<i>Aesculus glabra</i>	5.1	A				D	D						D					
H	257	<i>Aesculus glabra</i>	7.8	A				A	A	8.9					A	11.5				

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TABLE D-1
AIPi REVEGETATION RESEARCH PLOTS
SAPLING DATA

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Damage Severity (1 to 4)			Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Damage Severity (1 to 4)			Dead, Alive, or Resprout	Diam. (mm)	Damage Severity (1 to 4)				
					Vole	Deer	Rub				Vole	Deer	Rub	Fungus Present			Vole	Deer	Rub	Fungus Present
H	262	<i>Aesculus glabra</i>	41.1	A				A	A	42.3					A	48.3				
H	271	<i>Aesculus glabra</i>	31.7	A		2		A	A	33.7					A	42.3				
H	275	<i>Aesculus glabra</i>	28.2	A				A	A	31.9					A	34.2				
H	287	<i>Aesculus glabra</i>	26.5	A			1	A	A	37.3			3		RS				4	
H	291	<i>Aesculus glabra</i>	23.0	A		1		A	A	25.4					A	29.3				
H	297	<i>Aesculus glabra</i>	5.3	A	1			A	A	6.8										
H	298	<i>Aesculus glabra</i>	5.4	A	3			A	A	5.9					A	8.8	1			
H	299	<i>Aesculus glabra</i>	5.2	D	4			D	D											
H	203	<i>Celtis occidentalis</i>	41.2	D				A	A	41.6				X	A	46.7				
H	205	<i>Celtis occidentalis</i>	40.9	D			1	A	A	42.0					D					
H	209	<i>Celtis occidentalis</i>	34.8	D				A	A	35.3				X	D					
H	213	<i>Celtis occidentalis</i>	39.7	D				A	A	39.7				X	A	39.7				
H	215	<i>Celtis occidentalis</i>	33.1	D			3	A	A	34.7					A	35.5				
H	223	<i>Celtis occidentalis</i>	35.0	D				A	A	37.1					A	40.5				
H	225	<i>Celtis occidentalis</i>	41.3	A				A	A	42.8					A	42.2				
H	231	<i>Celtis occidentalis</i>	31.3	D				RS	RS						RS					
H	232	<i>Celtis occidentalis</i>	42.9	A				RS	D						D					
H	235	<i>Celtis occidentalis</i>	33.4	A				A	A	36.4				X	A	36.9				
H	239	<i>Celtis occidentalis</i>	35.1	A				A	A	36.9				X	A	37.7				
H	240	<i>Celtis occidentalis</i>	33.1	D				D	D						D					
H	246	<i>Celtis occidentalis</i>	44.4	A				A	A	44.4				X	A	46.6				X
H	260	<i>Celtis occidentalis</i>	37.8	D				A	A	40.6				X	A	43.7				
H	267	<i>Celtis occidentalis</i>	36.1	D				A	A	36.5					A	40.3				
H	269	<i>Celtis occidentalis</i>	37.9	D			2	A	A	40.0				X	A	38.7				
H	276	<i>Celtis occidentalis</i>	38.1	D				RS	RS						D					
H	278	<i>Celtis occidentalis</i>	30.8	D				A	D						A	36.2				
H	280	<i>Celtis occidentalis</i>	35.0	D				RS	D						D					X
H	290	<i>Celtis occidentalis</i>	36.1	A				A	A	37.3				X	A	39.7				
H	202	<i>Fraxinus pennsylvanicum</i>	37.8	A				A	A	38.7					A	40.3				
H	208	<i>Fraxinus pennsylvanicum</i>	36.6	A		1	3	A	A	36.5					RS				4	

**TABLE D-1
A1PI REVEGETATION RESEARCH PLOTS
SAMPLING DATA**

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01					
			Diam. (mm)	Dead, Alive, or Resprout	Vole	Deer	Rub	Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present	Dead, Alive, or Resprout	Diam. (mm)	Vole	Deer	Rub	Fungus Present
H	211	<i>Fraxinus pennsylvanicum</i>	40.0	A		1		A	A	42.3			2		RS				2	
H	212	<i>Fraxinus pennsylvanicum</i>	39.0	A				A	A	40.4			3		RS				3	
H	216	<i>Fraxinus pennsylvanicum</i>	45.9	A		2		A	A	46.7					A	48.3			4	
H	220	<i>Fraxinus pennsylvanicum</i>	34.6	A		1		A	RS				3		D					
H	222	<i>Fraxinus pennsylvanicum</i>	36.4	A			3	A	RS						RS					
H	229	<i>Fraxinus pennsylvanicum</i>	41.1	A			3	A	RS						D				4	
H	247	<i>Fraxinus pennsylvanicum</i>	36.1	A			1	A	A	38.2					A	39.5			2	
H	251	<i>Fraxinus pennsylvanicum</i>	39.5	A			2	RS	RS	39.6					D				4	
H	259	<i>Fraxinus pennsylvanicum</i>	34.8	A			3	D	D						D				4	
H	263	<i>Fraxinus pennsylvanicum</i>	44.5	A			3	A	A	47.2					A	51.6			3	
H	268	<i>Fraxinus pennsylvanicum</i>	43.2	A			4	RS	RS				3		RS					
H	273	<i>Fraxinus pennsylvanicum</i>	41.4	D			3	A	A	41.9					A	45.3			4	
H	274	<i>Fraxinus pennsylvanicum</i>	39.8	A			3	A	A	41.9					A				3	
H	283	<i>Fraxinus pennsylvanicum</i>	48.1	A			2	A	A	49.7					A	51.7			2	
H	284	<i>Fraxinus pennsylvanicum</i>	49.7	A			2	A	A	49.4					RS				4	
H	288	<i>Fraxinus pennsylvanicum</i>	38.1	A			1	A	A	41.6			3		A	46.5			4	
H	294	<i>Fraxinus pennsylvanicum</i>	44.5	A			3	A	A	46.3					A	49.8				
H	295	<i>Fraxinus pennsylvanicum</i>	33.2	A			2	A	A	36.5					A	39.0			2	
H	206	<i>Juglans nigra</i>	40.8	A				A	A	43.7					A	42.6	1			
H	207	<i>Juglans nigra</i>	42.9	A				A	A	42.9					A	43.8				
H	210	<i>Juglans nigra</i>	43.1	A				A	A	47.4					A	45.1				
H	221	<i>Juglans nigra</i>	46.2	D				A	A	47.8					A	51.4				X
H	224	<i>Juglans nigra</i>	39.6	A				A	RS						RS					
H	233	<i>Juglans nigra</i>	41.4	D				A	A	45.4					A	44.4				
H	236	<i>Juglans nigra</i>	41.5	A				A	A	42.8					A	42.8				X
H	241	<i>Juglans nigra</i>	40.0	D				A	A	43.6				X	A	42.5				X
H	243	<i>Juglans nigra</i>	38.2	D				A	A	39.4					A	42.4				X
H	244	<i>Juglans nigra</i>	40.1	A				A	A	41.4					A	44.0				
H	248	<i>Juglans nigra</i>	46.2	D				RS	RS	47.4					D					X
H	254	<i>Juglans nigra</i>	39.5	A				A	A	39.6				X	A	43.5				X

000072

4051

000073

TABLE D-1
AIFI REVEGETATION RESEARCH PLOTS
SAMPLING DATA

Plot	ID	Species	Fall-99				Spring-00				Fall-00				Fall-01						
			Diam. (mm)	Dead, Alive, or Resprout	Damage Severity (1 to 4)			Dead, Alive, or Resprout	Dead, Alive, or Resprout	Diam. (mm)	Damage Severity (1 to 4)			Dead, Alive, or Resprout	Diam. (mm)	Damage Severity (1 to 4)			Fungus Present		
					Vole	Deer	Rub					Vole	Deer	Rub	Fungus Present			Vole	Deer	Rub	Fungus Present
H	256	<i>Juglans nigra</i>	40.0	D					A	A	40.7					A	43.0				
H	258	<i>Juglans nigra</i>	24.6	A		1			A	A	24.7					A	27.9				
H	265	<i>Juglans nigra</i>	44.5	A					A	A	45.4					A	49.4				
H	266	<i>Juglans nigra</i>	39.4	A					A	A	41.4					A	47.9				X
H	272	<i>Juglans nigra</i>	49.5	D					A	RS						A	47.2				X
H	277	<i>Juglans nigra</i>	30.3	A			1		A	A	32.0					A	34.9				
H	281	<i>Juglans nigra</i>	44.5	D					A	A	46.6					A	47.3				
H	282	<i>Juglans nigra</i>	43.2	A			4		A	A	45.7			3		A					
H	285	<i>Juglans nigra</i>	40.1	A			1		A	A	41.3					A	46.4				
H	201	<i>Quercus muehlenbergii</i>	24.8	A		2			A	A	24.9					A	26.8		2	1	
H	204	<i>Quercus muehlenbergii</i>	16.6	A		2			A	A	22.6					A	20.8		2	2	
H	217	<i>Quercus muehlenbergii</i>	26.3	A		2			A	A	26.9					A	26.1				
H	218	<i>Quercus muehlenbergii</i>	23.4	A		2			A	A	30.6					A	32.1			1	
H	219	<i>Quercus muehlenbergii</i>	25.1	A					A	A	27.3					A	28.7			2	
H	227	<i>Quercus muehlenbergii</i>	16.4	A		2	1		A	A	18.6					A	21.3			2	
H	228	<i>Quercus muehlenbergii</i>	24.9	A		2			A	A	27.3					A	30.5				
H	237	<i>Quercus muehlenbergii</i>	29.4	A		2			A	A	30.0					A	32.3				
H	238	<i>Quercus muehlenbergii</i>	24.7	A		2	2		A	A	24.9					A	26.3			2	
H	245	<i>Quercus muehlenbergii</i>	19.8	A		2			RS	RS	22.6					A	22.3				
H	249	<i>Quercus muehlenbergii</i>	25.1	A		2			A	A	27.7					A	30.4				
H	261	<i>Quercus muehlenbergii</i>	26.5	A		2	1		A	A	32.1					A	38.4	1			
H	264	<i>Quercus muehlenbergii</i>	24.9	A		1			A	A	33.3					A	36.8				
H	270	<i>Quercus muehlenbergii</i>	23.1	A		2			A	A	26.0					A	27.1				
H	279	<i>Quercus muehlenbergii</i>	28.3	A		2			A	A	25.7					A	28.0				
H	286	<i>Quercus muehlenbergii</i>	21.8	A		1	4		RS	RS				2		RS				4	
H	289	<i>Quercus muehlenbergii</i>	26.5	A		2	1		A	A	28.4			2		A	31.7			2	
H	292	<i>Quercus muehlenbergii</i>	24.6	A		2			A	A	26.0					A	33.6				
H	293	<i>Quercus muehlenbergii</i>	24.9	A		2	1		A	A	30.5					A					
H	296	<i>Quercus muehlenbergii</i>	21.4	A		2	4		RS	RS	21.4					RS				4	
H	300	nd	nd	nd	nd	nd	nd	nd	ND	ND											

APPENDIX E

**ECOLOGICAL RESTORATION
FUNCTIONAL PHASE MONITORING PLAN**

**APPENDIX E
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1 and macroinvertebrate surveys are conducted by OEPA, so sample and analysis methods are not
2 discussed in this plan.

3 4 3.0 VEGETATION CHARACTERIZATION

5 Vegetation characterization using the parameters discussed above will require that species richness,
6 abundance (for woody plants), cover (for herbaceous plants), and size (for woody plants) is collected
7 from each baseline, reference site, and restoration project. The sampling methods and processes for data
8 analysis are discussed below.

9 10 3.1 Sample Design

11 Most of the study areas that will be characterized are too large for an analysis of the entire plant
12 population. Therefore, random samples must be taken to characterize the system. Vegetation sampling
13 will be conducted through the systematic random location of quadrats. Two different types of quadrats
14 will be used, depending on the type of vegetation to be surveyed. One m² quadrats will be established for
15 herbaceous vegetation. Woody vegetation will be surveyed with 100 m² quadrats. The process for
16 locating quadrats within the study area is described below.

17
18 Samples must be randomly chosen in order to provide an unbiased characterization of the community. To
19 accomplish this, the following system has been developed. First, establish a permanent transect that
20 approximates the longitudinal axis of the study area. Flag each end of the transect and measure its
21 distance in meters. Record the bearing of the transect so that it can be followed even if dense vegetation
22 obscures the stakes and/or flags used to mark it.

23
24 Ten quadrats will be randomly located off of this transect during each sampling event. For the first
25 quadrat, establish a random starting point from 5 to 30 meters out at one end of the transect by rolling a
26 die and assigning multiples of five, as follows:

27
28 1(5m) 2(10m) 3(15m) 4(20m) 5(25m) 6(30m)

29
30 Divide the remaining length of the transect by nine in order to establish ten transect points from which
31 quadrats will be established. During each sampling event, establish points starting from the same end of
32 the transect.

1 To position quadrats off of the transect, roll the die to determine whether the quadrat will be placed to the
2 left or right of the quadrat. (A roll of one to three would send the quadrat to the left of the transect, while
3 a roll of four to six would go to the right.) Lastly, roll the die one more time to determine the distance of
4 the quadrat from the transect. The distance from the transect will depend on the overall width of the study
5 area. Determine the distance from the transect to the edge of the study area, then divide by six to obtain
6 distance intervals that will be determined by rolling a die. For example, a 60-meter area would result in
7 the following intervals:

8
9 1(10m) 2(20m) 3(30m) 4(40m) 5(50m) 6(60m)

10
11 Note that the quadrat location may need to be adjusted due to obstructions that would prevent sampling,
12 such as roads, bodies of water, etc.

13
14 For wetlands where a small strip of vegetation surrounds an open water area, the transect will run the
15 length of the water's edge. Quadrat locations will be placed on regular intervals following a randomized
16 start point, as described above.

17
18 The steps outlined above will determine random sample points from which vegetation quadrats can be
19 laid out. Quadrats should be established parallel to the transect, with the top right corner of the quadrat
20 set at the sample point. Use a compass to orient the quadrat parallel to the transect. For instance, if a
21 transect runs north to south across a study area and the survey was initiated at the southern end, each
22 sample point would comprise the northeast corner of the quadrat. In areas where woody vegetation is
23 present, establish the 100-m² woody vegetation quadrat first, and then nest the herbaceous quadrat within
24 the woody quadrat, using the same top right corner location. Be careful not to trample the herbaceous
25 vegetation when establishing the quadrats and sampling the woody vegetation. One m² herbaceous
26 quadrats are delineated with pre-measured PVC pipe. The inside dimensions of the square measure
27 1 meter on each side. Woody vegetation 100-m² quadrats are flagged in the field by measuring out a
28 10-meter by 10-meter square.

29
30 As stated above, ten quadrats of each vegetation layer should be established during each sample event.
31 Additional quadrats may be surveyed in order to characterize features that are of particular interest, such
32 as wetlands. Additional vegetation samples will be treated separately from the randomized quadrats,
33 since including them could bias the results of the data analysis.

1 In order to identify all vegetation within the study area, three separate sampling events should be
2 completed during the growing season. Conduct the first survey in early spring, the second in early
3 summer, and the third in late summer. This approach will account for early and late-blooming species
4 that may not be recorded if just one survey was conducted. Also, it increases to 30 the number of
5 quadrats used to characterize the study area, thereby strengthening the statistical representation of the
6 data.

7 8 3.2 Data Collection

9 Once the quadrat location is established, begin data collection. Field forms will be used to organize and
10 record field data (Figures E-1 and E-2). A Vegetation Field Survey Gear List is also provided as
11 Figure E-3. A separate field form will be used for herbaceous and woody vegetation. A unique
12 identification code will be assigned to each quadrat surveyed. The generation of ID codes is described
13 below.

14
15 Each quadrat identification code will consist of an area designation, the survey number, the survey type,
16 and the quadrat number. One or more letters will be used as a study area code. Next, the survey number
17 will be designated using "A, B, or C," with "A" being the first survey, etc. The survey type will be either
18 woody (W) or herbaceous (H). Lastly, quadrats will be numbered one to ten. As an example of this
19 approach, G-B-H-5 represents the fifth herbaceous quadrat sampled during the second survey of the
20 grazed pasture baseline site. Each species identified within a quadrat will also be numbered, so that it is
21 uniquely identified as well. Using the same example from above, G-B-H-5-2 is the identification code
22 assigned to the second species identified in the fifth herbaceous quadrat of the second survey of the
23 grazed pasture.

24
25 Once the quadrat code information is entered, record the necessary administrative information onto the
26 field forms. Required information includes the date, the quadrat survey start time, the survey team, a
27 general description of the weather, the quadrat location in relation to the transect (i.e., 30 meters west of
28 transect at 85 meters), and a brief narrative description of the quadrat, such as "canopy gap with much
29 understory growth." Photograph the quadrat with a 35-mm SLR camera equipped with a 50-mm lens.
30 Include a label in the photo indicating the survey date and the quadrat ID code. Next, estimate and record
31 the total herbaceous cover and the total canopy cover of the quadrat, using the following cover class
32 estimates:

1 0(0%) 1(1-5%) 2(6-25%) 3(26-50%) 4(51-75%) 5(76-100%)

2
3 When cover estimates are being used to comply with Implementation Phase monitoring, make an
4 additional note regarding whether the total cover exceeds 90 percent.

5
6 Species-specific information can now be gathered. First, list each species identified within the quadrat.
7 Unidentified species should be assigned an ID number and listed as "unknown." Photograph the species
8 or take a voucher for later identification. Off site, vouchers will only be collected if permission and
9 appropriate collection permits are in place. On site, one voucher will be taken for each native species
10 identified across all baseline and restored areas, unless the species is threatened or endangered. If a
11 voucher is collected, label it with its identification number, date, and species name (if known). Note on
12 the field form if a voucher was collected.

13
14 For each species, record the type of vegetation it is (grass, forb, tree, etc.). Next, estimate the cover of the
15 species using the cover class designations listed above. For woody vegetation, record the diameter at
16 breast height (dbh) for trees greater than 2 meters in height, or the diameter of shrubs less than 2 meters in
17 height, so that foliage area can be calculated. Since dbh or foliage area measurements will be made for
18 each woody plant, individuals shall be listed on the field form. For herbaceous vegetation, only the
19 species present will be listed. Abundance will not be recorded but rather inferred from species-specific
20 cover class estimates.

21
22 Lastly, note any special conditions or other comments onto the field form. Record the end time on the
23 form and break down the quadrat, leaving the sample point (top right corner) flagged and labeled with the
24 date and quadrat ID code. For off-site reference sites, make sure that sample flags are permitted.

25 26 3.3 Data Analysis

27 From the data collected in the field, several characterization parameters can be developed. As stated in
28 Section 2.0 of this plan, the vegetation parameters include FQAI, MSI, percent native cover, and plant
29 size. Each of these parameters is discussed in more detail below. However, in order to develop these
30 parameters, the survey area data must be organized. First, a list shall be compiled of all species identified
31 during each sample event. Tabulate the woody vegetation abundance and mean dbh/foliage area for each
32 species. For herbaceous species, calculate the mean cover class as follows. First, combine all "1" and
33 "2" cover class assignments to obtain a single cover class of "1." The combined cover class designation

1 represents a cover range of 1 to 25 percent. The remaining three cover classes then need to be adjusted
2 down one unit. In this way, a field-recorded cover class of "3" would be assigned a "2." Four would
3 become 3, and 5 would become 4. These steps are needed to make a linear scale from which to average.
4 Then sum all cover classes and divide by 30 to obtain a mean cover class for each species. Individual
5 vegetation parameters can now be calculated.

6 7 3.3.1 FQAI

8 The calculation of FQAI requires that a coefficient of conservatism (CC) value is assigned to each species
9 identified in the study area. A CC is a number from 1 to 10 that ranks the degree to which a species
10 represents a quality system. A widespread species that is often found in degraded systems would have a
11 low CC, while a rare plant with very specific habitat requirements be assigned a high CC. Non-native
12 species are always assigned a CC of 0. A statewide list of CC values is being developed (Mack 2001).
13 Once published, all species identified during Functional Phase monitoring will be assigned a statewide
14 CC value. Until then, CC values for northeast Ohio developed for evaluation of wetlands will be used
15 (Andreas 1995). FQAI for each study area is then calculated using the following formula:

$$16 \qquad \qquad \qquad 17 \qquad \qquad \qquad \text{FQAI} = C \ n$$

18 Where:

19 C = the mean CC value of all species
20 n = the total number of species recorded
21

22 The FQAI is a value that can be used to compare the extent of floristic quality between baseline sites,
23 restored areas, and reference sites (Packard 1997). It is suspected that baseline sites will have a relatively
24 low FQAI when compared to reference sites. Restored areas should show some increase in FQAI values
25 over time. The use of FQAI to compare sites is discussed in Section 5.3 below.

26 27 3.3.2 MSI

28 MSI provides a measure of species diversity for a study area (Brower 1990). Normally, the calculation of
29 Simpson's Index is a calculation of species dominance, and it would require abundance values for each
30 species identified in the study area. The abundance of woody vegetation will be tabulated for each study
31 area. However, since the abundance of herbaceous vegetation will not be collected, a modified approach
32 using herbaceous cover estimates is needed. Therefore, the mean cover estimates for each species will be
33 used as a surrogate for species abundance. In terms of calculating Simpson's Index, this would mean that
34 each herbaceous species would have an abundance of one to four. Because of this, the calculation of

1 Simpson's Index would be bunched very close together and thus difficult to compare. To rectify this, the
2 formula for calculating Simpson's Index must be inverted. This change in the equation, along with the
3 use of cover class estimates instead of abundance values, results in the establishment of an MSI value.

4 MSI is calculated as follows:

$$5 \quad \text{MSI} = \frac{N(N-1)}{[n_i(n_i-1)]}$$

6
7
8 Where:

9 N = sum of all cover classes

10 n_i = species-specific cover class

11
12 Since abundance will be available for all woody vegetation, separate MSI calculations will be conducted
13 for woody and herbaceous layers. For woody vegetation, N = the total number of individuals recorded in
14 a study area, and n_i = the abundance for each species. For woody vegetation, the MSI will represent the
15 number of times needed to take pairs of individuals at random to find a pair of the same species within a
16 study area (Brower 1990). This same statement probably does not hold true for herbaceous vegetation,
17 since cover class estimates are used to calculate MSI instead of abundance. Instead, the MSI for
18 herbaceous vegetation provides a relative comparison of diversity between study areas.

19 20 3.3.3 Percent Native Cover

21 The percent native cover is calculated with the converted native cover classes discussed above. Sum all
22 native species converted cover classes, then divide into the cover class total for the study area. The
23 resulting value will represent a range between the four mean cover class values. Native species will be
24 designated by their CC. If a species has a CC between 1 and 10, it is included as a native species.

25 Non-native species will always have a CC of 0.

26 27 3.3.4 Plant Size

28 This survey parameter applies only to woody vegetation. The mean dbh and foliage area of each study
29 area will be established by obtaining species-specific dbh and foliage area measurements in the field. The
30 mean dbh of a study area should be calculated and reported. Foliage area needs to be calculated for each
31 species before it can be averaged. Assume that all shrubs are circular, and calculate foliage area by using
32 $A = r^2$. Then calculate the mean foliage area for shrubs within the study area.

1 4.0 BIRD SURVEYS

2 Breeding bird surveys will be conducted in each survey area. Also, migratory waterfowl observations
3 will be made in open water areas. Field implementation and data analysis is not as involved as the
4 requirements for vegetation characterization. Each process is described in more detail below.
5

6 4.1 Breeding Bird Surveys

7 To conduct breeding bird surveys, establish a walking transect across the project area. The walking
8 transect is separate from the vegetation characterization transect described in Section 3.1 of this plan. The
9 walking transect must be an accessible, repeatable route that allows for observation of the entire study
10 area. The entire transect route should be able to be completed in 0.5 to 1 hour. The transect route should
11 be identified on a map of the project area.
12

13 Three surveys shall be conducted during the month of June. Survey the study area in the morning, during
14 the time of peak bird activity. For each survey, record all individuals seen or heard along the transect.
15 Two individuals should participate in the survey: a local birding expert and a recordkeeper. The birding
16 expert shall name the species and quantity while walking along the transect, followed by the
17 recordkeeper. The recordkeeper is responsible for recording additional information as well, including the
18 date, start time, end time, weather conditions, and any additional notes of interest. Species and quantity
19 lists will be consolidated from the three surveys, resulting in a species richness and abundance list for
20 breeding birds within each study area. Calculate MSI for each study area pursuant to the formula in
21 Section 3.3.2 of this plan.
22

23 4.2 Migratory Waterfowl Observations

24 Migratory waterfowl observations shall be conducted in March, during the peak of the spring migration
25 season. Observe the water body in the morning from the same location on five occasions, recording
26 species and quantities observed. Record the date, time, weather, observation location, and observer.
27 After all surveys are conducted, sum the species and quantities, and calculate MSI.
28

29 5.0 REPORTING

30 Once all measurement parameters are calculated for each study area, they must be compared in order to
31 demonstrate the extent of progress for restored areas. As stated in Section 1.0 of this plan, restored
32 ecosystems at the FEMP will be compared to pre-remediation baseline conditions and to off-property
33 reference sites. This evaluation of restored areas is discussed in more detail below.

1 5.1 Baseline Conditions

2 The FEMP site has been divided into six different pre-remediation baseline conditions: grazed pasture,
3 riparian forest, successional woodlot, pine plantation, open water, and developed. A representative
4 baseline system will be characterized using the processes discussed in Sections 3.0 and 4.0 of this plan.
5 These representative systems will serve as the baseline template for similar areas across the site. Once an
6 area is ecologically restored, the ecological system components that comprise the restored area will be
7 compared to the baseline conditions present prior to restoration. Project-specific NRRDPs will specify
8 the applicable baseline condition for the project area. Usually, only one baseline condition will be
9 assigned to a project area. Larger restoration projects may require comparisons to several baseline
10 conditions.

11
12 Most of the restoration projects will be established on developed land. In this case, ecological baseline
13 conditions would be considered non-existent. For other areas, however, the restored ecosystems will be
14 compared to the measurement parameters calculated for the applicable baseline condition. It is important
15 to note that baseline conditions are area-based, while restored area evaluations will be ecosystem based.
16 For example, a grazed pasture is restored to an emergent wetland and a wet meadow. When Functional
17 Phase monitoring for the emergent wetland is conducted, it will be compared to the area-specific
18 conditions that were present prior to the restoration effort. In this example, the baseline comparison
19 would be to the grazed pasture template. These comparisons are applicable, since the same measurement
20 parameters will be calculated for each system.

22 5.2 Reference Sites

23 Restored area comparisons to reference sites will also be conducted. To accomplish this, a series of
24 reference sites will be established and characterized using similar measurement parameters. The
25 reference sites for FEMP ecological restoration include the following:

- 27 • Upland beech-maple/oak hickory forest complex
- 28 • Wet forest
- 29 • Riparian forest
- 30 • Emergent wetland/open water area
- 31 • Wet meadow/marsh
- 32 • Tallgrass prairie.

34 The location and access to each reference site is to be determined. The selected reference site for each
35 system should be as close to the FEMP site as possible, and should be approximately the same size as the

1 planned restored areas at the FEMP. Once specific reference sites are established, they will be
2 characterized using the same monitoring parameters as the restored areas and baseline conditions. Unlike
3 the baseline conditions, reference sites and restored areas will be compared on a system-specific bases.
4 Using the example from above, the emergent wetland component of the restored area will be compared to
5 the emergent wetland reference site, while the wet meadow component of the restoration project is
6 compared to the wet meadow/marsh reference site.

7 8 5.3 Project Comparisons

9 As described above, the restored systems will be compared to both baseline conditions and appropriate
10 reference sites. These comparisons will be reported as part of the annual consolidated monitoring report.
11 The intent is to demonstrate that the restored system has achieved some level of progress from the
12 baseline condition towards its corresponding reference site. To do this, statistical comparisons will be
13 made between restored systems, baseline conditions, and reference sites using standard t-Tests (given that
14 the sample data do not severely violate the assumptions of normality). The normality assumption will be
15 tested using the Shapiro-Wilk test procedure. If the normality assumption can not be justified then a
16 log-transformation of the data will be attempted to 'normalize' the data. If the data can not be normalized
17 then the Wilcoxon Rank-Sum (non-parametric) procedure will be employed to test for differences
18 between the restored system and either the baseline or reference data.

19
20 It is anticipated that the restored system will show initial improvement from the baseline, then a much
21 slower progression towards its reference site conditions. Similarity to reference sites will probably take
22 decades to achieve, if ever. The scope of Functional Phase monitoring at the FEMP probably does not
23 include the timeframes for monitoring that would be necessary to demonstrate attainment of reference site
24 similarity. Therefore, an alternative approach has been developed to assess the progress of the restored
25 system within the timeframes planned for monitoring. A linear rate of progress from baseline conditions
26 towards the reference site will be assumed for each measurement parameter. The number of years for
27 reference system maturation will be decided jointly by the NRTs. This "system progression" can then be
28 displayed as a function of time, and compared to the restored system. An example of this quasi-technical
29 approach to visualize progress is shown in Figure E-4. The diagonal line indicates a linear progression
30 from baseline to reference (in this fictitious example, FQAI going from 5 to 40, with a maturation time of
31 10 years). The solid diamond represents average for the year and the vertical bar represents the
32 confidence bound on the estimate. If the confidence bound overlaps the "estimated progress line" then
33 restoration would be considered "on schedule."

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1 In reality, the quality and diversity of vegetation and wildlife in a maturing ecosystem would rarely
2 progress linearly. Vegetation diversity, for instance, would probably peak during the early successional
3 stages of forest development, when the system is transitioning from an old field to a forest community.
4 However, as stated above, these changes would often take decades and even centuries to develop.
5 Therefore, an assumption of linear progression may prove useful for system comparisons within the
6 10-year functional monitoring window. Alternative methods of comparison agreed to by the NRTs will
7 be described and presented in future annual consolidated monitoring reports.

8 9 6.0 SCHEDULE

10 The schedule for Functional Phase monitoring is presented in the NRRP (DOE 2001a), and provided in
11 Table E-1. This schedule is set up to evaluate a single type of system on an annual rotation. In other
12 words, all wetland restoration projects will be evaluated in year one, all prairies and savannas in year two,
13 and all forest systems in year three. This rotation will be repeated several times, starting in 2003.
14 Baseline and reference sites will be characterized in 2001 and 2002.

**TABLE E-1
 FUNCTIONAL PHASE MONITORING SCHEDULE**

Year	Monitoring Activity
2001	Baseline sites
2002	Reference sites
2003	A1PI Wetland Mitigation A8PII Forest Demonstration (wetland) Borrow Area (wetland, interim restoration)
2004	A8PII Forest Demonstration (savanna)
2005	A8PII Forest Demonstration (forest) Southern Waste Units (forest/riparian, interim restoration) Northern woodlot (forest, interim restoration)
2006	A1PI Wetland Mitigation A8PII Forest Demonstration (wetland) Northern Woodlot (wetland) Borrow Area (wetland, interim restoration)
2007	A8PII Forest Demonstration (savanna) A8PI restored prairie Northern Woodlot (prairie)
2008	A8PII Forest Demonstration (forest) Southern Waste Units (forest/riparian) Northern Woodlot (forest) Paddys Run Corridor East (forest) Northern Pines (forest)
2009	A1PI Wetland Mitigation A8PII Forest Demonstration (wetland) Southern Waste Units (wetland) Borrow Area (wetland) Northern Woodlot (wetland) Waste Pit Area (wetland)
2010	A8PII Forest Demonstration (savanna) Paddys Run Corridor West (prairie/savanna) Borrow Area (prairie) Waste Pit Area (prairie) Production Area (prairie) Northern Woodlot (prairie) On-Site Disposal Facility Perimeter (prairie)
2011	A8PII Forest Demonstration (forest) Southern Waste Units (forest/riparian) Northern Pines (forest) Paddys Run Corridor East (forest) Paddys Run Corridor West (forest/riparian) Northern Woodlot (forest)
2012	A1PI Wetland Mitigation A8PII Forest Demonstration (wetland) Borrow Area (wetland) Northern Woodlot (wetland) Waste Pit Area (wetland) Production Area (wetland) Silos Area (wetland)

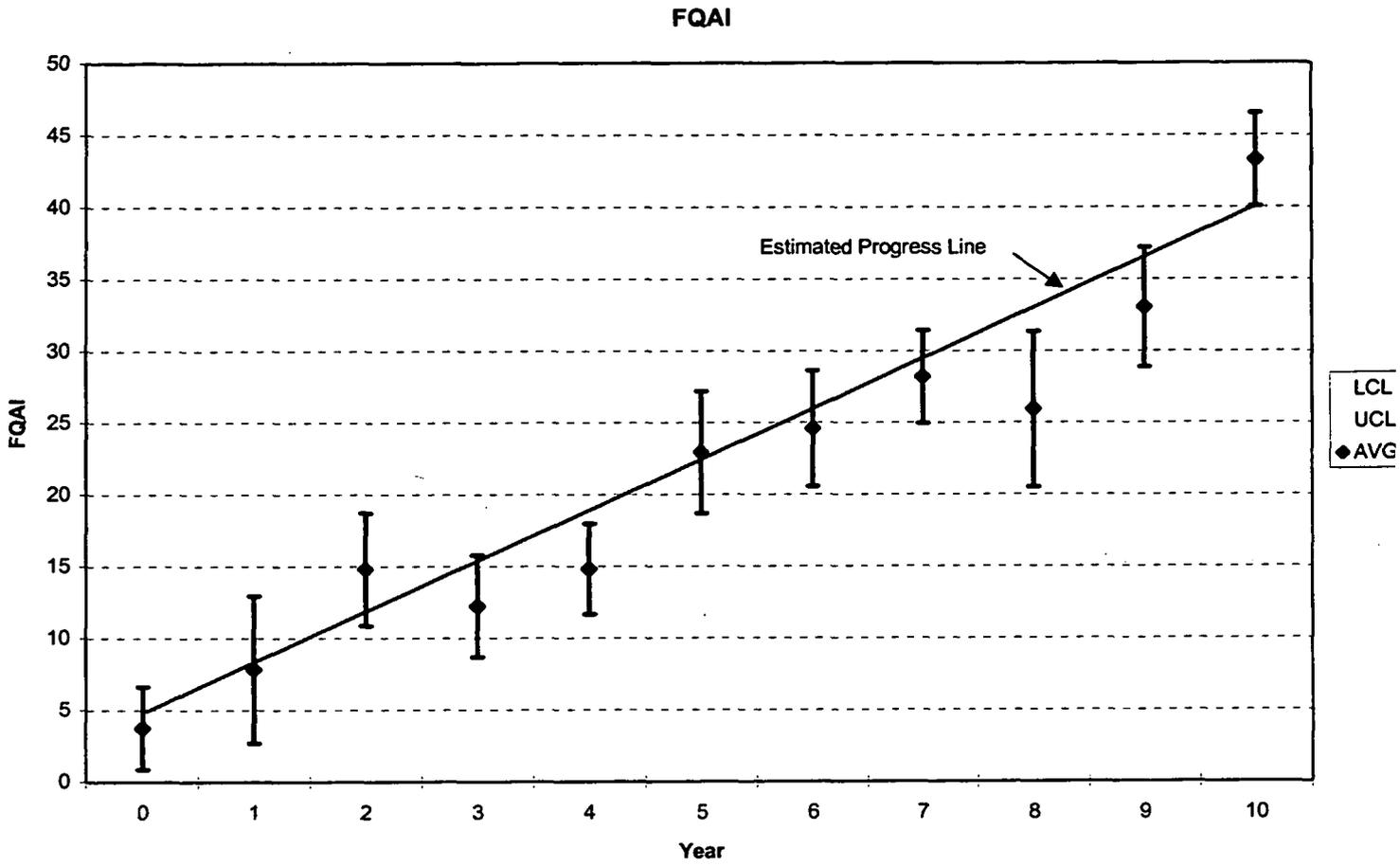
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**FIGURE E-3
BASELINE ECOLOGICAL MONITORING
VEGETATION SURVEY GEAR LIST**

- radio/cell phone
- bug spray
- field log
- field forms
- site map
- graph paper
- clipboard
- pencils
- sharpie
- plant press w/materials
- hand lens
- 30cm ruler
- field books/keys
- ziploc bags
- camera/film
- film roll ID sheets
- calculator
- compass (2)
- 50m measuring tape
- 100m measuring tape
- 10m dbh tape
- marking flags
- hand trowel
- scissors

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FIGURE E-4
EXAMPLE GRAPH SHOWING SYSTEM PROGRESS



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