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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POST-CONSTRUCTION PERFORMANCE EVALUATION REPORT (PER4F)

ANDALUSIA REFUGE REHABILITATION AND ENHANCEMENT

POOL 16, MISSISSIPPI RIVER MILES 462-463
ROCK ISLAND COUNTY, ILLINOIS

AUGUST 1997

ACKNOWLEDGMENT

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ROCK ISLAND DISTRICT, CORPS OF ENGINEERS

PROJECT ENGINEER:	Celia C. Kool, P.E.
TECHNICAL MANAGER FOR HABITAT PROJECTS:	Darron Niles
ENVIRONMENTAL ANALYSIS:	Charlene Carmack
WATER QUALITY:	Dave Bierl
CADD SUPPORT AND CLIP ART:	Sue Brown
REPORT PREPARATION:	Nancy Holling

U.S. FISH AND WILDLIFE SERVICE

EMP COORDINATOR:	Ross Adams

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

PROJECT INSPECTION, OPERATION, AND MAINTENANCE:	Steve Francisko
DISTRICT WILDLIFE BIOLOGIST:	Doug Dufford
DISTRICT FISHERY BIOLOGIST:	Dan Sallee
REFUGE MANAGER:	Steve Moser

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1. INTRODUCTION

The Andalusia Refuge Rehabilitation and Enhancement project, hereafter referred to as "the Andalusia Refuge project," is an ongoing part of the Upper Mississippi River System (UMRS) Environmental Management Program (EMP). The Andalusia Refuge project is located within the Mark Twain National Wildlife Refuge. Plate 1 contains the site plan and vicinity map.

a. Purpose. The purposes of this Performance Evaluation Report (PER) are as follows:

(1) Summarize the performance of the Andalusia Refuge project, based on the project goals and objectives;

(2) Review the monitoring plan for possible revision;

(3) Summarize project operation and maintenance efforts to date; and

(4) Review engineering performance criteria to aid in the design of future projects.

b. Scope. This report summarizes available project monitoring data, inspection records, and observations made by the U.S. Army Corps of Engineers (Corps) and the Illinois Department of Natural Resources (ILDNR) for the period from March 1994 through July 1997.

2. PROJECT GOALS, OBJECTIVES, AND MANAGEMENT PLAN

a. General. As stated in the DPR, the Andalusia Refuge project was initiated primarily because of limited management capability to provide quality habitat for waterfowl due to a lack of water level control. In the refuge south of Dead Slough, little or no water was present during the fall waterfowl migration. Sediments from the Mississippi River and adjacent uplands were decreasing the water volume in the refuge and adjacent backwater fisheries, causing a succession from a dominance of aquatic bed-palustrine wetlands to more emergent class plant species such as sedge, rice cutgrass, and willow, and reducing deepwater fish habitat off the main channel.

b. Goals and Objectives. Goals and objectives were formulated during the project design phase and are summarized in Table 2-1. The DPR included a third goal, "Decrease adjacent tributary sediment volume." The objective for this goal was "reduce sedimentation in refuge." In preparing the O&M manual, this objective was absorbed by the broader goal to enhance aquatic habitat, eliminating the "Decrease adjacent tributary sediment volume" goal.

TABLE 2-1

Project Goals and Objectives

Goals	Objectives	Project Features
Enhance Migratory Waterfowl Habitat	Increase reliable food production area (moist-soil species)	Provide water control
	Increase reliable resting and feeding water area	Mechanical dredging
Enhance Aquatic Habitat	Restore deep (6 feet) aquatic habitat	Mechanical dredging
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging/excavation
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure
	Reduce sedimentation in refuge	Construct levee and divert tributary

c. Management Plan. As with more recently developed EMP projects, such as Potters Marsh, Illinois (RM 522.5 - 526.0), and Brown's Lake, Iowa (RM 545.8), a formal Annual Management Plan has been developed for the Andalusia Refuge project. The Management Plan was developed by the Corps in coordination with the ILDNR and is shown in Table 2-2. The Andalusia Refuge project is managed by the ILDNR under authority of Cooperative Agreements with the U.S. Fish and Wildlife Service (USFWS) and the Corps. Andalusia Refuge is operated as generally outlined in the O&M manual.

TABLE 2-2

Annual Management Plan for Andalusia Refuge

Month	Management Action	Purpose
May-July	Dewater Moist-Soil Management Unit (MSMU) by pump station or gravity to 542.0 MSL drawdown elevation. [1/]	Expose mudflats to allow revegetation
August-November	Gradually increase MSMU water levels to correspond with growth of marsh plant community (elevations higher than 547 MSL must be coordinated with adjacent property owners during the non-crop season).	Provide access to food plants for migratory waterfowl
December-April	Maintain MSMU water levels to maximum extent possible (547 MSL) primarily by use of pumping capability. [2/]	Control excessive plant growth, if necessary, and provide stable, deeper water to prevent complete ice-up (a critical concern for resident furbearers).

[1/] Some adjustment will be made to the drawdown elevation so that fisheries benefits will be maximized without adversely impacting moist-soil plant production.

[2/] Dewatering during February-April may be required to accomplish vegetation changes within the moist-soil management unit.

3. PROJECT DESCRIPTION

a. Project Features. The project consists of: a Moist-Soil Management Unit; Deep Aquatic Habitat; Lentic-Lotic Access Channel; Diversion Drainage Ditch; and Project Access Road. The project features are illustrated below in Figure 3-1 and on plate 2.

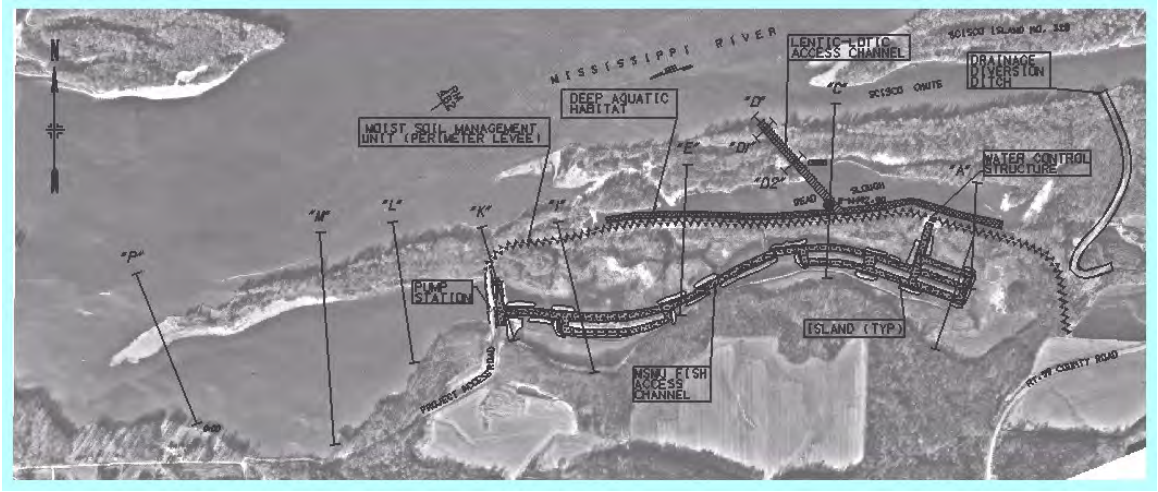

FIGURE 3-1. Project Features.

(1) Moist-Soil Management Unit (MSMU). Construction of a 130-acre MSMU protected by a perimeter levee. Other MSMU features include a pump station, water control structure, and interior and side drainage channels and associated islands.

(a) Perimeter Levee. The MSMU consists of an 8,600-foot-long, 2-year event perimeter levee with a 12-foot crown (60-foot crown parallel to Dead Slough) and 4H:1V side slopes. The perimeter levee includes a 600-foot-long armored overflow section.

(b) Pump Station. The pump station has two pumps which provide the capability to dewater the MSMU during drawdown times and to pump water from the Mississippi River into the MSMU if rainfall is insufficient to maintain desired water levels. The pump station was sized to evacuate the MSMU in approximately 14 days; however, actual performance exceeds design requirements. The pump station will dewater the MSMU in about 7 to 10 days. The rated capacity of these pumps is 6,775 gpm @ 8.5 feet Total Dynamic Head (TDH).

The pump station includes trash racks on both the MSMU side and the river side. A sedimentation zone was provided on the MSMU side, which consists of an overflow weir protecting the entrance to the station to minimize sediment entering the pump station during drawdown periods.

The station includes an electrically driven 3-foot by 3-foot sluice gate to allow passage of gravity flows. This gate is used only when gravity discharge through the water control

structure alone does not have sufficient capacity to drain the refuge as quickly as required, or when access to the water control structure is difficult due to wet conditions that would cause damage to the levee surface.

(c) Water Control Structure. The water control structure consists of a 36-inch-diameter concrete conduit controlled by a 3-foot by 3-foot sluice gate, and is located within the perimeter levee section near the eastern edge of Dead Slough.

(d) Interior and Side Drainage Channels and Associated Islands. MSMU interior drainage is provided by excavated fish access channels, as shown on plate 2. Two types of typical sections were constructed. Type I consists of drainage channels constructed on both sides of an island. The excavated material produces an approximate 45-foot-wide island at elevation 551 feet MSL. Type II refuge excavation consists of a drainage channel constructed on one side of the excavation with excavated material producing an approximate 10-foot-wide island with an elevation of 551 feet MSL. The overall length of the refuge drainage excavation is about 8,600 feet.

The MSMU was designed to provide a reliable resting and feeding area for migrating waterfowl in existing open areas, as well as an additional food source within the inundated "green tree" portion of the unit.

(2) Deep Aquatic Habitat Excavation. The contractor excavated approximately 85,000 cubic yards from Dead Slough for deep aquatic habitat improvement. Approximately 4,500 linear feet of Dead Slough was excavated to 9 feet below flat pool (elevation 545 MSL) and an average bottom width of 60 feet. The excavated material was placed in the levee section adjacent to Dead Slough.

(3) Lentic-Lotic Access Channel. A 1,100-foot lentic-lotic access channel connects Scisco Chute to the Dead Slough area. Original channel construction was approximately 30 feet wide with a depth that varied from 4 feet to 9 feet below flat pool (elevation 545 MSL). The river access channel experienced greater than expected sedimentation rates as a result of the Great Flood of 1993. It was subsequently re-excavated in March 1994 to 7 feet below flat pool to approximate existing river bottom elevations.

(4) Diversion Drainage Ditch. Drainage from the watershed on the eastern edge of the project area is routed through the diversion drainage ditch to Scisco Chute. The bottom width of the excavated ditch is approximately 30 feet, with average depth of excavation of 3 feet. The drainage ditch was sized to pass a 2-year precipitation event within bank. The outlet of the diversion drainage ditch was placed near flat pool in Scisco Chute which closely approximates the existing outlet and should minimize outlet area maintenance.

The diversion ditch was designed to reduce the present sediment load in the area by approximately 25 percent (reference DPR Appendix G). This reduction will increase the

water quality in Dead Slough by reducing suspended solids and agricultural runoff chemicals.

(5) Project Access Road. The approximately 3,600-foot-long project access road follows the Government property line from the pump station to a county road which abuts Corps land just outside the project site.

b. Construction and Operation. Following award of the construction contract on August 24, 1989, dredging began during late summer. Deep aquatic habitat excavation was completed in the summer of 1992. The project was essentially completed in September 1994. The Great Flood of 1993 caused minor erosion along the access road and some silting of ditches. The access road and ditches were restored by contract modification. Excavation of the river access channel to remove sediment deposited as a result of the Great Flood of 1993 was completed in March 1994 by Corps labor forces. A low-water crossing to improve access road drainage and avoid sedimentation build-up was completed in August 1997.

Project operation and maintenance generally consists of: (1) mowing and maintaining the perimeter levee to ensure serviceability during times of flood; (2) operating the pump station and water control structure to achieve desired water elevations consistent with vegetative growth, and opening the gates to minimize overtopping erosion when the river reaches elevation 550 MSL on the Fairport gage with predicted stage to increase; (3) maintaining the interior and side drainage channels and associated islands as determined by the Site Manager; and (4) removing snags and other debris from Dead Slough, the river access channel, and the diversion drainage ditch.

4. OPERATION, MAINTENANCE, AND PROJECT MONITORING

a. General. Appendix A presents the Post-Construction Evaluation Plan. This plan was developed during the design phase and serves as a guide to measure and document project performance. Appendix B contains the Monitoring and Performance Evaluation Matrix and Resource Monitoring and Data Collection Summary. This schedule presents the types and frequency of data that have been collected to meet the requirements of the Performance Evaluation Plan.

b. Corps of Engineers. The physical locations of the sampling stations referenced in the Performance Evaluation Plan and the Resource Monitoring and Data Collection Schedule are presented in Figure 4-1 and on plate 3. The Corps collects data at 11 sedimentation transects. Transects A-K are within project construction limits. Transects L, M, and P are control transects and will be used to monitor sediment deposition outside project construction limits. Plates 4 through 7 show the Corps sedimentation transect data. The sediment transects are surveyed at various times during the year, depending on project access, water level, and workload. The Corps has also collected vegetation data within the MSMU, and water quality data at one station, located in Dead Slough. The success of the project relative to original project objectives will be measured using this data along with other data, field observations, and project inspections performed by the USFWS and the ILDNR. The Corps has overall responsibility to measure and document project performance.

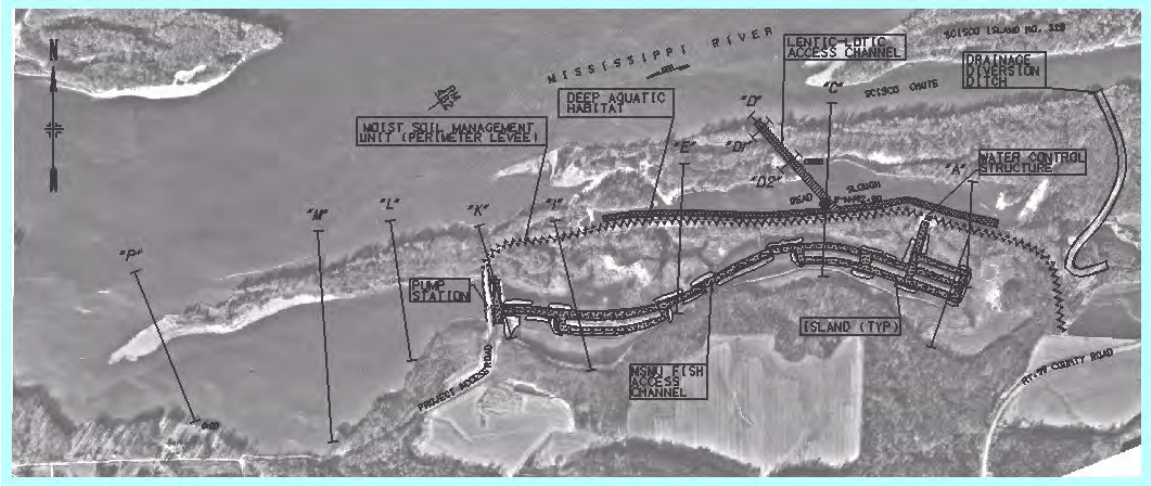

FIGURE 4-1. Andalusia Refuge Monitoring Plan.

c. U.S. Fish and Wildlife Service. The USFWS has not conducted any post-construction monitoring.

d. Illinois Department of Natural Resources. The ILDNR conducts aerial waterfowl surveys and fish surveys on an annual basis. The ILDNR Site Manager is

required to conduct annual inspections of the project and participate in periodic joint inspections of the project with the Corps. As Refuge Manager, the ILDNR is also in a position to make regular field observations which aid in determining the success or failure of the Andalusia Refuge project. The ILDNR has conducted wood duck nest box surveys within the project area during 1996 and 1997, surveyed moist-soil vegetation in the MSMU in 1996, and sampled larval fish production in and escapement from the MSMU in 1995.

5. EVALUATION OF MIGRATORY WATERFOWL HABITAT OBJECTIVES

a. Increase Reliable Food Production Area (Moist-Soil Species).

Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 50 Target With Alternative	Feature Measurement	Annual Field Observations by Site Manager
Increase reliable food production area (moist-soil species)	Provide water control	Acres	0		40 (Qualitative estimate)	130 (from DPR)	Informal vegetation surveys	Development of emergent vegetation

(1) Monitoring Results. As shown above and in Appendix A, Table A-1, the year 50 target with project is a 130-acre increase in the reliable food production area. Rock Island District personnel conducted site visits on three dates during the period following summer drawdown (7/30/96, 8/16/96, and 9/27/96) to monitor moist-soil vegetation development. Photos taken during site visits, with accompanying descriptions, are reproduced in Appendix C. Visual inspection of several locations in the MSMU revealed good growth of moist-soil vegetation, particularly in the downstream portion of the project site (see Figures 5-1 and 5-2). Moist-soil plants representing four genera—pigweeds (*Amaranthus*), nutsedges (*Cyperus*), wild millet or barnyard grass (*Echinochloa*), and smartweeds (*Polygonum*)—were observed in the drawdown areas of the MSMU. To control bulrush, lotus, and willow encroachment, the MSMU was aerially sprayed in the spring of 1996 by the Site Manager.

FIGURE 5-1. Flooded moist-soil vegetation —smartweeds.

FIGURE 5-2. Flooded moist-soil vegetation.

On-site observations and examination of photographs taken during an aerial survey of the project area on September 24, 1996, indicated that some remnants of this less desirable growth may still be present in the upstream portion of the MSMU and on the tops of islands.

ILDNR personnel performed an inventory of moist-soil vegetation development on August 28, 1996. Twenty-five plots (each 0.5 meter in size) were sampled to determine species composition, height, and percentage of ground coverage for each species present. A total of nine species occurred in sample plots (listed by percentage of occurrence): pigweed (68%), nutsedge (40%), bulrush – live (36%), bulrush – dead (36%), smartweed (32%), barnyard grass (28%), reed canarygrass (12%), American lotus (8%), cattail (4%), and

cucumber vine (4%). Pigweed was the most dominant species within the sampled plots, comprising 24.6% of the ground cover. Other dominant species included bulrush – dead (21.4%), bulrush – live (12.8%), and nutsedge (10.2%). A more detailed breakdown of plot sampling results is contained in Appendix A.

(2) Conclusions. In this first year of evaluated operation since project construction, observation of conditions in the MSMU indicate good progress toward meeting the year 50 target acreage for moist-soil production. Water level control appears to have been successful in promoting the growth of natural waterfowl food sources such as smartweeds, wild millet, pigweeds, and nutsedges. Continued management of the MSMU in accordance with the plan outlined in Table 2-2, with additional measures, such as burning or herbicide application, taken by the Site Manager as necessary to control less desirable vegetation, should allow further progress toward meeting the target acreage in future years.

b. Increase Reliable Resting and Feeding Water Area.

Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 50 Target With Alternative	Feature Measurement	Annual Field Observations by Site Manager
Increase reliable resting and feeding water area	Mechanical dredging	Acres	0		49.3	~~200~~ 50	Perform hydrographic soundings of transects	Waterfowl presence or absence

(1) Monitoring Results. Sedimentation transects are shown on plates 4, 6, and 7. As shown above and in Appendix A, Table A-1, the year 50 target with alternative was a 200-acre increase in reliable resting and feeding water area. The 200-acre area was based on an MSMU configuration which included Dead Slough. This larger MSMU configuration was not implemented as it would have greatly diminished fishery benefits gained from dredging Dead Slough. The 49.3-acre reliable resting and feeding water area was calculated by determining water surface area between transects during the time when the MSMU is maintained at maximum water level (December-April, water surface elevation 547).

The 1993 Flood Damage Assessment Report noted refuge islands were overtopped, but that no excessive erosion was noted. Although willows within the MSMU had been sprayed during construction, the inundation of the islands was not sufficient to kill the willows that had started to take over some of the islands. No adverse effects were noted in the fish access channels as a result of the Great Flood of 1993. The Site Manager reported that approximately half of the islands were burned during the spring of 1997 to control undesirable vegetation. Burning of the remaining islands is currently scheduled for the spring of 1998.

Site management staff have observed considerable waterfowl use in the downstream portion of the recently reflooded MSMU. Use of the area by wood ducks has been documented through checking of nest boxes installed in the refuge by ILDNR personnel. Of 27 nest boxes checked by site management staff on March 11, 1996, 16 showed evidence of having been used by wood ducks. Checks of nest boxes on January 31 and March 26, 1997, showed evidence of wood duck use in 22 of the 26 available boxes.

Transects within the MSMU were surveyed in January 1997 with the MSMU at increased water levels in order to determine the reliable resting and feeding water area. As illustrated in Figure 5-3 below, the tree symbol indicates the tree line, which will be used to monitor vegetative encroachment.

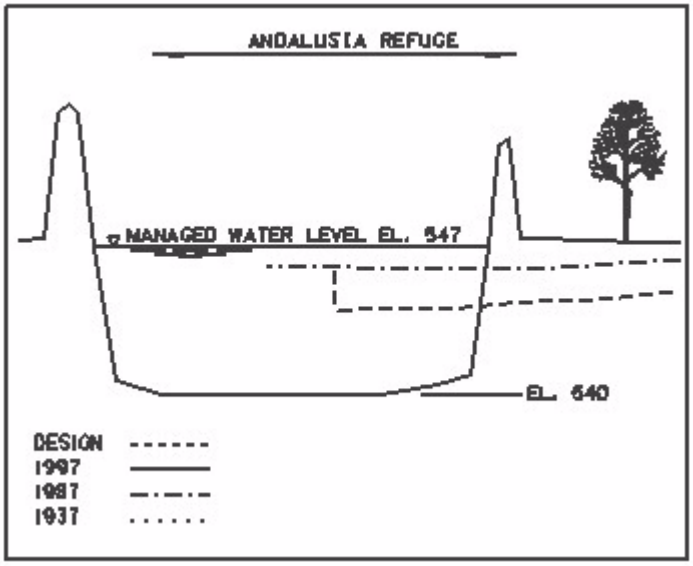

FIGURE 5-3. Typical transect in refuge area with water surface at December-April management level.

(2) Conclusions. Continued monitoring will help determine the success of vegetative management as well as monitor topographical changes within the MSMU. The results of wood duck box checks during 1996 and 1997 suggest an increased use of the project area by wood ducks and provide evidence of a positive response to the project by waterfowl.

6. EVALUATION OF AQUATIC HABITAT OBJECTIVES

a. Restore Deep (6 feet) Aquatic Habitat.

Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 25 Target With Alternative	Feature Measurement	Annual Field Observations by Site Manager
Restore deep (6 ft) aquatic habitat	Mechanical dredging	Acre-feet	0		34	40	Perform hydrographic soundings of transects	Development of emergent vegetation within deep dredged areas

(1) Monitoring Results. Deep aquatic habitat sedimentation transects are shown on plates 4 through 6. As shown above and in Appendix A, Table A-1, the year 50 target with alternative is restoration of 40 acre-feet of deep aquatic habitat. The deep aquatic habitat portions of transects A, C, and E are shown below in Figures 6-1 through 6-3.

FIGURE 6-1. Transect A. **FIGURE 6-2. Transect C.** **FIGURE 6-3. Transect E.**

Approximately 34 acre-feet of deep aquatic habitat exists at year 5, as shown in Table 6-1 and Appendix E, Table E-1. The deep aquatic habitat was determined using the excavated channel portions of the sedimentation transects A, C, and E, as identified in Table A-2.

Table 6-1 shows an average existing deep aquatic habitat depth of 7.4 feet after 5 years. Assuming an as-built deep aquatic habitat depth of 9 feet below Pool 16 adjusted flat pool (Fairport gauge elevation 545 feet NGVD 1912), an annual sedimentation rate of 4.9 in/year can be calculated. In comparison, the design sediment deposition rate at the Year 25 target was 1 in/year (reference DPR page 24).

TABLE 6-1

Andalusia Deep Aquatic Habitat

	Year		
	1992	1997	2044
	(As-built)	(Year 5)	(Design - Year 25 Target) [2/]
Average Depth, ft [1/]	9	7.4	6
Average Width, ft	60	44.9	60
Average Area, SF	540	328.8	360
Deep Aquatic Habitat, ac-ft	55.8	34.0	37.2
Sediment Deposition, in/yr		4.9	1.0

[1/] Depth is in reference to adjusted flat pool (Fairport gauge 545 feet NGVD 1912)

[2/] L=4,500'; W=60'; D=6'. See DPR page 24.

ILDNR personnel conducted an electrofishing survey in Dead Slough on July 30, 1996. A total of 571 individuals representing 19 species, plus one hybrid, were collected during the survey. Table 6-2 provides a detailed listing of numbers and species.

TABLE 6-2

Andalusia Refuge (Dead Slough) Electrofishing Survey

Period: 60 **Date: 30 Jul 96**

Common Name	Number
Bigmouth buffalo	17
Black crappie	12
Bluegill	84
Bluegill x Green sunfish hybrid	1
Bowfin	9
Bullhead minnow	3
Carp	32
Channel catfish	37
Emerald shiner	16
Flathead catfish	4
Freshwater drum	39
Gizzard shad	176
Largemouth bass	26
Orangespotted sunfish	31
Quillback	4
River carpsucker	2
Sauger	2
Shortnose gar	2
Smallmouth buffalo	55
White bass	19

Source: ILDNR Boundary Rivers

(2) Conclusions. The as-built bottom elevation of 536 was based on a maintained water depth of 6 feet, low-flow regulation of 1 foot below flat pool, and 2 feet of sediment accumulation over 25 years (reference DPR page 24). This 2 feet of sediment accumulation is equivalent to an annual sedimentation rate of 1 in/year. The calculated average annual sediment deposition rate of nearly 5 in/year is based on an assumed as-built depth. This higher sediment deposition rate may be a result of the Flood of 1993 or the tendency of excavated channels to behave as sediment traps in the early years following construction or sloughing of the channel side slopes. The 1993 Flood Damage Assessment Report noted that soundings indicated there was not excessive sedimentation within the refuge channels; however, sounded depths were not identified in the assessment, and no comparison of the post-1993 flood depths can be made. While the existing channel width is somewhat narrower than the as-built width, channel depths are still in excess of 7 feet and fish are utilizing the cut.

To more accurately assess sediment deposition in the deep aquatic habitat at Year 5, a profile of the deep aquatic habitat area should be surveyed for inclusion in the next performance evaluation report. Continued monitoring will better define sedimentation rates and patterns.

b. Restore Lentic-Lotic Habitat Access Cross-Sectional Area.

Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 50 Target With Alternative	Feature Measurement	Annual Field Observations by Site Manager
Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging	Sq. feet	0		177.5	180	Perform hydrographic soundings of transects	Development of emergent vegetation within access area

(1) Monitoring Results. As shown above and in Appendix A, Table A-1, the year 50 target with alternative is restoration of 180 square feet of lentic-lotic habitat access. In January 1997, the average cross-sectional area of the lentic-lotic habitat access channel was approximately 178 SF. The 1993 Flood Damage Assessment Report noted the lentic-lotic access channel had silted in considerably, from initial elevations of 536 -541 to 544 in some places. The channel was re-excavated to elevation 538 in March 1994 by Corps labor forces. As shown below in Figures 6-4 and 6-5 and on plate 5, the channel elevation near the mouth of the lentic-lotic access channel was approximately 2 feet below flat pool (elevation 545 feet MSL).

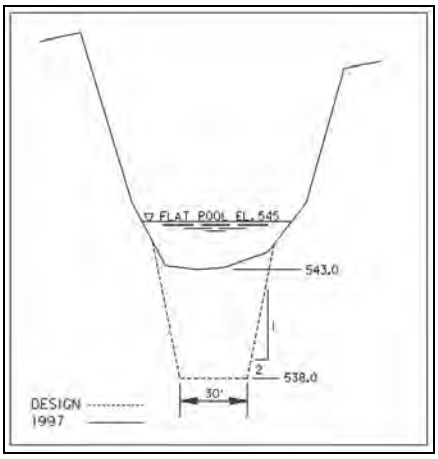

FIGURE 6-4. Transect D1
Near mouth of lentic-lotic access channel
Cross-sectional area = 104.8 SF
Depth = 2'

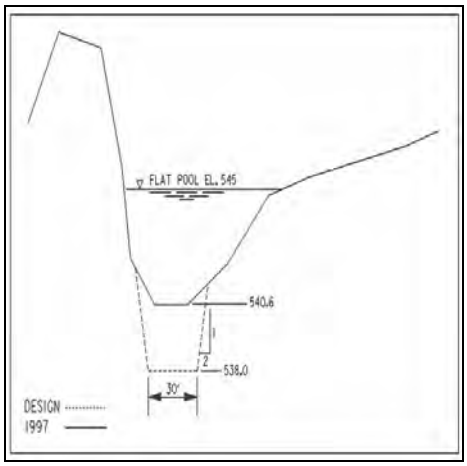

FIGURE 6-5. Transect D2
Upstream end lentic-lotic access channel
Cross-sectional area = 250.2 SF
Depth = 4.4'

Although the lentic-lotic access channel provides a connection from the river to Dead Slough, it does not introduce flow to Dead Slough. Because there is no flow in the lentic-lotic access channel, more sediment deposition, particularly the heavier sands, may be occurring near the channel entrance than in Dead Slough. Sloughing of the channel side slopes may have also contributed to the accelerated sedimentation. A hydraulic study is underway to determine the cause of sedimentation at the mouth of the channel. Possible solutions to the problem are also being investigated. The study is scheduled for completion in late fall of 1997.

(2) Conclusions. The Site Manager is aware that the lentic-lotic access channel is subject to sediment deposition in excess of the design sedimentation rate. Possible solutions to reduce the sedimentation rate will be discussed with the Site Manager pending completion of the hydraulic study.

c. Improve Dissolved Oxygen Concentration During Critical Seasonal Stress Periods.

Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 50 Target With Alternative	Feature Measurement	Annual Field Observations by Site Manager
Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure	Mg/l	< 4.0		> 4.0 most of the time	> 4.0	Perform water quality testing at stations	Fish stress or fish kills

(1) Monitoring Results. The water quality objective of the Andalusia Refuge project is to improve dissolved oxygen (DO) concentrations in Dead Slough during critical seasonal stress periods. As shown above and in Appendix A, Table A-1, the goal of the project is to maintain a DO concentration greater than 4 mg/l. Prior to project completion, severe summer and winter fish kills in Dead Slough were reported by local residents and ILDNR (formerly IDOC) personnel. It is presumed these fish kills were due to low DO concentrations coupled with thermal stresses. In an effort to avoid future fish kills, dredging was utilized to create deep aquatic habitat within Dead Slough and an access channel from the slough to the Mississippi River.

Post-project water quality monitoring was performed by the Corps in Dead Slough (site W-M462.5O) from April 7, 1992 through February 25, 1997, and is still ongoing. The site is located in a dredged channel and is identified on plate 4. The project O&M manual calls for post-construction water quality monitoring at four sites. This was apparently an error. Site W-M462.5O is the only site where post-construction monitoring was performed. Water quality monitoring results are found in Appendix D, Table D-1. DO concentrations ranged from 3.04 mg/l to 24.00 mg/l. Two of the 42 DO measurements were below the 4 mg/l target level (see Table 6-3 and Figure D-1). These low values were due to a combination of factors, of which phytoplankton growth/decomposition, cloud cover and wind speed appear to be the most important. On both sampling days, the chlorophyll *a* concentration was significantly lower than the average value (46.4 mg/m^3), cloud cover was at least 95 percent, and the wave height was zero. Apparently there was little photosynthesis or reaeration occurring on these two days; therefore, DO concentrations were low.

TABLE 6-3

DO Concentrations Below 4 mg/l

Date	DO (mg/l)	Chlorophyll *a* (mg/m^3)
5/24/94	3.58	18.0
6/27/95	3.04	24.0

In addition to the manual collection of data, an *in-situ* continuous monitor (YSI 6000UPG) was used to measure DO concentrations in Dead Slough. This device has water quality measuring and data logging capabilities. Typically, the YSI 6000UPG was suspended 3 feet above the bottom and collected data for a period of about 2 to 4 weeks before the monitor was retrieved and the data were downloaded. A YSI 6000UPG was deployed at site W-M462.5O on five occasions: December 13, 1995; July 10, 1996; August 13, 1996; December 23, 1996; and February 11, 1997. The YSI 6000UPG was programmed to take readings every 2 hours. The results from the five sampling events are presented graphically in Figures D-2 through D-6. The data have been compensated to correct for drift that occurred during the deployment period. The maximum drift that occurred during the five deployments was .82 mg/l, 1.06 mg/l, .44 mg/l, .81 mg/l, and 1.15 mg/l, respectively. To better visualize trends in the five graphs, the data were filtered and every third reading was plotted. The DO concentration remained well above the target level of 4 mg/l during the winter deployments (see Figures D-2, D-5 and D-6). In fact, supersaturated concentrations were recorded frequently. Apparently, sunlight was penetrating the ice cover and the oxygen produced by photosynthesis could not escape. During the July deployment, the DO concentration fell below 4 mg/l on several occasions (see Figure D-3). When the monitor was positioned on July 10th, the DO concentration was 9.07 mg/l at the surface and 2.06 mg/l near the bottom, thereby indicating that the slough was stratified. Therefore, although the DO concentration at 3 feet above the bottom was often below 4 mg/l, surface concentrations probably exceeded 4 mg/l much of the time. The data also suggest diurnal changes in DO caused the concentration to fall below 4 mg/l at night. Except for the final two days, the DO "rebounded" to above 4 mg/l during the day. Upon retrieval, the monitor was covered with mud and insect larvae. It is suspected that during the final days of deployment, the monitor's flotation failed and it sank into the mud. During the August deployment, the DO concentration remained above 4 mg/l for the entire monitoring period (see Figure D-4).

(2) Conclusions. The Andalusia Refuge project has successfully met its water quality objective of 4 mg/l DO the majority of the time. During the summer, when concentrations below 4 mg/l were measured 3 feet off the bottom, it is likely that the concentration at the surface exceeded 4 mg/l. During the critical winter months, the DO concentration has remained well above 4 mg/l. Another indication of the project's success is the fact that several fish kills were reported prior to project completion. However, according to Dan Sallee, a fisheries biologist with the ILDNR, no fish kills have occurred since project completion.

d. Reduce Sedimentation in Refuge.

Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 50 Target With Alternative	Feature Measurement	Annual Field Observations by Site Manager
Reduce sedimenta-tion in refuge	Construct levee and divert tributary	Acre-feet/year	11		Not available	4.2	Perform hydrographic soundings of transects	Shoaling in shallow areas

(1) Monitoring Results. Refuge sedimentation transects are shown on plates 4 and 6. As shown above and in Appendix A, Table A-1, the year 50 target with alternative is a reduction of sedimentation in the refuge of 4.2 acre-feet/year, due primarily to construction of the excavated diversion ditch which diverts adjacent watershed erosion/ deposition from the refuge to Scisco Chute. Although the MSMU is afforded a 2-year level of protection by the perimeter levee, the perimeter levee was not considered to contribute towards sediment reduction during the project design phase and is not a part of the 4.2 acre-feet/year sediment reduction. The sedimentation transects which will be used to determine refuge sedimentation are identified in Table A-2.

The sedimentation study conducted during the design phase (see DPR page 10 and DPR Technical Appendix G) estimated a pre-project sedimentation rate of 17 acre-feet/year from the river (6.0 acre-feet/yr) and adjacent watersheds (11.0 acre-feet/yr). This was determined based upon the transects identified in Table A-2, a 1-inch/year sedimentation rate, and a project area of approximately 200 acres (Dead Slough and the MSMU area).

The sedimentation transects of the refuge area were obtained in January 1997. As shown below in Figures 6-6 through 6-8, sedimentation in the refuge area is noticeably less than Dead Slough or the lentic-lotic access channel.

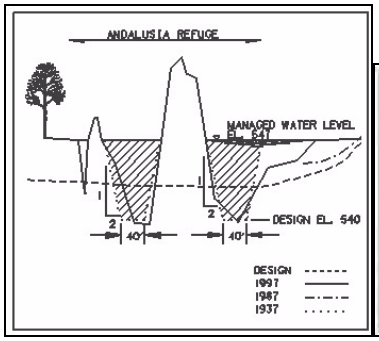

FIGURE 6-6. Transect C.

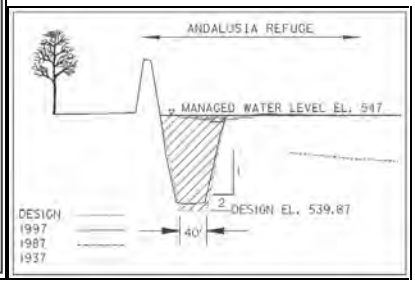

FIGURE 6-7. Transect E.

FIGURE 6-8. Transect I.

The 1993 Flood Damage Assessment Report noted refuge islands were overtopped, but that no excessive erosion occurred. No adverse effects were noted in the fish access channels.

(2) Conclusions. The diversion drainage ditch appears to be successful in decreasing sedimentation to the refuge area. Sedimentation in the fish access channels is most likely due to post-construction sloughing of the channel side slopes. The reduction in sedimentation due to construction of the MSMU levee and the excavated diversion ditch will be determined in the next post-construction performance evaluation report.

7. OPERATION AND MAINTENANCE SUMMARY

a. Operation. Project operations are detailed in the O&M manual and generally consist of: (1) inspecting the perimeter levee during flood periods; (2) operating the pump station and water control structure to achieve desired water elevations consistent with vegetative growth, and opening the gates to minimize overtopping erosion when the river reaches elevation 550 MSL on the Fairport gage with predicted stage to increase; (3) maintaining the interior and side drainage channels and associated islands as determined by the Site Manager; and (4) removing snags and other debris from Dead Slough, the river access channel, and the diversion drainage ditch.

The project has been operated successfully in this manner since its completion in the fall of 1994. As described in the Annual Management Plan (Table 2-2), the MSMU is dewatered from May-July to expose mudflats and allow revegetation of moist-soil species. The MSMU water levels are gradually increased from August through November to correspond with the growth of the moist-soil plant community and to provide migratory waterfowl access to food plants. The higher water levels are maintained in the MSMU from December through April to control excessive plant growth and to provide deeper water to prevent complete ice-up.

In the spring of 1996, a landowner adjacent to the refuge suggested that spring water levels in the MSMU interfered with the drainage on his land. This occurred when the MSMU water level was at elevation 546.5 feet. The MSMU was developed to allow interior water levels to be raised to elevation 547.0 prior to coordination with adjacent landowners (see the Annual Management Plan). The drain tile outlet locations, elevations, and proximity to the project construction zone were surveyed. Upon investigation, it was discovered that all of the drain tile outlets were below ground, and that the tiles and outlets were located away from the construction zone. The invert of the lowest drain tile outlet was 547.0, indicating that a water elevation of 547.0 would not affect drainage of the adjacent landowner's property. Construction of the Andalusia Refuge project did not affect the adjacent landowner's drain tiles or the outlets because they are outside the limits of the construction zone. The blocked tile outlets, coupled with heavy spring rains, probably caused the landowner's drainage problems.

b. Maintenance.

(1) Inspections. Inspections of the Andalusia Refuge project are to be made by the ILDNR (Site Manager) at least annually and will follow inspection guidance presented in the O&M manual. Other project inspections should occur as necessary after high water events or as scheduled by the Site Manager. Joint inspections of the Andalusia Refuge project are to be conducted periodically by the ILDNR, USFWS, and the Corps. These inspections are necessary to determine maintenance needs. The Site Manager's project inspection and monitoring results for 1996 and 1997 can be found at Appendix C.

(2) Maintenance Based on Inspections. When the pump was turned on in the fall of 1994 to fill the MSMU, the trash rack clogged with vegetation and cut off the water supply. Subsequently, a chain link fence was installed 6 feet out from the pump intake, and a larger mesh fence was installed approximately 100 feet from the intake. The outer fence was subjected to damage from ice during the winter of 1995-1996. The 1997 Site Manager's project inspection and monitoring results states the fences are not working as intended and have been destroyed by ice, and that vegetative growth on the river side of the pump house has filled back in from shore to shore. The trash rack fence system was designed for those years when there is an excess of floating or dead vegetation outside of the MSMU, river levels are low, and fall pumping is required. The outer fence could be removed, leaving the posts in place, and re-installed when needed. If the fence remains in place, annual maintenance should be performed prior to ice-over of the refuge.

The pump station stop logs would not seal due to the presence of construction debris in the channels. Additionally, the stop logs were difficult to remove because of their proximity to the trash rack. With assistance from Corps labor forces during the summer of 1996, the pump station trash rack was relocated and a hoist installed. The stop log channels were cleaned. Pump station electrical problems were also remedied.

The perimeter levee was mowed in the early summer of 1996 and 1997. Erosion caused by overtopping during high water and ruts along the perimeter levee caused by vehicle use during inclement weather was repaired by the Site Manager during the fall of 1996. The spring of 1997 flood made the levee surface very rough, and the levee has been subjected to unauthorized use by ATVs and snowmobiles. In 1996, woody vegetation growing in the riprap was removed, and eroded areas on the project access road were repaired, additional gravel surfacing placed, and adjacent ditches cleaned. To remedy an area of poor drainage along the access road, a low water crossing was constructed in August 1997.

The MSMU was aerially sprayed by the Site Manager in the spring of 1996 to control bulrush, lotus, and willow growth. Approximately half of the islands were burned in the spring of 1997 to control undesirable vegetation. The remaining islands are scheduled to be burned in 1998.

8. CONCLUSIONS AND RECOMMENDATIONS

a. Project Goals, Objectives, and Management Plan. Based on data and observations collected since project completion, it appears the stated goals and objectives are being met, except for restoration of lentic-lotic habitat access cross-sectional area (see Table 8-1). When the hydraulic study is completed in late fall of 1997, available options for restoring or maintaining the channel will be discussed with the Site Manager. Continued data collection will better define the sedimentation rate reduction in the refuge, water quality improvement, deep aquatic and lentic-lotic habitat restoration, the increase in reliable food production, resting, and feeding area.

TABLE 8-1

Project Goals and Objectives

Goals	Objectives	Project Features	Status
Enhance Migratory Waterfowl Habitat	Increase reliable food production area (moist-soil species)	Provide water control	Met
	Increase reliable resting and feeding water area	Mechanical dredging	Met
Enhance Aquatic Habitat	Restore deep (6 feet) aquatic habitat	Mechanical dredging	Met
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging/excavation	Failed
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure	Met
	Reduce sedimentation in refuge	Construct levee and divert tributary	Met

b. Post-Construction Evaluation and Monitoring Schedules. In general, project monitoring efforts have been performed according to the Post-Construction Performance Evaluation Plan in Appendix A and the Resource Monitoring and Data Collection Summary in Appendix B. The next Post-Construction Performance Evaluation will be completed in 2002 following collection of data for the next 5-year interval. A Performance Evaluation Supplement will be prepared annually.

(1) Post-Construction Evaluation.

(a) Increase reliable food production area (moist-soil species). Initial evaluations indicate the project has been generally successful in promoting moist-soil plant growth and increasing the reliability of natural waterfowl food production. Some active measures, such as burning or herbicide application, may still be necessary to control encroachment of less desirable plant species within the MSMU to meet the 50-year target acreage. In future supplements, the target acreage will need to be revised based on a more accurate quantification of the maximum potential moist-soil production area within the MSMU. ILDNR staff have indicated that some minor adjustments to the water control plan may be made, if necessary (see Table 2-2, note 2), and other measures such as controlled burning or additional spraying may be implemented, as appropriate. No formal vegetation transects were established in the MSMU prior to project completion, and no formal transect sampling is included in the Post-Construction Evaluation Plan. Informal vegetation surveys by Rock Island District personnel and observations by ILDNR site management personnel will be utilized to monitor development of food production areas.

(b) Increase reliable resting and feeding water area. The Year 50 Target with Alternative will be changed from 200 acres to reflect the as-constructed 50-acre area of the MSMU. Transects within the MSMU should be surveyed early in the year (January or February) with the MSMU at increased water levels. Changes in vegetation (i.e., timber to shrub to grass) will be noted to better monitor vegetative encroachment within the MSMU.

(c) Restore deep (6 feet) aquatic habitat. Based on sedimentation data collected to date, approximately 34 acre-feet of deep aquatic habitat exists at Year 5. This is equivalent to an annual sedimentation rate of 4.9 in/year. Although the channel width has narrowed from 60 to 40 feet, probably due to sloughing of the side slopes, present channel depths are in excess of 7 feet and well within the range expected for deep aquatic habitat. The Year 50 Target with Alternative identified in Table A-1 will be revised to a Year 25 Target with Alternative to be consistent with design assumptions. To better monitor this feature, a channel profile should be surveyed at the same time as the lentic-lotic access channel.

(d) Restore lentic-lotic habitat access cross-sectional area. The mouth of the lentic-lotic access has filled with sediment and is too shallow to provide access to fish during the winter if pool levels are low and ice cover is greater than 6 inches.

(e) Improve dissolved oxygen concentration during critical stress periods. To date, the Andalusia Refuge project has performed well in meeting its water quality objectives.

(f) Reduce sedimentation in refuge. Compared to sedimentation in the lentic-lotic access channel and Dead Slough, sedimentation in the refuge is markedly less.

The drainage ditch is successfully diverting sediment from the MSMU. The sedimentation within the MSMU is most likely due to sloughing of the sides of the fish access channels.

(2) Resource Monitoring and Data Collection Schedules. The monitoring schedule will be revised to include surveying profiles of the lentic-lotic access channel and deep aquatic habitat and the two sedimentation transects of the lentic-lotic access channel at a 5-year interval. Coordinates for the access channel sedimentation transects and the extension of the present sedimentation transects will be obtained for ease of recovery for continued post-construction monitoring.

c. Project Operation and Maintenance. Project operation and maintenance has been conducted in accordance with the O&M manual. Annual site inspections by the Site Manager have resulted in proper corrective maintenance actions.

d. Project Design Enhancement. Discussions with ILDNR and Corps personnel involved with operation, maintenance, and monitoring activities at the Andalusia Refuge project have resulted in the following general conclusions regarding project features which may affect future project design:

(1) Perimeter Levee. For projects with structures requiring operation during inclement weather, crushed rock surfacing should be provided to strengthen the levee surface under adverse conditions.

The levee was originally seeded with a mixture which was predominantly Indian grass. Initial establishment was successful, however, there was no post-Flood of 1993 re-establishment of the Indian grass on the side slopes of the perimeter levee, nor was the levee re-seeded. Reed canary grass is now the predominant species. As reed canary grass is very invasive, spraying or controlled burns in the MSMU may be necessary to limit it to the perimeter levee only.

(2) MSMU. Self-propagation of beneficial moist-soil species appears to be an initial success. Future MSMU projects should provide an initial period of several years to evaluate the viability of the existing seed bank.

In 1995, the ILDNR monitored larval fish production in the MSMU by sampling larval fish populations while water levels in the unit were maintained in a high, stable condition following the spring flood of 1995, and by sampling larval fish escapement to the river during drawdown. Results of the monitoring indicated substantial numbers of larval fish, including centrarchid species such as crappie and largemouth bass, were produced in the MSMU and returned to the Mississippi River.

(3) Pump Station. After correction of initial pump station operation problems, migration of vegetation towards the pump intake during operation remains. The trash rack fence system should restrict movement of vegetation outside of the fenced areas towards the intake during low water years when pumping is necessary to fill the MSMU.

(4) Water Control Structure. See perimeter levee conclusions.

(5) Deep Aquatic Habitat. The deep aquatic habitat is filling in at a faster rate than anticipated during design. However, this may be due to initial sloughing of the side slopes and the tendency for deeper areas to behave as sediment traps. Continued monitoring will determine the feasibility of a 25-year life for dredged channels.

(6) Lentic-Lotic Habitat Access Channel. A hydraulic study is underway to investigate the source of the sediment and options to maintain fish access to Dead Slough.

(7) Project Access Road. The effects of upland drainage versus project access should be addressed during the design phase.

A P P E N D I X A

POST-CONSTRUCTION EVALUATION PLAN

TABLE A-1

Andalusia Refuge Rehabilitation and Enhancement Project
Post-Construction Evaluation Plan [1/]

Enhancement Potential

Goal	Objective	Enhancement Feature	Unit	Year 0 (1992) Without Alternative	Year 0 (1992) With Alternative (As-Built)	Year 5 With Alternative	Year 50 Target With Alternative [2/]	Feature Measurement	Annual Field Observations by Site Manager
Enhance Migratory Waterfowl Habitat	Increase reliable food production area (moist-soil species)	Provide water control	Acres	0		40	130	Informal vegetation surveys	Development of emergent vegetatio
	Increase reliable resting and feeding water area	Mechanical dredging	Acres	0	N/A	49.3	~~200~~ 50	Perform hydrographic soundings of transects 5/, 6/	Waterfowl presence or absence
Enhance Aquatic Habitat	Restore deep (6 ft) aquatic habitat	Mechanical dredging	Acre-feet	0	55.8	34	40 3/	Perform hydrographic soundings of transects 5/	Development of emergent vegetatio within deep dredged areas
	Restore lentic-lotic habitat access cross-sectional area	Mechanical dredging	Sq. feet	0	308	177.5	180 3/	Perform hydrographic soundings of transects 5/	Development of emergent vegetatio within access area
	Improve dissolved oxygen concentration during critical stress periods	Mechanical dredging and gated inlet structure	Mg/l	< 4.0		>4.0 most of the time	> 4.0	Perform water quality testing at stations 4/	Fish stress or fish kills
	Reduce sedimentation in refuge	Construct levee and divert tributary	Acre-feet/ year	11	N/A		4.2 3/	Perform hydrographic soundings of transects 5/	Shoaling in shallow areas

TABLE A-1 (Cont'd)

Andalusia Refuge Rehabilitation and Enhancement Project

1/ See Plate 3 of this report for active monitoring sites.

2/ Year 50 Target with Alternative are shown as underlined for revised targets and strike outs if deleted from the monitoring program.

3/ Year 25 Target with Alternative.

4/ Corps Water Quality Station Remarks

W-M462.5O

5/ Sedimentation Transects (Post-Construction Phase)

Performance Evaluation	O&M Manual	DPR
A	S-M462.6X to S-M462.9Q	Range A
C	S-M462.5U to S-M462.8L	Range C
D	New	
D-1	New	
D-2	New	
E	S-M462.3U to S-M462.5M	Range E
I	S-M462.1W to S-M462.2N	Range I
K	S-M462.0Q to S-M462.1N	Range K
L	S-M461.8O to S-M461.8V	Range L
M	S-M461.7X to S-M461.7O	Range M
P	S-M461.3Y to S-M461.2S	Range P

2002 PER - Obtain channel profile of deep aquatic habitat.

6/ Mapping (Post-Construction Phase)

Aerial survey will be performed of the project area to determine the amount of waterfowl resting and feeding water areas.

July 12, 1993, Color Aerial Photography (Scale = 1000 ft/in)
April 17, 1994, Color Aerial Photography (Scale = 1000 ft/in)
November 21, 1995, Black and White Aerial Photography (low flight - Scale = 1400 ft/in)
November 24, 1995, Black and White (high flight - Scale = 2800 ft/in)
September 26, 1996, Color Oblique Aerial Photography

TABLE A-2

Andalusia Refuge Rehabilitation and Enhancement Project
Sedimentation Transect Project Objectives Evaluation

	Project Objectives to Be Evaluated			
	Increase Reliable Resting and Feeding Water Area	**Restore Deep (6 ft) Aquatic**	**Restore Lentic-Lotic Habitat Access Cross-Sectional Area**	**Reduce Sedimentation in Refuge**
A	X	X		X
C	X	X		X
D			X	
D1			X	
D2			X	
E	X	X		X
I	X			X
K	X			X
L[1/]				
M[1/]				
P[1/]				

[1/] Transects undisturbed by project construction.

A P P E N D I X B

MONITORING AND PERFORMANCE EVALUATION MATRIX
AND
RESOURCE MONITORING AND DATA COLLECTION SUMMARY

TABLE B-1

Andalusia Refuge Rehabilitation and Enhancement Project
Monitoring and Performance Evaluation Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Pre-Project	Sedimentation Problem Analysis	System-wide problem definition. Evaluates planning assumptions.	USGS	USGS (EMTC)	LTRMP 1/	--
	Pre-Project Monitoring	Identifies and defines problems at HREP site. Establishes need of proposed project features.	USFWS	USFWS	USFWS	--
	Baseline Monitoring	Establishes baselines for performance evaluation.	Corps	Corps	HREP	See Table A-2
Design	Data Collection for Design	Includes quantification of project objectives, design of project, and development of performance evaluation plan.	Corps	Corps	HREP 2/	See Table A-2
Construction	Construction Monitoring	Assesses construction impacts; assures permit conditions are met.	Corps	Corps	HREP	See State Section 401 Stipulations
Post-Construction	Performance Evaluation Monitoring	Determines success of project as related to objectives.	Corps (quantitative) Sponsor (field observation)	Corps USFWS	HREP	See Table A-2
	Analysis of Biological Responses to Projects	Evaluates predictions and assumptions of habitat unit analysis. Studies beyond scope of performance evaluation, or if projects do not have desired biological results.	Corps	Corps	HREP	--

1/ Long-Term Resource Monitoring Program is a component of the UMRS-EMP.
2/ Habitat Rehabilitation and Enhancement Projects

TABLE B-2

Andalusia Refuge Rehabilitation & Enhancement Project
Resource Monitoring and Data Collection Summary [1/]

Type Measurement	Water Quality Data					Engineering Data			Natural Resource Data			Sampling Agency	Remark
	Pre-Project Phase	Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
		Apr-Sep	Oct-Mar	Jun-Sep	Dec-Mar								
NT MEASUREMENTS													
er Quality Stations [1/, 2/, 3/]												Corps	
rbidity				2M	M								
cchi Disk Transparency	2W			2M	M								
spended Solids	2W			2M	M								
ssolved Oxygen	2W			2M	M								
ecific Conductance	2W			2M	M								
ater Temperature	2W			2M	M								
	2W			2M	M								
tal Alkalinity				2M	M								
lorophyll	2W			2M	M								
locity				2M	M								
ater Depth	2W			2M	M								
Thickness					M								
ow Depth					M								
ind Direction				2M	M								
ind Velocity				2M	M								
ave Height				2M	M								
r Temperature				2M	M								
rcent Cloud Cover				2M	M								

TABLE B-2 (Continued)

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar								
NT MEASUREMENTS nt'd)														
iment Test Stations [3/]														
k Sediment			1										Corps	
triate			1										Corps	
in Size			1										Corps	
ing Stations														
otechnical Borings - e Construction Drawings [5/] lumn Settling Analysis [4/]								1					Corps	
erfowl Surveys														
rial Survey												Y	ILDNR	
Stations														
ectrofish/Netting												1M	ILDNR	
NSECT ASUREMENTS														
imentation Transects [6/]														
drographic Soundings							1		5Y				Corps	
rmal Vegetation Surveys [7/]														
oist-Soil Plant Survey												5Y	Corps	

TABLE B-2 (Continued)

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remar
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar								
A MEASUREMENTS														
ping [8/]														
rial Photography										1		5Y	Corps	

end

M = Monthly
Y = Yearly
nM = n-Month interval
nY = n-Year Interval
3,.... = Number of times data was collected within designated project phase

TABLE B-2 (Continued)

Andalusia Refuge Rehabilitation and Enhancement Project

1/ See Plate 3 of this report for locations of post-construction phase sampling points, transects, and area measurements. See DPR for locations of design phase sampling locations.

2/ Corps Water Quality Station — Remarks
W-M462.5O

3/ Sediment Test Stations (Design Phase)

DPR-R-1
DPR-R-2
DPR-R-3
DPR-L-1
DPR-L-2
DPR-L-3

4/ Column Settling Station (Design Phase)

(50# Settlement Analysis)
DPR-Sample 1
DPR-Sample 2

5/ Boring Stations (Design Phase)

DPR A-87-1 through A-87-14

6/ Sedimentation Transects

Performance Evaluation	O&M Manual	DPR
A	S-M462.6X to S-M462.9Q	Range A
C	S-M462.5U to S-M462.8L	Range C
D	New	
D1	New	
D2	New	
E	S-M462.3U to S-M462.5M	Range E
I	S-M462.1W to S-M462.2N	Range I
K	S-M462.0Q to S-M462.1N	Range K
L	S-M461.8O to S-M461.8V	Range L
M	S-M461.7X to S-M461.7O	Range M
P	S-M461.3Y to S-M461.2S	Range P

2002 PER - Obtain channel profile of deep aquatic habitat.

7/ Mapping (Post-Construction Phase)

Aerial survey will be performed of the project area to determine the amount of waterfowl resting and feeding water areas.

July 12, 1993, Color Aerial Photography (Scale = 1000 ft/in)
April 17, 1994, Color Aerial Photography (Scale = 1000 ft/in)
November 21, 1995, Black and White Aerial Photography (low flight - Scale = 1400 ft/in)
November 24, 1995, Black and White (high flight - Scale = 2800 ft/in)
September 26, 1996, Color Oblique Aerial Photography

A P P E N D I X C

COOPERATING AGENCY CORRESPONDENCE

A P P E N D I X D

WATER QUALITY DATA

A P P E N D I X F

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Mr. Ross Adams U.S. Fish and Wildlife Service Mark Twain National Wildlife Refuge 1704 North 24th Street Quincy, IL 62301	1	1
Mr. Richard Nelson Field Supervisor U.S. Fish and Wildlife Service 4469 48th Avenue Court Rock Island, IL 61201	1	1
Dr. John Barko Environmental Management Technical Center 575 Lester Drive Onalaska, WI 54650	1	1
Mr. Scott Gritters LTRM Mississippi River Monitoring Station 206 Rose Street Bellevue, IA 52031	2	2
Team Leader LTRM Mississippi River Monitoring Station 4134 Alby Street Alton, IL 62002	1	1

Ms. Holly Stoerker Upper Mississippi River Basin Association 415 Hamm Building 408 St. Peter Street St. Paul, MN 55111		1
Mr. Harlan Hirt U.S. Environmental Protection Agency, Region V 77 West Jackson Blvd. Chicago, IL 60604		1
Mr. Dan Sallee Illinois Department of Natural Resources P.O. Box 149 Aledo, IL 61231	1	1
Mr. Doug Dufford Illinois Department of Natural Resources Dearborn Hall 205 East Seminary Mt. Carroll, IL 61053	2	2
Mr. Steve Moser Illinois Department of Natural Resources Hennepin Canal Parkway R.R. 2, Box 201 Sheffield, IL 61361	2	2
Mr. Marvin Hubbell Illinois Department of Natural Resources Office of Resource Conservation 600 North Grand Avenue West Springfield, IL 62706	1	1
ATTN: CEMVP-PE-P (Donald Powell) U.S. Army Engineer District, St. Paul 190 - 5th Street East St. Paul, MN 55101-1638		1
ATTN: CEMVP-PE-H (Jon Hendrickson) U.S. Army Engineer District, St. Paul 190 - 5th Street East St. Paul, MN 55101-1638		1

ATTN: CEMVS-P (David Gates) 1
U.S. Army Engineer District, St. Louis
1222 Spruce Street
St. Louis, MO 63103-2833

ATTN: CEMVD-PD-G (Buddy Arnold) 1
U.S. Army Engineer Division, Mississippi Valley
Box 80
Vicksburg, MS 39181-0080

ATTN: CEMVD-ET-PR (Tom Pullen) 1
U.S. Army Engineer Division, Mississippi Valley
Box 80
Vicksburg, MS 39181-0080

ATTN: CEMVD-PM-E (David Sills) 1
U.S. Army Engineer Division, Mississippi Valley
Box 80
Vicksburg, MS 39181-0080

ATTN: CEWES-ES-P (Steve Ashby) 1
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

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PLATES

REFERENCES

Published reports which relate to the Andalusia Refuge project or which were used as references in the production of this document are presented below.

(1) *Definite Project Report with Environmental Assessment (R-4), Andalusia Refuge Rehabilitation and Enhancement, Pool 16, River Mile 462-463, Upper Mississippi River, Rock Island County, Illinois*, January 1989 (DPR). This report presents a detailed proposal for construction of a Moist-Soil Management Unit (MSMU) (2-year event levee), a pump station, a water control structure, mechanical excavation of a river access channel, mechanical excavation in Dead Slough and the interior of the MSMU, island construction in the MSMU, excavation of a diversion drainage ditch, and construction of an access road. The report marks the conclusion of the planning process and serves as a basis for approval of the preparation of final plans and specifications and subsequent project construction.

(2) *Plans and Specifications, Upper Mississippi River System, Environmental Management Program, Pool 16, River Mile 462-463, Andalusia Refuge*, September 8, 1989, Contract No. DACW25-89-C-0066. This document was prepared to provide sufficient detail of project features to allow construction of the MSMU, pump station, water control structure, mechanical excavation in Dead Slough and the interior of the MSMU, island construction in the MSMU, and construction of an access road by a contractor.

(3) *Operation and Maintenance Manual, Andalusia Refuge Rehabilitation and Enhancement, Upper Mississippi River Environmental Management Program, Pool 16, River Miles 445.8, Rock Island County, Illinois*, December 1995 (O&M Manual). This manual was prepared to serve as a guide for the operation and maintenance of the Andalusia Refuge project. Operation and maintenance instructions for major features of the project are presented.

(4) *Andalusia Refuge Habitat Rehabilitation and Enhancement Project, Great Flood of 1993 Damage Assessment*, March 1994. This document was prepared to summarize the Flood of 1993 damage, proposed corrective action, and estimated cost for repairs.