UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM (EMP)
DEFINITE PROJECT REPORT (DPR) WITH INTEGRATED
ENVIRONMENTAL ASSESSMENT
STAGE II

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

FINAL
SEPTEMBER 2006

MISSISSIPPI RIVER POOL 20 -
RIVER MILES 358.5-353.6
CLARK COUNTY, MISSOURI

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

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FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

EXECUTIVE SUMMARY

The Fox Island Division Habitat Rehabilitation and Enhancement Project (HREP) is located on the west bank of the Mississippi River, one mile downstream of Alexandria, MO in Clark County. The project lies in Pool 20 between Upper Mississippi River Miles (RM) 353.6 and 358.5. The 2,033-acre Fox Island Division (Division), part of the Great River National Wildlife Refuge, is made up of un-leveed bottomland forests, fields, and sloughs. There are myriad wetlands on the Division and several features with open water for at least part of every year. Water features include Coin Pond, Slim Slough, Logsdon Slough, Old Lake, and Nelson Lake. All project lands are in Federal ownership and are managed by the U.S. Fish and Wildlife Service (USFWS).

The forest, prairie and water resources of the Division have suffered degradation. Sedimentation is continually filling the wetlands and water bodies. Local erosion and floods from the Mississippi and Fox Rivers are the source of the sediment. Many forested areas were cleared to create farmland prior to purchase by the USFWS. Native prairies were long ago converted to cropland.

The goal of this HREP is to rehabilitate and enhance wildlife habitat. The following objectives and enhancement measures were considered in detail to achieve the project goal:

1. Reduce Forest Fragmentation and Enhance Forest Species Diversity
   - No action (Natural Regeneration)
   - Plant mast-producing hardwood trees using container-grown stock
   - Plant mast-producing hardwood trees using precision direct seeding
   - Plant mast-producing hardwood trees using container-grown stock and direct seeding

2. Enhance and Expand Existing Wetlands
   - No action
   - Enhance Logsdon Slough by developing a new well and improving existing water control structures
   - Enhance Coin Pond, Slim Slough, and Old Lake by developing a new well and a surface water source, improving distribution channels, and constructing new water control structures
   - Enhance Logsdon Slough, Coin Pond, Slim Slough, and Old Lake

3. Restore Native Grassland
   - No action
   - Plant native grasses and forbs

The benefits of the project enhancement features were evaluated using the Wildlife Habitat Appraisal Guide (WHAG) and U.S. Army Corps of Engineers Institute for Water Resources program (IWR) Plan. The WHAG evaluation quantifies habitat output in the form of habitat units, which are used in

conjunction with project cost data and functional life expectancy to compare the benefit-cost relationship for each category of proposed enhancement features.

The recommended plan (figure ES-1) includes:

- planting mast-producing hardwoods on 215 acres using container-grown stock and 60 acres using direct seeding;
- enhancing 78 acres of wetlands in and around Logsdon Slough, Coin Pond, Slim Slough, and Old Lake; and
- planting 98 acres of native prairie grasses and forbs.

Planting mast-producing hardwood trees would improve wildlife habitat by providing a source of food. Planting container-grown tree stock increases the probability of surviving periods of flooding because these trees are larger and stronger than common seedling stock. Direct seeding hard mast trees provides a dense canopy in a relatively short period of time and is less expensive than planting rootstock. Precision planting enables the use of mechanical equipment to control weeds during the critical stage before a canopy is established.

Supplying and controlling water levels in the low areas in and around Logsdon Slough, Coin Pond, Slim Slough, and Old Lake would allow the USFWS to extend the period and expand the area of wetland habitat. These areas would provide habitat for waterfowl, songbirds, reptiles, amphibians, and other wildlife.

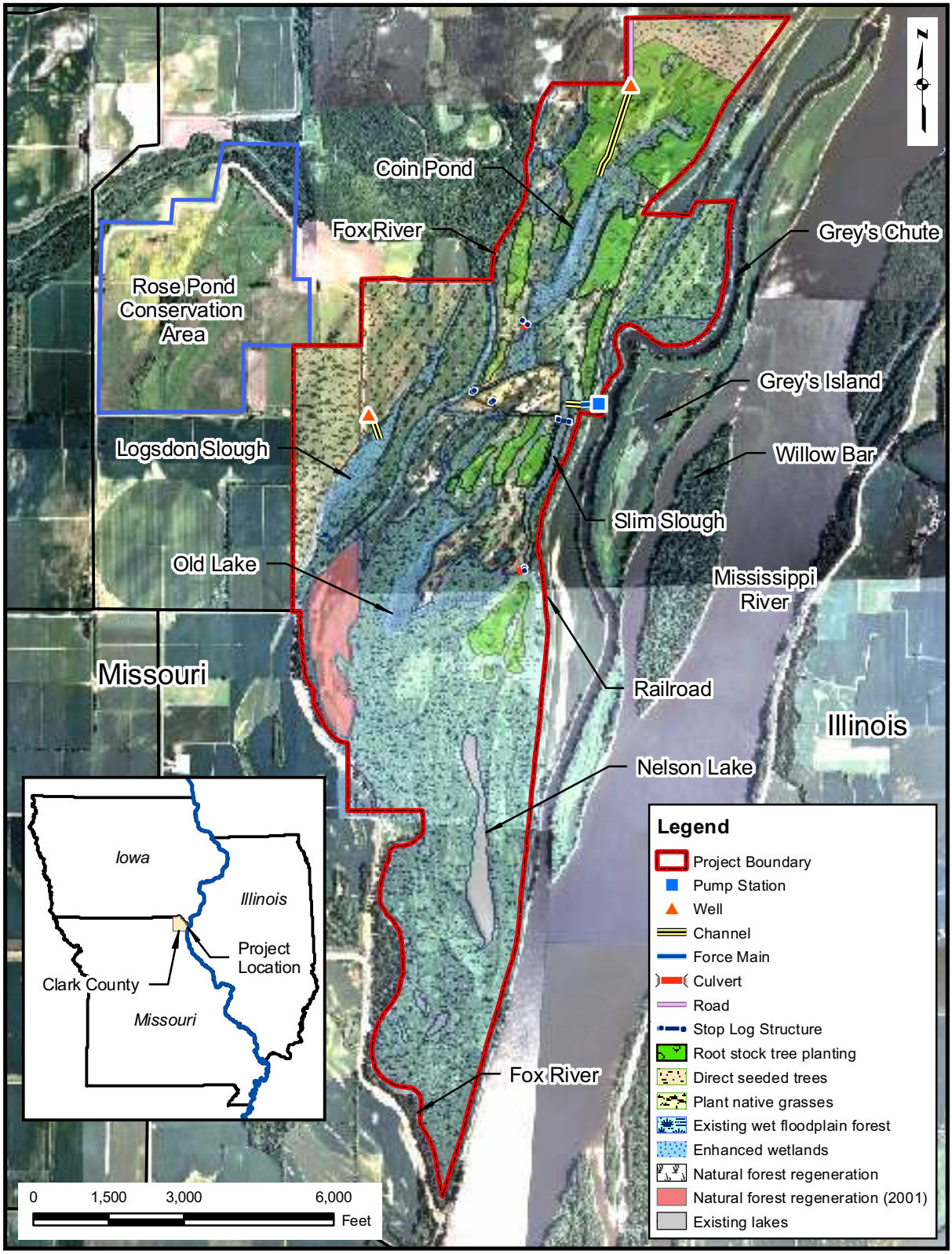
Planting native prairie grasses and forbs would improve conditions for birds, reptiles, insects, and mammals by increasing the diversity of habitats and food sources.

Implementation of the recommended plan would increase the quality and quantity of preferred habitat on the Division. The project outputs are consistent with the refuge Comprehensive Conservation Plan (2004) goals and objectives and support the overall goals and objectives of the Upper Mississippi River System-Environmental Management Program (UMRS-EMP), the North American Waterfowl Management Plan, and the Partners in Flight Program.

The U.S. Army Corps of Engineers (Corps) would be responsible for the Federal share of any mutually agreed-upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the final Definite Project Report (DPR) and that is needed as a result of specific storm or flood events. Rehabilitation of the project is considered to be reconstructive work, which cannot be accurately estimated at this time.

All Fox Island Division project features would be located on Federally-owned lands managed by the USFWS. As a result, first cost funding for enhancement features would be 100 percent Federal. Project operation and maintenance at an estimated average annual cost of $23,796 would be accomplished by the USFWS, the Federal project sponsor. The Missouri Department of Conservation is a non-Federal, non cost-sharing project sponsor.

The Corps' Rock Island District Engineer has reviewed the project outputs and determined that implementation of the recommended plan is justified and in the Federal interest. Therefore, the Rock Island District Engineer recommends construction approval at an estimated Federal expense of $2,098,130 for the Fox Island Division HREP. Total Federal cost, including general design and construction management, is $3,071,130.



US Army Corps of Engineers
Rock Island District

Fox Island Division HREP
Location and Site Map
Figure ES-1

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

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UPPER MISSISSIPPI RIVER SYSTEM
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FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

1. INTRODUCTION

A. Purpose. The purpose of this report is to present a detailed proposal for the rehabilitation and enhancement of the Fox Island Division project area. This Definite Project Report (DPR) provides planning, engineering, and sufficient construction details to allow final design and construction of the recommended plan to proceed. The U. S. Fish and Wildlife Service (USFWS) serves as the Federal project sponsor. The Missouri Department of Conservation (MDC) and the Illinois Department of Natural Resources (IDNR) serve as non-Federal project sponsors.

B. Resource Problems and Opportunities. Fox Island Division is part of the USFWS Great River National Wildlife Refuge (NWR), which is part of the Mark Twain NWR Complex. The project area is comprised primarily of low-profile bottomland, unprotected by flood control levees. The project area contains several bodies of water, including Nelson Lake, Coin Pond, Logsdon Slough, Slim Slough, and Old Lake.

Fox Island Division is subject to annual flooding by the Mississippi and Fox Rivers and is losing its valuable wetland and aquatic habitats to siltation.

Significant opportunities are available for preserving and enhancing habitat for migratory birds, aquatic wildlife, amphibians, and terrestrial species by reintroducing mast trees, encouraging re-forestation of flood prone cropland, enhancing water supply to wetlands, and re-establishing native prairie grasslands.

C. Project Selection. The USFWS nominated the Fox Island Division Habitat Rehabilitation and Enhancement Project (HREP) for inclusion in the Rock Island District's Environmental Management Program (EMP). The Fish and Wildlife Interagency Committee (FWIC) then ranked the project habitat benefits based on critical habitat needs along the Mississippi and Illinois Rivers. After considering resource needs and deficiencies, pool by pool, the FWIC and the River Resources Coordinating Team (RRCT) recommended that the Fox Island Division HREP be pursued. The recommendation is based upon the project's potential for providing significant aquatic, wetland, and terrestrial benefits. Implementing the proposed project features would enhance the USFWS's capability to improve migratory waterfowl and wildlife usage of the project area. Development of this report was actively coordinated with the project sponsors: USFWS, MDC, and IDNR. Coordination occurred during visits to the project site, team meetings, and phone conversations (Appendix A).

D. Scope of Study. The 2,033-acre Fox Island Division is located in Clark County, Missouri, about one mile south of Alexandria, Missouri. It lies on the right descending bank of the Mississippi River in Pool 20 between RMs 353.6 and 358.5. All project lands are in Federal ownership. Plate 1 provides vicinity and location maps for the Fox Island Division.

This study focuses on proposed project features that would improve aquatic, wetland, and terrestrial habitat and enhance overall resource values. The project is consistent with USFWS, HREP, and the Rock Island District's EMP management goals and was planned for the benefit of resident and migratory birds, reptiles, and other wildlife.

Field surveys, aerial photography, and habitat quantification procedures were completed to support the planning and assessment of proposed project alternatives. Soil borings were taken to determine soil properties such as gradation, permeability, and consolidation, which are required for the design of water control features.

The USFWS and the MDC have made wildlife observations within the study area. These observations, along with future studies and monitoring, would assist in evaluating project performance.

E. Format of Report. The DPR is organized to follow a general problem-solving format. The purpose, problems, and project selection process are presented in Section 1. Section 2 establishes the baseline for existing resources. Section 3 presents the objectives of the project. Section 4 proposes and Section 5 evaluates alternatives for meeting the objectives. Section 6 describes the recommended plan and lists general design and construction considerations. Section 7 proposes the schedule for final design and construction. Section 8 contains cost estimates for initial construction and operation and maintenance. Section 9 assesses the environmental effects of the recommended plan. Section 10 describes a plan for monitoring performance and evaluating progress. Section 11 describes real estate requirements. Section 12 summarizes the roles of each sponsoring agency. Section 13 records the coordination effort with local, state, and Federal agencies and comments received through public outreach. Sections 14 and 15 present the conclusions and recommendations. A *Finding of No Significant Impact* statement and *References* follow. Plates and appendices have been furnished to provide sufficient detail to allow review of the existing features and the recommended plan.

F. Authority. The Upper Mississippi River System – Environmental Management Program (UMRS-EMP) is currently a Federal-State partnership designed to (a) plan, construct, and evaluate measures for fish and wildlife habitat improvement through HREPs and (b) monitor the natural resources of the river system through the Long Term Resource Monitoring Program (LTRMP). The Water Resources Development Act (WRDA) of 1986 (P.L. 99-662) states:

> To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system. Congress further recognizes that the system provides a diversity of opportunities and experiences. The system shall be administered and regulated in recognition of its several purposes. (Section 1103).

The UMRS-EMP was originally comprised of five elements: HREP; LTRMP; Recreation Projects; Economic Impacts of Recreation; and Navigation Monitoring. Currently, EMP is comprised of only two elements—HREP and LTRMP. The other EMP elements have either been successfully completed or are now carried out under other authorities.

The original authorizing legislation has been amended three times since its enactment. The 1990 WRDA, Section 405, extended the original EMP authorization an additional 5 years to FY 2002, which allowed for ramping up of the program. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the habitat projects program and the long-term resource monitoring program. WRDA 1992 also assigns sole responsibility for operation and maintenance of habitat projects to the agency that manages the lands on which the project is located. The 1999 WRDA, Section 509, reauthorized EMP as a continuing authority with Reports to Congress every 6 years and changed the cost sharing percentage from 25 percent to 35 percent. The Fox Island HREP has no cost sharing requirement because all project features are located on Federally owned land managed by the USFWS as a national wildlife refuge.

2. ASSESSMENT OF EXISTING RESOURCES

The Great River NWR is centrally located within the Mark Twain NWR complex. The Mark Twain complex stretches 350 miles along the Mississippi River in the states of Iowa, Illinois and Missouri. The Great River NWR contains approximately 15,000 acres along 100 miles of the river in Illinois and Missouri. It is managed as four large tracts—Fox Island Division (formerly Gregory Landing), Long Island Division (formerly Gardner), Delair Division, and Clarence Cannon NWR. Key management goals are to enhance the quality and diversity of fish and wildlife habitat, especially for migrating birds, and to restore floodplain functions in the river corridor. Great River NWR headquarters are located near Annada, Missouri, 40 miles north of St. Louis.

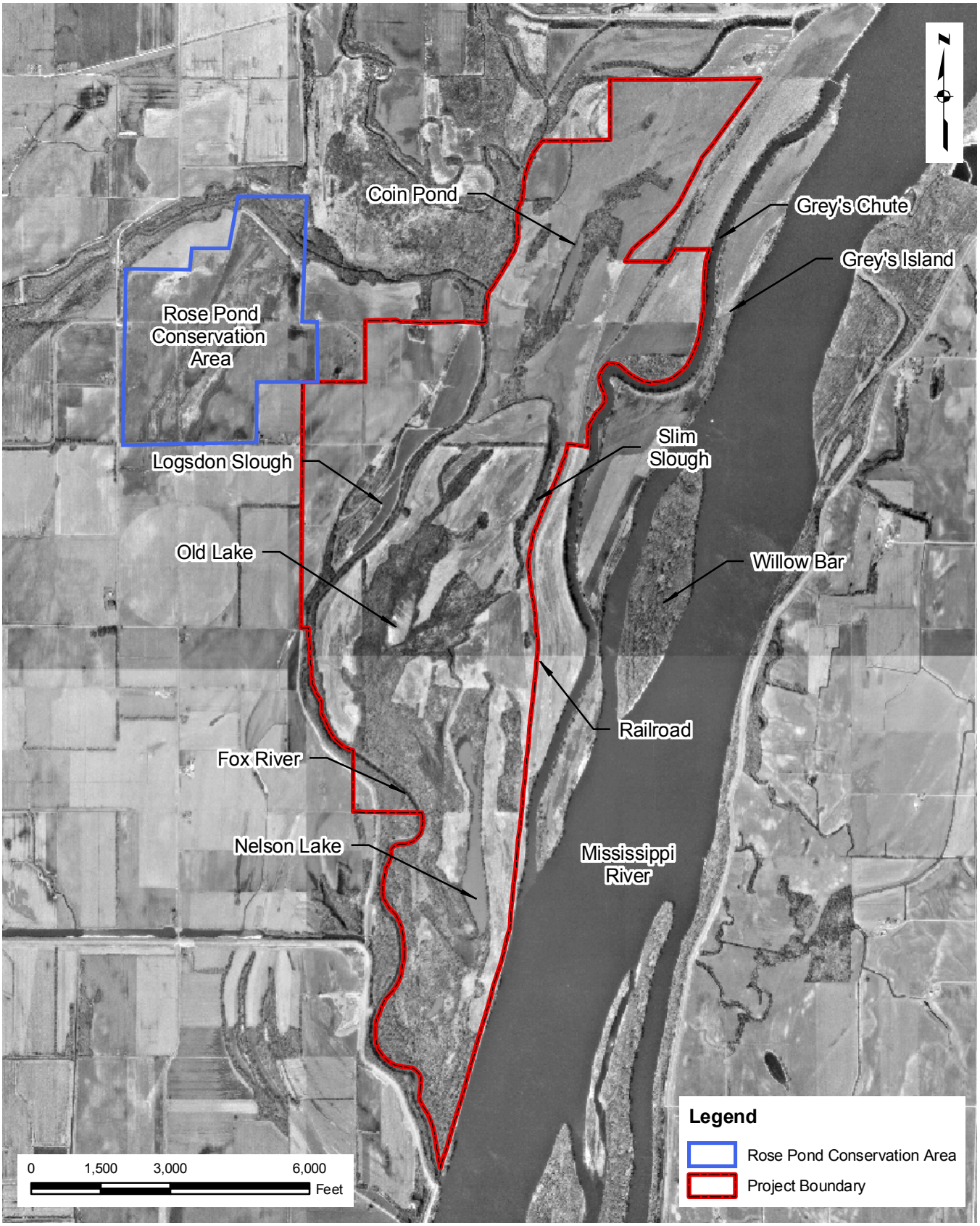
The Fox Island Division is located on the right descending bank (west side) of the Mississippi River immediately downstream of Alexandria in the southeast corner of Clark County, Missouri. The 2,033 acre refuge lies generally between the Mississippi River on the east and the Fox River on the west. It extends from Upper Mississippi River Mile 353.6 to 358.5. The western tip of the Fox Island Division touches the eastern edge of the 620-acre Rose Pond Conservation Area, which is managed by the Missouri Department of Conservation. An aerial view of Fox Island Division showing existing features is included as figure 2-1. Key water bodies are labeled on the photo, including the Fox and Mississippi Rivers, Grey Chute, Logsdon Slough, Slim Slough, Coin Pond, Nelson Lake, and Old Lake.

A. Resource History and Description of Existing Features. As with most low-profile tracts of bottomland in the Mississippi River floodplain, the Fox Island Division area was formed from alluvial deposits over millions of years. The lakes and ponds on the division are former channels of the Fox and Mississippi Rivers, remnants of past meanderings. Vegetative land cover has been affected by the tendency for frequent flooding.

Most of the land that now lies within the Fox Island Division was cultivated during the last half of the 19th century and most of the 20th century. No agricultural levees were ever constructed in this area because the extensive wetlands, lakes, streams, and floodplain forests rendered the area only marginally productive. The levees were constructed, instead, west of the Fox River, where farming conditions were more favorable and flood protection more manageable.

There had been several homes within the current refuge boundaries. A county road provided access from Alexandria. There was a bridge over the Fox River near the mouth of Logsdon Slough. The homes were gradually abandoned and removed, due in part to increased frequency of flooding in the latter half of the 20th century. The fields have continued to be cultivated even though flooding frequently causes crop damage. The USFWS has now taken most fields out of production.

The chutes, sloughs and ponds on the Fox Island Division provide resting, brooding, and foraging habitat for waterfowl and many other marsh and wading birds, and quality habitat for reptiles and amphibians. Over the years, the water bodies within the Fox Island Division have filled with sediment, deposited from floodwaters and from local erosion. Now Coin Pond and the sloughs are nearly filled in. Nelson Lake and Old Lake are the only non-flowing bodies of water that contain water year round. Nelson Lake, once a significant and popular fishery resource, is now too shallow and muddy to sustain populations of game fish.



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Rock Island District

Figure 2-1. Existing Features Map.

B. Land Use and Current Area Management Objectives. Figure 2-2 indicates the land on the division is divided among farm or idle fields, wet floodplain forest and willow stands (Salix Community). There are also large areas of open water and wet meadows. The Burlington Northern-Santa Fe (BNSF) Railroad transects the Fox Island Division along the Mississippi River shoreline. Levees for the Des Moines–Mississippi Levee District No. 1 and Mississippi-Fox Drainage and Levee District No. 2 separate the Fox Island Division from the city of Alexandria, to the north, and the surrounding farmland to the west and south. A small portion (approximately 98 acres) of the Division lies within the Levee District west of Logsdon Slough.

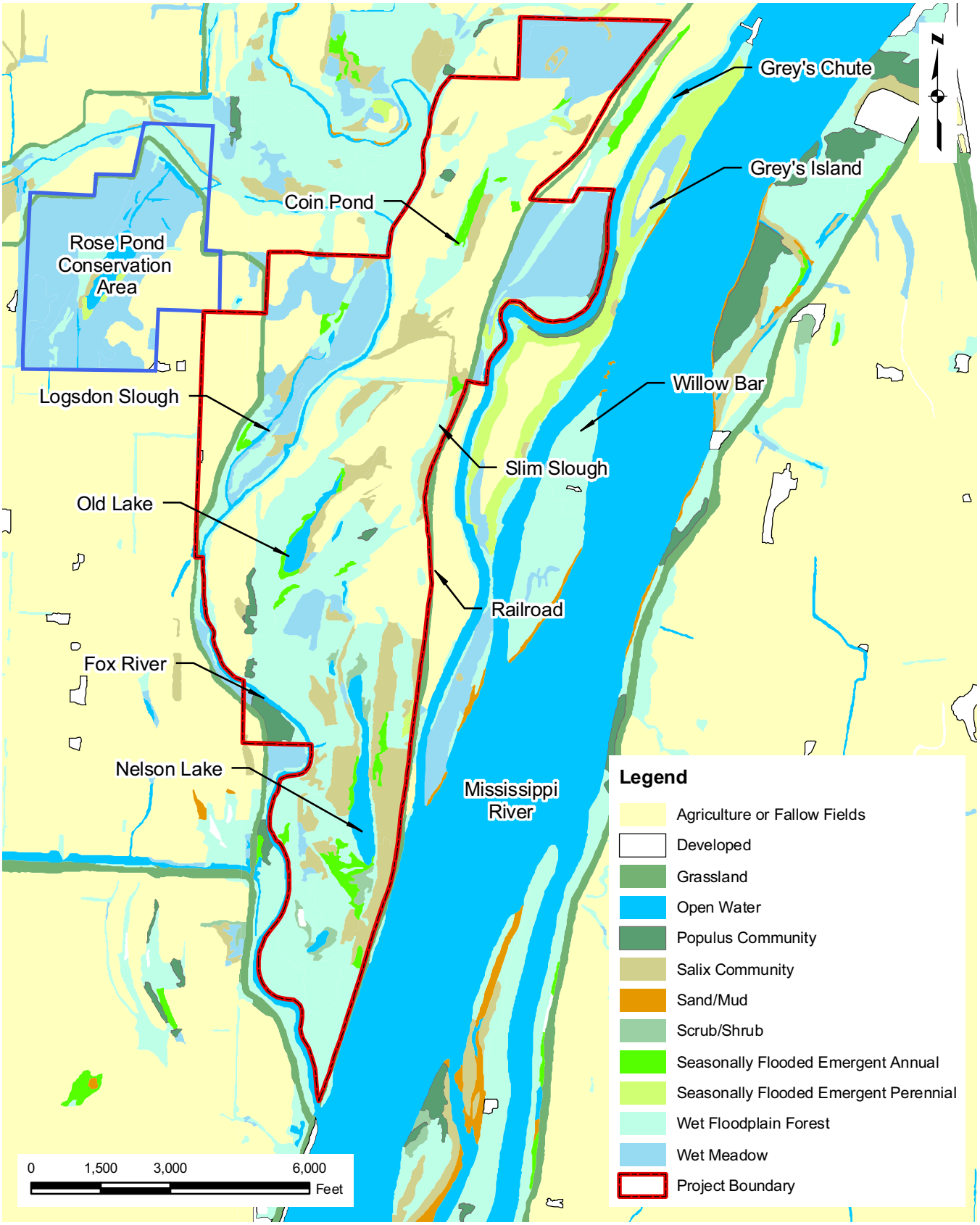
A former unpaved county road runs through the Division, entering on the north and running along the east bank of the Fox River.

The primary purpose of the Fox Island Division is to provide resting and feeding areas for resident and migratory birds, especially waterfowl. Habitat is also preserved for bald eagles, herons, and a variety of other wildlife species. Acquisition of property for the Fox Island Division began in the late 1980s. Approximately 1,100 acres were added after the 1993 flood, bringing the Fox Island Division to its current size of 2,033 acres. There are plans to acquire additional acreage in the future. All acquisitions would be from willing sellers only and are dependent upon available funding.

Approximately 925 acres of the Fox Island Division are floodplain forest, dominated by silver maple and cottonwood. Pin oaks occur in higher elevations. Wetlands, sloughs, and oxbows comprise about 111 acres of the Fox Island Division. The remaining 997 acres are a combination of farmland and abandoned fields. Approximately 620 acres are being farmed to maintain open areas for hardwood reforestation. The yield from cultivation is variable from year to year because of flooding. In the year 2001, only 60 acres of row crops were harvested. Many of the fields in the southern half of the Fox Island Division were farmed until the mid 1990s, but cottonwood and other wetland forest species have regenerated under USFWS management.

The soils found on higher ground of the Fox Island Division are silty and sandy loam, typical of alluvial deposits. They are characterized as fast draining, occasionally to frequently flooded, on shallow slopes. The swales and lowland have a higher concentration of clay and hydric soils, that is soils that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soils include soils developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation. They are less porous and often vegetated with hydrophytic plant communities. Figure 2-3 is a map of the soils within the Fox Island Division, created from data by the Natural Resources Conservation Services (NRCS). The map is indicative of the pattern of deposition that occurs along channels and oxbows. Attribute data include the type of vegetation supported, the annual period of inundation, the slope, and other information that can help determine which areas are best for plantings of various species of trees, herbs, or grasses, and which areas may sustain high quality wetlands.

USFWS has partially restored wetlands in and around Coin Pond and Logsdon Slough. The Service has excavated or cleared channels to promote connectivity between water bodies and has installed galvanized metal stoplog structures to increase management capability. These wetlands are dependent upon surface water runoff or flooding and do not typically maintain open water year round. They are usually dry during the fall waterfowl migratory season.



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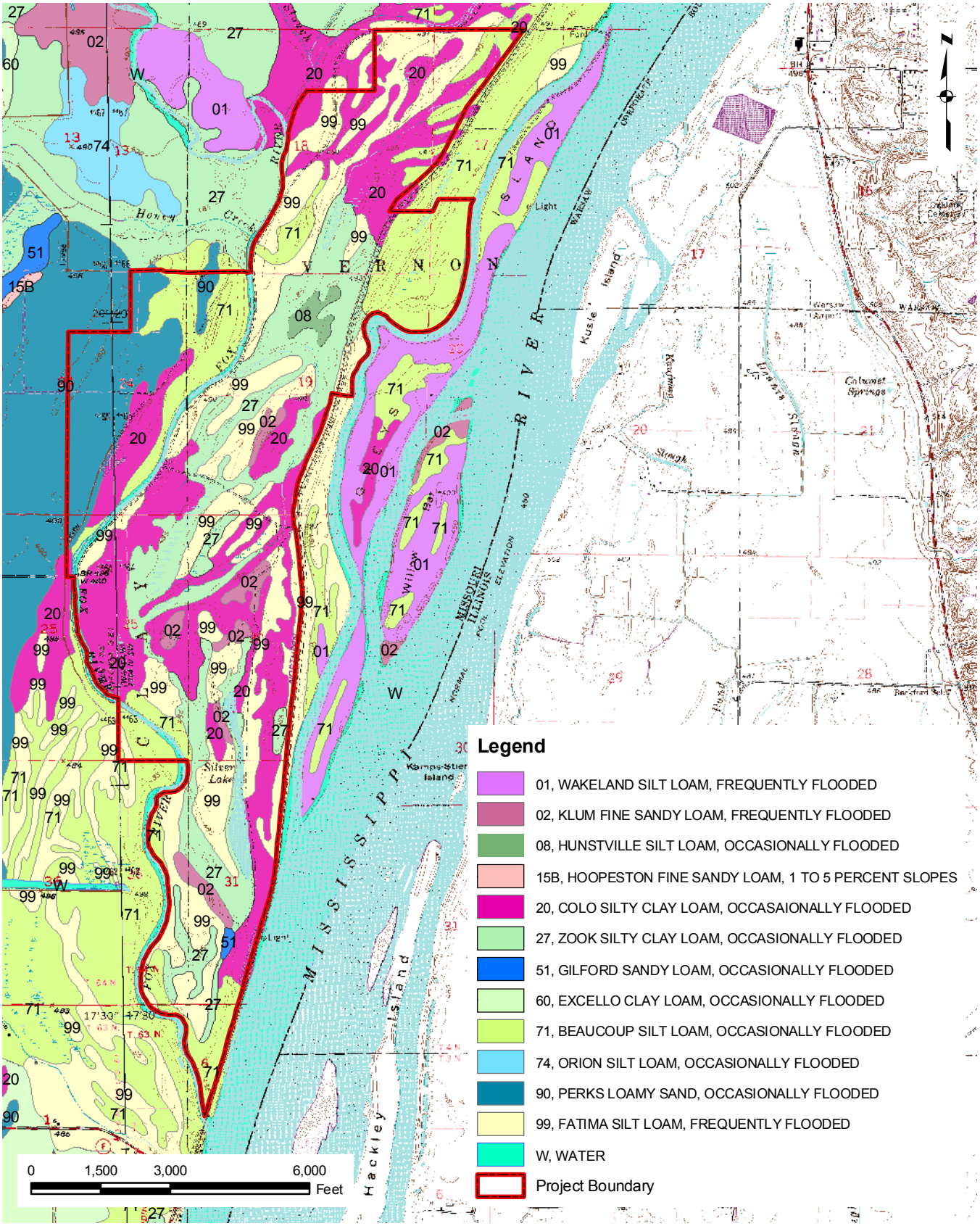
Rock Island District

Figure 2-2. Land Cover/Land Use.



US Army Corps of Engineers
Rock Island District

Figure 2-3. Soils Map.

A significant focus of Fox Island Division management has been on reforestation of farmland to increase wildlife habitat. In 1994, 160 acres were planted with acorns and pecans. An additional 80 acres were planted in 1998. The success of these tree plantings has been limited due to competition from grasses and other, faster-growing species, and by flooding. Those areas that have been left to revegetate naturally have grown up in thick stands of cottonwood, silver maple and willow. The USFWS continues to lease much of the area for cultivation of row crops and small grains in order to keep the land open for future plantings of hardwoods. Plate 3 shows the location of previous acorn/pecan plantings and the location of existing water control structures.

C. Aquatic Resources. Surface water features on or adjacent to the Fox Island Division include rivers, channels, ponds, and wetlands. The project area is bordered on the east by the Mississippi River and by the Fox River on the west. The Fox River is a small, highly variable flow river which drains about 500 square miles at its mouth. Grey Chute, a side channel of the Mississippi River, forms the northern half of the east boundary. Other named water features include:

- Logsdon Slough, an oxbow channel on the west side of the Fox River, dries out much of the year but supports dense annual and perennial hydrophytic vegetation. The USFWS has installed a stoplog structure at the south end (mouth) of the slough, but the structure is in need of repair.
- Slim Slough, an oxbow channel on the east side of the Division, is dry most of the year but sustains both annual and perennial hydrophytic vegetation.
- Coin Pond, a shallow pond in the north central area of the division, surrounded by forests and wetlands. The pond is mostly filled with sediment and dries out in the summer.
- Old Lake, a perennial open-water body on the west side of the Division.
- Nelson Lake, the largest body of water on the Division. With at least 23 acres of open water year round (more in the spring), the lake is an attractive resource for frogs, turtles and wading birds. The water is shallow and muddy. The bottom is unconsolidated sediment and does not support vegetation.

These water bodies are fringed with a 20- to 100-foot-wide band of woody vegetation, while annuals dominate the channels of the sloughs and centers of the ponds when the water has receded.

These resources and other unnamed wetlands and drainage ways are shown on figure 2-1 and Plate 3. The ground surface in the Fox Island Division lies about 10 feet higher than the normal pool elevation (480.0 feet MSL) of the Mississippi River. Most of the sloughs, ponds, and swales are 2 to 5 feet lower than the surrounding terrain. All of them except Nelson Lake and Old Lake dry out in most years during the summer and fall. Their value to aquatic wildlife is diminished throughout much of the summer and most years they are nearly dry during the waterfowl migration in the fall. Insufficient storage and the inability to control water levels are the primary limitations on the quality of the wetlands on the Fox Island Division.

A variety of birds, reptiles, and mammals are found in and around the water of the Fox Island Division. Resident and migratory birds include eagles, herons, egrets, geese, ducks, and many kinds of song birds. Reptiles include toads, frogs, northern water snakes, snapping turtles, and western

painted turtles. Mammals on the division include muskrats, deer, fox, squirrels, and raccoons. Fish and mussels are found in the Mississippi and Fox Rivers adjacent to the Fox Island Division.

Spring flooding plays a significant role in the planning for this unprotected floodplain between two rivers. Floodwaters nourish the wetlands, providing a source of water that can last for weeks. It affects planting times and crop success or failure. The type of natural vegetation that occurs across the Division is largely a function of the length of time that its location is under water.

Figure 2-4 indicates the location of hydric soils, which are indicative of conditions conducive to the formation of wetlands. These wetlands could be enhanced by improving water supply and restoring natural vegetation. The NRCS soil survey was supplemented with soil borings at specific sites on the project. The borings were performed to gather information about porosity in areas that were identified for wetland enhancement. The borings show that the soils are tight in the lowest areas of the sloughs, where hydric conditions are most apparent. On the perimeter of the sloughs the soil is quite porous. The natural wetlands are clearly demarcated by a perimeter band of woody, hydrophytic vegetation.

The soil borings identify only the conditions at the location they were made and cannot give surety that there are no sand lenses where water could escape. Site visits shortly after a heavy rainfall in June 2003 found Coin Pond, Nelson Lake, and Old Lake brimming with water while Slim Slough had no standing water.

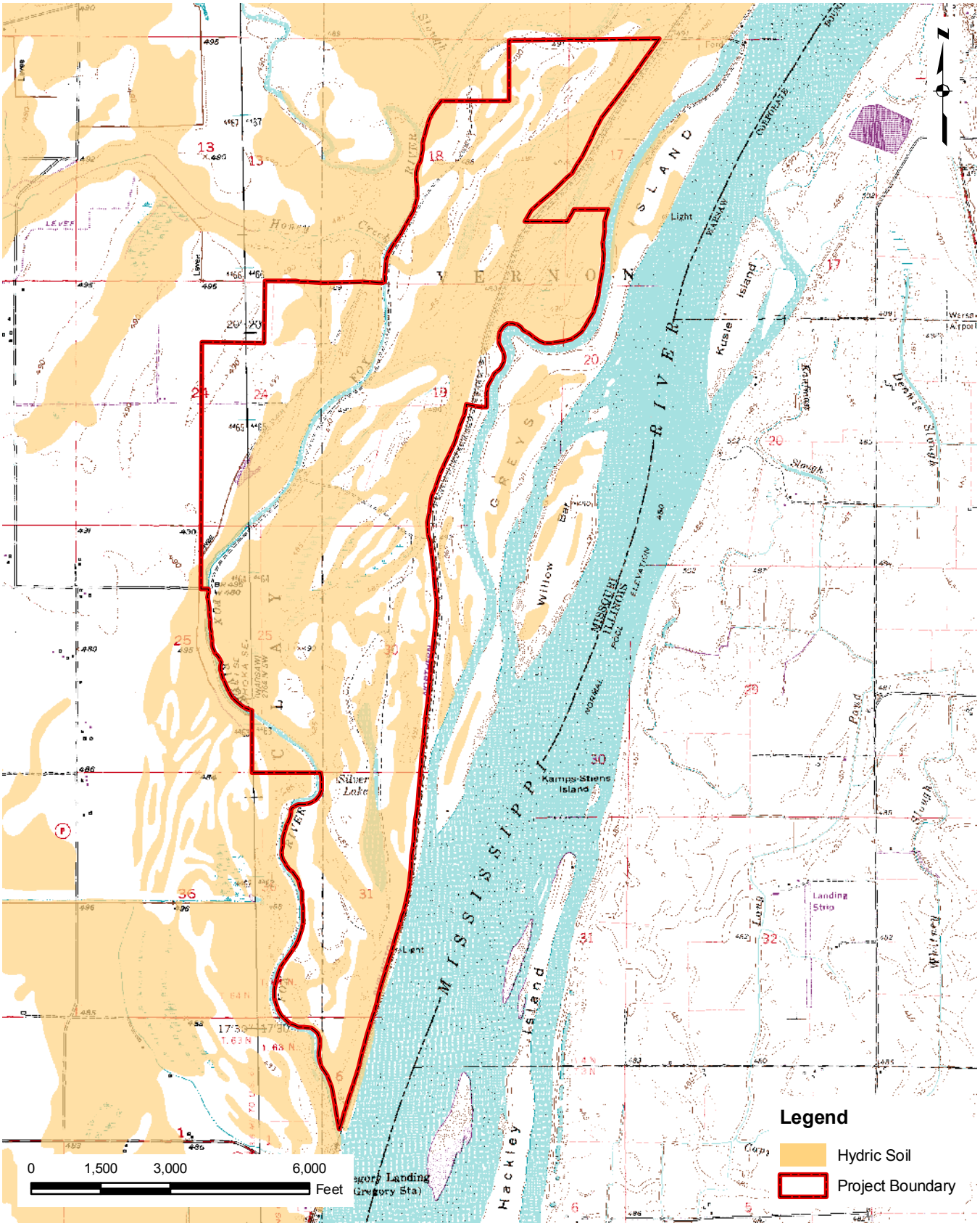
D. Terrestrial Habitat Resources. The floodplain forests are predominately comprised of silver maple, willow, and cottonwood. Pin oaks are found in mixed stands on higher ground in the Division. The pin oaks and other hardwoods scattered sparsely throughout the division produce high quality mast which benefits a wide variety of wildlife.

Approximately 621 acres of the Fox Island Division are under cultivation. The farm lease agreement sets aside a portion of the crop to be left in the field each fall for wildlife. Wild turkeys, squirrels, and deer feed on the un-harvested grain. In early winter, migrating ducks and geese also forage on the grain. The 160 acres of open ground that has been left unplanted has grown up in a variety of grasses, forbs, and willows.

Wood ducks utilize the open water areas in the Division for spring and summer foraging and brood habitat. The shallow marshes are attractive to wildlife such as deer, raccoons, birds, frogs and turtles, but they usually dry up during the summer months.

Flood events of significant magnitude and duration can be particularly harmful to trees, depriving roots of oxygen and causing direct mortality. The 1993 flood was particularly detrimental to trees throughout much of the Upper Mississippi River Valley.

E. Water Quality. Increasing water supply to Slim Slough, Coin Pond, and Logsdon Slough could have a beneficial effect on the quality of area surface water. Possible sources of this water would include groundwater and flood water from the Fox and Mississippi Rivers. The enhanced wetlands would improve surface water quality by removing sediments and nutrients. Information is available on the past and present water quality within the Fox and Mississippi Rivers from USGS sampling sites at Wayland and Canton, Missouri. This information is summarized in the following paragraphs, and provided in detail in Appendix G.



US Army Corps of Engineers
Rock Island District

Figure 2-4. Hydric Soils.

On its list of impaired rivers, the State of Missouri has deemed the Fox River a Category Three waterway. Category Three waters are presently recognized as impaired, but there is no practicable remedy for them. All of the Fox River was placed in this category due to naturally occurring manganese concentrations ranging from 218 – 311 micrograms per liter (µg/L), exceeding the Missouri water quality criterion of 50 µg/L. The State has given the Fox River a low priority for analysis and is scheduled to conduct a use attainability analysis to examine the manganese levels in 2007. The Fox River reach that passes through the Fox Island Division is classified by the State of Missouri (10 CSR 20-7.031) as Class P1, defined as "a standing water reach of a stream that maintains permanent flow, even in drought periods." The designated uses for the Fox River reach that goes through the Fox Island Division are livestock and wildlife watering, protection of warm water aquatic life, human health protection for fish consumption, boating and canoeing, and drinking water supply. Overall, water quality appears to be good and use of the water for wetlands augmentation would be acceptable. However, naturally occurring manganese levels may be too high, and could limit the use of the water where human consumption of fish is planned.

The Mississippi River in Missouri has been placed in Category Two on the State of Missouri list of impaired waters. Category Two waters were originally reported as impaired, but the data used to determine this designation is considered older or of lesser quality. Additional data collection on Category Two waters is planned to determine whether to proceed with U. S. Environmental Protection Agency (USEPA) Total Maximum Daily Load (TMDL) program development. The entire length of the Mississippi River in Missouri is considered impaired due to habitat loss from channelization. The State has given this section of the Mississippi River a medium priority and has scheduled it for further data collection in 2005.

F. Endangered Species. The list of animals and plant below are of "conservation concern" in Missouri and was compiled by the USFWS (see letter dated August 23, 2004 in Appendix A).

Animals

Central mudminnow *(Umbra limi)* – a state-endangered fish species found in sloughs, oxbows, and backwaters of streams with low gradients, mud bottoms, and dense aquatic vegetation.

Western fox snake *(Elaphe vulpina vulpina)* – a state-endangered species found in natural wet prairies, marshes, and sometimes in lowland forests or edge habitats between wood lots and pastures.

Illinois mud turtle *(Kinosternon flavescens spooneri)* – a state-endangered species found in sandy soil in association with ponds, marshes, wetlands, lakes, and oxbows with turbid water and soft bottoms that rests on logs and in shallow water near shore and spends winters and hot summer months buried in sand.

Blanding's Turtle *(Emydoidea blandingii)* – state-endangered species found in marshes, waterholes, sloughs, streams, and ponds with mud or silt bottoms and moderate to dense aquatic vegetation that nests in grasslands.

Plant

Patterson's dawnflower *(Stylisma pickeringii var pattersonii)* – a state "critically imperiled" plant species known to prefer relatively open, sandy soils. This plant has been found in the vicinity of the project area.

The Illinois mud turtle and the Western fox snake have been reported from the Rose Pond Conservation Area but neither species has been observed since the 1993 flood. An active bald eagle nest exists near the Fox Island Division. Patterson's dawnflower has been found on the levee on the western side of the Division. No other state or Federal endangered or threatened species have been observed on the Fox Island Division. The endangered fat pocketbook mussel may occur undetected around the islands in the Mississippi River adjacent to the Fox Island Division.

G. Historic Properties. Three historic properties reports—a literature review and two Phase I surveys—have been prepared for this project. The report cover pages and management summaries appear in Appendix M, figures M-1, M-2, and M-3

The literature review was prepared by Benn and Hengesteg (2002) and entitled *Archival, Historical, Archaeological, and Geomorphological Background Literature and Records Review and Research for Historic Properties at the Fox Island Division of the Great River National Wildlife Refuge, Mississippi River Pool 20, Clark County, Missouri.* The authors' Fox Island Division (FID) study area boundary is shown in Appendix M, figure M-4 [reproduced from Benn and Hengesteg (2002:Figure 2)].

Benn and Hengesteg found a number of archaeological surveys had been conducted between 1978 and 2001 in areas just outside the FID study area and within its western margins. No archaeological sites were found to be located within the boundaries of the FID study area; nine sites were located within one mile of it (Benn and Hengesteg 2002:4).

Three Landform Sediment Assemblages were identified by Benn and Hengesteg (2002:5-7) in the FID study area. These are the Kingston Terrace (KINGSA), Middle Holocene Mississippi Channel Belt (EMHOL2), and Late Holocene Mississippi Channel Belt (LAHOL). All three have the potential to contain significant historic properties and were recommended for archaeological investigation "in the event adverse impacts are planned for all or part of the study area" (Benn and Hengesteg 2002:15).

Two Phase I archaeological surveys have been conducted to cover the footprint of the current FID project.

The first, *A Phase I Archaeological Survey and Geomorphological Evaluation for Historic Properties, Fox Island EMP Project, Clark County, Missouri*, was prepared by Hoppin and Benn (2004). The footprint of this survey covered 194.2 ha (480 ac) with boundaries as marked by the "Fox Island Division Project Area" as shown in Appendix M, figure M-5 [reproduced from Hoppin and Benn (2004:Figure 2)]. Three historic property sites were located. The Corps concurred with the authors (Hoppin and Benn 2004:19-22) that the historic period sites 23CK346 and 23CK347 were not eligible for inclusion in the National Register of Historic Places (NRHP). The Corps also concurred that prehistoric site 23CK345 was potentially eligible for inclusion in the NRHP.

The second survey, finalized in July 2004, is entitled *Intensive Archaeological Survey for Historic Properties at the New Pump Station, Fox Island EMP Project, Mississippi River Pool 20, Clark County, Missouri*, and was prepared by Benn (2004). The footprint of this survey covered approximately 0.6 ha (1 ac) with boundaries as marked by the "Project Area" as shown at Appendix M, figure M-6 [reproduced from Benn (2004:Figure 2)]. No historic properties were located by this survey. The Corps has concurred with the negative findings of this report and its conclusion that "no additional archaeological investigations" are required (Benn 2004:11-12).

H. Sedimentation. Sedimentation impacts the Fox Island Division by filling lowland areas and thus depleting their capacity for holding water (see Appendix I). This results in diminished aquatic habitat, reduction in surface area of wetlands, and reduced capability to withstand dry spells.

There are two sources for the sediment loads reaching low-lying areas:

- Erosion occurring within the Fox Island Division itself, and
- Sediment laden floodwater from the Mississippi and Fox Rivers

The Fox Island Division floods frequently from both the Mississippi and Fox Rivers (42 percent chance of flooding each year from the Mississippi River plus a 50 percent chance of flooding each year from the Fox River). The flood waters contain higher concentrations of suspended solids, which tend to settle out in the relatively acquiescent ponds and sloughs. In addition, flood flows aggravate erosion within the site, producing additional sediment that is carried into the low-lying wetlands and ponds. The significant water features (Coin Pond, Slim Slough, Logsdon Slough, Old Lake, and Nelson Lake) have all filled appreciably since 1937, when the first survey was conducted by the Corps of Engineers (Ref #8). Nelson Lake and Coin Pond, formerly popular fishing spots, are now too shallow to sustain sport fish populations.

I. Hazardous, Toxic and Radioactive Waste. A hazardous, toxic, and radioactive waste (HTRW) compliance assessment was conducted. The project is located in an area that primarily is and historically has been agricultural land. There is little evidence that the land has been used for other purposes. There were no obvious indications of potential contamination sources or migration pathways from surrounding properties. It does not appear that there is a risk of HTRW contamination within the project area. Appendix F provides additional details on the compliance assessment and recommendations for site clean-up.

3. PROJECT OBJECTIVES

A. Problem Identification. The extent and quality of forests, wetlands, and grasslands along the Mississippi River have been steadily declining due to pressure from civilization and agriculture. This is particularly true for Pool 20, which has a lower percentage of Federal- and State-managed riparian land than other pools in the Upper Mississippi River System. The Fox Island Division is the only Federal wildlife refuge within the 21-mile reach of Pool 20. Sedimentation and agricultural practices have contributed to the deterioration of the habitat value of Fox Island lands. Hardwood, mast-producing forests were cleared to make room for crops. Wetlands have been drained to create cropland. Floodplain ponds and wetlands have suffered from sedimentation, which has reduced their area, volume, and habitat value. Native prairies were long ago converted to cropland or pasture. Specific habitat losses on the Fox Island Division lands include:

i. Forest Fragmentation. Hardwood forests were cleared in the 19th and 20th centuries to make room for agriculture and development. Former continuous reaches of Mississippi River floodplain forests were reduced to small tracts interspersed with fields. This fragmentation eliminated habitat for large game and reduced the attraction for nesting and migrating birds. Widespread forests with rich species diversity have been reduced to narrow stands of flood-tolerant species on the fringes of the Division's water bodies and waterways.

ii. Loss of Wetlands. The Fox Island Division lies within the floodplain of the Mississippi and Fox Rivers. Oxbow lakes, sloughs and wetlands were once abundant. Many of these features have been drained or leveed to create farmland. Others have been filling with sediment through natural processes of erosion and flood-borne sedimentation. The net result has been the loss of wetland and loss of plant and wildlife diversity tied to this habitat. This condition is recurrent all along the Mississippi River, but the Fox Island Division provides special opportunities because of its location – the only riparian refuge land within Pool 20, and because most of the floodplain has not been separated from the rivers by levees.

Approximately 621 acres of the Fox Island Division are presently devoted to cultivation. These cultivated areas provide marginal agricultural benefits because of frequent flood losses. Unless managed specifically for the purpose of wildlife enhancement, they provide relatively low quality habitat. Agriculture on the Division also results in sediment, nutrient and pesticide runoff into the Mississippi and Fox Rivers. These pollutants effectively lower the dissolved oxygen content within the streams, diminishing their capability for sustaining diverse aquatic populations

The ponds and sloughs on the Division are filling with sediment from on-site erosion and from sediment-laden flood flows. With insufficient depth to prevent solid winter freezing, they have lost their capacity to sustain fish populations. The unconsolidated, silty bottoms diminish their capacity to support aquatic plants and wildlife. Eventually the water bodies fill to the level of dry land and provide no surface water resource. This sequence is in advanced stages throughout the Fox Island Division. Nelson Lake and Old Lake have filled to only a couple feet of depth. Coin Pond has only a few inches of water in the late summer and fall. The upper reaches of Logsdon Slough and all of Slim Slough are dry for most of the year.

iii. Loss of Natural Prairie. Native grassland habitat is in critically short supply along the Mississippi River Valley. Many varieties of native warm-season tall grasses and forbs are now found only in restored prairies. The tall grass prairies are important for preservation of species diversity and

for the habitat they provide to a variety of wildlife such as butterflies, frogs, turtles, songbirds, pheasants, deer, and small mammals.

B. General Fish and Wildlife Management Goals. The mission of the NWR System is "to administer a national network of lands and waters for the conservation, management and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans." Great River NWR was established primarily to provide protection and sanctuary for migratory birds. Refuge lands also provide important habitat for numerous species of resident and migratory wildlife.

The goal of the Fox Island Division Habitat Rehabilitation and Enhancement Project is to rehabilitate and enhance the quality and diversity of wildlife habitat. The goal should be achieved through expansion of wet, bottomland forests, establishment of mast producing forests, enhancement of wetlands, and restoration of tall grass prairies.

The HREP proposed enhancements are designed to increase the capability for the USFWS to manage the Fox Island Division, providing increased flexibility to meet changing conditions.

C. Project Goals, Objectives, and Potential Enhancement Features. The specific goals, objectives, and potential features of the Fox Island Division HREP are listed in Table 3-1.

Table 3-1. Project Goals, Objectives, and Potential Enhancement Features

Goal	Objectives	Potential Enhancement Features
Rehabilitate & Enhance Wildlife Habitat	Reduce forest fragmentation and enhance forest species diversity Enhance and expand existing wetlands Restore native grassland	Establish hardwood, mast-producing forests Allow natural reforestation in low-lying areas Enhance water supply, distribution and control for wetlands Seed part of Logsdon Tract with native grasses and forbs.

D. Criteria for Potential Enhancement Features. Table 3-2 presents general and specific criteria developed to assess potential enhancement features.

Table 3-2. Potential Enhancement Features Development Criteria

Criteria	Purpose of Criteria
A. General Criteria	
Locate and construct features consistent with EMP directives	Comply with program goals and authorities
Construct features consistent with Federal, state, and local laws	Comply with environmental laws
Develop features that can be monitored (e.g., sedimentation, stability, water levels, water quality)	Provide means to measure integrity, effectiveness, and efficiency of improvements.
Design features to facilitate operation and maintenance	Minimize operation and maintenance costs. Realize USFWS logistical difficulties in accessing the site
Locate and construct features consistent with best planning and engineering practices	Provide basis for project evaluation and alternative selection
Construct features which meet one or more of the project objectives	Meet project goals and objectives
B. Rehabilitate and Enhance Wildlife Habitat	
Establish hardwood, mast-producing forests	Improve forage and shelter for wildlife and increase plant diversity
Locate hardwood plantings on high ground	Maximize survival of species that are less flood-tolerant
Natural reforestation in low-lying areas	Reduce forest fragmentation and increase shelter and nesting habitat
Augment water supply to wetlands	Provide habitat for migrating waterfowl, other wetland dependent birds, and aquatic and amphibious species
Enhance area of wetlands	Increase habitat for migrating waterfowl and aquatic and amphibious species
Provide means to control water levels	Increase management flexibility; control invasive species; enhance vegetative opportunities; improve spring planting; improve maintenance operations
Provide access to water supply and control facilities	Facilitate operations and maintenance
Re-create native prairie grassland	

4. POTENTIAL PROJECT FEATURES

This section describes potential features to meet the goal to rehabilitate and enhance the quality and diversity of wildlife habitat. Potential enhancement features were determined based on their ultimate contribution to the goals and objectives, engineering considerations, and local restrictions or constraints. Features that were not considered feasible were not subjected to further evaluation. These features are shown on Plate 4, *Potential Enhancement Features Not Evaluated*. Section 5 discusses the evaluation of the feasible project alternatives. These features are shown on Plate 5, Potential Enhancement Features Evaluated. For planning purposes, project life was established at 50 years.

A. Potential Features to Reduce Forest Fragmentation and Enhance Forest Species Diversity. The once contiguous Mississippi River floodplain forests have been dissected into small plots to make room for agriculture, towns, levees and roads. The loss of contiguous forest affects the density and diversity of wildlife in this riparian zone. The following features would re-establish contiguous forest along the entire north-south extent of the Division.

i. Plant Mast-Producing, Hardwood Trees. Several methods were considered for planting mast trees, including:

- Precision direct seeding in rows, using a drill: This method would be used to create rows of trees, closely spaced within the row but with rows spaced far enough apart to allow mowing.
- Broadcast direct seeding: This method would result in a dense, random pattern of seedlings. Herbicides would be used for weed control because there would not be room to mow around the trees. This option was dropped without further analysis after USFWS and Corps of Engineers foresters indicated precision seeding worked better with their current operations and maintenance program. Precision seeding provides better access and improved capacity to monitor and repair problems.
- Plant common nursery rootstock: This rootstock comes in a variety of sizes, from bare-root seedlings to 5-gallon root balls. The stock is typically planted in rows with sufficient room between rows to mow. This option was dropped in favor of container-grown stock plantings because recent experience by the USFWS and Corps of Engineers indicated much better survival and overall improved economics despite the higher initial costs. Container-grown stock comes in pots three gallons or greater. They are 4 to 6 feet tall, have a caliber of 5/8 inch or greater at the base of the tree, and have a dense, fibrous root mass. These trees are becoming more prevalent at nurseries in the Midwest, and as they do, their price is coming down.
- Plant vigorous container-grown stock, which is more expensive than common root stock but has a much higher survival rate. These saplings are also planted in rows with enough space between the rows for mowing.

All methods of selective planting require vigorous weed control to enhance survival rates. Several methods were considered. The objective of all the methods is to limit competition until the saplings have reached sufficient height and breadth to create a canopy that shades out competitive species. Under normal growing conditions, the weed control program can be stopped or reduced after three years.

Mechanical weed control (mowing) requires the trees to be planted in patterns that allow equipment to pass near each tree. Typically the trees are planted in rows, too close within the row for cross mowing but with rows spaced wide enough to allow tractor access. Sometimes the trees are spaced far enough apart in both directions to allow mowing each way. The disadvantage of planting for cross mowing is a lower tree population, especially if some of the trees die. Trees planted densely in rows can be thinned to the proper spacing after it becomes clear which trees would survive.

Tree mats and rolls of plastic were considered for weed control. Trees would be planted through holes in strips of material laid along the ground in rows to prevent weed growth. Spacing between rows would allow water to reach the root system.

Many foresters have success with herbicides for weed control. A proper regime of pre- and post-emergent herbicides can prevent unwanted species without damaging the preferred crop.

Some areas of the Division were seeded with hardwoods a few years prior to this project. Some of those seeded areas have not resulted in viable hardwood stands and this study investigated replanting there. One such area, the East Winkleman Tract, consists of the Division land lying east of the BNSF Railroad. Acorns were broadcast over this area in 2001, but there are few oak saplings to be found now. After site investigation and discussions the project team decided not to pursue re-seeding because the area is more prone to flooding than other areas on the Division. This is because it lies outside the protection of the railroad berm.

Another area that was recently seeded with hardwoods lies on the east band of the Fox River, near Old Lake. The USFWS has decided to leave this area to grow up in combination of hardwood trees from the seeding and native species that take hold through natural regeneration.

ii. Reforestation of Lowland Areas. This option is to allow lower-lying ground to reforest naturally, yielding flood tolerant species such as silver maple and cottonwood. This option would restore the extent of forested area on the Division to pre-development levels, providing habitat for woodland wildlife and improving conditions for forest-dwelling birds that require larger continuous tracts. The soft-mast varieties that would dominate the forest would not provide as much food value or diversity as the hard-mast forest, but they are much more capable of withstanding flood events.

B. Potential Features to Enhance and Expand Existing Wetland. The Fox Island Division is rich with ponds, wetlands and natural channels. The area is frequently inundated from high spring flows in the Mississippi and Fox Rivers, as well as local flood-producing storms. Three smaller basins converge with the Fox River at the Division:

- Pickle House Slough flows in from the north,
- Hemp Slough from the northwest, and
- Honey Creek from the west.

The flood waters remain in the Division wetlands for weeks after the streams have receded, nourishing hydrophytic plants and expanding habitat for puddling ducks, wading birds, amphibians, and other wetland species. By developing alternative water sources and new means to control water levels, the wetland habitat can be expanded spatially and temporally.

i. Enhance Logsdon Slough. This option would increase the water levels in Logsdon Slough, on the west side of the Fox River, by developing a source of water and controlling the discharge from the slough to the Fox River. Part of this tract is currently enrolled in the Natural Resources Conservation Service (NRCS) Wetland Reserve Program (WRP).

For a source of water, there is an existing well on Logsdon tract, on the opposite side of the flood control levee from the slough. To utilize this water, a new discharge line would have to be constructed over the levee. Two concerns led to the early dismissal of this option for water supply:

- The capacity of the well was questionable and marginal; and
- The cost of piping the water from the well over the levee was higher than the cost of developing a new well.

There was some consideration for pumping water out of the Fox River, but the river is not very accessible from the west side and the water supply is not reliable, especially in the late summer and fall.

A new well could be drilled to develop a dependable source of water. Several irrigation companies were contacted and confirmed that new wells in this area are capable of developing the 600 to 2,000 gallons per minute discharge required to operate the wetlands efficiently. The feeder channel from the new well to the slough would be located on land in the wetland reserve program.

There is an existing stoplog structure, located near the mouth of the slough, where it discharges to the Fox River, capable of pooling water to about elevation 485. The 2-inch dimensional lumber water stops are missing, but the structure is sound. New lumber and some channel excavation could restore its full design capability. There does not appear to be a need to replace it.

The new well and repaired stoplog structure could develop the means to inundate a reach of the slough that is currently dry during most of the late summer and fall.

ii. Enhance Coin Pond, Slim Slough, Old Lake Complex. Many wetlands, ponds, sloughs, and drainage ditches occur on the east side of the Fox River, between the Fox River and the Mississippi. The centrally located water bodies—Coin Pond, Slim Slough, and Old Lake—are connected by a series of natural channels, wetlands, and swales. Altogether, more than 350 acres of continuous lowland is capable of being inundated by a single pumping source and a single water control structure.

A little more than 50 acres of this complex occurs within the discernable banks of the three water bodies. Although these water bodies recede during dry periods, the limits of normal high water are recognizable by the dark hydric soils, hydrophytic plants, and border of water-tolerant trees and brush. The remaining 300 acres of lowland within this complex are farmed or recently abandoned farmland. These low areas show signs of frequent inundation. Uncultivated areas are dominated by hydrophytic plants such as smart weed, nettles, and willows.

There is concern that uncontrollable seepage could occur if too high of water levels are attempted. The natural channels are lined with fine-grained sediments, which have accumulated over centuries of erosion and flood deposition. Outside the channels, however, soils on the Division are sandy and pervious. Cultivation in the cropland swales may have disturbed the impervious layer that continues

to seal the natural wetlands. Natural sand lenses may also provide a seepage path. Some evidence of this varying permeability was observed in July 2003, when Coin Pond, Logsdon Slough and Old Lake were observed bank-full, while Slim Slough had almost no open water. Therefore, this option calls for inundation of only the 53 acres of still-natural wetland within the complex. The structural features that provide the capability to manage the 53 acres, however, are also capable of inundating the remaining 300 acres (by raising water levels).

Additional stoplog structures are included in the plan so that segments of the complex may be isolated and managed separately. In the event that part of the complex could hold higher water levels without leaking, the extra control would allow that to happen.

Under this option, new water sources would be developed. The wetland complex is so extensive that there was significant uncertainty whether a single well could develop sufficient flow to fill and maintain water at desired levels in a timely fashion. A plan for developing two wells near Coin Pond was developed as a means to ensure sufficient water supply. This concept was developed enough to derive a cost estimate and discuss operation and maintenance concerns. One concern was that the two wells would draw down the groundwater, reducing the total capacity. Another option utilized a groundwater well near Coin Pond and a surface water pump on Grey Chute to fill the wetlands. The combination of ground water and surface water sources provides management flexibility. Redundant sources provide greater reliability under varying conditions such as fluctuations in ground water levels, river levels, pump maintenance, and accessibility.

One option for developing a surface water source involved a portable or stationary pump station on the east bank of the Fox River. To create enough depth in the river to supply a pump, a low sill would need to be constructed across the river. This is problematic in that the pool created by the sill would be prone to sedimentation and would require frequent maintenance dredging. Furthermore, there is insufficient flow in the Fox River in the late summer and fall, when pumping would be most advantageous, to sustain the river ecology and nourish the wetlands. This option was eliminated without further analysis.

The option for using water from Grey Chute was immediately appealing because the water source is perennial and overwhelmingly sufficient to meet the needs of the Division wetlands. A major obstacle for developing this water source was getting the water to the other side of the railroad, into the wetlands. The plan for constructing a force main from the pump station, beneath the railroad, to the upper reaches of Slim Slough provided a solution. The pump station would be located in the south panhandle of the East Winkleman Tract, where there is access to Grey Chute and the length of the force main would be minimized.

A self-contained trailer-mounted pump was considered for the Grey Chute pump station. In addition to being less expensive than a stationary pump station, this type of pump is completely removable during the non-pumping season to prevent damage from flooding or vandalism.

A significant disadvantage is that the design head and discharge for this application are at the extreme high end of the trailer-mounted pump's capabilities. A stationary pump is also simpler for applications such as this that require connecting to a force main, because the connection only needs to be made once. By contrast, a trailer-mounted pump must be disconnected and re-connected each time it is moved.

The wetland complex currently drains through a natural channel into the Fox River. The original concept called for a new reinforced concrete stoplog structure to be constructed across this channel to control water level within the complex. Four additional water control structures have been incorporated into the preliminary design, to provide additional water control capability. In order to protect the area from uncontrolled seepage and to maximize wetland area, stoplog structures have been incorporated into the connecting channel design to allow the water levels in each wetland to be operated independently.

The main water control structure for the Coin Pond- Slim Slough-Old Lake complex would be constructed of reinforced concrete. This structure would serve as the primary means for controlling water levels within the wetland. This structure would also act as a bridge to supply vehicular access across the inlet channel. Additional stoplog structures installed in the connecting channels between segments of the wetland would be lighter-weight, corrugated metal structures. These structures would be used to isolate segments of the wetland, to provide greater management flexibility.

One option for inundating the wetland complex involved installation of a flap gate or Tideflex® valve on the Fox River stoplog structure to capture Fox River flood pulses. This alternative was not considered as very beneficial because the flood pulses normally occur in the spring, when the wetlands are typically already inundated. Also, wetland managers often plan to draw down water levels in the spring to encourage consolidation of the sediments and growth of plants for forage. This option was eliminated without further design.

Some work would be required to improve existing channels, to enhance connectivity throughout the complex. Connecting channels would be constructed with zero longitudinal slope so that water movement can occur in either direction. Corrugated metal culverts would be installed at road crossings.

Some roadwork would be required within the complex, to provide all-season access to the pumping stations and water control structures. An existing county road provides access to much of the refuge but extensions would be required to reach the Coin Pond well and Grey Chute pumping station. Additional work would be needed at the reinforced concrete stoplog structure.

The main connection between the wetland complex and the Fox River occurs at the natural channel where the proposed concrete stoplog structure would be constructed. Natural berms along the east bank of the Fox River would provide containment up to the design wetland water levels. But there is a location about 500 feet upstream of the main water control structure where the bank has eroded. This site would be repaired and armored with riprap in order to provide closure to the containment perimeter. The repair is about 50 feet long and the bank must be built up from 3 to 6 feet above its existing grade.

iii. Enhance East Winkleman Tract Wetland. There is a long, narrow, wooded swale running parallel to the Mississippi River, about 200 feet east of the BNSF railroad on the area known as the East Winkleman Tract. The new pumping station on Grey Chute lies at the southern end of this former river channel. The swale extends beyond the 4,000–foot north-south dimension of the Winkleman Tract, about 3,000 feet onto private property. By constructing a berm near the northern boundary of the Division, this swale could be inundated to enhance additional wetland. The Grey Chute pump could be designed to flood this area in addition to the Coin Pond,/Slim Slough/Old Lake

complex, so no additional pump would be required. A drainage swale would be required to direct the runoff from the private land directly to Grey Chute, rather than passing through the Winkleman Tract as it currently does.

The USFWS was concerned that the adjacent landowner would be adversely impacted by construction of this wetland. The additional water on the Winkleman Tract could cause wet conditions on adjacent farmland, which could result in crop damage. There is also concern for the effect that the berm would have during Mississippi River flooding. The berm would alter the deposition pattern of flood-borne sediments, which could result in crop damage, damage to the wetland, or increased maintenance costs. Due to these concerns, this potential feature was not further analyzed.

iv. Dredge Nelson Lake. The largest and southernmost water body, Nelson Lake, has lost its deep-water aquatic habitat due to sedimentation. The murky water and unconsolidated bottom are not conducive to aquatic plants or wildlife. This option would restore aquatic habitat by hydraulically dredging the lake to restore deep water and remove unconsolidated sediment. Measures would be taken to reduce recurring sedimentation, such as constructing a low berm around the lake to prevent inflow from frequent, sediment-rich floods. Preliminary analysis and discussions with USFWS and MDC removed this option from further consideration. There were several concerns:

- The cost of dredging would be higher than the costs of all other improvements combined.
- To prevent further siltation a berm would need to be constructed to reduce the frequency of flooding. These frequent flood pulses are a significant feature of the Division, one of the last remnants of the unleveed Mississippi River floodplain.
- With no connection to either river, the lake's fishery benefit is limited.

C. Potential Features to Restore Native Grasslands. The portion of the Fox Island Division that lies west of the Fox River is adjacent to the 377-acre, MDC-managed, Rose Pond Conservation Area. Rose Pond Conservation Area has been widely planted in native tall grass prairie species of grasses and forbs. Native grassland restoration on the Fox Island Division would expand the Rose Pond prairies and reclaim some of the tall-grass ecology that prevailed prior to the development of modern agricultural practices. These improvements would also provide potential habitat for two state endangered herpetological species, Blandings Turtle and the Illinois Mud Turtle.

Ninety-eight acres of the Logsdon tract are protected by a levee that is owned and maintained by the Mississippi-Fox Drainage and Levee District No. 2. This option is for planting that flood-protected parcel of former cropland in native grasses and forbs.

5. EVALUATION OF FEASIBLE PROJECT FEATURES AND FORMULATION OF ALTERNATIVES

This section describes the features that met the goals and objectives of this project. Each feature was evaluated to determine its potential for environmental restoration and enhancement. Estimated costs were also derived for each of the feasible alternatives.

A. Environmental Output Evaluation. A habitat analysis was performed for the Fox Island Division project, with the goal to rehabilitate and enhance terrestrial and wetland habitat quality and diversity. This analysis employed a multi-agency team approach with representatives from the Corps of Engineers, the USFWS, Illinois DNR, and Missouri Department of Conservation.

Analysis of existing study area conditions, future conditions without the project, and impacts of several proposed features and alternatives was completed using the Wildlife Habitat Appraisal Guide (WHAG) procedures developed by the Missouri DOC and the USDA Natural Resources Conservation Service. The WHAG is a numerical habitat appraisal methodology based on USFWS Habitat Evaluation Procedures (HEP) (1980).

WHAG procedures evaluate the quality and quantity of particular habitats for animal species selected for evaluation by the WHAG team members. The qualitative component of the analysis is known as the Habitat Suitability Index (HSI) and is rated on a 0.1 to 1.0 scale. The quantitative component of the analysis is the measure of acres of habitat that are available for the selected evaluation species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula HSI x Acres = HUs. Changes in the quality and/or quantity of HUs would occur as a habitat matures naturally or is influenced by development. Cumulative HUs are annualized and averaged. To facilitate comparison, target years were established at 0 (baseline or existing conditions), 1, 25, and 50 years. HSIs and average annual habitat units (AAHUs), for each evaluation species, were calculated to reflect expected habitat conditions over the life of the project.

For a more detailed description of the habitat analysis, refer to Appendix D of this report.

B. Feasible Project Features. Plate 5,*Potential Enhancement Features – Evaluated,* shows the locations of all feasible project features described below.

A. Reduce Forest Fragmentation and Enhance Forest Species Diversity. About 620 acres of cropland and approximately 220 acres of open land could be converted to 840 acres of forests. Approximately 275 acres on higher ground could be planted with mast-producing hardwood trees. The remaining open areas would be allowed to reforest naturally.

A0. No Action. This alternative would not require any additional management effort. Present farm leases would be discontinued and open areas would be allowed to revegetate naturally. This feature would result in an increase of forest habitat comprised of floodplain species such as silver maple and cottonwood, which compete favorably on wet soils and periodic flooding.

A1. Plant Hardwood Container-Grown Stock. This feature consists of planting hardwood trees on 215 acres of higher ground on the north end of the Fox Island Division.

These seedlings would be container-grown stock from a local nursery. The container-grown stock system produces vigorous, competitive stock, which stand a greater chance of survival than bare-root seedlings. The container-grown stock would include a mixture of Swamp White Oak, Bur Oak, Pin Oak, Northern Pecan, Shell Bark Hickory, Kentucky Coffeetree, and Persimmon. Areas for planting would be selected to minimize the duration of flood inundation. This feature yields a net benefit of 60 Average Annual Habitat Units (AAHUs).

A2. Plant Hardwood Trees By Precision Direct Seeding. This feature consists of planting 60 acres of hardwood trees by direct seeding of nuts and acorns. The mix would include species such as oak, walnut, sycamore, and green ash. This method utilizes chemical and mechanical weed control until a thick canopy is achieved, typically within three years of planting. The precision planting method requires less seedbed preparation and less seed than broadcast seeding, and the resulting rows make for easier monitoring, management and weed control. This feature yields a net benefit of 12 AAHUs.

A3. Plant Hardwood Trees Using Container-Grown Stock and Direct Seeding. This alternative is a combination of Alternatives A1 and A2.

B. Enhance and Expand Existing Wetlands. About 78 acres of existing wetlands, on both sides of the Fox River, could be enhanced by providing reliable water sources and the means to control water levels. The enhanced wetlands would provide increased benefits for migratory waterfowl and wading birds by enabling the draining and filling of these areas for optimum management of forage plants, nesting habitat, and fall resting grounds.

B0. No Action. This alternative would require no additional management effort. No habitat gain or loss would be realized other than what occurs naturally. The benefit to fall migratory waterfowl and other wetland species would be minimal except during exceptionally wet years.

B1. Enhance Logsdon Slough. This action would enhance water supply and control within Logsdon Slough. A new well would provide the capability of inundating 25 acres through long periods without rain. The 100-foot-deep well with a 20-inch casing would be located on the east (unprotected) side of the Mississippi-Fox Drainage and Levee District levee, near the west Division access road. A 2,000 gallon per minute (GPM) irrigation pump, energized by a portable diesel power unit, would supply the wetland via a new channel. The upper 40 feet of the 200-foot-long channel would be lined with riprap to promote aeration and control erosion. An existing galvanized metal stoplog structure at the south end of the slough would be renovated to control the water levels. The renovation would involve some excavation to renew the channel depth and improve the hydraulic capacity of the structure. The 2-inch dimensional lumber stoplogs also need to be replaced. A system for locking the stoplogs in place and securely storing the ones that are not in use should be included in the renovation to reduce losses due to vandalism. The area could be drained by gravity following spring floods and allowed to vegetate naturally in forage for waterfowl, then flooded in the fall to provide food and shelter for migrating flocks. This feature yields a net benefit of 17 AAHUs.

B2. Enhance Coin Pond - Slim Slough - Old Lake. This action would enhance water supply and control to the channels and wetland areas within the Coin Pond - Slim Slough - Old Lake complex. Proposed new features include a well near Coin Pond, a surface water pump at Grey Chute, stoplog structures, and channel improvements. The new well near Coin Pond would include a 20-inch casing 100 feet deep and a 2,000 GPM pump powered by a portable diesel unit. This setup, comparable in size to irrigation systems in the vicinity, would be capable of filling the 53-acre wetland complex in approximately 30 days.

A new line-shaft surface water pump, powered by a portable diesel unit, would be installed on the bank of Grey Chute, on the East Winkleman Tract. A 24-inch force main would convey the water beneath the BNSF Railroad before discharging into a new channel that connects to Slim Slough and Coin Pond. This 10,000 GPM pump would have a capacity to fill the Coin Pond, Slim Slough, Old Lake wetland complex in approximately 6 days.

A cast-in-place concrete stoplog structure would be constructed on the west side of the complex, where two natural drainage channels come together before discharging into the Fox River. This structure would also serve as a bridge, providing access along the east side of the Fox River between the north and south halves of the Division.

Four galvanized metal stoplog structures would be installed across the distribution channel, separating it into three reaches. These structures would allow independent manipulation of the water levels in Coin Pond, Slim Slough, and Old Lake wetland areas. The level-bottomed channel would provide equal flow capacity in either direction.

This alternative also includes repair and protection of a 50-foot section of the east bank of the Fox River. This eroded stream bank could short-circuit the main water control structure if not repaired. This feature, enhancing wetlands in Coin Pond, Slim Slough, and Old Lake yields a net benefit of 34 AAHUs.

B3. Enhance Logsdon Slough and Coin Pond/Slim Slough/Old Lake. This alternative is a combination of Alternatives B1 and B2.

C. Restore Native Grassland

C0. No Action. This alternative would not require any additional management effort. No habitat gain or loss would be realized other than what occurs naturally. The abandoned cropland would experience natural revegetation by forbs and woody plants with no control over selection. Habitat enhancement would be less than optimal.

C1. Plant Grasses and Forbs. Under this option, approximately 98 acres of the Logsdon Tract located inside the protection of the levee of the Mississippi-Fox Drainage and Levee District No. 2 would be restored to native grassland. This restoration, adjacent to existing grassland within the Rose Pond Conservation Area, would result in a contiguous grassland area of up to 400 acres when the Rose Pond Prairie restoration has been completed. Native grass and forbs species would be selected based on their historical range, affinity for open, sandy meadows, and ability to withstand some flooding.

Candidate species include grasses such as:

Big and Little Bluestem	Indian Grass
Switchgrass	Prairie Cord-grass

and forbs such as:

Black-Eyed Susan	Butterfly Milkweed	Compass Plant
Evening Primrose	Lanceleaf Coreopsis	Large-Flowered Beardtongue
Leadplant	Pale Purple Coneflower	Rattlebox
Showy Goldenrod	Stiff Goldenrod	Upland White Aster
White Prairie Clover	White Wild Indigo	Yellow Coneflower

Some areas near Logsdon Slough would be cleared of recent growth cottonwoods and willows. This feature yields a net benefit of 55 AAHUs.

C. Cost Estimates for Habitat Improvement Measures. Table 5-1 summarizes the outputs and costs associated with each management measure. A breakdown of costs is outlined in Section 8, *Cost Estimates.*

Table 5-1. Environmental Output and Costs of Each Feature

Feature	Symbol	Output [1]	Cost [2]	Annualized Cost [3]
Reduce Forest Fragmentation and Enhance Forest Species Diversity (Reforestation)				
Plant Hardwood Container-Grown Stock	A1	60	762	42.4
Plant Hardwood Trees By Precision Direct Seeding	A2	12	74.4	4.1
Enhance and Expand Existing Wetlands (Wetland Enhancement)				
No Action	B0	0	0	0
Enhance Logsdon Slough	B1	17	158.8	8.8
Enhance Coin Pond/Slim Slough/Old Lake	B2	34	1,053	58.6
Restore Native Grassland				
No Action	C0	0	0	0
Plant grasses and forbs	C1	55	192.8	10.7

[1] Outputs are calculated as Average Annual Habitat Units (AAHUs).
[2] All costs in $1,000s.
[3] Annualized cost is initial construction cost based on a 50-year project life, 5.1% interest rate.

D. Incremental Cost Analysis of Alternatives. Cost effectiveness analysis has been used to assist the decision-making process to determine which project features should be built. The decision is based upon the habitat benefits (outputs) that meet the goals and objectives of the project in the most cost effective way. The cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. After the cost effectiveness of each alternative has been established, subsequent incremental cost is conducted to reveal changes in costs for increasing levels of environmental output. In the absence of a common measurement unit for

comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analysis are valuable tools to assist in decision making. Appendix E presents the results of the cost effectiveness analysis and incremental cost analysis.

i. Method. The project was evaluated using guidance and software prepared by the Corps of Engineers' Institute for Water Resources (IWR). Institute for Water Resources - Plan Decision Support Software (Version 3.33) was used in this analysis.

The cost effectiveness and incremental cost analysis procedures are presented in nine steps, which can be grouped into four tasks:

Formulation of combinations:
- Step 1 – Display outputs and costs.
- Step 2 – Identify combinable management measures.
- Step 3 – Calculate outputs and costs of combinations.

Cost effectiveness analysis:
- Step 4 – Eliminate economically inefficient solutions.
- Step 5 – Eliminate economically ineffective solutions.

Development of incremental cost curve:
- Step 6 – Calculate average costs.
- Step 7 – Recalculate average costs for additional outputs.

Incremental cost analysis:
- Step 8 – Calculate incremental costs.
- Step 9 – Compare successive outputs and incremental costs.

The results of these analyses are displayed as graphs and tables (tables 5-2 through 5-8 and figure 5-1). They permit the decision makers to progressively compare alternative levels of environmental outputs and ask if the additional environmental output in the next level is worth its additional monetary costs.

It is important to note that these analyses would not usually lead, and are not intended to lead, to a single best solution as in economic cost-benefit analysis. They would improve the quality of decision making by ensuring that a rational, supportable, focused and traceable approach is used for considering and selecting alternative methods to produce environmental outputs.

ii. Formulation of Combinations

Step 1: Display Outputs and Costs. Table 5-2 displays the outputs and costs of potential management measures. Outputs were determined using WHAG and are presented as net Average Annual Habitat Units. Costs were annualized based upon a 50-year project life and 5.1 percent interest rate.

Step 2: Identify Combinable Management Measures. The two methods of forest regeneration, A1 and A2, are combinable for the 275 acres of higher ground that can be planted with mast-producing hardwood trees. The combination of these methods is limited by the divisibility of the 275 acres into areas of sufficient size to make each of the methods practicable. For planning purposes,

60 acres is considered sufficient size to use one of the forest regeneration methods and to assess the success of that method. Natural Regeneration was the preferred method for the wet floodplain forest on the Logsdon Tract; outside the WRP easement, on the west side of the Fox River, which is the "no action" alternative. A total of four combinations were found:

- No Action – A0,
- Plant Container-Grown Stock – A1,
- Precision Direct Seeding – A2, and
- Combination of Container-Grown Stock and Precision Direct Seeding – A3.

The two wetland enhancement features, Logsdon Slough and Coin Pond /Slim Slough/ Old Lake are combinable, as both have benefits of wetland AAHUs. Coin Pond, Slim Slough and Old Lake would benefit from the same structural features and therefore are not separable. A total of four combinations were formed

- No Action - B0,
- Enhance Logsdon Slough - B1,
- Enhance Coin Pond, Slim Slough, and Old Lake - B2, and
- Enhance Both Sets of Wetlands - B3.

Native grassland restoration has no combinable methods. The two alternatives for prairie restoration are (No Action - C0 and Plant Grasses and Forbs - C1). The incremental cost analysis was not performed on the grassland restoration because there was only one alternative, other than No Action.

Incremental Cost Analysis is typically used to compare the habitat enhancement features with the same output (Average Annual Habitat Units). For this project the wetland enhancement features have an output of wetland AAHUs, primarily mallard and Canada goose habitat. The reforestation features have an output of forest AAHUs, consisting of white-tailed deer, wild turkey, pileated woodpecker, fox squirrel, wood thrush, and Kentucky warbler habitat.

The alternatives for wetland enhancement, reforestation and prairie enhancement could be evaluated together if the different types of outputs were weighted. On this project, each of the alternatives was evaluated separately because they each provide unique conditions that are not duplicated by other alternatives. A combined evaluation would not provide information that would assist decision-making.

Table 5-2. Annualized Cost of Environmental Enhancement Features Based Upon 50 Year Life and 5.1% Interest

Feature Alternative	Area (Acres)	Symbol	Output (AAHUs)	Cost ($1,000)	Annualized Cost ($1,000)	Average Cost ($1,000 per AAHU)
Reforestation						
No Action		A0	0	0	0	0
Plant hardwood container-grown stock	215	A1	60	762	42.4	0.7067
Plant hardwood trees by precision direct seeding	60	A2	12	74.4	4.1	0.3417
Wetland Enhancement						
No Action		B0	0	0	0	0
Enhance Logsdon Slough	25	B1	17	158.8	8.8	0.5176
Enhance Coin Pond/Slim Slough/Old Lake	53	B2	34	1,053	58.6	1.7235
Restore Native Grassland						
No Action		C0	0	0	0	0
Plant Grasses and Forbs	98	C1	55	192.8	10.7	0.1945

Step 3: Calculate Output and Costs of Combinations. Table 5-3 displays the outputs and costs of the forest regeneration alternatives. The combinations are listed in ascending order of their total AAHU outputs. For features with only one possible alternative other than No Action, incremental cost analysis is not necessary, such as with the native grassland. Table 5-4 displays the respective outputs and costs of wetland enhancement features, which are combinations of Logsdon Slough and Coin Pond/Slim Slough/Old Lake.

Table 5-3. Reforestation Alternatives: Outputs and Costs of Combinations Ranked in Order of Output

Alternative Combination	Symbol	Output (AAHUs)	Annualized Cost $1,000)	Average Cost ($1,000/AAHU)
No Action	A0	0	0	0
Plant hardwood trees by precision direct seeding	A2	12	4.1	0.3417
Plant hardwood container-grown stock	A1	60	42.4	0.7067
Plant hardwood trees using container-grown stock and direct seeding	A3	72	46.5	0.6500

Table 5-4. Wetland Enhancement Alternatives: Outputs and Costs of Logsdon Slough Combinations with Coin Pond/Slim Slough/Old Lake Ranked in Order of Output

Alternative Combination	Symbol	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)
No Action	B0	0	0	0
Enhance Logsdon Slough	B1	17	8.8	0.5176
Enhance Coin Pond/Slim Slough/Old Lake	B2	34	58.6	1.7235
Enhance Logsdon Slough and Coin Pond/ Slim Slough/Old Lake	B3	51	67.4	1.3218

Steps 4 and 5: Eliminate Economically Inefficient Solutions and Economically Ineffective Solutions. Step 4 eliminates economically inefficient solutions and identifies the least cost solution for each level of output. For example, if two plans produce two AAHUs and one costs $3,000 while the other $4,000, the more expensive plan is eliminated.

Step 5 eliminates the economically ineffective solutions by identifying and deleting those solutions that would produce less output at equal or greater cost than subsequently ranked solutions. For example, if one plan produces 2 AAHUs for $8,000 and the next plan produces 4 AAHUs for $6,000, the first plan would be eliminated because it is not economically effective.

Table 5-5 displays the least cost alternatives for forest regeneration. The alternative of using only the container-grown trees was eliminated in this process for its high cost per AAHU. The analysis did not evaluate the survivability of the two planting methods. Trees started from seeds are more susceptible to flooding than root stock during the first few years. Therefore, USFWS prefers a combination of planting methods to enhance the chances for hardwood reforestation while taking advantage of the lower cost and efficiency of direct seeding.

Table 5-6 displays the least cost wetland enhancement combinations. The cost of enhancing Logsdon Slough is much less than the cost of enhancing the wetland complex on the east side of the Fox River (Coin Pond/Slim Slough/Old Lake) because Logsdon Slough would not require as many structural improvements. But the wetland area is limited and much smaller than on the east side. Therefore combination B2—enhancing Coin Pond/Slim Slough and Old Lake—is not cost effective (the low-cost enhancement should be constructed before the high cost); however, the combination of both wetlands, B3, is cost effective because it develops a much larger area of preferred habitat.

Table 5-5. Reforestation Alternatives Cost Effective and Least Cost Combinations

Alternative	Symbol	Output (AAHUs)	Annualized Cost (1,000)	Average Cost ($1,000/AAHU)
No Action	A0	0	0	0
Plant hardwood trees by precision direct seeding	A2	12	4.1	0.3417
Plant hardwood trees using container-grown stock and precision direct seeding	A3	72	46.5	0.6500

Table 5-6. Wetland Enhancement Alternatives Cost Effective and Least Cost Combinations

Alternative Combination	Symbol	Output (AAHUs)	Annualized Cost $1,000)	Average Cost ($1,000/AAHU)
No Action	B0	0	0	0
Enhance Logsdon Slough	B1	17	8.8	0.5176
Enhance Logsdon Slough and Coin Pond/Slim Slough/Old Lake	B3	51	67.4	1.3218

iii. Development of Incremental Cost Curve

Step 6: Calculate Average Costs. Average costs for each least-cost, cost-effective plan are determined by dividing the cost of the plan by the output (AAHUs). Average costs are expressed in cost per AAHU ($/AAHU). The plan with the lowest average cost is identified. Plans with less output at a higher average cost are eliminated.

Step 7: Recalculate Average Costs for Additional Outputs. This step asks the question "of the remaining levels of output, which has the lowest additional cost for additional output?"

Using levels of output from Step 6, the average annual costs for additional output are calculated. The previous step's lowest average cost level of output was used as the "zero level." Levels of output less than the lowest average cost level are dropped from further analysis, while level of output greater than the lowest average cost level advance to the next recalculation. Recalculations are then made using the new lowest average cost level as the "zero level." Recalculations are made until the highest level of output is reached. The analysis of incremental costs for additional outputs was not applied to reforestation because the extent of coverage for each of the four combinations was based on survivability, not economics. The more expensive Container-Grown Stock has higher cost per AAHU, but, due to its vigorous growth pattern, has a greater chance of surviving. Common rootstock and direct seeded trees are more

susceptible to flooding and competition from weeds and brush during the first few years. Direct-seeded trees would be planted over sixty acres of higher ground that is less susceptible to flooding. Utilizing two planting methods for this project would provide comparative maintenance and survivability data that should be helpful to foresters in the future for selecting planting methods. Accurate incremental analysis would require knowledge of the risk, timing, and duration of flooding with respect to the time that the trees are most vulnerable.

In this case of wetland enhancement, there is no breaking point where incremental additions cause a change in average cost per AAHU. Once you have created the structure to contain the water and have developed a source to supply the water, the entire wetland area would be enhanced, due to the connectivity that exists there. Separating areas, to reduce inundation would require additional earthwork and cost more money. The ability to increase the area of inundation is limited by the extent of pervious soil outside the naturally-occurring wetlands. Therefore the best buy combination is the same combination as shown in Table 5-6.

iv. Incremental Cost Analysis

Step 8: Calculate Incremental Costs. The plans in Table 5-7 are the "best buys," producing the most AAHUs per dollar. The incremental costs shown in Table 5-7 are calculated by dividing the differences between each plans output and annualized cost.

Table 5-7. Wetland Enhancement Features Incremental Costs (Best Buy Plans)

Alternative Combination	Symbol	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)	Incremental Cost per Output
No Action	B0	0	0	0	0
Enhance Logsdon Slough	B1	17	8.8	0.5176	0.5176
Enhance Logsdon Slough and Coin Pond/ Slim Slough/Old Lake	B3	51	67.4	1.3218	1.7235

As noted in Step 7, incremental cost analysis was not calculated for reforestation (A0 through A3) because the areas allocated to each application (i.e. natural regeneration, planting container-grown stock, and direct seeding) were determined by non-economic factors. Natural regeneration is the least expensive but does not increase diversity. Direct seeding is less expensive than planting rootstock but is more vulnerable to flooding. The preferred mixture could not be assessed by incremental analyses without putting a dollar value on diversity and flood tolerance.

Incremental cost analysis was not applied to Restore Native Grassland (C0 and C1) because no alternative means of acquiring the same habitat benefits were put forward. Either the prairie would be planted in native grasses and forbs or it would not. The species mixture and relative costs and benefits of each were not developed for this preliminary design. Such an analysis would involve too much detail and provide too little benefit to a study such as this; instead it should be left to final design.

Figure 5-1 is a graph of the costs of wetland combinations as listed in Table 5-7; as the graph shows, there are two "best buy" combinations, B1 and B3.

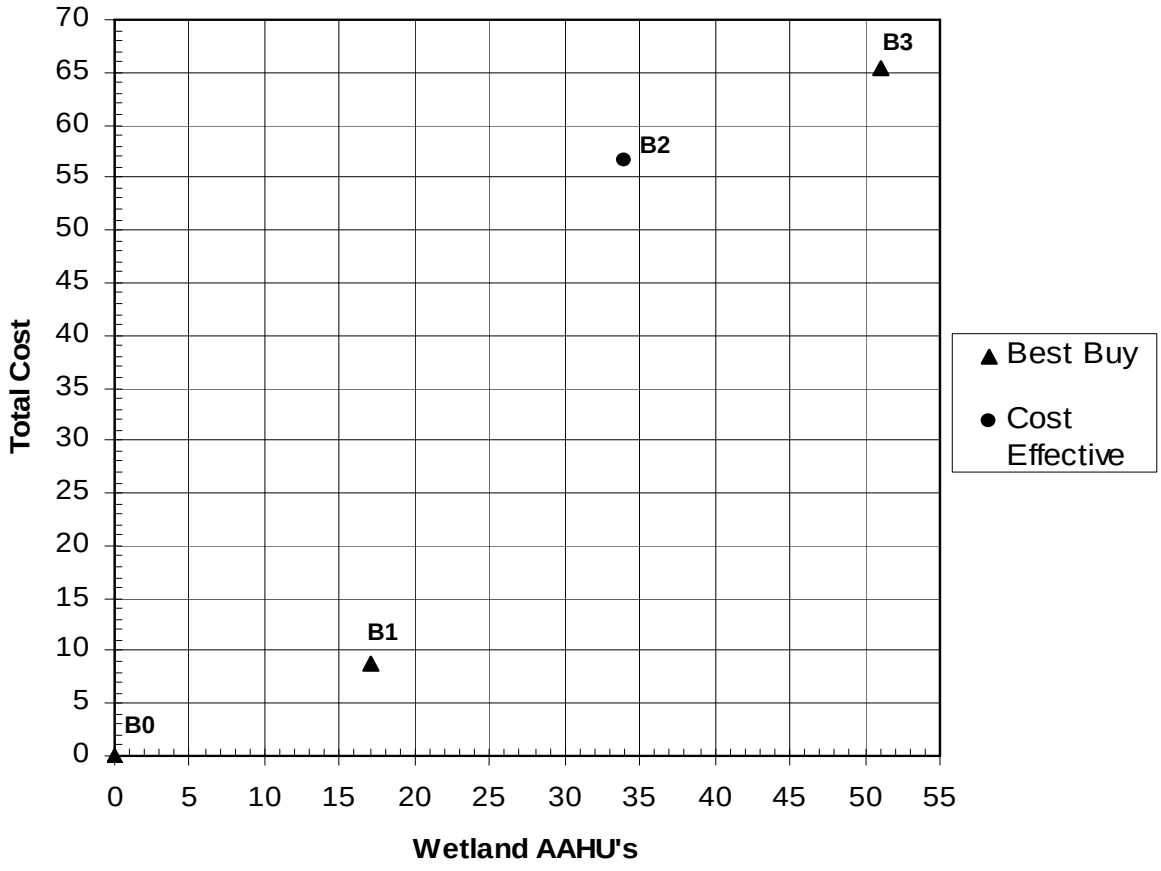


Figure 5-1. Cost Effective and Best Buy Plans Wetland Enhancement Alternatives

Step 9: Compare Successive Outputs and Incremental Costs. Table 5-7 and figure 5-1 were used as decision making tools by progressively proceeding through available levels of output and asking if the next level was worth its additional monetary cost. This step examined the additional habitat value, as measured by increased AAHU output, for an increase in monetary costs.

Federal planning for water resources development is conducted in accordance with the requirements of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G). The P&G provides a decision rule for selecting a recommended plan where both outputs and costs are measured in dollars. This rule states, "The alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (National Economic Development Plan, NED Plan) is to be selected… (Paragraph 1.10.2)". There is no similar rule for plan selection where the outputs are not measured in dollars, as is the case in planning for restoration and mitigation. In the absence of such a decision-making rule, cost-effectiveness and incremental-cost analyses helped to better understand the consequences of the preferred plan in relation to other choices.

Other factors considered in the selection were site topography, management objectives of the resource agencies, critical needs of the region, and ecosystem needs of the Upper Mississippi River System.

v. Recommended Plan. For reforestation, the combination planting container-grown rootstock and direct seeding (Alternative A3) was selected for its versatility. This alternative has higher costs than total precision direct seeding, but provides a better chance for survival over the full range of conditions that may be encountered during the critical first three years after planting. Furthermore, the combination of planting container-grown rootstock and precision direct seeding would provide useful data for comparing the two methods. This evaluation would help determine the optimum methods for future HREP projects.

For wetland enhancement (Alternative B3) improving water supply and control on both sides of the Fox River, including Logsdon Slough, Coin Pond, Slim Slough, and Old Lake, is preferred because of its capability to expand the area of wetland habitat and to extend the inundation period to the fall migration. This plan is a best buy although the additional AAHUs provided by the Coin Pond/Slim Slough/Old Lake area have higher average cost per AAHU than Logsdon Slough. The Logsdon Slough wetland alone is too small to achieve the wetland benefits desired for this refuge.

To restore native grassland (Alternative C1) planting Logsdon Tract with grasses and forbs is preferred over the No Action Alternative (C0). Restoring native grasslands improves plant diversity and increases the extent of this vastly diminished habitat.

E. Summary. The results of the incremental analyses in this section were considered with other factors, including physical features on the site, management objectives of the resource agencies, critical needs of the region, and ecosystem needs of the Upper Mississippi River System.

In cooperation with USFWS, MDC, and Illinois DNR, the Corps has planned and designed a cost-effective project that serves the needs of the refuge managers. The preferred alternative has an overall output of 178 AAHUs. These figures are summarized in Table 5-8.

Table 5-8. Recommended Plan: Environmental Output and Cost of Each Feature

Feature Alternative	Symbol	Output (AAHUs)	Cost ($1000s)	Annualized Cost ($1000s)
Plant hardwood trees using container-grown stock and precision direct seeding	A3	72	836.4	46.5
Enhance Logsdon Slough, Coin Pond, Slim Slough and Old Lake	B3	51	1,211.9	67.4
Restore native grassland	C1	55	192.8	10.7
TOTAL		**178**	**2,241.1**	**124.7**

6. RECOMMENDED PLAN: DESCRIPTION WITH DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE CONSIDERATIONS

The recommended plan for habitat rehabilitation and enhancement on the Fox Island Division includes reforestation through planting hardwood container-grown stock and precision direct seeding (Alternative A3). The forests would replace the open farm fields that are currently or were recently in production. The recommended plan also includes enhancing wetlands in Logsdon Slough, Coin Pond, Slim Slough, and Old Lake (Alternative B3). And the recommended plan includes restoring native grassland on Logsdon Tract by replanting an abandoned farm field in native grasses and forbs (Alternative C1). The details of this plan are described below and mapped on Plate 2.

A. Reduce Forest Fragmentation and Enhance Forest Species Diversity: Direct Seeding and Container-Grown Planting (A3). This feature consists of reforestation by the cultivation of high-forage-value, mast-producing trees. There are currently about 840 acres of open land on the refuge, clear of forests because of current or recent cultivation. Mast-producing trees would be planted over approximately 275 acres of higher ground on the north end of the Division, where exposure to flooding is infrequent and of short duration. The planted trees would serve as a seed source for natural re-vegetation, improve terrestrial habitat for resident and migratory birds, and expand habitats for mast consuming species such as turkeys and squirrels. Proposed species include Swamp White Oak, Pin Oak, Bur Oak, Northern Pecan, Sycamore, Green Ash, Kentucky Coffeetree, Walnut, Shellbark Hickory, and Persimmon. All tree plantings would be on areas above elevation 488.0, where there is less than a 31 percent chance of flooding lasting more than four weeks in any year (Appendix J, table J-2).

Approximately 60 of the 275 mast-producing acres would be direct seeded with equal numbers of the target mast tree species. Nuts and acorns would be drilled 4 to 6 inches on center, in rows 9 to 10 feet apart, yielding 10 thousand seedlings per acre. To provide ground cover and limit competition from other species, the site would be tilled and seeded with grasses prior to tree-planting and a nursery crop of oats or wheat would be sewn. Competition would be further controlled by herbicides and mowing for approximately three years, until the trees develop a canopy. Some thinning would be required, once the trees have become established, to achieve the desired density.

The remaining 215 acres would be planted with container-grown nursery stock. Container grown stock are specially raised by the nurseries using methods to induce vigorous growth and increase root mass. The trees exhibit vigorous growth upon transplantation, capable of withstanding some flooding and competition from other vegetation. The saplings are grown in 3- to 5-gallon containers, stand about 5 feet and have at least 5/8-inch caliper. They should be grown from acorns or seeds obtained from bottomland sources within 100 miles of the project site. The trees would be planted on a 30-foot by 30-foot spacing, staggered in adjacent rows and intermixed to avoid blocks of the same species. This spacing yields 50 trees per acre. Trees would be planted in the spring between March 1 and May 15, or in the fall between October 1 and December 10.

Table 6-1 shows planting rates for container-grown rootstock by species per acre.

Table 6-1. Container-Grown Stock Mast Tree Planting Rates

Common Name	Scientific Name	Planting Rates Per Acre	Number of Mast Trees
Swamp White Oak	*Quercus bicolor*	8	1,720
Bur Oak	*Quercus macrocarpa*	8	1,720
Pin Oak	*Quercus palustris*	8	1,720
Northern Pecan	*Carya illinoensis*	8	1,720
Shellbark Hickory	*Carya laciniosa*	6	1,290
Kentucky Coffeetree	*Gymnocladus dioicus*	6	1,290
Persimmon	*Diospyros virginiana*	6	1,290
Total		**50**	**10,750**

The container-grown tree area would be prepared similarly to the direct seeded area. Prior to planting, the site would be tilled and seeded with red top grass or Kentucky bluegrass and a nursery crop of oats or wheat. The trees would be planted in the middle of a 4-foot by 4-foot weed barrier mat to reduce competition. A pre-emergent herbicide would be applied in a 12-foot diameter circle around each tree immediately after planting. Follow-up spraying would be performed during the following growing season. The contractor would be required to replace trees that do not survive at least one year, unless the loss is due to flooding.

B. Enhance and Expand Existing Wetlands (B3)

Enhance Logsdon Slough. The water supply to Logsdon Slough would be enhanced by construction of a new 18-inch diameter well. The 100-foot-deep well would be located adjacent to but not in the slough and would be accessible by truck or car via an existing farm road. The well would have a permanently mounted pump equipped with a right angle gear drive and a coupling for connection to a portable diesel engine. The pump is estimated to require approximately 30 horsepower but the final configuration, based upon ultimate yield and groundwater levels, would be determined during final design and implementation. The 30-horsepower portable diesel unit and a fuel wagon capable of at least 7 days continuous operation between fills would be provided. The diesel power unit and fuel wagon would be stored off site, protected from flooding, during the non-pumping season. The pump would be capable of producing a peak discharge of 2,000 gpm. The pumped water would be conveyed to the slough through a 200-foot long channel. The upper 40 feet of the channel would be lined with riprap to increase aeration and prevent scour.

The well would be used to fill Logsdon Slough to a planned water surface elevation of 484.5, whereby approximately 25 acres would be inundated. An existing stoplog structure at the downstream end of the slough would be used to adjust water levels and control the discharge to the Fox River. The stoplogs could be completely removed to drain the slough. The existing stoplog structure is in need of minor repair. This structure was constructed as part of the WRP restoration. The base of the structure and the channel on both sides of the structure has silted in and needs to be excavated to restore its hydraulic capacity. A system should be installed for locking the stoplogs in place when they are in use, and securely storing them when they are not.

An existing agricultural well located on the Logsdon Tract west of the Mississippi-Fox Drainage and Levee District levee would be abandoned and capped.

Enhance Coin Pond – Slim Slough – Old Lake Complex. Enhancing this wetland, on the east side of the Fox River, would provide the capability of controlling water levels within the banks of the three water bodies - Coin Pond, Slim Slough, and Old Lake. Fifty-three acres are inundated within these water bodies when they are filled to the top-of-bank elevation of 484. An additional 130 acres of interconnected lowlands, natural channels and field swales also become inundated when these water bodies are filled to this level. There is evidence, such as crop discoloration and crop loss from long-standing water, hydrophytic plants such as smartweed in uncultivated areas, and direct observation of standing water up to 10 days after storm events, that indicate water could be held within this complex as high as elevation 485. At this elevation an additional 170 acres, 353 acres altogether, would be inundated.

The recommended plan for this area provides the capability to contain water to elevation 485 and higher. The entire 353 acres lying below elevation 485 is not expected to be inundated because of the sandy composition of high ground. The natural depressions on the Division are lined with cohesive, low permeability silts and clays but the subsurface soils are predominantly porous sands. Pockets of porous soil, areas of low embankments, and natural drainage swales could result in water losses from areas that are not currently wetland that are beyond the capability of the pumps to replace. The combination of pumping rates and water control features would provide the flexibility to raise water levels in those areas that can retain it, while avoiding areas of high seepage losses. Plate 12 illustrates the location of water control features for this complex.

The management plan calls for draining much of the wetland area after flood waters recede to encourage growth of forage plants. The water levels would be raised in the late summer and fall to enhance resting habitat for migrating waterfowl. The stoplog water control structures and conveyance channels would provide the capability to drain the complex by gravity.

Re-supplying the wetlands would require pumping during dry periods. For practical operation the pumping rates should be sufficient to fill these areas within about 15 days of constant, 24-hours per day, pumping. To achieve this time frame for filling the complex to elevation 484, the pumps must deliver an average discharge of 4,000 gpm. If the higher elevation of 485 is achievable, the pumping rate, not including seepage losses, should be 8,000 gpm for 15 days. Two pumps are recommended for achieving these goals, one using groundwater as the source, the other using the Mississippi River.

The combination of groundwater and surface water supply increases the management flexibility and reliability. It also enhances the capacity of the wetland to improve water quality. The capability of wetlands for removing nutrients, pesticides, and other pollutants from both groundwater and surface water sources would be an integral part of the project at no additional cost. The water sources include:

- A new well and pump, with similar characteristics to the aforementioned Logsdon Tract well, (18-inch casing, 100 feet deep, 30 HP diesel motor, capable of producing 2,000 gpm), installed to pump water through a new channel, into Coin Pond. The channel would be approximately 200 feet long and the upper 40 feet would be lined with riprap to dissipate the energy from the pump discharge, prevent erosion, and increase aeration.

- A surface water pump station, constructed on Grey Chute to supply water to the Coin Pond/Slim Slough/Old Lake complex through a force main installed beneath the railroad (plate 6). This pump station would consist of a belt-driven, angled line shaft pump with a

jackshaft connection for a portable diesel engine. The pump would discharge through a 24" force main jacked beneath the railroad into a channel that would outlet into the north end of Slim Slough. The end of the discharge would be equipped with a flap gate to prevent back flow through the pump. The pump would have a capacity of approximately 10,000 gpm. A 100-horsepower portable diesel unit and a fuel wagon capable of at least 7 days continuous operation between fills would be provided. The diesel power units and fuel wagons would be stored off site during the non-pumping season to protect them from flooding. The pump station would be located at the top of the west bank of Grey Chute at the southern end of the East Winkelman Tract. A sheet pile wall would be constructed to increase bank stability. The ends of the wall would be armored with riprap to prevent bank cutting.

Stoplog water control structures would be used to manage water levels within the wetlands. The main structure would be located where the two natural drainage channels from the northeast (Coin Pond and Slim Slough) and southeast (Old Lake) merge before reaching the Fox River. This structure, depicted in Plates 7, 8, and 9, would be cast-in-place concrete, with a bridge deck to provide vehicular access between the north and south halves of the Division along the east bank of the Fox River. This structure would be stronger and more durable than the other stoplog structures on this project because it is designed to be adjusted more often and to carry vehicular traffic. This stoplog structure would be accessible by vehicle and would provide the capability to adjust water levels throughout the wetland complex, drain the system, or capture flood pulses from the Fox River. The deck of the structure would be constructed of heavy duty steel grating, capable of supporting HS-20 wheel loads.

The3 ½ "H x 6"W x 60"L stoplogs would be fabricated from aluminum tube stock and designed to fit in slots created from steel channels cast into the reinforced concrete structures. The stoplogs would be designed with rubber seals and be easily removable even when submerged. The reinforced concrete channel through the structure would facilitate the removal of sediment that may be deposited during periods of high water.

Additional galvanized metal stoplog structures would be located on the connecting channels to allow independent control of water within separate segments of the wetland. These structures (depicted on Plate 10), are fabricated from sections of corrugated metal pipe and fitted with steel channels to receive 2-inch dimensional lumber. The stoplogs are each approximately 60 inches long:

- An existing water control structure, located at the south end of Coin Pond, would be replaced with a new galvanized metal stoplog structure. This structure, located on a spur off the main distribution channel, would provide the capability of isolating Coin Pond and the new well from the rest of the complex. The existing spur channel would be cleaned and leveled to provide two-way flow capability.
- Two galvanized metal stoplog structures would be constructed on Slim Slough, one at each end. The structures would provide the capability for isolating Slim Slough and allow it to be filled or drained from either end.
- A fourth galvanized metal stoplog structure would be constructed on the channel at the north end of Old Lake This structure, in combination with the structure at the south end of Slim Slough, would provide the capability for isolating Old Lake and allow it to be filled or drained from either end.

The connecting channels within the wetland complex would be designed to flow both ways:

- To drain the complex into the Fox River, or
- To fill the wetlands by pumping or from the Fox River when it is in high stage. High stage in the Fox River could be the result of storms within the Fox River basin or backwater from the Mississippi River.

Channel improvements include clearing, excavating and regrading existing channels; few new channels would be required. A length of new channel would be required at the point of discharge from each of the new pump locations. These channels would be lined with riprap in their upper reaches to dissipate energy and increase aeration:

- The well pump north of Coin Pond would require a short channel to an existing swale that flows to Coin Pond. This channel would allow placement of the well outside the pond and wale for improved accessibility.
- Discharge from the Grey Chute pump force main would flow through a newly constructed channel from the railroad right-of-way to the upper end of Slim Slough.

The channel between Coin Pond and Slim Slough would be cleared and graded to improve conveyance. An existing stoplog structure would be removed from this reach, to be replaced by the stoplog structure at the upper end of Slim Slough described above. The channel between the south end of Slim Slough and Old Lake would be cleared and re-graded to improve conveyance. The channel connecting the north end of Old Lake to the main water control structure would also be cleared and graded. Vegetation that is cleared and grubbed during channel improvements would be piled on site. Excavated material would be used as required to construct berms and backfill structures. Excess material would be spread over adjacent fields and tilled to match existing terrain.

When completed, all channels would be approximately 5-feet deep with 8-foot wide bottoms and 3H:1V side slopes. They would be graded level at constant bed elevation of 480, and provide a complete loop connecting Coin Pond, Slim Slough, Old Lake, and the Fox River. The two pumping locations would be indirectly connected to this distribution channel. The looped channel would provide the means to distribute water throughout the wetlands and to selectively isolate and drain individual segments.

Culverts would be required at two locations to provide vehicular access across drainage channels. Both culverts would be 36” diameter corrugated metal pipe (CMP), 50 ft long. They would be laid level, at invert elevation 480.0, to match the channel thalweg:

- One culvert would be integral with the galvanized metal stoplog structure on the south end of Coin Pond. The road at this culvert provides access between the areas on the east and west sides of Coin Pond and Slim Slough.
- A second culvert would be integral with the galvanized metal stoplog structure at the south end of Slim Slough. The road at this culvert provides access from the south to the center of the wetland complex.

The channels would be protected from erosion with riprap in the high velocity areas such as the pump discharge sites. Twelve-inch D_{50} riprap would be applied in a 24-inch thick layer over a 6-inch layer of bedding stone. The bedding stone is a uniform-graded 1½ - inch crushed rock that acts as a filter to prevent fine soil from eroding between the riprap.

A 50-foot eroded section of the east bank of the Fox River, located about 500 feet north of the primary water control structure, would also be repaired and protected with riprap. This low bank line would reduce the capability for controlling inflow and outflow to the Coin Pond, Slim Slough, Old Lake wetlands if not repaired.

There is an existing county road that provides access to the part of the Division lying east of the Fox River. This road comes out of Alexandria on the north, then follows the east bank of the Fox River to a point about midway between Alexandria and the mouth of the Fox River, where there once was a bridge crossing the river. The bridge has long been removed and maintenance of the roadway within the Division has ceased. In many locations the road is no longer discernible or passable. Clark County has tentatively agreed to vacate this right-of-way. The roads would not be improved to increase public visitation. Proposed road repairs under this project would involve some re-grading to fill holes and improve drainage. A new 250-foot-long road would be constructed to access the pump on Grey Chute. The new well pump near Coin Pond would require 1,000 feet of new road. Figure 6-1 shows project access roads and rights-of-way.

The 12-foot wide roads would be constructed by cutting a drainage ditch on each side of the roadway, and using the excavated material to raise and level the road sub-grade. Then a 6-inch thick base course of crushed-stone would be applied, leveled and compacted. Finally, a 3-inch thick surface layer of smaller gradation crushed stone would be applied and compacted over the base course.

Most of the roads on the Division are un-surfaced dirt farm roads. These roads would not be improved at this time; so traffic should be limited during wet conditions to avoid creating large impasses. Two existing railroad crossings would be maintained, but not improved. These crossings provide access from a dirt farm road on the east side of the BNSF Railroad tracks to dirt roads in the Division between the Fox River and the railroad.

Description of the Excavated Material. The channel improvements proposed for Logsdon Slough, Coin Pond, Slim Slough, and the Old Lake Complex will result in approximately 16,000 cubic yards of excess excavated material. This excess material will be spread over open ground in areas where mast trees are to be planted. The material will be spread level, in lifts up to 6-inches thick, and then incorporated with the layer below by disking. No material will be placed in open water.

C. Restore Native Grassland (C1). Approximately 98 acres of the Logsdon Tract, lying west of the Fox River levee system, would be planted in native grasses and forbs. This tract is the only flood-protected area within the Fox Island Division. The levee is owned and maintained by the Mississippi-Fox Drainage and Levee District No. 2. The grassland would be created by seeding land that was formerly planted in row crops and small grains.

The proposed grassland is adjacent to a native prairie that was recently planted within the Rose Pond Conservation Area, managed by the Missouri Department of Conservation. The Logsdon Tract restoration, in combination with additional plantings planned by the Missouri Department of Conservation would result in a contiguous grassland area of up to 400 acres. Although miniscule in proportion to the native prairies that existed before the mid 19th century, this would become one of the largest native grasslands in this part of the state. It would provide habitat for nesting and migrating prairie wildlife.

Establishing the prairie would require tilling and seeding the area with native grasses and forbs. Some clearing would be required near the slough, where recent growth cottonwoods and willows have become established on former agricultural land. Weed control would be required until the preferred vegetation becomes well established. This can be accomplished through a combination of herbicides, mowing and seasonal burning.

Native grass and forbs species would be selected based on their historical range, their affinity for open, sandy meadows, and their ability to withstand some flooding.
Candidate species include grasses such as:

Big and Little Bluestem	Indian Grass
Switchgrass	Prairie Cord-grass

and forbs such as:

Black-Eyed Susan	Butterfly Milkweed	Compass Plant
Evening Primrose	Lanceleaf Coreopsis	Large-Flowered Beardtongue
Leadplant	Pale Purple Coneflower	Rattlebox
Showy Goldenrod	Stiff Goldenrod	Upland White Aster
White Prairie Clover	White Wild Indigo	Yellow Coneflower

The seed may be a commercial mesic prairie mix from a nursery in Iowa, Illinois or Missouri with a slightly different composition than shown here.

D. Project Feature Summary. Table 6-2 summarizes project data.

Table 6-2. Fox Island Division Project Feature Summary Table

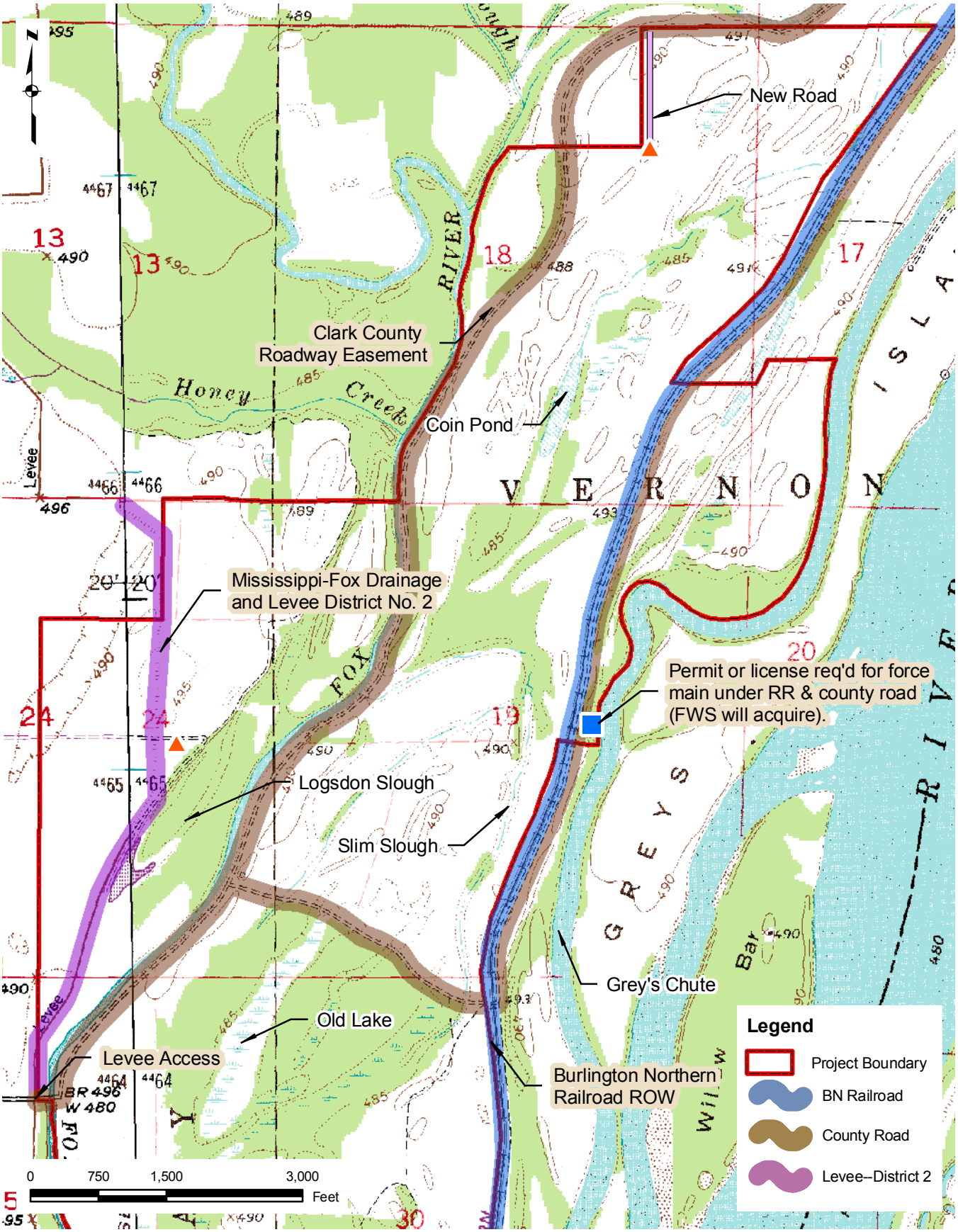
Item	Measurement	Unit of Measure
REDUCE FOREST FRAGMENTATION AND ENHANCE FOREST SPECIES DIVERSITY		
Hardwood Mast Forest		
Root Production Method Stock	215	Acres
50 trees per Acre	10,750	Trees
Cover Crop, Seeding & Weeding	215	Acres
Mulch	215	Acres
Plant Trees By Seeding	60	Acres
10,000 seeds per acre	600,000	Seeds
ENHANCE AND EXPAND EXISTING WETLANDS		
Enhance Logsdon Slough	25	Acres
Water Supply		
Drilled Well	100	Feet Deep
Well Casing and Screen	18	Inches Diameter
Submersible Well Pump	2,000	Gallon per Minute Capacity
Trailer-mounted Diesel Power Unit	30	Horsepower
Fuel Wagon	1,000	Gallon Capacity
Channel Improvements	200	Linear Feet
Channel Excavation	148	Cubic Yards
Cross Section Area	80	Square Feet
Clearing and Grubbing	7,000	Square Feet
Seeding	7,000	Square Feet
Riprap Channel Lining	1,500	Square Feet
2 Feet Thick	60	Cubic Yards
6" of Riprap bedding	15	Cubic Yards
Rehabilitate Existing Stoplog Structure		
Excavation	200	Cubic Yards
Clearing and Grubbing	6,100	Square Feet
Seeding	6,100	Square Feet
Backfill and compact	90	Cubic Yards
Place and grade spoils	110	Cubic Yards
Cap Existing Well	1	Each
Enhance Coin Pond, Slim Slough & Old Lake	130	Acres
Coin Pond Water Supply		
Drilled Well	100	Feet Deep
Well Casing and Screen	18	Inches Diameter
Submersible Well Pump	2,000	Gallons per Minute Capacity

Table 6-2. Fox Island Division Project Feature Summary Table – Continued

Item	Measurement	Unit of Measure
Channel Improvements	2,000	Linear Feet
Channel Excavation	8,300	Cubic Yards
Cross Section Area	203	Square Feet
Clearing and Grubbing	60,984	Square Feet
Seeding	60,984	Square Feet
Riprap Channel Lining	1,500	Square Feet
2 Feet Thick	60	Cubic Yards
6" of Riprap bedding	15	Cubic Yards
Road to Site	1,000	Linear Feet
Crushed Stone Aggregate	333	Cubic Yards
Pump Water From Greys Chute		
Pump with Power Unit	10,000	Gallons per Minute Capacity
Cantilevered Sheet Pile Wall	230	Linear Feet
Riprap Bank Protection	340	Cubic Yards
24" Diameter Force Main	320	Linear Feet
Bore Under Railroad	75	Linear Feet
Fuel Wagon	1	1,000 gallon capacity
Flap Gate	1	Each
Channel Improvements	450	Linear Feet
Channel Excavation	2,704	Cubic Yards
Cross Section Area	115	Square Feet
Clearing and Grubbing	74,052	Square Feet
Seeding	74,052	Square Feet
Riprap Channel Lining	1,500	Square Feet
2 Feet Thick	60	Cubic Yards
6" of Riprap bedding	15	Cubic Yards
Road to Site	250	Linear Feet
Crushed Stone Aggregate	84	Cubic Yards
Water Control Structures and Channels		
Fox River Structure		
Excavation and Backfill for Structures	300	Cubic Yards
CIP Reinforced Concrete	45	Cubic Yards
Grating for road deck	70	SF
Aluminum Stoplogs	55	SF
Guard Rail	100	Linear Feet
Embankment	1,000	Cubic Yards
Riprap Bank Protection	239	Cubic Yards

Table 6-2. Fox Island Division Project Feature Summary Table – Continued

Item	Measurement	Unit of Measure
Old Lake Structure		
Galvanized Stoplog Structure	1	Each
Corrugated Metal Pipe	50	Linear Feet
Excavation and Backfill for Structures	90	Cubic Yards
Channel Improvements	700	Linear Feet
Channel Excavation	3,230	Cubic Yards
Cross Section Area	80	Square Feet
Clear and Grub	130,680	Square Feet
Seeding	130,680	Square Feet
Coin Pond Structure		
Remove Existing Structure	1	Each
Galvanized Stoplog Structure	1	Each
Corrugated Metal Pipe	50	Linear Feet
Excavation and Backfill for Structures	90	Cubic Yards
Channel Improvements	2,200	Linear Feet
Channel Excavation	4,563	Cubic Yards
Cross Section Area	80	Square Feet
Clear and Grub	87,120	Square Feet
Seeding	6,111	Square Feet
Upper Slim Slough Structure		
Remove Existing Structure	1	Each
Galvanized Stoplog Structure	1	Each
Corrugated Metal Pipe	25	Linear Feet
Excavation and Backfill for Structures	90	Cubic Yards
Channel Improvements	400	Linear Feet
Channel Excavation	370	Cubic Yards
Cross Section Area	115	Square Feet
Clear and Grub	1,612	Square Feet
Seeding	1,200	Square Feet
Lower Slim Slough Structure		
Galvanized Stoplog Structure	1	Each
Corrugated Metal Pipe	50	Linear Feet
Excavation and Backfill for Structures	90	Cubic Yards
Channel Improvements	1,500	Linear Feet
Channel Excavation	3,011	Cubic Yards
Cross Section Area	115	Square Feet
Clear and Grub	101,930	Square Feet
Seeding	5,200	Square Feet
RESTORE NATIVE GRASSLAND		
Plant Native Grasses and Forbs	98	Acres



General Note: Line thicknesses are not to scale.

US Army Corps of Engineers
Rock Island District

Access Roads and ROW.
Figure 6-1.

E. Construction Considerations

i. Storm Water Pollution/Erosion Control. The potential for storm water pollution during construction can be contained within the confines of the Fox Island Division. Preparation of the fields for planting trees and prairie would expose some soil to erosion, but these areas would not be as vulnerable as under the current farming practices. Minimizing tilling and planting nursery cover crops would help reduce erosion. Pipes, stoplog structures and channel excavation would require sediment control measures such as silt fence and erosion control mats to keep soil in place until the vegetation can be re-established. The long-term storm water runoff characteristics of the site would be improved by the cessation of tilling.

ii. Permits. A public notice, as required by Section 404 of the Clean Water Act, was distributed on December 21, 2005 (CEMVR-OD-P-2005-1309). A Section 401 Water Quality Certificate from the Missouri Department of Natural Resources and a Section 404(b)(1) Evaluation are included in Appendix A *Correspondence* and Appendix B *Clean Water Act Section 404(b)(1)*, respectively,. Since all land disturbances are addressed in the 404(b)(1) Evaluation, a National Pollutant Discharge Elimination System (NPDES or Section 402) permit for storm water discharges would not be required.

iii. Historic Properties. Avoidance of all impacts to archaeological site 23CK345—which is considered potentially eligible for inclusion in the National Register of Historic Places—would be accomplished by restricting the proposed mast tree plantings both within the site area and within a 100-foot wide buffer zone all around the site boundary. This site's location is not specified in this public document, but would be detailed in the construction contract specifications with clear directions for the restriction of mast tree plantings in this area.

iv. Construction Sequence. The probable construction sequence is summarized in Table 6-3; however, no sequence would be required contractually. Planting and construction can be completed in one year. Weed control for planting may continue for three years.

F. Operational Considerations. Operation of water supply and water control equipment is primarily aimed for enhancing habitat for fall waterfowl migration. To that effect, the wetlands may be partially drained after spring floods to allow plant growth to provide food for waterfowl. These areas would then be re-flooded in the fall to provide protected resting and feeding areas. Fluctuating water levels provide a wider variety and more dependable supply of food. Planned features would allow wetlands to be drained to elevation 480 or filled to elevation 490. Normal high water operations would be held at 484 (484.5 in Logsdon Slough), however, to prevent excessive seepage. Widely varying flow conditions and events as well as fall rain conditions would result in variations in operations.

Many of the wetlands in the Fox Island Division are capable of sustaining perennial aquatic habitat. This habitat has resulted in an abundance of fishes, frogs and turtles, as well as species of birds and mammals that feed on them. The increased water control made possible through this project would ensure that those populations can survive dry spells.

G. Maintenance Considerations. The proposed features have been designed to require low annual maintenance. Routine maintenance would include periodic inspection and lubrication of the

pumps and water control structures. The pumps should be designed to withstand flooding and the engines should be removed before a flood occurs. When a flood has inundated the pumps, they must be examined and serviced according to the manufacturer's routine. Vandalism is always a concern under these isolated conditions. The pumps should be "exercised" periodically to ensure operational readiness. The Fox River shoreline should be routinely inspected for evidence of erosion. Weed control would be required around the mast trees for at least the first three years following planting. Weed control may involve mowing and/or herbicide application. The estimated annual maintenance costs are presented in Table 8-2. These quantities and costs may change during final design.

Table 6-3. Probable Construction Sequence

Sequence	Construction Work Item	Instructions	Purpose
1	Abandon county road or obtain easement	Address real estate concerns early	Obtain permanent access and management control.
2	Excavate channels	Excavate during low river/groundwater levels	Excavation would be in relatively dry soil if water table is low.
3	Spread and compact excavated material	Allow material to dry before spreading	Drying would facilitate spreading and compacting.
4	Remove old / construct new water control structures	Construct during low river/groundwater levels	Construction during dry period would minimize dewatering. Work has to be performed "in the dry".
5	Repair eroded area	Fill with dry excavated material and armor with riprap	Riverbank repair must occur during low river levels.
6	Place and Compact Berms	Control moisture content	To achieve compaction requirements.
7	Line channels	Line channels with riprap while dry period persists	Better control is achieved when riprap is not placed under water.
8	Install culverts	Install during channel work	Improves efficiency and reduces risk of flood failure during construction.
9	Construct roadways	Construct prior to well and pump work	Prevent environmental damage during pump station construction.
10	Drill Wells; install and test pumps	Perform work after channels, culverts, and water control structures have been completed	Pump tests can continue to test entire water supply and circulation to wetland areas.
11	Construct surface water pump station	Coordinate pump installation with Corps	The Corps would need to review the design and installation plans for this facility.
12	Install force main	Acquire easement for railroad crossing; acquire construction permit from RR	Construction cannot proceed on the jacked railroad crossing until a permit has been obtained.
13	Direct seed mast trees	Mow seeding area in mid August, allow 4-8" of re-growth, apply herbicides, till soil, and plant seeds; require follow-up maintenance	This assumes fall planting and properly prepares seedbed. Maintenance eliminates competition form other vegetation.
14	Plant mast tree nursery stock	Use 5-gallon container-grown nursery stock and require follow-up maintenance; plant between Mar 1 and May 15 or after Oct 1 and before Dec 10	Vigorous root stock improves survivability. Control competition. Spring and fall plantings are both acceptable. Fall planting is preferred.
15	Restore Prairie	Till planting area, broadcast seed (spring or fall), harrow, and roll. Mow through following year to prevent weeds from going to seed.	Provide good seed bed, minimize competition.

7. SCHEDULE FOR DESIGN AND CONSTRUCTION

Table 7-1 presents the schedule of project completion steps.

Table 7-1. Project Implementation Schedule

Requirement	Scheduled Date
Distribute Draft DPR	October 2003
Complete Internal Technical Review of Draft DPR	January 2004
Submit DPR for public and agency review	January 2005
Submit Final DPR to Mississippi Valley Division	September 2006
Initiate plans and specifications	January 2007
Submit plans and specifications for Internal Technical Review	March 2007
Complete plans and specifications	May 2007
Advertise contract	June 2007
Award contract	August 2007
Complete construction	December 2008
Prepare Operation and Maintenance Manual	February 2009

8. COST ESTIMATES

Project elements and contingency costs are presented in Appendix K. This appendix includes an analysis of the fully funded estimate (FFE) and the current work estimate (CWE). Table 8-1 compares these costs.

Table 8-1. Fox Island Division Habitat Rehabilitation and Enhancement Fully Funded Estimate vs. Current Work Estimate January 2005 Price Level

Account Code	Item	FFE	CWE
01	Lands and Damages	$0	$0
02	Relocations	$0	$0
06	Fish and Wildlife Facilities	$2,238,260	$2,098,130
30	Planning, Engineering and Design	$744,544	$698,000
31	Construction Management	$293,341	$275,000
	Total	**$3,276,145**	**$3,071,130**

The FFE was calculated based on the proposed construction schedule, expected escalation costs, and a contingency factor, and represents the money expected to be spent at the end of project construction. The CWE, with a 20 to 30 percent contingency factor, was used for annualized costs in the incremental analysis and is shown in a detailed estimate of project construction costs as presented in Table 8-2.

A detailed estimate of operation, maintenance, and rehabilitation costs is presented in Table 8-3. Table 8-4 presents the estimated annual monitoring costs. These tables use the January 2005 price levels.

Table 8-2. Fox Island Division Habitat Rehabilitation and Enhancement Construction Cost Summary, January 2005 Price Level

Acct Code	Item	Quantity	Unit	Unit Price	Amount*	Contingency	Cont. %
01	**LANDS AND DAMAGES**						
02	**RELOCATION**						
06	**FISH AND WILDLIFE FACILITIES**						
	WILDLIFE FACILITIES AND SANCTUARIES						
06.01	**Plant Hardwood Mast Trees**						
	Plant Container-Grown Stock						
	Cover Crop, Seeding & Weeding	215	AC	$ 1,021	$ 219,515	$ 43,884	30%
	Plant Container-Grown Trees	215	AC	$ 1,748	$ 375,820	$ 75,169	30%
	TOTAL Plant Container-Grown Stock				**$ 595,335**	**$ 119,053**	
	Plant Trees By Seeding						
	Plant Trees By Seeding	60	AC	$ 895	$ 53,700	$ 16,104	30%
	TOTAL Plant Hardwood Mast Trees				**$649,035**	**$135,157**	
06.02	**ENHANCE WETLANDS**						
	Enhance Logsdon Slough						
	Drill Well	100	LF	$ 718	$ 71,800	$ 14,366	20%
	Pump	1	EA	$ 17,161	$ 17,161	$ 4,290	25%
	Channel Excavation	200	LF	$ 14	$ 2,800	$ 555	20%
	Channel Lining	52	TN	$ 92	$ 4,784	$ 1,199	25%
	Portable Diesel Power Unit	1	EA	$ 17,760	$ 17,760	$ 3,552	20%
	Fuel Wagon	1	EA	$ 5,911	$ 5,911	$ 1,182	20%
	Repair Stoplog Structure	1	EA	$ 2,210	$ 2,210	$ 442	20%
	Cap Existing Well	1	EA	$ 733	$ 733	$ 147	20%
	TOTAL Enhance Logsdon Slough				**$ 123,159**	**$ 25,733**	
	Enhance Coin Pond, Slim Slough & Old Lake						
	Coin Pond Well						
	Drill Well	100	LF	$ 718	$ 71,800	$ 14,366	20%
	Well Pump	1	EA	$ 17,161	$ 17,161	$ 3,432	20%
	Channel Excavation	2000	LF	$ 30	$ 60,000	$ 12,094	20%
	Channel Lining	130	TN	$ 37	$ 4,810	$ 1,199	25%
	Road Improvements	1000	LF	$ 12	$ 12,000	$ 3,593	30%
	TOTAL Coin Pond Well				**$ 165,771**	**$ 34,684**	
	Pump Water From Grey's Chute						
	Angled Drive Pump w/ Power Unit	1	EA	$ 107,870	$ 107,870	$ 21,574	20%
	Cantilevered Sheet Pile Wall	2250	SF	$ 36	$ 81,000	$ 24,411	30%
	Dumped Rip Rap	600	TN	$ 41	$ 24,600	$ 6,150	25%
	24" Dia Force Main	320	LF	$ 47	$ 15,040	$ 3,738	25%
	Flap Gate	1	EA	$ 4,040	$ 4,040	$ 808	20%
	Channel Excavation	1600	LF	$ 16	$ 25,600	$ 4,969	20%
	Jack Force Main Under RR	50	LF	$ 1,108	$ 55,400	$ 13,844	25%
	Road Improvements	250	LF	$ 12	$ 3,000	$ 906	30%
	Fuel Wagon	1	EA	$ 6,652	$ 6,652	$ 1,330	20%
	Channel Lining	130	TN	$ 37	$ 4,810	$ 1,199	25%
	TOTAL Pump Water From Grey's Chute				**$ 328,012**	**$ 78,929**	

Table 8-2. Fox Island Division Habitat Rehabilitation and Enhancement Construction Cost Summary, January 2005 Price Level – Continued

Acct Code	Item	Quantity	Unit	Unit Price	Amount	Contingency	Cont. %
	Fox River Water Control						
	Excavation and Backfill for Structures	300	CY	$ 62	$ 18,600	$ 4,644	25%
	Channel Clearing and Excavation	1000	CY	$ 3	$ 3,000	$ 710	25%
	Structural Concrete	45	CY	$ 730	$ 32,850	$ 8,210	25%
	Structural Steel and Misc. Metals	1	LS	$ 10,606	$ 10,606	$ 2,651	25%
	Riprap Erosion Protection	78	CY	$ 320	$ 24,960	$ 6,248	25%
	TOTAL Fox River Water Control				**$90,016**	**$22,463**	
	Old Lake Water Control						
	Excavation and Backfill for Structures	90	CY	$ 15	$ 1,350	$ 342	25%
	Channel Clearing and Excavation	3230	CY	$ 19	$ 61,370	$ 15,534	25%
	Structural Steel and Misc. Metals	1	LS	$ 8,919	$ 8,919	$ 2,230	25%
	TOTAL Old Lake Water Control				**$71,639**	**$18,106**	
	Coin Pond Water Control						
	Excavation and Backfill for Structures	90	CY	$ 15	$ 1,350	$ 342	25%
	Channel Clearing and Excavation	4563	CY	$ 12	$ 54,756	$ 14,052	25%
	Structural Steel and Misc. Metals	1	LS	$ 8,919	$ 8,919	$ 2,230	25%
	Stoplog Structure Removal	1	LS	$ 392	$ 392	$ 98	25%
	TOTAL Coin Pond Water Control				**$65,417**	**$16,722**	
	Upper Slim Slough Water Control						
	Excavation and Backfill for Structures	90	CY	$ 15	$ 1,350	$ 342	25%
	Channel Clearing and Excavation	370	CY	$ 19	$ 7,030	$ 1,747	25%
	Structural Steel and Misc. Metals	1	LS	$ 6,593	$ 6,593	$ 1,648	25%
	Stoplog Structure Removal	1	LS	$ 392	$ 392	$ 98	25%
	TOTAL Upper Slim Slough Water Control				**$15,365**	**$3,835**	
	Lower Slim Slough Water Control						
	Excavation and Backfill for Structures	90	CY	$ 15	$ 1,350	$ 342	25%
	Channel Clearing and Excavation	3011	CY	$ 16	$ 48,176	$ 12,265	25%
	Structural Steel and Misc. Metals	1	LS	$ 8,919	$ 8,919	$ 2,230	25%
	TOTAL Lower Slim Slough Water Control				**$58,445**	**$14,837**	
	TOTAL Enhance Coin Pond, Slim Slough & Old Lake				**$794,665**	**$189,576**	
	TOTAL Enhance Wetlands				**$ 917,824**	**$ 215,309**	
06.03	**GRASSLAND RESTORATION**						
	Logsdon Tract Restoration	98	AC	$ 1,476	$ 144,648	$ 36,157	25%
	TOTAL Grassland Restoration				**$ 144,648**	**$ 36,157**	
	FISH AND WILDLIFE FACILITIES COST SUBTOTAL				**$ 1,711,507**		
	CONTINGENCIES SUBTOTAL					**$ 386,623**	
	FISH AND WILDLIFE FACILITIES COST TOTAL				**$ 2,098,130**		
30	**PLANNING, ENGINEERING AND DESIGN**	1	LS	$ 698,000	**$ 698,000**		
	Definite Project Report				$ 538,000		
	Plans and Specifications				$ 120,000		
	Engineering During Construction				$ 40,000		
31	**CONSTRUCTION MANAGEMENT**	1	LS	$ 275,000	**$ 275,000**		
	Contract Administration				$ 60,000		
	Shop Drawing Review				$ 15,000		
	Inspection and Quality Assurance				$ 200,000		
	TOTAL PROJECT COST				**$ 3,071,130**		

Table 8-3. Estimated Annual Operation and Maintenance Costs January 2005 Price Level

Item	Quantity	Unit	Unit Price ($)	Total Cost ($)
Operation				
Pump Operation	1,400	Hr	2.50	3.500
Maintenance				
Tree Planting (first 3 years)	275	Acre	20	5,500
Pumping Equipment	60	Hr	25	1,500
Roadway Surface	1,250	LF	5	6,250
Water Control Structure	24	Hr	25	600
Galvanized Metal Stoplog Structures	60	Hr	25	1,500
Prairie Planting	98	Acre	10	980
Rehabilitation[1]				
Subtotal				**19,830**
Contingencies (20%)				3,966
TOTAL				**23.796**

[1] Rehabilitation cannot be accurately measured. Rehabilitation is the reconstructive work that significantly exceeds the annual operation and maintenance requirements identified above and that is needed as a result of major storms or flood events.

Table 8-4. Estimated Post-Construction Annual Monitoring Costs (January 2005 Price Level)

Item	Annual Cost
Engineering Data	$4,000
Natural Resources Data	$2,000
Subtotal	**$6,000**
Contingencies (20%)	$1,200
Data Subtotal	**$7,200**
Planning, Engineering, Design[1]	$1,500
Total	**$8,700**

[1] Includes annual cost of evaluation report

9. ENVIRONMENTAL EFFECTS

A. Summary of Effects. The proposed project would result in positive long-term effects to habitats located in the Fox Island Division. The project would result in some trade-offs in wildlife habitat because of conversion of cover types but the resulting changes would provide habitat to a greater diversity of species. No Federally protected species would be negatively affected. The project would result in short-term decreases in water quality due to localized increases in turbidity resulting from construction activities. No significant social or economic impacts would result. No impacts to historic properties are anticipated.

B. Economic and Social Impacts

i. Community and Regional Growth. No impacts to the growth of the community or region would be realized as a result of the proposed project.

ii. Community Cohesion. The proposed environmental enhancement project would not adversely impact community cohesion. No public opposition has been expressed, nor is any expected.

iii. Displacement of People. No residential relocations would be required as a result of the project.

iv. Property Values and Tax Revenues. The project would have no direct impact on property values or related tax revenues. All project lands are in Federal ownership.

v. Public Facilities and Services. Puddle ducks and other waterfowl would benefit from the proposed wetland enhancement. Mast-consuming species would benefit from the improved forest diversity. The long-term effects of habitat enhancement would increase wildlife populations and diversity, and thus enhance the opportunities for hunting and sightseeing.

vi. Life, Health, and Safety. The proposed project poses no threats to the life, health, or safety of the public. An HTRW assessment was conducted and no obvious indications of potential contamination sources were reported.

vii. Business and Industrial Growth. No long-term impacts to business or industrial activity would result from the proposed project. No business relocations would be required.

viii. Employment and Labor Force. There could be a slight increase in short-term employment opportunities resulting from project construction. No long-term impacts would occur.

ix. Farm Displacement. Currently, the USFWS leases all agricultural land (621 acres) within the Fox Island Division to a local farmer for planting crops. The fields produce a relatively low yield because of flooding, and one-third of the crops are left behind for wildlife. Current farming would be phased out over the implementation of the project tree planting. No privately owned farms would be displaced as a result of the project.

x. Aesthetic Resources. The proposed environmental enhancement project would not diminish the aesthetic resources of the area.

xi. Noise Levels. Project construction would generate a temporary increase in noise levels. No long-term impacts would result.

C. Natural Resources Impacts. Impacts of the project on natural resources were evaluated using the Wildlife Habitat Appraisal Guide (WHAG) by Urich *et. al*. (1984). This habitat evaluation method was used during the planning process to evaluate various proposed project alternatives in terms of benefits to wildlife. The process attempts to optimize benefits relative to project costs to aid in the selection of project features. Benefits are expressed as "Habitat Units" (HUs). Results of this evaluation are summarized in Table 5-1. A detailed analysis is included in Appendix D. Experience and established management practices were also used to assess impacts.

i. Terrestrial Habitat. Currently, the Fox Island Division consists of about 925 acres of floodplain forest dominated by silver maple and cottonwood; 111 acres of wetlands, sloughs and backwater; and 621 acres of cultivated land. An additional 376 acres are old field, with recently seeded trees and areas in the early stages of natural forest regeneration. There is a limited number of mast-producing trees, which are primarily pin oak. These areas exhibit relatively low vegetative diversity and are characterized by low quality habitat and a limited number of wildlife species. The proposed project would replace 275 acres of open area with mast-producing trees, and 98 acres of old field with native prairie. The remaining open areas would be allowed to regenerate woodland naturally. This plan would restore the historic native plant community, increase habitat diversity, and improve habitat quality for a variety of resident and migratory wildlife.

ii. Wetland Habitat. Currently, wetland habitat on the Fox Island Division relies on flooding and rains to maintain water levels. Opportunities to control and manipulate water levels are limited and most of the shallow wetland areas dry up following spring flooding. The proposed wetland enhancement features would provide a perennial water source and water level control for some of these areas. This would give management personnel the flexibility to fill or drain wetlands for the benefit of waterfowl and other wildlife. Quality wetland habitat could be provided on a consistent basis.

There would be short-term negative effects on the aquatic habitat in the project area due to construction activities. These effects may include increased sedimentation and turbidity in the surface water. The long-term impacts of the project would be positive.

iii. Wildlife. Improved habitat would increase wildlife populations and diversity. Habitat improvements that are part of this project, including enhanced wetlands, native prairie restoration and expanded forests, should directly affect the populations of native wildlife. Wildlife species expected to benefit include fox squirrel, pileated woodpecker, wood thrush, Kentucky warbler, dickcissel, puddle ducks and other wetland-loving birds.

iv. Fish. The proposed wetland enhancement features would have minimal impact on fish. No deepwater habitats would be created for sustaining year round fish populations. Opportunities for creating a sport fishery are hampered by frequent flooding which would regularly introduce rough fish from the Fox and Mississippi Rivers.

v. Threatened and Endangered Species. The following is a list of State- or Federally-endangered species potentially occurring in Clark County, Missouri:

COMMON NAME	SCIENTIFIC NAME	STATUS
Patterson's Dawnflower	*Stylisma pickerinaii var. pattersonii*	E (S)
Fat Pocketbook Mussel	*Potamilus capax*	E (S & F)
Topeka Shiner	*Notropis topeka*	E (S & F)
Central Mudminnow	*Umbra limi*	E (S)
Western Fox Snake	*Elaphe vulpina vulpina*	E (S)
Illinois Mud Turtle	*Kinosternon flavescens spooneri*	E (S)
Blandings Turtle	*Emydoidea blandingii*	E (S)
Bald Eagle	*Haliaeetus leucocephalus*	E (S), T (F)
Indiana Bat	*Myotis sodalis*	E (S & F)

E = Endangered S = State Listed
T = Threatened F = Federal Listed

The State-listed Patterson's Dawnflower has been found on the sandy slopes of the levee on the west side of the Division; no construction is planned for the levees and no impact on this species is expected.

The State-listed Illinois Mud Turtle and the Western Fox Snake have been reported from the Rose Pond area but neither species has been sited since the 1993 flood, and are not expected to be impacted.

The State-listed Central Mudminnow has been documented from Nelson Lake but no work is planned at this location.

The State-listed Blandings Turtle is not known to occur on the Division and is not expected to be impacted.

The Federally-listed endangered Topeka Shiner is known to occur in Clark County. However, Topeka shiner habitat is not found in the project area, therefore the project would not impact the Topeka shiner.

The Federally-listed endangered fat pocketbook mussel is a large river species and historically has been known to occur in the main stem of the Mississippi River near the Fox Island Division. No work is planned in the main stem of the river, and no impact to the species would occur.

The Federally-listed threatened bald eagle occurs on the Fox Island Division as a winter resident, and a bald eagle nest exists in an area adjacent to the Division. The construction of the project would not occur during the nesting season and would be outside of the proximity of the nest, therefore the nest would not be disturbed by this project. A few trees must be removed to construct the surface water pump station, but this activity would be managed to avoid disturbance to bald eagles and damage to their habitat. No trees would be removed when eagles are present. Therefore, the project is not likely to adversely affect the bald eagle.

The Federally-listed endangered Indiana bat also may occur in the project area. Very few trees would be removed for this project. An Indiana bat habitat suitability survey would be implemented. If roosting habitat characteristics are not evident, then the trees would be removed. If roosting habitat is evident, more detailed survey methods, such as mist-netting, would be done to further evaluate project area use by Indiana bats. Therefore, the project is not likely to adversely affect the Indiana bats.

vi. Hazardous, Toxic, and Radioactive Waste. A hazardous, toxic, and radioactive waste (HTRW) compliance assessment was conducted and is included as Appendix F to this report. This assessment evaluated the presence of HTRW or other environmental conditions on the Fox Island Division that might impact the HREP. The assessment concluded that no evidence of recognized environmental conditions was noted on the Fox Island Division and no further environmental investigations are needed.

vii. Prime and Unique Farmland. No prime and unique farmland would be impacted by the proposed project.

D. Historic Properties. Historic properties coordination under Section 106 of the National Historic Preservation Act is being conducted using the "process and documentation required for the preparation of an EA/FONSI or an EIS/ROD to comply with Section 106 of the National Historic Preservation Act, in lieu of the procedures set forth in 36 CFR 800.3 through 800.6" [35 Code of Federal Regulations (CFR) Part 800.8(c)]. Advance notice as required under 36 CFR 800.8(c) was provided to the Advisory Council on Historic Preservation (ACHP) and the Missouri State Historic Preservation Officer (SHPO) in a Corps letter dated January 28, 2004 (Appendix A).

i. Federal Undertaking. The Corps has determined that, for purposes of Section 106 of the National Historic Preservation Act [see 36 CFR 800. 3(a) and 800.16(y)], the Federal "undertaking" which has the potential to cause effects on historic properties is limited to the activities described in the Recommended Plan at Section 6.b, above—excluding only the acreage described as being allowed to "reforest naturally" [(Section 6.b.(2)].

ii. Consulting Parties. The Corps finds the following entitled to be consulting parties, as set out in 36 CFR 800.2, and invites them to participate in the Section 106 process:

- Advisory Council on Historic Preservation (ACHP)
- Choctaw Nation of Oklahoma
- Clark County (Missouri) Historical Society
- Eastern Shawnee Tribe of Oklahoma
- Iowa Tribe of Kansas and Nebraska
- Iowa Tribe of Oklahoma
- Jena Band of Choctaw Indians
- Miami Tribe of Oklahoma
- Missouri State Historic Preservation Officer at the Missouri DNR
- Muscogee (Creek) Nation of Oklahoma
- Sac and Fox of the Mississippi in Iowa
- Sac and Fox Nation of Oklahoma
- Sac and Fox of the Missouri in Kansas and Nebraska
- U.S. Fish and Wildlife Service

iii. Area of Potential Effect (APE). The APE is illustrated on the map at figure 2-1 showing project features. This is the same area as covered by the Phase I archaeological surveys (Appendix M, figures M-5 and M-6). The Phase I surveys covered the footprint of all project features in the Recommended Plan described at Section 6.b-c, above, with the exception of the acreage of lands described as being allowed to "reforest naturally." The APE is all on Federal land; none is on tribal lands [36 CFR 800.16(d) and 36 CFR 800.4(a)(1)].

iv. State Historic Preservation Officer (SHPO) and Tribal Historic Preservation Officers (THPOs) Invitations. The Corps invites the SHPO/THPOs to:

- Identify any other consulting parties as per 36 CFR 800.3(f);
- Comment as per 36 CFR 800.2(d)(3) on the Corps' plan to involve the public by utilizing the Corps' normal procedures for public involvement under the National Environmental Policy Act;
- Concur in the Corps' decision that it is appropriate to address multiple steps in 36 CFR 800.3-800.6 as provided at 36 CFR 800.3(g); and,
- Comment on, or contribute to, identification efforts including definition of the APE, all as per 36 CFR 800.4(a-b).

v. Identification of Historic Properties. Review of existing information [36 CFR 800.4(a)(2)] is summarized at Section 2.g., above. Only three sites have been located within the APE (23CK345, 23CK346, and 23CK347).

The Corps finds that historic properties identification has been completed for the entire APE [reference 36 CFR 800.4(b)].

vi. Request for Information from Consulting Parties. The Corps is seeking information from all consulting parties regarding their concerns with issues relating to this undertaking's potential effects on historic properties and, particularly, the tribes' concerns with identifying properties which may be sacred sites under Executive Order No. 13007 or of religious and cultural significance to them and may be eligible for the National Register [36 CFR 800.4(a)(3-4)]. Concerns about confidentiality [36 CFR 800.11(c)] regarding locations of properties can be addressed under Section 304 of the National Historic Preservation Act which provides withholding from public disclosure the location of properties under several circumstances including in cases where it would cause a significant invasion of privacy, impede the use of a traditional religious site by practitioners, endanger the site, etc.

vii. Agency Evaluation of Historic Significance, Determination of National Register Eligibility, and Invitation to the SHPO/THPOs and Consulting Parties to Comment. The Corps finds site 23CK345 to be within the APE and to be potentially eligibility for inclusion in the National Register of Historic Places (NRHP) under the criterion found at 36 CFR 60.4(d)—sites that have yielded, or may be likely to yield, information important in prehistory or history.

Partial coordination of the Hoppin and Benn (2004) Phase I report was conducted with the Missouri SHPO through a Corps letter dated November 20, 2003, and with a SHPO response dated December 9, 2003 (Log number 003-CK-04). These letters are found at Appendix A. The SHPO concurred with the Corps that "sites 1149-2 [23CK346] and 1149-3 [23CK347] are not eligible for the National

Register, and that archaeological site 1149-1 [23CK345] may be eligible the National Register of Historic Places."

The Corps invites the opinion of the SHPO/THPOs and consulting parties on this determination [36 CFR 800.4(c)].

viii. Agency Determination of No Adverse Effect and Invitation to All Consulting Parties to Submit their Views. The Corps finds this undertaking would have a No Adverse Effect [36 CFR 800.5(b)] on site 23CK345. This determination is based upon the avoidance of all impacts to 23CK345 by restricting the proposed mast tree plantings both within the site area and within a 100-foot wide buffer zone all around the site boundary.

The SHPO in its December 9, 2003, letter concurred that the project would have "no adverse effect on site 1149-1 [23CK345], on the condition that mast tree plantings are restricted within the sites area, and within a 100-foot-wide buffer zone around the site."

The Corps notified all consulting parties including the SHPO/THPOs and the ACHP of this Finding of No Adverse Effect and provided them with the documentation as specified at 36 CFR 800.11(e)—see Appendix M. The Corps invited the Council and all other consulting parties to review the finding as per 36 CFR 800.5(c).

ix. Consulting Party Comments Received and Corps Responses. The Corps received three comments from the review of this document by the consulting parties and/or the public (Appendix A). In a letter dated January 14, 2005, the Eastern Shawnee Tribe of Oklahoma stated they had "no objection to the proposed construction. However if any human skeletal remains and/or any objects falling under NAGPRA (Native American Graves Protection and Repatriation Act) are uncovered during construction, the construction should stop immediately, and the appropriate persons, including state and tribal NAGPRA representative contacted." All Corps construction contracts require cessation of work, protection of materials discovered, and immediate notification of the proper parties upon the discovery of any unanticipated human remains and/or cultural resources.

In a Missouri Department of Natural Resources letter dated January 24, 2005, the Missouri State Historic Preservation Office stated their concurrence with Corps' determination that "23CK345 is eligible for inclusion in the National Register of Historic Places (and). . . . that the proposed project would have no adverse effect on site 23CK345, on that condition that mast tree plantings are restricted within the site area and within a 100 foot wide buffer zone around the sites." The FONSI at the end of this EA incorporates the restrictions on mast tree planting. These restrictions would be incorporated into the relevant contract specifications.

In a letter dated February 1, 2005, referencing this project, the Jena Band of Choctaw Indians stated that, "After thorough review of the documents submitted, it has been determined that there would be no significant impact in regards to the Jena Band of Choctaw Indians. We have no objections to its implementation."

E.. Mineral Resources. No impacts are expected to occur to mineral resources as a result of this project.

F. Cumulative Impacts. No adverse cumulative impacts are identified. Habitat modifications should have long-term benefits to the fish and wildlife utilizing this area. This project, in concert with other EMP HREPs on the Mississippi River, should counter other impacts to the river ecosystem such as sedimentation, pollution, and general decline in river habitats.

G. Adverse Impacts Which Cannot Be Avoided. During construction, temporary noise impacts and a temporary increase in turbidity cannot be avoided.

H. Short-Term Versus Long Term-Productivity. Short-term construction impacts would be offset by the long-term increase in quantity and diversity of terrestrial, wetland and aquatic vegetation.

I. Irreversible or Irretrievable Resource Commitments. The purchase of materials and the commitment of labor, fuel, and machinery to construct the project are considered irretrievable. Other than the aforementioned, none of the proposed actions are considered irreversible.

J. Relationship of the Proposed Project to Land-Use Plans. The proposed action is in agreement with the *Land Use Allocation Plan* (Corps of Engineers, 1989) and *Comprehensive Mark Twain NWR Conservation Phase* (2004). The proposed project is not in conflict with any land-use plans currently being used for the site.

K. Compliance with Environmental Quality Statutes. Table 9-1 summarizes compliance with applicable statutes.

Table 9-1. Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Policies	Compliance
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full Compliance
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full Compliance
Clean Water Act, 33 U.S.C. 1857h-7, et seq.	Full Compliance
Endangered Species Act, 16 U.S.C. 1531, et seq	Full Compliance
Federal Water Project Recreation Act, 16 U.S.C. 460-1(12), et seq.	Not Applicable
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et Seq.	Full Compliance
Land and Water Conservation Fund Act, 16 U.S.C. 460/-461/-11, et seq.	Not Applicable
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	Full Compliance
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full Compliance
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full Compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not Applicable
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Not Applicable
Flood Plain Management (Executive Order 11988)	Full Compliance
Protection of Wetlands (Executive Order 11990)	Full Compliance
Farmland Protection Policy Act, 7 U.S.C. 4201, et seq.	Full Compliance
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 11 Aug 80)	Not Applicable

Full Compliance: Having met all requirements of the statute for the current stage of planning.
Not Applicable: No requirements for the statute required.

i. Archaeological and Historic Preservation Act, as amended. The one historic property that is potentially eligible for inclusion in the National Register of Historic Places is being avoided by all project impacts. Details are set out in the Section 9 (d) Historic Properties portion of this document.

ii. Clean Air Act, as amended. No aspect of the proposed project has been identified that would result in violations of air quality standards.

iii. Clean Water Act, as amended. A Section 404 (b)(1) evaluation for the recommended plan is found in Appendix B of this report.

iv. Endangered Species Act, as amended. Construction activities would be timed to avoid impacts to bald eagles and Indiana bats. The central mudminnow has been documented from Nelson Lake, but no work is planned at this location. The western fox snake and Illinois mud turtle has been reported from the Rose Pond area, but neither species has been sighted since the 1993 flood; therefore, impacts are not expected. The Fat Pocketbook Mussel, Topeka Shiner, and Blandings Turtle are not known to occur on the Fox Island Division and no impact is expected. Patterson's Dawnflower is known from the sandy slopes of the levee on the west side of the Division but no work is planned in this area and no impact is expected. Overall, no impacts to endangered species are anticipated.

v. Federal Water Project Recreation Act, as amended. Since this action is not a navigation, flood control, reclamation, hydroelectric, or multiple purpose water resource project, this Act is not considered applicable.

vi. Fish and Wildlife Coordination Act, as amended. Project plans have been coordinated with the U.S. Fish and Wildlife Service, Illinois DNR, and the Missouri DOC. Coordination with these agencies, as well as others, is detailed in Section 13, *Coordination, Public Views, and Comments,* and Appendix A, *Correspondence.*

vii. Land and Water Conservation Fund Act, as amended. This Act regulates admission and special recreation user fees at certain recreational areas and establishes a fund to subsidize state and Federal acquisition of lands and waters for recreational and conservation purposes. No admission or user fees are charged for recreational use of the Division and no Federal money is being used to acquire lands or waters on this project. Therefore, this Act is not considered applicable.

viii. National Environmental Policy Act, as amended. The completion of the EA and signing of the FONSI would fulfill NEPA compliance.

ix. National Historic Preservation Act, as amended. Historic properties coordination under Section 106 of the National Historic Preservation Act is integrated into this document using the "process and documentation required for the preparation of an EA/FONSI or an EIS/ROD to comply with Section 106 of the National Historic Preservation Act, in lieu of the procedures set forth in 36 CFR 800.3 through 800.6" [35 Code of Federal Regulations (CFR) Part 800.8(c)]. Advance notice as required under 36 CFR 800.8(c) was provided to the Advisory Council on Historic Preservation (ACHP) and the Missouri SHPO in a Corps letter dated January 28, 2004 (Appendix A). Details are in the Section 9 (d) Historic Properties portion of this document. The completion of the EA process and signing of the FONSI would evidence completion of the Section 106 compliance process.

x. Rivers and Harbors Act, 33 U.S.C. as amended. This Act regulates activities in, under, or over a navigable water, such as the Mississippi River. No activity is proposed that impacts the main stem of the Mississippi. However, the proposed surface water pump station would be constructed adjacent to Grey's Chute, which connects to the river at both its upstream and downstream end. The Section 404 permit application would address issues that could be regulated by this Act. Obtaining a Section 404 permit would result in full compliance with Section 10 of the Rivers and Harbors Act.

xi. Watershed Protection and Flood Prevention Act, as amended. Under this Act, the Soil Conservation Service at the Department of Agriculture provides planning assistance and construction funding for projects constructed by local sponsors, often in the form of flood control districts. This project is not being constructed by local sponsors, therefore, this Act is not considered applicable.

xii. Wild and Scenic Rivers Act, as amended. The Fox and Mississippi Rivers are not listed as component rivers in the National Wild and Scenic River System.

xiii. Flood Plain Management, Executive Order 11988. The project would not directly or indirectly induce growth (construction of structures and/or facilities) in the floodplain. Therefore, the project would be in full compliance with this executive order.

xiv. Protection of Wetlands, Executive Order 11990. While existing wetland habitat would be temporarily impacted by construction of the water control structures, the long-term impact to these wetlands would be protection and enhancement.

xv. Farmland Protection Policy Act, as amended. The proposed action would not result in the conversion of any prime, unique state or locally important farm land to non-agricultural uses.

xvi. Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 11 Aug 80). Prime farmland is defined as land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Unique farmland is defined as land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as, citrus, tree nuts, olives, cranberries, fruits, and vegetables (7 U.S.C. 4201(c)(1)(A) & (B)). No farmland conforming to either of these definitions exists on the Fox Island Division. Therefore, this Act is not considered applicable.

10. PROJECT PERFORMANCE ASSESSMENT MONITORING

This section summarizes the monitoring and data collection aspects of the project. The primary project objectives have been summarized elsewhere in this document, and the performance assessment is designed to gauge progress toward meeting these objectives.

Table 10-1 presents overall types, purposes, and responsibilities of monitoring and data collection. Table 10-2 presents actual monitoring and data parameters grouped by project phase, as well as data collection intervals. Table 10-3 presents the post construction evaluation plan, which displays the specific parameters and the levels of enhancement for the project (see Plate 16).

Table 10-1. Fox Island Division Monitoring and Performance Evaluation Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Pre-Project	Baseline Monitoring	Establish baselines for performance evaluation	Corps	USFWS	HREP Sponsor	See Table 10.2.
	Pre-Project Monitoring	Identify and define problems at HREP site. Establish need of proposed project features	Corps	USFWS	USFWS	--
Design	Data Collection for Design	Include quantification of project objectives, design of project, and development of performance evaluation plan	Corps	Corps	HREP	See Table 10.2.
Construction	Construction Monitoring	Assess construction impacts; assure permit conditions are met	Corps	Corps	HREP	See State Section 401 Stipulations
Post-Construction	Performance Evaluation Monitoring	Determine success of project as related to objectives	Corps (quantitative) Sponsor (field observations)	USFWS and Corps	HREP and USFWS	See Table 10.3.

Table 10-2. Fox Island Division Resource Monitoring and Data Collection Summary

	Engineering Data			Natural Resource Data				Area Measurements	
Point Measurements	**Pre-Project Phase**	**Design Phase**	**Post-Const. Phase**	**Pre-Project Phase**	**Design Phase**	**Post-Const. Phase**	**Sampling Agency**	**Wetland Water Surface Survey**	**Prairie Plant Survey**
Mast Tree Survey				1	1	5Y	USFWS and Corps		
Floristic Survey					1	1-5Y	Corps and MDC		X
Mapping (Aerial Photography)	2 [1]	2 [2]					Corps and USGS		
Plane Table Survey (1934)	1						Corps		
Aerial Photogrametry (1995)		1 [3]					Corps		

[1] Aerial Photos 1927 and 1995
[2] Aerial Photo 1998 (Corps) and Digital Ortho Quad by USGS 1993
[3] Aerial Survey for Flow Frequency Study, approved for public release 2003

Table 10-3. Fox Island Division Post-Construction Evaluation Plan

Enhancement Potential									
Goal	**Objective**	**Enhancement Feature**	**Unit**	**Year 0 w/out Alternative**	**Year 1 w/ Alternative**	**Year 25 w/ Alternative**	**Year 50 Target w/ Alternative**	**Feature Measurement**	**Annual Field Observations by Site Manager**
Rehabilitate and Enhance Wildlife Habitat	Restore native grassland	Seed part of Logsdon Tract with native grasses and forbs	Acres	0	98	98	98	Floristic Inventory	Estimate effective acreage and wildlife use
	Expand and enhance existing wetlands	Enhance water supply, distribution and control for wetlands	Acres	15	78	75	70	Aerial photo of inundated area on October 31	Estimate effective acreage and wildlife use
	Reduce forest fragmentation and enhance species diversity	Plant container-grown trees	% survival	100	95	45	40	Tree count	Estimate effective acreage and wildlife use
		Direct seed hardwood trees	% survival	95	65	15	4	Tree count	Estimate effective acreage and wildlife use
		Allow natural reforestation in low-lying areas	Acres		50	200	345	Aerial photo of re-forestation	Estimate effective acreage and wildlife use
		Bank protection	Linear feet of bank protection	0	50	50	50	Surveys, inspections and mapping	Evaluate bank stability and erosion

11. REAL ESTATE REQUIREMENTS

The Fox Island Division Habitat Rehabilitation and Enhancement Project will be constructed on land owned by the Federal Government and managed as a National Wildlife Refuge by the United State Fish and Wildlife Service (USFWS). A draft Memorandum of Agreement between the USFWS and the U. S. Army Corps of Engineers is included as Appendix C. A full description of the project area and real estate information is in the Real Estate Plan which is included as Appendix L. The project is located in the Great River National Wildlife Refuge in Clark County, Missouri.

12. IMPLEMENTATION RESPONSIBILITIES

A. Corps of Engineers. The U.S. Army Corps of Engineers, Rock Island District, is responsible for project management and coordination with the USFWS, MDC, the State of Illinois, and other affected agencies. The Rock Island District would submit the subject Definite Project Report (DPR); administer program funds; finalize plans and specifications; complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration. Section 906(e) of WRDA 1986 states that first cost funding for enhancement features would be 100 percent Federal cost because the project features would be located on Federally owned land that is managed by the USFWS as a national wildlife refuge. Any mutually agreed upon major rehabilitation of the project that exceeds the identified annual operation and maintenance cost requirements would be the Corps of Engineers responsibility. Major rehabilitation would be considered as a result of specific storm or flood events and is not included in the project costs estimate (Table 8-2 and Table 8-3)

B. U.S. Fish and Wildlife Service. The USFWS is the Federal project sponsor and has provided a Coordination Act Report (CAR) for this project (see Appendix A). Operation and maintenance of the project, as described in Sections 6.e, 6.f, and Table 8-3 is the responsibility of the USFWS in accordance with Section 107(b) of the WRDA of 1992, Public Law 102-580. These functions would be further specified in the Project Operation and Maintenance Manual to be provided by the U.S. Army Corps of Engineers prior to final acceptance of the project by the sponsors.

C. Missouri Department of Conservation. The MDC, a non-Federal project sponsor, has provided technical and other advisory assistance during all phases of the project and would continue to provide assistance during project implementation.

D. Illinois Department of Natural Resources. The IDNR, a non-Federal project sponsor, has provided technical and other advisory assistance during all phases of the project and would continue to provide assistance during project implementation.

13. COORDINATION, PUBLIC VIEWS, AND COMMENTS

Coordination has been made throughout the planning and design process with the following State and Federal agencies:

Illinois Department of Natural Resources
Missouri Department of Conservation (MDOC)
Missouri Department of Natural Resources
Iowa Department of Natural Resources
U.S. Natural Resources Conservation Service
U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency

A. Coordination Meetings. Coordination with project sponsors occurred during the following meetings:

Date	Subject	Attendance
Aug 6, 2002	Kickoff Feasibility Study - Site visit	Corps, USFWS, Illinois DNR, Stanley Consultants
Nov 8, 2002	Draft Review Chapters 1 -5	Corps, USFWS, Illinois DNR, Stanley Consultants
Jun 19, 2003	Phase 2 kick-off to complete DPR	Corps, USFWS, MDOC, Stanley Consultants
Jul 17, 2003	Reforestation Plan	Corps, Stanley Consultants
Aug 29, 2003	Progress Meeting	Corps, USFWS, Illinois DNR, Stanley Consultants
Nov 25, 2003	Draft Review	Corps, Stanley Consultants
Mar 2, 2004	Draft Review Meeting	Corps, Stanley Consultants
Jan 26, 2005	Project Open House, Keokuk, IA	Corps, Stanley Consultants, USFWS, MDOC, Public

B. Coordination by Correspondence. The following letters are contained in Appendix A, *Correspondence.*

1. Letter dated August 4, 2003, from Corps of Engineers to Distribution List.
2. Stanley Consultants, Inc. Meeting Notes #1, dated June 19, 2003, subject: Minutes of Coordination Meeting.
3. Stanley Consultants, Inc. Meeting Notes #2, dated August 9, 2003, subject: Minutes of Coordination Meeting.
4. MVR-ED E-mail, dated July 17, 2003, from Heather Whitman, U.S. Army Corps of Engineers, to Dan Miller, Stanley Consultants, Inc., subject: Fox Island Stage 2 distribution letter address list.
5. Stanley Consultants, Inc. E-mail, dated July 28, 003, from Michael Knott, Stanley Consultants, Inc., to Joseph Lundh, U.S. Army Corps of Engineers, subject: Fox Island Tree Planting.
6. MVR-ED E-mail, dated August 14, 2003, from Heather Whitman, U.S. Army Corps of Engineers, to Michael Knott, Stanley Consultants, Inc., subject: HTRW for Fox Island DPR.

7. Stanley Consultants, Inc. Telephone Call Report, dated September 9, 2003, from Dan Miller, Stanley Consultants, Inc., to Dick Klassen, Grosch Well Drilling Company, subject: Electrical vs. Diesel Motors for Irrigation Pumps.

8. Stanley Consultants, Inc. Telephone Call Report, dated July 25, 2003, from Dan Miller, Stanley Consultants, Inc., to Dick Klassen, Grosch Irrigation Co., subject: Well production and cost in Clark County Missouri.

9. Stanley Consultants, Inc. Telephone Call Report, dated July 18, 2003, from Brad Roeth, Stanley Consultants, Inc., to Dave Meyer, Layne-Western, subject: Fox Island Water Supply Wells.

10. Stanley Consultants, Inc. Telephone Call Report, dated August 21, 2003, from Steve Sutter, Landmark Irrigation, Inc., to Heather Cross, Stanley Consultants, Inc., subject: Fox Island Well Drilling.

11. MVR-PM Letter dated September 22, 2003, from Janet E. Sternburg, Missouri Department of Conservation, to Dan Miller, Stanley Consultants, Inc., subject: Endangered and Threatened Species near Fox Island.

12. Letter dated November 20, 2003, from Kenneth A. Barr, U.S. Army Corps of Engineers, to Mark Miles, Department of Natural Resources, subject: National Historic Preservation Association.

13. MVR-PM Letter dated December 9, 2003, from Mark Miles, Department of Natural Resources, to Kenneth A. Barr, U.S. Army Corps of Engineers, subject: Historic Preservation.

14. Letter dated January 28, 2004, from Kenneth A. Barr, U.S. Army Corps of Engineers, Mr. Don Klima, Advisory Council on Historic Preservation.

15. Coordination Act Report (CAR), dated August 23, 2004, from Richard C. Nelson, Fish & Wildlife Service, to Colonel Duane P. Gapinski, U.S. Army Corps of Engineers.

16. Letter dated January 14, 2005, from Jo Ann Beckham, Eastern Shawnee Tribe of Oklahoma, to Darren Niles, U.S. Army Corps of Engineers.

17. Letter dated January 24, 2005, from Mark A. Miles, Department of Natural Resources to Darron Niles, U.S. Army Corps of Engineers.

18. Letter dated February 1, 2005, from Lillie Strange, Jena Band of Choctaw Indians, to Darron Niles, U.S. Army Corps of Engineers.

19. Coordination Act Report (CAR), dated March 14, 2005, from Richard C. Nelson, Fish & Wildlife Service, to Colonel Duane P. Gapinski, U.S. Army Corps of Engineers.

20. Conversation Record, dated January 26, 2005, from Darron Niles, U.S. Army Corps of Engineers.

21. Letter from Mayor Bob Davis, Mayor of City of Alexandria, Missouri, to Darron Niles, U.S. Army Corps of Engineers.

14. CONCLUSIONS

The natural habitat value on the Fox Island Division has been diminished by sedimentation of wetlands and water bodies, loss of bottomland forest, and destruction of native grasslands. Re-establishing terrestrial food sources and reliable wetland habitat would benefit migratory birds and local wildlife.

The recommended project features for the Fox Island Division HREP are designed to meet the project's goal to rehabilitate and enhance wildlife habitat. These goals would be met by reducing forest fragmentation and enhancing forest diversity; enhancing and expanding existing wetlands; and by restoring native grassland.

The future with-project scenario shows increased habitat value over the 50-year project life for the target species. This increase represents measurable outputs of improved habitat quality and preferred habitat quantity.

The project is consistent with and fully supports the overall goals and objectives of the Upper Mississippi River System-Environmental Management Program, the North American Waterfowl Management Plan, and the Partners in Flight Program.

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of this habitat rehabilitation and enhancement project against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. In my judgment, this project, as proposed, justifies expenditure of Federal funds. I recommend that the Mississippi Valley Division Engineer approve the proposed project to include: planting 275 acres of mast-producing trees on current farm fields; planting 98 acres of native prairie grasses and forbs on a former farm field; and installing water supply and control facilities for enhancement of 78 acres of wetland habitat. The wetland enhancement facilities would include three water supply pumps, two culverts, five water control structures, and connecting channels. New gravel roads would be constructed for access to the water supply pumps. 560 acres of farmland would be allowed to naturally revegetate into wet floodplain forest.

The current estimated Federal construction cost of this project is $2,098,130. Total Federal estimated project cost, including general design and construction management is $3,071,130. The full implementation of this project would generate 178 average annual habitat units.

At this time, I further recommend that funds in the amount of $120,000 be allocated for the preparation of project plans and specifications.

19 SEP 2006
(Date)

Robert A. Sinkler
Colonel, U.S. Army
District Engineer

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

FINDING OF NO SIGNIFICANT IMPACT

I have reviewed the information provided by this Environmental Assessment, along with data obtained from Federal and State agencies having jurisdiction by law or special expertise, and from the interested public. I find that the proposed habitat rehabilitation and enhancement project at Fox Island Division would not significantly affect the quality of the human environment. Therefore, it is my determination that an Environmental Impact Statement is not required. This determination may be reevaluated if warranted by further developments.

An array of management features and alternatives was considered for habitat enhancement, including:

A. No Federal Action
B. Reforestation
C. Wetland Enhancement
D. Native Grassland Restoration

The preferred alternative includes 275 acres of reforestation by planting mast-produced trees, 78 acres of wetland enhancement, and 98 acres of native grassland restoration. The reforestation would convert current open land into hard mast forest by transplanting rootstock from local nurseries and by planting hard mast seeds directly on site. The wetland enhancement includes development of new water sources to provide year-round water supply capability and construction of water control structures to improve management of water levels within the wetland. The improvements would provide the capability of lowering water levels in the spring and early summer to promote plant growth that would provide additional forage for migrating waterfowl when the wetlands are re-filled in the fall. The native grassland restoration would expand this region's tall grass prairie. The benefits would be leveraged by the continuity between this prairie and the Missouri Department of Conservation's Rose Pond Conservation Area Prairie.

Factors considered in making a determination that an Environmental Impact Statement was not required are as follows:

A. The project is anticipated to improve the value of Fox Island Division for migratory and resident birds and other wildlife species.
B. Aside from temporary disturbance, no long-term adverse impacts to natural or cultural resources are anticipated. No endangered or threatened species, either State or Federal, would be adversely affected by the project action.
C. The project is in compliance with Sections 401 and 404 of the Clean Water Act.
D. The project is in compliance with Section 106 of the National Historic Preservation Act based upon the avoidance of all impacts to archaeological site 23CK345 by restricting the proposed mast tree plantings both within the site area and within a 100-foot wide buffer zone all around the site boundary.
E. No significant social or economic impacts are expected to occur as a result of this action.

19 SEP 2006
(Date)

Robert A. Sinkler
Colonel, U.S. Army
District Engineer

REFERENCES

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CORRESPONDENCE

APPENDIX A

DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-13F)

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX A
CORRESPONDENCE

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APPENDIX A-A

Open House After Action Report by Ms. Marsha Dolan, Rock Island District, U.S. Army Corps of Engineers

Fox Island
EMP
06 August 2002 Site Visit

1. Background (Ellis):
   - FWS began acquiring land in the late 80s. A major buy out occurred after the 1993 flood.
   - Early 90s the FWS put a fact sheet for HREP together. This fact sheet detailed a more extensive effort then the latest fact sheet (which initiated this DPR).
   - Mostly agriculture land with some remnant sloughs and forests
   - Some leased forming still occurring
   - FWS began reforestation efforts.
   - Refuge purpose is for migratory birds and floodplain habitat restoration
   - In the late 90s, a few water control structures that were added
   - Limited public lands in pool 20
   - Road access is difficult/weather dependent
   - Several tracts with in project area are not owned by FWS (this was clarified later as being the islands that are not included in the project boundary)
   - Cottonwood and silver maple are dominant
   - Hydric soils – not sure how dependent on river levels
   - There is an eagle nest located and marked on Stanley's map.

2. Proposed project features/needs/considerations

   <u>Reforestation</u>
   - Want RPMs planted. Possibly some bare root to lower costs
   - Desire more acorns and pecans… want diversity
   - No clearing to plant trees will be necessary
   - Suggested setting up a long-term planting plan, plantings every 5 to 10 years to increase sustainability
   - Perhaps option of dredging to lower elevations to lessen the amount of structural components – caution was given regarding the inconsistencies in soil and the possibility of hitting a sand lens

   <u>Prairie</u>
   - 90 acres (Logsden tract) west of the levee: Proposed prairie restoration
   - Bluestem, switch, prairie cord grass for grasslands – coordinate with Mike Flaspohler
   - Forbes are susceptible to frequent spring burns. MDOC is experimenting with Fall/early winter burns to increase the success rate of Forbes.
   - Key in on plants used at the Rose Pond Conservation area

Water features

- Silver/Nelson Lake used to be deeper and used for fishing – possible dredging site
- Wells or pumps will be primarily used during the fall. Source of water is a concern – wells may have better water quality.
- Proposed pump station just north of coin pond
- Flap gates instead of pumping to capitalize on flashiness of Fox River should be considered. Again, concern of water quality was brought up regarding this option. Other suggestions included a weir.
- Wells/pumps are an option for increasing water during the fall

Misc.

- Some concern was expressed regarding the schedule. Need to coordinate all work so that FWS can plan ahead.
- Restoration efforts will be concentrated on upper end of project site.
- Dave will get Stanley farmer information. There were some houses on the site
- Refuge is closed during migration
- When designing project features requiring maintenance, need to consider access.
- Preference is for a low maintenance approach.

3. Action Items for me:
   - DMMP Sites: Info on DMMP sites in the project area has been obtained from the DMMP database and will be sent to Stanley along with site visit notes. Highlighted items are ones occurring on the right bank (same side as project area).
   - Original Photos: Obtain original photos and loan them to Stanley so that they can scan them in, as needed, to get better resolution for maps.
   - Hazard Plan – sent email on 08 August 2002 to Dan and Becky stating that the site safety plan will be required.

Stanley Consultants INC

MEETING NOTES

No. 1

Date: Thursday, June 19, 2003

Place: Holiday Inn Express, Keokuk Iowa

Project/Purpose: Fox Island HREP DPR
Phase 2 Kickoff

Attendees:

USFWS:
- Dave Ellis - Manager - Great River Wildlife Refuge (GRWR), Annada, MO
- Candice Chambers – Refuge Operations Specialist - GRWR, Annada, MO
- Dick Steinbach -- Manager – Mark Twain NWR Complex, Quincy, IL

Missouri Department of Conservation:
- Darlene Swearingen, Manager, Rose Pond Conservation Area

USACE – Rock Island District
- Daren Niles, PM-M
- Joe Lundh, OD-MN
- Rachel Fellman ED-DG
- Heather Whitman ED-HH
- Charlene Carmack PM-A

Berlin Consulting
- Joe Berlin

Stanley Consultants
- Mike Knott, Biology
- Becky Svatos, Environmental Engineering
- Heather Cross, Student Intern
- Dan Miller, Project Manager

Notes By: Dan Miller and Heather Cross

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

---

1) Miller presented project background, including:
   - Review of Phase 1 project
   - Review of material included in current version of DPR
   - Plan for developing the remaining chapters of DPR
   - Discussion of new items to include in possible project alternatives:
     - Dredge Nelson Lake to make deep water aquatic habitat
     - Create a wetland on the parcel east of the railroad by pumping water out of Grey's Chute, using portable surface water pumps.
2) Ellis added information about the USFWS plans and needs, emphasizing the need for access to the pumping sites by construction of aggregate-surfaced roads.
   Steinbach indicated the Service is not interested in inland deep-water habitat, such as Nelson Lake, because it would be prone to sedimentation during flooding and prone to becoming dominated by trash fish. The fisheries biologists have not shown any interest in this lake.

4) Steinbach indicated the Service was more interested in the deep water potential at Grey's Chute than Nelson Lake. This led to some discussion about the causeway across the head of Grey's Chute, which does serve to reduce sedimentation within the chute, but raises some concern for Ellis. The causeway is maintained by the gun club that occupies Grey's Island.
5) Svatos discussed elevated Manganese levels detected in the Fox River at the Wayland gaging station. Ground water data by USGS also indicates high levels. Miller will discuss with Whitman the possibility of testing the water from agricultural wells located on or near the refuge.
6) Discussion of progress on analysis of potential wetland surface area and water volume, based on topography from 1934 plane table maps. The area is quite a bit larger than originally delineated by USFWS, especially in an area labeled Old Lake on the plane table maps (West Central area on east side of the Fox River). There was discussion whether the soils would hold water. (Site visit after meeting detected abundance of hydrophytic plants in the draws in this area).
7) Whitman and Fellman reported that the aerial topography that was developed for the flow frequency study is now available. Stanley Consultants will employ this information in the detailed demarcation of wetland and upland areas.
8) Miller presented details of cost estimate for potential project features. There were several suggestions, including:
   - FWS prefers larger wells, bigger pumps. Miller and Ellis will investigate the optimum pumping rate, based on the volume of water needed, the time frame for pumping it, and expected seepage and evaporation rates. Ellis wants SCI to revisit the idea from phase 1 to pump water from the Mississippi under the railroad to the Slim Slough and Coin Pond wetlands. The surface water pumps may be able to pump the higher flow rates more economically than well pumps. If this measure is taken, the parcel east of the railroad may be more easily incorporated into the plan, using the same pump to fill both wetlands.
   - Dredging Nelson Lake was a non-starter. Miller reported that the nearly $2 Million cost represented the effort to dredge 5 feet from the entire plan area of the lake. A smaller area could be dredged for less. The dredged material could not be placed as a berm around the lake (thus isolating the lake from the more frequent floods that cause rapid sedimentation) without substantial clearing. The spoils could be placed in a field northeast of the lake which has been designated for mast hardwood plantings. The spoils could add a couple feet of elevation to the area if the material is good for growing such trees. Due to the cost of the dredging, the inability to prevent flood induced sedimentation, and the difficulty in keeping unwanted aquatic species out of the lake, dredging was not considered a good alternative, and will not be developed further. The alternative will be discussed in Chapter 4 of the DPR but not evaluated using the Wildlife Habitat Assessment Guide (WHAG) or incremental analysis in Chapter 5.
   - Discussion of unit cost for planting prairie. Wearingen has information on the Rose Pond tract, but there are some differences between that and the Fox Island tract. MDOC has some little blue stem seed available, but Fox Island will probably include a mixture of grasses and forbs. Wearingen will ask the MDOC natural resources specialist to survey the Logsden tract. There may be rare plant species present on the site already.
   - Discussion of the unit cost per tree for the hardwood plantings. MDOC reported costs as low as $7 to $10 per tree. SCI used $40 in the estimate. Niles reported that $40 was in line with costs experienced on other projects and that the Corps has seen prices as high as $70. Planting costs should include maintenance at least until the saplings are well established. Planting may take place over a 3-year period. Steinbach asked that Lundh work SCI on the tree planting plan. SCI will meet with Lundh during the week of July 7, then discuss the results of that meeting with Ellis.

Stanley Consultants will prepare a revised cost estimate with these changes for use in the incremental cost/benefit analysis. The estimate will be discussed with Ellis prior to incorporating into the

economic model.

10) The Corps reported that the archaeological investigation has been contracted.

11) Following a lunch recess, Carmack presented the baseline WHAG for this project. Existing conditions for each of the proposed features; wetland enhancement, re-forestation, and prairie restoration, were discussed and consensus was reached for the appropriate values to assign. Carmack reported that further models will consider target years 1 (end of planting season) and 25. Other years may be added if needed.

12) The meeting adjourned at about 3:30. In two separate groups, FWS (Ellis and Chambers) and Stanley Consultants (Miller, Knott, Svatos, Cross and Berlin) visited the site. Photos by Stanley Consultants from that visit are attached (Apologies for the unsteady hand and poor focus. The camera takes some getting used to). Observations by Stanley Consultants included:

- Coin Pond was full to the top of bank as determined by the tree line. Logsdon Slough was full to the top of bank as evidenced by the line of woody vegetation along the middle reach. Nelson Lake was full to the top of bank. There was no standing water in Slim Slough.
- The "Old Lake" area designated on the plane table maps was dry but there was an abundance of smartweed and other hydrophytic plants in the low-lying areas.
- The causeway to Grey's Island was washed out but water was cascading over the submerged remnants.

Distribution:

Attendees

From: Heather E.Whitman@mvr02.usace.army.mil
Sent: Thursday, July 17, 2003 10:56 AM
MillerDanielP@stanleygroup.com
Darron L.Niles@mvr02.usace.army.mil; Charlene.Carmack@mvr02.usace.army.mil;
el.C.Fellman@mvr02.usace.army.mil
Subject: Fox Island Stage 2 distribution letter address list

Dan,

We looked over the DRAFT Stage 2 coordination letter you handed out on June 19th. The distribution list should be changed to reflect the following:

1) Add everyone from SOW:
Dan Johnson, Heather Whitman, Charlene Carmack, Ron Pulcher, Tom Kirkeeng, Nicolas Davila, Rachel Fellman, Amy Moore, Terri Kirkeeng, Gary Swenson, Wayne Hannel, Dave Ellis, Karen Westphall, Gary Christoff, Mike Flaspohler, Scott Stuewe, NRCS, Rick Nelson

2) From proposed DRAFT distribution list:
Remove Kathy Maycroft
Remove Bill Ohde
Keep Mike Griffin
Keep Karen Westphall (listed in SOW)
Remove Dick Steinbach
Remove Kevin Szcodronski
Keep Richard Nelson (listed in SOW)
Keep U. Gale Hutton
Remove Don Line
Keep Director Western Rivers Operations
Remove Marvin Hubell

3) Add:
Darlene Swearingen from Rose Pond Conservation Area

Let me know if you have any questions.
Thanks,

Heather Whitman
Hydraulic Engineer
US Army Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004
Phone: (309) 794-5836 Fax: (309) 794-5584
email: Heather.E.Whitman@usace.army.mil

Stanley Consultants INC.

TELEPHONE CALL REPORT

Date: July 18, 2003 **Time:** 9:30 am **Project No.:**

To: Dave Meyer **Representing:** Layne-Western

Location: Fenton, MO **Phone No.:** 636-343-3700

From: Brad Roeth **Representing:** SCI

Location: Muscatine **Phone No.:** 563-264-6321

Subject: Fox Island water supply wells

I called Dave to discuss the Fox Island project. Layne-Western is a well drilling company.

To proceed with the groundwater option, he recommended drilling some test holes with an auger rig to sample the material and test the water production. Cost would be $1000 mobilization and $2000/hole, around $10,000 total for the site.

2,000 gpm seems high, even for an alluvial aquifer. 1,000 gpm is pretty common. When I said that the land owner had reported 2,400 gpm, Dave said it was entirely possible if we're in gravel.

50' deep, 20" diameter well would be $60-70,000. 100' deep, 20" diameter well would be around $100,000.

Stanley Consultants INC.

TELEPHONE CALL REPORT

Date:	July 25, 2003	**Time:**	
		Project No.:	
To:	Dick Klassen	**Representing:**	Grosch Irrigation Co
Location:	Mason City, Illinois	**Phone No.:**	877-482-5479
From:	Dan Miller	**Representing:**	SCI
Location:	Muscatine	**Phone No.:**	563-264-6304
Subject:	Well production and cost in Clark County Missouri		

Miller called to find out about this driller's experience and expectations for wells in Clark County.

Klassen has drilled many irrigation wells in northeast Missouri, along the Mississippi River, but it has been several years since he has been there. He reported that he would not expect to be able to produce 4,000 GPM from a single well. He would feel safe with 2,000 GPM and it may be possible to develop 4,000 GPM but 4,000 GPM is getting to a range that is hard to find in that area and if it is found, that rate may shorten the life expectancy of the screens.

Klassen estimated that a 100-foot deep well would cost $25,000. If he supplied the pump, that would cost about $15,000, not including the diesel engine.

From: Knott, Michael
Sent: Monday, July 28, 2003 2:57 PM
To: 'Joseph.S.Lundh@mvr02.usace.army.mil'
Cc: Miller, Daniel
Subject: Fox Island Tree Planting

Joe

I've attached our proposed tree planting plan. The blue-shaded area at the north end is where we propose to direct seed (either broadcast or precision). This area is about 60 acres and is on the highest (elev. 491+) and most accessible portion of the Division. We are thinking oak (bur, red, pin, swamp white), walnut, green ash and sycamore as you suggested. We may also consider pecan and shellbark hickory.

We're proposing seedling or RPM plantings in the green-shaded areas These areas total about 215 acres, all above elevation 488. These plantings may include all of the species we discussed.

We have talked to everyone you suggested and others besides. They all seem to know you. Stan Tate was particularly helpful and I enjoyed talking to Gretchen Cline at Geode. I haven't heard anything negative about direct seeding yet. We are getting cost estimates in the $450-500 range but will probably use a higher/more conservative number in the report.

Please let me know if you see anything that troubles you with the proposed planting and feel free to call if you have any questions (563/264-6293).

Mike

ProposedTreePlanting.pdf (2 MB...

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING - P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF:

August 4, 2003

Planning, Programs, and
Project Management Division

SEE DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers (Corps) is preparing the Definite Project Report (DPR) with Integrated Environmental Assessment (EA) for the Fox Island Habitat Rehabilitation and Enhancement Project (HREP). This project is located on the right descending bank of the Mississippi River in Pool 20 from River Miles 353.6 to 358 5, near Alexandria, Missouri. This project is funded through the Upper Mississippi River System – Environmental Management Program (EMP), under authority of the Water Resources Development Act (WRDA) of 1986. In accordance with the provisions of Section 906(e) of WRDA, cost sharing for general design and construction would be 100-percent Federal The U.S. Fish and Wildlife Service (USFWS) is the project sponsor.

The Fox Island Division of the Great River National Wildlife Refuge is comprised of 2,100 acres of land and water within the Mississippi River floodplain. About 95 percent of the Division is un-leveed and open to river flood pulses. Currently about 1,200 acres are flood plain forest dominated by silver maple and cottonwood. Higher elevations include a strong pin oak component. Wetlands, backwaters, and sloughs comprise about 300 acres. The remaining 600 acres are currently being farmed to hold them in open condition until reforestation plans can be implemented.

The goal of the Fox Island HREP is to conserve and enhance the quality and diversity of wildlife habitat. The project would allow full development and management potential of the Fox Island Division. The following objectives have been identified to meet the restoration goals: (1) reduce forest fragmentation; (2) enhance existing wetlands; and (3) restore native grasslands. Several rehabilitation measures to meet the identified objectives will be addressed and evaluated in the DPR and EA. These measures are described in the following paragraphs (see enclosed map).

a. Bottomland hardwood reforestation would reduce forest fragmentation by creating a large contiguous tract located along a reach of the river currently deficient in managed and protected forests. Planting of the hardwood species would significantly add to the wildlife value of this forest habitat. Numerous neotropical bird species that rely on the river corridor for nesting habitat, as well as migration habitat, would directly benefit.

b. Wetland enhancement would be accomplished by the installation of wells and water control structures. These features would provide improved and reliable wetland conditions on Logsdon Slough, Coin Pond, and Slim Slough. The potential value of these enhanced wetlands is significantly increased due to the scarcity of managed and protected wetlands along the Pool 20 reach of the river. Some gravel road construction may be needed to provide access to the well sites for operation and maintenance.

c. About 90 acres of native grassland would be restored on the Logsdon Tract by seeding abandoned cropland that lies inside the Mississippi-Fox Drainage & Levee District. This restoration is adjacent to the Missouri Department of Conservation's existing native grassland at the Rose Pond Conservation Area.

The project is expected to be beneficial to wildlife habitat with no significant adverse impacts to the quality of the human environment. The project would not increase flood frequency, height, or duration on the Mississippi or Fox Rivers. Most of the work for this project involves the conversion of former agricultural land to bottomland forest and native grassland. Construction would require very little disturbance of existing wildlife habitat. Because construction of the water control features may require placement of fill material into waters of the United States, the project could require processing under Section 404 of the Clean Water Act.

We request your comments concerning the proposed project within 30 days of the date of this letter. We further request any information concerning rare, threatened or endangered species, sensitive habitats, or other important resources in the study area. Additional opportunities to comment will be provided as part of our processing of the initial draft and public review draft DPRs for the subject project.

Stanley Consultants, Inc. has been contracted to coordinate the development of the DPR. If you have any questions or need additional information, please call Mr. Dan Miller, Senior Civil Engineer, at Stanley Consultants, telephone 563/264-6304. Written comments may be sent to the address below, or emailed to the following address: MillerDanielP@StanleyGroup.com.

Stanley Building
ATTN: Dan Miller
225 Iowa Avenue
Muscatine, Iowa 52761

Sincerely,

Mark A. Cornish
for

Kenneth A. Barr
Chief, Economic and Environmental
Analysis Branch

Enclosure

DISTRIBUTION LIST

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Annada, MO 63330

Karen Westphall
U.S. Fish and Wildlife Service
Mark Twain Refuge
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Quincy, IL 62301

Richard Nelson
U S. Fish and Wildlife Service
4469 – 48th Avenue Court
Rock Island, IL 61201

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Missouri Department of Conservation
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Mike Flaspohler
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Darlene Swearingen
Missouri Department of Conservation
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Edina, MO 63537

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Natural Resources Conservation Service
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Kahoka, MO 63445-9650

Mike Griffin
Iowa Department of Natural Resources
206 Rose Street
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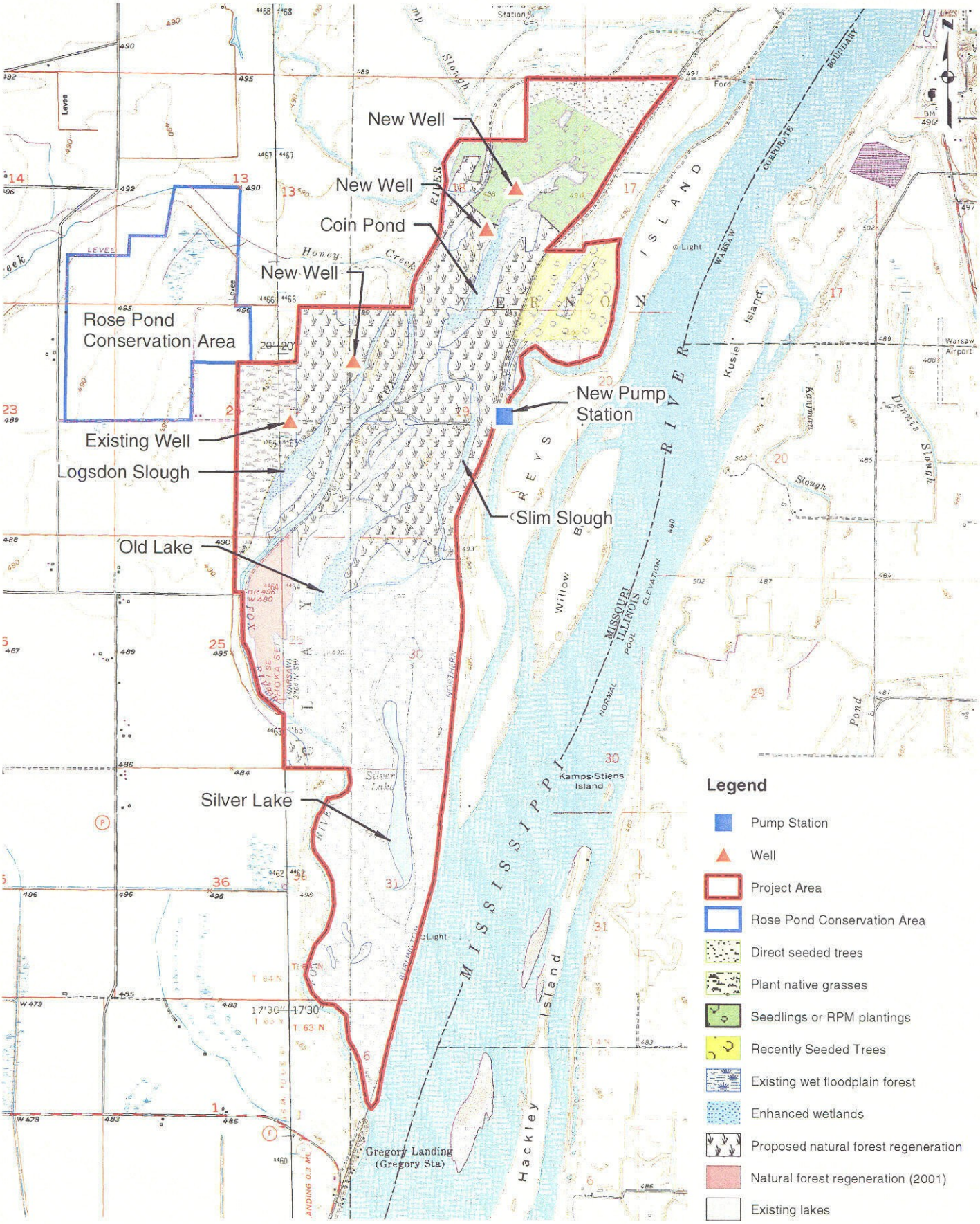
U. Gale Hutton
Water Resources Protection Branch (WWPD/WRPB)
U.S. Environmental Protection Agency
Region 7
726 Minnesota Avenue
Kansas City, KS 66101

Director
Western Rivers Operations (OB)
U.S. Coast Guard, Eighth District
1222 Spruce Street
St. Louis, MO 63103-2835



3000 0 3000 6000 Feet

Proposed Enhancements A-12

From: Whitman, Heather E MVR [Heather.E.Whitman@mvr02.usace.army.mil]
Sent: Thursday, August 14, 2003 11:15 AM
'knottmichael@stanleygroup.com'
Niles, Darron L MVR; 'Miller, Daniel'
S ct: HTRW for Fox Island DPR

Mike,
As per our phone conversation, I did some checking. It would be best to include the entire THREW as an appendix in the DRY instead of an abbreviated version. A good example to look at is Lake Odessa (I believe I gave Dan Miller a CD copy of it).

Please let me know if you have any more questions.

Heather Whitman
Hydraulic Engineer
US Army Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004
Phone: (309) 794-5836 Fax: (309) 794-5584
email: Heather.E.Whitman@usace.army.mil

A-13

Stanley Consultants INC.

TELEPHONE CALL REPORT

Date: August 21, 2003 **Time:** 1:16 **Project No.:** 15845.04.00

To: Heather Cross **Representing:** Stanley Consultants, Inc.

Location: Muscatine, Iowa **Phone No.:** 563.264.6779

From: Steve Sutter **Representing:** Landmark Irrigation, Inc.

Location: Taylor, Missouri **Phone No.:** 573.393.2497

Subject: Fox Island Well Drilling

Steve is the owner of Landmark Irrigation. His company drilled all of the wells in the area on and around Fox Island. He is very knowledgeable about the area and its groundwater. He would like to be notified when it is time to bid for the well drilling.

A 4000 gpm well is very unlikely in the area. To get one would require 5-20 test holes. If test holes showed a possibility of 4000 gpm, the well would have to be built on a much larger scale which would be very expensive. There is a chance that after going to great expense to get this well, the ground would not continue to produce 4000 gpm, and the owner would have a very expensive 4000 gpm well that delivers 600 gpm.

If this well was desired, the owner would need to be willing to pay for the extra test holes, and would have to have an alternate plan in case the final well did not produce the desired amount.

Steve strongly recommends going with a combination of two wells at 2000 gpm. There is about an 80% guarantee that this is possible from the area. The cost from Steve for these wells is budgetary and should not be considered a quote.

The price of a fully constructed well includes three test holes and is $18,000.
The price of the pump to deliver 2000 gpm is $8,000.
These prices are for each well not all of the wells together.

It is important to note that this price includes the cost of test holes. When evaluating bids, the cost of drilling test holes should be considered because test holes are necessary to get the desired result. The area that Fox Island Division is located has many irregularities in its ground structure. It is not recommended that wells be drilled in this area without drilling at least 3 test holes first.

Stanley Consultants INC.

MEETING NOTES

No. 2

Date: August 29,2003

Place: Hawkeye Restaurant, Keokuk, IA

Project/Purpose: Fox Island HREP

Attendees:

Heather Whitman	USACE – Hydraulic Eng./PM
Darron Niles	USACE – Project Management
Dan Johnson	USACE – Environmental Engineering
Charlene Carmack	USACE – Environmental
Joe Lundh	USACE – Miss River Project
Dave Ellis	USFWS – Great River NWR
Scott Stuewe	IL DNR
Joseph Berlin	Berlin Consulting – Economist
Becky Svatos	Stanley Consultants
Mike Knott	Stanley Consultants
Dan Miller	Stanley Consultants

otes By: Dan Miller

The following meeting notes set forth our understanding of the discussions and decisions made at this meeting. If you have any questions, additions, or comments, please contact the writer immediately. If we do not hear from you, we will assume that our understandings are the same. We are proceeding based on the contents of these meeting notes.

Clarification: The Missouri Department of Conservation (MDC) will be included as a local sponsor for this project. MDC is not contributing financially.

At the request of the MDC, Fish and Wildlife Service (FWS) has included in their master plan a boat ramp on the Fox River where the bridge washed out. Dave Ellis clarified that this boat ramp should not be included in this project.

The recommended plan currently shows tree planting to elevation 489. Dave Ellis would like to see

crops on the land to keep it open until the recommended plan is implemented, there may be a problem. However, the northern-most part of the refuge where the tree plantings are planned is also the best farm nd and it should be possible to find a farmer to continue farming that area. The areas that the farmers e having the most difficulties with are those planned for natural forest regeneration.

It may be fiscal year 2006 before this plan is constructed. The tree plantings can be expedited because they do not require a design phase and that work would be handled by a separate contractor.

FWS planted acorns on the 75-acre east Winkelman tract a few years ago. They are not sure how the trees are doing, but can check on them later in the fall when some of the brush has died down. The recommended plan will include tree planting over this area. If these trees are doing well, the acreage in the plan can be adjusted downward.

Knott led a discussion of the tentatively proposed recommended. Each plan feature was discussed and the following plan was established:

- Plant 215 acres of RPM trees on north end of the division. This number includes 75 acres on the East Winkelman Tract. If, at a later date, it is determined that the previous acorn seeding on this tract was successful, the planting acreage will be reduced to 140 acres.

- Seed 60 acres of the highest ground on the northern border of the division with mast producing trees by precision drilling. Seeds will be planted on 4-6" centers in rows spaced 9-10' apart with a target population of 15,00 seedlings per acre.

- Allow 564 acres of open area to regenerate bottomland forest naturally.

- Install new well and pump at Logsdon Slough. This feature includes a 200-foot channel, lined with rip rap, which will discharge into the slough. A portable diesel engine and fuel wagon will also be included.

- Install new well and pump at the north end of Coin Pond. This feature will include a 200-foot lined channel and a portable engine and fuel wagon. Approximately 4000 feet of gravel access roadway is also included in this feature.

- Install new angled-shaft surface water pump at Grey Chute for water supply to the Coin Pond/Slim Slough/Old Lake wetland complex. The pump installation will include a sheet pile wall, rip rap bank protection, 24" diameter force main with jacked railroad crossing, 300 feet of rip rap-lined channel, 250 feet of gravel access roadway, portable engine and fuel wagon.

The work at the north end of Slim Slough will also include berm construction. The one on Coin Pond and the northern one on Slim Slough will replace existing structures that are currently not functioning properly due to siltation in the channels.

- Plant 98 acres of native grasses and forbs on Logsdon Tract for prairie restoration.

Stuewe will check with Mike Flaspohler on tree planting costs on the Ted Shanks Conservation Area near Ashburn, Missouri.

Ellis reported that the Logsdon Slough stop log structure is in need of some repair but that will be done by FWS and will not be part of this HREP.

Johnson gave SCI review comments on the cost estimate. SCI will address comments.

Ellis indicated that the levee district would likely be taking 2-3 acres of the Logsdon Tract.

Darron Niles mentioned that the cost estimate should not include natural forest regeneration.

Heather Whitman stated that the proposed enhancement plan should not show natural forest regeneration.

Joe Berlin gave a presentation on the Incremental Cost Analysis.

It was decided that the No Action alternative would include natural forest regeneration. "No Action" ill assume that cultivation will be discontinued.

Charlene instructed Joe to only include precision seeding and RPM planting in his analysis. Seedling planting and broadcast seeding need not be included.

Dave Ellis will prepare some text on the importance of pumping reliability for Charlene to include in the WHAG analysis.

Dan Johnson indicated that SCI and the Corps should revisit and revise the schedule to more accurately reflect reality.

Dave Ellis will check on current cultivation acreage and give SCI a current number.

Stanley Consultants INC.

600 0 600 1200 1800 2400 Feet

A-18

Proposed Tree Planting

Stanley Consultants INC

TELEPHONE CALL REPORT

Date:	September 9, 2003	**Time:**	
Project No.:			
To:	Dick Klassen	**Representing:**	Grosch Well Drilling Company
Location:	Mason City Illinois	**Phone No.:**	
From:	Dan Miller	**Representing:**	SCI
Location:	Muscatine	**Phone No.:**	5632646304
Subject:	Electircal vs Diesel motors for irrigation pumps		

Klassen reported that it is common to install electrical motors for irrigation wells as high as 20 feet above the ground, in order to keep the motor out of floods. Typically the cost of the electric motor and panel run about the same cost as diesel, but the cost of bringing power to the site is higher.

The states usually require the well casing to extend at least 2 feet above the 50-year flood elevation but his company often puts the electric motors higher than that. It does not cost very much more to raise the motors an extra three or four feet.

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters

2901 West Truman Boulevard, P.O Box 180, Jefferson City, Missouri 65102-0180

Telephone: 573/751-4115 ▲ Missouri Relay Center: 1-800-735-2966 (TDD)

JOHN D. HOSKINS, Director

September 22, 2003

RECEIVED
STANLEY CONSULTANTS
SEP 26 2003
GOVCOM

Mr. Dan Miller
Stanley Building
225 Iowa Avenue
Muscatine, Iowa 52761

Dear Mr. Miller:

RE: Fox Island Habitat and Rehabilitation and Enhancement Project (HREP)
Great River National Wildlife Refuge, River Miles 353.6 to 358.5

Department of Conservation (Department) staff reviewed your August 4, 2003, notice on the Fox Island HREP and our comments are noted below. We also provide information on species of conservation concern located near the project site. This project proposes bottomland hardwood reforestation, installation of wells and water control structures, and native grassland plantings on Fox Island Division.

As you note in your description of the Fox Island Division, about 95 percent of the site is unleveed and open to river flood pulses. It currently comprises most of the unleveed acreage of the Pool 20 floodplain and is functioning as a natural floodplain now. Areas functioning as such are rare on the river and it would be a loss to close the area off from the river. The description of the project does not go into detail on the use of water control structures that will be built on the site. Therefore we have several questions regarding the design and purpose of these structures and question whether the site will be closed off from natural river flooding events.

You note that you plan to install wells and water control structures to provide improved and reliable wetland conditions on Logsdon Slough, Coin Pond, and Slim Slough. Does this include constructing levees that will prevent natural river flooding of the area? If so, where will the levees be located? What will be their height and width? Are the pumps and water control structures primarily to be used for maintaining water in the sloughs all year long? If these structures will not be used for maintaining water in the sloughs, what is their purpose? Will natural river flooding events still occur on-site?

Several state listed animals and plants are known to occur on the adjacent Rose Pond Conservation Area (CA) or are located nearby and should be taken into consideration in project design and planning. As scheduling permits, Department staff is available to assist Fox Island staff in searching for these species.

Central mudminnow (*Umbra lima*)—state Endangered and SRANK of S1 (critically imperiled). This species occurs in a private marsh near Wayland, Missouri, and a historic location is known from a slough in Clark County. It is likely that other small populations exist in marshes along the upper Mississippi River from Clark County southward. We recommend that the area be evaluated for the presence of central mudminnows prior to construction activities.

COMMISSION

STEPHEN C. BRADFORD
Cape Girardeau

ANITA B. GORMAN
Kansas City

CYNTHIA METCALFE
St. Louis

LOWELL MOHLER
Jefferson City

A-20

Two state listed turtles occur on Rose Pond CA and may occur on Fox Island: Illinois mud turtle (*Kinosternon flavescens spooneri*), and Blanding's turtle (*Emydoidea blandingii*). Both turtles are state Endangered and have an SRANK of S1 (critically imperiled). Studies of the Illinois mud turtles on Rose Pond CA reported that many turtles moved several hundred yards toward the Fox Island site, with some moving two or more miles from Rose Pond CA. Fox Island is definitely within range of both species. Blanding's turtles are found in shallow water along the edges of marshes, ponds, sloughs, and drainage ditches that have abundant aquatic and emergent vegetation and a muddy bottom. Illinois mud turtles are found in marshes, oxbow lakes, and in flooded fields associated with sandy soils. If suitable habitat exists on Fox Island, these species could occur on-site. We recommend that the site be evaluated for the presence of these two turtle species. Management recommendations for these two species include extending the planned prairie restoration to the shore of Logsdon Slough, and that no trees be planted along the Slough where the planned prairie restoration borders it. This would provide the turtles with access to the slough.

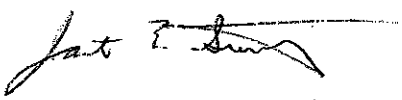
Western Fox Snake (*Elaphe vulpina vulpina*)—State Endangered and SRANK of S1 (critically imperiled). This snake occurs on Rose Pond CA. Western Fox Snakes are found in marshes and wet prairies, though it may be found in lowland forest. We recommend that the area be evaluated for the presence of this snake prior to construction activities.

Bald eagle (*Haliaeetus leucocephalus*)—Federally Endangered and SRANK of S2 (imperiled). A nest is known to exist in Section 19, at about the location of the new pump station. However, as of 2000, no young had ever been produced on this site. Fox Island staff may have more current information on nesting eagles.

Stylisma pickeringii var *pattersonii*—SRANK of S1 (critically imperiled). This plant was found on the sandy soil of the slope of the levee located in Section 24, in the NE4. Only one other site is known to exist in Missouri. This species prefers sandy soils that are relatively open. If this levee will be undisturbed by the project, this plant is not a concern.

Thank you for the opportunity to comment and provide input on this project. If you have questions regarding these comments, please contact me at (573) 522-4115 Extension 3372 or at Janet.Sternburg@mdc.mo.gov

Sincerely,



JANET E. STERNBURG
POLICY COORDINATOR

JEE:dcl
c: Greg Gremaud, Missouri Department of Conservation
Travis Moore, Missouri Department of Conservation
Ken Brummett, Missouri Department of Conservation
Darlene Swearingen, Missouri Department of Conservation

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November 20, 2003

Planning, Programs, and
Project Management Division

Mr. Mark Miles
Director, State Historic Preservation Office
Deputy State Historic Preservation Officer
Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

Dear Mr. Miles:

The Rock Island District of the U.S. Army Corps of Engineers (Corps) has reviewed the draft report entitled Phase I Archaeological Survey and Geomorphological Evaluation for Historic Properties, Fox Island EMP Project, Clark County, Missouri, dated September 2003 (Enclosure 1). Art Hoppin and David W. Benn of Bear Creek Archeology, Inc., Cresco, Iowa, prepared the report under Corps Contract No. DACW25-03-D-0001, Work Order No. 0001.

Three historic property sites were located. The Corps concurs that the historic period Sites 1149-2 and 1149-3 are not eligible for inclusion in the National Register of Historic Places (NRHP). The Corps also concurs that prehistoric Site 1149-1 is potentially eligible for inclusion in the NRHP.

Based on this report's recommendation, the Corps will avoid all impacts to Site 1149-1 by restricting the proposed mast tree plantings within the site area and within a 100-foot-wide buffer zone around the site.

Based upon the restriction above, the Corps has determined that this project will have "no effect" on historic properties listed in, or eligible for listing in, the National Register of Historic Places, and the Corps requests your response within 30 days from the date of this letter.

If we do not hear from you within this time, we will proceed with the project as described here [36 CFR 800.3(c)(4)].

If you have any questions regarding this matter, please call Mr. Ron Pulcher of our Economic and Environmental Analysis Branch, telephone 309/794-5384, or write to our address above, ATTN: Planning, Programs, and Project Management Division (Ron Pulcher).

Sincerely,

ORIGINAL SIGNED BY

Kenneth A. Barr
Chief, Economic and Environmental
Analysis Branch

Enclosure

MFR: Letter requesting comments from the Missouri State Historic Preservation Office regarding the subject project.

CF (all wo/encl):
Dist File (PM-M)
PM-A (Pulcher, Carmack, Cornish)
PM-M (Perk, Hubbell, Niles)
ED-HH (Schwar)

A-23

STATE OF MISSOURI

Bob Holden, Governor • Stephen M. Mahfood, Director

DEPARTMENT OF NATURAL RESOURCES

www.dnr.state.mo.us

Rec'd in PM-A
DEC 15 2003

December 9, 2003

Kenneth A. Barr, Chief
Economic & Environmental Analysis Branch
Corps of Engineers, Rock Island District
P.O. Box 2004
Rock Island, Illinois 61204-2004

Re: Fox Island EMP Project (COE) Clark County, Missouri

Dear Mr. Barr:

Thank you for submitting information on the above referenced project for our review pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which requires identification and evaluation of cultural resources.

We have reviewed the September 2003 report entitled *Phase I Archaeological Survey and Geomorphological Evaluation for Historic properties, Fox Island EMP Project, Clark County, Missouri* by Bear Creek Archeology, Inc. Based on this review it is evident that a thorough and adequate cultural resources survey has been conducted of the project area. We concur with your recommendation that archaeological sites 1149-2 and 1149-3 are not eligible for inclusion in the National Register, and that archaeological site 1149-1 may be eligible for the National Register of Historic Places. We also concur that the proposed project will have **no adverse effect** on site 1149-1, on the condition that mast tree plantings are restricted within the site area, and within a 100-foot-wide buffer zone around the site.

Please be advised that, should project plans change, information documenting the revisions should be submitted to this office for further review. In the event that cultural materials are encountered during project activities, all construction should be halted, and this office notified as soon as possible in order to determine the appropriate course of action.

If you have any questions, please write Judith Deel at State Historic Preservation Office, P.O. Box 176, Jefferson City, Missouri 65102 or call 573/751-7862. Please be sure to include the **SHPO Log Number (003-CK-04)** on all future correspondence or inquiries relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Mark A. Miles

Mark A. Miles
Director and Deputy State
Historic Preservation Officer

MAM:jd

c Ron Pulcher, COE/RI

CF: PM (DIST FILE)
PM-A (PULCHER)
PM-A (CARMACK)
PM-A (CORNUSH)
PM-M (BEEK, HURBELL)
PM-M (NILES)
ED-H H (SCHWAR, H)

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January 28, 2004

Planning, Programs, and
Project Management Division

Mr. Don Klima
Chief, Eastern Division Project Review
Advisory Council on Historic Preservation
Old Post Office Building, #809
1100 Pennsylvania Avenue, NW
Washington, DC 20004

Dear Mr. Klima:

The Rock Island District of the U.S. Army Corps of Engineers (Corps) is providing advance notice under 36 CFR 800.8(c) to the Advisory Council on Historic Preservation and the Missouri State Historic Preservation Officer (SHPO) that it intends to use the process and documentation required for the preparation of an EA/FONSI or an EIS/ROD to comply with Section 106 of the National Historic Preservation Act, in lieu of the procedures set forth in 36 CFR 800.3 through 800.6. This notice applies to the Fox Island Habitat Rehabilitation and Enhancement Project, Clark County, Missouri. Please reference Missouri SHPO Log No. 003-CK-04.

If you have any questions, please call Mr. Ron Pulcher of our Economic and Environmental Analysis Branch, telephone 309/794-5384, or write to our address above, ATTN: Planning, Programs, and Project Management Division (Ron Pulcher).

Sincerely,

ORIGINAL SIGNED BY

Kenneth A. Barr
Chief, Economic and Environmental
Analysis Branch

MFR: Transmittal of 36 CFR 800.8(c)
Notice for use of NEPA procedures
to address Section 106 of the NHPA.
Note: Letters individually addressed
to ACHP and MO SHPO (see Dist List).

CF:
Dist File (PM-M)
PM-A (Pulcher, Cornish)
PM-M (Perk, Hubbell, Niles)
ED-HH (H. Schwar)

A-25

DISTRIBUTION LIST

Mr. Don Klima
Chief, Eastern Division Project Review
Advisory Council on Historic Preservation
Old Post Office Building, #809
1100 Pennsylvania Avenue, NW
Washington, DC 20004

Mr. Mark Miles
Director, State Historic Preservation Office
Deputy State Historic Preservation Officer
Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office
4469 48th Avenue Court
Rock Island, Illinois 61201
Phone: (309) 793-5800 Fax: (309) 793-5804

IN REPLY REFER TO:

FWS/RIFO

RECEIVED
STANLEY CONSULTANTS
AUG 26 2004
GOVCOM

August 23, 2004

Colonel Duane P. Gapinski
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Gapinski:

This letter constitutes our draft Fish and Wildlife Coordination Act report for the Fox Island Division Habitat Rehabilitation and Enhancement Project (Fox Island Division HREP) located on the west bank of the Mississippi River two miles downstream of Alexandria, Missouri. It has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); the Endangered Species Act of 1973, as amended; and in accordance with the U.S. Fish and Wildlife Service's Mitigation Policy.

The Fox Island Division HREP is a component of the Upper Mississippi River System Environmental Management Program (EMP) authorized in Section 1103 of the Water Resources Development Act of 1986. The goal of the EMP is to implement "...numerous enhancement efforts...to preserve, protect, and restore habitat that is deteriorating due to natural and man-induced activities."

PROJECT OBJECTIVES

The goal of the Fox Island Division HREP is to rehabilitate and enhance the quality and diversity of wildlife habitat. The goal should be achieved through the expansion of wet, bottomland forests, establishment of mast-producing forests, enhancement of wetlands, and restoration of tallgrass prairies.

A-27

DESCRIPTION OF THE PROJECT AREA

The study area is located in Clark County, Missouri, between Upper Mississippi River Miles (RM) 358.5 and 353.6 in Pool 20. The 2,033-acre area is entirely in Federal ownership located in the Fox Island Division of the Great River National Wildlife Refuge (Division), which is part of the Mark Twain National Wildlife Refuge Complex. The project area is comprised of low-profile bottomland and contains several bodies of water including: Nelson Lake, Coin Pond, Logsdon Slough, Slim Slough, and Old Lake.

The Division is currently managed by the U.S. Fish and Wildlife Service as part of the Great River National Wildlife Refuge. The primary purpose of the Refuge is to provide resting and feeding habitat for resident and migratory birds, especially waterfowl. Habitat for state and federally listed species, shorebirds, and many other wildlife species is also provided. Approximately 925 acres of the Division are floodplain forest, dominated by silver maple and cottonwood, with pin oaks prevalent in higher elevation areas. Wetlands, sloughs, and oxbows comprise about 111 acres of the Division. The remaining 997 acres are a combination of farmland, abandoned fields, and areas recently planted with trees. Approximately 621 acres are being farmed to maintain open areas for hardwood reforestation. Cultivation is variable from year to year because of flooding.

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

By copy of our letter dated October 15, 2003, we provided a list of federally listed threatened and endangered species known to occur in Clark County, Missouri.

The federally listed endangered Topeka shiner (*Notropis topeka)* is known to occur in Clark County. However, Topeka shiner habitat is not found in the project area; therefore, the project should not impact the Topeka shiner.

The federally listed endangered fat pocketbook mussel (*Potamilus capax)* is a large river species and historically has been known to occur in the main stem of the Mississippi River near the Division. No work is planned in the main stem of the river, and no impact to the species should occur.

The federally listed threatened bald eagle (*Haliaeetus leucocephalus*) occurs on the Division as a winter resident, and a bald eagle nest exists in an area adjacent to the Division. The construction of the project will not occur during the nesting season and will be outside of the proximity of the nest; therefore, the nest would not be disturbed by this project. A few trees must be removed to construct the surface water pump station, but this activity will be managed to avoid disturbance to bald eagles and damage to their habitat. No trees will be removed when eagles are present. Therefore, the project is not likely to adversely affect the bald eagle.

The federally listed endangered Indiana bat (*Myotis sodalis)* also may occur in the project area. According to the environmental assessment, there are no known maternal roost trees for Indiana bats on the Division. Very few trees would be removed for this project. An Indiana

bat habitat suitability survey will be implemented. If roosting habitat characteristics are not evident, then the trees may be removed. If roosting habitat is evident, more detailed survey methods, such as mist-netting, will be done to further evaluate project area use by Indiana bats.

Based on the information provided in the environmental assessment, we concur that the proposed Fox Island Division HREP will have no impact on the federally listed endangered Topeka shiner and fat pocketbook mussel. We also concur that the proposed Fox Island Division HREP is not likely to adversely affect the federally listed threatened bald eagle and federally listed endangered Indiana bat, provided measures described above are implemented to avoid effects to listed species. Should this project be modified or new information indicate endangered species may be affected, consultation should be initiated.

STATE LISTED THREATENED AND ENDANGERED SPECIES

There are several State of Missouri threatened and endangered species that may occur in the project area. The central mudminnow, the western fox snake, Illinois mud turtle, and Blanding's turtle are all state endangered species that could potentially occur in the project area. Patterson's dawnflower (*Stylisma pickeringii* var *pattersonii*), a state listed endangered plant species, also could potentially occur in the project area.

EXISTING FISH AND WILDLIFE RESOURCES

A variety of fish and mussels are found in the waters of the Division. The Mississippi and Fox Rivers that surround the project area are home to game fish such as bass, panfish, and catfish; rough fish such as carp and drum; and a variety of other common species. Common mussels, such as the three ridge, mapleleaf, giant floater, and fragile papershell are also likely to occur in these waters.

A variety of birds, reptiles, mammals, and amphibians are found in and around the waters of the Division. A variety of resident and migrant waterfowl, in addition to herons, egrets, and other marsh, wading, and shorebirds are abundant. Amphibians and common aquatic reptiles include toads, frogs, northern water snakes, snapping turtles, and western painted turtles. Mammals that rely on or utilize the water for habitat needs include muskrats and raccoons.

The floodplain forest areas are dominated by silver maple and cottonwood. Pin oaks are found on higher ground in the Division. The pin oaks produce high quality mast, as do the oaks and pecans that were planted as part of reforestation projects in the past decade.

Approximately 621 acres on the Division are under cultivation. The farm lease agreement sets aside a portion of the crop to be left in the field each fall for wildlife. Wild turkeys, squirrels, and deer feed on the un-harvested grain. In early winter, migrating ducks and geese also forage on the grain. The 160 acres of open ground that have been left unplanted have grown up in a variety of grasses, forbs, and willows.

Wood ducks utilize the open water areas in the Division for spring and summer foraging and brood habitat. The shallow marshes are attractive to wildlife such as deer, raccoons, birds, frogs, and turtles, but they usually dry up during the summer months. Flood events of significant magnitude and duration can be particularly harmful to trees, depriving roots of oxygen and causing direct mortality. The 1993 flood was particularly detrimental to trees throughout much of the Upper Mississippi River Basin.

METHODOLOGY

Habitat analysis of existing study area conditions, future conditions without the project, and impacts of the several proposed alternatives and increments were accomplished using the Wildlife Habitat Appraisal Guide (WHAG) procedures developed by the Missouri Department of Conservation and the USDA Natural Resources Conservation Service. This analysis employed a multi-agency team approach with representatives from the Corps of Engineers, Fish and Wildlife Service, Illinois Department of Natural Resources, and Missouri Department of Conservation.

The WHAG analysis is a numerical system for evaluating the quality and quantity of particular habitats for species selected by the WHAG team members. The qualitative component of the analysis is known as the habitat suitability index (HSI) and is rated on a 0.1 to 1.0 scale. The suitability of a given habitat type for a set of evaluation species is determined by the qualitative characteristics of the habitat type. The WHAG procedures include the use of limiting factors, which are habitat requirements for an individual species during a critical time of year. Absence of one or more habitat characteristics makes the habitat unsuitable and results in the lowest HSI value of 0.1. The quantitative component of the WHAG analysis is the measure of acres of habitat that are available for the selected target species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula (HSI x Acres = HUs).

Existing habitat conditions were evaluated onsite by the team, whereas future conditions with and without the project, were estimated using the expertise of team members. The team considered wetland and upland habitats and both game and nongame species aspects of the project. Target species were selected to represent groups of species to be able to focus in on and evaluate the goals and objectives of the project. Several planning iterations were required as the project evolved and engineering data was refined.

For project planning and impact analysis, project life was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions), 1, 25, and 50 years. HSI and average annual habitat units (AAHUs) for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Several species, each representing a guild of other similar species that utilize the specified habitat type in similar ways, were selected for the evaluation.

Table 1. Evaluation Species Selected for Habitat Analysis

Species	Scientific Name	Habitat Type Evaluated
White-tailed deer	*Odocoileus virginianus*	cropfield/grassland/forest
Wild turkey	*Meleagris galopavo*	cropfield/forest
Pileated woodpecker	*Dryocopus pileatus*	forest
Fox squirrel	*Sciurus niger*	forest
Wood thrush	*Hylocichla mustelina*	forest
Kentucky warbler	*Oporornis formosus*	forest
Bobwhite quail	*Colinus virginianus*	cropfield/grassland
Eastern cottontail	*Sylvilagus floridanus*	cropfield/grassland
Dickcissel	*Spiza americana*	native grassland
Ring-necked pheasant	*Phasianus colchicus*	cropfield/grassland
Mallard	*Anas platyrhynchos*	nonforested wetland
Canada goose	*Branta canadensis*	nonforested wetland
Lesser yellowlegs	*Tringa flavipes*	nonforested wetland
King rail	*Railus elegans*	nonforested wetland
Green heron	*Butorides virescens*	nonforested wetland

Eight wildlife species were used to evaluate the reforestation of agricultural fields on the Division. White-tailed deer and wild turkey are game species that utilize both forested and nonforested habitat types. The fox squirrel utilizes mature forest with a hard mast (acorn-producing) component. The pileated woodpecker utilizes large tracts of mature bottomland hardwood forest. The wood thrush and Kentucky warbler are neotropical migrant songbirds that utilize mature bottomland forest habitat during the breeding season. Bobwhite quail and eastern cottontail rabbit are small game species which utilize a variety of open land and edge habitats. Deer, turkey, quail, and rabbit were also used to evaluate the conversion of the 80-acre Logsdon Tract field to native prairie habitat. Other species that were used to evaluate this feature were the dickcissel, a migratory or resident bird that utilizes native grassland habitats; and the ring-necked pheasant, a gamebird species that utilizes cropfield-dominated habitats.

Five wetland species were used to evaluate the effects of water control features on wetland areas of the project. Mallard and Canada goose are both migratory waterfowl species that utilize early successional nonforested wetland habitat and are important game species. Lesser yellowlegs is a migratory shorebird that utilizes mud flats and initial successional wetland habitat during summer and early fall in the Midwest. The king rail is a wading bird that favors

sedge-dominated, permanent summer wetland habitats. Green heron utilizes midsuccessional herbaceous and shrub dominated wetland habitat.

Reforestation

The WHAG analysis indicates that conversion of cover type from crop and fallow fields to bottomland hardwood forest results in a "trade-off" of habitat suitability from conditions favoring species that utilize cropfields as well as bottomland forest with larger percentages of "edge" between the different habitats (deer, turkey, quail, cottontail), to species that generally use only forest habitat and favor larger, less fragmented tracts of that habitat, or that use the types of trees proposed for planting as a food source (woodpecker, squirrel, thrush, warbler). Alternative methods of reforestation (natural regeneration, direct seeding of acorns, and planting of large stock hard and soft mast seedlings) are anticipated to vary slightly from one another, as reflected in the HSI values shown below. The HSI values were coupled with acreage figures to calculate the expected net benefits in AAHUs of the evaluated alternatives.

Wetland Enhancement

The WHAG analysis for wetland enhancement indicates that under baseline conditions, the nonforested wetland areas of the Division provide some habitat value for wading birds such as least bittern, king rail, and green heron. However, uncontrolled fluctuations in water levels during summer and fall months severely limit availability of feeding and resting habitat for migratory waterfowl such as mallard and Canada goose, resulting in a baseline HSI of 0.1 for both species. Construction of the wetland enhancement feature would produce net benefits to mallard and Canada goose (with a small net benefit to green heron as well) by allowing Refuge staff to manage water levels in the affected wetlands to mimic the historic hydrologic regime and facilitate summer food plant production and fall reflooding of feeding and resting areas.

Prairie Restoration

The results of the WHAG analysis project slight declines in habitat suitability for deer, turkey, cottontail, and pheasant under with-project conditions as compared to without-project conditions. However, the introduction of additional warm-season grass and forb species as a restoration feature results in net AAHU benefits due to increases in habitat availability for dickcissel, a native songbird whose habitat requirements are strongly associated with native grasslands.

The results of the WHAG analysis suggest that the Division can be enhanced through implementation of the features proposed for this project. Results of the WHAG application were compared as incremental alternatives where applicable. The proposed project for the Division involves three primary enhancement features: **reforestation, wetland enhancement,** and **prairie restoration**. These features are expected to increase diversity of native plant species in the project area, increase habitat values for resident and migratory wildlife, and would best meet the overall management objectives for the site.

PROPOSED ARRAY OF OPTIONS

Reforestation

A0 No Action – Natural Regeneration

A1 Plant Hardwood RPM™ Stock

This feature consists of planting hardwood trees on 215 acres on the north end of the Division. These seedlings would be of Forrest Keeling Nurseries' root production method (RPM). The RPM system produces vigorous, competitive stock, which stand a greater chance of survival than bare-root seedlings. The RPM stock would include a mixture of swamp white oak, burr oak, pin oak, northern pecan, shellbark hickory, Kentucky coffeetree, and persimmon. Areas for planting would be selected to minimize the duration of flood inundation.

A2 Plant Hardwood Trees by Precision Direct Seeding

This feature consists of planting 60 acres of hardwood trees by direct seeding of nuts and acorns. The mix would include species such as oak, walnut, sycamore, and green ash. This method utilizes chemical and mechanical weed control until a thick canopy is achieved, typically within three years of planting. The precision planting method requires less seedbed preparation and less seed than broadcast spreading, and the resulting rows make for easier monitoring, management, and weed control.

A3 Plant Hardwood Trees Using RPM Stock and Direct Seeding

Combines Alternatives A1 and A2.

Wetland Enhancement

B0 No Action

B1 Enhance Logsdon Slough

This action would enhance water supply and control within Logsdon Slough. A new well would provide the capability of inundating 25 acres through long periods without rain. The 100-foot-deep well with a 20-inch casing would be located on the east (unprotected) side of the Mississippi-Fox Drainage and Levee District levee, near the west Division access road. A 2,000 gallon per minute (GPM) irrigation pump, energized by a portable diesel power unit, would supply the wetland via a new channel. The upper 40 feet of the 200-foot-long channel would be lined with riprap to promote aeration and control erosion. An existing galvanized metal stoplog structure at the south end of the slough would be renovated to control the water levels. The renovation would involve some excavation to renew the channel depth and improve the hydraulic capacity of the structure. The 2-inch dimensional lumber stoplogs also need to be replaced. A system for locking the stoplogs in place and securely storing the ones

that are not in use should be included in the renovation to reduce losses due to vandalism. The area could be drained by gravity in the spring and planted (or allowed to vegetate naturally) in forage for waterfowl, then flooded in the fall to provide food and shelter for migrating flocks.

B2 Enhance Coin Pond – Slim Slough – Old Lake

This action would enhance water supply and control to the channels and wetland areas within the Coin Pond – Slim Slough – Old Lake Wetland Complex. Proposed new features include a well near Coin Pond, a surface water pump at Grey Chute, stoplog structures, and channel improvements. The new wells near Coin Pond would include a 20-inch casing 100 feet deep and a 2,000 GPM pump powered by a portable diesel unit. This setup, comparable in size to irrigation systems in the vicinity, would be capable of filling the 53-acre wetland complex in approximately 30 days.

A new line-shaft surface water pump, powered by a portable diesel unit, would be installed on the bank of Grey Chute, on the East Winkelman Tract. A 24-inch force main would convey the water beneath the Burlington Northern-Santa Fe Railroad before discharging into a new channel that connects to Slim Slough and Coin Pond. This 10,000 GPM pump would have a capacity to fill the Coin Pond, Slim Slough, Old Lake Wetland Complex in approximately six days.

A cast-in-place concrete stoplog structure would be constructed on the west side of the complex, where two natural drainage channels come together before discharging into the Fox River. This structure would also serve as a bridge, providing access along the east side of the Fox River between the northern and southern halves of the Division.

Four galvanized metal stoplog structures would be installed across the distribution channel, separating it into three reaches. These structures would allow independent manipulation of the water levels in Coin Pond, Slim Slough, and Old Lake wetland areas. The level-bottomed channel will provide equal flow capacity in either direction.

This alternative also includes repair and protection of a 50-foot section of the east bank of the Fox River. This eroded stream bank could short-circuit the main water control structure if not repaired.

B3 Enhance Logsdon Slough and Coin Pond – Slim Slough – Old Lake

This alternative is a combination of Alternatives B1 and B2.

Restore Native Grassland

C0 No Action

C1 Plant Grasses and Forbs

Approximately 98 acres of native grassland will be restored on the Logsdon Tract located inside the levee of the Fox River Drainage District. The grassland will be created by seeding former cropland. The proposed restored grassland area lies adjacent to existing grassland within the Rose Pond Conservation Area. This restoration will result in a contiguous grassland area of up to 400 acres providing habitat for birds and small mammals.

Native grass and forbs species will be selected based on their historical range, their affinity for open, sandy meadows, and their ability to withstand some flooding. Candidate species include big and little bluestem, Indian grass, switchgrass, and prairie cordgrass. Some areas near the slough will be cleared of recent growth cottonwoods and willows.

DISCUSSION OF PROJECT FEATURES

The following features were evaluated and best met the project goals and objectives as well as meeting their respective agencies' goals and objectives.

PREFERRED FEATURES

Reforestation

Alternative A3, the combination planting of RPM rootstock and direct seeding was selected for its versatility. This alternative has higher costs than total precision direct seeding, but provides a better chance for survival over the full range of conditions that may be encountered during the critical first three years after planting. Furthermore, the combination of planting RPM rootstock and precision direct seeding will provide useful data for comparing the two methods. This evaluation will help determine the optimum methods for future HREP projects.

Wetland Enhancement

Alternative B3, improving water supply and control on both sides of the Fox River, including Logsdon Slough, Coin Pond, Slim Slough, and Old Lake, is preferred because of its capability to expand the areas of wetland habitat and to extend the inundation period to the fall migration. This plan is more costly than Logsdon Slough, but it provides greater wetland benefits desired for this refuge.

Restore Native Grassland

Alternative C1, planting Logsdon Tract with warm-season grasses and forbs is preferred over the No Action Alternative (C0). Restoring native grasslands improves plant diversity and increases the extent of this vastly diminished habitat.

FUTURE WITHOUT PROJECT

The No Federal Action alternative is the future without the project condition.

Reforestation

The no action alternative would not require any additional management effort. Present farm leases would be discontinued and open areas would be allowed to revegetate naturally. There would be an increase of forest habitat comprised of floodplain species such as silver maple and cottonwood, which compete favorably on wet soils and periodic flooding.

Wetland Enhancement

The no action alternative would not require any additional management effort. No habitat gain or loss would be realized other than what may increase naturally. The benefit to fall migratory waterfowl and other wetland species would be minimal except during exceptionally wet years.

Restore Native Grassland

The no action alternative would not require any additional management effort. No habitat gain or loss would be realized other than what occurs naturally. The abandoned cropland will experience natural revegetation by forbs and woody plants with no control over selection. Habitat enhancement would be less than optimal.

FUTURE WITH PROJECT

The proposed project would result in positive long-term effects to habitats located in the Division. The project would result in some trade-offs in wildlife habitat because of conversion of cover types, but the resulting changes would provide habitat to a greater diversity of species. The project would result in short-term decreases in water quality due to localized increases in turbidity resulting from construction activities.

NATURAL RESOURCE IMPACTS

Terrestrial Habitat: Currently, the Division consists of about 925 acres of floodplain forest dominated by silver maple and cottonwood; 111 acres of wetlands, sloughs and backwaters; and 621 acres of cultivated land. An additional 376 acres are old field, areas with recently seeded trees, and areas in the early stages of natural forest regeneration. There is a limited number of mast producing trees in this old field, which are primarily pin oak. These areas exhibit relatively low vegetative diversity and are characterized by low quality habitat and a limited number of wildlife species. The proposed project would replace 275 acres of open area with mast-producing trees, and 98 acres of old field with native prairie. The remaining open areas would be allowed to regenerate to woodlands naturally. This plan would restore the

historic native plant community, increase habitat diversity, and improve habitat quality for a variety of resident and migratory wildlife.

Wetland Habitat: Currently, wetland habitat on the Division relies on flooding and rains to maintain water levels. Opportunities to control and manipulate water levels are limited and most of the shallow wetland areas dry up following spring flooding. The proposed wetland enhancement features would provide a perennial water source and water level control for some of these areas. This would give management personnel the flexibility to fill or drain wetlands for the benefit of waterfowl and other wildlife. Quality wetland habitat could be provided on a consistent basis.

There will be short-term negative effects on the aquatic habitat in the project area due to construction activities. These effects may include increased sedimentation and turbidity in the surface water. The long-term impacts of the project would be positive.

Wildlife: Improved habitat will increase wildlife populations and diversity. Habitat improvements that are part of this project, including enhanced wetlands, native prairie restoration, and expanded forests, should directly affect the populations of native wildlife. Wildlife species expected to benefit include fox squirrel, pileated woodpecker, wood thrush, Kentucky warbler, dickcissel, puddle ducks, and other wetland-loving birds.

Fish: The proposed wetland enhancement features will have minimal impact on fish. No deepwater habitats would be created for sustaining year round fish populations. Opportunities for creating a sport fishery are hampered by frequent flooding which would regularly introduce rough fish from the Fox and Mississippi Rivers.

DISCUSSION

The planting of a total of 98 acres of native grasses and forbs will provide habitat for grassland species of birds, animals, and insects. The installation of a new well, new pumps, stoplog structures, and channel improvements will allow managers to better manipulate water levels ensuring habitat for migrating and resident birds as well as wetland wildlife species. The planting of trees and natural regeneration of forests will increase the amount of habitat for neotropical migrants and other bird and wildlife species. Overall, the project will create a more diverse mosaic of habitats for this ecosystem.

CONCLUSIONS AND RECOMMENDATIONS

The Fox Island Division HREP offers a unique opportunity to conserve and enhance wildlife habitat. The proposed Fox Island Division HREP will also contribute directly to achieving the goals of the North American Waterfowl Management Plan (an international inter-agency plan to increase waterfowl populations) for waterfowl species and the goals of the Partners for Flight program to protect and increase the habitats for neotropical migrants.

Therefore, we recommend the preferred alternative which includes:

1. **Reforestation**. The planting of saplings and the direct seeding of 60 acres of mast trees, planting 215 acres of RPM mast trees, and allowing 564 acres of natural reforestation.

2. **Wetland Enhancement**. The installation of a new well, new pumps, stoplog structures, and channel improvements to provide the area with a reliable source of water throughout the year, creating better habitat for migratory birds, shorebirds, and wetland wildlife.

3. **Grassland Restoration**. The planting of 98 acres of native grasses and forbs on the Logsdon Tract.

We appreciate the opportunity to provide these comments and look forward to continued coordination. If you have any questions, please contact Ginger Molitor of my staff at (309) 793-5800 ext. 212.

Sincerely,

Richard C. Nelson
Supervisor

cc: Stanley Consultants (Miller)
COE PM-A (Carmack)

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\Fish and Wildlife Coordination Act report2 doc

EASTERN SHAWNEE TRIBE
OF OKLAHOMA

P.O. Box 350 · Seneca, MO 64865 · (918) 666-2435 · FAX (918) 666-2186

January 14, 2005

Department of the Army
Attention: Mr. Darren Niles
Rock Island District, Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

Re: Fox Island habitat Rehabilitation & Enhancement Project

To Whom It May Concern:

Thank you for notice of the referenced project(s). The Eastern Shawnee Tribe of Oklahoma is currently unaware of any documentation directly linking Indian Religious Sites to the proposed construction. In the event any items falling under the Native American Graves Protection and Repatriation Act (NAGPRA) are discovered during construction, the Eastern Shawnee Tribe request notification and further consultation.

The Eastern Shawnee Tribe has no objection to the proposed construction. However, if any human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction, the construction should stop immediately, and the appropriate persons, including state and tribal NAGPRA representatives contacted.

Sincerely,

Jo Ann Beckham

Jo Ann Beckham
Administrative Assistant

Charles Enyart, Chief
Eastern Shawnee Tribe of Oklahoma

STATE OF MISSOURI
Matt Blunt, Governor • Michael D. Wells, Acting Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

January 24, 2005

Darron Niles, Technical Coordinator
Rock Island District Habitat Projects
Corps of Engineers, Rock Island District
Clock Tower Building – P.O. Box 2004
Rock Island, Illinois 61204-2j004

Re: Fox Island Habitat Rehabilitation & Enhancement Project (COE) Clark County, Missouri

Dear Mr. Niles:

Thank you for submitting information about the above referenced project for our review pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which require identification and evaluation of cultural resources.

We have reviewed the document entitled *Upper Mississippi River System Environmental Management Program Definite Project Report With Integrated Environmental Assessment: Fox Island Habitat Rehabilitation & Enhancement Project*. We concur with your determination that archaeological site 23CK345 is eligible for inclusion in the National Register of Historic Places. We also concur with your determination that the proposed project will have **no adverse effect** on site 23CK345, on that condition that mast tree plantings are restricted within the site area and within a 100 foot wide buffer zone around the site.

Please be advised that, should project plans change, information documenting the revisions should be submitted to this office for further review and comment on possible effects to historic properties.

If you have any questions, please write Judith Deel at State Historic Preservation Office, P.O. Box 176, Jefferson City, Missouri 65102 or call 573/751-7862. Please be sure to include the SHPO Log Number (G088) on all future correspondence or inquiries relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Mark A. Miles
Director and Deputy State
Historic Preservation Officer

MAM:jd

c Ron Deiss, COE/RI

CONVERSATION RECORD	TIME	DATE 26 January 2005

TYPE [ ] VISIT [ ] CONFERENCE [X] TELEPHONE [X] INCOMING [ ] OUTGOING

Location of Visit/Conference:

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO:
Don McKenzie	Dept. of Energy	301-903-7426

SUBJECT Fox Island HREP-Public Review Draft DPR

ROUTING NAME/SYMBO	INI

SUMMARY

Mr. Mckenzie stated that he had reviewed the subject draft report and had no comments. He added that the report was well thought out and designed.

ACTION REQUIRED

Include this conversation record in the DPR's correspondence appendix.

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Darron Niles	Darron Niles	26 January 2005

ACTION TAKEN

SIGNATURE	TITLE	DATE

CONVERSATION RECORD

OPTIONAL FORM 271 (12-76)
DEPARTMENT OF DEFENSE

A-54

Jena Band of Choctaw Indians

P. O. Box 14 • Jena, Louisiana 71342-0014 • Phone: 318-992-2717 • Fax: 318-992-8244

February 1, 2005

Department of the Army
Rock Island District. Corps of Engineers
Mr. Darron Niles, Technical Coordinator
Clock Tower Building - P O Box 2004
Rock Island, Illinois 61204-2004

RE: DPR R-14PR
EA FOR FOX ISLAND, MISSOURI, HABITAT REHABILITATION AND ENHANCEMENT PROJECT.

To Whom It May Concern:

Reference is made to your letter dated January 7, 2005, concerning the above-proposed project.

After thorough review of the documents submitted, it has been determined that there will be no significant impact in regards to the Jena Band of Choctaw Indians. We have no objections to its implementation.

If I may be of any further assistance, please do not hesitate to call

Sincerely,

Lillie Strange

Lillie Strange
Environmental Director
Jena Band of Choctaw Indians
Lilliestrange72@aol.com
318-992-8258

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office
4469 48th Avenue Court
Rock Island, Illinois 61201
Phone: (309) 793-5800 Fax: (309) 793-5804

IN REPLY REFER TO:
FWS/RIFO

March 14, 2005

Colonel Duane P. Gapinski
District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Gapinski:

This letter constitutes our final Fish and Wildlife Coordination Act report for the Fox Island Division Habitat Rehabilitation and Enhancement Project (Fox Island Division HREP) located on the west bank of the Mississippi River two miles downstream of Alexandria, Missouri. It has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); the Endangered Species Act of 1973, as amended; and in accordance with the U.S. Fish and Wildlife Service's Mitigation Policy.

The Fox Island Division HREP is a component of the Upper Mississippi River System Environmental Management Program (EMP) authorized in Section 1103 of the Water Resources Development Act of 1986. The goal of the EMP is to implement "...numerous enhancement efforts...to preserve, protect, and restore habitat that is deteriorating due to natural and man-induced activities."

PROJECT OBJECTIVES

The goal of the Fox Island Division HREP is to rehabilitate and enhance the quality and diversity of wildlife habitat. The goal should be achieved through the expansion of wet, bottomland forests, establishment of mast-producing forests, enhancement of wetlands, and restoration of tallgrass prairies.

DESCRIPTION OF THE PROJECT AREA

The study area is located in Clark County, Missouri, between Upper Mississippi River miles (RM) 358.5 and 353.6 in Pool 20. The 2,033-acre area is entirely in Federal ownership located in the Fox Island Division of the Great River National Wildlife Refuge (Division), which is part of the Mark Twain National Wildlife Refuge Complex. The project area is comprised of low-profile bottomland and contains several bodies of water including: Nelson Lake, Coin Pond, Logsdon Slough, Slim Slough, and Old Lake.

The primary purpose of the Refuge is to provide resting and feeding habitat for resident and migratory birds, especially waterfowl. Habitat for state and federally listed species, shorebirds, and many other wildlife species is also provided. Approximately 925 acres of the Division are floodplain forest, dominated by silver maple and cottonwood, with pin oaks prevalent in higher elevation areas. Wetlands, sloughs, and oxbows comprise about 111 acres of the Division. The remaining 997 acres are a combination of farmland, abandoned fields, and areas recently planted with trees. Approximately 621 acres are being farmed to maintain open areas for hardwood reforestation. Cultivation is variable from year to year because of flooding.

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

By copy of our letter dated October 15, 2003, we provided a list of federally threatened and endangered species known to occur in Clark County, Missouri. Based on that information and further analysis, the U.S. Army Corps of Engineers made the impact determinations discussed below.

The federally listed endangered Topeka shiner (*Notropis topeka)* is known to occur in Clark County. However, Topeka shiner habitat is not found in the project area; therefore, the project should not impact the Topeka shiner.

The federally listed endangered fat pocketbook mussel (*Potamilus capax)* is a large river species and historically has been known to occur in the main stem of the Mississippi River near the Division. No work is planned in the main stem of the river, and no impact to the species should occur.

The federally listed threatened bald eagle (*Haliaeetus leucocephalus*) occurs on the Division as a winter resident, and a bald eagle nest exists in an area adjacent to the Division. The construction of the project will not occur during the nesting season and will be outside of the proximity of the nest; therefore, the nest would not be disturbed by this project. A few trees must be removed to construct the surface water pump station, but this activity will be managed to avoid disturbance to bald eagles and damage to their habitat. No trees will be removed when eagles are present. Therefore, the project is not likely to adversely affect the bald eagle.

The federally listed endangered Indiana bat (*Myotis sodalis)* also may occur in the project area. According to the environmental assessment, there are no known maternal roost trees for

Indiana bats on the Division. Very few trees would be removed for this project. An Indiana bat habitat suitability survey will be implemented. If roosting habitat characteristics are not evident, then the trees may be removed. If roosting habitat is evident, more detailed survey methods, such as mist-netting, will be done to further evaluate project area use by Indiana bats. Therefore, the project is not likely to adversely affect the Indiana bat.

Based on the information provided in the environmental assessment, we concur that the proposed Fox Island Division HREP will have no impact on the federally listed endangered Topeka shiner and fat pocketbook mussel. We also concur that the proposed Fox Island Division HREP is not likely to adversely affect the federally listed threatened bald eagle and federally listed endangered Indiana bat, provided measures described above are implemented to avoid effects to listed species. Should this project be modified or new information indicate endangered species may be affected, consultation should be initiated.

STATE LISTED THREATENED AND ENDANGERED SPECIES

There are several State of Missouri threatened and endangered species that may occur in the project area. The central mudminnow, the western fox snake, Illinois mud turtle, and Blanding's turtle are all state endangered species that could potentially occur in the project area. Patterson's dawnflower (*Stylisma pickeringii* var *pattersonii),* a state listed endangered plant species, also could potentially occur in the project area.

EXISTING FISH AND WILDLIFE RESOURCES

A variety of fish and mussels are found in the waters of the Division. The Mississippi and Fox Rivers that surround the project area are home to game fish such as bass, panfish, and catfish; rough fish such as carp and drum; and a variety of other common species. Common mussels, such as the three ridge, mapleleaf, giant floater, and fragile papershell are also likely to occur in these waters.

A variety of birds, reptiles, mammals, and amphibians are found in and around the waters of the Division. A variety of resident and migrant waterfowl, in addition to herons, egrets, and other marsh, wading, and shorebirds are abundant. Amphibians and common aquatic reptiles include toads, frogs, northern water snakes, snapping turtles, and western painted turtles. Mammals that rely on or utilize the water for habitat needs include muskrats and raccoons.

The floodplain forest areas are dominated by silver maple and cottonwood. Pin oaks are found on higher ground in the Division. The pin oaks produce high quality mast, as do the oaks and pecans that were planted as part of reforestation projects in the past decade.

Approximately 621 acres on the Division are under cultivation. The farm lease agreement sets aside a portion of the crop to be left in the field each fall for wildlife. Wild turkeys, squirrels, and deer feed on the un-harvested grain. In early winter, migrating ducks and geese also forage on the grain. The 160 acres of open ground that have been left unplanted have grown up in a variety of grasses, forbs, and willows.

Wood ducks utilize the open water areas in the Division for spring and summer foraging and brood habitat. The shallow marshes are attractive to wildlife such as deer, raccoons, birds, frogs, and turtles, but they usually dry up during the summer months. Flood events of significant magnitude and duration can be particularly harmful to trees, depriving roots of oxygen and causing direct mortality. The 1993 flood was particularly detrimental to trees throughout much of the Upper Mississippi River Basin.

METHODOLOGY

Habitat analysis of existing study area conditions, future conditions without the project, and impacts of the several proposed alternatives and increments were accomplished using the Wildlife Habitat Appraisal Guide (WHAG) procedures developed by the Missouri Department of Conservation and the USDA Natural Resources Conservation Service. This analysis employed a multi-agency team approach with representatives from the Corps of Engineers, Fish and Wildlife Service, Illinois Department of Natural Resources, and Missouri Department of Conservation.

The WHAG analysis is a numerical system for evaluating the quality and quantity of particular habitats for species selected by the WHAG team members. The qualitative component of the analysis is known as the habitat suitability index (HSI) and is rated on a 0.1 to 1.0 scale. The suitability of a given habitat type for a set of evaluation species is determined by the qualitative characteristics of the habitat type. The WHAG procedures include the use of limiting factors, which are habitat requirements for an individual species during a critical time of year. Absence of one or more habitat characteristics makes the habitat unsuitable and results in the lowest HSI value of 0.1. The quantitative component of the WHAG analysis is the measure of acres of habitat that are available for the selected target species. From the qualitative and quantitative determinations, the standard unit of measure, the Habitat Unit (HU), is calculated using the formula (HSI x Acres = HUs)

Existing habitat conditions were evaluated onsite by the team, whereas future conditions with and without the project, were estimated using the expertise of team members. The team considered wetland and upland habitats and both game and nongame species aspects of the project. Target species were selected to represent groups of species to be able to focus in on and evaluate the goals and objectives of the project. Several planning iterations were required as the project evolved and engineering data was refined.

For project planning and impact analysis, project life was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions), 1, 25, and 50 years. HSI and average annual habitat units (AAHUs) for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Several species, each representing a guild of other similar species that utilize the specified habitat type in similar ways, were selected for the evaluation.

Table 1. Evaluation Species Selected for Habitat Analysis

Species	Scientific Name	Habitat Type Evaluated
White-tailed deer	*Odocoileus virginianus*	cropfield/grassland/forest
Wild turkey	*Meleagris galopavo*	cropfield/forest
Pileated woodpecker	*Dryocopus pileatus*	forest
Fox squirrel	*Sciurus niger*	forest
Wood thrush	*Hylocichla mustelina*	forest
Kentucky warbler	*Oporornis formosus*	forest
Bobwhite quail	*Colinus virginianus*	cropfield/grassland
Eastern cottontail	*Sylvilagus floridanus*	cropfield/grassland
Dickcissel	*Spiza americana*	native grassland
Ring-necked pheasant	*Phasianus colchicus*	cropfield/grassland
Mallard	*Anas platyrhynchos*	nonforested wetland
Canada goose	*Branta canadensis*	nonforested wetland
Lesser yellowlegs	*Tringa flavipes*	nonforested wetland
King rail	*Railus elegans*	nonforested wetland
Green heron	*Butorides virescens*	nonforested wetland

Eight wildlife species were used to evaluate the reforestation of agricultural fields on the Division. White-tailed deer and wild turkey are game species that utilize both forested and nonforested habitat types. The fox squirrel utilizes mature forest with a hard mast (acorn-producing) component. The pileated woodpecker utilizes large tracts of mature bottomland hardwood forest. The wood thrush and Kentucky warbler are neotropical migrant songbirds that utilize mature bottomland forest habitat during the breeding season. Bobwhite quail and eastern cottontail rabbit are small game species which utilize a variety of open land and edge habitats. Deer, turkey, quail, and rabbit were also used to evaluate the conversion of the 80-acre Logsdon Tract field to native prairie habitat. Other species that were used to evaluate this feature were the dickcissel, a migratory or resident bird that utilizes native grassland habitats; and the ring-necked pheasant, a gamebird species that utilizes cropfield-dominated habitats.

Five wetland species were used to evaluate the effects of water control features on wetland areas of the project. Mallard and Canada goose are both migratory waterfowl species that utilize early successional nonforested wetland habitat and are important game species. Lesser yellowlegs is a migratory shorebird that utilizes mud flats and initial successional wetland habitat during summer and early fall in the Midwest. The king rail is a wading bird that favors

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sedge-dominated, permanent summer wetland habitats. Green heron utilizes midsuccessional herbaceous and shrub dominated wetland habitat.

Reforestation
The WHAG analysis indicates that conversion of cover type from crop and fallow fields to bottomland hardwood forest results in a "trade-off" of habitat suitability from conditions favoring species that utilize cropfields as well as bottomland forest with larger percentages of "edge" between the different habitats (deer, turkey, quail, cottontail), to species that generally use only forest habitat and favor larger, less fragmented tracts of that habitat, or that use the types of trees proposed for planting as a food source (woodpecker, squirrel, thrush, warbler). Alternative methods of reforestation (natural regeneration, direct seeding of acorns, and planting of large stock hard and soft mast seedlings) are anticipated to vary slightly from one another, as reflected in the HSI values shown below. The HSI values were coupled with acreage figures to calculate the expected net benefits in AAHUs of the evaluated alternatives.

Wetland Enhancement
The WHAG analysis for wetland enhancement indicates that under baseline conditions, the nonforested wetland areas of the Division provide some habitat value for wading birds such as least bittern, king rail, and green heron. However, uncontrolled fluctuations in water levels during summer and fall months severely limit availability of feeding and resting habitat for migratory waterfowl such as mallard and Canada goose, resulting in a baseline HSI of 0.1 for both species. Construction of the wetland enhancement feature would produce net benefits to mallard and Canada goose (with a small net benefit to green heron as well) by allowing Refuge staff to manage water levels in the affected wetlands to mimic the historic hydrologic regime and facilitate summer food plant production and fall reflooding of feeding and resting areas.

Prairie Restoration
The results of the WHAG analysis project slight declines in habitat suitability for deer, turkey, cottontail, and pheasant under with-project conditions as compared to without-project conditions. However, the introduction of additional warm-season grass and forb species as a restoration feature results in net AAHU benefits due to increases in habitat availability for dickcissel, a native songbird whose habitat requirements are strongly associated with native grasslands.

The results of the WHAG analysis suggest that the Division can be enhanced through implementation of the features proposed for this project. Results of the WHAG application were compared as incremental alternatives where applicable. The proposed project for the Division involves three primary enhancement features: **reforestation, wetland enhancement,** and **prairie restoration**. These features are expected to increase diversity of native plant species in the project area, increase habitat values for resident and migratory wildlife, and would best meet the overall management objectives for the site.

PROPOSED ARRAY OF OPTIONS

Reforestation

A0 No Action – Natural Regeneration

A1 Plant Hardwood RPM™ Stock
This feature consists of planting hardwood trees on 215 acres on the north end of the Division. These seedlings would be of Forrest Keeling Nurseries' root production method (RPM). The RPM system produces vigorous, competitive stock, which stand a greater chance of survival than bare-root seedlings. The RPM stock would include a mixture of swamp white oak, burr oak, pin oak, northern pecan, shellbark hickory, Kentucky coffeetree, and persimmon. Areas for planting would be selected to minimize the duration of flood inundation.

A2 Plant Hardwood Trees by Precision Direct Seeding
This feature consists of planting 60 acres of hardwood trees by direct seeding of nuts and acorns. The mix would include species such as oak, walnut, sycamore, and green ash. This method utilizes chemical and mechanical weed control until a thick canopy is achieved, typically within three years of planting. The precision planting method requires less seedbed preparation and less seed than broadcast spreading, and the resulting rows make for easier monitoring, management, and weed control.

A3 Plant Hardwood Trees Using RPM Stock and Direct Seeding
Combines Alternatives A1 and A2.

Wetland Enhancement

B0 No Action

B1 Enhance Logsdon Slough
This action would enhance water supply and control within Logsdon Slough. A new well would provide the capability of inundating 25 acres through long periods without rain. The 100-foot-deep well with a 20-inch casing would be located on the east (unprotected) side of the Mississippi-Fox Drainage and Levee District levee, near the west Division access road. A 2,000 gallon per minute (GPM) irrigation pump, energized by a portable diesel power unit, would supply the wetland via a new channel. The upper 40 feet of the 200-foot-long channel would be lined with riprap to promote aeration and control erosion. An existing galvanized metal stoplog structure at the south end of the slough would be renovated to control the water levels. The renovation would involve some excavation to renew the channel depth and improve the hydraulic capacity of the structure. The 2-inch dimensional lumber stoplogs also need to be replaced. A system for locking the stoplogs in place and securely storing the ones that are not in use should be included in the renovation to reduce losses due to vandalism. The area could be drained by gravity in the spring and planted (or allowed to vegetate naturally) in forage for waterfowl, then flooded in the fall to provide food and shelter for migrating flocks.

B2 Enhance Coin Pond – Slim Slough – Old Lake
This action would enhance water supply and control to the channels and wetland areas within the Coin Pond – Slim Slough – Old Lake Wetland Complex. Proposed new features include a well near Coin Pond, a surface water pump at Grey Chute, stoplog structures, and channel improvements. The new wells near Coin Pond would include a 20-inch casing 100 feet deep and a 2,000 GPM pump powered by a portable diesel unit. This setup, comparable in size to irrigation systems in the vicinity, would be capable of filling the 53-acre wetland complex in approximately 30 days.

A new line-shaft surface water pump, powered by a portable diesel unit, would be installed on the bank of Grey Chute, on the East Winkelman Tract. A 24-inch force main would convey the water beneath the Burlington Northern-Santa Fe Railroad before discharging into a new channel that connects to Slim Slough and Coin Pond. This 10,000 GPM pump would have a capacity to fill the Coin Pond, Slim Slough, Old Lake Wetland Complex in approximately six days.

A cast-in-place concrete stoplog structure would be constructed on the west side of the complex, where two natural drainage channels come together before discharging into the Fox River. This structure would also serve as a bridge, providing access along the east side of the Fox River between the northern and southern halves of the Division.

Four galvanized metal stoplog structures would be installed across the distribution channel, separating it into three reaches. These structures would allow independent manipulation of the water levels in Coin Pond, Slim Slough, and Old Lake wetland areas. The level-bottomed channel will provide equal flow capacity in either direction.

This alternative also includes repair and protection of a 50-foot section of the east bank of the Fox River. This eroded stream bank could short-circuit the main water control structure if not repaired.

B3 Enhance Logsdon Slough and Coin Pond – Slim Slough – Old Lake
This alternative is a combination of Alternatives B1 and B2.

Restore Native Grassland

C0 No Action

C1 Plant Grasses and Forbs
Approximately 98 acres of native grassland will be restored on the Logsdon Tract located inside the levee of the Fox River Drainage District. The grassland will be created by seeding former cropland. The proposed restored grassland area lies adjacent to existing grassland within the Rose Pond Conservation Area. This restoration will result in a contiguous grassland area of up to 400 acres providing habitat for birds and small mammals.

Native grass and forbs species will be selected based on their historical range, their affinity for open, sandy meadows, and their ability to withstand some flooding. Candidate species include big and little bluestem, Indian grass, switchgrass, and prairie cordgrass. Some areas near the slough will be cleared of recent growth cottonwoods and willows.

DISCUSSION OF PROJECT FEATURES

The following features were evaluated and best met the project goals and objectives as well as meeting their respective agencies' goals and objectives.

PREFERRED FEATURES

Reforestation
Alternative A3, the combination planting of RPM rootstock and direct seeding was selected for its versatility. This alternative has higher costs than total precision direct seeding, but provides a better chance for survival over the full range of conditions that may be encountered during the critical first three years after planting. Furthermore, the combination of planting RPM rootstock and precision direct seeding will provide useful data for comparing the two methods. This evaluation will help determine the optimum methods for future HREP projects.

Wetland Enhancement
Alternative B3, improving water supply and control on both sides of the Fox River, including Logsdon Slough, Coin Pond, Slim Slough, and Old Lake, is preferred because of its capability to expand the areas of wetland habitat and to extend the inundation period to the fall migration. This plan is more costly than Logsdon Slough, but it provides greater wetland benefits desired for this refuge.

Restore Native Grassland
Alternative C1, planting Logsdon Tract with warm-season grasses and forbs is preferred over the No Action Alternative (C0). Restoring native grasslands improves plant diversity and increases the extent of this vastly diminished habitat.

FUTURE WITHOUT PROJECT

The No Federal Action alternative is the future without the project condition.

Reforestation
The no action alternative would not require any additional management effort. Present farm leases would be discontinued and open areas would be allowed to revegetate naturally. There would be an increase of forest habitat comprised of floodplain species such as silver maple and cottonwood, which compete favorably on wet soils and periodic flooding, but it would have little wildlife habitat value.

Wetland Enhancement
The no action alternative would not require any additional management effort. No habitat gain or loss would be realized other than what may increase naturally. The benefit to fall migratory waterfowl and other wetland species would be minimal except during exceptionally wet years.

Restore Native Grassland
The no action alternative would not require any additional management effort. No habitat gain or loss would be realized other than what occurs naturally. The abandoned cropland will experience natural revegetation by forbs and woody plants with no control over selection. Habitat enhancement would be less than optimal.

FUTURE WITH PROJECT

The proposed project would result in positive long-term effects to habitats located in the Division. The project would result in some trade-offs in wildlife habitat because of conversion of cover types, but the resulting changes would provide habitat to a greater diversity of species. The project would result in short-term decreases in water quality due to localized increases in turbidity resulting from construction activities.

NATURAL RESOURCE IMPACTS

Terrestrial Habitat: Currently, the Division consists of about 925 acres of floodplain forest dominated by silver maple and cottonwood; 111 acres of wetlands, sloughs and backwaters; and 621 acres of cultivated land. An additional 376 acres are old field, areas with recently seeded trees, and areas in the early stages of natural forest regeneration. There is a limited number of mast producing trees in this old field, which are primarily pin oak. These areas exhibit relatively low vegetative diversity and are characterized by low quality habitat and a limited number of wildlife species. The proposed project would replace 275 acres of open area with mast-producing trees, and 98 acres of old field with native prairie. The remaining open areas would be allowed to regenerate to woodlands naturally. This plan would restore the historic native plant community, increase habitat diversity, and improve habitat quality for a variety of resident and migratory wildlife.

Wetland Habitat: Currently, wetland habitat on the Division relies on flooding and rains to maintain water levels. Opportunities to control and manipulate water levels are limited and most of the shallow wetland areas dry up following spring flooding. The proposed wetland enhancement features would provide a perennial water source and water level control for some of these areas. This would give management personnel the flexibility to fill or drain wetlands for the benefit of waterfowl and other wildlife. Quality wetland habitat could be provided on a consistent basis.

There will be short-term negative effects on the aquatic habitat in the project area due to construction activities. These effects may include increased sedimentation and turbidity in the surface water. The long-term impacts of the project would be positive.

Wildlife: Improved habitat will increase wildlife populations and diversity. Habitat improvements that are part of this project, including enhanced wetlands, native prairie restoration, and expanded forests, should directly affect the populations of native wildlife. Wildlife species expected to benefit include fox squirrel, pileated woodpecker, wood thrush, Kentucky warbler, dickcissel, puddle ducks, and other wetland-loving birds.

Fish: The proposed wetland enhancement features will have minimal impact on fish. No deepwater habitats would be created for sustaining year round fish populations. Opportunities for creating a sport fishery are hampered by frequent flooding which would regularly introduce rough fish from the Fox and Mississippi Rivers.

DISCUSSION

The planting of a total of 98 acres of native grasses and forbs will provide habitat for grassland species of birds, animals, and insects. The installation of a new well, new pumps, stoplog structures, and channel improvements will allow managers to better manipulate water levels ensuring habitat for migrating and resident birds as well as wetland wildlife species. The planting of trees and natural regeneration of forests will increase the amount of habitat for neotropical migrants and other bird and wildlife species. Overall, the project will create a more diverse mosaic of habitats for this ecosystem.

CONCLUSIONS AND RECOMMENDATIONS

The Fox Island Division HREP offers a unique opportunity to conserve and enhance wildlife habitat. The proposed Fox Island Division HREP will also contribute directly to achieving the goals of the North American Waterfowl Management Plan (an international inter-agency plan to increase waterfowl populations) for waterfowl species and the goals of the Partners for Flight program to protect and increase the habitats for neotropical migrants.

Therefore, we recommend the preferred alternative which includes:

1. **Reforestation**. The planting of saplings and the direct seeding of 60 acres of mast trees, planting 215 acres of RPM mast trees, and allowing 564 acres of natural reforestation.

2. **Wetland Enhancement**. The installation of a new well, new pumps, stoplog structures, and channel improvements to provide the area with a reliable source of water throughout the year, creating better habitat for migratory birds, shorebirds, and wetland wildlife.

3. **Grassland Restoration**. The planting of 98 acres of native grasses and forbs on the Logsdon Tract.

We appreciate the opportunity to provide these comments and look forward to continued coordination. If you have any questions, please contact Ginger Molitor of my staff at (309) 793-5800 ext. 212.

Sincerely,

for Richard C. Nelson
Field Supervisor

cc: Stanley Consultants (Miller)
COE PM-A (Carmack)

S:\Office Users\Ginger\IE\completed\Fox Island HREP
\Fish and Wildlife Coordination Act report2.doc

Dear Mr Dawson Niles

Im the mayor of Alexandria, Mo my name is Robert H. Davis.

We were wondering why the Fox Island Project hasnt been opened for the Buck and Doe. Dont you think that the bucks will get over stocked if they are not thinned out.

Will you save the trees at Fox Valley as there are two eagles nest there plus all the squirrels, coons, hawks and other birds.

Another thing we were wondering why there isnt a road to Nelson Lake, so we can fish in it.

Why does the Wildlife service need so much ground for wildlife. We feel you want us to quit hunting and fishing

You have most of are hunting ground now.

I have hunted all my life but now I cant walk very far as it is now you have to walk too far to get the Water.

Why dont you consider having a Eagles Days in Alexandria as I counted 25 eagles this past weekend.

over

A-55

Why doesn't the fish and Wildlife put in a big lake that we can fish in at Fort Island project?

I will be at your meeting Jan. 26th

Thank You
I hope to hear from you
Mayor Bob Davis
P.O Box 206
Alexandria Mo 63430

PUBLIC NOTICE

US Army Corps of Engineers

Applicant: U. S. Army Corps of Engineers
Rock Island District

CEMVR-OD-P-2005-1309

Date: December 21, 2005

Expires: January 10, 2006

Section: 404

Joint Public Notice
U. S. Army Corps of Engineers
State of Missouri

1. **Applicant**. U.S. Army Corps of Engineers, Clock Tower Building, Rock Island, Illinois 61204-2004.

2. **Project Location**. Sections 24, 25, and 36, Township 64 North, Range 6 West; Sections 8, 17, 18, 19, 20, 30, and 31, Township 64 North, Range 5 West; Section 1, Township 63 North, Range 6 West; Section 6, Township 63 North, Range 5 West; Clark County, Missouri; approximate Mississippi River miles 353.6 – 358.5.

3. **Project Description**. The Fox Island Division Habitat Rehabilitation and Enhancement Project (HREP) is located on the west bank of the Mississippi River one mile downstream of Alexandria, in Clark County, Missouri. The project lies in Pool 20 between Upper Mississippi River Miles (RM) 353.6 and 358.5. The 2,033-acre Fox Island Division (referred to as Division), part of the Great River National Wildlife Refuge, is made up of un-leveed bottomland forests, fields, and sloughs. There are a myriad of wetlands on the Division and several features with open water for at least part of every year. Named water features include Coin Pond (which dries up in late summer), Slim Slough (a.k.a. Ribbon Slough, which is dry most of the year except in the spring), Logsdon Slough (which usually has water in its lower reaches but can expand several-fold in the spring), Old Lake (perennial open water), and Nelson Lake (a.k.a. Silver Lake, also perennial). All project lands are in Federal ownership and are managed by the U.S. Fish
and Wildlife Service (USFWS). The proposed plan includes:

- Planting 215 acres of mast-producing hardwood nursery stock on moderately flood-prone land,
- Planting 60 acres of trees by direct seeding on higher, less flood-prone land,
- Enhancing 78 acres of wetlands in and around Logsdon Slough, Coin Pond, Slim Slough, and Old Lake, and
- Planting 98 acres of native prairie grasses and forbs.

Tree Planting.

- Approximately 60 of the 275 mast-producing acres will be direct seeded with equal numbers of swamp white oak, pin oak, bur oak, walnut, green ash and sycamore. Nuts and acorns will be drilled 4- to 6-inches on center, in rows 9- to 10-feet apart, yielding 10 thousand seedlings per acre.
- The remaining 215 acres will be planted with container-grown nursery stock. Container grown stock are specially raised by the nurseries using methods to induce vigorous growth and increased root mass. The saplings are grown in 3- to 5-gallon containers, stand about 5 feet in height and have at least 5/8-inch caliper. The trees will be planted on a 30-foot by 30-foot spacing, staggered in adjacent rows and intermixed to avoid blocks of the same species. This spacing yields 50 trees per acre. Trees will be planted in the spring between March 1 and May 15, or in the fall between October 1 and December 10.

Mast Trees	Scientific Name	Planting Rate / Acre	Total Number of Trees
Swamp White Oak	*Quercus bicolor*	8	1,720
Bur Oak	*Quercus macrocarpa*	8	1,720
Pin Oak	*Quercus palustris*	8	1,720
Northern Pecan	*Carya illinoensis*	8	1,720
Shellbark Hickory	*Carya laciniosa*	6	1,290
Kentucky Coffeetree	*Gymnocladus dioicus*	6	1,290
Persimmon	*Diospyros virginiana*	6	1,290

CULTURAL RESOURCE ASSESSMENT
Section 106 Review

RECEIVED
JAN 0 9 2006
CEMVR-OD-P

CONTACT PERSON/ADDRESS

Wayne Hannel
Corps of Engineers, Rock Island District
ATTN: OD-P
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

C:

Joe Cothern, EPA
Ron Deiss, COE/KC

PROJECT:

Fox Island Division Habitat Rehabilitation & Enhancement Project CEMVR-OD-P-2005-1309

FEDERAL AGENCY

COE

COUNTY:

CLARK

The State Historic Preservation Office has reviewed the information submitted on the above referenced project. Based on this review, we have made the following determination:

☐ After review of initial submission, the project area has a low potential for the occurrence of cultural resources. A cultural resource survey, therefore, is not warranted.

☐ Adequate documentation has been provided (36 CFR Section 800.11). There will be "no historic properties affected" by the current project.

☒ An adequate cultural resource survey of the project area has been previously conducted. It has been determined that for the proposed undertaking there will be "no historic properties affected".

For the above checked reason, the State Historic Preservation Office has no objection to the initiation of project activities. PLEASE BE ADVISED THAT, IF THE CURRENT PROJECT AREA OR SCOPE OF WORK ARE CHANGED, A BORROW AREA IS INCLUDED IN THE PROJECT, OR CULTURAL MATERIALS ARE ENCOUNTERED DURING CONSTRUCTION, APPROPRIATE INFORMATION MUST BE PROVIDED TO THIS OFFICE FOR FURTHER REVIEW AND COMMENT. Please retain this documentation as evidence of compliance with Section 106 of the National Historic Preservation Act, as amended.

By: Mark A. Miles — December 28, 2005

Mark A. Miles, Deputy State Historic Preservation Officer — **Date**

MISSOURI DEPARTMENT OF NATURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE
P.O. Box 176, Jefferson City, Missouri 65102
For additional information, please contact Judith Deel, (573) 751-7862. Please be sure to refer to the project number: 001-CK-06

Matt Blunt
Governor

Michael N. Keathley
Commissioner

State of Missouri
OFFICE OF ADMINISTRATION
Intergovernmental Relations
Post Office Box 809
Jefferson City, 65102
573/751-1851

RECEIVED
JAN 17 2006
CEMVR-OD-P

12/30/05

Wayne Hannel
District Engineer
US Army Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Dear Mr. Hannel:

Subject: 0512045
Assistance

The Missouri Federal Assistance Clearinghouse, in cooperation with state and local agencies interested or possibly affected, has completed the review on the above project application.

None of the agencies involved in the review had comments or recommendations to offer at this time. This concludes the Clearinghouse's review.

A copy of this letter is to be attached to the application as evidence of compliance with the State Clearinghouse requirements.

Sincerely,

Sara VanderFeltz

Sara VanderFeltz
Administrative Assistant

cc:

CMVR-OD-P — 2005-1709

The Pawnee Nation of Oklahoma
Post Office Box 470
Pawnee, Oklahoma 74058
Tribal Historic Preservation Office *(918) 762-3624 Ext. 107*

RECEIVED
JAN 17 2006
CEMVR-OD-P

December 30, 2005

US Army Corps of Engineers, Rock Island District
ATTN: OD-P Wayne Hannel, Project Manager
Clock Tower Building
Post Office Box Office 2004
Rock Island, Illinois 61204-2004

Dear Mr. Hannel:

We appreciate your time and effort in consulting with the Pawnee Nation of Oklahoma, regarding the initiation of the Section 106 Process of identifying historic properties.

Your efforts do not go unnoticed and our office strives to continue to reply within the 30-day time frame, Section 800.5(c)(1), should we have any objections. However, our office receives, several requests for comment letters, on a daily basis, from several agencies from different states. So that you know, we respond only to letters that pertain to possible historic sites, or known historic sites of the Pawnee Nation. The Pawnee Nation has no interests in the State of Missouri.

So that you may update your mailing list, The Pawnee Nation Business Council President is Mr. Ron Rice and Mr. Francis Morris continues as our NAGPRA Coordinator. Should you have any questions, please do not hesitate to call the Tribal Historic Preservation Office at (918) 762-3624, Ext. 107.

Sincerely,

Francis Morris,
Tribal Historic Preservation Officer "Acting"

Xc: THPO Outgoing

2005-1209

PEORIA TRIBE OF INDIANS OF OKLAHOMA
118 S. Eight Tribes Trail (918) 540-2535 FAX (918) 540-2538
P.O. Box 1527
MIAMI, OKLAHOMA 74355

CHIEF
John P. Froman

SECOND CHIEF
Jason Dollarhide

January 1, 2006

JAN 09 2006

District Engineer
U.S. Army Corps of Engineers
Rock Island District
ATTN: OD-P (Wayne Hannel)
Clock Tower Building—P.O. Box 2004
Rock Island, Illinois 61204-2004

RE: CEMVR-OD-P-2005-1309

Thank you for notice of the referenced project. The Peoria Tribe of Indians of Oklahoma is currently unaware of any documentation directly linking Indian Religious Sites to the proposed construction. In the event any items falling under the Native American Graves Protection and Repatriation Act (NAGPRA) are discovered during construction, the Peoria Tribe request notification and further consultation.

The Peoria Tribe has no objection to the proposed construction. However, if human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction should stop immediately, and the appropriate persons, including state and tribal NAGPRA representatives contacted.

John P. Froman
Chief

xc: Bud Ellis, Repatriation/NAGPRA Committee Chairman

TREASURER
John Sharp

SECRETARY
Hank Downum

FIRST COUNCILMAN
Claude Landers

SECOND COUNCILMAN
Jenny Rampey

THIRD COUNCILMAN
Alan Goforth

This purpose of this public notice is to solicit comments on the proposed project. **POC: Wayne Hannel, Telephone: 309/794-5378**

PUBLIC NOTICE

US Army Corps of Engineers

Applicant: U. S. Army Corps of Engineers
Rock Island District

Date: December 21, 2005

Expires: January 10, 2006

CEMVR-OD-P-2005-1309

NO OBJECTION
U.S. Fish & Wildlife Service
Rock Island, Illinois
Supervisor 1/4/06 Date

Joint Public Notice
U. S. Army Corps of Engineers
State of Missouri

1. **Applicant.** U.S. Army Corps of Engineers, Clock Tower Building, Rock Island, Illinois 61204-2004.

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and Wildlife Service (USFWS). The proposed plan includes:

- Planting 215 acres of mast-producing hardwood nursery stock on moderately flood-prone land,
- Planting 60 acres of trees by direct seeding on higher, less flood-prone land,
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Shellbark Hickory	*Carya laciniosa*	6	1,290
Kentucky Coffeetree	*Gymnocladus dioicus*	6	1,290
Persimmon	*Diospyros virginiana*	6	1,290

DEC 23 2005

Sac and Fox Nation of Missouri in Kansas and Nebraska

305 North Main Street • Reserve, Kansas 66434
Phone (785) 742-7471 • Fax (785) 742-3785

RECEIVED
JAN 12 2006
CEMVR-OD-P

January 9, 2006

Department of the Army
Corps of Engineers
Rock Island District
ATTN: OD-P (Wayne Hannel)
Clock Tower Building - Post Office Box 2004
Rock Island Illinois 61204-2004

Dear Mr. Hannel:

Thank you for your letter, which is in compliance with Section 106 of the National Historic Preservation Act, and Section 110.

Project: CEMVR-OD-P-2005-1309

The Sac and Fox Nation of Missouri in Kansas and Nebraska NAGPRA department have determined the above project as:

No objections. However, if human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction, please stop immediately and notify NAGPRA representative, Deanne Bahr, at the address above.

There are two other bands of Sac and Fox that also need to be contacted, the Sac and Fox Nation of Oklahoma and the Sac and Fox of the Mississippi in Iowa.

Johnathan Buffalo, NAGPRA Representative
Sac and Fox of the Mississippi in Iowa
349 Meskwaki Rd.
Tama, IA 52339-9629

Sandra Massey, NAGPRA Representative
Sac and Fox Nation of Oklahoma
Rt. 2, Box 246
Stroud, OK 74079

If you have any questions, please contact me at the number or address above.

Sincerely,

Deanne Bahr

Deanne Bahr
Sac and Fox Nation of Missouri in Kansas and Nebraska
NAGPRA Contact Representative

Niles, Darron L MVR

From: Hannel, Wayne MVR
Sent: Tuesday, January 10, 2006 1:59 PM
To: Niles, Darron L MVR; Anderson, Heather L MVR
Subject: FW: Army Corps of Engineers, Fox Island Division Habitat Enhancement and Rehabilitation Project, CEMVR-OD-P-2005-1309/CER000216

/i
Vayne H

rom: Don Boos [mailto:don.boos@dnr.mo.gov]
ent: Tuesday, January 10, 2006 12:29 PM
o: Hannel, Wayne MVR
c: Hansen, Rick MVS; Sternburg, Janet MVS; Carl Stevens
ubject: RE: Army Corps of Engineers, Fox Island Division Habitat Enhancement and Rehabilitation Project, CEMVR-OD-P-2005-309/CER000216

'he Missouri Department of Natural Resources' Water Protection Program has reviewed Public Notice No. CEMVR-)D-P-2005-1309/CER000216 in which the applicant has proposed the Fox Island Division Habitat Rehabilitation and :nhancement Project (HREP). The project is located on the west bank of the Mississippi River one mile downstream of \lexandria, in Clark County, Missouri. The project lies in Pool 20 between Upper Mississippi River Miles (RM) 353.6 nd 358.5. The 2,033-acre Fox Island Division (referred to as Division), part of the Great River National Wildlife :efuge, is made up of un-leveed bottomland forests, fields and sloughs. There are a myriad of wetlands on the Division nd several features with open water for at least part of every year. Named water features include Coin Pond (which ries up in late summer), Slim Slough (a.k.a. Ribbon Slough, which is dry most of the year except in the spring), Logsdoı :lough (which usually has water in its lower reaches but can expand several-fold in the spring), Old Lake (perennial oper vater), and Nelson Lake (a.k.a. Silver Lake, also perennial). All project lands are in federal ownership and are managed ·y the U.S. Fish and Wildlife Service (USFWS).

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Planting 60 acres of trees by direct seeding on higher, less flood-prone land;
Enhancing 78 acres of wetlands in and around Logsdon Slough, Coin Pond, Slim Slough and Old Lake; and
Planting 98 acres of native prairie grasses and forbs.

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Kentucky Coffeetree	*Gymnocladus dioicus*	6	1,290
Persimmon	*Diospyros virginiana*	6	1,290
Total		**50**	**10,750**

:nhance Logsdon Slough. The water supply to Logsdon Slough will be enhanced by construction of a new 20-inch iameter well. The 100-foot-deep well will be located adjacent to but not in the slough and will be accessible by truck or ar via an existing farm road. The well will have a permanently mounted pump connected to a portable diesel engine. The pumped water will be conveyed to the slough through a 200-foot long channel. The upper 40 feet of the channel vill be lined with riprap to increase aeration and prevent scour. The well will be used to fill Logsdon Slough to a lanned water surface elevation of 484.5, whereby approximately 25 acres will be inundated. An existing stoplog tructure at the downstream end of the slough will be used to adjust water levels and control the discharge to the Fox :iver. The stoplogs can be completely removed to drain the slough. The existing stoplog structure is in need of minor epair. This structure was constructed as part of the WRP restoration. The base of the structure and the channel on both ides of the structure has silted in and needs to be excavated to restore its hydraulic capacity. A system should be nstalled for locking the stoplogs in place when they are in use, and securely storing them when they are not.

:nhance Coin Pond – Slim Slough – Old Lake Complex. Enhancing this wetland, on the east side of the Fox River, vill provide the capability of controlling water levels within the banks of the three waterbodies - Coin Pond, Slim Slough nd Old Lake. Fifty-three acres are inundated within these waterbodies when they are filled to the top-of-bank elevation f 484. An additional 130 acres of interconnected lowlands, natural channels and field swales also become inundated vhen these waterbodies are filled to this level. At elevation 485, an additional 170 acres, 353 acres altogether, will be nundated. The recommended plan for this area provides the capability to contain water to elevation 485 and higher. The ntire 353 acres lying below elevation 485 is not expected to be inundated because of the sandy composition of high round. The management plan calls for draining much of the wetland area after flood waters recede to encourage growth f forage plants. The water levels will be raised in the late summer and fall to enhance resting habitat for migrating vaterfowl. The stoplog water control structures and conveyance channels will provide the capability to drain the omplex by gravity. Re-supplying the wetlands will require pumping during dry periods. If the higher elevation of 485 s achievable, the pumping rate, not including seepage losses, should be 8,000 gpm for 15 days. Two pumps are ecommended for achieving the goals, one using groundwater as the source, the other using the Mississippi River. The ombination of groundwater and surface water supply increases the management flexibility and reliability. The water ources include:

A new well and pump, with similar characteristics to the Logsdon Tract well installed to pump water through a nev hannel, into Coin Pond. The channel will be approximately 200 feet long and the upper 40 feet will be lined with riprap o dissipate the energy from the pump discharge, prevent erosion, and increase aeration.

A surface water pump station, constructed on Grey Chute to supply water to the Coin Pond/Slim Slough/Old Lake omplex through a force main installed beneath the railroad. This pump station will be connected to a portable diesel ngine. The pump will discharge through a 24" force main jacked beneath the railroad into a channel that will outlet into ne north end of Slim Slough. The end of the discharge will be equipped with a flap gate to prevent back flow through ne pump. The pump station will be located at the top of the west bank of Grey Chute at the southern end of the East Vinkelman Tract. A sheet pile wall will be constructed to increase bank stability. The ends of the wall will be armored vith riprap to prevent bank cutting. Stoplog water control structures will be used to manage water levels within the vetlands. The main structure will be located where the two natural drainage channels from the northeast (Coin Pond and lim Slough) and southeast (Old Lake) merge before reaching the Fox River. This structure will be cast-in-place oncrete, with a bridge deck to provide vehicular access between the north and south halves of the Division along the eas ank of the Fox River. This stoplog structure will be accessible by vehicle and will provide the capability to adjust water evels throughout the wetland complex, drain the system, or capture flood pulses from the Fox River. The 3½-inch high y 6-inch thick by 60-inch long stoplogs will be fabricated from aluminum tube stock and designed to fit in slots created rom steel channels cast into the reinforced concrete structures. The reinforced concrete channel through the structure vill facilitate the removal of sediment that may be deposited during periods of high water. Additional galvanized metal

toplog structures will be located on the connecting channels to allow independent control of water within separate egments of the wetland. The stoplogs are each approximately 60 inches long.

An existing water control structure, located at the south end of Coin Pond, will be replaced with a new galvanized ıetal stoplog structure. This structure, located on a spur off the main distribution channel, will provide the capability of solating Coin Pond and the new well from the rest of the complex. The existing spur channel will be cleaned and levele ɔ provide two-way flow capability.

Two galvanized metal stoplog structures will be constructed on Slim Slough, one at each end. The structures will rovide the capability for isolating Slim Slough and allow it to be filled or drained from either end.

A fourth galvanized metal stoplog structure will be constructed on the channel at the north end of Old Lake. This tructure, in combination with the structure at the south end of Slim Slough, will provide the capability for isolating Old ake and allow it to be filled or drained from either end. The connecting channels within the wetland complex will be esigned to flow both ways:

. To drain the complex into the Fox River, or

. To fill the wetlands by pumping or from the Fox River when it is in high stage. Channel improvements include learing, excavating and regrading existing channels; few new channels will be required. A length of new channel will e required at the point of discharge from each of the new pump locations. These channels will be lined with riprap in ıeir upper reaches to dissipate energy and increase aeration.

The well pump north of Coin Pond will require a short channel to an existing swale that flows to Coin Pond. This hannel will allow placement of the well outside the pond and swale for improved accessibility.

Discharge from the Grey Chute pump force main will flow through a newly constructed channel from the railroad ight-of-way to the upper end of Slim Slough. The channel between Coin Pond and Slim Slough will be cleared and raded to improve conveyance. An existing stoplog structure will be removed from this reach, to be replaced by the toplog structure at the upper end of Slim Slough described above. The channel between the south end of Slim Slough nd Old Lake will be cleared and re-graded to improve conveyance. The channel connecting the north end of Old Lake ɔ the main water control structure will also be cleared and graded. Vegetation that is cleared and grubbed during hannel improvements will be piled on site. Excavated material will be used as required to construct berms and backfill tructures. Excess material will be spread over adjacent fields and tilled to match existing terrain. When completed, all hannels will be approximately 5 feet deep with 8-foot wide bottoms and 3H:1V side slopes. They will be graded level a onstant bed elevation of 480, and provide a complete loop connecting Coin Pond, Slim Slough, Old Lake and the Fox iver. The two pumping locations will be indirectly connected to this distribution channel. The looped channel will rovide the means to distribute water throughout the wetlands and to selectively isolate and drain individual segments. Culverts will be required at two locations to provide vehicular access across drainage channels. Both culverts will be 6" diameter corrugated metal pipe (CMP), 50 feet long. They will be laid level, at invert elevation 480.0, to match the hannel thalweg:

. One culvert will be integral with the galvanized metal stoplog structure on the south end of Coin Pond. The road t this culvert provides access between the areas on the east and west sides of Coin Pond and Slim Slough.

. A second culvert will be integral with the galvanized metal stoplog structure at the south end of Slim Slough. The oad at this culvert provides access from the south to the center of the wetland complex.

The channels will be protected from erosion with riprap in the high velocity areas such as the pump discharge sites Twelve-inch D50 riprap will be applied in a 24-inch thick layer over a 6-inch layer of bedding stone. The bedding stone s a uniform-graded 1½-inch crushed rock that acts as a filter to prevent fine soil from eroding between the riprap. A 50-oot eroded section of the east bank of the Fox River, located about 500 feet north of the primary water control structure, vill also be repaired and protected with riprap. This low bank line will reduce the capability for controlling inflow and utflow to the Coin Pond, Slim Slough, Old Lake wetlands if not repaired. There is an existing county road that provides ccess to the part of the Division lying east of the Fox River. In many locations the road is no longer discernible or assable. The roads will not be improved to increase public visitation. Proposed road repairs under this project will ıvolve some re-grading to fill holes and improve drainage. A new 250-foot-long road will be constructed to access the ump on Grey Chute. The new well pump near Coin Pond will require 1,000 feet of new road. The 12-foot wide roads vill be constructed by cutting a drainage ditch on each side of the roadway, and using the excavated material to raise and evel the road sub-grade. Two existing railroad crossings will be maintained, but not improved. These crossings provide ccess from a dirt farm road on the east side of the Burlington Northern Santa Fe (BNSF) Railroad tracks to dirt roads in ıe Division between the Fox River and the railroad.

Restore Native Grassland. Approximately 98 acres of the Logsdon Tract, lying west of the Fox River levee system, will be planted in native grasses and forbs. The levee is owned and maintained by the Mississippi-Fox Drainage and Levee District No. 2. The grassland will be created by seeding land that was formerly planted in row crops and small grains. The proposed grassland is adjacent to a native prairie that was recently planted within the Rose Pond Conservation Area, managed by the Missouri Department of Conservation. The Logsdon Tract restoration, in combination with additional plantings planned by the Missouri Department of Conservation will result in a contiguous grassland area of up to 400 acres. It will provide habitat for nesting and migrating prairie wildlife. Native grass and forbs candidate species include grasses such as Big and Little Bluestem, Indian Grass, Switchgrass, Prairie Cord-grass; and forbs such as Black-Eyed Susan, Butterfly Milkweed, Compass Plant, Evening Primrose, Lanceleaf Coreopsis, Large-Flowered Beardtongue, Leadplant, Pale Purple Coneflower, Rattlebox, Showy Goldenrod, Stiff Goldenrod, Upland White Aster, White Prairie Clover, White Wild Indigo and Yellow Coneflower. Some areas near Logsdon Slough will be cleared of recent growth, cottonwoods and willows. The seed may be a commercial mesic prairie mix from a nursery in Iowa, Illinois, or Missouri with a slightly different composition than shown here.

The project is located in Sections 24, 25 and 36, Township 64 north, Range 6 west; Sections 8, 17, 18, 19, 20, 30 and 31, Township 64 north, Range 5 west; Section 1, Township 63 north, Range 6 west; and in Section 6, Township 63 north, Range 5 west in Clark County, Missouri, approximate Mississippi River miles 353.6 – 358.5.

We offer the following comments:

. Wetlands were once a significant component of Missouri's natural heritage, accounting for almost 11 percent of its surface area. Historical wetland losses in Missouri have been significant. It is encouraging to occasionally witness projects that are intended/designed to enhance wetlands.

. The project site is described as 'un-leveed bottomland forests, fields and sloughs'. Since there is still natural connectivity with the river and its' flooding regimes, how critical is the pumping that is proposed and will it in fact result in higher quality of wetlands than now exists? Obviously the river regimes have been altered and flood regimes have been reduced, but is artificial manipulation going to provide adequate replacement and be a real enhancement? Wetlands are a very complex ecosystem with hydrology being a significant, but certainly not a sole component. Increases in the number of days and acres flooded (open water) will change the wetland, but may be of uncertain benefit to particular wetland communities. Pumping will not replace the sediment loading, nutrient deposition and seed stock renewal of natural flooding regimes.

. The new roads that are being constructed will utilize a footprint of wetland somewhat over 12 feet in width for at least 1250 feet. Is it to be assumed that the project is to be considered mitigation to offset the 0.34 acre loss? Will a separate mitigation plan be offered? In any case, project managers need to assure the road does not function as a low levee that restricts the free exchange of floodwater across the wetlands.

. Jurisdictional springs or a spring with connectivity to a jurisdictional stream should not be filled.

. Care should be taken to keep machinery out of the waterway as much as possible. Fuel, oil and other petroleum products, equipment and any solid waste should not be stored below the ordinary high water mark at any time or in the adjacent floodway beyond normal working hours. All precautions should be taken to avoid the release of wastes or fuel to streams and other adjacent waterbodies as a result of this operation.

. Clearing of vegetation/trees should be the minimum necessary to accomplish the activity.

. The riparian area, banks, etc., should be restored to a stable condition to protect water quality as soon as possible. Seeding/planting of native vegetation, mulching and needed fertilization should be within three days of final contouring, or as soon as possible as seasonal timing permits. On-site inspections of these areas should be conducted by the permittee as necessary to ensure successful revegetation and stabilization, and to ensure that erosion and deposition of soil in waters of the state is not occurring from this project.

. Only clean, nonpolluting fill should be used.

'. Work should be conducted during low water or flow whenever possible.

0. The following materials are not suitable for bank stabilization and should not be used due to their potential to ause violations of the general criteria of the Water Quality Standards,
0 CSR 20-7.031 (3) (A) – (H):
. Earthen fill, gravel, broken concrete where the majority of material is less than 12 inches in diameter, and ragmented asphalt, since these materials are usually not substantial enough to withstand erosive flows;
'. Concrete with exposed rebar;
. Tires, vehicles or vehicle bodies, construction or demolition debris are solid waste and are excluded from lacement in the waters of the state; and
. Liquid concrete, including grouted riprap, if not placed as part of an engineered structure.

Recycled concrete may be used provided that it is clean material broken into appropriately sized pieces (greater than 12 nches) of riprap with no protruding rebar.

1. Culverts should be sized and placed to maintain a depth of water at least as deep as the water at the culvert's pposite end.

'hank you for the opportunity to comment on this project. If you have any questions, please call Don W. Boos of the JPDES Permits and Engineering Section at (573) 751-1404.

)WB:pc

January 11, 2006

District Engineer
US Army Corps of Engineers
Rock Island District
Attn: OD-P (Wayne Hannel), Clock Tower Bldg.
Post Office Box 2004
Rock Island, Illinois 61204-2004

Re: CEMVR-OD-P-2005-1309

Dear Mr. Wayne Hannel,

Thank you for your letter. The Cultural Preservation Office would like to inform you that the Winnebago Tribe of Nebraska had no village sites, grave sites, or sacred sites in the area of the proposed construction. If there are cultural properties or human remains discovered in the proposed construction area, can you please notify my office at 402-878-3313. Thank you.

Sincerely,

Emily Lucy De Leon
Temporary Director,
Repatriation and Cultural Preservation Office
(402) 878-3313

"MESKWAKI NATION"

Sac & Fox Tribe of the Mississippi in Iowa

349 Meskwaki Road, Tama, IA 52339-9634 • (641) 484-4678 FAX (641) 484-5424

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JAN 18 2006
CEMVR-OD-P

January 13, 2006

US Army Corps of Engineers- Rock Island District
Mr. Wayne Hannel
ATTN: OD-P, Clock Tower Bldg
Post Office Box 2004
Rock Island, IL 61204-2004

Dear Mr. Hannel:

Thank you for the notice concerning the project:

CEMVR-OD-P-2004-0582
CEMVR-OD-P-2005-1309

At this time, the Historical Preservation Department of the Sac and Fox of the Mississippi in Iowa has determined that the above listed has:

- ☐ No interest in the area geographically
- ☐ No comment on the proposed undertaking
- ☑ No objections. However, if human skeletal remains and/or any objects falling under NAGPRA are uncovered during construction, please stop immediately and notify the NAGPRA Representative, Johnathan L Buffalo.
- ☐ Have an objection or require additional project information. Please send the following: _____.

Sincerely,

Johnathan L. Buffalo
Historical Preservation Coordinator
Sac and Fox of the Mississippi in Iowa

Cc: File

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters

2901 West Truman Boulevard, P.O. Box 180, Jefferson City, Missouri 65102-0180

Telephone: 573/751-4115 ▲ Missouri Relay Center: 1-800-735-2966 (TDD)

JOHN D. HOSKINS, Director

January 20, 2006

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JAN 25 2006
CEMVR-OD-P

District Engineer
U.S. Army Corps of Engineers
Rock Island District
ATTN: OD-P (Wayne Hannel)
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Dear Sir:

RE: Fox Island Division Habitat Rehabilitation and Enhancement Project, Clark County, MO
Public Notice CEMVR-OD-P-2005-1309

Department of Conservation (Department) staff participated in several of the planning efforts associated with the above referenced project and commented on the 2003 draft project plan. We believe the proposed project will provide improved habitat conditions for many wildlife species in the project area through the proposed bottomland hardwood reforestation, native grassland plantings, and wetland enhancement features. With regards to impacting wetlands, this project should result in an improvement of existing wetland habitat conditions.

The Department is the agency responsible for fish, forest and wildlife resources in Missouri. As such, we actively participate in project review when projects might impact those resources. However, we have no regulatory authority over the Clean Water Act permitting process. Our comments and recommendations for your consideration are to provide additional information and management suggestions on important natural resources in the project vicinity.

While it is unlikely this project will impact federally listed animals or plants if the actions noted in Section 6 of the public notice are followed, three state Endangered species are found on the adjacent Rose Pond Conservation Area. These species may occur on Fox Island Division if suitable habitat is present. In Missouri, these three species are found in few locations. Identification of an additional area supporting any of these species would be important. As scheduling permits, Department staff may be available to assist Fox Island Division staff in searching for these species.

Both the Illinois mud turtle (*Kinosternon flavescens spooneri*) and Blanding's turtle (*Emydoidea blandingii*) were found during 2004 and 2005 surveys on Rose Pond CA. Nine Illinois mud turtles and twelve Blanding's turtles were captured and released. Previous studies on the area reported that the mud turtle moved several hundred yards toward Fox Island Division. The Illinois mud turtles are found in marshes, oxbow lakes and in flooded fields associated with sandy soils. Blanding's turtle are found in shallow water along the edges of marshes, ponds, sloughs and drainage ditches that

COMMISSION

STEPHEN C. BRADFORD Cape Girardeau | CHIP McGEEHAN Marshfield | CYNTHIA METCALFE St. Louis | LOWELL MOHLER Jefferson City

have abundant aquatic and emergent vegetation and a muddy bottom. If suitable habitat exists on Fox Island Division these species could occur on-site.

We support the proposed grassland plantings near the Logsdon Slough, and recommend clearing and establishing the grassland down to the water's edge, especially in the area located between the levee and the slough. Keeping the area open would provide the endangered turtles with access to the slough, should they exist on-site or move in from Rose Pond CA.

Another state Endangered reptile, Western fox snake (*Elaphe vulpina vulpina*), has been found recently on Rose Pond CA. This species is found in marshes and wet prairies, though it could also be found in lowland forest. Given the habitat conditions on Fox Island Division, and nearby Western fox snake occurrence, this snake may occur on the project area. Projects that alter wetland habitat where the species exists could negatively impact this snake, depending on the habitat modifications. However, proposed actions could also prove beneficial by improving certain wetland habitats.

A fourth species of conservation concern, the flat floater (*Anodonta suborbiculata*), and listed imperiled in the state, may occur within the wet locations planned to be drained or filled. However, this species thrives in environments that are frequently drained, such as reservoirs, and we expect no long term impacts.

Finally, from a fisheries perspective, the stoplog structure presently located at the end of the Logsdon Slough will not allow fish to move into the wetland from the Fox River. Removal of the structure would reduce opportunity to retain higher water levels in the slough, which is one of the purposes of the project. However, we recognize that one purpose of the project is to improve the wetland conditions within the Logsdon tract for wetland species, and therefore understand the tradeoff.

Thank you for the opportunity to review and comment. If you have questions regarding these comments, please contact me at 573-522-4115, Extension 3372, or at Janet.Sternburg@mdc.mo.gov.

Sincerely,

JANET E. STERNBURG
POLICY COORDINATOR

c: Missouri Department of Conservation: Brian Todd, Mike Jones, Jeff Briggler, Greg Gremaud, Travis Moore, Darlene Hoffman

Prairie Band Potawatomi Nation
Government Center

RECEIVED
FEB 0 8 2006
CEMVR-OD-P

February 3, 2006

District Engineer
US Army Corps of Engineers, Rock Island District
Clock Tower Bldg., PO Box 2004
Rock Island, Illinois 61204-2004

Dear **Mr. Hannel:**

I am writing to inform you that I am in receipt of your recent National Historic Preservation Act (NHPA), Section 106 and Section 110 correspondence.

After reviewing the contents of your recent mailing we would like to inform that we have no objections to the following project(s):

Project(s): CEMVR-OD-P-2005-1256

At this time we are unaware of any historical cultural resources in the proposed development area. However, we do request to be immediately contacted if any inadvertent discoveries are uncovered at anytime throughout the various phases of the project.

Please feel free to call me at (785) 966-4007 or additional information can be faxed to (785) 966-4009. We look forward to working with you.

Respectfully,

Tracy Stanhoff
Tribal Chair
NAGPRA Representative
Prairie Band Potawatomi Nation

TS/mls

16281 Q Road • Mayetta, KS 66509 • 785.966.4000 • Fax: 785.966.4002

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CEMVR-OD-F

STATE OF MISSOURI
Matt Blunt, Governor • Doyle Childers, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

April 19, 2006

Colonel Duane P. Gapinski
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Clark County
2005-1309/CER000216

Dear Colonel Gapinski:

The Missouri Department of Natural Resources' Water Protection Program has reviewed Public Notice No. CEMVR-OD-P-2005-1309/CER000216 in which the applicant has proposed the Fox Island Division Habitat Rehabilitation and Enhancement Project (HREP). The project is located on the west bank of the Mississippi River one mile downstream of Alexandria, Clark County, Missouri. The project lies in Pool 20 between Upper Mississippi River Miles (RM) 353.6 and 358.5. The 2,033-acre Fox Island Division (referred to as Division), part of the Great River National Wildlife Refuge, is made up of un-leveed bottomland forests, fields and sloughs. There are a myriad of wetlands on the Division and several features with open water for at least part of every year. Named water features include Coin Pond (which dries up in late summer), Slim Slough (a.k.a. Ribbon Slough, which is dry most of the year except in the spring), Logsdon Slough (which usually has water in its lower reaches but can expand several-fold in the spring), Old Lake (perennial open water), and Nelson Lake (a.k.a. Silver Lake, also perennial). All project lands are in federal ownership and are managed by the U.S. Fish and Wildlife Service (USFWS).

The proposed plan includes:

- Planting 215 acres of mast-producing hardwood nursery stock on moderately flood-prone land;
- Planting 60 acres of trees by direct seeding on higher, less flood-prone land;
- Enhancing 78 acres of wetlands in and around Logsdon Slough, Coin Pond, Slim Slough and Old Lake; and
- Planting 98 acres of native prairie grasses and forbs.

Recycled Paper

Tree Planting.

- Approximately 60 of the 275 mast-producing acres will be direct seeded with equal numbers of swamp white oak, pin oak, bur oak, walnut, green ash and sycamore. Nuts and acorns will be drilled 4- to 6-inches on center, in rows 9- to 10-feet apart, yielding 10 thousand seedlings per acre.
- The remaining 215 acres will be planted with container-grown nursery stock. Container grown stock are specially raised by the nurseries using methods to induce vigorous growth and increased root mass. The saplings are grown in 3- to 5-gallon containers, stand about 5 feet in height and have at least 5/8-inch caliper. The trees will be planted on a 30-foot by 30-foot spacing, staggered in adjacent rows and intermixed to avoid blocks of the same species. This spacing yields 50 trees per acre. Trees will be planted in the spring between March 1 and May 15, or in the fall between October 1 and December 10.

Mast Trees	Scientific Name	Planting Rate/Acre	Total # of Trees
Swamp White Oak	*Quercus bicolor*	8	1,720
Bur Oak	*Quercus macrocarpa*	8	1,720
Pin Oak	*Quercus palustris*	8	1,720
Northern Pecan	*Carya illinoensis*	8	1,720
Shellbark Hickory	*Carya laciniosa*	6	1,290
Kentucky Coffeetree	*Gymnocladus dioicus*	6	1,290
Persimmon	*Diospyros virginiana*	6	1,290
Total		**50**	**10,750**

Enhance Logsdon Slough. The water supply to Logsdon Slough will be enhanced by construction of a new 20-inch diameter well. The 100-foot-deep well will be located adjacent to but not in the slough and will be accessible by truck or car via an existing farm road. The well will have a permanently mounted pump connected to a portable diesel engine. The pumped water will be conveyed to the slough through a 200-foot long channel. The upper 40 feet of the

channel will be lined with riprap to increase aeration and prevent scour. The well will be used to fill Logsdon Slough to a planned water surface elevation of 484.5, whereby approximately 25 acres will be inundated. An existing stoplog structure at the downstream end of the slough will be used to adjust water levels and control the discharge to the Fox River. The stoplogs can be completely removed to drain the slough. The existing stoplog structure is in need of minor repair. This structure was constructed as part of the Wetland Reserve Program (WRP) restoration. The base of the structure and the channel on both sides of the structure has silted in and needs to be excavated to restore its hydraulic capacity. A system should be installed for locking the stoplogs in place when they are in use, and securely storing them when they are not.

Enhance Coin Pond – Slim Slough – Old Lake Complex. Enhancing this wetland, on the east side of the Fox River, will provide the capability of controlling water levels within the banks of the three waterbodies - Coin Pond, Slim Slough and Old Lake. Fifty-three acres are inundated within these waterbodies when they are filled to the top-of-bank elevation of 484. An additional 130 acres of interconnected lowlands, natural channels and field swales also become inundated when these waterbodies are filled to this level. At elevation 485, an additional 170 acres, 353 acres altogether, will be inundated. The recommended plan for this area provides the capability to contain water to elevation 485 and higher. The entire 353 acres lying below elevation 485 is not expected to be inundated because of the sandy composition of high ground. The management plan calls for draining much of the wetland area after floodwaters recede to encourage growth of forage plants. The water levels will be raised in the late summer and fall to enhance resting habitat for migrating waterfowl. The stoplog water control structures and conveyance channels will provide the capability to drain the complex by gravity. Re-supplying the wetlands will require pumping during dry periods. If the higher elevation of 485 is achievable, the pumping rate, not including seepage losses, should be 8,000 gallons per minute (gpm) for 15 days. Two pumps are recommended for achieving the goals, one using groundwater as the source, the other using the Mississippi River. The combination of groundwater and surface water supply increases the management flexibility and reliability. The water sources include:

- A new well and pump, with similar characteristics to the Logsdon Tract well installed to pump water through a new channel, into Coin Pond. The channel will be approximately 200 feet long and the upper 40 feet will be lined with riprap to dissipate the energy from the pump discharge, prevent erosion, and increase aeration.
- A surface water pump station, constructed on Grey Chute to supply water to the Coin Pond/Slim Slough/Old Lake complex through a force main installed beneath the railroad. This pump station will be connected to a portable diesel engine. The pump will discharge through a 24" force main jacked beneath the railroad into a channel that will outlet into the north end of Slim Slough. The end of the discharge will be equipped with a flap gate to prevent back flow through the pump. The pump station will be located at the top of the west bank of Grey Chute at the southern end of the East Winkelman Tract. A sheet pile wall will be constructed to increase bank stability. The ends of the wall will be armored with riprap to

prevent bank cutting. Stoplog water control structures will be used to manage water levels within the wetlands. The main structure will be located where the two natural drainage channels from the northeast (Coin Pond and Slim Slough) and southeast (Old Lake) merge before reaching the Fox River. This structure will be cast-in-place concrete, with a bridge deck to provide vehicular access between the north and south halves of the Division along the east bank of the Fox River. This stoplog structure will be accessible by vehicle and will provide the capability to adjust water levels throughout the wetland complex, drain the system, or capture flood pulses from the Fox River. The 3½-inch high by 6-inch thick by 60-inch long stoplogs will be fabricated from aluminum tube stock and designed to fit in slots created from steel channels cast into the reinforced concrete structures. The reinforced concrete channel through the structure will facilitate the removal of sediment that may be deposited during periods of high water. Additional galvanized metal stoplog structures will be located on the connecting channels to allow independent control of water within separate segments of the wetland. The stoplogs are each approximately 60 inches long.

- An existing water control structure, located at the south end of Coin Pond, will be replaced with a new galvanized metal stoplog structure. This structure, located on a spur off the main distribution channel, will provide the capability of isolating Coin Pond and the new well from the rest of the complex. The existing spur channel will be cleaned and leveled to provide two-way flow capability.
- Two galvanized metal stoplog structures will be constructed on Slim Slough, one at each end. The structures will provide the capability for isolating Slim Slough and allow it to be filled or drained from either end.
- A fourth galvanized metal stoplog structure will be constructed on the channel at the north end of Old Lake. This structure, in combination with the structure at the south end of Slim Slough, will provide the capability for isolating Old Lake and allow it to be filled or drained from either end. The connecting channels within the wetland complex will be designed to flow both ways:
  1. To drain the complex into the Fox River, or
  2. To fill the wetlands by pumping or from the Fox River when it is in high stage. Channel improvements include clearing, excavating and regrading existing channels; few new channels will be required. A length of new channel will be required at the point of discharge from each of the new pump locations. These channels will be lined with riprap in their upper reaches to dissipate energy and increase aeration.
- The well pump north of Coin Pond will require a short channel to an existing swale that flows to Coin Pond. This channel will allow placement of the well outside the pond and swale for improved accessibility.
- Discharge from the Grey Chute pump force main will flow through a newly constructed channel from the railroad right-of-way to the upper end of Slim Slough. The channel between Coin Pond and Slim Slough will be cleared and graded to improve conveyance. An existing stoplog structure will be removed from this reach, to be replaced by the stoplog structure at the upper end of Slim Slough. The channel between the south end of Slim

Slough and Old Lake will be cleared and re-graded to improve conveyance. The channel connecting the north end of Old Lake to the main water control structure will also be cleared and graded. Vegetation that is cleared and grubbed during channel improvements will be piled on-site. Excavated material will be used as required to construct berms and backfill structures. Excess material will be spread over adjacent fields and tilled to match existing terrain. When completed, all channels will be approximately 5 feet deep with 8-foot wide bottoms and 3H:1V side slopes. They will be graded level at constant bed elevation of 480, and provide a complete loop connecting Coin Pond, Slim Slough, Old Lake and the Fox River. The two pumping locations will be indirectly connected to this distribution channel. The looped channel will provide the means to distribute water throughout the wetlands and to selectively isolate and drain individual segments. Culverts will be required at two locations to provide vehicular access across drainage channels. Both culverts will be 36" diameter corrugated metal pipe (CMP), 50 feet long. They will be laid level, at invert elevation 480.0, to match the channel thalweg:

1. One culvert will be integral with the galvanized metal stoplog structure on the south end of Coin Pond. The road at this culvert provides access between the areas on the east and west sides of Coin Pond and Slim Slough.
2. A second culvert will be integral with the galvanized metal stoplog structure at the south end of Slim Slough. The road at this culvert provides access from the south to the center of the wetland complex.

- The channels will be protected from erosion with riprap in the high velocity areas such as the pump discharge sites. Twelve-inch D50 riprap will be applied in a 24-inch thick layer over a 6-inch layer of bedding stone. The bedding stone is a uniform-graded 1½-inch crushed rock that acts as a filter to prevent fine soil from eroding between the riprap. A 50-foot eroded section of the east bank of the Fox River, located about 500 feet north of the primary water control structure, will also be repaired and protected with riprap. This low bank line will reduce the capability for controlling inflow and outflow to the Coin Pond, Slim Slough, Old Lake wetlands if not repaired. There is an existing county road that provides access to the part of the Division lying east of the Fox River. In many locations the road is no longer discernible or passable. The roads will not be improved to increase public visitation. Proposed road repairs under this project will involve some re-grading to fill holes and improve drainage. A new 250-foot-long road will be constructed to access the pump on Grey Chute. The new well pump near Coin Pond will require 1,000 feet of new road. The 12-foot wide roads will be constructed by cutting a drainage ditch on each side of the roadway, and using the excavated material to raise and level the road sub-grade. Two existing railroad crossings will be maintained, but not improved. These crossings provide access from a dirt farm road on the east side of the Burlington Northern Santa Fe (BNSF) Railroad tracks to dirt roads in the Division between the Fox River and the railroad.

Restore Native Grassland. Approximately 98 acres of the Logsdon Tract, lying west of the Fox River levee system, will be planted in native grasses and forbs. The levee is owned and maintained by the Mississippi-Fox Drainage and Levee District No. 2. The grassland will be

created by seeding land that was formerly planted in row crops and small grains. The proposed grassland is adjacent to a native prairie that was recently planted within the Rose Pond Conservation Area, managed by the Missouri Department of Conservation. The Logsdon Tract restoration, in combination with additional plantings planned by the Missouri Department of Conservation will result in a contiguous grassland area of up to 400 acres. It will provide habitat for nesting and migrating prairie wildlife. Native grass and forbs candidate species include grasses such as Big and Little Bluestem, Indian Grass, Switchgrass, Prairie Cord-grass; and forbs such as Black-Eyed Susan, Butterfly Milkweed, Compass Plant, Evening Primrose, Lanceleaf Coreopsis, Large-Flowered Beardtongue, Leadplant, Pale Purple Coneflower, Rattlebox, Showy Goldenrod, Stiff Goldenrod, Upland White Aster, White Prairie Clover, White Wild Indigo and Yellow Coneflower. Some areas near Logsdon Slough will be cleared of recent growth, cottonwoods and willows. The seed may be a commercial mesic prairie mix from a nursery in Iowa, Illinois, or Missouri with a slightly different composition than shown here.

The project is located in Sections 24, 25 and 36, Township 64 north, Range 6 west; Sections 8, 17, 18, 19, 20, 30 and 31, Township 64 north, Range 5 west; Section 1, Township 63 north, Range 6 west; and in Section 6, Township 63 north, Range 5 west in Clark County, Missouri, approximate Mississippi River miles 353.6 – 358.5.

This office certifies that the ongoing activities apparently will not cause the general or numeric criteria to be exceeded nor impair beneficial uses established in Water Quality Standards, 10 CSR 20-7.031, provided the enclosed, as well as following, conditions are met:

1. Pumping regimes shall be designed to mimic the natural historical cycles of the unaltered river hydrology to the extent possible.

2. The new roads shall be designed with features that assure consistent hydrological connectivity within the wetlands and shall not include drop structures.

3. Jurisdictional springs or a spring with connectivity to a jurisdictional stream shall not be filled.

4. Care shall be taken to keep machinery out of the waterway as much as possible. Fuel, oil and other petroleum products, equipment and any solid waste shall not be stored below the ordinary high water mark at any time or in the adjacent floodway beyond normal working hours. All precautions shall be taken to avoid the release of wastes or fuel to streams and other adjacent waterbodies as a result of this operation.

5. Clearing of vegetation/trees shall be the minimum necessary to accomplish the activity.

6. The riparian area, banks, etc., shall be restored to a stable condition to protect water quality as soon as possible. Seeding/planting of native vegetation, mulching and needed fertilization

shall be within three days of final contouring, or as soon as possible as seasonal timing permits. On-site inspections of these areas shall be conducted by the permittee as necessary to ensure successful revegetation and stabilization, and to ensure that erosion and deposition of soil in waters of the state is not occurring from this project.

7. Only clean, nonpolluting fill shall be used.

8. Work shall be conducted during low water or flow whenever possible.

9. The following materials are not suitable for bank stabilization and shall not be used due to their potential to cause violations of the general criteria of the Water Quality Standards, 10 CSR 20-7.031 (3) (A) – (H):
   a. Earthen fill, gravel, broken concrete where the majority of material is less than 12 inches in diameter, and fragmented asphalt, since these materials are usually not substantial enough to withstand erosive flows;
   b. Concrete with exposed rebar;
   c. Tires, vehicles or vehicle bodies, construction or demolition debris are solid waste and are excluded from placement in the waters of the state; and
   d. Liquid concrete, including grouted riprap, if not placed as part of an engineered structure.

   Recycled concrete may be used provided that it is clean material broken into appropriately sized pieces (greater than 12 inches) of riprap with no protruding rebar.

10. Culverts shall be sized and placed to maintain a depth of water at least as deep as the water at the culvert's opposite end.

Pursuant to Chapter 644.052.9, RSMo, commonly referred to as the Missouri Clean Water Law, this 401 Water Quality Certification shall be valid only upon payment of a fee of seventy-five dollars ($75.00). The enclosed invoice contains the necessary information on how to submit your fee. Payment must be received within fifteen (15) days of receipt of this certification. Upon receipt of the fee, a copy of the certification will be mailed to the applicable office of the Corps of Engineers to inform them the certification is now in effect and final.

If you were affected by this decision, you may appeal to have the matter heard by the administrative hearing commission. To appeal, you must file a petition with the administrative hearing commission within thirty (30) days after the date this decision was mailed or the date it was delivered, whichever date was earlier. If any such petition is sent by registered mail or certified mail, it will be deemed filed on the date it is mailed; if it is sent by any method other than registered mail or certified mail, it will be deemed filed on the date it is received by the administrative hearing commission.

Water Quality Standards must be met during any operations authorized by these permits. If you have any questions, please contact Mr. Don Boos of the NPDES Permits and Engineering Section at (573) 751-1404, e-mail *don.boos@dnr.mo.gov*, or by mail at Missouri Department of Natural Resources, Water Protection Program, P.O. Box 176, Jefferson City, MO 65102-0176.

Sincerely,

WATER PROTECTION PROGRAM

Refaat Mefrakis, P.E.
NPDES Storm Water Permit Unit Chief

RM/dbp

Enclosure

c: Mr. Matt Zager, Army Corps of Engineers, Rock Island District
Mr. Wayne Hannel, Army Corps of Engineers, Rock Island District
DNR - NERO

CORRESPONDENCE

APPENDIX A-A

AFTER ACTION REPORT

ENVIRONMENTAL MANAGEMENT PROGRAM
HABITAT REHABILITIATION AND ENHANCEMENT PROJECT
FOX ISLAND DIVISION OPEN HOUSE
AFTER ACTION REPORT

1. Introduction. This document serves as the after-action report for the Fox Island Division Habitat Rehabilitation and Enhancement Project (HREP) open house held on 26 January 2004. The project is located on the west bank of the Mississippi River one mile downstream of Alexandria, in Clark County, Missouri. The project lies in Pool 20 between Upper Mississippi River Miles (RM) 353.6 and 358.5. The goals of the proposed project are to rehabilitate and enhance wildlife habitat. The objectives identified to meet these goals were: (1) reduce forest fragmentation and enhance forest species diversity; (2) enhance and expand existing wetlands, and (3) restore native grassland.

2. Open House Objective. The objective of the open house was to explain on a one-to-one basis to each open house attendee the draft report results and to answer questions and listen to comments on the proposed modifications.

3. Open House Location. The open house was held at the Holiday Inn Express, 325 Main Street, Keokuk, Iowa.

4. Medium. An announcement was mailed to 141 addressees including congressional interests, federal, state and local governmental agencies; businesses, environmental organizations, media and the general public inviting them to attend an open house. The Public Affairs Office also sent a news release to area television and radio stations and newspapers.

5. Open House Format.

a. Date/Time: The open house was held on 26 January 2005 from 1:00 pm – 3:00 pm and then from 5:00 pm – 7:00 pm.

b. Staff: The Fox Island Division HREP is a joint effort with the following agencies: Rock Island District Corps of Engineers; US Fish and Wildlife Service; and the Missouri Department of Conservation and Stanley Consultants (Corps contractor). The Corps/agency representatives were present to talk one-to-one with the attendees during the open house and to answer any questions. The representatives were:

Darron Niles – Corps of Engineers
Marsha Dolan – Corps of Engineers
Karen Westphal – MO US Fish and Wildlife Service
Darlene Hoffman – MO Dept of Natural Conservation
Dave Ellis – US Fish and Wildlife Service
Greg Germaud - MO Dept of Conservation
Dan Miller – Stanley Consultants

Displays: Two maps of the study area and a PowerPoint slideshow on EMP in general were displayed in the room for the public to view and ask questions. The FWS brought an aerial photo of the area and a poster of Mark Twain National Wildlife Refuge Complex. These maps drew attention at the open house and created good discussion between the attendees and the study team.

6. Attendance. There were approximately 15 attendees in the early afternoon and 1 during the evening section (inclement weather may have held down attendance at the evening session). The attendees were offered a handout of the executive summary, including a study map, a disk with the draft report, and were asked to complete a comment sheet. Attendees were also given a business card with the new website "Help Us Help You" for any further comments for the Corps. The attendees included representatives from one radio station, one television station, one newspaper, the City of Alexandria, MO (mayor), and 1 Congressional office (Hulshof's). Results of the returned comments are shown in paragraph 7 below.

7. Public Comments. Open house attendees were asked to fill out a comment sheet. A total of 31% of comment sheets were returned. Responses indicated that the public strongly agreed the open house was worth their time, the displays and materials were informative, the study team answered questions, the attendees had the opportunity to offer comments, and the open house provided the opportunity to gain information and a better understanding of the Fox Island Division Habitat Rehabilitation and Enhancement Project.

Summary of Additional Responses: The comment sheet also provided space for additional comments regarding the project. Following are the comments typed verbatim:

- Any program to improve the duck hunting would be important to many hunters.
- Would like to see public access to Nelson Lake area during the off season for migration.

Responses regarding, "In my opinion, the one most important thing that the Rock Island District, Corps of Engineers can do during the next year to improve its service is?" indicated:

- More dredging of river and rising some levees.
- Make duck hunters clean up blinds after hunting season.

Comments unrelated to this project will be forwarded to the appropriate partnering agency or internal Corps office.

8. **Summary.** The open house met the objective of providing information on the draft report for the proposed project. The discussion between the study team personnel and the public was informative. Attendees were generally supportive of the open house format and of the project.

Marsha Dolan

MARSHA DOLAN
Public Involvement Specialist
Economic & Environmental Analysis Branch

CF:
PM-F (D Niles)
PM-M (R. Perk)
PM-A (M. Dolan)
PM-M (Dist File)
PM-A (C Carmack)
ED-DN (H. Anderson)
FWS (D. Steinbach, H. Woebber)
MDOC (J. Sterburg)
USFWS (K. Westphal)
MDOC (D. Hoffman, G. Germaud)
USFWS (D. Ellis)
STANLEY CONSULTANTS (Dan Miller)

CLEAN WATER ACT
SECTION 404(b)(1)

APPENDIX B

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-13F)

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX B
CLEAN WATER ACT
SECTION 404(b)(1)

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX B
CLEAN WATER ACT
SECTION 404(b)(1)

1. PROJECT DESCRIPTION

A. Location. The Fox Island Division Habitat Rehabilitation and Enhancement Project (HREP) is located near Alexandria, Missouri in the upper end of Pool 20. The project lies in Clark County, Missouri between Upper Mississippi River Miles (RM) 353.6 and 358.5.

B. General Description. The Corps of Engineers is proposing to construct the Fox Island Division Habitat Rehabilitation and Enhancement Project as part of the Environmental Management Program. The project involves planting hardwood mast-producing trees, planting native prairie grasses, and enhancing wetland habitat. The improvements would benefit a variety of wildlife and would enhance overall habitat diversity. The proposed tree planting and prairie restoration do not involve discharge of fill material into the wetlands and are not considered activities requiring a Section 404 permit or evaluation. Only those planned activities associated with wetland enhancement are addressed herein.

1. Well Pumps. A new well would be drilled on the east side of the levee (west of the Fox River) on the Logsdon Tract. The well would have a permanently mounted pump equipped with a right angle gear drive, and a coupling for connection to a portable diesel engine. This pump would be used to fill Logsdon Slough to a planned elevation of 484.5. The slough would have approximately 25 acres of open water at this elevation. A stoplog structure at the lower/south end of the slough would be used to adjust water elevation and surface water area. This pump would discharge into a 200-foot long channel leading into Logsdon Slough. The channel would be lined with riprap to prevent scouring.

On the east side of the Fox River, a new well and well pump would be installed to provide a water supply for filling the Coin Pond/Slim Slough/Old Lake complex. The pump and well will be sized to produce 2,000 gpm. Filling this wetland complex to a planned elevation of 484 will result in approximately 53 acres of open water. A series of stoplog structures would be employed to maintain the planned elevation and provide the capability to adjust the elevation. The pump would discharge into a 200-foot long channel leading into Coin Pond. The first 40 feet of channel would be lined with riprap.

2. Surface Water Pump. A surface water pump station would be constructed at Grey Chute to supply water for filling the Coin Pond/Slim Slough/Old Lake complex. This pump station would consist of an angled line shaft pump, and a belt-driven drive unit with jackshaft for connection to a portable diesel engine. The pump would pump through a discharge pipe, jacked beneath the railroad, and on into a channel that would outlet into the upper/north end of Slim Slough. The end of the

discharge would be equipped with a flap gate to prevent back feed through the pump. The pump would have a capacity of approximately 10,000 gpm. This pump would fill this wetland complex in approximately six days. This pump would discharge into a 300-foot long channel leading into Slim Slough. The channel would be lined with riprap for the first 40 feet.

3. Water Control Structures. Water control structures would be used to manage water levels within the wetlands. These structures would be cast-in-place concrete or galvanized metal with stoplogs for adjusting water elevations. One concrete structure would be located where the two natural drainage channels from the northeast and southeast reach the Fox River. The channel is deep here, making it possible to capture high flows on the Fox River and direct them into the wetland complex. The water control structure would allow control of the two channels that converge at this location. The structure would outlet into a single channel connecting to the Fox River. Individual stop log structures would be located on each of the two channels extending northeast into Coin Pond and Southeast into Old Lake. These structures would allow independent manipulation of the water depths and isolation capabilities of wetland areas in two directions.

An existing water control structure, located at the south end of Coin Pond, would be replaced with a new stoplog structure. This structure would enable Coin Pond to be isolated from Slim Slough and the wetlands to the south. This would permit filling Coin Pond with only one well pump or filling it very quickly using both pumps. This structure would also allow Coin Pond to be kept dry while filling the southern wetlands with the surface water pump at Grey Chute.

Two new stoplog structures would be constructed across both ends of Slim Slough. The upper/northern structure would be located south of the Grey Chute pump station discharge. This structure would permit backfilling Coin Pond from the south and filling Old Lake with counterclockwise flow. The two structures would provide the option of isolating Slim Slough. There is some concern that the less pervious soils, believed to exist in the vicinity of Slim Slough, might result in seepage losses.

All water control structures would be galvanized metal except the one concrete structure at the Fox River.

4. Culverts. Culverts would be installed at two locations to provide access across drainage channels. One culvert would be located in the channel leading to the south end of Coin Pond. A second culvert would be required in the drainageway connecting Slim Slough and Old Lake. Both culverts would be 36” diameter corrugated metal pipe (CMP).

5. Channels. New channels would be excavated and several existing channels would be cleared and re-graded. New channels would be required at each of the three pumping sites to direct pumped discharges into the wetlands. These three channels would be located north of Coin Pond, north of Logsdon Slough and from the surface water pump station at Grey Chute to Slim Slough. The first 40 feet of each of these channels would be lined with riprap. The riprap layer would be 2 feet thick and cover the bottom and sides of the channels with a 6-inch layer of bedding stone will be placed beneath the riprap to prevent the loss of fine soil.

New channels would also be constructed at both the upper and lower ends of Slim Slough. The upper channel would provide unimpeded flow between Slim Slough and the drainageways west toward the

Fox River and north toward Coin Pond. The lower channel would ensure unimpeded flow between Slim Slough and Old Lake to the west.

Two sections of channel would be cleared and re-graded to sufficient size to convey design flow in either direction. One channel is at the lower end of Coin Pond and the second is the existing channel extending southeast from the Fox River control structure.

All channels would be approximately 5 feet deep with 8-foot wide bottoms and 3:1 side slopes.

6. Sedimentation Control. All construction will utilize best management practices to control erosion and prevent sedimentation of waterways. Specific measures to control erosion and sedimentation will be developed as part of the final design and by the Contractor prior to beginning construction. The measures could include a combination of measures such as:

- Scheduling earthwork to minimize the length of time the soil would be disturbed and unprotected;
- Restricting movement of equipment and minimizing disturbance of ground cover as much as practicable;
- Diverting runoff from upland areas around disturbed areas;
- Applying mulch or erosion control mats on disturbed slopes to hold the soil until vegetation can take hold;
- Applying silt fences, straw bales or rock check dams along drainage paths in disturbed ground to stop the sediment before it reaches streams or pools.

7. Access Roads. Approximately 1,000 lineal feet of access road would be constructed to provide access to the new pump at Coin Pond. Another 250 lineal feet would be installed for access to the surface water pump station at Grey Chute. These roadways would be 12 feet wide with aggregate surfacing comprised of a 6" base course and a 3" surface course. No excavation or clearing would be required to construct these roadways. Only the last 50 feet of the road to the Grey Chute pump station will impact existing wetlands.

C. Authority and Purpose. The authority for this action is provided by the 1985 Supplemental Appropriations Act (Public Law 99-88) and Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662), as amended (See Section 1.f. of the DPR).

The purpose of this project under Section 1103 is "to ensure the coordinated development and enhancement of the Upper Mississippi River (UMR)." The project is the result of planning efforts by the State of Missouri, the State of Illinois, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

D. General Description of the Excavated Material. Most of the material encountered in the channel excavation will consist of cohesive soils, lean to fatty clays, that have washed into the lowlands from years of runoff. The underlying stratum is poorly graded sand to the full depth of

excavation required for this project. Soil borings conducted for this project discovered ground water at elevations between 473 and 482.

E. Description of the Proposed Placement Site. Approximately 16,000 cubic yards of excess excavated material will be spread over open ground in areas where mast trees are to be planted. The material will be spread level, in lifts up to 6-inches thick, then incorporated with the layer below by disking. No material will be placed in open water.

Some fill will be placed to construct berms across the connecting channels in conjunction with water control structures. This activity will literally be placing fill in wetland, but with the associated channel excavation, the extent of the wetland will actually be increased.

F. Description of the Placement Method. Excavation and placement would be done with track-mounted hydraulic excavators, bulldozers, and scrapers. The placement of riprap would be accomplished with hydraulic excavators.

2. FACTUAL DETERMINATIONS

A. Physical Determinations

1. Elevation and Slope. The elevations on the Fox Island Division range from 480 at the bottom of the ponds and sloughs to 495 atop a small hill on the west side of the Fox River. The highest elevation on the east side of the Fox River is 492. The majority of the land within the Division lies between elevation 485 and 490. Slopes are gradual throughout the Division and there is little erosion from sheet flow on land with cover during normal rainfall.

There is no dredging included in the recommended plan.

2. Sediment Type. Sediment that occurs as a result of erosion from soil disturbance during construction will be lean to fatty clay or sand.

3. Excavation/Fill Material Movement. Material will be moved by scrapers, backhoes, bulldozers, and trucks.

4. Actions Taken to Minimize Impacts. Best Management Practices for construction will be enforced as described in Section 1d. above.

B. Water Circulation, Fluctuation, and Salinity Determinations

1. Water. Excavation would not affect water quality in the wetland areas on the Fox Island Division. Since no dredging or excavation would occur in open water, no bottom sediments will be disturbed and the water column would be unaffected. Evidence exists, however, from tests conducted on wells in the area, that manganese levels are relatively high in the groundwater. The new wells at Logsdon Slough and Coin Pond may raise concentrations in surface water on the Division. Although

this increased concentration may exceed EPA recommendations for consumption of aquatic species from the affected water, there is no predicted affect on the aquatic organisms themselves.

2. Current Patterns and Circulation. No adverse impact on current patterns in the Fox or Mississippi Rivers would occur. Water circulation in the enhanced wetlands will change. Increased water supply and control will improve management capabilities, allowing the areas to be drained or filled to benefit wildlife habitat.

3. Normal Water Level Fluctuations. Water levels in the enhanced wetlands could be manipulated by the installation of the proposed structures. Normal water level fluctuations in the Fox and Mississippi Rivers and in Grey Chute would be unaffected. Flood elevations and extent of inundation would remain unchanged.

4. Actions That Will Be Taken to Minimize Impacts. Using water from the Mississippi River, via the pump station or Grey Chute, will further reduce manganese concentrations. The Mississippi River has lower concentrations of manganese than either the Fox River or ground water sources.

No other adverse impacts are expected. Manganese-laden well water will be aerated by the turbulence as the pumped discharge passes over the riprap channel lining, resulting in some reduction in Manganese levels.

C. Suspended Particulate/Turbidity Determinations

1. Expected Changes in Suspended Particles and Turbidity Levels in Vicinity of Placement Site. No changes expected.

2. Effects on Chemical and Physical Properties of the Water Column

- Light Penetration. No effects expected.
- Dissolved Oxygen. No effects expected.
- Toxic Metals and Organics. Manganese concentrations may be affected by high levels in the groundwater.
- Aesthetics. No adverse effects are expected.

3. Effects on Biota. No adverse effects are expected.

D. Contaminant Determinations. The Phase I Hazardous, Toxic, and Radioactive Waste survey conducted for this study did not discover any environmental contamination and no further environmental testing was recommended.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton. No adverse effects are expected.

2. Effects on Benthos. The project could have a temporary adverse affect on benthic organisms living in the ponds and sloughs. The initial pump discharges could erode soil that is disturbed during construction and carry the sediment into the wetlands. However, long-term benefits would be

experienced by benthos as construction areas are re-vegetated and water supply fills wetlands that are presently dry much of the summer.

3. Effects on Nekton. Temporary adverse effects may be experienced by free-swimming aquatic life upon system start-up, but as with the benthic community the long-term impact would be beneficial. The wetlands are a relatively hostile environment for larger nekton because of the likelihood of drying up in the summer and freezing solid in the winter.

4. Effects on Aquatic Food Web. The enhanced wetlands will have the capability to be operated as a moist soil unit, which can help consolidate bed material and improve the density and diversity of vegetation, which will improve the entire aquatic food web.

5. Effects on Special Aquatic Sites. The project is located entirely within the Fox Island Division of the Great River National Wildlife Refuge. The purpose of the project is to improve wetland, forest, and prairie habitat. There will be no adverse effects upon aquatic habitat.

6. Threatened and Endangered Species. Presence of, or use by, endangered and threatened species is discussed in the Environmental Assessment. No adverse impacts are expected to result from this project.

7. Other Wildlife. The enhanced wetlands will greatly benefit migratory waterfowl by providing open water resting and feeding sites. Other wildlife, such as song birds, mammals, amphibians, and reptiles, will also benefit from the project.

F. Proposed Placement Site Determinations

1. Mixing Zone Determinations. No fill material will be placed in water. The discharge of water from the enhanced wetlands into the Fox River will occur at the same locations as the existing wetlands. The discharge rates will be within the same range as the uncontrolled discharges, so the mixing zone will remain unchanged.

The water quality is expected to be better than existing because of the increased retention capabilities. There is the possibility that discharges would have higher concentrations of Manganese (especially from Logsdon Slough, which does not have access to Mississippi River water). Background levels of Manganese in the Fox River are already high. Since there is no predicted effect of elevated concentrations of Manganese on aquatic habitat, no noticeable effect is anticipated. Annual monitoring is recommended.

2. Determination of Compliance with Applicable Water Quality Standards. Water quality standards will not be violated.

3. Potential Effects on Human Use Characteristics. The proposed project would have no adverse impact on municipal and private water supplies; recreational and commercial fisheries; water-related recreation; aesthetics; or parks, national and historic monuments, national seashores, wilderness areas, research sites or similar preserves. Following construction, the proposed project would greatly enhance wetlands on the Fox Island Division.

G. Determinations of Cumulative Effects on the Aquatic Ecosystem. No negative cumulative impacts are anticipated to occur. The wetland enhancement should benefit resident and migratory wildlife. This project, in concert with other EMP projects on the Upper Mississippi River System, should counter other impacts to the river ecosystem such as sedimentation, pollution, and general loss of important river habitats.

H. Determinations of Secondary Effects on the Aquatic Ecosystem. No adverse secondary affects should result from the proposed action. Long-term benefits to aquatic habitat and wildlife are expected.

3. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

A. No significant adaptations of the 404(b)(1) guidelines were made relative to this evaluation.

B. Alternatives that were considered for the proposed action were as follows:

1. No Federal Action. No Federal action in this instance means no change in land cover or current management practices.

2. Reduce Forest Fragmentation and Enhance Forest Species Diversity
   - Plant hardwood container-grown stock
   - Plant hardwood trees by Precision Direct Seeding
   - Plant hardwood trees using container-grown stock and Precision Direct Seeding

3. Enhance and Expand Wetlands
   - Enhance Logsdon Slough
   - Enhance Coin Pond-Lim Slough-Old Lake
   - Enhance Logsdon Slough and Coin Pond-Slim Slough-Old Lake

4. Restore Native Grassland
   - Plant grasses and forbs

5. Certification under Section 401 of the Clean Water Act would be obtained from the Missouri Department of Natural Resources prior to project construction.

6. The proposed fill activity is in compliance with Applicable Toxic Effluent Standards of Prohibition Under Section 307 of the Clean Water Act.

7. Prior to construction, full compliance with the Endangered Species Act would be documented.

8. The project is situated along an inland freshwater river system. No marine sanctuaries are involved or would be affected by the proposed action.

9. No municipal or private water supplies would be affected by the proposed action, and no degradation of waters of the United States is anticipated to result from the proposed action. The proposed fill activity would not have a significant adverse effect on human health and welfare, recreation and commercial fisheries, plankton, fish, shellfish, wildlife, or special aquatic sites. No significant adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems are expected to result. The proposed fill activity would have no significant adverse effects on aquatic ecosystem diversity, productivity, and stability. No significant adverse effects on recreational, aesthetic, and economic values would occur.

10. The materials used for construction would be chemically and physically stable and non-contaminating.

11. No other practical alternatives have been identified. The proposed action is in compliance with Section 404(b)(1) of the Clean water Act, as amended. The proposed action would not significantly impact water quality.

14 SEP 2006

(Date)

Robert A. Sinkler
Colonel, U.S. Army
District Engineer

DRAFT MEMORANDUM OF AGREEMENT

APPENDIX C

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT OF THE GREAT RIVER NATIONAL WILDLIFE REFUGE AT MISSISSIPPI RIVER POOL 20, CLARK COUNTY, MISSOURI

MEMORANDUM OF AGREEMENT BETWEEN THE UNITED STATES FISH AND WILDLIFE SERVICE AND THE DEPARTMENT OF THE ARMY

I. PURPOSE

The purpose of this memorandum of agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (USFWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the Fox Island Division, Great River National Wildlife Refuge, Clark County, Missouri, separable element of the Upper Mississippi River System- Environmental Management Program (UMRS-EMP).

II. BACKGROUND

Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. The project area is managed by the USFWS and is on land managed as a national wildlife refuge. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, 100 percent of the construction costs of those fish and wildlife features for the Fox Island Division Refuge Area are the responsibility of the DOA, and pursuant to Section 107 (b) of the Water Resources Development Act of 1992, Public Law 102-580, 100 percent of the cost of operation and maintenance for the Fox Island Division Refuge Area are the responsibility of USFWS.

III. GENERAL SCOPE

The project to be accomplished pursuant to this MOA shall consist of:

A. planting approximately 275 acres of existing cropland into a variety of hard mast tree species;

B. constructing wetland enhancement by the installation of two new wells, a surface water pump and six water control structures;

C. allowing 564 acres of land to reforest naturally; and

D. restoring approximately 98 acres of native grassland.

IV. RESPONSIBILITIES

A. The DOA is responsible for:

1. Construction. Construction of the project, which consists of constructing approximately two new water wells, a pump station, a cantilevered sheet pile wall, a 24" force main to be jacked under railroad tracks, five new stop log water control structures, rebuilding an existing stop log water control structure, channel excavation and improvement at seven locations for a total of approximately 7500 linear feet including riprap as needed, two access roads for a total of approximately 1250 feet, and planting a variety of hard mast tree species and restoration of native grassland.

2. Major Rehabilitation. The Federal share of any mutually agreed upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the definite project report and that is needed as a result of specific storm or flood events.

3. Construction Management. Subject to and using funds appropriated by the Congress of the United States, and in accordance with Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, DOA will construct the Fox Island Division Refuge Area, Missouri, Fish and Wildlife Enhancement Project as described in the Environmental Management Program Definite Project Report with Integrated Environmental Assessment Fox Island Division Refuge Area dated September 2006, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If DOA encounters potential delays related to construction of the project, DOA will promptly notify USFWS of such delays.

4. Maintenance of Records. The DOA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the project to the extent and in such detail as will properly reflect total costs. The DOA shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the project and resolution of all relevant claims arising therefrom, and shall make available at its offices, at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the USFWS.

B. The USFWS is responsible for operation, maintenance and repair. Upon completion of construction as determined by the District Engineer, Rock Island, the USFWS shall accept the Project and shall operate, maintain, and repair the project as defined in the definite project report entitled *Environmental Management Program Definite Project Report with Integrated Environmental Assessment Fox Island Division Refuge Area* dated September 2006, in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties.

USFWS: Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

DOA: District Engineer
U.S. Army Engineer District, Rock Island
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

VII. EFFECTIVE DATE OF MOA

This MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY

_____

Robert A. Sinkler
Colonel, U.S. Army
District Engineer

Dated _____

THE U.S. FISH AND WILDLIFE SERVICE

_____

Robyn Thorson
Regional Director
U.S. Fish and Wildlife Service

Dated _____

CERTIFICATION OF REVIEW

The draft Memorandum of Agreement (MOA) for the Upper Mississippi River System Environmental Management Program, Fox Island Division Project is in compliance with the Model Agreement prescribed by CENCD-PE-PD-PL directive of 30 March 1993.

Robert F. Tagey
Office of Counsel

July 28, 2006
Date

APPENDIX D

HABITAT EVALUATION AND QUANTIFICATION

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-13F)

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX D
HABITAT EVALUATION AND QUANTIFICATION

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-13F)

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX D
HABITAT EVALUATION AND QUANTIFICATION

1. INTRODUCTION

A habitat analysis was conducted to evaluate the potential benefits of alternative habitat improvement features at Fox Island Division. Active participants included biologists from the Rock Island District of the Corps of Engineers; the U.S. Fish and Wildlife Service, Mark Twain Refuge and Rock Island Ecological Service Office; the Missouri Department of Conservation; the Illinois Department of Natural Resources; and Stanley Consultants, the contractor for preparation of the DPR and EA.

The need for quantification of HREP outputs (project benefits) as a project performance evaluation tool, a project ranking tool, and a project planning tool has been discussed by various agencies associated with the UMRS-EMP. This application involves quantification solely for the purpose of project planning.

Quantification of outputs for this HREP is expressed in Habitat Units (HUs). Habitat units are a measure of habitat quality (habitat suitability indices, or HSI) and quantity (acres). Once construction begins and as a project matures, habitat changes occur, and therefore habitat benefits may change. Many features, such as tree planting, would not begin to show benefits until well into the project life. Annualization of HUs can then be used to determine changes brought about by project features/alternatives over time. These changes in outputs over the expected project life are expressed as average annual habitat units (AAHUs). The particular dynamics of the ecosystem under study then determine the target years chosen for analysis. With or without a project, habitat conditions change over time. Therefore, the overall value of a proposed project depends upon the comparison of with-project benefits and without-project benefits, expressed as net AAHUs.

2. HABITAT EVALUATION METHODOLOGY

The methodology used in this evaluation was the Wildlife Habitat Appraisal Guide (WHAG) (Urich, *et al.*, 1984). The WHAG was developed by the Missouri Department of Conservation and the U.S. Department of Agriculture, Soil Conservation Service (now NRCS). It is a field evaluation procedure designed to estimate habitat quality and account for changes due to land management practices. Checklist-type appraisal guides are used for upland, wetland, and aquatic habitats, and computer programs are used to analyze field data in terms of habitat suitability for

various evaluation species. This analysis employed a multi-agency team approach with representatives from the Corps of Engineers, the U.S. Fish and Wildlife Service, and the Illinois Department of Natural Resources.

The WHAG analysis is a numerical system for evaluating the quality and quantity of particular habitats for species selected by WHAG team members. The qualitative component of the analysis is known as the habitat suitability index (HSI) and is rated on a 0.1 to 1.0 scale. The suitability of a given habitat type for a set of evaluation species is determined by the qualitative characteristics of the habitat type. The WHAG procedures include the use of limiting factors, which is a habitat requirement for an individual species during a critical time of year. Absence of that habitat characteristic makes the habitat unsuitable and results in the lowest HSI value of 0.1. Habitat quality ratings can be improved by (1) increasing acreages for particular habitat types that may be limited or lacking; (2) altering a limiting factor, such as unpredictable water levels; (3) initiating or altering a management action such as planting native vegetation or changing cropping practices; or (4) a combination of the preceding, depending on management goals, target species requirements, or available funds.

The quantitative component of the WHAG analysis is the measure of acres of habitat that are available for the selected species. From the qualitative and quantitative determinations, the standard unit of measure, the habitat unit (HU), is calculated using the formula (HSI x Acres = HUs). For the purpose of planning, design, and impact analysis, project life was established as 50 years. To facilitate comparison, target years were established at 0 (existing conditions), 1, 25, and 50 years. HSIs and average annual habitat units (AAHUs) for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Prior to field evaluation, the study team reviewed aerial photography, topographic maps, and preliminary design drawings. During field evaluation, assumptions were developed regarding existing conditions and projected post-project conditions relative to limiting factors and management practices.

3. EVALUATION SPECIES SELECTION

Table D-1 lists the evaluation species used in this analysis. These species are an established set in the WHAG model. Although a set list of species has been used, each species represents a guild of other similar species that utilize the specified habitat type in similar ways. In essence, each species represents an array of habitat variables for the species being evaluated. These species are used in the habitat analysis to represent key management goals and objectives of the Fox Island Division HREP.

Table D-1. Evaluation Species Selected for Habitat Analysis

Species	Scientific Name	Habitat Type Evaluated
White-tailed deer	*Odocoileus virginianus*	cropfield/grassland/forest
Wild turkey	*Meleagris gallopavo*	cropfield/forest
Pileated woodpecker	*Dryocopus pileatus*	forest
Fox squirrel	*Sciurus niger*	forest
Wood thrush	*Hylocichla mustelina*	forest
Kentucky warbler	*Oporornis formosus*	forest
Bobwhite quail	*Colinus virginianus*	cropfield/grassland
Eastern cottontail	*Sylvilagus floridanus*	cropfield/grassland
Dickcissel	*Spiza Americana*	native grassland
Ring-necked pheasant	*Phasianus colchicus*	cropfield/grassland
Mallard	*Anas platyrhynchos*	nonforested wetland
Canada goose	*Branta canadensis*	nonforested wetland
Lesser yellowlegs	*Tringa flavipes*	nonforested wetland
King rail	*Railus elegans*	nonforested wetland
Green-backed heron	*Butorides striatus*	nonforested wetland

Eight wildlife species were used to evaluate the reforestation of agricultural fields on Fox Island Division. White-tailed deer and wild turkey are game species that utilize both forested and nonforested habitat types. The pileated woodpecker utilizes large tracts of mature bottomland hardwood forest. The fox squirrel utilizes mature forest with a hard mast (acorn-producing) component. The wood thrush and Kentucky warbler are neotropical migrant songbirds that utilize mature bottomland forest habitat during the breeding season. Bobwhite quail and eastern cottontail rabbit are small game species which utilize a variety of open land and openland edge habitats. Deer, turkey, quail, and rabbit were also used to evaluate the conversion of the 80-acre Logsdon Tract oldfield to native prairie habitat. Other species that were used to evaluate this feature were the dickcissel, a migratory or resident bird that utilizes native grassland habitats; and the ring-necked pheasant, a gamebird species that utilizes cropfield dominated habitats.

Five wetland species were used to evaluate the effects of water control features on wetland areas of the project. Mallard and Canada goose are both migratory waterfowl species that utilize early successional nonforested wetland habitat and are important game species. Lesser yellowlegs is a migratory shorebird that utilizes mud flats and initial succession wetland habitat during summer and early fall in the Midwest. The king rail is a wading bird that favors sedge dominated, permanent summer wetland habitats. Green-backed heron utilizes midsuccessional herbaceous and shrub dominated wetland habitat.

4. ASSUMPTIONS

Several assumptions have been made in regards to model performance, changes in habitat conditions over time, and future management practices.

A. Model Performance. The WHAG has been designed to be applied to many different types of habitat. WHAG team members completed field data sheets for the Nonforest-Wetland habitat matrix, the Oldfield-Upland matrix, the Grassland-Upland matrix, and the Bottomland Hardwoods-Upland matrix in order to evaluate without-project and with-project conditions for the reforestation feature. The Cropfield matrix was used to represent baseline conditions for unleveed agricultural fields. Field data sheets were prepared for the Nonforest Wetland matrix to describe baseline and future conditions for the wetland enhancement feature. Two with-project field data sheets were prepared for the Bottomland Hardwoods matrix. One field sheet represented natural succession of uncultivated cropfields to a silver maple-cottonwood dominated forest community. The second field sheet represented future with-project conditions assuming successful planting of mast producing tree species such as pin oak, bur oak, swamp white oak, northern pecan, and sycamore.

B. Changes in Habitat Conditions Over Time. Habitat conditions are not static. Either through natural processes or human activity, habitat evolves and may change in quality and/or quantity. Imbedded in each cover type evaluation, change has been added to the model. To assess the change over the period of analysis, target years have been defined. At each target year, a change in the habitat variables may be noticed. Noticeable changes can be characterized by a change in habitat benefit output.

Target years of 0 (baseline condition), 1, 25, and 50 (future without and future with project conditions) are sufficient to analyze HUs and characterize habitat changes over the estimated project life.

For planning purposes, future conditions without implementation of the proposed grassland restoration and wetland enhancement features were assumed to be essentially the same as baseline conditions – the Logsdon Tract (and adjacent fields) would continue to be managed and maintained as under present conditions, and the nonforested wetlands and sloughs of the project area, though not actively managed, would maintain current plant cover types and hydrologic patterns. Future without-project conditions for the reforestation feature assumed that the unleveed cropfields and fallow fields would not continue to be cultivated and would therefore undergo a gradual natural succession to bottomland forest habitat over the next 50 years.

Evaluation of the reforestation feature assumes that under the with-project condition reforestation sites would retain some characteristics of openland (cropland or old field) habitats in target year 1. By target year 25 the sites would have all structural characteristics of forest habitat, though not fully mature forest. By target year 50, the sites would be assumed to have structural characteristics of mature bottomland hardwood forest. Alternative reforestation measures (direct acorn seeding, RPM planting) were distinguished from each other primarily through assumed differences in tree species composition and rates of maturity (and decay).

Evaluation of the wetland enhancement feature assumed that under with-project conditions water control structures would continue to operate and be operated at a consistent level of effectiveness throughout the 50-year planning period. Similarly, evaluation of the prairie restoration feature

assumed that under the with-project condition, the planted area would be maintained in a consistently effective manner through the life of the project.

C. Future Management Use. Evaluation of all feasible project features and alternatives assumed that current operation of all areas of the Fox Island Division not directly affected by project feature construction would continue essentially unchanged through the 50-year project life, and that the current management objectives for the entire Fox Island Division, including project feature sites, would remain in effect at least through the life of the HREP.

5. RESULTS OF HABITAT ANALYSIS

Results are provided for calculated HSI and estimated total AAHU values for the reforestation, wetland enhancement, and prairie restoration features of the project (tables D-2 through D-4). This section describes the HSI scores for each feature. In each feature discussion, the no action, or without-project condition is also discussed.

A. Reforestation. HSI values calculated through the WHAG analysis for reforestation are summarized in table D-2. The analysis indicates that conversion of cover type from crop and fallow fields to bottomland hardwood forest results in a “trade-off” of habitat suitability from conditions favoring species that utilize cropfields as well as bottomland forest with larger percentages of “edge” between the different habitats (deer, turkey, quail, cottontail), to species that generally use only forest habitat and favor larger, less fragmented tracts of that habitat, or that use the types of trees proposed for planting as a food source (woodpecker, squirrel, thrush, warbler). Alternative methods of reforestation (natural regeneration, direct seeding of acorns, and planting of large stock hard and soft mast seedlings) are anticipated to vary slightly from one another, as reflected in the HSI values shown in table D-2. The HSI values were coupled with acreage figures to calculate the expected net benefits in AAHUs of the evaluated alternatives, as shown in table D-3.

Table D-2. Habitat Suitability Index (HSI) Values for Reforestation Alternatives [1]

No Action (Natural Regen.) Species	**TY[2] 0 Crop**	**TY1 Regen 1**	**TY25 Regen 25**	**TY50 Regen 50**
White-tailed Deer	0.81	0.83	0.61	0.62
Wild Turkey	0.78	0.64	0.61	0.58
Pileated Woodpecker	0	0.1	0.57	0.81
Fox Squirrel	0	0.1	0.42	0.56
Wood Thrush	0	0.1	0.58	0.75
Kentucky Warbler	0	0.1	0.49	0.61
Bobwhite Quail	0.56	0.1	0.1	0.1
Eastern Cottontail	0.55	0.1	0.1	0.1

Direct Seeding Acorns Species	**TY 0 Crop**	**TY1 DS 1**	**TY25 DS 25**	**TY50 DS 50**
White-tailed Deer	0.81	0.88	0.65	0.67
Wild Turkey	0.78	0.69	0.65	0.64
Pileated Woodpecker	0	0.1	0.65	0.88
Fox Squirrel	0	0.1	0.5	0.63
Wood Thrush	0	0.1	0.58	0.75
Kentucky Warbler	0	0.1	0.47	0.61
Bobwhite Quail	0.56	0.1	0.1	0.1
Eastern Cottontail	0.55	0.1	0.1	0.1

Large Stock Seedlings Species (RPM™)	**TY 0 Crop**	**TY1 RPM 1**	**TY25 RPM 25**	**TY50 RPM 50**
White-tailed Deer	0.81	0.88	0.66	0.67
Wild Turkey	0.78	0.69	0.66	0.64
Pileated Woodpecker	0	0.1	0.68	0.92
Fox Squirrel	0	0.1	0.54	0.68
Wood Thrush	0	0.1	0.58	0.75
Kentucky Warbler	0	0.1	0.49	0.61
Bobwhite Quail	0.56	0.1	0.1	0.1
Eastern Cottontail	0.55	0.1	0.1	0.1

[1] In the WHAG methodology, an HSI value of 0.1 or less indicates unsuitable habitat.
[2] Target Year

Table D-3. Reforestation – Projected Net Habitat Benefits (AAHUs)

Species	No Action NR	DS 60 acres	LSS 60 acres	DS 215 acres	LSS 215 acres
White-tailed Deer	0	3	3	9	10
Wild Turkey	0	3	3	11	11
Pileated Woodpecker	0	3	5	12	18
Fox Squirrel	0	4	6	10	20
Wood Thrush	0	0	0	0	0
Kentucky Warbler	0	-1	0	0	0
Bobwhite Quail	0	0	0	0	0
Cottontail Rabbit	0	0	0	0	0
SUM NET AAHU	**0**	**12**	**17**	**42**	**59**

NR – natural regeneration
DS – direct seeding (acorns)
LSS – large stock seedlings

B. Wetland Enhancement. HSI values calculated through the WHAG analysis for wetland enhancement are summarized in table D-4. Results of the analysis indicate that under baseline conditions, the nonforested wetland areas of the Fox Island Division provide some habitat value for wading birds such as least bittern, king rail and green-backed heron. However, uncontrolled fluctuations in water levels during summer and fall months severely limit availability of feeding and resting habitat for migratory waterfowl such as mallard and Canada goose, resulting in a baseline HSI of 0.1 for both species. Construction of the wetland enhancement feature would produce net benefits to mallard and Canada goose (with a small net benefit to green-backed heron as well) by allowing Refuge staff to manage water levels in the affected wetlands to mimic the historic hydrologic regime and facilitate summer food plant production and fall reflooding of feeding and resting areas. Differences in net AAHUs among the different wetlands shown in table D-5 reflect their differing acreages.

Table D-4. HSI Values for Wetland Enhancement Alternatives [1]

No Action (No Water Control) Species	**TY 0 NFW**	**TY1 NFW 1**	**TY25 NFW 25**	**TY50 NFW 50**
Mallard	0.1	0.1	0.1	0.1
Canada Goose	0.1	0.1	0.1	0.1
Least Bittern	0.54	0.54	0.54	0.54
Lesser Yellowlegs	0.1	0.1	0.1	0.1
Muskrat	0.1	0.1	0.1	0.1
King Rail	0.51	0.51	0.51	0.51
Green-backed Heron	0.51	0.51	0.51	0.51

Pump and Water Control Species	**TY 0 NFW**	**TY1 PWC 1**	**TY25 PWC 25**	**TY50 PWC 50**
Mallard	0.1	0.42	0.42	0.42
Canada Goose	0.1	0.19	0.19	0.19
Least Bittern	0.54	0.54	0.54	0.54
Lesser Yellowlegs	0.1	0.1	0.1	0.1
Muskrat	0.1	0.1	0.1	0.1
King Rail	0.51	0.51	0.51	0.51
Green-backed Heron	0.51	0.55	0.55	0.55

[1] In the WHAG methodology, an HSI value of 0.1 or less indicates unsuitable habitat.

Table D-5. Wetland Enhancement – Projected Net Habitat Benefits (AAHUs)

Species	**No Action All Areas**	**Slim Slough 14 ac**	**Coin Pond 17 ac**	**Old Lake 21 ac**	**Logsdon Slough 26 ac**	**All Areas 78 ac**
Mallard	0	6	7	9	11	33
Canada Goose	0	3	3	4	5	15
Least Bittern	0	0	0	0	0	0
Lesser Yellowlegs	0	0	0	0	0	0
Muskrat	0	0	0	0	0	0
King Rail	0	0	0	0	0	0
Green-backed Heron	0	0	1	1	1	3
SUM NET AAHU	**0**	**9**	**11**	**14**	**17**	**51**

C. Prairie Restoration. HSI values calculated through the WHAG analysis for prairie restoration are summarized in table D-5. The results of the analysis project slight declines in habitat suitability for deer, turkey, cottontail, and pheasant under with-project conditions as compared to without-project conditions. However, the introduction of additional warm-season grass and forb species as a restoration feature results in net AAHU benefits (table D-6) due to increases in habitat availability for dickcissel, a native songbird whose habitat requirements (in the WHAG methodology) are strongly associated with native grasslands.

Table D-6. HSI Values for Prairie Restoration Feature

No Action (Old Field) Species	**TY 0 Old Field**	**TY1 Old Field**	**TY25 Old Field**	**TY50 Old Field**
White-tailed Deer43	0.66	0.66	0.66	0.66
Wild Turkey	0.66	0.66	0.66	0.66
Dickcissel	0	0	0	0
Eastern Bluebird	0.1	0.1	0.1	0.1
Bobwhite Quail	0.14	0.14	0.14	0.14
Eastern Cottontail	0.14	0.14	0.14	0.14
Indigo Bunting	0.1	0.1	0.1	0.1
Ringnecked Pheasant	0.72	0.72	0.72	0.72

Native WSG Planting Species	**TY 0 Old Field**	**TY1 WSG 1**	**TY25 WSG 25**	**TY50 WSG 50**
White-tailed Deer	0.66	0.62	0.62	0.62
Wild Turkey	0.66	0.62	0.62	0.62
Dickcissel	0	0.71	0.71	0.71
Eastern Bluebird	0.1	0.1	0.1	0.1
Bobwhite Quail	0.14	0.14	0.14	0.14
Eastern Cottontail	0.14	0.12	0.12	0.12
Indigo Bunting	0.1	0.1	0.1	0.1
Ringnecked Pheasant	0.72	0.68	0.68	0.68

WSG – warm season grasses (forbs also included for this HREP)

[1] In the WHAG methodology, an HSI value of 0.1 or less indicates unsuitable habitat.

Table D-7. Reforestation – Projected Net Habitat Benefits (AAHUs)

	98 acres (No Action)	**98 acres WSG Plant**
White-tailed Deer	0	-4
Wild Turkey	0	-4
Dickcissel	0	69
Eastern Bluebird	0	0
Bobwhite Quail	0	-1
Eastern Cottontail	0	-2
Indigo Bunting	0	0
Ringnecked Pheasant	0	-4
SUM NET AAHU	**0**	**55**

6. DISCUSSION

The results of the WHAG analysis suggest that Fox Island Division can be enhanced through implementation of the features proposed for this project. Results of the WHAG application were compared as incremental alternatives where applicable. The proposed project for Fox Island Division involves three primary enhancement features: reforestation, wetland enhancement, and prairie restoration. These features are expected to increase diversity of native plant species in the project area, increase habitat values for resident and migratory wildlife, and would best meet the overall management objectives for the site.

APPENDIX E

INCREMENTAL COST ANALYSIS

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APPENDIX E
COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

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E-1 Cost Effective and Best Buy Plans Wetland Enhancement Alternatives E-6

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APPENDIX E
COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

1. PURPOSE

Corps of Engineers guidance requires a cost effectiveness analysis and an incremental cost analysis for recommended environmental restoration and mitigation plans. A cost effectiveness analysis is conducted to ensure that the least cost solution is identified for each possible level of environmental output. An incremental cost analysis of the least cost solutions is conducted to reveal changes in costs for increasing levels of environmental outputs. In the absence of a common measurement unit for comparing the non-monetary benefits with the monetary costs of environmental plans, cost effectiveness and incremental cost analysis are valuable tools to assist in decision making.

This appendix presents the results of the cost effectiveness analysis and incremental cost analysis of the Fox Island Habitat Rehabilitation and Enhancement Project, Clark County, Missouri.

2. METHOD

The project was evaluated using guidance and software prepared by the Corps of Engineers' Institute for Water Resources (IWR). Institute for Water Resources -Plan Decision Support Software (Version 3.33) was used in this analysis. Much of the text of this appendix was borrowed from the IWR Report, *Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps* (Orth 1994).

The cost effectiveness and incremental cost analysis procedures are presented in nine steps, which are grouped into four tasks:

A. Formulation of Combinations
- Step 1 Display outputs and costs
- Step 2 Identify combinable management measures
- Step 3 Calculate outputs and costs of combinations

B. Cost Effectiveness Analysis
- Step 4 Eliminate economically inefficient solutions
- Step 5 Eliminate economically ineffective solutions

C. Development of Incremental Cost Curve
- Step 6 Calculate average costs
- Step 7 Recalculate average costs for additional outputs

D. Incremental Cost Analysis
- Step 8 Calculate incremental costs
- Step 9 Compare successive outputs and incremental costs

The results of these analyses are displayed as graphs and tables. They permit the decision makers to progressively compare alternative levels of environmental outputs and ask if the next level is "worth it" – that is, is the additional environmental output in the next level worth its additional monetary costs?

It is important to note that these analyses will not usually lead, and are not intended to lead, to a single best solution as in economic cost-benefit analysis. They will improve the quality of decision making by ensuring that a rational, supportable, focused and traceable approach is used for considering and selecting alternative methods to produce environmental outputs.

A. Formulation of Combinations

Step 1. Display outputs and costs. Table E1 below displays the outputs and costs of potential management measures. Outputs were determined using Habitat Evaluation Procedures and are presented as net Average Annual Habitat Units. Costs were annualized based upon a 50 year project life and 5.1% interest rate.

Table E-1. Annualized Cost of Environmental Enhancement Features Based Upon 50 Year Life and 5.1% Interest

Feature Alternative	Area (Acres)	Symbol	Output (AAHUs)	Cost ($1,000)	Annualized Cost ($1,000)	Average Cost ($1,000 per AAHU)
Reforestation						
No Action		A0	0	0	0	0
Plant Hardwood RPM™ Stock	215	A1	60	76.2	42.4	0.7067
Plant Hardwood Trees by Precision Direct Seeding	60	A2	12	74.4	4.1	0.3417
Wetland Enhancement						
No Action		B0	0	0	0	0
Enhance Logsdon Slough	25	B1	17	158.8	8.8	0.5176
Enhance Coin Pond/Slim Slough/Old Lake	53	B2	34	1,053	58.6	1.7235
Restore Native Grassland						
No Action		C0	0	0	0	0
Plant grasses and forbs	98	C1	55	192.8	10.7	0.1945

Step 2. Identify combinable management measures. The two methods of forest regeneration, A1 and A2, are combinable for the 275 acres of higher ground that can be planted with mast-producing hardwood trees. The combination of these methods is limited by the divisibility of the 275 acres into areas of sufficient size to make each of the methods practicable. For planning purposes, 60 acres is considered sufficient size to use one of the forest regeneration methods and to assess the success of that method. Natural Regeneration was the preferred method for the wet floodplain forest on the

Logsdon Tract, on the west side of the Fox River, which is the "no action" alternative. A total of four combinations were found (No action – A0; Plant RPM Stock – A1; Precision Direct Seeding – A2; and Combination of RPM Stock and Precision Direct Seeding – A3).

The two wetland enhancement features, Logsdon Slough and Coin Pond /Slim Slough/ Old Lake are combinable, as both have benefits of wetland AAHUs. Coin Pond, Slim Slough and Old Lake would benefit from the same structural features and therefore are not separable. A total of four combinations were formed (No action - B0; Enhance Logsdon Slough - B1; Enhance Coin Pond, Slim Slough, and Old Lake - B2; and enhance both sets of wetlands - B3).

Grassland restoration has no combinable methods. The two alternatives for prairie restoration are "no action" (C0) and "plant grasses and forbs" (C1). An incremental cost analysis will not address the grasslands plantings because there is only one possible alternative, other than no action.

Incremental Cost Analysis is typically used to compare the habitat enhancement features with the same output (average annual habitat units). For this project the wetland enhancement features have an output of wetland AAHUs, primarily mallard and Canada goose habitat. The reforestation features have an output of forest AAHUs, consisting of white-tailed deer, wild turkey, pileated woodpecker, fox squirrel, wood thrush, and Kentucky warbler habitat.

The alternatives for wetland enhancement, reforestation and prairie enhancement could be evaluated together if the different types of outputs were weighted. On this project, each of the alternatives was evaluated separately because they each provide unique conditions that are not duplicated by other alternatives. A combined evaluation would not provide information that would assist decision-making.

Step 3. Calculate output and costs of combinations. Table E-2 displays the outputs and costs of the forest regeneration alternatives. The combinations are listed in ascending order of their total AAHU outputs.

Table E-2. Reforestation Alternatives Outputs and Costs of Combinations Ranked in Order of Output

Alternative Combinations	Symbols	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)
No Action	A0	0	0	0
Plant Hardwood Trees By Precision Direct Seeding	A2	12	4.1	0.3417
Plant Hardwood Container-Grown Stock	A1	60	42.4	0.7067
Plant Hardwood Trees Using Container-Grown Stock and Direct Seeding	A3	72	46.5	0.6500

Table E-3 displays the respective outputs and costs of wetland enhancement features, which are combinations of Logsdon Slough and Coin Pond/Slim Slough/Old Lake.

Table E-3. Wetland Enhancement Alternatives Outputs and Costs of Logsdon Slough Combinations With Coin Pond/Slim Slough/Old Lake Ranked in Order of Output

Alternative Combinations	Symbols	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)
No Action	B0	0	0	0
Enhance Logsdon Slough	B1	17	8.8	0.5176
Enhance Coin Pond/Slim Slough/Old Lake	B2	34	58.6	1.7235
Enhance Logsdon Slough and Coin Pond/ Slim Slough/Old Lake	B3	51	67.4	1.3218

B. Cost Effectiveness Analysis

Steps 4 and 5. Eliminate economically inefficient solutions and economically ineffective solutions. Step 4 eliminates economically inefficient solutions and identifies the least cost solution for each level of output. For example, if two plans produce two AAHUs and one costs $3,000 while the other $4,000, the more expensive plan is eliminated.

Step 5 eliminates the economically ineffective solutions by identifying and deleting those solutions that will produce less output at equal or greater cost than subsequently ranked solutions. For example, if one plan produces 2 AAHUs for $8,000 and the next plan produces 4 AAHUs for $6,000, the first plan would be eliminated because it is not economically effective.

Table E-4 displays the least cost alternatives for forest regeneration. The alternative of using only the container-grown stock was eliminated in this process for its high cost per AAHU. The analysis did not evaluate the survivability of the two planting methods. Trees started from seeds are more susceptible to flooding than root stock during the first few years. Therefore, USFWS prefers a combination of planting methods to enhance the chances for hardwood reforestation while taking advantage of the lower cost and efficiency of direct seeding.

Table E-4. Reforestation Alternatives Cost Effective and Least Cost Combinations

Alternatives	Symbol	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)
No Action	A0	0	0	0
Plant Hardwood Trees by Precision Direct Seeding	A2	12	4.1	0.3417
Plant Hardwood Trees using Container-Grown Stock and Precision Direct Seeding	A3	72	46.5	0.6500

Table E-5 displays the least cost wetland enhancement combinations. The cost of enhancing Logsdon Slough is much less than the cost of enhancing the wetland complex on the east side of the Fox River (Coin Pond/Slim Slough/Old Lake) because Logsdon Slough will not require as many structural improvements. But the wetland area is limited and much smaller than on the east side. Therefore combination B2 – (enhancing Coin Pond/Slim Slough and Old Lake) is not cost effective (the low-cost enhancement should be constructed before the high cost), but the combination of both wetlands, B3, is cost effective because it develops a much larger area of preferred habitat.

Table E-5. Wetland Enhancement Alternatives Cost Effective and Least Cost Combinations

Alternative Combinations	Symbols	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)
No Action	B0	0	0	0
Enhance Logsdon Slough	B1	17	8.8	0.5176
Enhance Logsdon Slough and Coin Pond/Slim Slough/Old Lake	B3	51	67.4	1.3218

C. Development of Incremental Cost Curve

Step 6. Calculate average costs. Average costs for each least-cost, cost-effective plan are determined by dividing the cost of the plan by the output (AAHUs). Average costs are expressed in cost per AAHU ($/AAHU). The plan with the lowest average cost is identified. Plans with less output at a higher average cost are eliminated.

Step 7. Recalculate average costs for additional outputs. This step asks the question "of the remaining levels of output, which has the lowest additional cost for additional output?"

Using levels of output from Step 6, the average annual costs for additional output are calculated. The previous step's lowest average cost level of output was used as the "zero level." Levels of output less than the lowest average cost level are dropped from further analysis, while level of output greater than the lowest average cost level advance to the next recalculation. Recalculations are then made using the new lowest average cost level as the "zero level." Recalculations are made until the highest level of output is reached. The incremental costs for additional outputs was not applied to reforestation because the extent of coverage for each of the four combinations was not based upon economics, rather it was based upon survivability. The more expensive container-grown stock has higher cost per AAHU but has a greater chance of surviving. For comparison, direct-seeded trees will also be planted over sixty acres of high ground. The percentages to plant in container-grown stock versus direct seeding was not determined by incremental analysis.

In this case of wetland enhancement, there is no breaking point where incremental additions cause a change in average cost per AAHU. Once you have created the structure to contain the water and have developed a source to supply the water, the entire wetland area will be enhanced, due to the connectivity that exists there. Separating areas, to reduce inundation would require additional earthwork and cost more money. The ability to increase the area of inundation is limited by the extent of pervious soil outside the naturally-occurring wetlands. Therefore the Best Buy combination is the same combination as shown in table E-6.

D. Incremental Cost Analysis

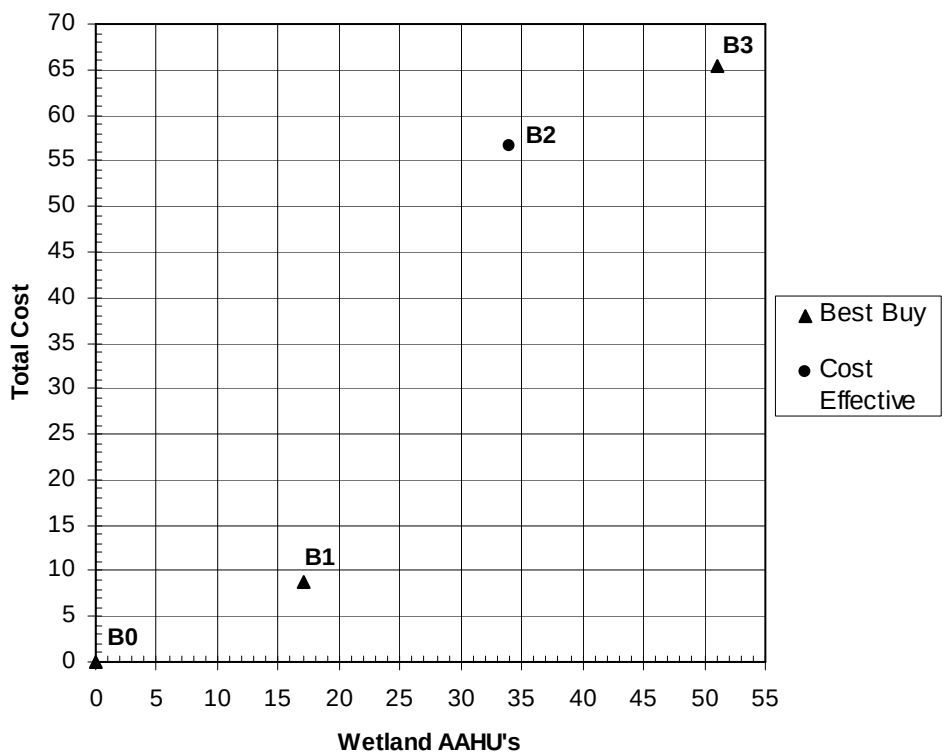
Step 8. Calculate incremental costs. The plans listed in table E-6 are the "best buys, " meaning these plans produce the most AAHUs per dollar.

Table E-6. Wetland Enhancement Features Incremental Costs (Best Buy Plans)

Alternative Combinations	Symbol	Output (AAHUs)	Annualized Cost ($1,000)	Average Cost ($1,000/AAHU)	Incremental Cost per Output
No Action	B0	0	0	0	0
Enhance Logsdon Slough	B1	17	8.8	0.5176	0.5176
Enhance Logsdon Slough and Coin Pond/ Slim Slough/Old Lake	B3	51	67.4	1.3218	1.7235

The incremental costs shown in table E-6 are calculated by dividing the difference between the different plans output. Figure E-1 is a graph of the costs of wetland combinations as listed in table E-6. As shown in the chart, there are two "best buy" combinations, B1 and B3.

Figure E-1. Cost Effective and Best Buy Plans Wetland Enhancement Alternatives



As noted above, incremental cost analysis was not applied to reforestation (A0 through A3) because the areas allocated to each application (i.e. natural regeneration, planting RPM stock, and direct seeding) was determined by non-economic factors. Natural regeneration is the least expensive but does not increase diversity. Direct seeding is less expensive than planting rootstock but is more vulnerable to flooding. The preferred mixture could not be assessed by incremental analyses without putting a dollar value on diversity and flood tolerance.

Incremental cost analysis was not applied to Restore Native Grassland (C0 and C1) because no alternative means of acquiring the same habitat benefits were put forward. Either the prairie would be planted in native grasses and forbs or it would not. The species mixture, and relative costs and benefits of each, were not developed for this preliminary design. Such an analysis would involve too much detail and provide too little benefit to a study such as this; instead it should be left to final design.

Step 9. Compare successive outputs and incremental costs. Table E-6 and figure E-1 were used as decision making tools by progressively proceeding through available levels of output and determining if the next level is worth its additional monetary costs. This step examined the additional habitat value, as measured by increased AAHU output, for an increase in monetary costs.

Federal planning for water resources development is conducted in accordance with the requirements of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G). The P&G provides a decision rule for selecting a recommended plan where both outputs and costs are measured in dollars. This rule states, "The alternative plan with the greatest net economic benefit consistent with protecting the Nation's environment (National Economic Development Plan, NED Plan) is to be selected… (Paragraph 1.10.2)". There is no similar rule for plan selection where the outputs are not measured in dollars, as is the case in planning for restoration and mitigation. In the absence of such a decision-making rule, cost-effectiveness and incremental-cost analyses helped to better understand the consequences of the preferred plan in relation to other choices. Other factors considered in the selection were site topography, management objectives of the resource agencies, critical needs of the region, and ecosystem needs of the Upper Mississippi River System.

3. RECOMMENDED PLAN

For reforestation, the combination planting RPM rootstock and direct seeding (Alternative A3) was selected for its versatility. This alternative has higher costs than total direct seeding but provides a better chance for survival over the full range of conditions that may be encountered during the critical first three years after planting. Furthermore, the combination of planting RPM rootstock and direct drilling seeds will provide useful data for comparing the two methods. This evaluation will help determine the optimum methods for future HREP projects.

For wetland enhancement, Alternative B3, improving water supply and control on both sides of the Fox River, including Logsdon Slough, Coin Pond, Slim Slough, and Old Lake, is preferred because of its capability to expand the area of wetland habitat and to extend the inundation period to the fall migration. This plan is a best buy although the additional AAHUs provided by the Coin Pond/Slim

Slough/Old Lake area have higher average cost per AAHU than Logsdon Slough. The Logsdon Slough wetland is much too small to provide the wetland benefits desired for this refuge.

To restore native grassland, Alternative C1, planting Logsdon Tract with warm-season grasses and forbs is preferred over the No Action Alternative (C0). Restoring native grasslands improves plant diversity and increases the extent of this vastly diminished habitat.

4. SUMMARY

The results of the incremental analyses in this section were considered with other factors, including physical features on the site, management objectives of the resource agencies, critical needs of the region, and ecosystem needs of the Upper Mississippi River System.

In cooperation with USFWS, MDC, and Illinois DNR, the Corps has planned and designed a cost-effective project that serves the needs of the refuge managers. The preferred alternative has an overall output of 178 AAHUs for a total construction cost of approximately $2,364,800. These figures are summarized in table E-7.

Table E-7. Recommended Plan: Environmental Output and Cost of Each Feature

Feature Alternative	Symbol	Output (AAHUs)	Cost ($1000s)	Annualized Cost ($1000s)
Plant Hardwood Trees Using RPM™ Stock and Precision Direct Seeding	A3	72	836.4	46.5
Enhance Logsdon Slough, Coin Pond, Slim Slough and Old Lake	B3	51	1,211.9	67.4
Restore native grassland	C1	55	192.8	10.7
TOTAL		**178**	**2,241.1**	**124.7**

HAZARDOUS, TOXIC AND RADIOACTIVE WASTE DOCUMENTATION REPORT

Separate Bound Document

A P P E N D I X F

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX F
HAZARDOUS, TOXIC AND RADIOACTIVE WASTE DOCUMENTATION REPORT

A Phase I Environmental Site Assessment of the Great River National Wildlife Refuge, Fox Island Division, Clark County, Missouri, project area (the Site) was conducted by Stanley Consultants, Inc. The Phase I Environmental Site Assessment (ESA) was completed in general accordance with the procedures outlined in American Society for Testing & Materials (ASTM) E1527-00, *Standard Practice of Environmental Site Assessments: Phase I Environmental Site Assessment Process*, and U.S. Army Corps of Engineers Hazardous, Toxic, and Radioactive Waste (HTRW) guidance in Engineering Regulation 1165-2-132 dated June 26, 1992. The goal of a Phase I ESA is to identify recognized environmental conditions that may indicate the presence or likely presence of any CERCLA hazardous substances, petroleum products, HTRW, or other regulated contaminants within the project area.

No visual evidence of environmental contamination was noted. Therefore, no environmental testing is recommended. There were no environmental concerns except for several discarded household goods, heating oil tanks, a 55-gallon drum, and a well tank. These items should all be removed and properly disposed of prior to construction. If not needed for the current Habitat Rehabilitation and Enhancement Project (HREP), an unused pole-mounted transformer should be removed and properly disposed of. A former irrigation well should be properly capped and abandoned.

The complete HTRW report is on file at the Rock Island District.

WATER QUALITY

APPENDIX G

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

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APPENDIX G
WATER QUALITY

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APPENDIX G
WATER QUALITY

1. PURPOSE

The purpose of this appendix is to discuss the past and present water quality within the Fox and Mississippi Rivers. Floodwater from these rivers may be used to supply water to the new wetland areas. Wetland enhancement within the Fox Island Division has the potential to improve water quality by removing sediments and nutrients.

2. INTRODUCTION

Increasing water supply to Slim Slough, Coin Pond, and Logsdon Slough could have a beneficial effect on the quality of area surface water. Possible sources of this water would include groundwater and floodwater from the Fox and Mississippi Rivers. The enhanced wetlands would improve surface water quality by removing sediments and nutrients. Information is available on the past and present water quality within the Fox and Mississippi Rivers from USGS sampling sites at Wayland and Canton, Missouri.

3. METHODS

Water quality data for the Fox River are available from a USGS gauging station at Wayland, Missouri, approximately 10 miles upstream of the Fox Island Division. Data from this station is available from 1967 through 2001. Selected recent data is presented in Table G-1 along with the applicable Federal and state water quality criteria.

Water quality data for the Mississippi River is available from a USGS gauging station at Canton, Missouri, approximately 7 miles downstream from the southern end of the Fox Island Division. Canton is just downstream of Lock and Dam 20, which regulates streamflow in the stretch of the Mississippi adjacent to the Fox Island Division. Unfortunately, data is only available for the period 1969 through 1975.

Adequate quantities of groundwater are readily available on the Fox Island Division at shallow depths. A 45-foot well formerly used for irrigation is present on the former Logsdon property. No water quality data is available for that well, but some data for the area was obtained from the United States Geological Survey (USGS). Data was available from a single sample collected on July 6, 1992, from a 15-foot deep well in Clark County, immediately west of the Fox Island Division.

4. RESULTS AND DISCUSSION

A. Fox River. The Federal Water Pollution Control Act, Section 303(d), requires all states to identify waters for which existing required pollution controls are not stringent enough to implement state water quality standards. Total maximum daily loads (TMDLs) must then be developed for these waters so they will meet water quality standards in the future. The State of Missouri has deemed the Fox River as a Category Three waterway on their list of impaired rivers. Category Three waters are presently recognized as impaired, but there is no practicable remedy for them. All of the Fox River was placed in this category due to elevated levels of naturally occurring manganese. The State has given the Fox River a low priority for analysis and is scheduled to conduct a use attainability analysis to examine the manganese levels in 2007.

The Fox River reach that passes through the Fox Island Division is classified by the State of Missouri as Class P1, a standing water reach of a stream that maintains permanent flow even in drought periods. The upstream reach of the Fox River is classified as Class P, a stream that maintains permanent flow even in drought periods. The designated uses for the Fox River reach that goes through the Fox Island Division are livestock and wildlife watering, protection of warm water aquatic life, human health protection for fish consumption, boating and canoeing, and drinking water supply. Overall, water quality appears to be good and use of the water for wetlands augmentation would be acceptable. However, naturally occurring manganese levels may be too high, and could limit the use of the water where human consumption of fish is planned.

1. General Water Quality Parameters. Dissolved oxygen data for the river are generally good with concentrations ranging from 6 to 14.9 milligrams per liter (mg/L), which is above the Missouri water quality criterion of 5 mg/L. The pH is within an acceptable range, varying from 7.4 to 8.2. Chloride levels are also in an acceptable range, varying from 7.4 to 22.2 mg/L. Data from 1967 to 1972 indicated the river water is somewhat hard with concentrations typically between 200 to 300 mg/L. Total suspended solids levels are an indication of the level of turbidity in the river. Typical levels in the Fox River are relatively low at 9 to 20 mg/L. However, during the May 16, 2001, sampling event, the solids concentration was high at 638 mg/L. The discharge data for that sampling event indicate the flow was 1,180 cubic feet per second (cfs), significantly above typical flow rates of less than 50 cfs as indicated by the USGS gauging station at Wayland, Missouri. Iron concentrations are all less than their national recommended water quality criterion (USEPA 822-Z-99-001, April 1999), although they were elevated during the May 16, 2001, high flow event. The elevated concentration in May 2001 exceeded the Missouri water quality criterion (10 CSR 20-7.031) for iron.

2. Nutrients. Nutrient levels in the Fox River are acceptable. Total phosphorus concentrations varied from <0.05 mg/L to 1.47 mg/L in recent data. These levels are consistent with past data back to 1969. Although no state or Federal water quality criteria have been established for phosphorus, a desired goal of 0.1 mg/L total phosphorus in streams is noted in the national water quality criteria document (USEPA 440/5-86-001, May 1, 1986) to prevent plant nuisances. Recent nitrate plus nitrite nitrogen concentrations have varied from <0.05 mg/L to 1.74 mg/L during the May 2001 high flow event, all below the Missouri water quality criterion of 10 mg/L. Ammonia nitrogen was detected during recent years and the detected concentrations of 0.03 mg/L and 0.076 mg/L are all well below the Missouri water quality criterion. Past ammonia concentrations have varied from below detection limits to as high as 0.72 mg/L.

Table G-1. Water Quality Data Fox River at Wayland, Missouri

NUMBER AND DESCRIPTION OF QUALITY PARAMETER

00010 - WATER TEMPERATURE (DEG. C)
00061 - INSTANTANEOUS FLOW (CFS)
00300 - DISSOLVED OXYGEN (MG/L)
00400 - PH, STANDARD UNITS
00530 - TOTAL NON FILTERABLE RESIDUE (MG/L)
00608 - DISSOLVED AMMONIA NITROGEN (MG/L AS N)
00631 - DISSOLVED NITRATE + NITRITE NITROGEN (MG/L AS N)
00665 - TOTAL PHOSPHORUS (MG/L AS P)
00940 - DISSOLVED CHLORIDE (MG/L AS CL)
01000 - DISSOLVED ARSENIC (UG/L AS AS)
01025 - DISSOLVED CADMIUM (UG/L AS CD)
01040 - DISSOLVED COPPER (UG/L AS CU)
01046 - DISSOLVED IRON (UG/L AS FE)
01049 - DISSOLVED LEAD (UG/L AS PB)
01056 - DISSOLVED MANGANESE (UG/L AS MN)
01090 - DISSOLVED ZINC (UG/L AS ZN)
01106 - DISSOLVED ALUMINUM (UG/L AS AL)
71900 - TOTAL RECOVERABLE MERCURY (UG/L AS HG)

RESULTS/VALUES													FEDERAL WATER QUALITY CRITERIA	MISSOURI WATER QUALITY CRITERIA
	DATE OF SAMPLES													
	1999	2000						2001						
PARAMETER NO.	23-Nov	18-Jan	14-Mar	23-May	11-Jul	13-Sep	27-Nov	9-Jan	27-Mar	16-May	24-Jul	4-Sep		
00010	10.7	1.9	5	20.5	24.2	19.3	3.5	0.5	2.7	20.4	32.1	28.4	NA	32
00061	7.3	7.5	11	6.9	1040	1.5	12	8E	182	1180	24	20	NA	NA
00300	6.2	15	11.3	6.8	6.1	6	14.9	13.9	13.6	7.5	6.7	8.7	NA	5
00400	7.6	7.8	8.2	7.8	7.5	7.7	7.9	7.8	7.4	7.5	7.8	8.2	6.5 - 9.0	6.5 - 9.0
00530	9	NS	NS	20	NS	NS	10	NS	NS	638	NS	NS	NA	NA
00608	<.02	<.02	<.02	<.02	<.02	<.02	<.04	<.04	0.076	.03E	<.04	<.04	NA	0.5 - 2.5
00631	<0.05	<0.05	0.064	<0.05	0.483	0.087	0.374	0.481	1.41	1.74	0.967	<0.05	NA	10
00665	.03E	<.05	<.05	0.103	1.47	0.074	.05E	.053E	0.225	0.722	0.182	0.089	NA	NA
00940	13.9	NS	NS	15.9	NS	NS	22.2	NS	NS	7.4	NS	NS	230,000	230
01000	NS	NS	NS	NS	NS	NS	0.7	NS	NS	1.4	NS	NS	150	20
01025	<8	NS	NS	<8	NS	NS	<8	NS	NS	<8	NS	NS	2.2	5
01040	5.1E	NS	NS	<10	NS	NS	<4.7	NS	NS	2.7E	NS	NS	9.0	500
01046	70	NS	NS	20	NS	NS	100	NS	NS	760	NS	NS	1000	300
01049	<100	NS	NS	<100	NS	NS	0.05E	NS	NS	1.16	NS	NS	2.5	15
01056	224	NS	NS	311	NS	NS	218	NS	NS	25.9	NS	NS	NA	50
01090	95	NS	NS	<20	NS	NS	14	NS	NS	119	NS	NS	120	5000
01106	21	NS	NS	<15	NS	NS	26	NS	NS	599	NS	NS	87	750
71900	<.3	NS	NS	<.3	NS	NS	<.14	NS	NS	0.03	NS	NS	0.77	2

Notes:
E - Estimate
NS - No Sample
NA - Not Available

Federal Water Quality Criteria are freshwater Criterion Continuous Concentrations from
National Recommended Water Quality Criteria - Correction, EPA 822-Z-99-001, April 1999

Missouri Water Quality Criteria are from 10 CSR 20-7.030 for Fox River designated uses
(protection of warm water aquatic life, human health protection - fish consumption, drinking water supply, livestock and wildlife watering)

Data Source: USGS

3. Manganese. Manganese data was reviewed because of the Fox River's listing as a Category Three impaired water. Dissolved manganese concentrations typically ranged from 218 to 311 micrograms per liter (µg/L). No water quality criterion for aquatic organisms is given for manganese in the national recommended water quality criteria. The human health criterion for consumption of water and aquatic organisms is 50 µg/L while the criterion for consumption of aquatic organisms only is 100 µg/L. The Missouri water quality criterion for manganese is 50 µg/L. The typical manganese concentrations in the Fox River are well above both the Federal human health criteria and the Missouri criterion, but the concentration during the high flow event was below these criteria. Therefore, diversion of floodwaters for wetlands augmentation may provide acceptable manganese levels while diversion of base river flows might not be acceptable if fishing were allowed in the area.

4. Heavy Metals. Recent water quality data from 1999, 2000, and 2001 were available for the following heavy metals: aluminum, arsenic, cadmium, copper, lead, mercury, and zinc. The data was compared to national recommended water quality criteria and Missouri water quality criteria. None of the dissolved metals concentrations, except for aluminum, exceeded Federal freshwater Criterion Continuous Concentrations (CCC's) or Missouri water quality criteria in the samples reported. The Federal CCC criteria are an estimate of the highest concentration of a parameter in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The dissolved aluminum concentration in the May 16, 2001, sample was 599 µg/L, above the freshwater CCC of 87 µg/L. However, the concentration was below the Criteria Maximum Concentration (CMC) of 840 µg/L and the Missouri criterion of 750 µg/L. The CMC is an estimate of the highest concentration of a parameter in surface water to which an aquatic community can be briefly exposed without unacceptable effects. The iron and zinc concentrations reported for the May 2001 sampling event were also elevated above typical levels although the concentrations were below water quality criteria. Because iron, zinc, and aluminum concentrations were observed to be elevated during a high flow event, additional sampling of Fox River floodwaters might be warranted before using high flow waters for wetlands augmentation. Water quality sampling of the existing wetlands would also be useful to evaluate existing water quality in the wetlands.

B. Mississippi River. The Mississippi River in Missouri has been placed in Category Two on the State of Missouri list of impaired waters. Category Two waters were originally reported as impaired, but the data used to determine they are impaired is considered older or of lesser quality. Additional data collection on Category Two waters is planned to determine whether to proceed with TMDL development for them. The entire length of the Mississippi River in Missouri is considered impaired due to habitat loss from channelization. The State has given it a medium priority and has scheduled it for further data collection in 2005.

1. General Water Quality Parameters. Dissolved oxygen concentrations for the Mississippi River for the period where data are available range from 4.4 to 13.6 mg/L. The oxygen levels typically drop to less than 6 mg/L in the summer and come back up above 9 mg/L in the winter. These levels are generally good except for the few times in the summer when dissolved oxygen has dropped below the Missouri criterion of 5 mg/L. The pH is within an acceptable range, varying from 6.7 to 8.5. Chloride levels are also in an acceptable range, varying from 7.6 to 32 mg/L. Hardness data indicates the river water is somewhat hard with concentrations between 110 to 290 mg/L. Iron was detected once above its national recommended water quality criterion of 1,000 µg/L at a concentration of 1,200 µg/L on March 2, 1971. This concentration also exceeded the Missouri criterion of 300 µg/L. The Missouri criterion was also exceeded on January 31, 1972, when the iron concentration was 400 µg/L. All other iron

concentrations were less than the Federal and state criteria and typically were less than 200 µg/L. Manganese concentrations in the Mississippi River are less than in the Fox River, ranging from below detection limits to 190 µg/L. The detected concentrations in the Mississippi were generally less than the Missouri criterion and the Federal human health criterion for consumption of water and aquatic organisms (50 µg/L) and the Federal criterion for consumption of aquatic organisms only (100 µg/L). However, one or more of these criteria were equaled or exceeded in 17 of the 75 measurements.

2. Nutrients. Nutrient levels in this stretch of the Mississippi River are acceptable. Total phosphorus concentrations varied from 0.08 mg/L to 10 mg/L, although most concentrations were less than 1 mg/L. Total nitrate plus nitrite nitrogen concentrations have varied from <0.1 mg/L to 6.1 mg/L, less than the Missouri nitrate criterion of 10 mg/L. Ammonia nitrogen concentrations ranged from below detection limits to 0.95 mg/L and were all below applicable Missouri criteria.

C. Groundwater. The only parameters recorded were pesticides, iron, and manganese. No pesticides were detected in the groundwater sample. The manganese concentration was 280 µg/L, similar to the typical levels detected in the Fox River and above the Federal and state water quality criteria. The iron concentration was 1,500 µg/L, well above the levels typically detected in the Fox River of 100 µg/L or less. The Federal and Missouri human health criteria for iron are 300 µg/L. The Federal and Missouri iron criteria for protection of aquatic life are both 1,000 µg/L. Dissolved iron in groundwater is readily removed by aeration. It is likely that a significant amount of iron will precipitate out of the groundwater if it is pumped to a wetland. The resultant concentrations in the wetland may be similar to those detected in the Fox River, around 100 µg/L.

5. CONCLUSIONS

To better evaluate site-specific groundwater quality and its impact on wetlands augmentation, sampling of the existing onsite irrigation well and standing water in Fox Island Division wetlands, is recommended. At a minimum, samples should be analyzed for iron, manganese, heavy metals, suspended solids, dissolved oxygen, and pH.

Water quality in the Fox River, the Mississippi River and in groundwater near the Fox Island Division is generally good. General parameters such as dissolved oxygen, pH, chloride, hardness, total suspended solids and iron are all within acceptable limits in the two rivers. Iron concentrations in the groundwater are relatively high. Nutrient levels, defined by phosphorous, nitrate, nitrite nitrogen, and ammonia nitrogen, are all within acceptable limits. Heavy metal concentrations are also at levels that do not justify water quality concerns. In both rivers and in the groundwater, only manganese consistently exceeds the Missouri water quality criterion. Elevated manganese levels would be a concern for human consumption of fish taken from the river. National water quality criteria do not list manganese for aquatic organism exposure.

The recommended plan does not include using surface water from the Fox River for supply to the wetlands. Both groundwater and Mississippi River surface water (via Grey Chute) would be used under the plan. Both iron and manganese levels can be decreased by aeration. It is likely that pumping water from these two water sources though a riprap-lined channel would reduce concentrations of these two parameters prior to discharge into the wetlands. No significant water quality concerns exist for using groundwater or Mississippi River water for wetland enhancement supply.

APPENDIX H

GEOTECHNICAL CONSIDERATIONS

UPPER MISSISSIPPI RIVER SYSTEM
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DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT

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APPENDIX H
GEOTECHNICAL CONSIDERATIONS

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Riprap Stone Protection Sizing

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX H
GEOTECHNICAL CONSIDERATIONS

1. PURPOSE

This appendix presents the general geology (physiography) and specific geotechnical analysis relevant to the project. TSi Engineering, Inc. (TSi) obtained soil borings and performed laboratory analysis and interpretation. Stanley Consultants performed geotechnical analyses and developed recommendations for the geotechnical features of the project.

2. PROJECT FEATURES

Key features of the project include island wetland enhancement, natural prairie restoration, and mast tree planting, as shown on Plate 2 of the Definite Project Report (DPR). These features are designed to protect and/or enhance wetland and terrestrial habitat.

3. LOCATION

The project features are located between Mississippi River Miles (RM) 353.6 and 358.5, as shown on DPR Plate 2. Wetland enhancement is proposed for Logsdon Slough, Coin Pond, Slim Slough, and Old Lake. The prairie restoration will be on the west side of the Fox River close to the Rose Pond Conservation Area, and the mast tree planting will be located in the north and east portions of the Division.

4. PHYSIOGRAPHY

The present Mississippi Valley was formed by glacial meltwaters eroding through older existing glacial sediments and down into bedrock. The majority of the bedrock is limestone and dolomite with an occasional shale unit. In many locations where the river impinges on the valley wall, massive vertical cliffs exist. In areas where the river flows more towards the center of the valley, as is the case here, the walls have become rounded and sloped, filling the valley edges with colluvium. As the last glacial meltwater volume decreased to allow deposition, most of the glacial valley filled with outwash sands and gravels in valley trains and alluvial terraces. At a few sites, the channel bottom remains bedrock controlled. Inter-tongued with this alluvium are coarser grained upland sediments from tributary streams that create fans along the valley wall. The normal alluvial deposits generally become increasingly coarse-grained with depth, which in some areas exceeds 100 feet, the sediments consist of a mix of igneous and metamorphic material from as far north as the Canadian Shield, and sedimentary carbonate rock material from the relative vicinity. These glacial valley train deposits are assigned to the Mackinaw Member of the Henry Formation.

The present Mississippi River is believed to erode as much as 50 feet below normal bottom in the active channels during high flood stages. This reworking of the upper portion of the glacial deposits, plus erosion of the upland till and loess, has left the upper layers of the modern valley tilled with relatively fine-grained sands and gravels, overlain by silts and clays, all assigned to the Cahokia Alluvium. This unit of floodplain and channel deposits consists largely of silt, clay, and clayey sand, with wood and shell fragments. Lenses and old channel fills of sand and gravel are locally common but generally have high silt content. The degree of sorting varies but is generally poor. Old cutoffs fill with clay plugs, which can become relatively compact and erosion resistant. This lateral variety of materials combined with human modification of flows makes prediction of future, channel direction or rates of erosion extremely difficult.

The project area lies in the valley near the confluence with the Fox River. At this point, the valley is 7.8 miles wide, with the active river occupying up to 0.7 miles in the eastern half. It is contained by a main stem levee system on both sides. The main channel is roughly 1/5 mile wide through this reach of the river. Grey Chute, a smaller secondary channel, skirts the western edge of the river. Between these two there are numerous braided backwaters and sloughs that create small wooded islands, generally composed of the alluvial material discussed above. With the exception of an occasional small terrace or sand ridge, the eastern half of the valley floor is generally flat with numerous swales, ditches, and oxbows. This area is under continuous cultivation and has been extensively modified by agriculture.

5. SUBSURFACE EXPLORATION

The subsurface exploration was completed by TSi on October 14 through October 16, 2002. Fifteen borings were drilled by an all-terrain CME 750 rotary drill rig using hollow-stem auger and mud rotary drilling methods. The borings were advanced to depths of 5 to 30 feet. Split-spoon and Shelby tubes samples were recovered from the borings. Split-spoon samples were recovered using a 2-inch outside-diameter, split-barrel sampler, driven by a CME automatic hammer. The Shelby tube samples were preserved by sealing the entire sample in the tube. The split-spoon samples were placed in glass jars and saved for later testing in the laboratory. The boring locations and boring logs are shown on Plates 13, 14, and 15.

6. LABORATORY TESTING

In order to determine selected engineering properties, the following laboratory tests were performed on selected samples recovered from the borings:

- Visual descriptions by color and texture of each sample
- Natural moisture content of each sample
- Hand penetrometer determinations of the approximate compressive strength of cohesive samples
- Atterberg Limits test on selected cohesive samples
- Grain size analyses of selected samples
- Percent passing No. 200 sieve
- Unit weight of selected undisturbed samples
- Unconfined compressive tests of selected cohesive samples

Results from laboratory testing are included at the end of this appendix.

7. STRATIGRAPHY

The foundation of the project area consists of brown and grey, medium to fine sands below brown to dark grey fat and lean clays. Fat clays were found between approximate elevations 487 and 478 [1929 National Geodetic Vertical Datum (NGVD)]. Lean clays were found at various locations ranging from elevations 487 to 475 (1929 NGVD).

8. SITE CHARACTERIZATION

A. General. The formation for the project area is composed of sand under clay. Since split spoon sampling methods were used, foundation shear strengths were obtained by compression tests performed in the lab. The test results are attached at the end of this appendix. The project features will apply minimal loads to underlying soils, and the clays will provide a suitable foundation for the standing water that will result from wetlands enhancement.

B. Subsurface Conditions. Fifteen core borings were advanced within the proposed project area (SB-1 through SB-10 and SB12 through SB-16). The core borings were advanced to depths ranging between 5 feet and 25 feet below the existing ground surface. The core boring locations were selected to investigate the subsurface conditions at proposed project structure/feature locations. Subsequent to the completion of the core borings, during conceptual development and evaluation of the project, some structures/features were added, removed or relocated. As a result, the closest available core borings are used as an indication of the subsurface conditions at the current proposed structure/feature locations.

The near surface soils encountered in the core borings were highly variable, as is typical of a river flood plain environment. The surficial soils consisted of soft lean and fat clays (CL and CH) in the lower elevation areas and very loose poorly graded sands (SP) in some of the higher elevation areas. Even though the surficial soils were found to be variable, the soils encountered at depth tended to be more uniform across the site. The core borings that encountered near surface fine grained soils typically transitioned to loose, poorly graded sands (SP) in the elevation range of 480 to 474. These sands were typically very loose to loose, grading to loose to medium dense with increasing depth. All of the core borings that were extended to elevation 474 or deeper ended in the SP soils, with the exception of core boring SB-8 which encountered a medium dense to dense gravel and clay (GC) till at approximately elevation 460.

Groundwater elevations measured at the time of drilling ranged from elevation 473 to elevation 483, with a majority of the measurements in the 475 to 480 range. It would be expected that the groundwater levels in the SP soils would closely follow the levels of the Mississippi. Perched water tables would be expected at higher elevations in the surficial fine grained CH and CL soils.

C. Geotechnical Design Parameters. In order to complete preliminary geotechnical analyses of the project features/structures, it was necessary to assign geotechnical design parameters to the foundation and embankment materials. The design parameters include soil shear strength parameters, unit weights and compressibility. The development of the geotechnical design parameters is based upon soil descriptions, standard penetration (N) values, sieve analyses, unit weight, moisture content, and pocket penetrometer and unconfined compressive strength testing. Additional exploration and testing may be warranted at some structure locations to provide information for the final design of critical structures/features. Since the current study was preliminary in nature, the following minimal laboratory and field testing was performed during the subsurface investigation.

Surficial Clays (CL and CH). Standard penetration (N) values, pocket penetrometer and unconfined compressive strength testing indicated the surficial clays to be very soft to soft in consistency. In some areas it is anticipated that the shear strength of these soils may be less than 500 psf. For the preliminary analysis, it was assumed that the surficial clay soils have a phi = 0 and a cohesion = 200 psf. Based on the available core boring information it appears that the soft clays will not impact the foundations of the structures proposed for the project. The base of these structures will typically be below elevation 480. The core borings indicate that the soft clays end above or slightly below this elevation. These clays will also not have a significant impact on the taller levee sections since they will also have bases at elevation 480 or lower.

Poorly Graded Sands (SP). Standard penetration (N) values indicated the sands to be loose grading to loose to medium dense with depth. For the preliminary analyses it is assumed that these sandy soils have a c = 0 and a phi = 28 degrees. A majority of the project features will bear upon these loose sandy soils. These structures will be lightly loaded and therefore the relative density and shear strength of these sandy soils should not be critical to the stability of these structures.

Semi-Compacted Embankment Fill. The embankment fill will consist of job excavated soils. The soils excavated from above elevation 480 will tend to be mixtures of clays and sands. The soils excavated below elevation 480 will tend to be sands. In constructing the embankments, the lower permeability, clay soils will be used for the upstream, wet sides of the embankments and lower portions of the embankments, while the sandier soils will be used for the dry side and upper portions of the embankments. For the preliminary analyses it was assumed that the semi-compacted embankment soils were a mixture of clays and sands having a c = 0 and a phi = 26 degrees. The embankments for the project are not extensive and the heights will typically be less than 10 feet. Therefore, as long as 4H on 1V side slopes are utilized, the shear strength of the fills should not be critical to the embankment stability.

9. EXCAVATIONS

A. General. The proposed construction does not involve dredging or excavating in open or standing water. All excavation will be in relatively dry ground. Construction is referred to as excavation rather than dredging. Excavation would be required to construct new or to re-grade existing channels, construct water control structures, and install piping and culverts. Some excavation will also be required to construct a jacking pit to bore and jack the force main under the railroad at the surface water pump station site. Generally, soils in the upper layers are lean to fat clays with underlying sand, although at several locations the borings encountered sand exclusively. It is assumed that most of the excavation would occur in clay soils and that these soils would be classed as “hydric” and the area as “wetland,” because of the water regime and wetland vegetation present on the Division.

B. Excavation Technique. All excavation would be done using a hydraulic excavator. It is anticipated that all excavation would be done “in the dry.” Excavation for the channels would be only to elevation 480 to match the bottom elevation of the sloughs and ponds. The soils borings show that three locations encountered groundwater slightly above elevation 480. At all other boring locations, groundwater was found below elevation 480.

C. Excavation Dewatering. Although the core boring information indicates that the dewatering effort should not be significant for the relatively shallow excavations and structures, in the event

dewatering is required, dewatering methods were investigated for applicability to the project. Three categories of dewatering methods are discussed in TM 5-818-5 *Dewatering and Groundwater Control:*

Category 1 - Interception and Removal of Groundwater. Includes pumping from sumps located in the base of the excavation, pumping from wells, wellpoints and vertical drains.

Of these methods, wellpoints and wells may have application to the project. Sumps could be used in conjunction with other systems but would not be effective by themselves for excavations more than a few feet below the water table due to the potential high permeability of the site soils below elevation 480. Well points and deep wells would be effective under the site conditions as long as well screens were carried across any confining layers/strata. Well points are generally applicable for situations when draw downs of 15 feet or less are required, which would include the proposed structures for this project.

Category 2 - Reduction of Artesian Pressures. Includes pumping from wells, wellpoints and non-pumping "relief" wells. Category 2 is intended to reduce artesian pressures, but not necessarily provide a dry excavation, and is therefore not considered for this project.

Category 3 - Isolation of Excavation. Includes sheet pile cutoffs, grout curtains, slurry trenches, and ground freezing.

Of these methods, sheet pile cut-offs appear to be the only practical option. Grout curtains, slurry walls and ground freezing are specialized operations and therefore prohibitively expensive to be practical on a project of this size. The methods in Category 3 generally require tying the cutoff into an impervious formation. The core borings did not indicate a continuous low permeability layer under the sands, therefore the effectiveness of a sheet pile cut-off at this sight is questionable.

10. STRUCTURE FOUNDATIONS

A. Foundation Type. Selection of the foundation type for the proposed structures was based on soil conditions encountered in the core borings and the size and weight of the proposed structures. A mat foundation is recommended for the project control and pump structures because the core borings indicated predominately granular soils at and below the proposed foundation levels and because the structures will impart light loadings on these soils. If some soft clay soils are encountered at the proposed foundation levels, it is recommended that these soft/compressible soils be overexcavated and replaced with compacted granular soils. The available core boring information indicates that any over excavation and replacement will be less than 5 feet.

B. Deep Foundations. Deep foundations could be used to support structures through the softer lens of material above approximately elevation 475. If deep foundations were used, helical piers would provide an economical option for the lightly loaded structures. However, mat foundations bearing on the natural sandy soils or replaced compacted granular soils would provide a more cost effective foundation.

C. Matt Foundations. A matt foundation is recommended for control and pump station structures. The core borings encountered predominately loose to medium dense non-cohesive soils at and below the base elevation of the structures. Occasional soft cohesive strata were encountered in

the core borings at or slightly below the proposed bearing level. However, these strata do not appear to be continuous and were typically less than 5 feet thick; furthermore, they can be removed and replaced with compacted granular fill.

The allowable bearing capacity of the soils underlying the structures was computed using the methods given in EM 1110-1-1905. Four methods were used to compute the allowable bearing capacity of the foundation soils; Terzaghi, Meyerhof, Hanson and Vesic Methods. With a factor of safety of 3.0, allowable bearing pressures on the order of 0.75 ksf were computed. While this is a relatively low allowable bearing capacity, the proposed structures will be lightly loaded with bearing pressures less than the predicted allowable. If additional bearing capacity is required, the mat foundations could be constructed at a greater depth below final grade, or the underlying loose sands could be excavated and recompacted to improve their shear strength properties. The bearing capacity computations are attached at the end of this appendix.

11. LATERAL EARTH PRESSURE FOR WALL DESIGN

Lateral earth pressure coefficients are required for the structural design of the structure walls and wingwalls. Recommended earth pressure coefficients for concrete (non-flexible) walls were determined using the methods presented in EM 1110-02-2502. Recommended earth pressure coefficients for sheet-pile (flexible) walls were determined using methods given in EM-1110-2 -2504. All of the walls to be constructed for the project will be retaining compacted fill and backfill. The material used as fill will consist of job excavated material. The core borings indicate that a majority of the excavated material will consist of poorly graded sands, silty sands and clayey sands. The earth pressure coefficients developed for design are based on the assumption that fill and backfill being retained by the walls will consist of moderately compact silty sand material having a unit weight of 120 pcf and an internal angle of friction of 28 degrees.

Concrete Walls	
At Rest earth pressure coefficient	k = 0.53
Sheet Pile Walls	
Active earth pressure coefficient	k = 0.36
Passive earth pressure coefficient	k = 2.77
Unit weight of Fill/Backfill	120 pcf
Saturated Unit Weight of Fill/Backfill	130 pcf
Lateral Fluid Pressure	62.4 pcf

Surcharge - 250 psf. Surcharge will be applied to structures where vehicles can be positioned within 0.5H of the structure (H measured from BOF to grade).

Surcharge. Loads due to placement of control structures, storage facilities, etc. adjacent to structures (i.e. retaining walls and foundations) shall be applied as required.

Compaction. The compactive forces on structure walls will control the wall design and result in a significant thickening of the concrete walls over that required for other design conditions. Therefore, in order to provide a more economical design, the compactive forces may be omitted from the design if requirements are added to the drawings and specifications that only hand operated compactors be used adjacent to the new walls.

12. UNDERSEEPAGE

An underseepage analysis was not performed for the closure structures. The design head differential across the structures will be less than 5 feet. Therefore, it is anticipated that underseepage will not be a concern in terms of seepage losses, undermining of the structures, or instability of the channel bottom downstream of the structures.

The base of the closure structures will be at approximately elevation 479. The core borings indicate that the surficial clay layer may or may not be continuous at this elevation. Therefore, it is possible that the base of the channels as they approach the closure structures and the subgrade of the closure structures will be in the sandy soils. While this is not conducive to controlling underseepage at the structure, seepage cut-offs should not be necessary for these low head structures. If further investigation during design reveals a requirement for underseepage control, nominal length (5 feet) long sheet pile under the structure should provide adequate protection for the low head structures.

13. GREY CHUTE INTAKE SHEETPILE WALL

A sheet pile wall to support the pump at the Grey Chute Intake is proposed. The wall would rise approximately 18 feet above the dredge line at the intake location. An analysis of the proposed structure was performed using the Corps of Engineers Computer Program CSHTWAL. The parameters used in the analysis are as discussed in previous paragraphs. The water level was assumed to be at normal river levels on the wet side of the wall and 2 feet above normal river levels on the dry side of the wall. A 250 psf surcharge was imposed on the dry side of the wall to represent the pumping equipment and any loads imposed by service vehicles.

Results of Computer Analyses. The computer analyses indicated that an eighteen-foot-tall, cantilevered sheet pile wall will require a penetration of approximately 26 feet below the dredge elevation of the Grey Chute channel. The maximum bending moments determined by the analyses indicate a PZ40 or heavier section will be required for construction of the wall. If during design it is determined that a taller wall section is required, or that the potential exists for the water level behind the wall to be more than 2 feet above the river surface, then anchorage system may be required for the wall. The sheet pile wall computations are included at the end of this appendix.

14. EMBANKMENT STABILITY/DESIGN

Stability analyses were performed on typical earthwork sections for the proposed embankments in order to verify that slope stability requirements are met. The embankments will be constructed of semi-compacted job excavated materials consisting of a mixture of clays and sands. Analyses were performed using the Limit Equilibrium Approach adapted to computer solution using the WINSTABL computer program. This program was developed at the Purdue University Engineering Experiment Station. WINSTABL utilizes the Modified Janbu, Modified Bishop's and Spencer's Methods for circular sliding surfaces to determine the margin of safety against slope failure. Spencer's method was used to search for the location of the most critical failure surfaces. Embankment slopes were analyzed for shallow and deep circular sliding surfaces.

Parameters used in the analyses were based on material classifications, correlations with SPT results, and laboratory testing results. The parameters used are discussed in the previous paragraphs.

Cross Sections. Analyses of the proposed embankment were performed for the tallest expected embankment section, which will occur within the channels at the proposed control structures, having inverts of elevation 480. These embankments will be approximately 10 feet tall and will be constructed with 4H on 1V sided slopes. Typically, a 3H on 1V slope would be used; however, the flatter slope was used due to the potential for soft/very loose foundation soils existing under the embankment. Additional slope stability analyses were performed for a shorter, five-foot-tall embankment which may be constructed over the soft clays typically encountered at elevations above 480.

Loading Condition. The proposed earthwork sections were analyzed for two loading conditions. The first is the end-of-construction condition with no water being retained by the embankment. The second condition analyzed assumed a phreatic surface condition of water to within 4 feet of the top of the embankment on the wet side and water at the toe of the embankment on the dry side. For this analysis it was assumed a steady-state seepage condition had occurred with a phreatic surface extending from the upstream pool and exiting slightly above the downstream toe of the embankment.

Results of Computer Analysis. The results of the analysis along with the recommended minimum factors of safety are summarized below.

Results of Embankment Stability Analysis

Condition	Minimum Factor of Safety	Required Factor of Safety
10-foot Embankment		
End of Construction	2.0	1.3
Normal Pond	1.5	1.4
5-foot Embankment		
End of Construction	2.0	1.3
Normal Pond	2.0	1.4

It should be noted that several shallow, surficial (about 1 foot deep) slough type failure surfaces were identified at the downstream toe of the embankment for the Normal Pond analysis. These shallow surfaces sometimes had computed factors of safety slightly less than the required. If this type of failure did occur during this extreme loading condition, they would be a maintenance issue and would not affect the overall integrity of the canal banks.

The embankment slope stability computations are included with this Appendix.

15. EROSION PROTECTION

In order to control erosion, riprap stone protection will be used to line the first 40 feet of all of the channels extending from pump sites. Riprap will also be used to stabilize a section of the Fox River bank. Just upstream of the proposed water control structure, there is a swale adjacent to the Fox River where the bank has washed away. This washed out area is contributing to current sediment problems. In order to control this, the river bank will be restored, and stone protection placed to prevent future erosion.

Stone protection for channels downstream of the pump outlets and for the Fox River bank restoration was sized using the procedures given in *Hydraulic Design Criteria – Sheet 712-1*. The stone protection is sized assuming a maximum flow velocity of up to 7.5 fps in the channel downstream of the structure and in the Fox River. A minimum stone unit weight of 165 pcf was assumed. Based on a velocity of 7.5 fps, a riprap gradation having a D_{50} greater than 9 inches (55 pounds) is required. The riprap layer thickness will be 18 inches. The riprap and sizing computations are included with this Appendix.

The recommended riprap protection systems are as follows:

Channel Lining

1. Line channel bottoms and sides for a distance of 40 feet downstream of pump outlets.
2. Provide 3H:1V slopes.
3. 6” thick bedding layer over geotextile using graded stone up to 3” diameter.
4. 18” thick riprap layer using 9” d_{50} stone.

Fox River Bank Restoration

1. Cut horizontal benches into the existing face of the washout.
2. Fill washout with compacted fill placed in 12 inch horizontal lifts.
3. 6” thick bedding layer over geotextile using graded stone up to 3” diameter.
4. 18’ thick riprap layer using 9” d_{50} stone.

16. PUMPING WELLS

Field pumping and laboratory permeability testing were not performed as part of this investigation. However, the soil borings indicate a relatively uniform sand layer underlies a majority of the site. This sand layer is typically 30 to 40 feet thick, with a majority of the formation below the normal level of the Mississippi river. The formation is likely to be hydraulically connected to the Mississippi. In order to estimate yields from wells constructed in the sands, Stanley Consultants contacted well installation and irrigation contractors familiar with the aquifer characteristics in the vicinity of the Mississippi River. The Contractors indicated that sand wells in the vicinity of the project typically produce 500 to 2000 gpm. Telephone call reports documenting these conversations are included with this Appendix.

Aquifer testing and detailed well design will be required during the design stage of the project to verify the assumptions used for the current study.

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
ROCK ISLAND, ILLINOIS
BEARING CAPACITY COMPUTATIONS

OBJECTIVE: Determine the allowable bearing capacity of foundation soils supporting the stoplog structures assuming a one-inch allowable settlement for the matt foundations of the structures assuming the highest water level inside the structure.

METHOD: Develop subsurface profiles for the two (2) different stoplog structures based on available core boring information. Perform bearing capacity analysis for design, unusual and extreme hydraulic conditions in accordance with the requirements of EM 1110-1-1905.

REFERENCES:

1) NAVFACS, September 1986. Design Manual 7.1, Soil Mechanics

2) Joseph E. Bowles, 1996. Foundation Analysis and Design, Fifth Edition, The McGraw-Hill Companies, Inc.

3) U.S. Army Corps of Engineers, October 1992. EM 1110-1-1905, Bearing Capacity of Soils

Stanley Consultants INC.

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Subject [illegible]

Computed by [illegible] Date [illegible]

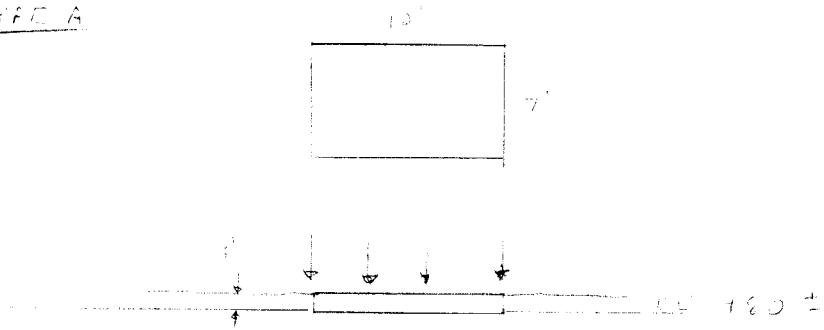
Checked by [illegible] Date [illegible]

Approved by Date

Sheet No. 3 of

BEARING CAPACITY & SETTLEMENT - CONTROL STRUCTURES

TYPE A

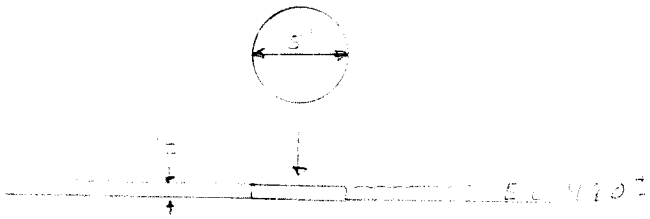


$\phi = 29°$

$\gamma_s = 110$ pcf

$\gamma_c = 112$

TYPE B



$\phi = 29°$

$\gamma_s = 110$ pcf

Control Structure - Type A
Ultimate Bearing Capacity Computation

Ultimate bearing capacity general equation:

$qu = C\,N_c\,\zeta_c + [1/2\,B\,\gamma'_h\,N\gamma\,\zeta_\gamma]\,r_\gamma + \sigma'_D\,N_q\,\zeta_q$ (Ref.3, equation 4-1)

where:	qu =	ultimate bearing capacity (ksf)
	C =	soil cohesion (ksf)
	B =	footing width (ft)
	γ'_h =	effective unit weight beneath foundation base (kcf)
	σ'_D =	effective overburden pressure at foundation depth, = γ'_D D (ksf)
	γ'_D =	effective unit weight of soil from ground surface to foundation depth (kcf)
	D =	foundation depth (ft)
	N_c, N_γ, N_q	dimensionless bearing capacity factors of cohesion, soil weight & surcharge
	ζc, $\zeta\gamma$, ζq	dimensionless correction factors of cohesion, soil weight and surcharge accounting for foundation geometry and soil type
	r_γ =	correction factor for mat foundation where B > 6 ft, = 1 - 0.25log (B/6)

For foundation soils, use loose sands (SP)

Short Term Analysis

C (ksf) =	0.0
ϕ =	28
B (ft) =	7
W (ft) =	10
D (ft) =	1
γ'_D (kcf) =	0.0476
σ'_D (ksf) =	0.048

Long Term Analysis

C (ksf) =	0.0
ϕ =	28
B (ft) =	7
W (ft) =	10
r_γ =	0.98
D (ft) =	1
γ'_D (kcf) =	0.0476
σ'_D (ksf) =	0.048
γ'_h (kcf) =	0.0476

Correction Factors

Terzaghi:	Nc	Nγ	Nq
For ϕ=28:	31.61	15.7	17.81 (Table 4-1, Ref. 3)
For any ϕ:	ζc	$\zeta\gamma$	ζq
	1.3	0.8	1.0 (Table 4-2, Ref. 3)

Meyerhof:	Cohesion, c	Wedge, γ	Surcharge, q	
	Nc	Nγ	Nq	
For ϕ=28:	25.80	11.19	14.72	(Table 4-3, Ref. 3)
				(Table 4-4, Ref. 3)
	ζcs	ζγs	ζqs	
For ϕ=28:	1.39	1.19	1.19	
	ζcd	ζγd	ζqd	
For ϕ=28:	1.05	1.02	1.02	

Hansen:	Cohesion, c	Wedge, γ	Surcharge, q	
	Nc	Nγ	Nq	
For ϕ=28:	25.80	10.94	14.72	(Table 4-5, Ref. 3)
				(Table 4-4, Ref. 3)
	ζcs	ζγs	ζqs	
For ϕ=28:	1.40	0.72	1.37	
	ζcd	ζγd	ζqd	
For ϕ=28:	1.06	1.0	1.04	

Vesic:	Cohesion, c	Wedge, γ	Surcharge, q	
	Nc	Nγ	Nq	
For ϕ=28:	25.80	16.72	14.72	(Table 4-6, Ref. 3)
				(Table 4-4, Ref. 3)
	ζcs	ζγs	ζqs	
For ϕ=28:	1.40	0.72	1.37	
	ζcd	ζγd	ζqd	
For ϕ=28:	1.06	1.0	1.04	

Computation of qu

Long Term Analysis:

$C = 0$ $\zeta\gamma = \zeta\gamma s * \zeta\gamma d$

$\phi = 28$ $\zeta q = \zeta qs * \zeta qd$

$B = 7$

γ'_h (kcf) = 0.0476

$r_\gamma = 0.98$

σ'_D (ksf) = 0.048

qu (ksf)= $[1/2\ B\ \gamma'_h\ N_\gamma\ \zeta_\gamma]\ r_\gamma + \sigma'_D\ N_q\ \zeta_q$

qa (ksf)= qu/FS

	Terzaghi	Meyerhof	Hansen	Vesic
$N\gamma$	15.7	11.19	10.94	16.72
$\zeta\gamma$	0.80	1.22	0.72	0.72
Nq	17.81	14.72	14.72	14.72
ζq	1.0	1.22	1.43	1.43
qu (ksf)	2.91	3.10	2.29	2.97

q_u = 2.8 ksf

$q_a = q_u/3$ = 0.93 ksf

Control Structure - Type B
Ultimate Bearing Capacity Computation

Ultimate bearing capacity general equation:

$qu = C\,N_c\,\zeta_c + [1/2\,B\,\gamma'_h\,N\gamma\,\zeta_\gamma]\,r_\gamma + \sigma'_D\,N_q\,\zeta_q$ (Ref.3, equation 4-1)

where:	$qu =$	ultimate bearing capacity (ksf)
	$C =$	soil cohesion (ksf)
	$B =$	footing width (ft)
	$\gamma'_h =$	effective unit weight beneath foundation base (kcf)
	$\sigma'_D =$	effective overburden pressure at foundation depth, $= \gamma'_D\,D$ (ksf)
	$\gamma'_D =$	effective unit weight of soil from ground surface to foundation depth (kcf)
	$D =$	foundation depth (ft)
	N_c, N_γ, N_q	dimensionless bearing capacity factors of cohesion, soil weight & surcharge
	$\zeta c, \zeta\gamma, \zeta q$	dimensionless correction factors of cohesion, soil weight and surcharge accounting for foundation geometry and soil type
	$r_\gamma =$	correction factor for mat foundation where $B > 6$ ft, $= 1 - 0.25\log(B/6)$

For foundation soils, use loose sands (SP)

Short Term Analysis

C (ksf) =	0.0
ϕ =	28
B (ft) =	5
W (ft) =	5
D (ft) =	1
γ'_D (kcf) =	0.0476
σ'_D (ksf) =	0.048

Long Term Analysis

C (ksf) =	0.0
ϕ =	28
B (ft) =	5
W (ft) =	5
r_γ =	1.00
D (ft) =	1
γ'_D (kcf) =	0.0476
σ'_D (ksf) =	0.048
γ'_h (kcf) =	0.0476

Correction Factors

Terzaghi:		Nc	Nγ	Nq	
	For ϕ=28:	31.61	15.7	17.81	(Table 4-1, Ref. 3)
	For any ϕ:	ζc	ζγ	ζq	
		1.3	0.6	1.0	(Table 4-2, Ref. 3)

Meyerhof:	Cohesion, c	Wedge, γ	Surcharge, q	
	Nc	Nγ	Nq	
For ϕ=28:	25.80	11.19	14.72	(Table 4-3, Ref. 3)
				(Table 4-4, Ref. 3)
	ζcs	ζγs	ζqs	
For ϕ=28:	1.55	1.28	1.28	
	ζcd	ζγd	ζqd	
For ϕ=28:	1.07	1.03	1.03	

Hansen:	Cohesion, c	Wedge, γ	Surcharge, q	
	Nc	Nγ	Nq	
For ϕ=28:	25.80	10.94	14.72	(Table 4-5, Ref. 3)
				(Table 4-4, Ref. 3)
	ζcs	ζγs	ζqs	
For ϕ=28:	1.57	0.60	1.53	
	ζcd	ζγd	ζqd	
For ϕ=28:	1.08	1.0	1.06	

Vesic:	Cohesion, c	Wedge, γ	Surcharge, q	
	Nc	Nγ	Nq	
For ϕ=28:	25.80	16.72	14.72	(Table 4-6, Ref. 3)
				(Table 4-4, Ref. 3)
	ζcs	ζγs	ζqs	
For ϕ=28:	1.57	0.60	1.53	
	ζcd	ζγd	ζqd	
For ϕ=28:	1.08	1.0	1.06	

Computation of qu

Long Term Analysis:

C= 0 $\zeta\gamma = \zeta\gamma s * \zeta\gamma d$

ϕ= 28 $\zeta q = \zeta qs * \zeta qd$

B= 5

γ'_h (kcf) = 0.0476

r_γ= 1.00

σ'_D (ksf) = 0.048

qu (ksf)= $[1/2\ B\ \gamma'_h\ N_\gamma\ \zeta_\gamma]\ r_\gamma + \sigma'_D\ N_q\ \zeta_q$

qa (ksf)= qu/FS

	Terzaghi	Meyerhof	Hansen	Vesic
$N\gamma$	15.7	11.19	10.94	16.72
$\zeta\gamma$	0.60	1.32	0.60	0.60
Nq	17.81	14.72	14.72	14.72
ζq	1.0	1.32	1.62	1.62
qu (ksf)	1.97	2.68	1.92	2.33

q_u = 2.2 ksf

$q_a = q_u/3$ = 0.74 ksf

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
ROCK ISLAND, ILLINOIS
SHEET PILE DESIGN COMPUTATIONS

OBJECTIVE: Determine the required length and section modulus of the sheet pile wall for the grey chute intake; assuming a cantilever wall design.

METHOD: Perform sheet pile wall analysis using the computer program CWALSHT in general accordance with the requirements of EM 1110-2-2504. Use a factor of safety of 1.5 for usual conditions when determining the penetration of the sheet pile wall. Use a factor of safety of 1.0 when finding the moments in the wall for determining the required section modulus. Perform sheet pile analysis in general conformance with EM 1110-2-2504.

REFERENCE:

1) U.S. Army Corps of Engineers, March 1994. EM 1110-2-2504, Design of Sheet Pile Walls

2) U.S. Army Corps of Engineers, August 2001. CASE GCASE Program CWALSHT, Design/Analysis of Sheet-Pile Walls.

3) "Subsurface Investigation and Laboratory Testing – Fox Island HREP, Alexandria, Missouri", TSI Engineering, Inc., November 12, 2003.

4) Stanley Draft Report, "Fox Island Division Habitat Rehabilitation and Enhancement, Pool 20, Mississippi River Miles 358.5 Through 353.6, Clark County, Missouri."

Material Properties

The core borings (Ref. 3) indicate loose sands (SP) overlying medium dense sands (SP) at approximately elevation 472'. The following table summarizes the material properties for the sheet pile wall analysis.

	Unit Weight (pcf)		Angle of Internal		Angle of Wall	
	Saturated	Moist	Friction (deg)	Cohesion (psf)	Friction (deg)	Adhesion (psf)
Loose SP	110	105	28	0	15.12	0
Medium SP	120	115	32	0	17.28	0

The section analyzed, based on the plates in the draft report (Ref. 4), is shown on sheet 3.

Loading Conditions

For the sheetpile analysis it was assumed that the water for the river was at normal pool, elevation 482' (Ref. 4). The water level in the sands behind the sheetpile was assumed at 2' above the normal pool (elevation 484'). A 250 psf surcharge was assumed behind the wall to represent traffic and/ or structure loads.

Factor of Safety

The conditions analyzed represent normal/ usual operating conditions. For the first run, factors of safety of 1.0 (active) and 1.5 (passive) were used based on the requirements found in EM 1110-2-2504 assuming usual conditions. This found the penetration depth of the sheet pile walls. For the second run, factors of safety of 1.0 (active) and 1.0 (passive) were used to find the moment in the sheet pile walls for the determination of the required section modulus of the sheet piles.

Summary of Results

Soil Pressures were determined by the sweep search wedge method.

F.S.(Active)=1.0, F.S. (Passive)=1.5		F.S.(Active)=1.0, F.S. (Passive)=1.0	
Wall Bottom Elev. (ft)	46.08	Wall Bottom Elev. (ft)	54.06
Penetration (ft)	25.92	Penetration (ft)	17.94
Max. Bend. Moment (lb-ft)	1.22E+05	Max. Bend. Moment (lb-ft)	9.27E+04
At Elevation (ft)	58.84	At Elevation (ft)	63.37
Max. Scaled Defl. (lb-in^3)	1.15E+11	Max. Scaled Defl. (lb-in^3)	5.79E+10
At Elevation (ft)	90.00	At Elevation (ft)	90.00

Required Section Modulus (I)

$S_{\min} = M_{\max} / f_b$ (Ref. 1, Eq. 6-3)

$M_{\max}$ = maximum moment = $9.27 * 10^4$ ft-lb

f_b = allowable bending stress = $0.5 f_y$ normal conditions

f_y = yield stress of steel = 39 ksi for A328 steel

f_b = (0.5)(39 ksi) = 19.5 ksi

$$S_{\min} = \frac{(9.54 * 10^4)(12 in./ft)}{19500 lb/in^2} = 58.7 in^3/ft \text{ of wall}$$

PZ40 $S = 60.7 in^3/ft \geq 58.7 in^3/ft \therefore Okay$

Stanley Consultants INC.

Computed by _____ Date _____

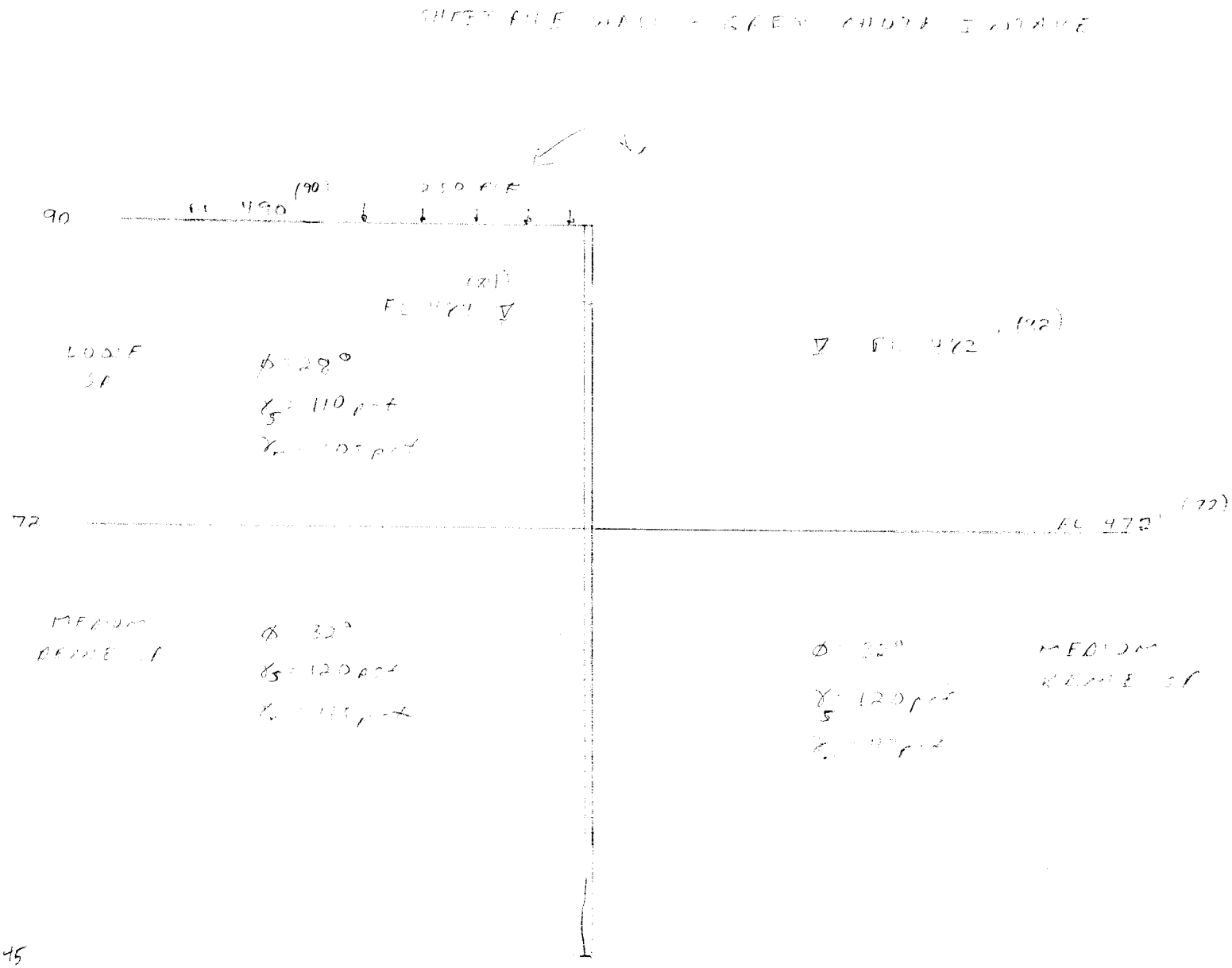
Checked by _____ Date _____

Approved by _____ Date _____

Project No. _____ Page No. _____

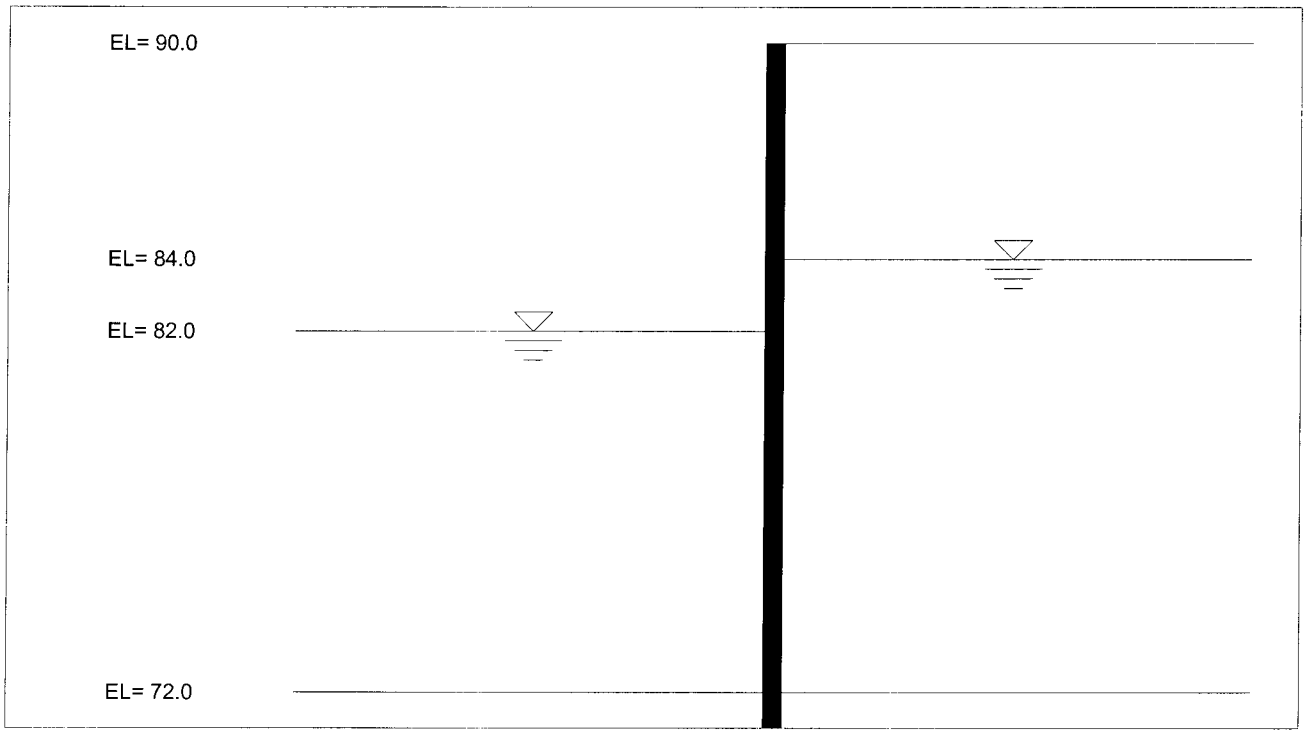
Subject _____

Sheet No. 1 of _____



-45

'SHEETPILE WALL - GREY CHUTE INTAKE



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:43:04

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***************
* INPUT DATA  *
***************
```

I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.50

III.--WALL DATA
ELEVATION AT TOP OF WALL = 90.00 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	90.00

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	72.00

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> ACT.	PASS.
110.00	105.00	28.00	0.00	15.12	0.00	72.00	0.00	DEF	DEF
120.00	115.00	32.00	0.00	17.28	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> ACT. FACTOR-	PASS.
120.00	115.00	32.00	0.00	17.28	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.50 (PCF)
RIGHTSIDE ELEVATION = 84.00 (FT)
LEFTSIDE ELEVATION = 82.00 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS

VII.A.--VERTICAL LINE LOADS
NONE

VII.B.--VERTICAL UNIFORM LOADS

LEFTSIDE (PSF)	RIGHTSIDE (PSF)
0.00	250.00

VII.C.--VERTICAL STRIP LOADS
NONE

VII.D.--VERTICAL RAMP LOADS
NONE

VII.E.--VERTICAL TRIANGULAR LOADS
NONE

VII.F.--VERTICAL VARIABLE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:43:17

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*************************
*  SOIL PRESSURES FOR   *
* CANTILEVER WALL DESIGN *
*************************
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I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

		<------NET------>					
NET	<---LEFTSIDE--->		(SOIL + WATER)		<--RIGHTSIDE--->		
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
90.0	0.0	0.0	0.0	78.4	636.0	78.4	636.0
89.0	0.0	0.0	0.0	111.3	903.1	111.3	903.1
88.0	0.0	0.0	0.0	144.3	1170.2	144.3	1170.2
87.0	0.0	0.0	0.0	177.2	1437.3	177.2	1437.3
86.0	0.0	0.0	0.0	210.2	1704.4	210.2	1704.4
85.0	0.0	0.0	0.0	243.1	1971.5	243.1	1971.5
84.0	0.0	0.0	0.0	276.0	2238.6	276.0	2238.6
83.0	62.5	0.0	0.0	353.4	2421.9	290.9	2359.4
82.0	125.0	0.0	0.0	430.8	2605.2	305.8	2480.2
81.0	125.0	0.0	0.0	445.7	2726.1	320.7	2601.1
80.0	125.0	0.0	0.0	460.6	2846.9	335.6	2721.9
79.0	125.0	0.0	0.0	475.5	2967.7	350.5	2842.7

78.0	125.0	0.0	0.0	490.4	3088.6	365.4	2963.6
77.0	125.0	0.0	0.0	505.3	3209.4	380.3	3084.4
76.0	125.0	0.0	0.0	520.2	3330.2	395.2	3205.2
75.0	125.0	0.0	0.0	535.1	3451.1	410.1	3326.1
74.0	125.0	0.0	0.0	550.0	3571.9	425.0	3446.9
73.0	125.0	0.0	0.0	564.9	3692.7	439.9	3567.7
72.0+	125.0	0.0	0.0	579.8	3813.6	454.8	3688.6
72.0-	125.0	0.0	0.0	508.7	4447.3	383.7	4322.3
71.0	125.0	171.4	15.2	352.5	4603.5	398.9	4493.7
70.0	125.0	342.8	30.4	196.3	4759.6	414.1	4665.1
69.0	125.0	514.2	45.6	40.2	4915.8	429.4	4836.5
68.7	125.0	558.3	49.6	0.0	4956.0	433.3	4880.5
68.0	125.0	685.6	60.9	-116.0	5072.0	444.6	5007.9
67.0	125.0	857.0	76.1	-272.2	5228.2	459.8	5179.3
66.0	125.0	1028.4	91.3	-428.4	5384.4	475.0	5350.7
65.0	125.0	1199.8	106.5	-584.6	5540.6	490.2	5522.1
64.0	125.0	1371.2	121.7	-740.8	5696.7	505.4	5693.5
63.0	125.0	1542.6	136.9	-896.9	5852.9	520.7	5864.9
62.0	125.0	1714.0	152.2	-1053.1	6009.1	535.9	6036.3
61.0	125.0	1885.4	167.4	-1209.3	6165.3	551.1	6207.7
60.0	125.0	2056.8	182.6	-1365.5	6321.5	566.3	6379.1
59.0	125.0	2228.2	197.8	-1521.7	6477.7	581.5	6550.5
58.0	125.0	2399.6	213.0	-1677.9	6633.8	596.7	6721.9
57.0	125.0	2571.0	228.2	-1834.0	6790.0	612.0	6893.3
56.0	125.0	2742.4	243.5	-1990.2	6946.2	627.2	7064.7
55.0	125.0	2913.8	258.7	-2146.4	7102.4	642.4	7236.1
54.0	125.0	3085.2	273.9	-2302.6	7258.6	657.6	7407.5
53.0	125.0	3256.6	289.1	-2458.8	7414.8	672.8	7578.9
52.0	125.0	3428.0	304.3	-2615.0	7570.9	688.0	7750.3
51.0	125.0	3599.4	319.5	-2771.2	7727.1	703.3	7921.7
50.0	125.0	3770.8	334.8	-2927.3	7883.3	718.5	8093.1
49.0	125.0	3942.2	350.0	-3083.5	8039.5	733.7	8264.5
48.0	125.0	4113.6	365.2	-3239.7	8195.7	748.9	8435.9
47.0	125.0	4285.0	380.4	-3395.9	8351.9	764.1	8607.3
46.0	125.0	4456.4	395.6	-3552.1	8508.1	779.3	8778.7
45.0	125.0	4627.8	410.8	-3708.3	8664.2	794.5	8950.1
44.0	125.0	4799.2	426.1	-3864.4	8820.4	809.8	9121.5
43.0	125.0	4970.6	441.3	-4020.6	8976.6	825.0	9292.9
42.0	125.0	5142.0	456.5	-4176.8	9132.8	840.2	9464.3
41.0	125.0	5313.4	471.7	-4333.0	9289.0	855.4	9635.7
40.0	125.0	5484.8	486.9	-4489.2	9445.2	870.6	9807.1
39.0	125.0	5656.2	502.1	-4645.4	9601.3	885.8	9978.5
38.0	125.0	5827.6	517.4	-4801.5	9757.5	901.1	10149.9
37.0	125.0	5999.0	532.6	-4957.7	9913.7	916.3	10321.3
36.0	125.0	6170.4	547.8	-5113.9	10069.9	931.5	10492.7
35.0	125.0	6341.8	563.0	-5270.1	10226.1	946.7	10664.1

34.0	125.0	6513.2	578.2	-5426.3	10382.3	961.9	10835.5
33.0	125.0	6684.6	593.4	-5582.5	10538.4	977.1	11006.9
32.0	125.0	6856.0	608.6	-5738.6	10694.6	992.4	11178.3
31.0	125.0	7027.4	623.9	-5894.8	10850.8	1007.6	11349.7
30.0	125.0	7198.8	639.1	-6051.0	11007.0	1022.8	11521.1
29.0	125.0	7370.2	654.3	-6207.2	11163.2	1038.0	11692.5
28.0	125.0	7541.6	669.5	-6363.4	11319.4	1053.2	11863.9
27.0	125.0	7713.0	684.7	-6519.6	11475.5	1068.4	12035.3
26.0	125.0	7884.4	699.9	-6675.8	11631.7	1083.7	12206.7
25.0	125.0	8055.8	715.2	-6831.9	11787.9	1098.9	12378.1
24.0	125.0	8227.2	730.4	-6988.1	11944.1	1114.1	12549.5
23.0	125.0	8398.6	745.6	-7144.3	12100.3	1129.3	12720.9
22.0	125.0	8570.0	760.8	-7300.5	12256.5	1144.5	12892.3
21.0	125.0	8741.4	776.0	-7456.7	12412.7	1159.7	13063.7
20.0	125.0	8912.8	791.2	-7612.9	12568.8	1175.0	13235.1
19.0	125.0	9084.2	806.5	-7769.0	12725.0	1190.2	13406.5
18.0	125.0	9255.6	821.7	-7925.2	12881.2	1205.4	13577.9
17.0	125.0	9427.0	836.9	-8081.4	13037.4	1220.6	13749.3

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:43:18

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***************************
* SUMMARY OF RESULTS FOR  *
* CANTILEVER WALL DESIGN  *
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I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 46.08
PENETRATION (FT) : 25.92

MAX. BEND. MOMENT (LB-FT) : 1.2162E+05
AT ELEVATION (FT) : 58.84

MAX. SCALED DEFL. (LB-IN^3): 1.1547E+11
AT ELEVATION (FT) : 90.00

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF
ELASTICITY IN PSI TIMES PILE MOMENT
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:43:18

****
* COMPLETE RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--RESULTS0. (LB))

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
90.00	0.0000E+00	0.	1.1547E+11	78.41
89.00	4.4696E+01	95.	1.1139E+11	111.35
88.00	2.0074E+02	223.	1.0731E+11	144.28
87.00	5.0107E+02	383.	1.0322E+11	177.22
86.00	9.7861E+02	577.	9.9138E+10	210.15

85.00	1.6663E+03	804.	9.5057E+10	243.09
84.00	2.5971E+03	1063.	9.0979E+10	276.02
83.00	3.8113E+03	1378.	8.6905E+10	353.42
82.00	5.3789E+03	1770.	8.2838E+10	430.82
81.00	7.3670E+03	2208.	7.8780E+10	445.72
80.00	9.8007E+03	2662.	7.4735E+10	460.61
79.00	1.2695E+04	3130.	7.0707E+10	475.51
78.00	1.6065E+04	3613.	6.6701E+10	490.41
77.00	1.9925E+04	4110.	6.2723E+10	505.31
76.00	2.4291E+04	4623.	5.8779E+10	520.21
75.00	2.9177E+04	5151.	5.4878E+10	535.11
74.00	3.4598E+04	5693.	5.1027E+10	550.01
73.00	4.0568E+04	6251.	4.7236E+10	564.91
72.00	4.7104E+04	6823.	4.3515E+10	579.80
72.00	4.7104E+04	6823.	4.3515E+10	508.71
71.00	5.4156E+04	7254.	3.9875E+10	352.53
70.00	6.1560E+04	7528.	3.6329E+10	196.34
69.00	6.9160E+04	7647.	3.2889E+10	40.16
68.74	7.1127E+04	7652.	3.2024E+10	0.00
68.00	7.6801E+04	7609.	2.9569E+10	-116.02
67.00	8.4326E+04	7415.	2.6382E+10	-272.21
66.00	9.1578E+04	7064.	2.3340E+10	-428.39
65.00	9.8402E+04	6558.	2.0457E+10	-584.58
64.00	1.0464E+05	5895.	1.7743E+10	-740.76
63.00	1.1014E+05	5076.	1.5211E+10	-896.94
62.00	1.1474E+05	4101.	1.2868E+10	-1053.13
61.00	1.1829E+05	2970.	1.0724E+10	-1209.31
60.00	1.2063E+05	1683.	8.7833E+09	-1365.50
59.00	1.2160E+05	239.	7.0512E+09	-1521.68
58.00	1.2106E+05	-1361.	5.5292E+09	-1677.86
57.00	1.1883E+05	-3117.	4.2160E+09	-1834.05
56.00	1.1477E+05	-5029.	3.1079E+09	-1990.23
55.00	1.0872E+05	-7097.	2.1979E+09	-2146.42
54.00	1.0052E+05	-9322.	1.4754E+09	-2302.60
53.00	9.0024E+04	-11702.	9.2627E+08	-2458.78
52.00	7.7066E+04	-14239.	5.3236E+08	-2614.97
51.48	6.9246E+04	-15630.	3.8065E+08	-2696.77
51.00	6.1534E+04	-16679.	2.7125E+08	-1708.15
50.00	4.4346E+04	-17350.	1.1623E+08	367.61
49.00	2.7527E+04	-15944.	3.7885E+07	2443.37
48.00	1.3150E+04	-12463.	7.4601E+06	4519.13
47.00	3.2930E+03	-6906.	4.1006E+05	6594.89
46.08	0.0000E+00	0.	0.0000E+00	8494.82

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT

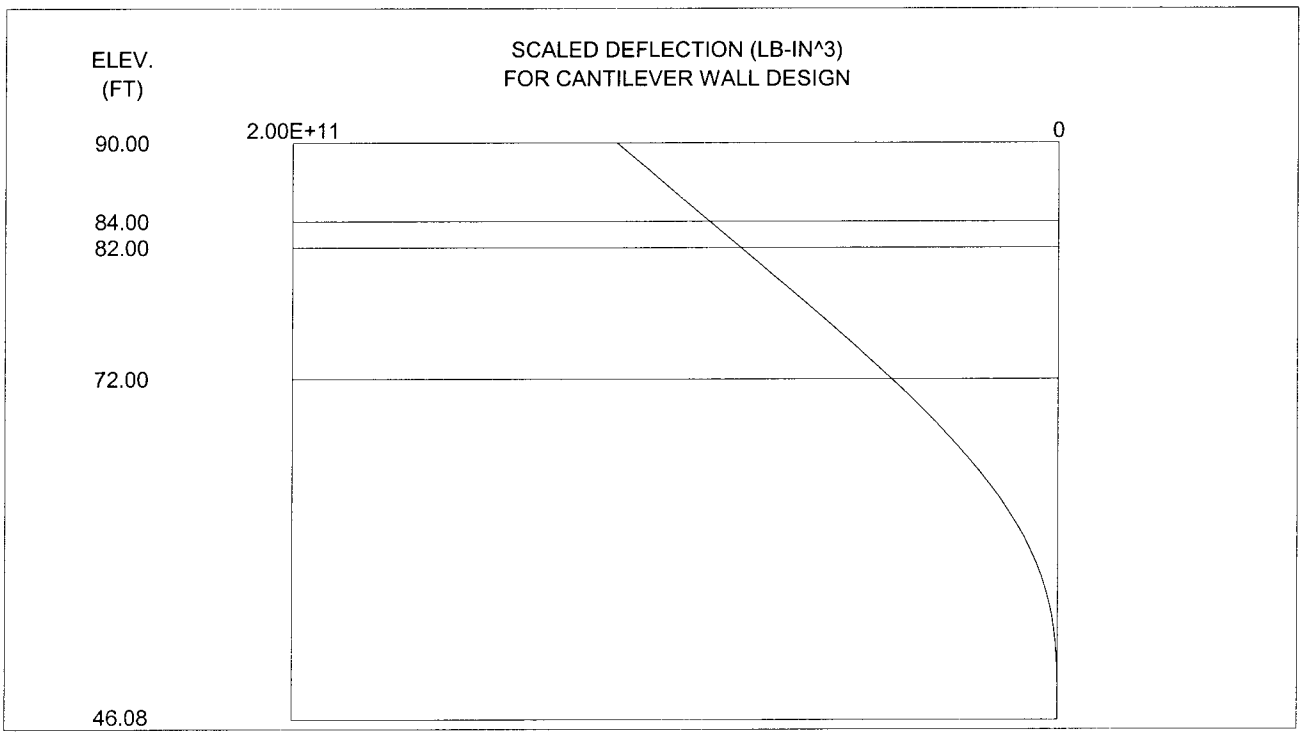
OF INERTIA IN IN^4 TO OBTAIN DEFLECTION
IN INCHES.

III.--WATER AND SOIL PRESSURES

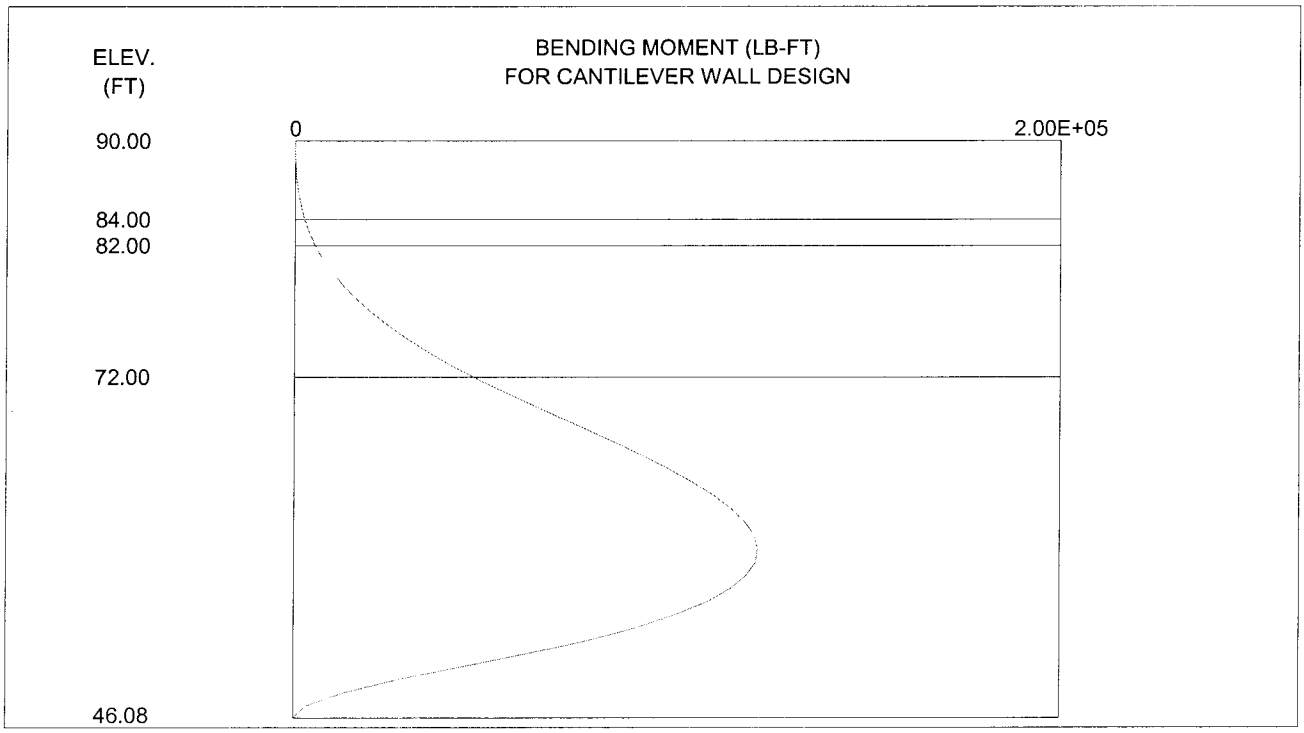
		<----------SOIL PRESSURES---------->			
	WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->	
ELEVATION	PRESSURE	PASSIVE	ACTIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
90.00	0.	0.	0.	78.	636.
89.00	0.	0.	0.	111.	903.
88.00	0.	0.	0.	144.	1170.
87.00	0.	0.	0.	177.	1437.
86.00	0.	0.	0.	210.	1704.
85.00	0.	0.	0.	243.	1971.
84.00	0.	0.	0.	276.	2239.
83.00	63.	0.	0.	291.	2359.
82.00	125.	0.	0.	306.	2480.
81.00	125.	0.	0.	321.	2601.
80.00	125.	0.	0.	336.	2722.
79.00	125.	0.	0.	351.	2843.
78.00	125.	0.	0.	365.	2964.
77.00	125.	0.	0.	380.	3084.
76.00	125.	0.	0.	395.	3205.
75.00	125.	0.	0.	410.	3326.
74.00	125.	0.	0.	425.	3447.
73.00	125.	0.	0.	440.	3568.
72.00+	125.	0.	0.	455.	3689.
72.00+	125.	0.	0.	384.	4322.
71.00	125.	171.	15.	399.	4494.
70.00	125.	343.	30.	414.	4665.
69.00	125.	514.	46.	429.	4836.
68.74	125.	558.	50.	433.	4881.
68.00	125.	686.	61.	445.	5008.
67.00	125.	857.	76.	460.	5179.
66.00	125.	1028.	91.	475.	5351.
65.00	125.	1200.	107.	490.	5522.
64.00	125.	1371.	122.	505.	5693.
63.00	125.	1543.	137.	521.	5865.
62.00	125.	1714.	152.	536.	6036.
61.00	125.	1885.	167.	551.	6208.
60.00	125.	2057.	183.	566.	6379.
59.00	125.	2228.	198.	582.	6550.
58.00	125.	2400.	213.	597.	6722.
57.00	125.	2571.	228.	612.	6893.
56.00	125.	2742.	243.	627.	7065.

55.00	125.	2914.	259.	642.	7236.
54.00	125.	3085.	274.	658.	7407.
53.00	125.	3257.	289.	673.	7579.
52.00	125.	3428.	304.	688.	7750.
51.48	125.	3518.	312.	696.	7840.
51.00	125.	3599.	320.	703.	7922.
50.00	125.	3771.	335.	718.	8093.
49.00	125.	3942.	350.	734.	8264.
48.00	125.	4114.	365.	749.	8436.
47.00	125.	4285.	380.	764.	8607.
46.08	125.	4456.	396.	779.	8779.
45.00	125.	4628.	411.	795.	8950.

'SHEETPILE WALL - GREY CHUTE INTAKE



'SHEETPILE WALL - GREY CHUTE INTAKE



PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:38:11

****
* INPUT DATA *
****

I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--CONTROL
CANTILEVER WALL DESIGN
FACTOR OF SAFETY FOR ACTIVE PRESSURES = 1.00
FACTOR OF SAFETY FOR PASSIVE PRESSURES = 1.00

III.--WALL DATA
ELEVATION AT TOP OF WALL = 90.00 FT.

IV.--SURFACE POINT DATA

IV.A.--RIGHTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	90.00

IV.B.--LEFTSIDE

DIST. FROM WALL (FT)	ELEVATION (FT)
0.00	72.00

V.--SOIL LAYER DATA

V.A.--RIGHTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF FRICTION (DEG)	ADH-ESION (PSF)	WALL ELEV. (FT)	<--BOTTOM--> SLOPE (FT/FT)	<-SAFETY-> ACT.	PASS.
110.00	105.00	28.00	0.00	15.12	0.00	72.00	0.00	DEF	DEF
120.00	115.00	32.00	0.00	17.28	0.00			DEF	DEF

V.B.--LEFTSIDE
LEVEL 2 FACTOR OF SAFETY FOR ACTIVE PRESSURE = DEFAULT
LEVEL 2 FACTOR OF SAFETY FOR PASSIVE PRESSURE = DEFAULT

SAT. WGHT. (PCF)	MOIST WGHT. (PCF)	ANGLE OF INTERNAL FRICTION (DEG)	COH-ESION (PSF)	ANGLE OF WALL FRICTION (DEG)	ADH-ESION (PSF)	<--BOTTOM--> ELEV. (FT)	SLOPE (FT/FT)	<-SAFETY-> ACT. FACTOR	PASS.
120.00	115.00	32.00	0.00	17.28	0.00			DEF	DEF

VI.--WATER DATA
UNIT WEIGHT = 62.50 (PCF)
RIGHTSIDE ELEVATION = 84.00 (FT)
LEFTSIDE ELEVATION = 82.00 (FT)
NO SEEPAGE

VII.--VERTICAL SURCHARGE LOADS

VII.A.--VERTICAL LINE LOADS
NONE

VII.B.--VERTICAL UNIFORM LOADS

LEFTSIDE (PSF)	RIGHTSIDE (PSF)
0.00	250.00

VII.C.--VERTICAL STRIP LOADS
NONE

VII.D.--VERTICAL RAMP LOADS
NONE

VII.E.--VERTICAL TRIANGULAR LOADS
NONE

VII.F.--VERTICAL VARIABLE LOADS
NONE

VIII.--HORIZONTAL LOADS
NONE

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:38:29

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*************************
*  SOIL PRESSURES FOR   *
* CANTILEVER WALL DESIGN *
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I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--SOIL PRESSURES

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

		<------NET------>					
NET	<---LEFTSIDE--->			(SOIL + WATER)		<--RIGHTSIDE--->	
ELEV.	WATER	PASSIVE	ACTIVE	ACTIVE	PASSIVE	ACTIVE	PASSIVE
(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
90.0	0.0	0.0	0.0	78.4	1058.7	78.4	1058.7
89.0	0.0	0.0	0.0	111.3	1503.4	111.3	1503.4
88.0	0.0	0.0	0.0	144.3	1948.1	144.3	1948.1
87.0	0.0	0.0	0.0	177.2	2392.8	177.2	2392.8
86.0	0.0	0.0	0.0	210.2	2837.4	210.2	2837.4
85.0	0.0	0.0	0.0	243.1	3282.1	243.1	3282.1
84.0	0.0	0.0	0.0	276.0	3726.8	276.0	3726.8
83.0	62.5	0.0	0.0	353.4	3990.5	290.9	3928.0
82.0	125.0	0.0	0.0	430.8	4254.1	305.8	4129.1
81.0	125.0	0.0	0.0	445.7	4455.3	320.7	4330.3
80.0	125.0	0.0	0.0	460.6	4656.4	335.6	4531.4
79.0	125.0	0.0	0.0	475.5	4857.6	350.5	4732.6

78.0	125.0	0.0	0.0	490.4	5058.8	365.4	4933.8
77.0	125.0	0.0	0.0	505.3	5259.9	380.3	5134.9
76.0	125.0	0.0	0.0	520.2	5461.1	395.2	5336.1
75.0	125.0	0.0	0.0	535.1	5662.2	410.1	5537.2
74.0	125.0	0.0	0.0	550.0	5863.4	425.0	5738.4
73.0	125.0	0.0	0.0	564.9	6064.6	439.9	5939.6
72.0+	125.0	0.0	0.0	579.8	6265.7	454.8	6140.7
72.0-	125.0	0.0	0.0	508.7	8101.4	383.7	7976.4
71.0	125.0	316.3	15.2	207.6	8402.5	398.9	8292.7
70.3	125.0	534.4	25.7	0.0	8610.1	409.4	8510.9
70.0	125.0	632.6	30.4	-93.5	8703.6	414.1	8609.0
69.0	125.0	948.9	45.6	-394.6	9004.7	429.4	8925.4
68.0	125.0	1265.2	60.9	-695.7	9305.8	444.6	9241.7
67.0	125.0	1581.5	76.1	-996.7	9606.9	459.8	9558.0
66.0	125.0	1897.8	91.3	-1297.8	9908.0	475.0	9874.3
65.0	125.0	2214.1	106.5	-1598.9	10209.1	490.2	10190.6
64.0	125.0	2530.5	121.7	-1900.0	10510.2	505.4	10506.9
63.0	125.0	2846.8	136.9	-2201.1	10811.2	520.7	10823.2
62.0	125.0	3163.1	152.2	-2502.2	11112.3	535.9	11139.5
61.0	125.0	3479.4	167.4	-2803.3	11413.4	551.1	11455.8
60.0	125.0	3795.7	182.6	-3104.4	11714.5	566.3	11772.1
59.0	125.0	4112.0	197.8	-3405.5	12015.6	581.5	12088.4
58.0	125.0	4428.3	213.0	-3706.6	12316.7	596.7	12404.7
57.0	125.0	4744.6	228.2	-4007.6	12617.8	612.0	12721.0
56.0	125.0	5060.9	243.5	-4308.7	12918.9	627.2	13037.3
55.0	125.0	5377.2	258.7	-4609.8	13220.0	642.4	13353.6
54.0	125.0	5693.5	273.9	-4910.9	13521.1	657.6	13670.0
53.0	125.0	6009.8	289.1	-5212.0	13822.2	672.8	13986.3
52.0	125.0	6326.1	304.3	-5513.1	14123.2	688.0	14302.6
51.0	125.0	6642.4	319.5	-5814.2	14424.3	703.3	14618.9
50.0	125.0	6958.8	334.8	-6115.3	14725.4	718.5	14935.2
49.0	125.0	7275.1	350.0	-6416.4	15026.5	733.7	15251.5
48.0	125.0	7591.4	365.2	-6717.5	15327.6	748.9	15567.8
47.0	125.0	7907.7	380.4	-7018.6	15628.7	764.1	15884.1
46.0	125.0	8224.0	395.6	-7319.6	15929.8	779.3	16200.4
45.0	125.0	8540.3	410.8	-7620.7	16230.9	794.5	16516.7
44.0	125.0	8856.6	426.1	-7921.8	16532.0	809.8	16833.0
43.0	125.0	9172.9	441.3	-8222.9	16833.1	825.0	17149.3
42.0	125.0	9489.2	456.5	-8524.0	17134.2	840.2	17465.6
41.0	125.0	9805.5	471.7	-8825.1	17435.2	855.4	17781.9
40.0	125.0	10121.8	486.9	-9126.2	17736.3	870.6	18098.3
39.0	125.0	10438.1	502.1	-9427.3	18037.4	885.8	18414.6
38.0	125.0	10754.4	517.4	-9728.4	18338.5	901.1	18730.9
37.0	125.0	11070.7	532.6	-10029.5	18639.6	916.3	19047.2
36.0	125.0	11387.0	547.8	-10330.6	18940.7	931.5	19363.5
35.0	125.0	11703.4	563.0	-10631.6	19241.8	946.7	19679.8

34.0	125.0	12019.7	578.2	-10932.7	19542.9	961.9	19996.1
33.0	125.0	12336.0	593.4	-11233.8	19844.0	977.1	20312.4
32.0	125.0	12652.3	608.6	-11534.9	20145.1	992.4	20628.7
31.0	125.0	12968.6	623.9	-11836.0	20446.1	1007.6	20945.0
30.0	125.0	13284.9	639.1	-12137.1	20747.2	1022.8	21261.3
29.0	125.0	13601.2	654.3	-12438.2	21048.3	1038.0	21577.6
28.0	125.0	13917.5	669.5	-12739.3	21349.4	1053.2	21893.9
27.0	125.0	14233.8	684.7	-13040.4	21650.5	1068.4	22210.2
26.0	125.0	14550.1	699.9	-13341.5	21951.6	1083.7	22526.5
25.0	125.0	14866.4	715.2	-13642.5	22252.7	1098.9	22842.9
24.0	125.0	15182.7	730.4	-13943.6	22553.8	1114.1	23159.2
23.0	125.0	15499.0	745.6	-14244.7	22854.9	1129.3	23475.5
22.0	125.0	15815.3	760.8	-14545.8	23156.0	1144.5	23791.8
21.0	125.0	16131.6	776.0	-14846.9	23457.1	1159.7	24108.1
20.0	125.0	16448.0	791.2	-15148.0	23758.1	1175.0	24424.4
19.0	125.0	16764.3	806.5	-15449.1	24059.2	1190.2	24740.7
18.0	125.0	17080.6	821.7	-15750.2	24360.3	1205.4	25057.0
17.0	125.0	17396.9	836.9	-16051.3	24661.4	1220.6	25373.3

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHORED OR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:38:31

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***************************
* SUMMARY OF RESULTS FOR  *
* CANTILEVER WALL DESIGN  *
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I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--SUMMARY

RIGHTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

LEFTSIDE SOIL PRESSURES DETERMINED BY COULOMB COEFFICIENTS
AND THEORY OF ELASTICITY EQUATIONS FOR SURCHARGE LOADS.

WALL BOTTOM ELEV. (FT) : 54.06
PENETRATION (FT) : 17.94

MAX. BEND. MOMENT (LB-FT) : 9.2679E+04
AT ELEVATION (FT) : 63.37

MAX. SCALED DEFL. (LB-IN^3): 5.7932E+10
AT ELEVATION (FT) : 90.00

NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

PROGRAM CWALSHT-DESIGN/ANALYSIS OF ANCHOREDOR CANTILEVER SHEET PILE WALLS
BY CLASSICAL METHODS
DATE: 12-MARCH-2004 TIME: 13:38:31

****
* COMPLETE RESULTS FOR *
* CANTILEVER WALL DESIGN *
****

I.--HEADING
'SHEETPILE WALL - GREY CHUTE INTAKE

II.--RESULTS0. (LB))

ELEVATION (FT)	BENDING MOMENT (LB-FT)	SHEAR (LB)	SCALED DEFLECTION (LB-IN^3)	NET PRESSURE (PSF)
90.00	0.0000E+00	0.	5.7932E+10	78.41
89.00	4.4696E+01	95.	5.5513E+10	111.35
88.00	2.0074E+02	223.	5.3095E+10	144.28
87.00	5.0107E+02	383.	5.0677E+10	177.22
86.00	9.7861E+02	577.	4.8259E+10	210.15

85.00	1.6663E+03	804.	4.5844E+10	243.09
84.00	2.5971E+03	1063.	4.3431E+10	276.02
83.00	3.8113E+03	1378.	4.1023E+10	353.42
82.00	5.3789E+03	1770.	3.8622E+10	430.82
81.00	7.3670E+03	2208.	3.6229E+10	445.72
80.00	9.8007E+03	2662.	3.3850E+10	460.61
79.00	1.2695E+04	3130.	3.1488E+10	475.51
78.00	1.6065E+04	3613.	2.9148E+10	490.41
77.00	1.9925E+04	4110.	2.6835E+10	505.31
76.00	2.4291E+04	4623.	2.4557E+10	520.21
75.00	2.9177E+04	5151.	2.2321E+10	535.11
74.00	3.4598E+04	5693.	2.0136E+10	550.01
73.00	4.0568E+04	6251.	1.8010E+10	564.91
72.00	4.7104E+04	6823.	1.5955E+10	579.80
72.00	4.7104E+04	6823.	1.5955E+10	508.71
71.00	5.4132E+04	7181.	1.3981E+10	207.62
70.31	5.9117E+04	7253.	1.2674E+10	0.00
70.00	6.1367E+04	7238.	1.2101E+10	-93.47
69.00	6.8508E+04	6994.	1.0326E+10	-394.56
68.00	7.5255E+04	6449.	8.6703E+09	-695.65
67.00	8.1307E+04	5603.	7.1442E+09	-996.74
66.00	8.6361E+04	4456.	5.7585E+09	-1297.83
65.00	9.0118E+04	3008.	4.5219E+09	-1598.92
64.00	9.2276E+04	1258.	3.4407E+09	-1900.01
63.00	9.2534E+04	-793.	2.5188E+09	-2201.10
62.00	9.0591E+04	-3144.	1.7564E+09	-2502.19
61.00	8.6145E+04	-5797.	1.1502E+09	-2803.28
60.00	7.8896E+04	-8751.	6.9241E+08	-3104.38
59.00	6.8543E+04	-12006.	3.7054E+08	-3405.47
58.00	5.4785E+04	-15562.	1.6662E+08	-3706.56
57.60	4.8189E+04	-17084.	1.1247E+08	-3828.24
57.00	3.7503E+04	-18494.	5.6842E+07	-904.78
56.00	1.9374E+04	-16946.	1.1742E+07	4001.64
55.00	5.2469E+03	-10491.	6.9623E+05	8908.07
54.06	0.0000E+00	0.	0.0000E+00	13501.88

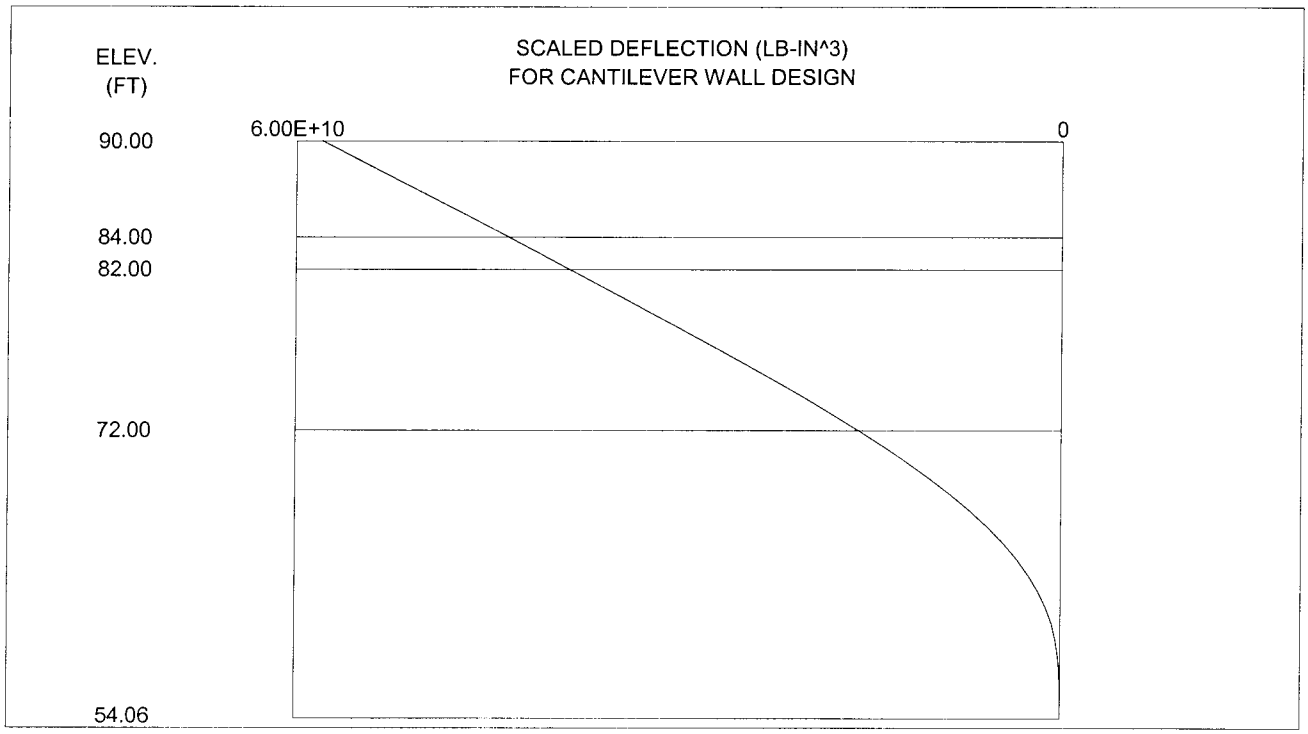
NOTE: DIVIDE SCALED DEFLECTION MODULUS OF ELASTICITY IN PSI TIMES PILE MOMENT OF INERTIA IN IN^4 TO OBTAIN DEFLECTION IN INCHES.

III.--WATER AND SOIL PRESSURES

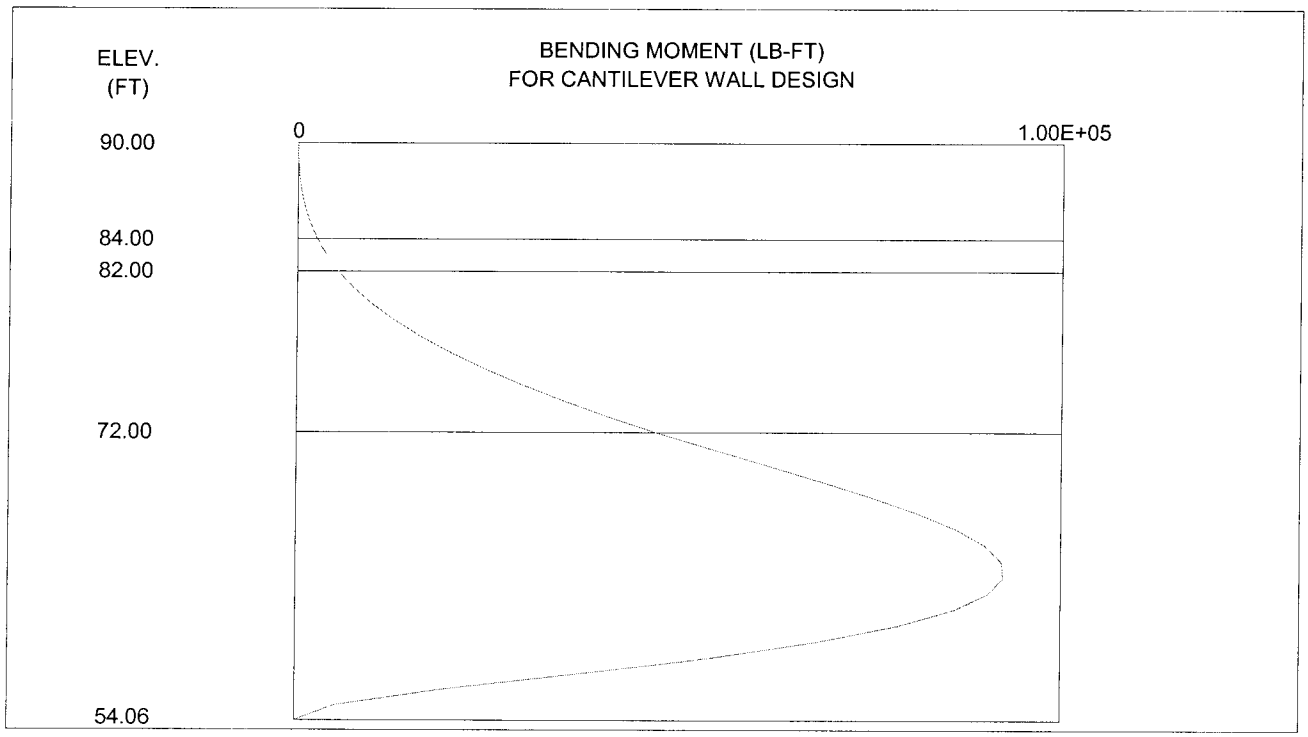
	<----------SOIL PRESSURES---------->				
WATER	<----LEFTSIDE----->		<---RIGHTSIDE---->		
ELEVATION	PRESSURE	PASSIVE	ACTIVE	ACTIVE	PASSIVE

(FT)	(PSF)	(PSF)	(PSF)	(PSF)	(PSF)
90.00	0.	0.	0.	78.	1059.
89.00	0.	0.	0.	111.	1503.
88.00	0.	0.	0.	144.	1948.
87.00	0.	0.	0.	177.	2393.
86.00	0.	0.	0.	210.	2837.
85.00	0.	0.	0.	243.	3282.
84.00	0.	0.	0.	276.	3727.
83.00	63.	0.	0.	291.	3928.
82.00	125.	0.	0.	306.	4129.
81.00	125.	0.	0.	321.	4330.
80.00	125.	0.	0.	336.	4531.
79.00	125.	0.	0.	351.	4733.
78.00	125.	0.	0.	365.	4934.
77.00	125.	0.	0.	380.	5135.
76.00	125.	0.	0.	395.	5336.
75.00	125.	0.	0.	410.	5537.
74.00	125.	0.	0.	425.	5738.
73.00	125.	0.	0.	440.	5940.
72.00+	125.	0.	0.	455.	6141.
72.00+	125.	0.	0.	384.	7976.
71.00	125.	316.	15.	399.	8293.
70.31	125.	534.	26.	409.	8511.
70.00	125.	633.	30.	414.	8609.
69.00	125.	949.	46.	429.	8925.
68.00	125.	1265.	61.	445.	9242.
67.00	125.	1582.	76.	460.	9558.
66.00	125.	1898.	91.	475.	9874.
65.00	125.	2214.	107.	490.	10191.
64.00	125.	2530.	122.	505.	10507.
63.00	125.	2847.	137.	521.	10823.
62.00	125.	3163.	152.	536.	11140.
61.00	125.	3479.	167.	551.	11456.
60.00	125.	3796.	183.	566.	11772.
59.00	125.	4112.	198.	582.	12088.
58.00	125.	4428.	213.	597.	12405.
57.60	125.	4556.	219.	603.	12533.
57.00	125.	4745.	228.	612.	12721.
56.00	125.	5061.	243.	627.	13037.
55.00	125.	5377.	259.	642.	13354.
54.06	125.	5694.	274.	658.	13670.
53.00	125.	6010.	289.	673.	13986.

'SHEETPILE WALL - GREY CHUTE INTAKE



'SHEETPILE WALL - GREY CHUTE INTAKE



FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
ROCK ISLAND, ILLINOIS
SLOPE STABILITY ANALYSIS

Objective

Evaluate the stability of the proposed embankments that will tie the control structures into the surrounding, higher ground. Determine the stable slope for the proposed structures.

Method

Stability analyses were performed using the Limit Equilibrium Approach adapted to computer solution using the WINSTABL2 computer program. This program was developed at Purdue University Engineering Experiment Station. WINSTABL2 utilizes the Modified Janbu, Modified Bishop's and Spencer's Method for circular sliding surfaces to determine the margin of safety against slope failure. The Spencer's method was used to search for the locations of the most critical failure surface. The embankment slopes were analyzed for shallow and deep circular sliding surfaces. The stability analyses were performed in general accordance with the requirements of EM 1110-2-1913 requirements.

References

1. "Subsurface Investigation and Laboratory Testing – Fox Island HREP, Alexandria, Missouri", TSI Engineering, Inc., November 12, 2003.
2. EM-1110-2-1913 *"Design and Construction of Levees"*
3. WINSTABL2 User's Manual
4. Stanley Draft Report, " Fox Island Division Habitat Rehabilitation and Enhancement, Pool 20, Mississippi River Miles 358.5 Through 353.6, Clark County, Missouri".

Subsurface Conditions

The near surface soils encountered in the core borings were highly variable, as is typical of a river flood plain environment. The surficial soils consisted of soft lean and fat clays (CL and CH) in the lower elevation areas and very loose poorly graded sands (SP) in some of the higher elevation areas. Even though the surficial soils were found to be variable, the soils encountered at depth tended to be more uniform across the site. In the elevation range of 480 to 474, all of the core borings indicated loose poorly graded sands (SP). These sands were typically very loose to loose, grading to loose to medium dense with increasing depth. All of the core borings that were extended to elevation 474 or deeper, ended in the SP soils, with the exception of core boring SB-8 which encountered a medium dense to dense gravel and clay (GC) till at approximately elevation 460.

Groundwater elevations measured at the time of drilling ranged from elevation 473 to elevation 483, with a majority of the measurements in the 475 to 480 range. It would be expected that the groundwater levels in the SP soils would closely follow the levels of the Mississippi. Perched water tables would be expected at higher elevations in the surficial fine grained CH and CL soils.

Geotechnical Design Parameters.

In order to complete preliminary geotechnical analyses of the of the project features/structures, it was necessary to assign geotechnical design parameters to the foundation and embankment materials. The design parameters include soil shear strength parameters and unit weights. Since the current study was preliminary in nature, minimal laboratory and field testing was performed during the subsurface investigation. The development of the geotechnical design parameters is based upon soil descriptions, standard penetration (N) values, sieve analyses, unit weight, moisture content and pocket penetrometer and unconfined compressive strength testing. Additional exploration and testing may be warranted at some structure locations to provide information for the final design of critical structures/features.

Surficial Clays (CL and CH): Standard penetration (N) values, pocket penetrometer and unconfined compressive strength testing indicated the surficial clays to be very soft to soft in consistency. In some areas it is anticipated that the shear strength of these soils may be less than 500 psf. For the preliminary analysis, it was assumed that the surficial clay soils have a phi = 0 and a cohesion = 200 psf. Based on the available core boring information it appears these clays will not have a significant impact on the taller levee sections since they will have bases at elevation 480 or lower. The core borings indicate that the soft clays end above or slightly below this elevation. The shorter embankment sections, with bases at elevations above 480, may be founded on these soft surficial clays.

Poorly Graded sands (SP): Standard penetration (N) values indicated the sands to be loose grading to loose to medium dense with depth. For the preliminary analyses it is assumed that these sandy soils have a c = 0 and a phi = 28 degrees. A majority of the taller embankment sections will bear upon these loose sandy soils.

Semi-Compacted Embankment Fill: The embankment fill will consist of job excavated soils. The soils excavated from above elevation 480 will tend to be mixtures of clays and sands. The soils excavated below elevation 480 will tend to be sands. In constructing the embankments, the lower permeability, clay soils will be used for the upstream, wet sides of the embankments and lower portions of the embankments, while the sandier soils will be used for the dry side and upper portions of the embankments. For the preliminary analyses it was assumed that the semi-compacted embankment soils were a mixture of clays and sands having a c = 0 and a phi = 26 degrees. The embankments for the project are not extensive and the heights will typically be less than 10 feet. Therefore, as long as 4H on 1V side slopes are utilized, the shear strength of the fills should not be critical to the embankment stability.

Slope Stability Analysis

Stability analyses were performed on typical earthwork sections for the proposed embankments in order to verify that slope stability requirements are met. The embankments will be constructed of semi-compacted job excavated materials consisting of a mixture of clays and sands. Analyses were performed using the Limit Equilibrium Approach adapted to computer solution using the WINSTABL computer program. This program was developed at the Purdue University Engineering Experiment Station. WINSTABL utilizes the Modified Janbu, Modified Bishop's and Spencer's Methods for circular sliding surfaces to determine the margin of safety against slope failure. Spencer's method was used to search for the location of the most critical failure surfaces. Embankment slopes were analyzed for shallow and deep circular sliding surfaces.

Parameters used in the analyses were based on material classifications, correlations with SPT results, and laboratory testing results. The parameters used are discussed in the previous paragraphs

Cross Sections: Analyses of the proposed embankment were performed for the tallest expected embankment section, which will occur within the channels at the proposed control structures, having inverts of elevation 480. These embankments will be approximately 10 feet tall and will be constructed with 4H on 1V sided slopes. Typically, a 3H on 1V slope would be used, however, the flatter slope was used due to the potential for soft/very loose foundation soils existing under the embankment. Additional slope stability analyses were performed for a shorter, 5 foot tall embankment which may be constructed over the soft clays typically encountered at elevations above 480.

Loading Condition: The proposed earthwork sections were analyzed for two loading conditions. The first is the end-of-construction condition with no water being retained by the embankment. The second condition analyzed assumed a phreatic surface condition of water to within four (4) feet of the top of the embankment on the wet side and water at the toe of the embankment on the dry side. For this analysis it was assumed a steady-state seepage condition had occurred with a phreatic surface extending from the upstream pool and exiting slightly above the downstream toe of the embankment.

Results of Slope Stability Analysis:
The results of the analysis along with the recommended minimum factors of safety are summarized in the table below.

Results of Embankment Stability Analysis (10 Foot Embankment)

CONDITION	MINIMUM F. of S.	REQUIRED F. of S.
End-of-Construction	2.0	1.3
Normal Pond	1.5	1.4

Results of Embankment Stability Analysis (5 Foot Embankment)

CONDITION	MINIMUM F. of S.	REQUIRED F. of S.
End-of-Construction	2.0	1.3
Normal Pond	2.0	1.4

Stanley Consultants INC.

Project No. _____ Page No. 2

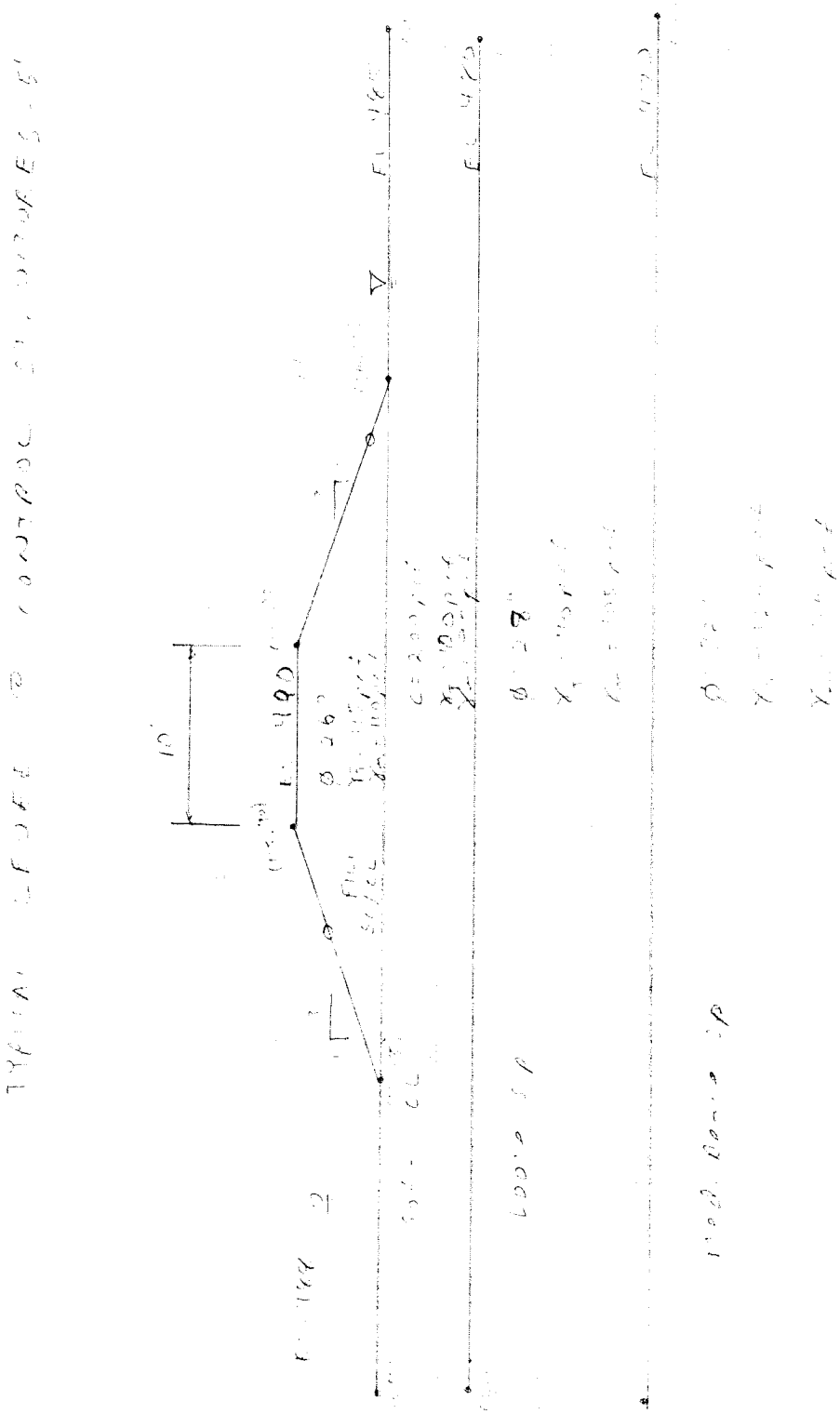
Subject _____

Computed by _____ Date _____

Checked by _____ Date _____

Approved by _____ Date _____

Sheet No. 5 of



Stanley Consultants INC.

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Subject _____

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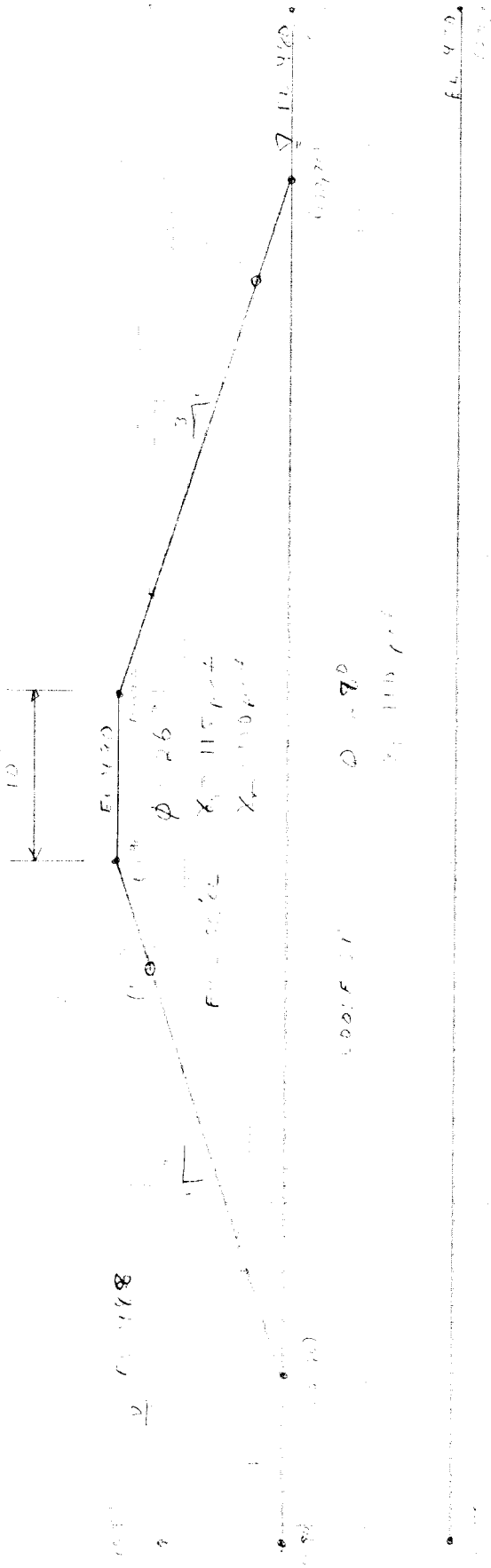
Sheet No. 6 of



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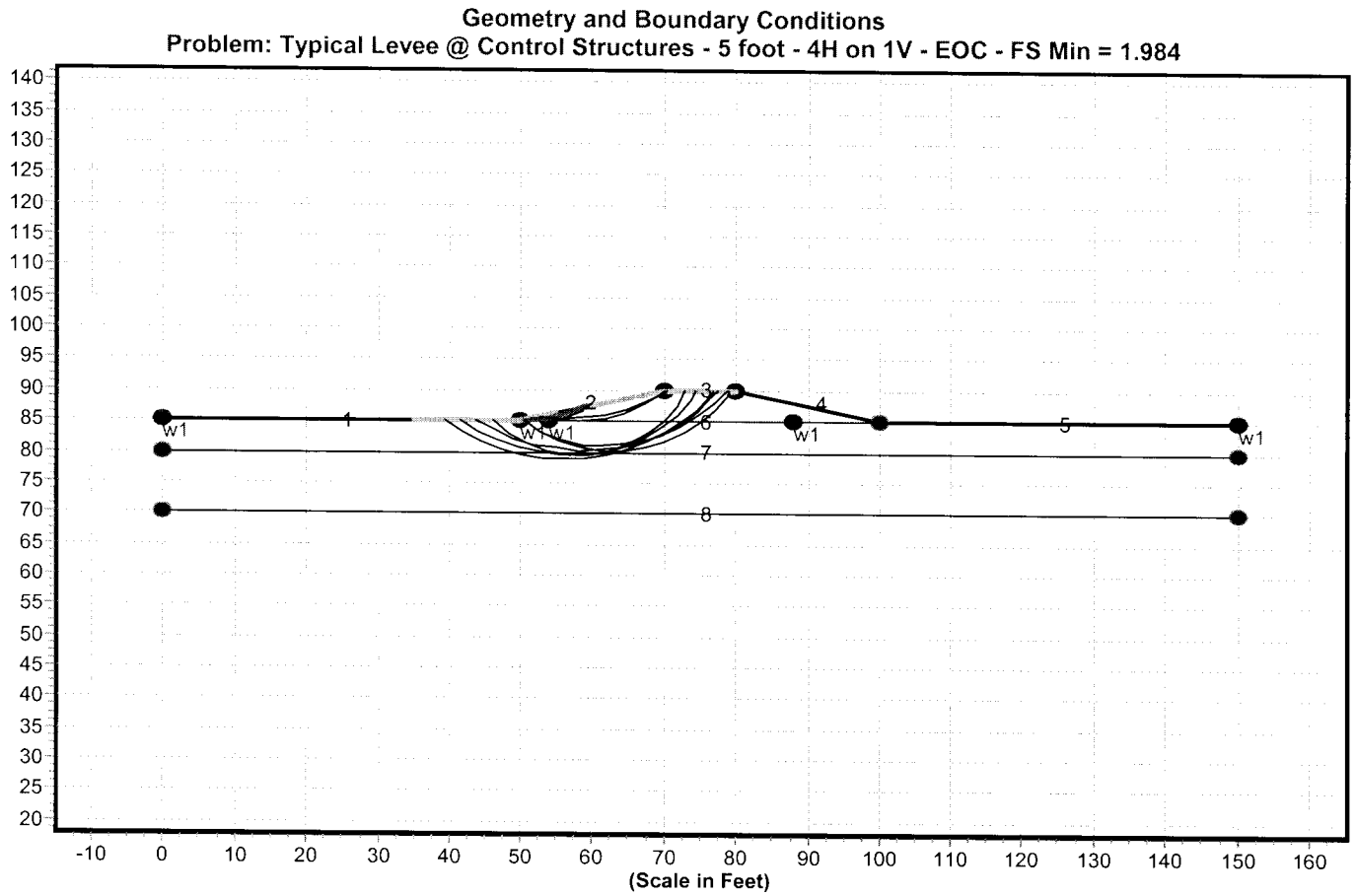

Geometry and Boundary Conditions
Problem: Typical Levee @ Control Structures - 5 foot - 4H on 1V - EOC - FS Min = 1.984
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
(Scale in Feet)
1
2
3
4
5
6
7
8
w1
w1
w1
w1
w1

result.out
** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Typical Levee @ Control Structures - 5 f
oot - 4H on 1V - EOC

BOUNDARY COORDINATES

5 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	85.00	50.00	85.00	2
2	50.00	85.00	70.00	90.00	1
3	70.00	90.00	80.00	90.00	1
4	80.00	90.00	100.00	85.00	1
5	100.00	85.00	150.00	85.00	2
6	50.00	85.00	100.00	85.00	2
7	0.00	80.00	150.00	80.00	3
8	0.00	70.00	150.00	70.00	4

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	0.0	26.0	0.00	0.0	1
2	95.0	100.0	200.0	0.0	0.00	0.0	1
3	105.0	110.0	0.0	28.0	0.00	0.0	1
4	115.0	120.0	0.0	32.0	0.00	0.0	1

1

result.out

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	85.00
2	50.00	85.00
3	54.00	85.00
4	88.00	85.00
5	150.00	85.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 35.00 ft.
and X = 55.00 ft.

Each Surface Terminates Between X = 59.00 ft.
and X = 80.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By Spencer`s Method * *

Number of convergent trials 100
Number of non convergent trials 0

Failure Surface Specified By 5 Coordinate Points

Point	X-Surf	Y-Surf

result.out

No.	(ft)	(ft)
1	50.56	85.14
2	53.53	85.50
3	56.45	86.22
4	59.24	87.30
5	59.26	87.32

Circle Center At X = 49.2 ; Y = 109.0 and Radius, 23.9

*** Factor of Safety = 1.984 ***

Individual data on the 4 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	3.0	63.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.9	124.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	2.8	61.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.78	85.69
2	55.77	85.47
3	58.77	85.60
4	61.73	86.08
5	64.61	86.92
6	67.37	88.09
7	69.97	89.59
8	70.53	90.00

Circle Center At X = 56.2 ; Y = 110.3 and Radius, 24.9

*** Factor of Safety = 2.086 ***

1

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.78	85.69
2	55.77	85.52
3	58.53	86.70
4	59.01	87.25

Circle Center At X = 54.6 ; Y = 91.6 and Radius, 6.2

*** Factor of Safety = 2.229 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.78	85.69
2	55.72	85.09
3	58.71	84.99
4	61.69	85.41
5	64.54	86.32
6	67.20	87.71
7	69.59	89.53
8	70.03	90.00

Circle Center At X = 57.8 ; Y = 102.4 and Radius, 17.4

*** Factor of Safety = 2.250 ***

1

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.89	85.00
2	46.43	83.41
3	49.15	82.13
4	51.99	81.17
5	54.93	80.56
6	57.91	80.29
7	60.91	80.37
8	63.88	80.81
9	66.78	81.59
10	69.56	82.70
11	72.20	84.13
12	74.65	85.86
13	76.88	87.86
14	78.76	90.00

Circle Center At X = 58.7 ; Y = 105.8 and Radius, 25.6

*** Factor of Safety = 2.380 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	39.44	85.00
2	41.83	83.18
3	44.41	81.65
4	47.15	80.44
5	50.02	79.56
6	52.98	79.03
7	55.97	78.85
8	58.97	79.03
9	61.92	79.56
10	64.79	80.43
11	67.53	81.64
12	70.12	83.17
13	72.50	84.99
14	74.65	87.08
15	76.54	89.41
16	76.91	90.00

Circle Center At X = 56.0 ; Y = 104.1 and Radius, 25.3

*** Factor of Safety = 2.393 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.67	85.00
2	44.12	83.28
3	46.77	81.86
4	49.57	80.78
5	52.47	80.03
6	55.45	79.64
7	58.45	79.61
8	61.43	79.93
9	64.35	80.61
10	67.17	81.64
11	69.84	83.00
12	72.34	84.66
13	74.62	86.62
14	76.64	88.83
15	77.48	90.00

Circle Center At X = 57.2 ; Y = 104.6 and Radius, 25.0

*** Factor of Safety = 2.395 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.11	85.00
2	48.29	82.94
3	50.82	81.33
4	53.61	80.23
5	56.56	79.67
6	59.56	79.67
7	62.51	80.24
8	65.29	81.36
9	67.82	82.98
10	69.99	85.05
11	71.74	87.49
12	72.89	90.00

Circle Center At X = 58.0 ; Y = 95.4 and Radius, 15.8

*** Factor of Safety = 2.401 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.56	85.14
2	52.90	83.27
3	55.52	81.81
4	58.35	80.80
5	61.30	80.28
6	64.30	80.24
7	67.27	80.70
8	70.12	81.64
9	72.77	83.03
10	75.16	84.84
11	77.22	87.03
12	78.90	89.52
13	79.12	90.00

Circle Center At X = 63.0 ; Y = 98.4 and Radius, 18.2

*** Factor of Safety = 2.409 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.56	85.14
2	52.91	83.28
3	55.59	81.93
4	58.48	81.14

5	61.48	80.96
6	64.45	81.38
7	67.27	82.40
8	69.83	83.96
9	72.03	86.00
10	73.76	88.45
11	74.45	90.00

Circle Center At X = 60.9 ; Y = 95.8 and Radius, 14.8

*** Factor of Safety = 2.415 ***

1

```
              Y            A     X     I     S            F     T

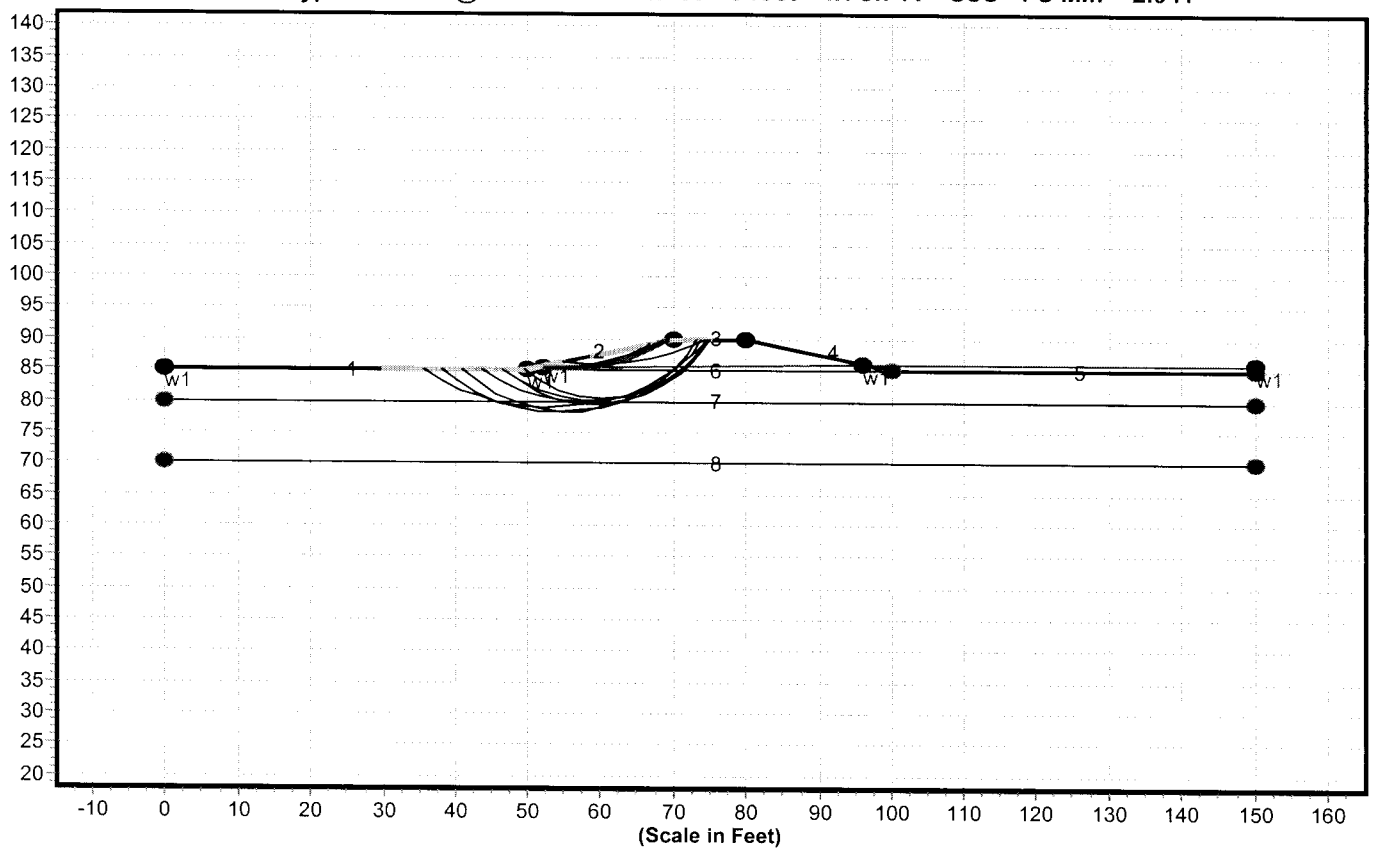
              0.00     18.75     37.50     56.25     75.00     93.75

X       0.00 +---------+---------+---------+------*--+--*-*----+
             -
             -
             -
             -
             -
       18.75 +
             -
             -
             -
             -
             -                                                .
A      37.50 +                                                ..
             -                                              .66
             -                                             ..65
             -                                             .658
             -                                             675*
             -                                             659W1
X      56.25 +                                            .65941
             -                                            .65.421
             -                                             65..2.
             -                                             .65.2..
             -                                              958.2*
             -                                              .95082
I      75.00 +                                                9506
             -                                                955
             -                                                  *
             -
             -                                              W
             -
S      93.75 +
             -
             -                                              *
             -
             -
             -
      112.50 +
             -
             -
             -
             -
```

```
                -
F     131.25 +
                -
                -
                -
                -
                -
T     150.00 +                                        *      * *
```

Geometry and Boundary Conditions

Problem: Typical Levee @ Control Structures - 5 foot - 4H on 1V - SSS - FS Min = 2.041



result.out
** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Typical Levee @ Control Structures - 5 f
oot - 4H on 1V - SSS

BOUNDARY COORDINATES

5 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	85.00	50.00	85.00	2
2	50.00	85.00	70.00	90.00	1
3	70.00	90.00	80.00	90.00	1
4	80.00	90.00	100.00	85.00	1
5	100.00	85.00	150.00	85.00	2
6	50.00	85.00	100.00	85.00	2
7	0.00	80.00	150.00	80.00	3
8	0.00	70.00	150.00	70.00	4

1

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	0.0	26.0	0.00	0.0	1
2	95.0	100.0	200.0	0.0	0.00	0.0	1
3	105.0	110.0	0.0	28.0	0.00	0.0	1
4	115.0	120.0	0.0	32.0	0.00	0.0	1

1

result.out

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	85.00
2	50.00	85.00
3	52.00	85.50
4	96.00	86.00
5	150.00	86.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 30.00 ft.
and X = 55.00 ft.

Each Surface Terminates Between X = 59.00 ft.
and X = 75.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By Spencer`s Method * *

Number of convergent trials 99
Number of non convergent trials 1

Failure Surface Specified By 7 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	52.22	85.56
2	55.21	85.33
3	58.21	85.49
4	61.16	86.03
5	64.02	86.95
6	66.73	88.23
7	69.17	89.79

Circle Center At X = 55.5 ; Y = 108.5 and Radius, 23.2

*** Factor of Safety = 2.041 ***

Individual data on the 8 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.6	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	2.4	155.4	0.0	15.7	0.0	0.0	0.0	0.0	0.0
3	3.0	421.4	0.0	27.6	0.0	0.0	0.0	0.0	0.0
4	0.5	85.9	0.0	1.3	0.0	0.0	0.0	0.0	0.0
5	2.5	454.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	2.9	520.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	2.7	374.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.4	128.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.22	85.56
2	55.22	85.39
3	58.21	85.65
4	61.12	86.35
5	63.91	87.46
6	66.51	88.96
7	66.82	89.21

Circle Center At X = 54.9 ; Y = 106.0 and Radius, 20.7

*** Factor of Safety = 2.050 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	46.67	85.00
2	49.03	83.15
3	51.67	81.72
4	54.50	80.75
5	57.47	80.27
6	60.47	80.29
7	63.42	80.81
8	66.25	81.81
9	68.86	83.28
10	71.20	85.16
11	73.19	87.40
12	74.78	89.95
13	74.80	90.00

Circle Center At X = 58.9 ; Y = 98.1 and Radius, 17.9

*** Factor of Safety = 2.287 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.89	85.00
2	46.27	83.18
3	48.90	81.73
4	51.71	80.68
5	54.64	80.05
6	57.64	79.87
7	60.63	80.12
8	63.55	80.81
9	66.33	81.93
10	68.92	83.44
11	71.26	85.32
12	73.30	87.52
13	74.99	90.00
14	75.00	90.00

Circle Center At X = 57.4 ; Y = 100.2 and Radius, 20.3

*** Factor of Safety = 2.314 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	85.00
2	48.90	82.99
3	51.45	81.41
4	54.23	80.30
5	57.17	79.69

6	60.17	79.60
7	63.14	80.04
8	65.98	81.00
9	68.61	82.43
10	70.96	84.31
11	72.93	86.56
12	74.48	89.13
13	74.82	90.00

Circle Center At X = 59.2 ; Y = 96.6 and Radius, 17.1

*** Factor of Safety = 2.317 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.44	85.00
2	51.74	83.06
3	54.36	81.61
4	57.22	80.71
5	60.20	80.38
6	63.19	80.64
7	66.07	81.48
8	68.73	82.87
9	71.06	84.76
10	72.98	87.07
11	74.41	89.71
12	74.50	90.00

Circle Center At X = 60.4 ; Y = 95.6 and Radius, 15.2

*** Factor of Safety = 2.326 ***

1

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.11	85.00
2	43.25	82.90
3	45.69	81.15
4	48.37	79.81
5	51.23	78.90
6	54.20	78.45
7	57.20	78.47
8	60.16	78.96
9	63.01	79.90
10	65.67	81.28
11	68.09	83.06
12	70.20	85.19

13	71.95	87.62
14	73.15	90.00

Circle Center At X = 55.6 ; Y = 97.5 and Radius, 19.1

*** Factor of Safety = 2.346 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	38.33	85.00
2	40.55	82.98
3	43.03	81.29
4	45.71	79.94
5	48.55	78.97
6	51.49	78.39
7	54.49	78.22
8	57.48	78.45
9	60.41	79.08
10	63.23	80.11
11	65.88	81.51
12	68.32	83.26
13	70.50	85.32
14	72.38	87.66
15	73.79	90.00

Circle Center At X = 54.3 ; Y = 100.3 and Radius, 22.1

*** Factor of Safety = 2.371 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.00	86.25
2	57.99	85.96
3	60.99	85.97
4	63.97	86.29
5	66.91	86.90
6	69.76	87.81
7	72.52	89.01
8	74.29	90.00

Circle Center At X = 59.4 ; Y = 115.3 and Radius, 29.4

*** Factor of Safety = 2.434 ***

result.out

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	85.00
2	37.99	83.25
3	40.61	81.78
4	43.36	80.60
5	46.23	79.72
6	49.18	79.17
7	52.17	78.94
8	55.17	79.04
9	58.14	79.47
10	61.05	80.22
11	63.85	81.28
12	66.53	82.64
13	69.04	84.28
14	71.35	86.19
15	73.44	88.34
16	74.74	90.00

Circle Center At X = 52.7 ; Y = 106.3 and Radius, 27.4

*** Factor of Safety = 2.453 ***

1

```
            Y            A     X     I     S            F     T

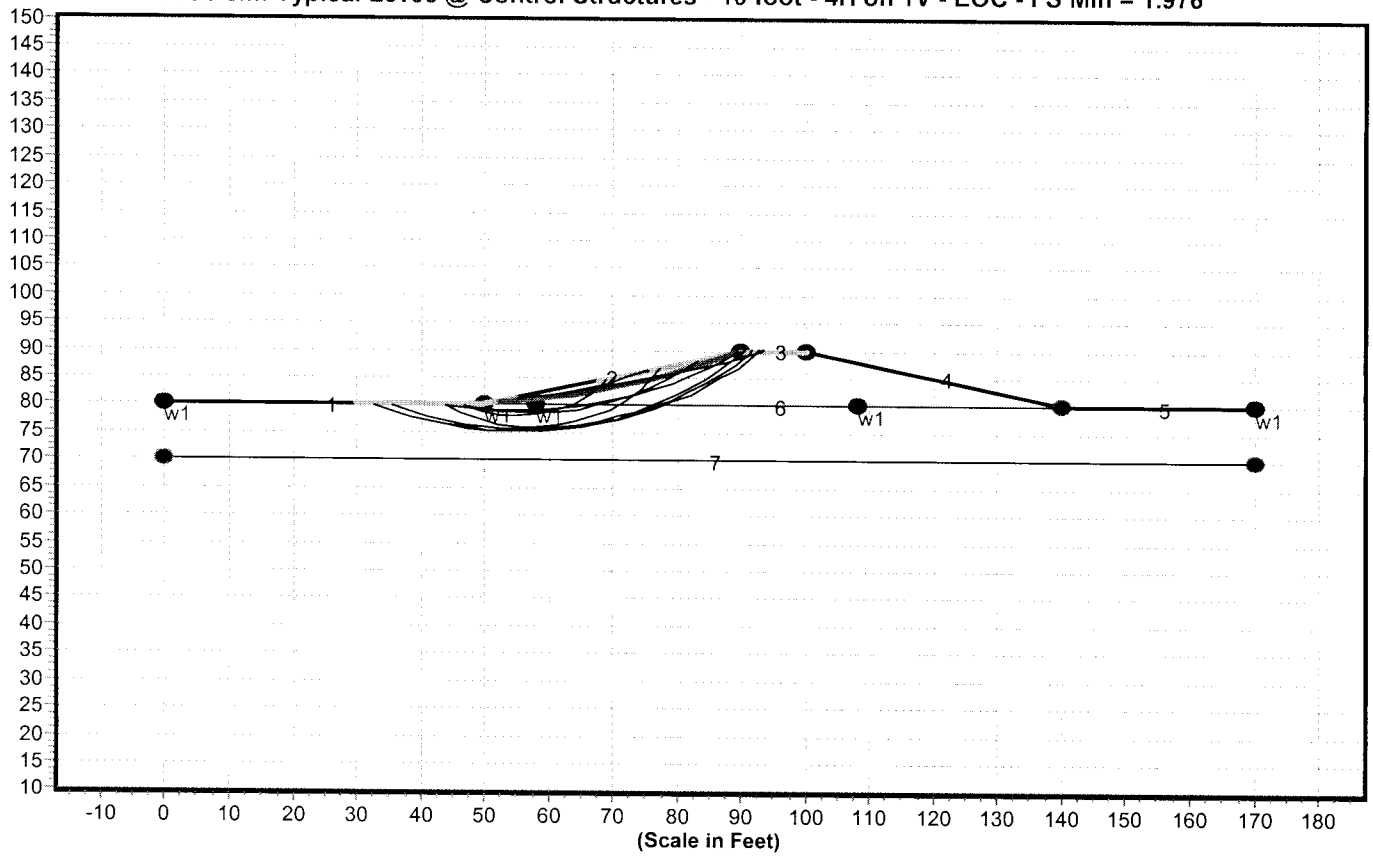
            0.00     18.75     37.50     56.25     75.00     93.75

X       0.00 +---------+---------+---------+------*--+--*-*----+
             -
             -
             -
             -
             -
       18.75 +
             -
             -
             -
             -                                                ..
             -                                               ..0
A      37.50 +                                              ..08
             -                                              ..87
             -                                             ..874
             -                                             ..743
             -                                             .753*
             -                                             .733.W
X      56.25 +                                              73..1
             -                                              53..1.
             -                                               3..12
             -                                               53.912
             -                                                34.9*
             -                                                 3437
```

```
I      75.00 +                                                  03
             -
             -                                                   *
             -
             -
             -
S      93.75 +
             -                                                W
             -                                               *
             -
             -
             -
      112.50 +
             -
             -
             -
             -
             -
F     131.25 +
             -
             -
             -
             -
             -
T     150.00 +                                  *      * *W
```

Geometry and Boundary Conditions

Problem: Typical Levee @ Control Structures - 10 foot - 4H on 1V - EOC - FS Min = 1.976



result.out
** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Typical Levee @ Control Structures - 10 foot - 4H on 1V - EOC

BOUNDARY COORDINATES

5 Top Boundaries
7 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	80.00	50.00	80.00	2
2	50.00	80.00	90.00	90.00	1
3	90.00	90.00	100.00	90.00	1
4	100.00	90.00	140.00	80.00	1
5	140.00	80.00	170.00	80.00	2
6	50.00	80.00	140.00	80.00	2
7	0.00	70.00	170.00	70.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	0.0	26.0	0.00	0.0	1
2	105.0	110.0	0.0	28.0	0.00	0.0	1
3	115.0	120.0	0.0	32.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	80.00
2	50.00	80.00
3	58.00	80.00
4	108.00	80.00
5	170.00	80.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 30.00 ft.
and X = 55.00 ft.

Each Surface Terminates Between X = 68.00 ft.
and X = 100.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By Spencer`s Method * *

Number of convergent trials 100
Number of non convergent trials 0

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	52.22	80.56
2	55.21	80.81
3	58.19	81.15
4	61.16	81.57
5	64.12	82.07
6	67.07	82.65
7	69.99	83.31
8	72.90	84.04
9	75.79	84.85
10	78.65	85.74
11	81.49	86.71
12	84.31	87.76
13	87.09	88.87
14	89.26	89.82

Circle Center At X = 44.1 ; Y = 191.6 and Radius, 111.4

*** Factor of Safety = 1.976 ***

Individual data on the 13 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	3.0	80.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	3.0	226.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	3.0	345.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	3.0	435.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	2.9	498.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	2.9	532.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	2.9	540.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	2.9	520.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	2.9	474.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	2.8	402.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	2.8	306.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	2.8	186.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	2.2	47.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.00	81.25
2	57.99	81.51
3	60.96	81.93
4	63.91	82.50
5	66.82	83.22
6	69.69	84.09
7	72.51	85.11
8	75.28	86.27
9	75.50	86.38

Circle Center At X = 51.4 ; Y = 139.3 and Radius, 58.2

*** Factor of Safety = 1.979 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	80.00
2	49.44	78.85
3	52.36	78.17
4	55.35	77.99
5	58.34	78.31
6	61.23	79.12
7	63.94	80.39
8	66.40	82.11
9	68.55	84.20
10	68.94	84.73

Circle Center At X = 54.9 ; Y = 95.9 and Radius, 17.9

*** Factor of Safety = 2.011 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	80.00
2	49.59	79.34
3	52.56	78.89
4	55.55	78.67
5	58.55	78.67
6	61.54	78.90
7	64.51	79.35
8	67.43	80.02
9	70.30	80.90
10	73.09	82.00
11	75.79	83.30
12	78.39	84.80
13	80.87	86.49
14	83.11	88.28

Circle Center At X = 57.0 ; Y = 118.8 and Radius, 40.1

*** Factor of Safety = 2.025 ***

1

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	80.00
2	38.33	78.85
3	41.16	77.87
4	44.05	77.05
5	46.98	76.41
6	49.94	75.95
7	52.93	75.66
8	55.93	75.55
9	58.93	75.62
10	61.92	75.87
11	64.89	76.29
12	67.83	76.89
13	70.72	77.67
14	73.57	78.61
15	76.36	79.72
16	79.07	81.00
17	81.71	82.43
18	84.25	84.02
19	86.70	85.76
20	89.04	87.64
21	91.26	89.66
22	91.59	90.00

Circle Center At X = 56.3 ; Y = 126.0 and Radius, 50.4

*** Factor of Safety = 2.028 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.89	80.00
2	46.86	79.56
3	49.84	79.26
4	52.84	79.11
5	55.84	79.10
6	58.84	79.23
7	61.82	79.51
8	64.79	79.93
9	67.74	80.49
10	70.66	81.19
11	73.54	82.02
12	76.38	83.00
13	79.16	84.11
14	81.89	85.35
15	84.56	86.72
16	87.16	88.22
17	89.69	89.84
18	89.87	89.97

Circle Center At X = 54.6 ; Y = 141.8 and Radius, 62.7

*** Factor of Safety = 2.028 ***

1

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.89	80.00
2	46.49	78.51
3	49.26	77.35
4	52.15	76.54
5	55.11	76.09
6	58.11	76.02
7	61.10	76.31
8	64.03	76.97
9	66.85	77.98
10	69.53	79.34
11	72.01	81.01
12	74.28	82.98
13	76.28	85.21
14	77.42	86.86

Circle Center At X = 57.2 ; Y = 100.2 and Radius, 24.2

*** Factor of Safety = 2.043 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.00	81.25
2	57.97	81.65
3	60.94	82.10
4	63.90	82.59
5	66.85	83.13
6	69.80	83.70
7	72.73	84.32
8	75.66	84.98
9	78.57	85.69
10	81.48	86.43
11	84.37	87.22
12	87.26	88.05
13	90.13	88.93
14	92.98	89.84
15	93.45	90.00

Circle Center At X = 28.7 ; Y = 285.6 and Radius, 206.0

*** Factor of Safety = 2.059 ***

1

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.78	80.00
2	35.54	78.82
3	38.36	77.80
4	41.23	76.95
5	44.15	76.26
6	47.11	75.75
7	50.09	75.41
8	53.09	75.24
9	56.09	75.25
10	59.08	75.43
11	62.06	75.79
12	65.01	76.32
13	67.93	77.02
14	70.80	77.89
15	73.62	78.93
16	76.37	80.13
17	79.04	81.48
18	81.63	82.99
19	84.13	84.65
20	86.53	86.45
21	88.82	88.39
22	90.52	90.00

Circle Center At X = 54.4 ; Y = 126.7 and Radius, 51.5

*** Factor of Safety = 2.066 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.78	80.00
2	35.55	78.85
3	38.38	77.86
4	41.26	77.02
5	44.18	76.34
6	47.14	75.82
7	50.12	75.45
8	53.11	75.25
9	56.11	75.21
10	59.11	75.34
11	62.09	75.63
12	65.06	76.07
13	68.00	76.68
14	70.90	77.45
15	73.75	78.37
16	76.55	79.44
17	79.29	80.67

18	81.96	82.04
19	84.55	83.55
20	87.05	85.20
21	89.46	86.99
22	91.78	88.90
23	92.96	90.00

Circle Center At X = 55.3 ; Y = 130.6 and Radius, 55.4

*** Factor of Safety = 2.067 ***

1

```
              Y            A     X     I     S            F     T

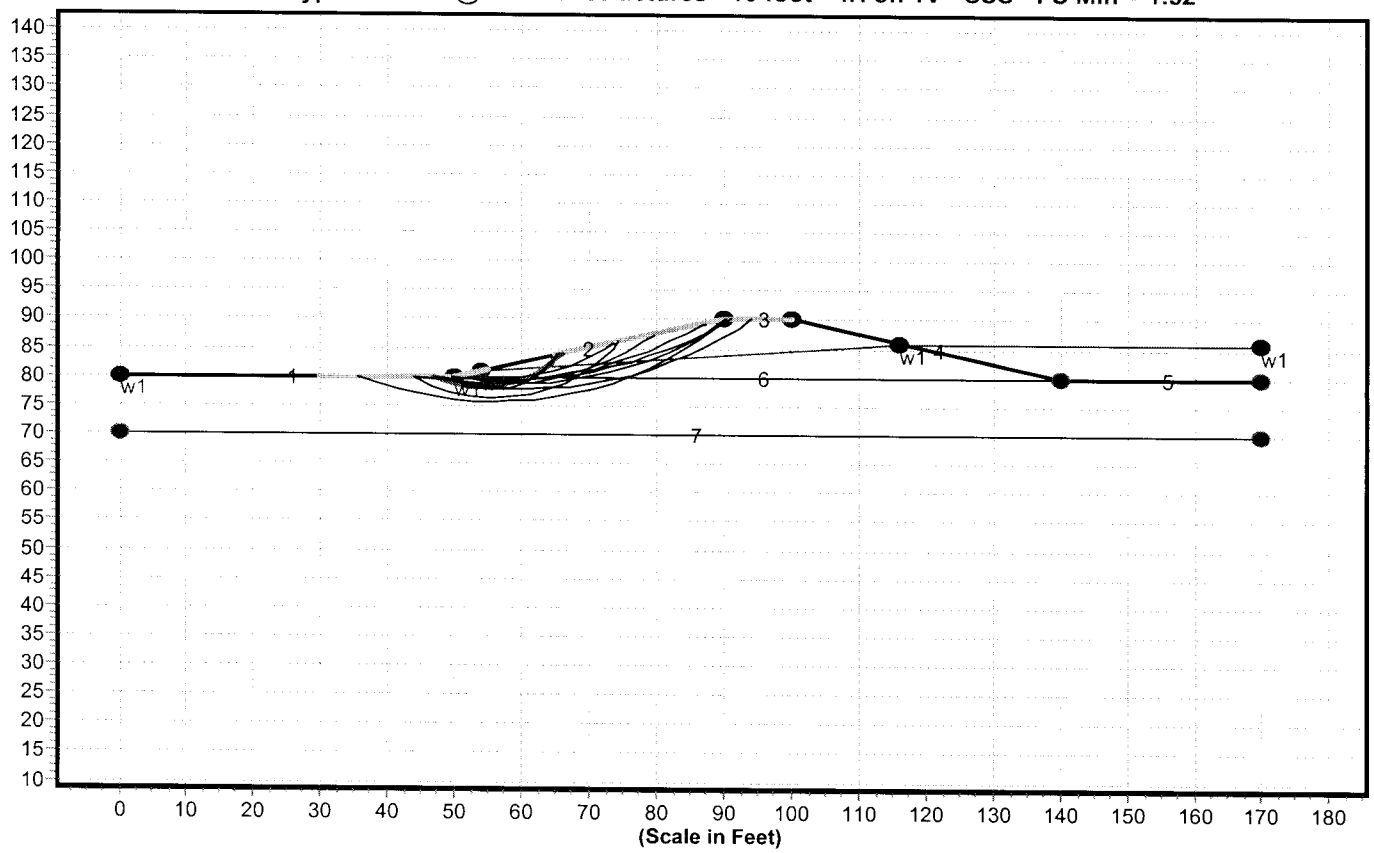
              0.00     21.25     42.50     63.75     85.00    106.25

X       0.00 +---------+---------+---------+--*----*-+---------+
             -
             -
             -
             -
             -
       21.25 +
             -
             -                                          .
             -                                         .9
             -                                       ..95
             -                                      ...5.
A      42.50 +                                      ..556
             -                                     ...563
             -                                     ..953*
             -                                     ..9531
             -                                     ..953W
             -                                    ...95312
X      63.75 +                                    ....5431
             -                                    ....57413
             -                                     ...05412
             -                                     ....5.412
             -                                     ....05617
             -                                      .....5614
I      85.00 +                                       ....051.
             -                                        ....05*
             -                                        ......5
             -                                          .....
             -                                              .*
             -
S     106.25 +                                          W
             -
             -
             -
             -
             -
     127.50 +
             -
             -
             -
             -                                          *
             -
```

```
F     148.75 +
             -
             -
             -
             -
             -
T     170.00 +                                  *     *
```

Geometry and Boundary Conditions

Problem: Typical Levee @ Control Structures - 10 foot - 4H on 1V - SSS - FS Min = 1.52



result.out
** PCSTABL6 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:
Time of Run:
Run By:
Input Data Filename: run.in
Output Filename: result.out
Unit: ENGLISH
Plotted Output Filename: result.plt

PROBLEM DESCRIPTION Typical Levee @ Control Structures - 10 foot - 4H on 1V - SSS

BOUNDARY COORDINATES

5 Top Boundaries
7 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	80.00	50.00	80.00	2
2	50.00	80.00	90.00	90.00	1
3	90.00	90.00	100.00	90.00	1
4	100.00	90.00	140.00	80.00	1
5	140.00	80.00	170.00	80.00	2
6	50.00	80.00	140.00	80.00	2
7	0.00	70.00	170.00	70.00	3

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	0.0	26.0	0.00	0.0	1
2	105.0	110.0	0.0	28.0	0.00	0.0	1
3	115.0	120.0	0.0	32.0	0.00	0.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	80.00
2	50.00	80.00
3	54.00	81.00
4	116.00	86.00
5	170.00	86.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 30.00 ft.
and X = 55.00 ft.

Each Surface Terminates Between X = 65.00 ft.
and X = 100.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

3.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By Spencer`s Method * *

Number of convergent trials 100
Number of non convergent trials 0

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	46.67	80.00
2	49.44	78.85
3	52.38	78.26
4	55.38	78.25
5	58.32	78.83
6	61.10	79.96
7	63.60	81.62
8	65.73	83.73
9	65.89	83.97

Circle Center At X = 53.9 ; Y = 93.5 and Radius, 15.3

*** Factor of Safety = 1.520 ***

Individual data on the 12 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	2.8	175.6	0.0	107.9	0.0	0.0	0.0	0.0	0.0
2	0.6	74.9	0.0	43.3	0.0	0.0	0.0	0.0	0.0
3	2.4	474.3	0.0	264.7	0.0	0.0	0.0	0.0	0.0
4	1.6	459.6	0.0	249.8	0.0	0.0	0.0	0.0	0.0
5	1.4	450.1	0.0	240.4	0.0	0.0	0.0	0.0	0.0
6	2.9	1046.4	0.0	502.5	0.0	0.0	0.0	0.0	0.0
7	2.8	946.2	0.0	385.5	0.0	0.0	0.0	0.0	0.0
8	0.1	17.3	0.0	6.5	0.0	0.0	0.0	0.0	0.0
9	2.4	625.0	0.0	157.9	0.0	0.0	0.0	0.0	0.0
10	0.2	31.9	0.0	1.1	0.0	0.0	0.0	0.0	0.0
11	2.0	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.2	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.44	80.00
2	52.42	79.63
3	55.42	79.55
4	58.41	79.76
5	61.37	80.25
6	64.27	81.02
7	67.09	82.06
8	69.79	83.37
9	72.35	84.93
10	73.68	85.92

Circle Center At X = 54.8 ; Y = 110.8 and Radius, 31.2

*** Factor of Safety = 1.600 ***

1

result.out

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	80.00
2	49.59	79.34
3	52.56	78.91
4	55.56	78.74
5	58.56	78.81
6	61.54	79.13
7	64.49	79.69
8	67.38	80.50
9	70.19	81.54
10	72.91	82.81
11	75.51	84.30
12	77.99	85.99
13	79.76	87.44

Circle Center At X = 56.2 ; Y = 115.1 and Radius, 36.4

*** Factor of Safety = 1.608 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	43.89	80.00
2	46.49	78.51
3	49.27	77.39
4	52.18	76.65
5	55.17	76.33
6	58.16	76.41
7	61.12	76.90
8	63.99	77.79
9	66.71	79.06
10	69.22	80.70
11	71.49	82.66
12	73.47	84.91
13	74.24	86.06

Circle Center At X = 56.1 ; Y = 98.2 and Radius, 21.9

*** Factor of Safety = 1.665 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	43.89	80.00
2	46.86	79.56
3	49.84	79.27
4	52.84	79.14
5	55.84	79.15
6	58.84	79.32
7	61.82	79.64
8	64.78	80.10
9	67.72	80.72
10	70.62	81.49
11	73.48	82.40
12	76.28	83.45
13	79.04	84.65
14	81.72	85.98
15	84.34	87.45
16	86.88	89.05
17	87.25	89.31

Circle Center At X = 54.0 ; Y = 138.4 and Radius, 59.3

*** Factor of Safety = 1.685 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.44	80.00
2	52.03	78.48
3	54.94	77.76
4	57.94	77.90
5	60.77	78.89
6	63.20	80.66
7	65.02	83.04
8	65.32	83.83

Circle Center At X = 55.9 ; Y = 88.0 and Radius, 10.3

*** Factor of Safety = 1.691 ***

1

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.44	80.00
2	52.39	79.44
3	55.37	79.06
4	58.36	78.88
5	61.36	78.88
6	64.36	79.08

7	67.33	79.46
8	70.28	80.03
9	73.18	80.78
10	76.03	81.72
11	78.82	82.83
12	81.53	84.12
13	84.15	85.57
14	86.68	87.19
15	89.09	88.97
16	90.33	90.00

Circle Center At X = 59.8 ; Y = 126.2 and Radius, 47.4

*** Factor of Safety = 1.699 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.56	80.00
2	38.33	78.85
3	41.16	77.87
4	44.05	77.07
5	46.99	76.44
6	49.95	76.00
7	52.94	75.74
8	55.94	75.66
9	58.94	75.77
10	61.93	76.06
11	64.89	76.53
12	67.82	77.18
13	70.70	78.01
14	73.53	79.02
15	76.29	80.19
16	78.97	81.54
17	81.56	83.04
18	84.06	84.70
19	86.46	86.51
20	88.73	88.46
21	90.31	90.00

Circle Center At X = 55.7 ; Y = 124.6 and Radius, 49.0

*** Factor of Safety = 1.710 ***

1

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	80.00

2	49.64	79.62
3	52.63	79.38
4	55.63	79.28
5	58.63	79.33
6	61.63	79.52
7	64.61	79.86
8	67.57	80.33
9	70.50	80.95
10	73.41	81.71
11	76.27	82.60
12	79.09	83.63
13	81.85	84.80
14	84.56	86.09
15	87.20	87.52
16	89.77	89.06
17	91.17	90.00

Circle Center At X = 56.1 ; Y = 142.0 and Radius, 62.8

*** Factor of Safety = 1.716 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	46.67	80.00
2	49.57	79.25
3	52.52	78.68
4	55.49	78.27
5	58.48	78.04
6	61.48	77.98
7	64.48	78.10
8	67.46	78.39
9	70.43	78.85
10	73.36	79.48
11	76.25	80.28
12	79.09	81.25
13	81.87	82.38
14	84.58	83.66
15	87.21	85.11
16	89.75	86.70
17	92.20	88.44
18	94.15	90.00

Circle Center At X = 61.0 ; Y = 129.7 and Radius, 51.7

*** Factor of Safety = 1.719 ***

1

Y A X I S F T

0.00 21.25 42.50 63.75 85.00 106.25

result.out

```
X       0.00 +---------+---------+---------+--*----*-+---------+
             -
             -
             -
             -
             -
      21.25 +
             -
             -                                      .
             -                                     ..
             -                                  ...8
             -                                 ...8.
A     42.50 +                                  ..884
             -                                ...841
             -                                ...41*
             -                                ...41w
             -                                ...412
             -                               ....431.
X     63.75 +                               ....8416
             -                               ....84311
             -                                ....8322
             -                                ....8732.
             -                                .....853.
             -                                 .....853
I     85.00 +                                  ....075.
             -                                  ....09*
             -                                   .....7
             -                                    ....0
             -                                       .*
             -
S    106.25 +
             -
             -
             -                                        W
             -
             -
     127.50 +
             -
             -
             -
             -                                      *
             -
F    148.75 +
             -
             -
             -
             -
             -
T    170.00 +                                *    * W
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Stanley Consultants INC.

Project No. 5245.04.00 Page No.

Subject Fox River HREP

Riprap Stone Protection Sizing

Computed by WEH Date 1/9/04

Checked by JAW Date 3/18/04

Approved by Date

Sheet No. 1 of

OBJECTIVE: Determine required size of riprap for shoreline protection downstream of gate structure and for protection of Fox River Banks.

METHOD: Use Hydraulic design criteria sheet 712-1, STONE STABILITY DENSITY US STONE RIVER

The flow velocity immediately downstream of the pumped gates will be about 7.5 feet per second (fps). As the water travels downstream the velocity is reduced to about 0.5 fps.

The 100-year velocity in the channel is 7.3 fps

Design riprap for 7.5 fps and the turbulent flow conditions (conservative for turbulence)

Using the design chart from sheet 712-1 (attached) unit weight of stone = 165 pcf (assumed)

$D_{50} = 0.71' \approx 9'' \approx$ 9 inches (see attached chart)

$W_{100} \geq (2)(W_{50}) \geq 110$ lbs $\approx 12''$ (Ref sheet 712-1)

$W_{100} \leq (5)(W_{50}) \leq 19''$ (Ref sheet 712-1)

The $W_{100} \geq 2(D_{50}) \geq 18'$ and $\geq 1.5\ D_{100} \geq 18$

SC 3004R4 898

Stanley Consultants INC.

Project No. Page No.

Subject

Computed by Date

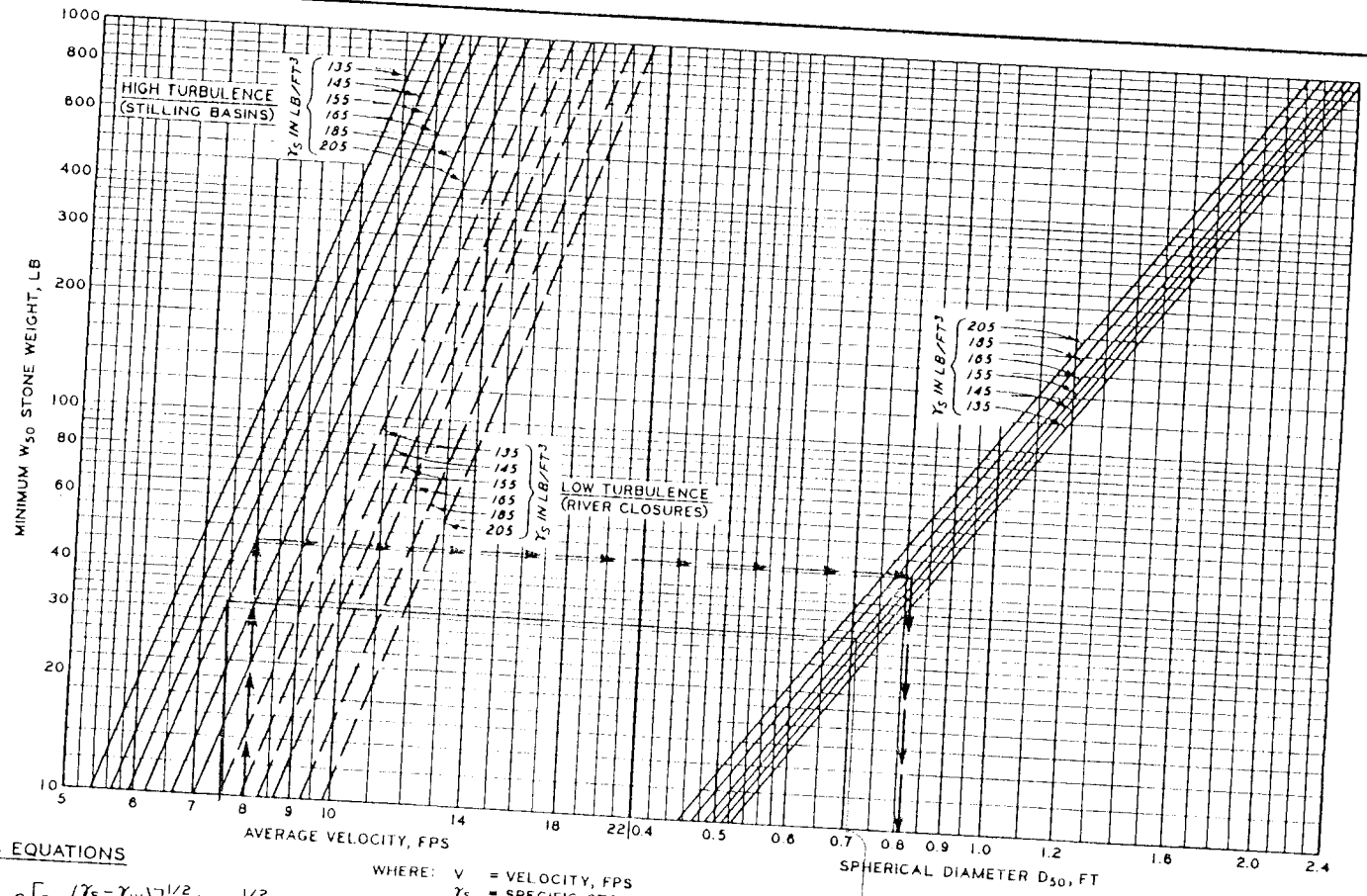
Checked by Date

Approved by Date Sheet No. 2 of

USE: D_{50} = 9"

D_{100} = 12"

T = 18"



BASIC EQUATIONS

$$V = C\left[2g\left(\frac{\gamma_S - \gamma_W}{\gamma_W}\right)\right]^{1/2}\left(D_{50}\right)^{1/2}$$

$$D_{50} = \left(\frac{6W_{50}}{\pi\gamma_S}\right)^{1/3}$$

WHERE:
- V = VELOCITY, FPS
- γ_S = SPECIFIC STONE WEIGHT, LB/FT³
- γ_W = SPECIFIC WEIGHT OF WATER, 62.5 LB/FT³
- W_{50} = WEIGHT OF STONE. SUBSCRIPT DENOTES PERCENT OF TOTAL WEIGHT OF MATERIAL CONTAINING STONE OF LESS WEIGHT.
- D_{50} = SPHERICAL DIAMETER OF STONE HAVING THE SAME WEIGHT AS W_{50}
- C = ISBASH CONSTANT (0.86 FOR HIGH TURBULENCE LEVEL FLOW AND 1.20 FOR LOW TURBULENCE LEVEL FLOW)
- g = ACCELERATION OF GRAVITY, FT/SEC²

D71

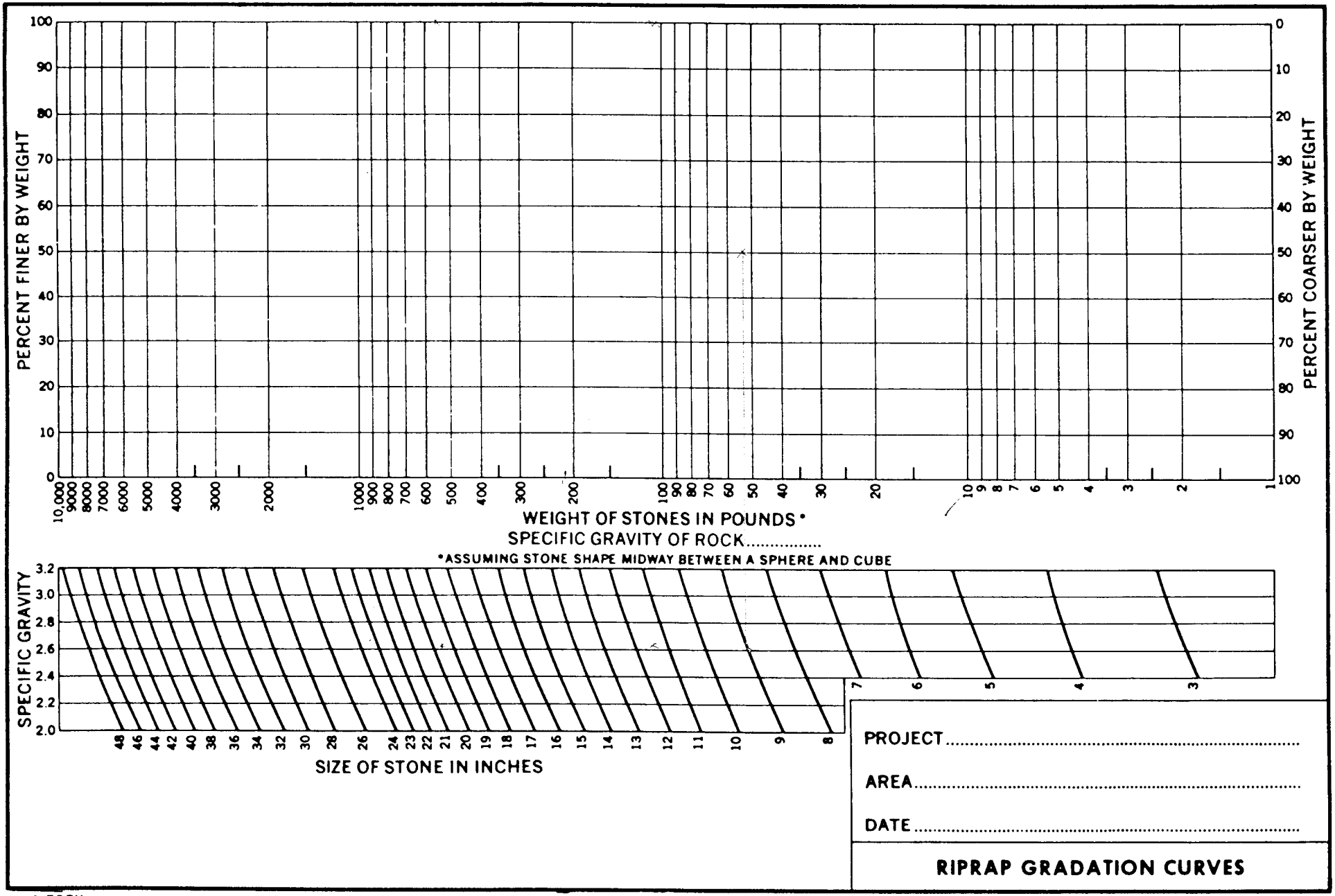
STONE STABILITY
VELOCITY VS STONE DIAMETER

HYDRAULIC DESIGN CHART 712-1
(SHEET 1 OF 2)

REV 8-58, 9-70

WES 6-57

PREPARED BY U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION, VICKSBURG, MISSISSIPPI



PROJECT.....

AREA.....

DATE.....

RIPRAP GRADATION CURVES

ENG FORM 4055
APR 67

SEDIMENTATION

APPENDIX I

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX I
SEDIMENTATION

1. INTRODUCTION

Sedimentation impacts the Fox Island Division by filling lowland areas and thus depleting their capacity for holding water. This results in diminished aquatic habitat, reduction in surface area of wetlands, and reduced capability to withstand dry spells.

There are two sources for the sediment loads reaching low-lying areas:

1. Erosion of uplands within the Fox Island Division itself, and
2. Sediment-laden floodwater from the Mississippi and Fox Rivers.

To estimate the rate of sedimentation, two approaches were taken:

1. Compare the topographic data from the 1934 plane table survey with the 1995 aerial topography. This comparison was more qualitative than quantitative, comparing the elevations of the lowest areas. The accretion has been varied, and the data is less accurate or not available for areas that had standing water during either of the surveys. No transect or hydrographic survey data are available.
2. Estimate the sediment load that is available from the two rivers. This analysis considers the frequency of inundation, the sediment load during a flood, and the percent of that load that will be deposited over the Fox Island Division.

2. COMPARISON OF 1934 AND 1998 SURVEYS

Spot elevations and contours on the plane table maps from the 1930s have been compared to elevation data developed by the Corps of Engineers in 1998. This comparison provides general information on erosion and accretion on the Fox Island Division over this period of record but it is difficult to determine sedimentation rates. Generally, flooding has had a “leveling” effect on the Fox Island Division. Mounds and low knolls identified in the 1930’s have been scoured away and depressions have filled in with sediment. The data varies considerably, Coin Pond and Old Lake show accretion of 1.5 to 2.5 feet around the edges (no hydrographic data were obtained), while Slim Slough and many of the channels on the Fox Island Division have retained a stable invert. The significant water features, Coin Pond, Slim Slough, Old Lake, Logsdon Slough and Nelson Lake have all suffered significant accretion in the period that the USFWS has been monitoring them. Nelson Lake, once a popular fishing site, has become too shallow to sustain fish over winter. The other ponds and sloughs are so shallow that they are mostly dry in the summer and fall.

3. RIVER-BORNE SEDIMENT

The Mississippi River and Grey Chute border the Fox Island Division on the east while the Fox River forms the west boundary for 75 percent of the Fox Island Division. Under normal conditions, when the rivers are within their banks, surface waters within the refuge remain isolated from the rivers and their sediment loads. However, the Fox Island Division experiences frequent flooding and sediments from both rivers are deposited throughout the refuge during each of these events

Mississippi River flooding is an increasingly common occurrence on the Fox Island Division. The seven highest Mississippi River flood elevations on record have all occurred since 1944. The three highest have occurred since 1965. A railroad berm along the east side of the Fox Island Division protects against direct inundation from the Mississippi up to elevation 491, but high water backs up the Fox River and overtops the banks to enter the refuge when it gets above 490. By comparison, most of the land within the Fox Island Division lies between elevation 485 and 490. The railroad berm is topped with as small as a 3-year flood. During the flood of 1993, the Mississippi River at Fox Island Division was above elevation 491 for 135 days.

The flow frequency information on the Fox River is based on the USGS gage at Wayland, Missouri. The gage has a drainage area of 400.0 square miles. The total drainage area of the Fox River basin is 502.0 square miles. The frequency analysis utilized the U.S. Army Corps of Engineers Hydrologic Engineering Center's Flood Frequency Analysis (FFA) program, which is based on the U.S. Geological Survey (USGS) Bulletin 17B, Guidelines for Determining Flood Flow Frequency. The peak stream flow values used in the FFA program come from an 80-year period of record, from 1922 to 2001. These values were entered as flow rates in a HEC-RAS backwater analysis. The 490-foot elevation of the top of bank along the Fox River was compared with the hydraulic analysis to determine the frequency of overtopping. From the water surface profiles it was determined that the Fox River will overflow its banks, spilling into the Fox Island Division about every 2 years. This inflow would be distributed by the natural swales within the Fox Island Division to Coin Pond, Slim Slough, and Old Lake.

Floodwaters contain higher concentrations of suspended solids than base flows, and these solids tend to settle out in the relatively acquiescent ponds and sloughs. No sedimentation or bathymetric measurements have been taken on the Fox Island Division. Sediment data are not collected on the Fox River but there are data for the nearby Fabius River. The average sediment load for the Fabius River is 300 mg/L. The Mississippi River at Canton averages 266 mg/L daily values over the 33-year period of record. The third quartile concentration, roughly corresponding to the concentration during a flood flow, is 300 mg/L. Using an average concentration of 300 mg/L, an inundation frequency of one event per year, and a sediment trap efficiency of 100% for the volume of water contained below elevation 484, 0% for water above 484 (that is the concentration of sediment leaving the Fox Island Division when the flood recedes is the same as the concentration entering the Fox Island Division), the volume of sediment deposited each year from the Mississippi and Fox Rivers would be about 3600 cubic feet. If this sediment finds its way to the lowest elevations (below elevation 481) it would accrete at a rate of about 2/3 inch per year or one foot every 18 years. The rate of accretion slows as the low areas fill and the sediment spreads over a wider area.

HYDROLOGY AND HYDRAULICS

APPENDIX J

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX J
HYDROLOGY AND HYDRAULICS

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ATTACHMENTS

Attachment 1 FLOOD FREQUENCY ANALYSIS (FFA)
Attachment 2 HEC-RAS Input
Attachment 3 HEC-RAS Output

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APPENDIX J
HYDROLOGY AND HYDRAULICS

1. INTRODUCTION AND LOCATION OF SITE

Fox Island Division is located on the Missouri side of the Mississippi River between River Miles (RM) 353.6 and 358.5. It is 4 miles upstream of Gregory Landing, Missouri, which is the site of the nearest stage gage to the project. Fox Island Division consists of agricultural land, bottomland forest, and inland lakes and sloughs.

This appendix presents a hydraulic analysis of the area and summarizes the hydrologic and hydraulic evaluation of the Fox and Mississippi Rivers. This analysis was completed to determine the frequency that the rivers could be expected to inundate the proposed Habitat Rehabilitation and Enhancement Project (HREP).

Mississippi River stage data for the Fox Island Division was interpolated from the tailwater gage at Lock and Dam 19 and the gage at Gregory Landing. The U. S. Geological Survey's (USGS) Upper Midwest Environmental Science Center (UMESC) in La Crosse, Wisconsin provided Mississippi River flood frequency and flood duration statistics for the reach along the Fox Island Division.

Analysis of up-to-date flow frequency information from the USGS gage at Wayland, Missouri with the U. S. Army Corps of Engineer's (USACE) Flood Frequency Analysis (FFA) program produced flow values at discrete return periods for the Fox River. Following the production of flow frequency results, a backwater hydraulic analysis of the Fox River occurred using the HEC-RAS model, updated from the old HEC-2 model.

2. CLIMATE

Temperature and precipitation data used for this site were recorded over a 30-year period at Alexandria, Missouri.

The climate of this area is typical of the Midwestern United States, with warm, wet summers and cold, dry winters. The maximum average temperature of 87 degrees Fahrenheit occurs in July, while the minimum average temperature of 15 degrees Fahrenheit occurs in January. The average annual precipitation is 37.3 inches. Monthly mean values appear in table J-1.

Table J-1. Temperature and Precipitation at Alexandria, MO (30-Year Period of Record)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average High	32°	38°	50°	62°	73°	82°	87°	85°	77°	66°	50°	37°
Average Low	15°	20°	30°	42°	52°	62°	67°	65°	56°	45°	33°	21°
Mean	24°	29°	40°	52°	63°	72°	77°	75°	67°	56°	41°	29°
Average	1.29”	1.42”	2.65”	3.51”	5.38”	3.92”	3.99”	3.20”	3.94”	3.04”	2.98”	1.99”

Source: www.weather.com

3. MISSISSIPPI RIVER

The closest Mississippi River gages to Fox Island Division are the gage at Gregory Landing and the tailwater gage at Lock and Dam No 19. The Gregory Landing gage is downstream at RM 352.9. Lock and Dam 19 is upstream at 364.2. Plates J1 through J7 show the past 20 years of stage hydrography at Fox Island Division as it was interpolated between the two gaging stations. Table J-2 is a tabulation of the percentage chance of flooding per year at Upper Mississippi RM 357 of the Mississippi River at various elevations and durations. For each duration, percentage estimates may include multiple flooding events within a single year. The tabulated analysis is based on USACE water surface elevation data collected from 1954 through 1998 for the estimated growing season, April 15 to October 15 (USGS UMESC, 2003).

The river, with its 133,600 square mile drainage area (above the Fox Island Division), experiences flood waves that are long and slow. Annual flood events often last a week or more. Much of the flooding from the Mississippi enters the Fox Island Division via backwater on the Fox River, because the railroad levee protects against direct inundation from the Mississippi up to elevation 491. When analyzing the flooding from the two rivers, backwater from the Mississippi is treated as an event on the Mississippi River, even when it spills into the Fox Island Division from the Fox River.

Mississippi River flooding is an increasingly common occurrence on the Fox Island Division. The seven highest Mississippi River flood elevations on record have all occurred since 1944. The three highest have occurred since 1965. Table J-3 shows the frequency and water surface elevation for the Mississippi River at the lower and upper end of the Fox Island Division. By comparison, most of the land within the Fox Island Division lies between elevation 485 and 490. Nearly all of the Fox Island Division lies below elevation 491. A railroad berm along the east side of the Fox Island Division prevents some of the flooding from the Mississippi. The most frequent flooding of the refuge by the Mississippi River occurs by backing up the Fox River. When the Mississippi River stage is at or above elevation 490 at the mouth of the Fox River (RM 357), the Fox River over tops its banks and inundates most of the land between the Fox River and the railroad. This occurs about once every 2 or 3 years.

Table J-2. Annual Percent Chance of Flooding During a Forest Growing Season
Mississippi River Pool 20 – River Mile 357

	Duration					
Elevation (MSL)	**3 days**	**1 week**	**2 weeks**	**4 weeks**	**6 weeks**	**8 weeks**
504	2	2	0	0	0	0
503	2	2	2	0	0	0
502	2	2	2	0	0	0
501	2	2	2	0	0	0
500	2	2	2	0	0	0
499	2	2	2	0	0	0
498	4	2	2	2	0	0
497	4	2	2	2	0	0
496	7	7	2	2	2	0
495	7	7	4	2	2	0
494	9	9	7	2	2	2
493	16	9	7	4	2	2
492	24	18	9	7	2	2
491	36	27	18	9	2	2
490	42	36	27	13	4	2
489	51	47	40	16	7	4
488	58	56	42	31	11	4
487	62	58	56	38	27	16
486	71	62	58	47	33	29
485	80	73	64	51	42	29
484	82	82	73	62	49	40
483	87	84	84	69	64	49
482	100	93	91	82	71	67
481	100	100	98	98	91	80
480	100	100	100	100	100	100

Source: http://www.umesc.usgs.gov/data_library/water_elevation/flood_potential.html

Table J-3. Mississippi River Flood Levels/Frequencies

	Water Surface Elevation (MSL)			
	Normal Pool	**50-Year**	**100-Year**	**500-Year**
South End Division (RM 353.6)	481	496	497	500.5
North End Division (RM 358.5)	~482	497.5	499	502

Source: U.S. Army Corps of Engineers (1994)

4. FOX RIVER

A. General. A hydraulic analysis was completed to determine the frequency with which the Fox River could be expected to inundate the proposed HREP. For this analysis, an event on the Fox River Basin was assumed to be independent of an event on the Mississippi River. The Burlington Northern railroad embankment separates the Mississippi River from the project area, so flooding is triggered by either:

1. A flood on the Mississippi River backing up the Fox River and spilling into the refuge in the vicinity of the proposed water control structure. This is where the banks of the Fox River are lowest. A natural waterway, draining most of the refuge, flows into the Fox River at this point. The Mississippi River is draining 133,600 square miles at this point.

2. A local event over the Fox River watershed. The Fox River watershed encompasses about 500 square miles at the Fox Island Division.

B. Fox River Flood Frequency Analysis. This analysis is for the second condition, a local flood on the Fox River. Mississippi River flood frequencies were developed in greater detail by the Upper Midwest Environmental Science Center in La Crosse, Wisconsin and reported in Section 3 of this appendix.

The flow frequency information is based on the USGS gage at Wayland, Missouri. The gage has a drainage area of 400 square miles. The total drainage area of the Fox River basin is 502 square miles. The frequency analysis utilized the USACE Hydrologic Engineering Center's FFA program, which is based on USGS Bulletin 17B, *Guidelines for Determining Flood Flow Frequency*. The peak streamflow values used in the FFA program come from an 80 year period of record, from 1922 to 2001. The FFA analysis is included as Attachment 1 at the end of this appendix. Table J-4 lists the flow values computed by FFA for discrete return periods. These values were entered as flow rates in the HEC-RAS backwater analysis.

Table J-4. Fox River Flood Frequency Analysis Results

Chance Exceedence (%)	Return Period	Computed Curve Flow (cfs)
0.2	500 Year	31,900
0.5	200 Year	27,900
1.0	100 Year	24,900
2.0	50 Year	21,800
5.0	20 Year	17,700
10.0	10 Year	14,500
20.0	5 Year	11,200
50.0	2 Year	6,600
80.0	15 Month	3,640
90.0	58 Week	2,590
95.0	55 Week	1,940
99.0	~1 Year	1,080

Source: Output from USACE Flood Frequency Analysis Program

C. Hydraulic Models. The HEC-2 model of the Fox River was developed by the Rock Island District. The model extends from the mouth of the Fox River upstream to the Highway 136 Bridge near Wayland, Missouri. The length of the HEC-2 model is approximately 15 miles. The Fox River Division is adjacent to the lowest 5 miles of the Fox River starting at its confluence with the Mississippi River. Since the area of interest is located at the downstream end, the length of the model was shortened to approximately 7.5 miles.

The HEC-2 model was converted and run as a HEC-RAS model. The HEC-RAS program has replaced HEC-2 with improved computational routines and additional capabilities for displaying results. The map, Plate J8, indicates the locations of the cross sections utilized in the HEC-RAS model. The HEC-RAS input and output are included at the end of this appendix as Attachments 2 and 3, respectively.

The original model included a bridge at cross section 4.2. That bridge has been removed, so the data for the bridge geometry was deleted from the new model. The Burlington Northern Railroad Bridge, located near the mouth of the Fox River, is not included in the HEC-2 model. This bridge is much higher and wider than the stream and is located at the confluence of the two rivers. It does not affect the hydraulic profile significantly.

The starting water surface elevation on the Fox River is controlled by the Mississippi River water elevation. Since this analysis is based on the assumption that an event on the Fox River is independent of an event on the Mississippi River, the tailwater elevation was set at 480.0 feet. This corresponds to the normal pool elevation of the Mississippi River at the mouth of the Fox River.

The resulting water surface profiles from the HEC-RAS analysis are plotted on Plate J9. The x-axis reflects the main channel distance above the mouth, in feet. The cross section locations are noted immediately above the x-axis.

The area of interest along the Fox River is at cross section number 5.0, 20,460 feet above the confluence, near the location of the proposed water control structure. The elevation of the top of bank in this location was compared with the hydraulic analysis to determine the frequency of overtopping. From the survey information, the elevation of the top of bank at this point is 490 feet. From the water surface profiles it was determined the Fox River will overflow its banks, spilling into the Fox Island Division about every 2 years (50.0 Percent Chance Exceedence).

This inflow would be distributed by the natural swales within the Fox Island Division to Coin Pond, Slim Slough, and other unnamed low areas. Lower-level, more frequent floods could also be captured by keeping the stop log structure open in the spring.

5. REFERENCES

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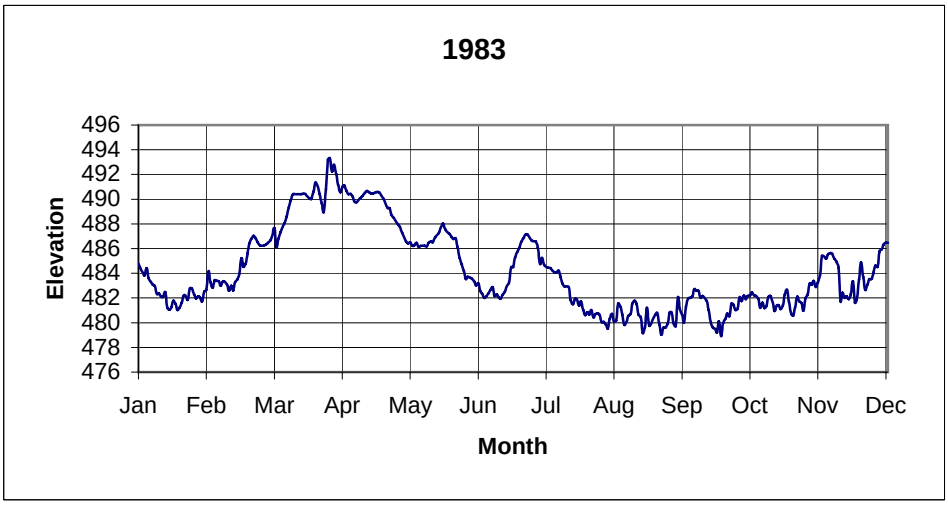
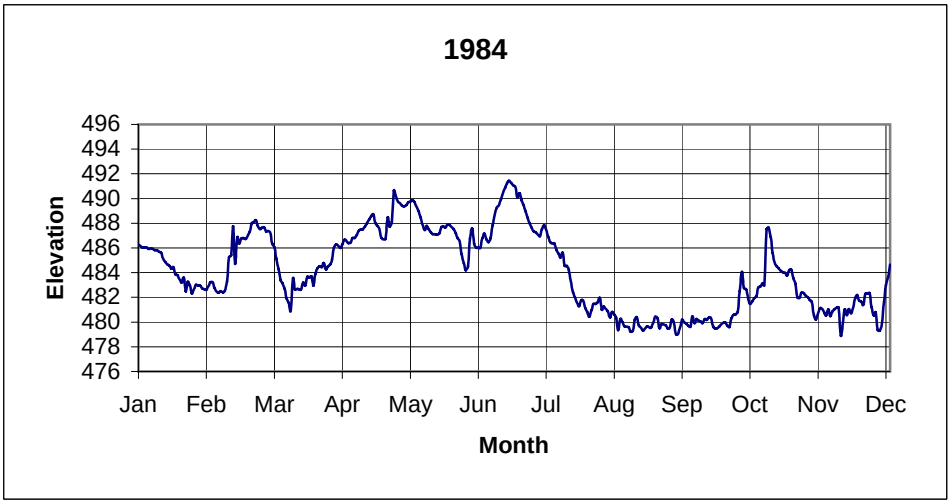
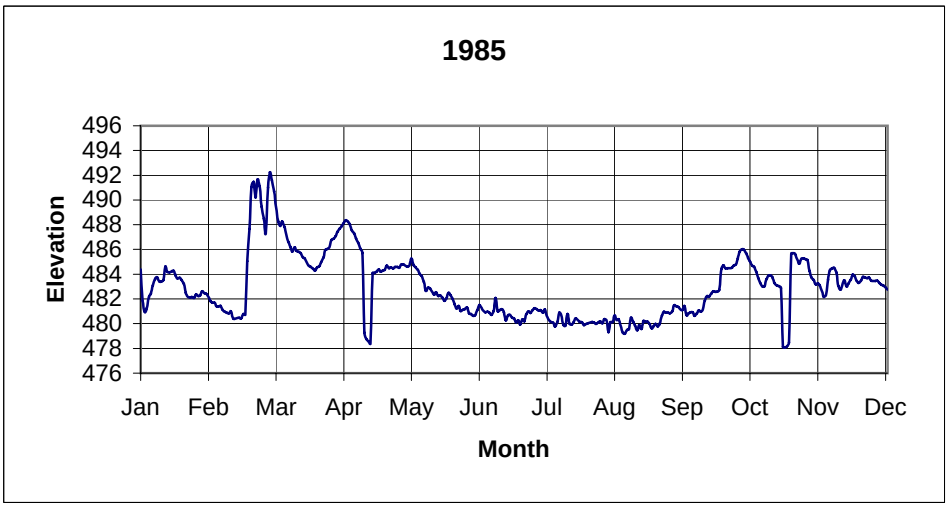
HYDROLOGY AND HYDRAULICS

PLATES

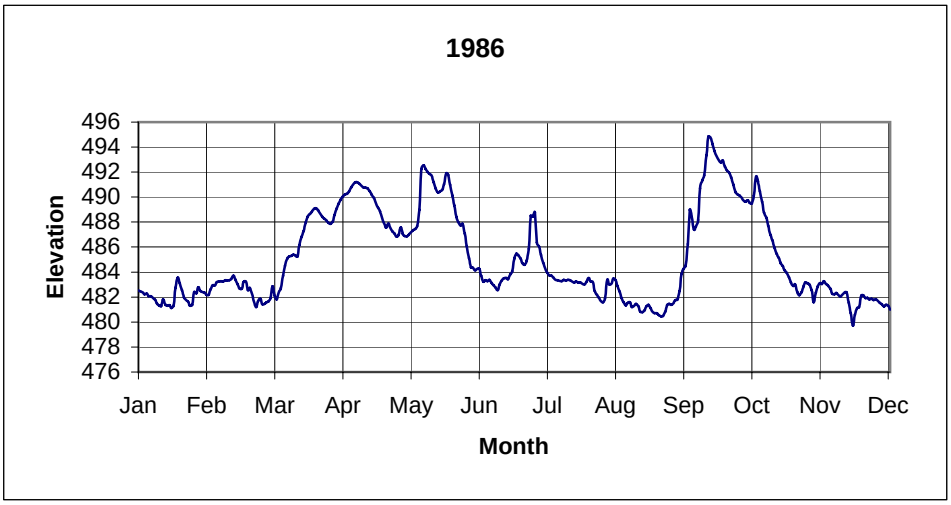
Mississippi River Stage Hydrographs (1983-1985)
River Mile (RM) 357

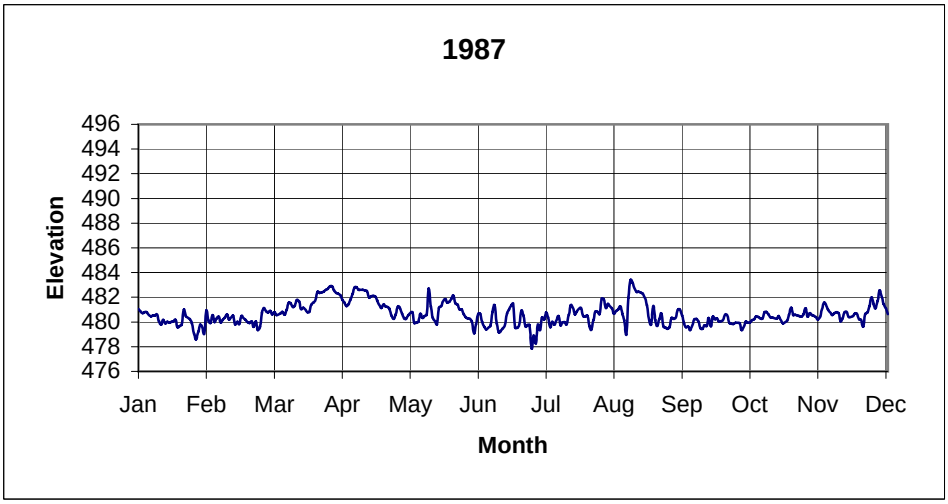


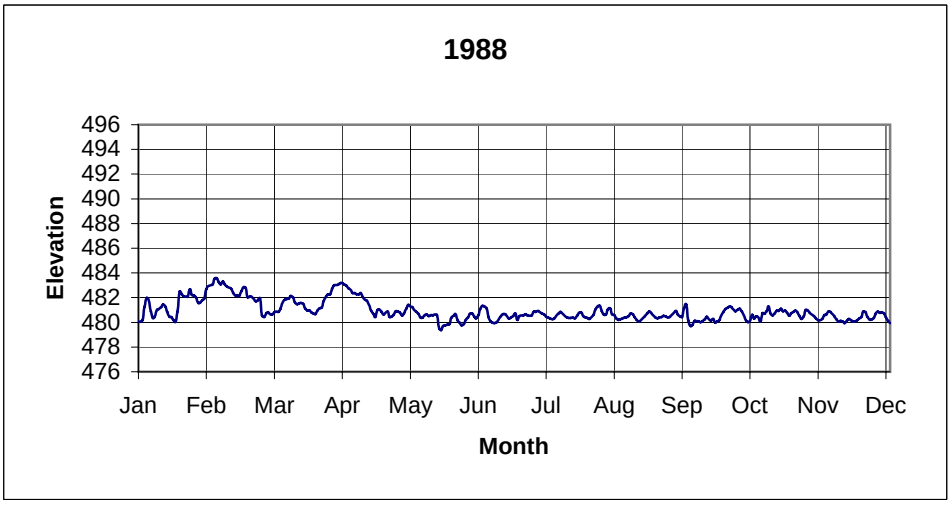




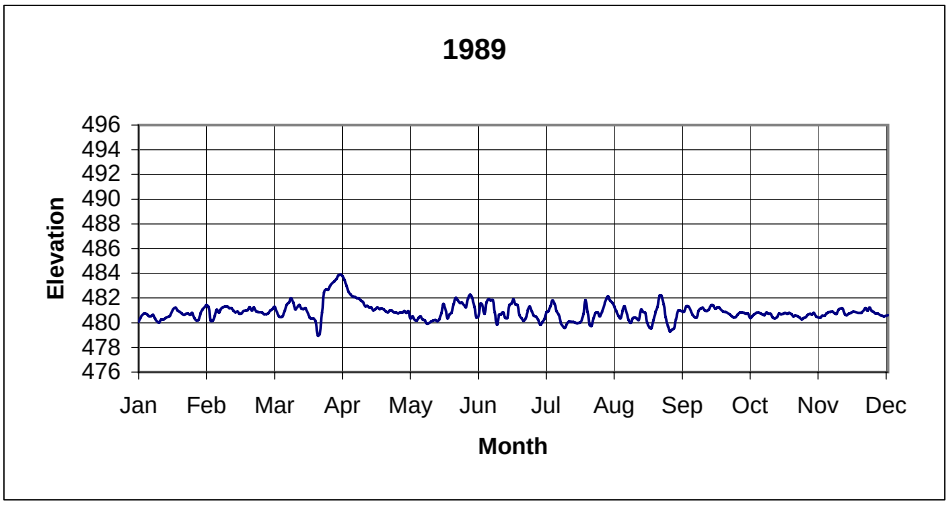
Mississippi River Stage Hydrographs (1986-1988)
River Mile (RM) 357

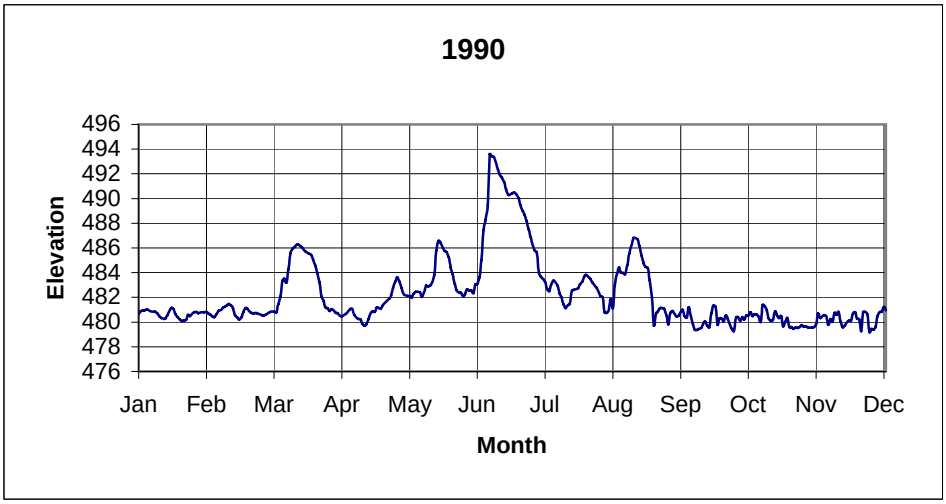


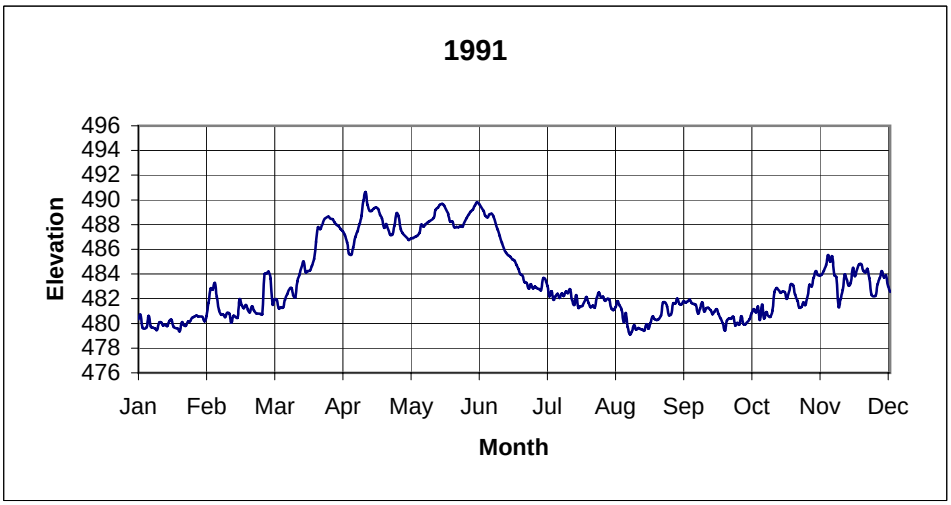




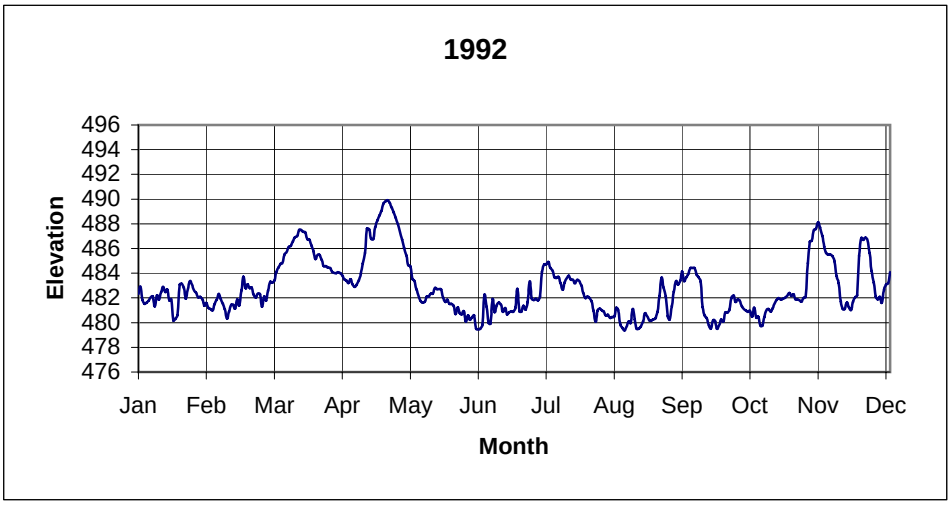
Mississippi River Stage Hydrographs (1989-1991)
River Mile (RM) 357

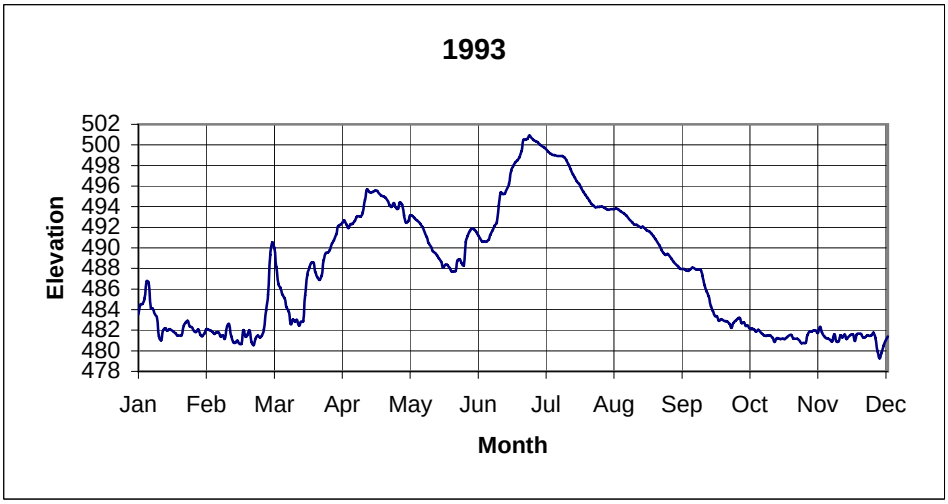


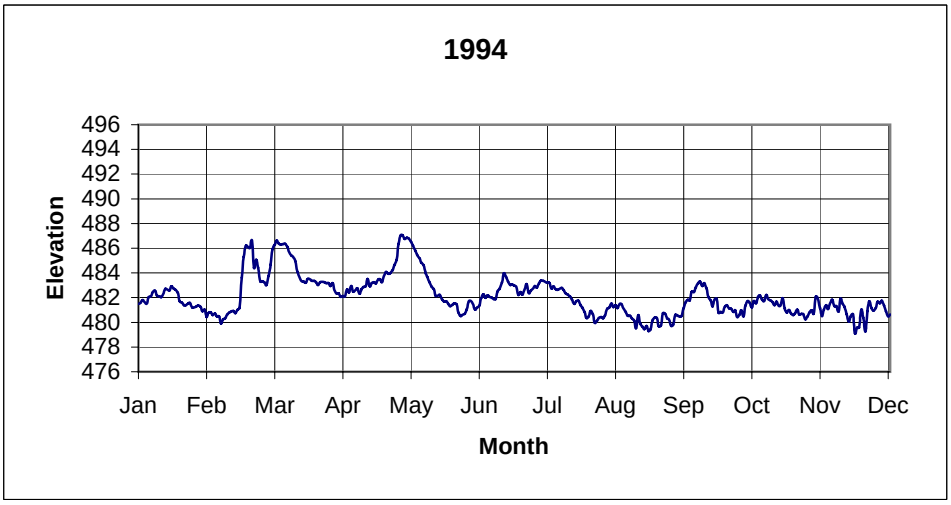




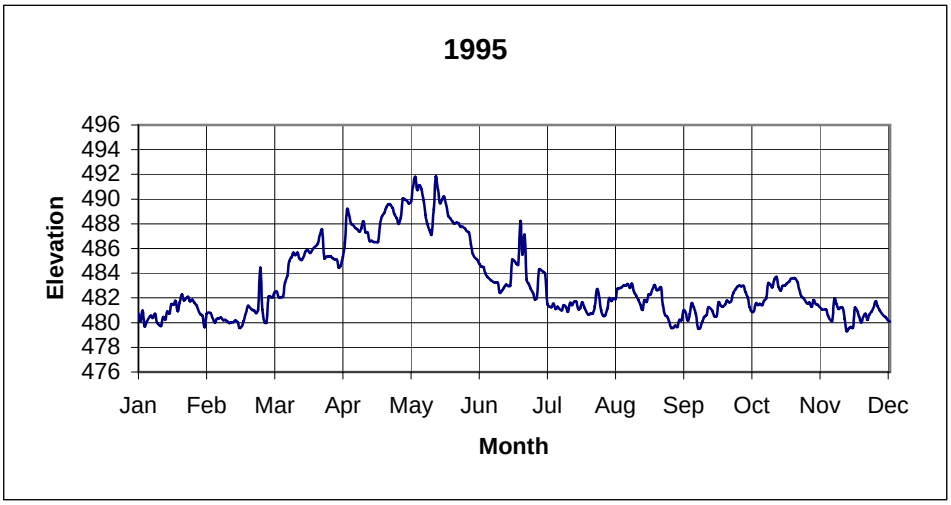
Mississippi River Stage Hydrographs (1992-1994)
River Mile (RM) 357

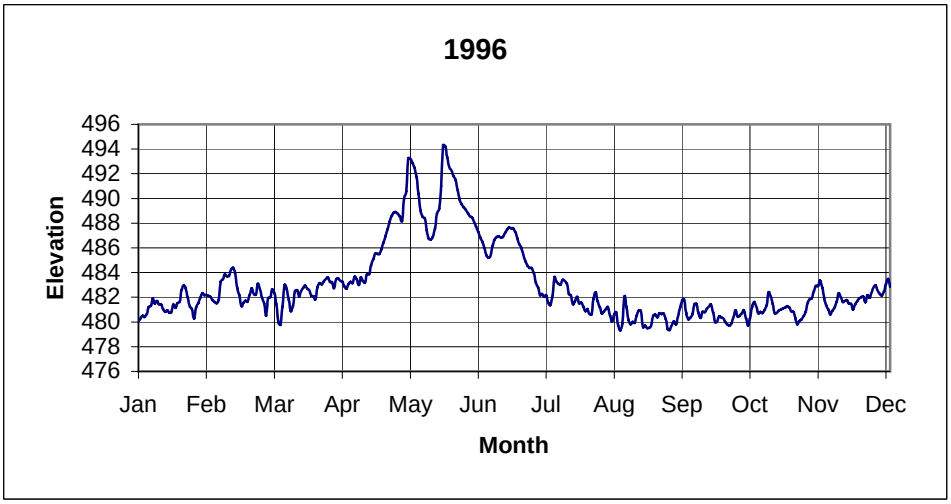


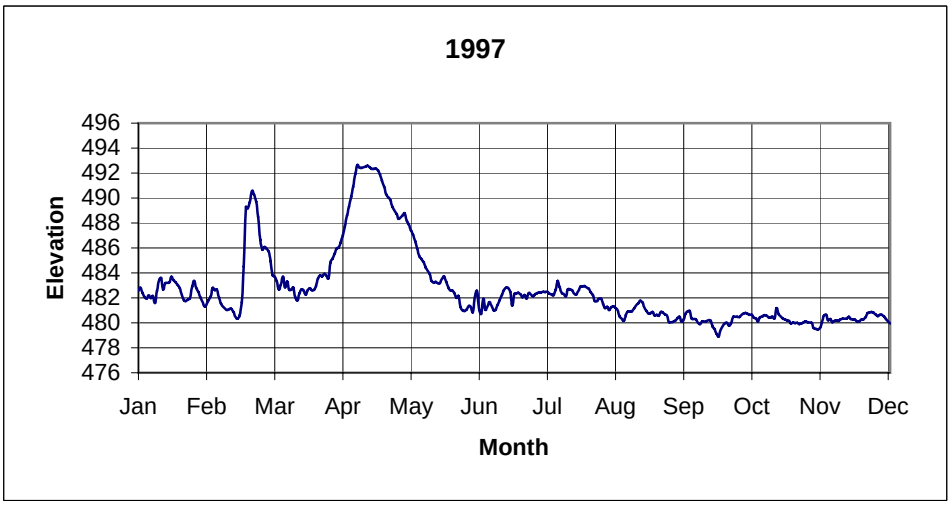




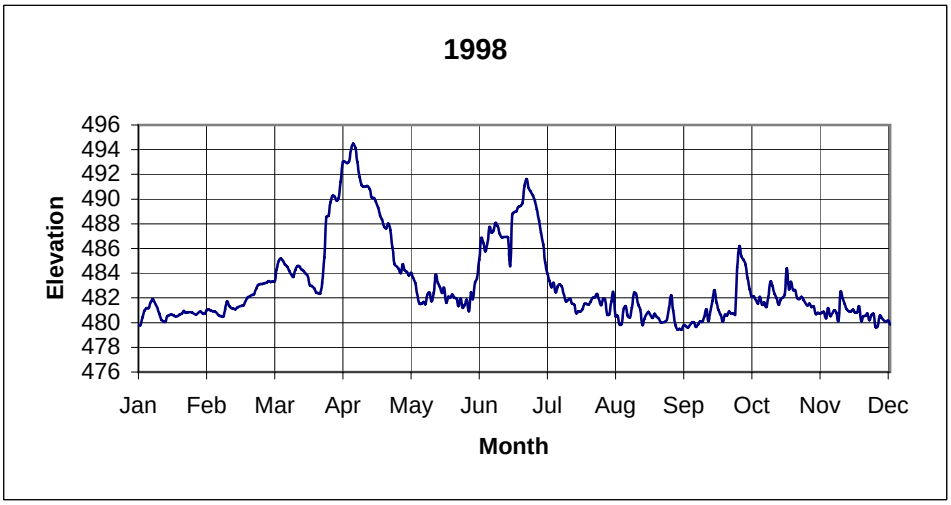
Mississippi River Stage Hydrographs (1995-1997)
River Mile (RM) 357

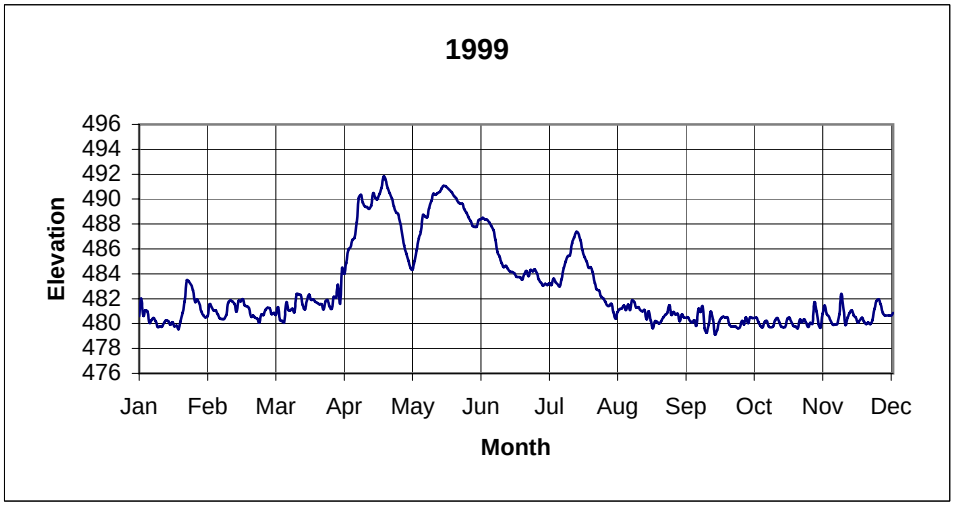


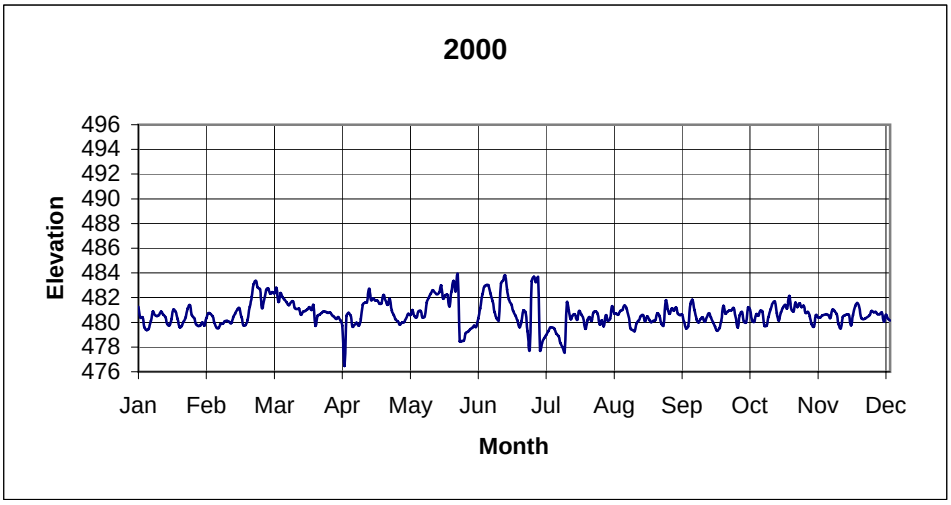




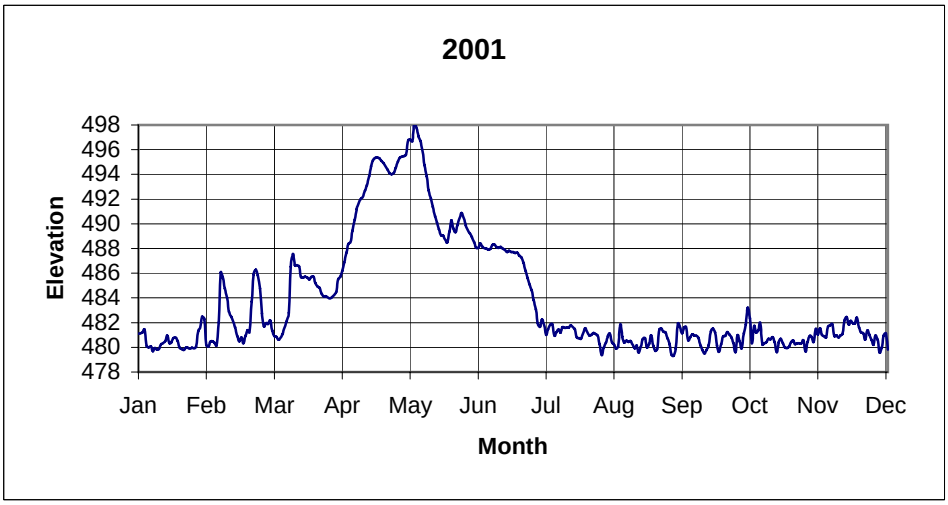
Mississippi River Stage Hydrographs (1998-2000)
River Mile (RM) 357

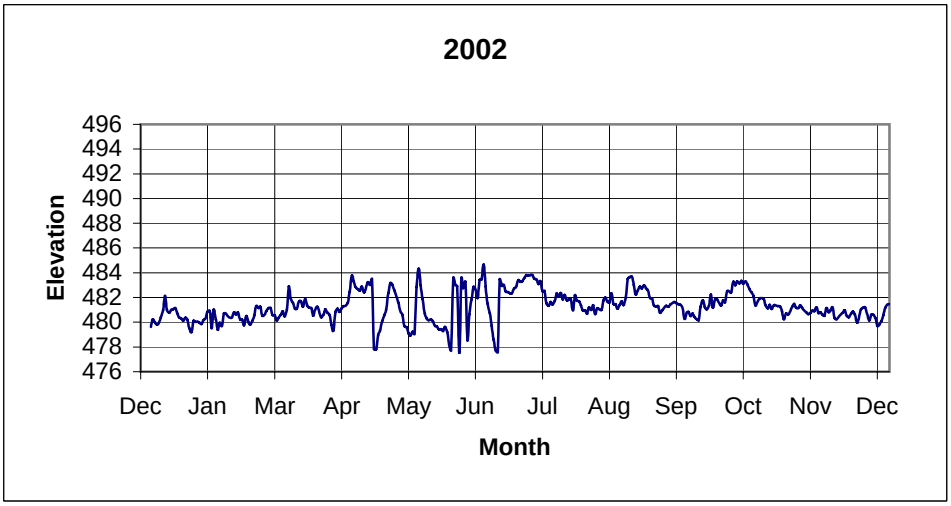


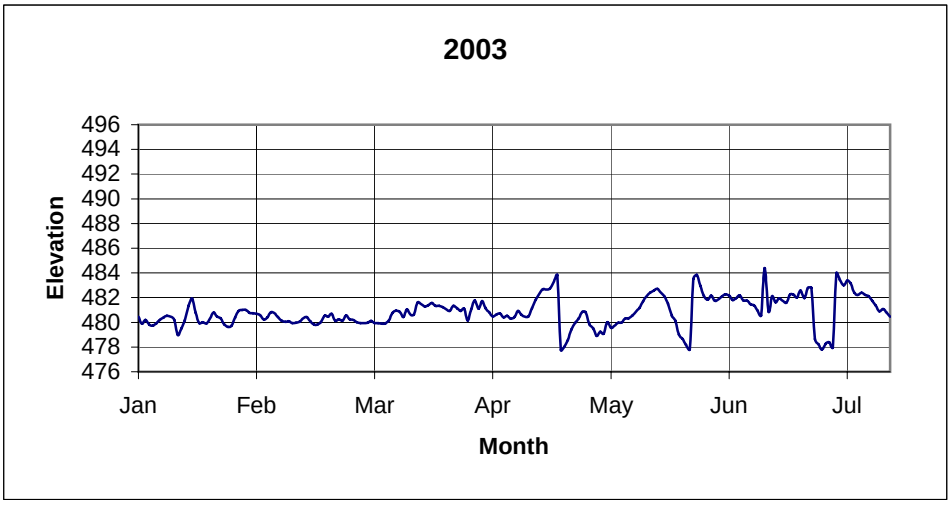


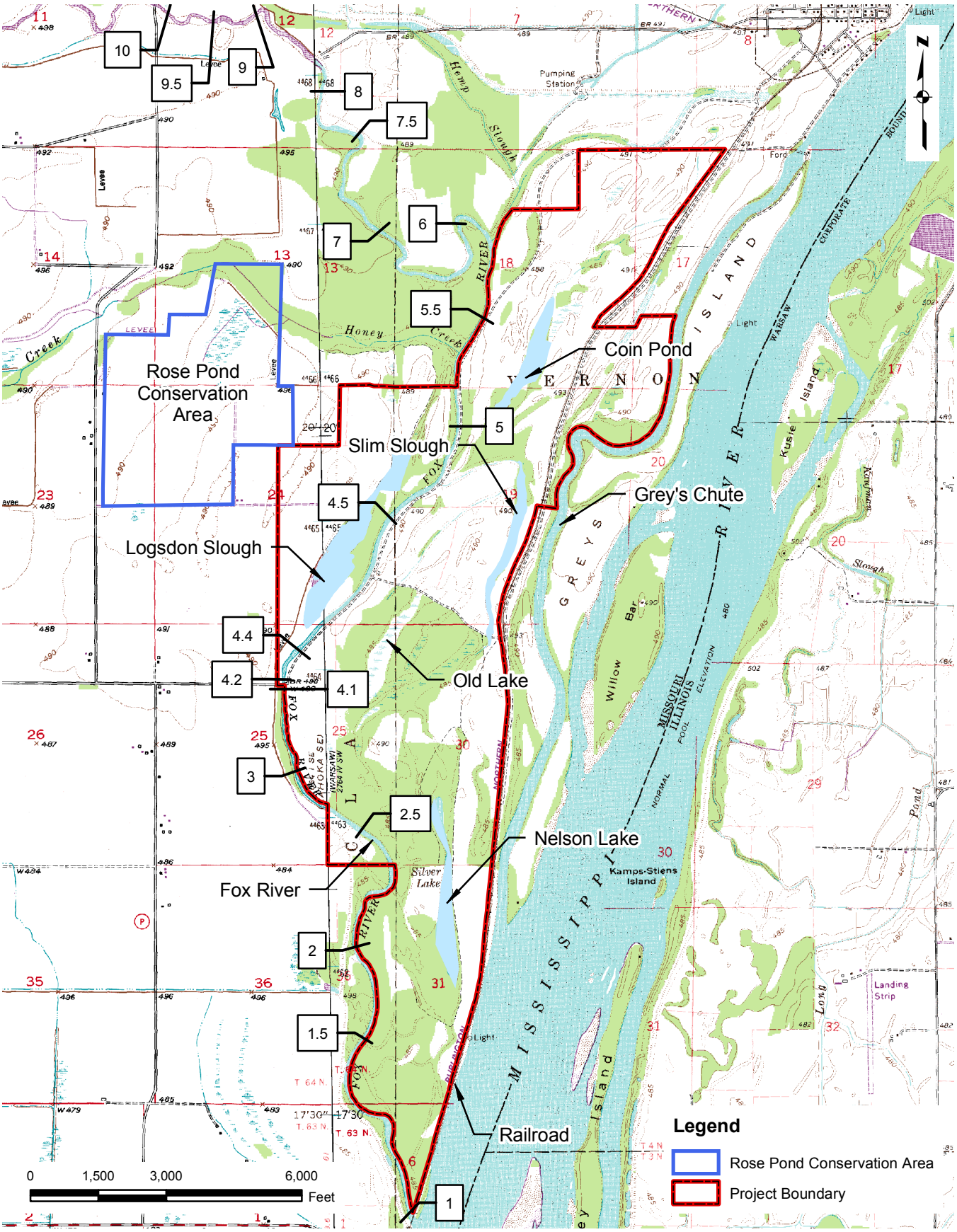


Mississippi River Stage Hydrographs (2001-2003)
River Mile (RM) 357









US Army Corps of Engineers
Rock Island District

HEC-RAS Cross Sections
Plate J8.

Fox River – Water Surface Profiles

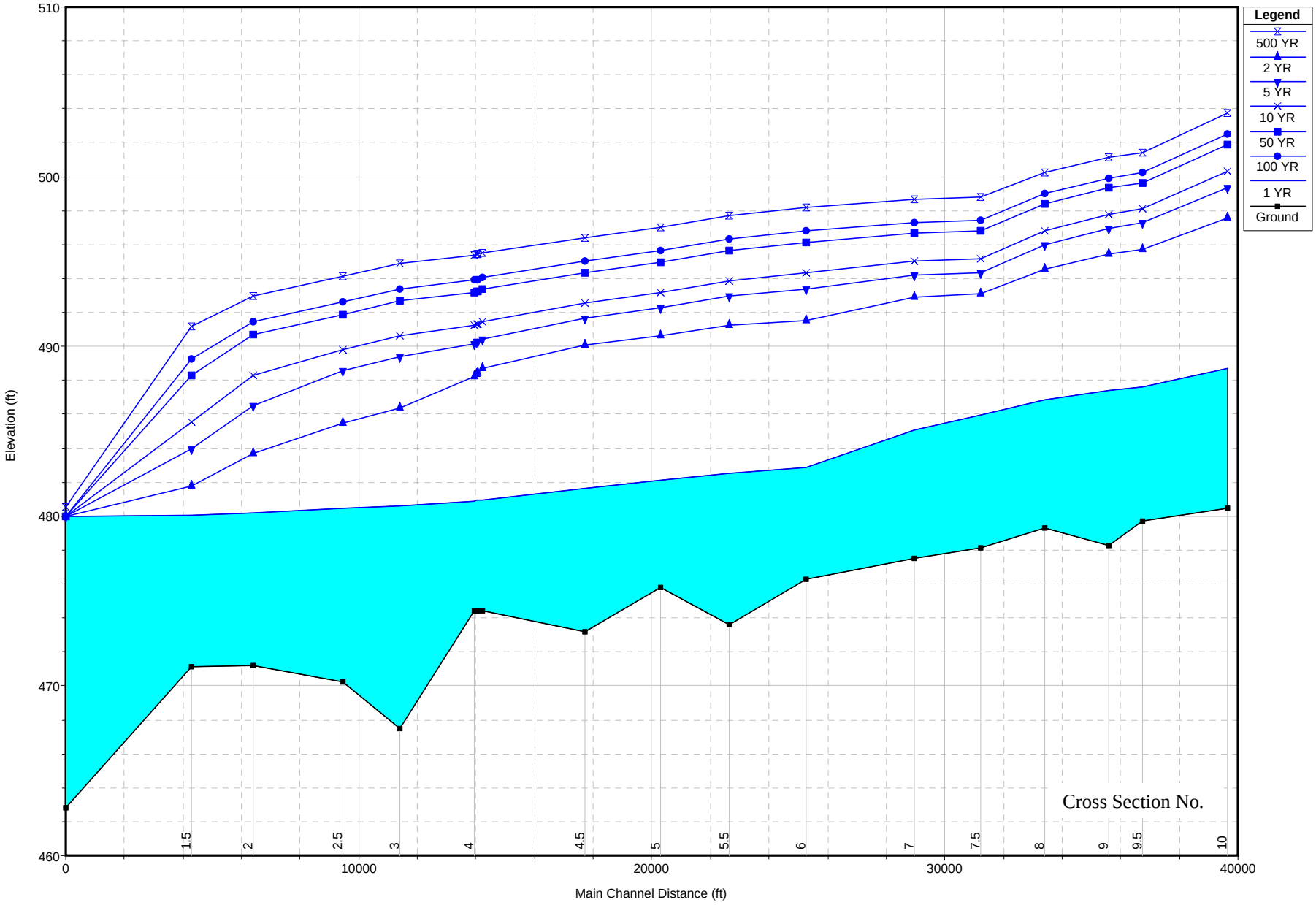


Plate J-9: HEC-RAS Water Surface Profiles

HYDROLOGY AND HYDRAULICS

ATTACHMENTS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX J
HYDROLOGY AND HYDRAULICS

ATTACHMENT 1
FLOOD FREQUENCY ANALYSIS (FFA)

```
*********************************************************************
*              FFA                  *                                *
*     FLOOD FREQUENCY ANALYSIS      *   U.S. ARMY CORPS OF ENGINEERS *
*     PROGRAM DATE:  FEB 1995       * THE HYDROLOGIC ENGINEERING CENTER *
*          VERSION:  3.1            *         609 SECOND STREET      *
*     RUN  DATE   AND   TIME:       *      DAVIS, CALIFORNIA 95616   *
*        13 OCT 02    15:49:53      *          (916) 756-1104        *
*                                   *                                *
*********************************************************************
 INPUT FILE NAME: FOX.DAT
 OUTPUT FILE NAME: FOX.OUT
**TITLE RECORD(S)**
TT   FOX RIVER AT WAYLAND, MISSOURI
TT   DRAINAGE AREA = 502 SQ.MI.
TT   05495000  RIVER MILE = 353.6

**GENERALIZED SKEW**
     ISTN   GGMSE    SKEW
GS           .000    -.20


  FINAL RESULTS    PLOTTING POSITIONS
-----------------------------------------------------------------
º      EVENTS ANALYZED      ³           ORDERED EVENTS          º
º                   FLOW    ³        WATER      FLOW   WEIBULL  º
º MON DAY  YEAR     CFS     ³   RANK  YEAR      CFS    PLOT POS º
-----------------------------------------------------------------¶
º   7  12  1922     2400.   ³     1   1973     26400.     1.23  º
º   3  16  1923     1980.   ³     2   1933     25000.     2.47  º
º   8   6  1924     3250.   ³     3   1946     19900.     3.70  º
º   4  26  1925     3760.   ³     4   1929     16100.     4.94  º
º   9  17  1926     6570.   ³     5   1983     14800.     6.17  º
º   4  20  1927     7300.   ³     6   1980     14700.     7.41  º
º  10   1  1927     8100.   ³     7   1996     14300.     8.64  º
º  11  18  1928    16100.   ³     8   1960     13400.     9.88  º
º   6  16  1930     3460.   ³     9   1976     13400.    11.11  º
º   6   7  1931     9940.   ³    10   1935     13300.    12.35  º
º  11  24  1931     6440.   ³    11   1986     13200.    13.58  º
º   6  29  1933    25000.   ³    12   1970     12800.    14.81  º
º   4   5  1934     1780.   ³    13   1981     12300.    16.05  º
º   6   2  1935    13300.   ³    14   1947     12200.    17.28  º
º   2  26  1936     8060.   ³    15   1948     11900.    18.52  º
º   3   5  1937     3540.   ³    16   1993     11900.    19.75  º
º   4   6  1938     4070.   ³    17   1982     11500.    20.99  º
º   3  13  1939     9260.   ³    18   1985     11500.    22.22  º
º   4  24  1940     1640.   ³    19   1995     11300.    23.46  º
º   6  11  1941     3080.   ³    20   1944     10200.    24.69  º
º  10  11  1941     4510.   ³    21   1979     10200.    25.93  º
º   5  17  1943     5290.   ³    22   1931      9940.    27.16  º
º   4  24  1944    10200.   ³    23   1959      9840.    28.40  º
º   6  17  1945     6810.   ³    24   2001      9800.    29.63  º
º   6  19  1946    19900.   ³    25   1950      9560.    30.86  º
º   6   7  1947    12200.   ³    26   1987      9300.    32.10  º
º   3  20  1948    11900.   ³    27   1939      9260.    33.33  º
º   4   1  1949     3350.   ³    28   1990      9040.    34.57  º
```

º	6	16	1950	9560.	³	29	1978	8820.	35.80	º
º	5	12	1951	5250.	³	30	1928	8100.	37.04	º
º	6	23	1952	6400.	³	31	1936	8060.	38.27	º
º	4	1	1953	7960.	³	32	1992	7980.	39.51	º
º	4	21	1954	4050.	³	33	1953	7960.	40.74	º
º	1	6	1955	6000.	³	34	1927	7300.	41.98	º
º	8	9	1956	1030.	³	35	1998	7270.	43.21	º
º	6	11	1957	6130.	³	36	1945	6810.	44.44	º
º	7	31	1958	4750.	³	37	2000	6800.	45.68	º
º	8	8	1959	9840.	³	38	1926	6570.	46.91	º
º	3	30	1960	13400.	³	39	1962	6480.	48.15	º
º	9	14	1961	4290.	³	40	1932	6440.	49.38	º
º	3	12	1962	6480.	³	41	1994	6410.	50.62	º
º	3	5	1963	5760.	³	42	1952	6400.	51.85	º
º	4	21	1964	6180.	³	43	1984	6370.	53.09	º
º	4	6	1965	5300.	³	44	1964	6180.	54.32	º
º	6	13	1966	2730.	³	45	1957	6130.	55.56	º
º	4	2	1967	5100.	³	46	1955	6000.	56.79	º
º	10	31	1967	3330.	³	47	1997	5990.	58.02	º
º	1	17	1969	5400.	³	48	1963	5760.	59.26	º
º	9	23	1970	12800.	³	49	1974	5630.	60.49	º
º	10	11	1970	3150.	³	50	1969	5400.	61.73	º
º	12	17	1971	4140.	³	51	1965	5300.	62.96	º
º	4	22	1973	26400.	³	52	1943	5290.	64.20	º
º	5	30	1974	5630.	³	53	1951	5250.	65.43	º
º	4	24	1975	3390.	³	54	1967	5100.	66.67	º
º	4	25	1976	13400.	³	55	1958	4750.	67.90	º
º	9	24	1977	4430.	³	56	1991	4700.	69.14	º
º	3	19	1978	8820.	³	57	1942	4510.	70.37	º
º	3	30	1979	10200.	³	58	1977	4430.	71.60	º
º	6	4	1980	14700.	³	59	1961	4290.	72.84	º
º	7	6	1981	12300.	³	60	1972	4140.	74.07	º
º	7	19	1982	11500.	³	61	1938	4070.	75.31	º
º	4	3	1983	14800.	³	62	1954	4050.	76.54	º
º	6	10	1984	6370.	³	63	1925	3760.	77.78	º
º	2	22	1985	11500.	³	64	1937	3540.	79.01	º
º	5	19	1986	13200.	³	65	1930	3460.	80.25	º
º	10	3	1986	9300.	³	66	1975	3390.	81.48	º
º	2	20	1988	1860.	³	67	1949	3350.	82.72	º
º	9	10	1989	946.	³	68	1968	3330.	83.95	º
º	6	21	1990	9040.	³	69	1924	3250.	85.19	º
º	5	5	1991	4700.	³	70	1971	3150.	86.42	º
º	4	20	1992	7980.	³	71	1941	3080.	87.65	º
º	7	12	1993	11900.	³	72	2000	2990.	88.89	º
º	3	22	1994	6410.	³	73	1966	2730.	90.12	º
º	7	6	1995	11300.	³	74	1922	2400.	91.36	º
º	5	27	1996	14300.	³	75	1923	1980.	92.59	º
º	2	21	1997	5990.	³	76	1988	1860.	93.83	º
º	6	30	1998	7270.	³	77	1934	1780.	95.06	º
º	10	18	1999	6800.	³	78	1940	1640.	96.30	º
º	7	11	2000	2990.	³	79	1956	1030.	97.53	º
º	5	15	2001	9800.	³	80	1989	946.	98.77	º

-OUTLIER TESTS -

LOW OUTLIER TEST

BASED ON 80 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.940

0 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF 867.0

HIGH OUTLIER TEST

BASED ON 80 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.940

0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF 45988.

-SKEW WEIGHTING -

BASED ON 80 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .093
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302

FINAL RESULTS -FREQUENCY CURVE-

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	.95
31900.	33400.	.2	42100.	25600.
27900.	28900.	.5	36200.	22700.
24900.	25600.	1.0	31800.	20400.
21800.	22300.	2.0	27400.	18100.
17700.	17900.	5.0	21700.	14900.
14500.	14700.	10.0	17400.	12400.
11200.	11300.	20.0	13200.	9810.
6600.	6600.	50.0	7490.	5830.
3640.	3610.	80.0	4170.	3120.
2590.	2560.	90.0	3040.	2150.
1940.	1890.	95.0	3040.	1550.
1080.	1020.	99.0	1370.	802.

SYSTEMATIC STATISTICS

LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.8003	HISTORIC EVENTS	0
STANDARD DEV	.2933	HIGH OUTLIERS	0
COMPUTED SKEW	-.4707	LOW OUTLIERS	0
REGIONAL SKEW	-.2000	ZERO OR MISSING	0
ADOPTED SKEW	-.4000	SYSTEMATIC EVENTS	80

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX J
HYDROLOGY AND HYDRAULICS

ATTACHMENT 2
HEC-RAS INPUT

```
                    HEC-RAS Version 3.0.1  Mar 2001
                      U.S. Army Corp of Engineers
                     Hydrologic Engineering Center
                       609 Second Street, Suite D
                      Davis, California 95616-4687
                             (916) 756-1104


            X     X  XXXXXX    XXXX        XXXX       XX      XXXX
            X     X  X        X    X       X   X     X  X    X
            X     X  X        X            X   X    X    X   X
            XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
            X     X  X        X            X  X     X    X        X
            X     X  X        X    X       X   X    X    X        X
            X     X  XXXXXX    XXXX        X    X   X    X   XXXXX



PROJECT DATA
Project Title: Fox River #2 - No Bridge - November 2002
Project File : Fox_2_NB.prj
Run Date and Time: 1/7/2003 10:53:07 AM

Project in English units

Project Description:
FOX RIVER, MISSOURI  ANALYSIS FOR R.I.D. C OF E
      100  YEAR FLOOD
EVENT
      T081-01-040




PLAN DATA

Plan Title: Imported Plan 01
Plan File : d:\Dan Miller Projects\Fox River\hec-ras\Fox_2_NB.p01

           Geometry Title: Imported Geom 01
           Geometry File : d:\Dan Miller Projects\Fox River\hec-ras\Fox_2_NB.g01

           Flow Title    : Imported Flow 01
           Flow File     : d:\Dan Miller Projects\Fox River\hec-ras\Fox_2_NB.f01

Plan Summary Information:
Number of:  Cross Sections =   19    Mulitple Openings =    0
            Culverts       =    0    Inline Weirs      =    0
            Bridges        =    0

Computational Information
    Water surface calculation tolerance =  0.003
    Critical depth calculaton tolerance =  0.003
    Maximum number of interations       =  20
    Maximum difference tolerance        =  0.1
    Flow tolerance factor               =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: Imported Flow 01
Flow File : d:\Dan Miller Projects\Fox River\hec-ras\Fox_2_NB.f01
```

Flow Data (cfs)

River	Reach	RS	PF 1	PF 2	PF 3	PF 4
RIVER-1	Reach-1	10	1080	1940	2590	3640

PF 5	PF 6	PF 7	PF 8
6600	11200	14500	17700

River	Reach	RS	PF 9	PF 10	PF 11	PF 12
RIVER-1	Reach-1	10	21800	24900	27900	31900

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
RIVER-1	Reach-1	PF 1		Known WS = 480
RIVER-1	Reach-1	PF 2		Known WS = 480
RIVER-1	Reach-1	PF 3		Known WS = 480
RIVER-1	Reach-1	PF 4		Known WS = 480
RIVER-1	Reach-1	PF 5		Known WS = 480
RIVER-1	Reach-1	PF 6		Known WS = 480

GEOMETRY DATA

Geometry Title: Imported Geom 01
Geometry File : d:\Dan Miller Projects\Fox River\hec-ras\Fox_2_NB.g01

CROSS SECTION RIVER: RIVER-1
REACH: Reach-1 RS: 10

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
2500	501	2540	498	2970	498	2997.9	498	2998	498
3000	496.5	3004	496.1	3015	491	3020	485.5	3025	481.5
3031	480.5	3040	480.7	3045	480.5	3050	481	3055	481.3
3070	482.6	3084	482.5	3085	485.5	3095	491.6	3100	493
3100.1	493	3130	498	4060	498	4100	501		

Manning's n Values num= 5

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
2500	.04	2920	.08	3020	.03	3085	.08	3185	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
2998	3100	2800	2930	2300	.2	.4

Blocked Obstructions num= 1

Sta L	Sta R	Elev
4020	4100	

Sediment Elevation = 0

CROSS SECTION RIVER: RIVER-1
REACH: Reach-1 RS: 9.5

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
3031	498.6	3045	492.4	3060	493.5	3072	491.3	3080	493.5
3090	494.5	3100	491.7	3112	491	3114	489	3145	485.5
3148	484.5	3170	481.7	3190	479.7	3209	485.5	3217	494.8
3300	494	3770	494	3780	498.5				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
3031	.07	3145	.028	3209	.035

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3145    3209             1150    1120     900             .2       .4

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 9

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2950     499    2980     496    3000   491.5    3005   493.5    3015     491
    3025   487.6    3030   487.5    3045   484.3    3050   482.5    3055   482.3
    3060   481.5    3065   481.2    3074   478.6    3078   478.3    3082   479.5
    3100   479.6    3112   484.3    3130     490    3131     494    4050     494
    4100     499

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2950     .07    3045    .028    3112     .07    3210    .035

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3045    3112             1900    2200    2000             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 8

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2880     499    2930   494.5    2980     494    2983     493    2993   492.7
    3000   491.5    3019   486.8    3027   482.8    3032   482.3    3038   482.6
    3061   482.7    3066   481.5    3076   480.7    3082   479.6    3088   479.3
    3098   482.8    3100   487.5    3105     493    3350     493    4550     494

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2880    .035    2930     .07    3027    .028    3098     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3027    3098             1400    2200    1750             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 7.5

INPUT
Description:
Station Elevation Data    num=      12
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2400     491    3007     492    3025   482.3    3033     482    3034   481.5
    3045   480.3    3055     480    3065   478.1    3077   479.5    3082     482
    3086   491.8    3750     492

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    2400     .07    3033    .028    3082     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3033    3082             1200    2250    2350             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 7

INPUT
Description:
Station Elevation Data    num=      13
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    1600     490    3000   491.5    3012   491.3    3028     482    3040     480
    3060   479.7    3062     479    3072   477.5    3080     478    3083   480.3
    3087     482    3100   491.3    3600     490

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
```

```
    1600    .035    2820     .07    3028    .028    3087     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3028    3087             2050    3700     800             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 6

INPUT
Description:
Station Elevation Data    num=      11
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2750     490    3000   490.5    3012     490    3026     481    3030     480
    3055     478    3062   476.4    3074   476.3    3082     481    3094     491
    5100     490

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    2750     .07    3026    .028    3082     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3026    3082             2650    2630    1250             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 5.5

INPUT
Description:
Station Elevation Data    num=      19
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2100     490    2800     490    3000     489    3060     488    3067   481.5
    3074     480    3108   474.3    3132   473.6    3150   474.8    3162   476.5
    3163     480    3164     482    3173   488.4    3260     488    3310   489.4
    3365   488.5    3370     488    3570     488    3600   489.4

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2100    .035    2970     .07    3074    .028    3163     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3074    3163             2400    2320    2150             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 5

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2500     488    2600     488    2700     490    2800     491    2900     490
    2992   488.7    3000   489.5    3005     489    3010     484    3016     480
    3018   478.6    3041     476    3053     477    3066     476    3077   475.8
    3090     480    3092     483    3106   488.7    3120   488.3    4200     490

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    2500     .06    3016    .028    3090     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3016    3090             2450    2580    2550             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 4.5

INPUT
Description:
Station Elevation Data    num=      24
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2400     488    2450     488    2600     490    2850     490    2900     488
    3110     488    3115     480    3120     479    3127     476    3145   473.2
    3155   473.2    3165   473.8    3175   473.8    3190     478    3195     480
    3205   488.2    3440     488    3470     489    3500     488    3550   490.5
    3560   490.5    3575     488    4200     488    4250     499
```

```
Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2400    .035    3015     .07    3115    .028    3195     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3115    3195              3400    3500    3100              .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 4.4

INPUT
Description: This is a REPEATED section.

Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2000     488    2960     488  3006.9     488    3007     488    3020   486.5
    3040     486    3052     480    3060   476.3    3070     475    3100   475.3
    3120   474.4    3130   475.6    3140     479    3141     480    3146     483
    3150   483.5    3160   489.5  3160.1   489.5    3250     495    3290     499

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2000    .035    2900     .07    3052    .028    3141     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3007    3160               185     185     185              .1       .3
Blocked Obstructions     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
    2000    2822     488    3192    3290     495

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 4.2

INPUT
Description: This is a REPEATED section.

Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2000     488    2960     488  3006.9     488    3007     488    3020   486.5
    3040     486    3052     480    3060   476.3    3070     475    3100   475.3
    3120   474.4    3130   475.6    3140     479    3141     480    3146     483
    3150   483.5    3160   489.5  3160.1   489.5    3250     495    3290     499

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2000    .035    2900     .07    3052    .028    3141     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3007    3160                15      15      15              .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
888       F
888       F

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 4.1

INPUT
Description: This is a REPEATED section.
TOWN RD. BR. N. 1/2 SECTION 25

Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2000     488    2960     488  3006.9     488    3007     488    3020   486.5
    3040     486    3052     480    3060   476.3    3070     475    3100   475.3
    3120   474.4    3130   475.6    3140     479    3141     480    3146     483
    3150   483.5    3160   489.5  3160.1   489.5    3250     495    3290     499

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2000    .035    2900     .07    3052    .028    3141     .07
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3007    3160              100     100     100             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
888       F
888       F

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 4

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2000     488    2960     488  3006.9     488    3007     488    3020   486.5
    3040     486    3052     480    3060   476.3    3070     475    3100   475.3
    3120   474.4    3130   475.6    3140     479    3141     480    3146     483
    3150   483.5    3160   489.5  3160.1   489.5    3250     495    3290     499

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    2000    .035    2900     .07    3052    .028    3141     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3007    3160             1600    2520    2700             .1       .3
Blocked Obstructions     num=       2
   Sta L   Sta R    Elev   Sta L   Sta R    Elev
    2000    2982     488    3185    3290     495

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 3

INPUT
Description:
Station Elevation Data    num=      18
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    1750     486    2000     486    3000     486    3011   483.7    3021     480
    3029     476    3040   472.5    3050   470.5    3060   467.5    3070   468.3
    3080     472    3099     478    3103     480    3110   484.8    3125   489.5
    3130   490.5    3200     491    3250     499

Manning's n Values        num=       5
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
    1750     .07    2100    .035    2920     .07    3021    .028    3103     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3021    3103             2450    1960    1450             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 2.5

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2400     486    2900     486    2960   486.5    3020     488    3032     487
    3049     480    3061     474    3080   470.8    3095   470.2    3115   470.8
    3138     480    3147     484    3151   486.5    3200   486.5    3240   487.6
    3290   487.6    3320     486    3790     486    3880     488    3910     499

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    2400     .07    3049    .028    3138     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3049    3138             2600    3050    2700             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 2

INPUT
Description:
Station Elevation Data    num=      21
```

```
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2100     486    2150     486    3000     486    3034   485.3    3039   482.3
    3053     480    3070     476    3100   473.4    3110     473    3120   471.6
    3130   471.2    3140   475.1    3150     476    3170     478    3180     480
    3187   481.3    3188   484.5    3190   487.5    3225     486    3600     486
    3650     498

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    2100     .07    3053    .028    3180     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3053    3180             2700    2100    1600             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 1.5

INPUT
Description:
Station Elevation Data    num=      22
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    2000     486    3000     486    3020     485    3025     480    3030     475
    3043     472    3055   471.1    3090   472.7    3102   472.4    3115   472.8
    3127   473.8    3140     480    3145     481    3146   484.3    3150   486.3
    3185   485.5    3190     484    3300     484    3310     488    3324   488.3
    3330     489    3350     497

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    2000     .07    3025    .028    3140     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3025    3140             3500    4300    4500             .1       .3

CROSS SECTION          RIVER: RIVER-1
REACH: Reach-1            RS: 1

INPUT
Description: CHICAGO, BURLINGTON & QUINCY R.R. BR. - BR. NOT CODED

Station Elevation Data    num=      16
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    1700     486    2700     485    3015     484    3028   483.5    3140   462.8
    3161   463.5    3167     470    3180   468.3    3210     474    3220   474.3
    3230   477.4    3258     480    3264   482.3    3280   482.6    3297     485
    3400     485

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
    1700     .07    3015    .028    3297     .07

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          3015    3297              150     150     150             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
888       F
888       F


SUMMARY OF MANNING'S N VALUES

River:RIVER-1

      Reach          River Sta.       n1        n2        n3        n4        n5

 Reach-1              10                .04       .08       .03       .08       .04
 Reach-1              9.5               .07      .028      .035
 Reach-1              9                 .07      .028       .07      .035
 Reach-1              8                .035       .07      .028       .06
 Reach-1              7.5               .07      .028       .07
 Reach-1              7                .035       .07      .028       .07
 Reach-1              6                 .07      .028       .07
```

Reach-1	5.5	.035	.07	.028	.07	
Reach-1	5	.06	.028	.07		
Reach-1	4.5	.035	.07	.028	.07	
Reach-1	4.4	.035	.07	.028	.07	
Reach-1	4.2	.035	.07	.028	.07	
Reach-1	4.1	.035	.07	.028	.07	
Reach-1	4	.035	.07	.028	.07	
Reach-1	3	.07	.035	.07	.028	.07
Reach-1	2.5	.07	.028	.07		
Reach-1	2	.07	.028	.07		
Reach-1	1.5	.07	.028	.07		
Reach-1	1	.07	.028	.07		

SUMMARY OF REACH LENGTHS

River: RIVER-1

Reach	River Sta.	Left	Channel	Right
Reach-1	10	2800	2930	2300
Reach-1	9.5	1150	1120	900
Reach-1	9	1900	2200	2000
Reach-1	8	1400	2200	1750
Reach-1	7.5	1200	2250	2350
Reach-1	7	2050	3700	800
Reach-1	6	2650	2630	1250
Reach-1	5.5	2400	2320	2150
Reach-1	5	2450	2580	2550
Reach-1	4.5	3400	3500	3100
Reach-1	4.4	185	185	185
Reach-1	4.2	15	15	15
Reach-1	4.1	100	100	100
Reach-1	4	1600	2520	2700
Reach-1	3	2450	1960	1450
Reach-1	2.5	2600	3050	2700
Reach-1	2	2700	2100	1600
Reach-1	1.5	3500	4300	4500
Reach-1	1	150	150	150

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: RIVER-1

Reach	River Sta.	Contr.	Expan.
Reach-1	10	.2	.4
Reach-1	9.5	.2	.4
Reach-1	9	.1	.3
Reach-1	8	.1	.3
Reach-1	7.5	.1	.3
Reach-1	7	.1	.3
Reach-1	6	.1	.3
Reach-1	5.5	.1	.3
Reach-1	5	.1	.3
Reach-1	4.5	.1	.3
Reach-1	4.4	.1	.3
Reach-1	4.2	.1	.3
Reach-1	4.1	.1	.3
Reach-1	4	.1	.3
Reach-1	3	.1	.3
Reach-1	2.5	.1	.3
Reach-1	2	.1	.3
Reach-1	1.5	.1	.3
Reach-1	1	.1	.3

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX J
HYDROLOGY AND HYDRAULICS

ATTACHMENT 3
HEC-RAS OUTPUT

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	10	1080	480.5	488.74		488.82	0.000326	2.29	471.21	73.26	0.16
Reach-1	10	1940	480.5	491.25		491.38	0.000489	2.93	662.85	79.96	0.18
Reach-1	10	2590	480.5	492.84		493	0.000643	3.25	796.32	88.39	0.19
Reach-1	10	3640	480.5	494.89		495.1	0.000734	3.7	994.16	104.79	0.2
Reach-1	10	6600	480.5	497.54		497.97	0.001347	5.26	1304.07	128.64	0.26
Reach-1	10	11200	480.5	499.38		499.75	0.001319	5.66	3414.02	1498.36	0.27
Reach-1	10	14500	480.5	500.3	493.3	500.57	0.001055	5.28	4808.68	1510.72	0.24
Reach-1	10	17700	480.5	501.08		501.31	0.000935	5.15	5987	1600	0.23
Reach-1	10	21800	480.5	501.92		502.12	0.000807	4.95	7338.27	1600	0.21
Reach-1	10	24900	480.5	502.51		502.7	0.000742	4.86	8276.11	1600	0.21
Reach-1	10	27900	480.5	503.04		503.23	0.000693	4.79	9134.7	1600	0.2
Reach-1	10	31900	480.5	503.72		503.9	0.000643	4.73	10219.22	1600	0.19
Reach-1	9.5	1080	479.7	487.62		487.77	0.000385	3.14	363.18	84.63	0.24
Reach-1	9.5	1940	479.7	489.94		490.16	0.000353	3.82	581.56	99.75	0.24
Reach-1	9.5	2590	479.7	491.38		491.64	0.000344	4.23	728.21	109.19	0.25
Reach-1	9.5	3640	479.7	493.37		493.69	0.000332	4.74	988.17	155.93	0.25
Reach-1	9.5	6600	479.7	495.72		496.11	0.000374	5.73	2318.41	736.34	0.28
Reach-1	9.5	11200	479.7	497.27		497.72	0.000462	6.84	3463.18	743.27	0.31
Reach-1	9.5	14500	479.7	498.11		498.6	0.000513	7.48	4089.44	747.03	0.33
Reach-1	9.5	17700	479.7	498.83		499.36	0.000553	7.99	4627.01	749	0.35
Reach-1	9.5	21800	479.7	499.65		500.23	0.000594	8.56	5244.85	749	0.36
Reach-1	9.5	24900	479.7	500.23		500.84	0.000619	8.93	5676.61	749	0.37
Reach-1	9.5	27900	479.7	500.76		501.41	0.00064	9.25	6073.51	749	0.38
Reach-1	9.5	31900	479.7	501.44		502.12	0.000662	9.64	6578.46	749	0.39
Reach-1	9	1080	478.3	487.39		487.48	0.000168	2.39	483.38	91.23	0.16
Reach-1	9	1940	478.3	489.7		489.84	0.000192	3.12	720.66	110.2	0.18
Reach-1	9	2590	478.3	491.14		491.32	0.000201	3.53	883.75	115.82	0.19
Reach-1	9	3640	478.3	493.13		493.37	0.000213	4.07	1131.81	135.57	0.2
Reach-1	9	6600	478.3	495.43		495.74	0.000268	5.12	2782.44	1081.72	0.24
Reach-1	9	11200	478.3	496.95		497.28	0.000315	5.92	4449.61	1109	0.26
Reach-1	9	14500	478.3	497.78		498.12	0.000339	6.35	5378.33	1125.63	0.27
Reach-1	9	17700	478.3	498.49		498.84	0.000355	6.69	6184.64	1139.86	0.28
Reach-1	9	21800	478.3	499.32		499.68	0.000369	7.02	7135.01	1150	0.29
Reach-1	9	24900	478.3	499.91		500.27	0.000374	7.22	7806.73	1150	0.29
Reach-1	9	27900	478.3	500.44		500.81	0.000378	7.39	8425.95	1150	0.29

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	9	31900	478.3	501.13		501.5	0.000381	7.59	9215.94	1150	0.3
Reach-1	8	1080	479.3	486.83		486.96	0.000343	2.91	386.66	80.84	0.23
Reach-1	8	1940	479.3	489.1		489.3	0.000323	3.61	582.35	91.76	0.23
Reach-1	8	2590	479.3	490.52		490.77	0.000317	4.01	717.88	98.8	0.24
Reach-1	8	3640	479.3	492.49		492.8	0.000314	4.56	922.3	110.29	0.24
Reach-1	8	6600	479.3	494.53		495	0.000433	6.01	2798.17	1620.35	0.3
Reach-1	8	11200	479.3	496.02		496.46	0.000472	6.75	5219.27	1636.87	0.31
Reach-1	8	14500	479.3	496.84		497.26	0.000487	7.12	6561.23	1645.95	0.32
Reach-1	8	17700	479.3	497.55		497.96	0.000495	7.39	7733.4	1653.85	0.33
Reach-1	8	21800	479.3	498.38		498.79	0.000496	7.66	9123.25	1663.16	0.33
Reach-1	8	24900	479.3	498.98		499.38	0.000493	7.82	10117.7	1669.79	0.33
Reach-1	8	27900	479.3	499.54		499.92	0.000489	7.95	11043.11	1670	0.33
Reach-1	8	31900	479.3	500.24		500.62	0.000481	8.1	12227.67	1670	0.33
Reach-1	7.5	1080	478.1	485.97		486.15	0.000397	3.48	345.76	65.43	0.25
Reach-1	7.5	1940	478.1	488.16		488.47	0.000447	4.54	494.67	70.39	0.28
Reach-1	7.5	2590	478.1	489.53		489.92	0.000471	5.16	593.25	73.5	0.29
Reach-1	7.5	3640	478.1	491.41		491.93	0.000502	5.99	786.39	326.86	0.31
Reach-1	7.5	6600	478.1	493.12		493.84	0.000705	7.78	2662.33	1350	0.38
Reach-1	7.5	11200	478.1	494.36		495.17	0.000899	9.33	4336.23	1350	0.43
Reach-1	7.5	14500	478.1	495.18		495.97	0.000927	9.83	5448.51	1350	0.44
Reach-1	7.5	17700	478.1	495.93		496.68	0.000925	10.14	6459.98	1350	0.45
Reach-1	7.5	21800	478.1	496.82		497.53	0.000913	10.44	7659.03	1350	0.45
Reach-1	7.5	24900	478.1	497.45		498.14	0.000901	10.62	8514.11	1350	0.45
Reach-1	7.5	27900	478.1	498.04		498.71	0.000888	10.78	9306.53	1350	0.45
Reach-1	7.5	31900	478.1	498.79		499.44	0.000871	10.97	10316.39	1350	0.44
Reach-1	7	1080	477.5	485.08		485.25	0.000409	3.29	340.4	68.61	0.25
Reach-1	7	1940	477.5	487.2		487.47	0.000438	4.24	492.77	75.22	0.27
Reach-1	7	2590	477.5	488.54		488.89	0.000449	4.78	596.66	79.41	0.28
Reach-1	7	3640	477.5	490.41		490.85	0.000456	5.46	860.48	624.5	0.29
Reach-1	7	6600	477.5	492.92		493.04	0.00018	3.94	5168.4	2000	0.19
Reach-1	7	11200	477.5	494.2		494.31	0.000187	4.27	7716.07	2000	0.2
Reach-1	7	14500	477.5	495.03		495.13	0.000182	4.37	9375.98	2000	0.2
Reach-1	7	17700	477.5	495.78		495.88	0.000176	4.43	10877.33	2000	0.19
Reach-1	7	21800	477.5	496.67		496.76	0.00017	4.51	12655.22	2000	0.19
Reach-1	7	24900	477.5	497.3		497.4	0.000166	4.56	13918.65	2000	0.19

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	7	27900	477.5	497.89		497.99	0.000162	4.61	15098.94	2000	0.19
Reach-1	7	31900	477.5	498.64		498.74	0.000157	4.67	16604.19	2000	0.19
Reach-1	6	1080	476.3	482.89		483.15	0.000832	4.16	263.66	61.19	0.34
Reach-1	6	1940	476.3	484.98		485.38	0.000763	5.11	397.68	66.96	0.35
Reach-1	6	2590	476.3	486.31		486.81	0.000734	5.66	489.74	70.64	0.35
Reach-1	6	3640	476.3	488.16		488.78	0.000717	6.42	624.58	75.72	0.36
Reach-1	6	6600	476.3	491.52		492.12	0.00058	7.02	3268.95	2350	0.34
Reach-1	6	11200	476.3	493.36		493.66	0.000397	6.34	7592.15	2350	0.29
Reach-1	6	14500	476.3	494.33		494.57	0.000355	6.25	9871.73	2350	0.27
Reach-1	6	17700	476.3	495.16		495.37	0.00033	6.23	11830.3	2350	0.27
Reach-1	6	21800	476.3	496.12		496.31	0.000311	6.27	14073.8	2350	0.26
Reach-1	6	24900	476.3	496.78		496.96	0.0003	6.31	15640.66	2350	0.26
Reach-1	6	27900	476.3	497.4		497.58	0.000291	6.36	17093.7	2350	0.26
Reach-1	6	31900	476.3	498.18		498.35	0.000282	6.42	18932.08	2350	0.25
Reach-1	5.5	1080	473.6	482.54		482.59	0.000081	1.72	641.82	98.89	0.11
Reach-1	5.5	1940	473.6	484.58		484.67	0.000111	2.38	848.76	103.96	0.14
Reach-1	5.5	2590	473.6	485.92		486.04	0.000125	2.76	989.72	107.27	0.15
Reach-1	5.5	3640	473.6	487.77		487.93	0.000141	3.28	1192.4	111.86	0.16
Reach-1	5.5	6600	473.6	491.26		491.42	0.000124	3.62	4257.9	1500	0.16
Reach-1	5.5	11200	473.6	492.95		493.12	0.000145	4.19	6787.87	1500	0.18
Reach-1	5.5	14500	473.6	493.89		494.06	0.000154	4.48	8201.72	1500	0.18
Reach-1	5.5	17700	473.6	494.72		494.89	0.00016	4.7	9434.57	1500	0.19
Reach-1	5.5	21800	473.6	495.66		495.84	0.000166	4.94	10854.23	1500	0.19
Reach-1	5.5	24900	473.6	496.32		496.5	0.000169	5.1	11846.71	1500	0.2
Reach-1	5.5	27900	473.6	496.94		497.12	0.000172	5.24	12764.21	1500	0.2
Reach-1	5.5	31900	473.6	497.71		497.9	0.000174	5.4	13927.89	1500	0.2
Reach-1	5	1080	475.8	482.12		482.25	0.000329	2.83	385.21	78.59	0.22
Reach-1	5	1940	475.8	484.02		484.23	0.00037	3.71	539.03	84.51	0.25
Reach-1	5	2590	475.8	485.29		485.56	0.000377	4.17	649.18	88.9	0.26
Reach-1	5	3640	475.8	487.05		487.4	0.000387	4.81	811.27	95	0.27
Reach-1	5	6600	475.8	490.61		490.97	0.000316	5.32	3369.31	1622.41	0.25
Reach-1	5	11200	475.8	492.26		492.6	0.000347	6.02	6153.59	1700	0.27
Reach-1	5	14500	475.8	493.2		493.53	0.000355	6.33	7747.03	1700	0.28
Reach-1	5	17700	475.8	494.02		494.34	0.000356	6.55	9148.62	1700	0.28
Reach-1	5	21800	475.8	494.97		495.28	0.000358	6.81	10758.09	1700	0.28

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	5	24900	475.8	495.63		495.94	0.000359	6.98	11883.88	1700	0.28
Reach-1	5	27900	475.8	496.24		496.56	0.000358	7.13	12928.12	1700	0.29
Reach-1	5	31900	475.8	497.02		497.33	0.000357	7.31	14253.81	1700	0.29
Reach-1	4.5	1080	473.2	481.63		481.7	0.00014	2.12	511.59	83.01	0.15
Reach-1	4.5	1940	473.2	483.38		483.52	0.0002	2.98	659.92	86.24	0.18
Reach-1	4.5	2590	473.2	484.61		484.8	0.000222	3.45	767.34	88.51	0.2
Reach-1	4.5	3640	473.2	486.33		486.58	0.000249	4.09	921.68	91.67	0.22
Reach-1	4.5	6600	473.2	490.06		490.3	0.000198	4.43	3940.98	1787.9	0.2
Reach-1	4.5	11200	473.2	491.65		491.88	0.00022	4.99	6811.95	1816.58	0.22
Reach-1	4.5	14500	473.2	492.57		492.79	0.000222	5.21	8499.1	1820.79	0.22
Reach-1	4.5	17700	473.2	493.4		493.61	0.00022	5.35	10007.16	1824.55	0.22
Reach-1	4.5	21800	473.2	494.35		494.55	0.000219	5.52	11733.74	1828.85	0.22
Reach-1	4.5	24900	473.2	495.01		495.21	0.000218	5.63	12950.39	1831.87	0.22
Reach-1	4.5	27900	473.2	495.63		495.83	0.000216	5.72	14085	1834.68	0.22
Reach-1	4.5	31900	473.2	496.42		496.61	0.000213	5.83	15529.32	1838.26	0.22
Reach-1	4.4	1080	474.4	480.97		481.05	0.000256	2.28	472.67	92.57	0.18
Reach-1	4.4	1940	474.4	482.33		482.49	0.000477	3.23	601.29	97.53	0.23
Reach-1	4.4	2590	474.4	483.35		483.56	0.000639	3.68	703.9	103.55	0.25
Reach-1	4.4	3640	474.4	484.88		485.15	0.000789	4.2	867.6	110.06	0.26
Reach-1	4.4	6600	474.4	488.72		488.97	0.001038	4.23	2108.46	1158.71	0.25
Reach-1	4.4	11200	474.4	490.46		490.62	0.000707	3.88	4127.23	1175.77	0.21
Reach-1	4.4	14500	474.4	491.47		491.62	0.000581	3.74	5329.68	1192	0.19
Reach-1	4.4	17700	474.4	492.37		492.51	0.000504	3.66	6397.09	1192	0.18
Reach-1	4.4	21800	474.4	493.36		493.5	0.000454	3.65	7574.4	1192	0.17
Reach-1	4.4	24900	474.4	494.05		494.19	0.000429	3.67	8394.08	1192	0.17
Reach-1	4.4	27900	474.4	494.69		494.84	0.000409	3.68	9156.94	1192	0.17
Reach-1	4.4	31900	474.4	495.49		495.65	0.000389	3.72	10148.26	1254.92	0.17
Reach-1	4.2	1080	474.4	480.92	477.06	481.01	0.000262	2.31	468.08	92.39	0.18
Reach-1	4.2	1940	474.4	482.23	477.96	482.4	0.000494	3.28	592	97.18	0.23
Reach-1	4.2	2590	474.4	483.23	478.55	483.44	0.00065	3.75	690.7	102.26	0.25
Reach-1	4.2	3640	474.4	484.72	479.37	485	0.000829	4.28	849.77	109.47	0.27
Reach-1	4.2	6600	474.4	488.42	481.28	488.75	0.001319	4.69	1759.91	1158.21	0.28
Reach-1	4.2	11200	474.4	490.3	483.73	490.48	0.000801	4.09	3932.46	1173.13	0.22
Reach-1	4.2	14500	474.4	491.35	485.15	491.5	0.000631	3.87	5154.41	1190.35	0.2
Reach-1	4.2	17700	474.4	492.27	486.86	492.41	0.000537	3.75	6215.36	1205.3	0.19

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	4.2	21800	474.4	493.26	489.64	493.41	0.000479	3.73	7373.91	1221.63	0.18
Reach-1	4.2	24900	474.4	493.96	489.88	494.11	0.00045	3.74	8177.74	1232.95	0.17
Reach-1	4.2	27900	474.4	494.6	490.09	494.76	0.000427	3.75	8924.9	1243.48	0.17
Reach-1	4.2	31900	474.4	495.42	490.3	495.58	0.000397	3.75	10158.85	1254.18	0.17
Reach-1	4.1	1080	474.4	480.92	477.06	481	0.000262	2.31	467.7	92.37	0.18
Reach-1	4.1	1940	474.4	482.22	477.97	482.39	0.000495	3.28	591.23	97.15	0.23
Reach-1	4.1	2590	474.4	483.22	478.54	483.43	0.000651	3.76	689.62	102.16	0.25
Reach-1	4.1	3640	474.4	484.71	479.36	484.99	0.000832	4.29	848.28	109.42	0.27
Reach-1	4.1	6600	474.4	488.39	481.28	488.73	0.001348	4.73	1726.23	1158.16	0.28
Reach-1	4.1	11200	474.4	490.28	483.73	490.46	0.00081	4.11	3915.75	1172.9	0.22
Reach-1	4.1	14500	474.4	491.34	485.15	491.49	0.000635	3.88	5142.16	1190.18	0.2
Reach-1	4.1	17700	474.4	492.26	486.82	492.4	0.00054	3.76	6205.27	1205.16	0.19
Reach-1	4.1	21800	474.4	493.26	489.64	493.4	0.000481	3.74	7365.06	1221.5	0.18
Reach-1	4.1	24900	474.4	493.95	489.88	494.1	0.000452	3.75	8169.46	1232.84	0.17
Reach-1	4.1	27900	474.4	494.59	490.09	494.75	0.000429	3.76	8917.08	1243.37	0.17
Reach-1	4.1	31900	474.4	495.41	490.3	495.58	0.000398	3.75	10151	1254.12	0.17
Reach-1	4	1080	474.4	480.89		480.98	0.000265	2.32	465.16	92.27	0.18
Reach-1	4	1940	474.4	482.17		482.34	0.000506	3.31	585.95	96.95	0.24
Reach-1	4	2590	474.4	483.15		483.37	0.000657	3.8	682.44	101.45	0.26
Reach-1	4	3640	474.4	484.61		484.91	0.000856	4.34	838.22	109.08	0.28
Reach-1	4	6600	474.4	488.19		488.58	0.001545	5	1495.07	1157.83	0.3
Reach-1	4	11200	474.4	490.18		490.38	0.000876	4.25	3803.91	1171.27	0.23
Reach-1	4	14500	474.4	491.27		491.42	0.000666	3.96	5080.74	1185	0.21
Reach-1	4	17700	474.4	492.2		492.34	0.000556	3.81	6184.63	1185	0.19
Reach-1	4	21800	474.4	493.21		493.35	0.00049	3.76	7379.61	1185	0.18
Reach-1	4	24900	474.4	493.9		494.06	0.000458	3.76	8206.16	1185	0.18
Reach-1	4	27900	474.4	494.55		494.71	0.000433	3.77	8973.65	1185	0.17
Reach-1	4	31900	474.4	495.37		495.53	0.000409	3.8	9964.6	1253.66	0.17
Reach-1	3	1080	467.5	480.62		480.66	0.000069	1.68	644.05	84.56	0.11
Reach-1	3	1940	467.5	481.57		481.69	0.000151	2.69	726.95	88.55	0.16
Reach-1	3	2590	467.5	482.34		482.51	0.000203	3.3	795.85	91.73	0.19
Reach-1	3	3640	467.5	483.51		483.78	0.000272	4.12	906.61	96.62	0.22
Reach-1	3	6600	467.5	486.35		486.85	0.000387	5.75	1645.48	1364.95	0.27
Reach-1	3	11200	467.5	489.42		489.62	0.000191	4.63	5849.76	1374.75	0.2
Reach-1	3	14500	467.5	490.62		490.8	0.000176	4.66	7508.06	1397.26	0.19

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	3	17700	467.5	491.63		491.79	0.000169	4.72	8953.46	1453.91	0.19
Reach-1	3	21800	467.5	492.68		492.84	0.000168	4.88	10482.74	1460.47	0.19
Reach-1	3	24900	467.5	493.4		493.56	0.000168	5	11535.1	1464.97	0.19
Reach-1	3	27900	467.5	494.06		494.23	0.000168	5.1	12514.28	1469.14	0.19
Reach-1	3	31900	467.5	494.9		495.07	0.000167	5.23	13747.05	1474.38	0.2
Reach-1	2.5	1080	470.2	480.48		480.52	0.000069	1.63	662.25	91.26	0.11
Reach-1	2.5	1940	470.2	481.27		481.38	0.000158	2.65	735.95	94.96	0.16
Reach-1	2.5	2590	470.2	481.93		482.09	0.000218	3.27	799.04	98.02	0.19
Reach-1	2.5	3640	470.2	482.96		483.22	0.000297	4.12	902.57	102.85	0.23
Reach-1	2.5	6600	470.2	485.49		486.02	0.000453	5.91	1176.75	113.7	0.3
Reach-1	2.5	11200	470.2	488.54		489.04	0.000394	6.38	4622.15	1481.47	0.29
Reach-1	2.5	14500	470.2	489.81		490.25	0.00037	6.51	6504.34	1484.93	0.28
Reach-1	2.5	17700	470.2	490.85		491.27	0.000355	6.65	8057.46	1487.78	0.28
Reach-1	2.5	21800	470.2	491.9		492.31	0.000361	6.96	9613.7	1490.63	0.28
Reach-1	2.5	24900	470.2	492.61		493.03	0.000365	7.18	10680.19	1492.58	0.29
Reach-1	2.5	27900	470.2	493.28		493.7	0.000367	7.36	11677.93	1494.4	0.29
Reach-1	2.5	31900	470.2	494.12		494.54	0.000368	7.57	12930.85	1496.69	0.29
Reach-1	2	1080	471.2	480.2		480.25	0.000124	1.71	633.16	129.34	0.13
Reach-1	2	1940	471.2	480.6		480.73	0.000309	2.84	685.57	133.91	0.22
Reach-1	2	2590	471.2	480.99		481.18	0.000437	3.54	737.65	138.3	0.26
Reach-1	2	3640	471.2	481.67		481.98	0.000592	4.43	834.78	144.28	0.31
Reach-1	2	6600	471.2	483.67		484.24	0.00078	6.09	1132.36	151.03	0.37
Reach-1	2	11200	471.2	486.49	481.46	487.35	0.000818	7.56	2228.82	1477.94	0.4
Reach-1	2	14500	471.2	488.3		488.9	0.000568	6.96	4938.33	1509.59	0.34
Reach-1	2	17700	471.2	489.6		490.09	0.000462	6.69	6907.17	1515.02	0.31
Reach-1	2	21800	471.2	490.69		491.16	0.000444	6.88	8556.6	1519.55	0.31
Reach-1	2	24900	471.2	491.42		491.88	0.000437	7.04	9668.02	1522.59	0.31
Reach-1	2	27900	471.2	492.11		492.57	0.000428	7.16	10720.58	1525.47	0.31
Reach-1	2	31900	471.2	492.97		493.42	0.000419	7.32	12027.37	1529.03	0.31
Reach-1	1.5	1080	471.1	480.05		480.08	0.000052	1.36	794.49	115.33	0.09
Reach-1	1.5	1940	471.1	480.17		480.26	0.000159	2.4	808.38	116.05	0.16
Reach-1	1.5	2590	471.1	480.31		480.46	0.000266	3.14	823.93	116.85	0.21
Reach-1	1.5	3640	471.1	480.59		480.88	0.000461	4.25	857.68	118.57	0.27
Reach-1	1.5	6600	471.1	481.75		482.44	0.000934	6.66	997.87	121.98	0.4
Reach-1	1.5	11200	471.1	483.96		485.21	0.001252	8.98	1270.14	124.86	0.48

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1.5	14500	471.1	485.52		487.06	0.001305	10.03	1644.68	258.64	0.5
Reach-1	1.5	17700	471.1	486.84	482.17	488.44	0.001252	10.51	2871.1	1307.1	0.5
Reach-1	1.5	21800	471.1	488.3		489.65	0.001043	10.26	4790.65	1324.04	0.46
Reach-1	1.5	24900	471.1	489.28		490.46	0.000919	10.04	6087.18	1330.7	0.44
Reach-1	1.5	27900	471.1	490.17		491.23	0.000821	9.84	7277.19	1332.94	0.42
Reach-1	1.5	31900	471.1	491.17		492.14	0.000753	9.79	8610.93	1335.44	0.41
Reach-1	1	1080	462.8	480	466.63	480.01	0.000008	0.61	1776.64	211.06	0.04
Reach-1	1	1940	462.8	480	467.98	480.02	0.000026	1.09	1776.64	211.06	0.07
Reach-1	1	2590	462.8	480	468.97	480.03	0.000046	1.46	1776.64	211.06	0.09
Reach-1	1	3640	462.8	480	470.1	480.07	0.00009	2.05	1776.64	211.06	0.12
Reach-1	1	6600	462.8	480	472.09	480.21	0.000296	3.71	1776.64	211.06	0.23
Reach-1	1	11200	462.8	480	474.45	480.62	0.000854	6.3	1776.64	211.06	0.38
Reach-1	1	14500	462.8	480	475.64	481.03	0.001431	8.16	1776.64	211.06	0.5
Reach-1	1	17700	462.8	480	476.68	481.54	0.002132	9.96	1776.64	211.06	0.61
Reach-1	1	21800	462.8	480	477.95	482.34	0.003235	12.27	1776.64	211.06	0.75
Reach-1	1	24900	462.8	480	478.86	483.05	0.00422	14.02	1776.64	211.06	0.85
Reach-1	1	27900	462.8	480	479.64	483.83	0.005298	15.7	1776.64	211.06	0.95
Reach-1	1	31900	462.8	480.5	480.5	484.96	0.005846	16.94	1883.64	215.09	1.01

COST ESTIMATE

APPENDIX K

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION AND ENHANCEMENT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX K
COST ESTIMATE

1. INTRODUCTION

This Appendix includes two cost estimate documents. The first document is the preliminary cost estimate used to evaluate alternatives in Chapter 5 of the main report. The second document is the cost estimate completed using MCACES software, which is discussed in Chapter 8.

Preliminary Construction Cost Estimate
Estimate for August 2003 Construction
Fox Island HREP

		Number of Units	Unit	Cost Per Unit	Sub-Total	Undeveloped Design Details	Total	Notes
				[$]	[$]	[PCT]	[$]	1
Plant Hardwood Mast Trees	**COMBINE A1 and A2 to total 275 Acres**							2
	A1 - Plant Root Production Method (RPM) Trees							
	Cover Crop, Seeding and Weed Control for 3 Years	215	ACRE	$300 00	$ 64,500	30%	$83,850	3
	Plant RPM Trees at 50 trees per acre	215	ACRE	$825.00	$ 177,375	30%	$230,588	4
					Total Cost of RPM Enhancement		**$314,438**	
	A2 - Plant trees using precision direct seed	60	ACRE	$500.00	$ 30,000	30%	$39,000	5
					Total Cost of Precision Drilled Enhancement		**$39,000**	
					Total Construction Cost of Plant Hardwood Mast Trees A1+A2		**$353,438**	
Enhance Wetlands								
Logsdon Slough	**Use B1 OR B2**							6
	B1 - Pump Water from an Existing Well							
	Pump	1	EA	$10,000 00	$ 10,000	25%	$12,500	7
	Piping over levee	1	LS	$5,000 00	$ 5,000	30%	$6,500	8
	Channel Excavation	500	LF	$29 50	$ 14,750	20%	$17,700	9
	Channel lining	90	TON	$30 00	$ 2,700	25%	$3,375	10
	Place, Shape, and Compact Berm	750	CY	$20 00	$ 15,000	25%	$18,750	11
	Portable Diesel Power Unit	1	EA	$8,000 00	$ 8,000	20%	$9,600	12
	Fuel Wagon	1	EA	$16,960.00	$ 16,960	20%	$20,352	13
					Total Construction Cost of B1 Enhancement		**$88,777**	
	B2 - Pump Water from a New Well							6
	Drill Well	100	LF	$250 00	$ 25,000	20%	$30,000	15
	Pump	1	EA	$15,000 00	$ 15,000	25%	$18,750	16
	Channel Excavation	200	LF	$29 50	$ 5,900	20%	$7,080	9
	Channel lining	90	TON	$30.00	$ 2,700	25%	$3,375	10
	Portable Diesel Power Unit	1	EA	$16,000 00	$ 16,000	20%	$19,200	12
	Fuel Wagon	1	EA	$10,000.00	$ 10,000	20%	$12,000	13
					Total Construction Cost of B2 Enhancement		**$90,405**	

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Preliminary Construction Cost Estimate
Estimate for August 2003 Construction
Fox Island HREP

		Number of Units	Unit	Cost Per Unit	Sub-Total	Undeveloped Design Details	Total	Notes
				[$]	[$]	[PCT]	[$]	1
Coin Pond and Slim Slough	**Use C1 PLUS C2 PLUS C3**							
	C1 - Pump Water from new well							14
	Drill Well	100	FT	$250 00	$ 25,000	20%	$30,000	15
	Pump	1	EA	$15,000 00	$ 15,000	20%	$18,000	16
	Channel Excavation	200	LF	$29 50	$ 5,900	20%	$7,080	9
	Channel Lining	90	TON	$30 00	$ 2,700	25%	$3,375	10
	Road Improvements	1500	LF	$12 29	$ 18,435 00	30%	$23,966	17
	Portable Diesel Power Unit	1	EA	$16,000 00	$ 16,000	20%	$19,200	12
	Fuel Wagon	1	EA	$10,000.00	$ 10,000	20%	$12,000	13
					Total Cost of C1 Enhancement		**$113,621**	
	C2 - Pump Water from Grey's Chute							14
	Angled Drive Pump w/ Power Unit & Appurt	1	EA	$70,000 00	$ 70,000 00	25%	$87,500	18
	Cantilevered Sheet Pile Wall	2250	SF	$16 43	$ 36,967 50	30%	$48,058	19
	Dumped Riprap	600	TON	$27 00	$ 16,200	25%	$20,250	20
	24" Diameter Force Main	230	LF	$75 00	$ 17,250 00	25%	$21,563	21
	TideFlex Duckbill Valve	1	EA	$8,000 00	$ 8,000 00	20%	$9,600	21
	Channel Excavation	300	LF	$29 50	$ 8,850	20%	$10,620	9
	Jacked Casing under Railroad	50	LF	$350 00	$ 17,500 00	25%	$21,875	22
	Road Improvements	250	LF	$11 50	$ 2,875 00	30%	$3,738	17
	Fuel Wagon	1	EA	$10,000.00	$ 10,000	20%	$12,000	13
					Total Construction Cost of C2 Enhancement		**$235,203**	
	C3 - Structures							
	a Fox R Water Control Structure							
	Dewatering	10	Days	$700 00	$ 7,000	25%	$8,750	23
	Excavation and Backfill	300	CY	$20 00	$ 6,000	25%	$7,500	24
	Cast-in-place Reinforced Concrete	45	CY	$400 00	$ 18,000	25%	$22 500	25
	Heavy Duty Grating	70	SF	$75 00	$ 5,250	25%	$6,563	26
	Place, Shape, and Compact Berm	1000	CY	$20 00	$ 20,000	20%	$24,000	27
	Riprap	420	TON	$30 00	$ 12,600	25%	$15,750	28
	Bedding For Riprap	140	TON	$20 00	$ 2,800	25%	$3,500	29
	Aluminum Stop Logs with seals	55	SF	$30 00	$ 1,650	25%	$2,063	30
	Vehicle Guard Rails	100	FT	$50.00	$ 5,000	25%	$6,250	31
					Total Construction Cost of Fox R Water Control Structure		**$96,875**	

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Preliminary Construction Cost Estimate
Estimate for August 2003 Construction
Fox Island HREP

	Number of Units	Unit	Cost Per Unit	Sub-Total	Undeveloped Design Details	Total	Notes
			[$]	[$]	[PCT]	[$]	1
b. Old Lake Water Control Structure							
Galvanized metal stop log structure	1	EA	$3,000 00	$ 3,000	25%	$3,750	32
36" Diameter Corrugated Metal Pipe	50	LF	$70 00	$ 3,500	25%	$4,375	33
Channel Excavation	1500	LF	$29.50	$ 44,250	20%	$53,100	9
Total Construction Cost of Old Lake Water Control Structure						**$61,225**	
c. Coin Pond Stop Log Structure							
Galvanized metal stop log structure	1	EA	$3,000 00	$ 3,000	25%	$3,750	32
36" Diameter Corrugated Metal Pipe	50	LF	$70 00	$ 3,500	25%	$4,375	33
Channel Excavation	400	LF	$29.50	$ 11,800	20%	$14,160	9
Total Construction Cost of Coin Pond Stop Log Structure						**$22,285**	
d. Upper Slim Slough Stop Log Structure							
Galvanized metal stop log structure	1	EA	$3,000 00	$ 3,000	25%	$3,750	32
36" Diameter Corrugated Metal Pipe	25	LF	$70 00	$ 1,750	25%	$2,188	33
Place, Shape, and Compact Berm	1200	CY	$20 00	$ 24,000	20%	$28,800	27
Channel Excavation	300	LF	$29.50	$ 8,850	20%	$10,620	9
Total Construction Cost of Upper Slim Slough Stop Log Struc.						**$45,358**	
e. Lower Slim Slough Stop Log Structure							
Galvanized metal stop log structure	1	EA	$2,500 00	$ 2,500	25%	$3,125	32
36" Diameter Corrugated Metal Pipe	50	LF	$70 00	$ 3,500	25%	$4,375	33
Channel Excavation	300	LF	$29.50	$ 8,850	20%	$10,620	9
Total Construction Cost of Lower Slim Slough Stop log Structure						**$18,120**	
TotalConstuction Cost of C3 Enhancement a+b+c+d+e						**$243,863**	
Total Const. Cost of Wetland Enhancement B2+C1+C2+C3						**$683,091**	
Prairie Restoration — Prepare and Plant Grasses and Forbs	98	ACRE	$1,000.00	$ 98,000	25%	$122,500	34
Total Construction Cost Logsdon Tract Prairie Enhancement						**$122,500**	
Total Construction Cost of Fox Island HREP - Hardwood Reforestation, Wetland Enhancement and Prairie Restoration						**$1,159,028**	

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Preliminary Construction Cost Estimate
Estimate for August 2003 Construction
Fox Island HREP

Notes	
1	Unit prices are from historical data from similar projects in the area by the Corps of Engineers where possible and as noted Other prices (as noted) are from similar conservation projects in the area either by state or federal agencies RS Means was used for prices not available from these sources All prices include Contractor's overhead and profit.
2	Approximately 275 acres will be planted in hardwood trees Two planting methods are shown here, planting 2-year old root stock propogated by the Root Production Method (RPM) and direct planting of seeds The final design will probably include a mixture of the two methods because the comparison will help evaluate methods for future projects 75 of the 275 acres were planted by direct seeding two years ago That stand will be evaluated this fall for possible replanting If that area, known as the Winkelman East Tract, does not need to be replanted, the total hard mast planting will be 200 acres.
3	Soil preparation, cover crop, seeding and weed control for three years until trees become established.
4	50 trees per acre, (900 SF per tree or 30' on-center each way) includes photodegradable tree wrap Price from recent project at nearby Ted Shanks Conservation Area.
5	Price per Iowa DNR confirmed by private contractor, includes clearing, soil preparation and herbicide and mowing for 3 years until seedlings become established.
6	Note that the well pumps in alternatives B1 and B2 are not the same The existing well (B1) is capable of producing 600 GPM, while the proposed replacement well (B2) will produce 2000 GPM.
7	Existing irrigation well on opposite side of levee from wetland The well reportedly produced 600 GPM when used for agriculture This item is for installing a new 600 GPM pump to discharge into Logsdon Slough.
8	Well is on opposite side of levee from wetland Construct piping over the levee, then protect this piping with extra berm (the berm is included as separate item below. This price includes pipes, valves and appurtenances to convey the water across the levee.
9	Excavation of water conveyance channels Spoils may be used as borrow to construct embankments where required, otherwise place spoils along channel banks No haulage required Required equipment includes scrapers and track-mounted excavators No need to stockpile or move twice Channel 3:1 side slopes, 8 foot bottom width, 5 feet deep => 115 cf per linear foot at $5/CY => $21 30/LF) PLUS Light clearing and grubbing, 38 SF per LF @ $0.10/SF=>$3.80/LF PLUS seeding completed channels 4.4SY/LF @ $1/SY=> $4.40/LF =>Total $29.50/LF
10	Provide scour protection and aeration Placed in areas of high velocity or concentrated flow from pumps, stormwater, or Fox River Calculated as a layer two feet thick by 40 feet long. No bedding. Unit price is from Calhoun Point estimate adjusted for inlation (3%/yr)
11	Protection for piping over berm.
12	Trailer -mounted diesel power unit connects to pump via drive belts or shaft.
13	Trailer-mounted Fuel Tank to run diesel power unit. Cost from Calhoun Point estimate adjusted for inflation at 3% per year.
14	Note that the well pump C1 is sized to produce 2000 GPM, while the surface water pump C2 is sized to produce10,000 GPM We are not comparing equivalent pumping rates.
15	16" to 20" Diameter Casing Water level is about 15 feet Each well drilled to depth of 100 feet Each well capable of producing 2000 GPM Price suggested by local contractor, adjusted to account for higher standards than common irrigation systems.
16	2000 GPM pump protected from flooding and vandalism. Powered by portable diesel engine.
17	Access road to pumps Constructed over existing dirt road 6" base at $17/ton, 3" surface coarse at $29/ton (From Calhoun Point estimate adjusted for inflation) 12' wide Aggregate weighs 130 pcf (6 cf of base => $6 63 per foot of road 3 cf of surface => $5 66 per foot of road) => Total $12 29/LF Price includes cost of grading and compacting.

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Preliminary Construction Cost Estimate
Estimate for August 2003 Construction
Fox Island HREP

Notes	
18	Includes pump and appurtenances such as portable diesel engine, discharge piping, jack shafts, pulleys, fencing, engine pad, flexible couplings, and check valves. Capable of pumping 10,000 GPM (22 cfs). Cost from manufacturer ($61,000 with remainder estimated for installation).
19	Cantilevered sheet pile wall to support bank and machinery 30 feet high (25 foot embedment) by 75 feet long Unit price from Calhoun Point estimate. Adjusted for inflation at 3%/yr
20	Erosion protection along bank of Grey Chute at pump station and also along first 60 feet of discharge channel to prevent scour and to aerate water. D50 = 9" 1.5' deep layer without bedding.
21	24" PVC force main with casing beneath railroad. Average depth of installation 4' Includes cost of materials and installation. Duckbill valve prevents backflow. Prices from pipe installation projects in Iowa.
22	Jack and bore metal casing pipe beneath railroad. Unit costs from recent similar railroad crossing in Iowa, adjusted for inflation (3% per year)
23	Drill well point or drive sand point to pump down groundwater to allow footing construction. The cost of dewatering is equally divided between the two water control structures on the Fox River.
24	Excavation by hydraulic excavator. Store material beside excavation, for use in backfilling Compact backfill with hand tampers. Includes final grading and seeding. Unit prices from RS Means.
25	Includes footings, walls, and slabs. Includes layout, formwork, reinforcing steel, imbedded shapes, and finishing.
26	Grating capable of supporting HS-20 load. Unit price from RS Means
27	Place, shape and compact berms using dozers and rollers Mostly for short section near water control structure, but also other low points. Material available from nearby channels or by scraping from adjacent fields Includes cost of clearing, grubbing, and stripping before construction, and for regrading and seeding afterwards.
28	Erosion protection Includes protection on bank of Fox River at water control structure and at a scour site approximately 500 feet upstream D50 = 9" At structure, 2,500 square feet of area, 1.5 feet deep, at 130 pounds per cubic foot => 250 tons At river bank repair, 75 feet of protection, 10 feet high at 2:1 slope, 1.5 feet thick => 170 tons
29	Six-inch layer of well-graded crushed limestone beneath riprap. Used 135 pcf.
30	From 2001 quote from Waterman Industries with 3% per year inflation applied.
31	Steel vehicle guard rails at water control structures. Unit price from RS Means
32	Prefabricated structure which uses 2 inch dimensional lumber for stop logs and connects to RCP or CMP discharge pipes Price from Thompson Culvert Company (Three sites in Missouri) Thompson price ($1,000 for 48" diameter vertical section, 7 feet high) was adusted to include cost for installation.
33	Galvanized corrugated steel pipe, for culverts where new ditches cross roadways. Unit price from RS Means.
34	Soil preparation, weed control, seeding. Unit price estimated from similar projects for MDC and FWS.

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Fox Island HREP Final Final
MISSISSIPPI RIVER

Designed By: STANLEY CONSULTANTS
Estimated By: STANLEY CONSULTANTS

Prepared By: T G. JENSEN

Preparation Date: 01/04/05
Effective Date of Pricing: 01/04/05
Est Construction Time: 240 Days

Sales Tax: 4.23%

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Release 5.31

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Fox Island Division is part of the U.S. Fish and Wildlife Service (USFWS) Great River National Wildlife Refuge (NWR), which is part of the Mark Twain NWR Complex. The 2,033-acre Fox Island Division project area is located in Clark County, Missouri, between Upper Mississippi River Miles (RM) 358.5 and 353.6 and is about one mile south of Alexandria, Missouri, in Pool 20. The project area is comprised of low-profile bottomland containing several bodies of water including: Nelson Lake, Coin Pond, Logsdon Slough, Slim Slough, and Old Lake. Significant opportunities are available for preserving, enhancing, and improving habitat for migratory birds, aquatic mammals, and endangered species by reintroducing mast trees into the timber stand, encouraging re-forestation of cropland, enhancing water supply to wetlands, and re-establishing native prairie grasslands.

This study focuses on proposed project features that would improve aquatic, wetland, and terrestrial habitat and enhance overall resource values. The project is consistent with USFWS goals for this Habitat Rehabilitation and Enhancement Project (HREP), the North American Waterfowl Management Plan, the Partners in Flight Program, and the Upper Mississippi River System-Environmental Management Program (UMRS-EMP). The following objectives have been identified to benefit resident and migratory birds, fish, and other wildlife: (1) reduce forest fragmentation, (2) increase bottomland hardwood diversity, (3) restore native prairie, and (4) enhance wetland areas. The following enhancement measures were considered in detail to achieve the project goals and objectives:

1. Reforestation
2. Wetland Enhancement - Logsdon Slough
3. Wetland Enhancement - Coin Pond/Slim Slough/Old Lake
4. Restore Native Grassland

The authority for this study is provided by the 1985 Supplemental Appropriations Act (Public Law 99-88), Section 1103 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), Section 405 of WRDA 1990 (Public Law 101-640), Section 107 of WRDA 1992 (Public Law 102-580), and Section 509 of WRDA 1999 (Public Law 106-53). The proposed project would be funded and constructed, under these authorizations, on federally owned lands managed, through a cooperative agreement, by the USFWS and the Missouri Department of Conservation, a non-Federal project sponsor.

The cost estimate is based on upon the premise that there will be one general contract awarded and that the general contractor (or his subcontractors) is responsible for equipment procurement, equipment installation, mechanical work, electrical work, site work, and general construction work.

Unit prices are from historical data from similar projects in the area by the Corps of Engineers where possible and as noted. Other prices (as noted) are from similar conservation projects in the area either by state or federal agencies. RS Means was used for prices not available from these sources.

Labor costs were based on the ongoing industry rates for professionals and the prevailing Davis-Bacon wage rates for local hires.

Contingencies were applied where areas of uncertainty exist. Contingencies

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range from 20%-30%, which is an acceptable range for the amount of planning and design that has been developed for this project

The estimate is escalated from the date of the final estimate 01/05 to the mid-point of construction which is assumed to be 08/08. The escalation factors were taken from Tri-Services escalation

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
10 BASE BID							
10.02 RELOCATIONS							
TOTAL RELOCATIONS							
10 06 FISH AND WILDLIFE FACILITIES							
10.06.01 Plant Hardwood Mast Trees							
10 06 01 01 Planting Trees							
10.06.01 01. A1 Plant Root Production Method							
10 06 01 01 A1. 01 Cover Crop, Seeding & Weeding	215.00	AC	219.419	43 884	17.561	280 864	1306 34
10 06 01 01 A1. 02 Plant RPM Trees	215.00	AC	375.846	75.169	30.081	481.096	2237 66
TOTAL Plant Root Production Method	215 00	AC	595 265	119 053	47 642	761 960	3544.00
10 06 01 01 A2 Plant Trees By Seeding							
10.06.01 01 A2 01 Plant Trees by Seeding	60 00	AC	53 680	16 104	4.654	74.438	1240 64
TOTAL Plant Trees By Seeding	60.00	AC	53.680	16 104	4.654	74 438	1240.64
TOTAL Planting Trees	1 00	JB	648 945	135.157	52.297	836 399	836399
TOTAL Plant Hardwood Mast Trees	1.00	JB	648 945	135 157	52 297	836.399	836399
10 06 02 Enhance Wetlands							
10 06 02.01 Logsdon Slough							
10 06 02 01 B1 Pump Water from a New Well							
10 06 02.01. B1. 01 Drill Well	100.00	LF	71 829	14.366	5.749	91.944	919.44
10 06.02 01 B1 02 Pump	1.00	EA	17.161	4 290	1 431	22.882	22882
10.06.02 01. B1 03 Channel Excavation	200 00	LF	2.773	555	222	3.550	17 75
10 06.02 01 B1. 04 Channel Lining	52 00	TN	4.796	1 199	400	6 394	122.97
10 06 02 01 B1. 05 Portable Diesel Power Unit	1 00	EA	17 760	3.552	1.421	22 733	22733
10 06 02.01. B1 06 Fuel Wagon	1 00	EA	5 911	1.182	473	7 567	7566.69
10 06 02.01. B1. 07 Repair Stoplog Structure	1.00	EA	2 210	442	177	2.828	2828.33
10.06.02 01. B1 08 Cap Existing Well	1.00	EA	733	147	59	938	938 04
TOTAL Pump Water from a New Well	1 00	JB	123.172	25 732	9 931	158 836	158836
TOTAL Logsdon Slough	1.00	JB	123 172	25.732	9.931	158 836	158836

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	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
10.06.02.02 Coin Pond Slim Slough Old Lake							
10.06.02.02 C1 Pump Water from new well							
10.06.02.02 C1 01 Drill Well	100.00	LF	71.829	14.366	5.749	91.944	919.44
10.06.02.02 C1 02 Pump	1.00	EA	17.161	3.432	1.373	21.966	21966
10.06.02.02 C1 03 Channel Excavation	2000.00	LF	60.470	12.094	4.840	77.404	38.70
10.06.02.02 C1 04 Channel Lining	130.00	TN	4.796	1.199	.400	6.394	49.19
10.06.02.02 C1 05 Road Improvements	1000.00	LF	11.976	3.593	1.038	16.607	16.61
TOTAL Pump Water from new well	1.00	JB	166.232	34.684	13.400	214.316	214316
10.06.02.02 C2 Pump water from Grey's Chute							
10.06.02.02 C2 01 Angled Drive Pump w/Power Unit	1.00	EA	107.870	21.574	8.633	138.078	138078
10.06.02.02 C2 02 Cantilevered Sheet Pile Wall	2250.00	SF	81.369	24.411	7.055	112.835	50.15
10.06.02.02 C2 03 Dumped Rip Rap	600.00	TN	24.598	6.150	2.051	32.799	54.66
10.06.02.02 C2 04 24" Dia Force Main	320.00	LF	14.953	3.738	1.247	19.938	62.31
10.06.02.02 C2 05 Flap Gate	1.00	EA	4.040	.808	.323	5.172	5171.73
10.06.02.02 C2 06 Channel Excavation	1600.00	LF	24.845	4.969	1.989	31.803	19.88
10.06.02.02 C2 07 Jacking under RR crossing	50.00	LF	55.377	13.844	4.617	73.838	1476.75
10.06.02.02 C2 08 Road Improvements	250.00	LF	3.021	.906	.262	4.189	16.76
10.06.02.02 C2 09 Fuel Wagon	1.00	EA	6.652	1.330	.532	8.515	8514.59
10.06.02.02 C2 10 Channel Lining	130.00	TN	4.796	1.199	.400	6.394	49.19
TOTAL Pump water from Grey's Chute	1.00	JB	327.522	78.930	27.109	433.561	433561
10.06.02.02 C3 Fox R. Water Control Structure							
10.06.02.02 C3 01 Excatn & Backfill for Structure	300.00	CY	18.575	4.644	1.549	24.768	82.56
10.06.02.02 C3 02 Channel Clearing & Excavation	1000.00	CY	2.841	.710	.237	3.788	3.79
10.06.02.02 C3 03 Stuctural Concrete	45.00	CY	32.839	8.210	2.738	43.787	973.04
10.06.02.02 C3 04 Structural Steel & Misc Metals	1.00	JB	10.606	2.651	.884	14.141	14141
10.06.02.02 C3 05 Rip Rap Erosion Protection	78.00	CY	24.993	6.248	2.084	33.324	427.23
TOTAL Fox R. Water Control Structure	1.00	EA	89.854	22.463	7.491	119.808	119808
10.06.02.02 C4 Old Lake Stoplog Structure							
10.06.02.02 C4 01 Excatn & Backfill for Structure	90.00	CY	1.370	.342	.114	1.827	20.30
10.06.02.02 C4 02 Channel Clearing & Excavation	3230.00	CY	62.137	15.534	5.180	82.851	25.65
10.06.02.02 C4 03 Structural Steel & Misc Metals	1.00	JB	8.919	2.230	.744	11.892	11892
TOTAL Old Lake Stoplog Structure	1.00	EA	72.425	18.106	6.038	96.570	96570
10.06.02.02 C5 Coin Pond Stop Log Structure							

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	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
10 06 02 02 C5 01 Excatn & Backfill for Structure	90.00	CY	1 370	342	114	1.827	20.30
10.06.02.02 C5 02 Channel Clearing & Excavation	4563.00	CY	56.209	14 052	4 686	74 947	16.42
10 06.02 02 C5 03 Structural Steel & Misc Metals	1.00	JB	8.919	2.230	744	11 892	11892
10 06 02 02 C5 04 Stoplog Structure Removal	1 00	JB	392	98	33	523	523 30
TOTAL Coin Pond Stop Log Structure	1.00	EA	66.890	16 722	5 577	89.189	89189
10.06 02.02 C6 Upper Slim Slough Stop Log Str							
10 06 02 02 C6 01 Excatn & Backfill for Structure	90 00	CY	1.370	342	114	1.827	20.30
10 06.02.02 C6 02 Channel Clearing & Excavation	370 00	CY	6 988	1.747	583	9 317	25 18
10 06 02 02 C6 03 Structural Steel & Misc Metals	1.00	JB	6 593	1.648	550	8 790	8790 36
10 06 02 02 C6 04 Stoplog Structure Removal	1.00	JB	392	98	33	523	523 30
TOTAL Upper Slim Slough Stop Log Str	1 00	EA	15.343	3.836	1 279	20.458	20458
10 06 02 02 C7 Lower Slim Slough Stop Log Str							
10 06 02 02 C7 01 Excatn & Backfill for Structure	90 00	CY	1.370	342	114	1.827	20 30
10 06 02 02 C7 02 Channel Clearing & Excavation	3011 00	CY	49 062	12.265	4 090	65 418	21.73
10 06 02.02 C7 03 Structural Steel & Misc Metals	1.00	JB	8 919	2 230	744	11 892	11892
TOTAL Lower Slim Slough Stop Log Str	1 00	EA	59.350	14 838	4 948	79.136	79136
TOTAL Coin Pond Slim Slough Old Lake	1.00	JB	797 616	189.579	65 842	1.053 037	1053037
TOTAL Enhance Wetlands	1 00	JB	920.788	215 311	75 774	1.211 872	1211872
10.06 03 Prairie Restoration							
10 06 03.01 Prairie Restoration							
10 06.03 01 D1 Prairie Restoration							
10 06.03.01 D1 01 Prairie Restoration	98 00	AC	144.626	36 157	12 058	192 840	1967 76
TOTAL Prairie Restoration	1.00	JB	144 626	36.157	12 058	192 840	192840
TOTAL Prairie Restoration	1 00	JB	144.626	36.157	12 058	192.840	192840
TOTAL Prairie Restoration	1.00	JB	144.626	36 157	12 058	192 840	192840
TOTAL FISH AND WILDLIFE FACILITIES	1 00	JB	1.714 359	386.625	140.128	2 241 112	2241112
10.30 PLANNING, ENGINEERING & DESIGN							
10 30.01 PLANNING ENGINEERING & DESIGN							

	QUANTY	UOM	CONTRACT	CONTINGN	ESCALATN	TOTAL COST	UNIT
10 30.01 01 PLANNING ENGINEERING & DESIGN							
10 30 01 01. 01 PLANNING. ENGINEERING & DESIGN							
10 30.01 01 01. 01 PLANNING. ENGINEERING & DESIGN	1 00	JB	698 000	0	46 554	744 554	744554
TOTAL PLANNING ENGINEERING & DESIGN	1.00	JB	698.000	0	46.554	744 554	744554
TOTAL PLANNING. ENGINEERING & DESIGN	1 00	JB	698 000	0	46 554	744 554	744554
TOTAL PLANNING ENGINEERING & DESIGN	1.00	JB	698.000	0	46.554	744 554	744554
TOTAL PLANNING. ENGINEERING & DESIGN	1 00	JB	698 000	0	46 554	744.554	744554
10 31 CONSTRUCTION MANAGEMENT							
10 31 01 CONSTRUCTION MANAGEMENT							
10.31 01 01 CONSTRUCTION MANAGEMENT							
10 31 01.01 01 CONSTRUCTION MANAGEMENT							
10.31.01.01 01. 01 CONSTRUCTION MANAGEMENT	1 00	JB	275 000	0	18 341	293 341	293341
TOTAL CONSTRUCTION MANAGEMENT	1.00	JB	275.000	0	18 341	293.341	293341
TOTAL CONSTRUCTION MANAGEMENT	1 00	JB	275 000	0	18.341	293 341	293341
TOTAL CONSTRUCTION MANAGEMENT	1 00	JB	275.000	0	18 341	293.341	293341
TOTAL CONSTRUCTION MANAGEMENT	1.00	JB	275 000	0	18.341	293 341	293341
TOTAL BASE BID	1 00	JB	2 687.359	386.625	205.023	3 279 007	3279007
TOTAL Fox Island HREP Final Final	1.00	EA	2.687.359	386 625	205 023	3 279.007	3279007

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	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
10 BASE BID								
10 02 RELOCATIONS								
TOTAL RELOCATIONS								
10 06 FISH AND WILDLIFE FACILITIES								
10.06 01 Plant Hardwood Mast Trees								
10 06 01.01 Planting Trees								
10.06 01 01 A1 Plant Root Production Method								
10 06 01.01. A1 01 Cover Crop, Seeding & Weeding	215 00 AC	154.418	28.449	14 629	19 750	2.172	219 419	1020 55
10 06 01 01 A1 02 Plant RPM Trees	215.00 AC	264 505	48 731	25.059	33.830	3 721	375.846	1748 12
TOTAL Plant Root Production Method	215 00 AC	418.923	77 181	39.688	53.579	5 894	595 265	2768.67
10 06 01 01 A2 Plant Trees By Seeding								
10 06 01 01 A2 01 Plant Trees by Seeding	60 00 AC	37.778	6.960	3.579	4.832	531	53.680	894.67
TOTAL Plant Trees By Seeding	60.00 AC	37 778	6 960	3.579	4 832	531	53 680	894 67
TOTAL Planting Trees	1 00 JB	456.701	84 141	43.267	58.411	6 425	648.945	648945
TOTAL Plant Hardwood Mast Trees	1.00 JB	456.701	84.141	43 267	58 411	6.425	648 945	648945
10.06 02 Enhance Wetlands								
10 06 02 01 Logsdon Slough								
10.06.02 01 B1 Pump Water from a New Well								
10 06 02.01. B1 01 Drill Well	100.00 LF	50.551	9.313	4 789	6 465	711	71 829	718.29
10.06 02 01 B1 02 Pump	1.00 EA	12 077	2 225	1.144	1 545	170	17 161	17161
10 06.02 01 B1. 03 Channel Excavation	200 00 LF	1.952	360	185	250	27	2 773	13 86
10 06.02.01 B1 04 Channel Lining	52.00 TN	3.375	622	320	432	47	4.796	92.22
10 06 02.01. B1 05 Portable Diesel Power Unit	1.00 EA	12 499	2.303	1 184	1.599	176	17.760	17760
10 06 02 01 B1 06 Fuel Wagon	1 00 EA	4 160	766	394	532	59	5 911	5911.31
10.06 02 01 B1. 07 Repair Stoplog Structure	1 00 EA	1 555	286	147	199	22	2.210	2209.57
10 06.02 01 B1. 08 Cap Existing Well	1 00 EA	516	95	49	66	7	733	732.83
TOTAL Pump Water from a New Well	1.00 JB	86.684	15.970	8.212	11.087	1 220	123.172	123172
TOTAL Logsdon Slough	1.00 JB	86 684	15.970	8 212	11.087	1 220	123 172	123172

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	QUANTY	UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
10 06 02 02 Coin Pond Slim Slough Old Lake									
10.06.02.02. C1 Pump Water from new well									
10 06 02 02 C1. 01 Drill Well	100 00	LF	50.551	9 313	4 789	6.465	711	71 829	718.29
10 06 02.02. C1 02 Pump	1.00	EA	12 077	2.225	1.144	1 545	170	17 161	17161
10.06.02.02. C1 03 Channel Excavation	2000.00	LF	42 556	7.840	4.032	5 443	599	60.470	30 23
10.06.02 02 C1 04 Channel Lining	130.00	TN	3.375	622	320	432	47	4.796	36.89
10 06 02 02 C1. 05 Road Improvements	1000 00	LF	8.428	1 553	798	1.078	119	11.976	11 98
TOTAL Pump Water from new well	1.00	JB	116 987	21.553	11.083	14 962	1.646	166 232	166232
10 06 02.02 C2 Pump water from Grey's Chute									
10.06.02.02 C2 01 Angled Drive Pump w/Power Unit	1 00	EA	75 915	13.986	7.192	9 709	1 068	107 870	107870
10 06.02.02. C2 02 Cantilevered Sheet Pile Wall	2250 00	SF	57 264	10.550	5.425	7 324	806	81 369	36 16
10 06 02 02 C2. 03 Dumped Rip Rap	600 00	TN	17.311	3 189	1 640	2.214	244	24 598	41 00
10 06 02 02. C2. 04 24" Dia Force Main	320.00	LF	10.524	1.939	997	1.346	148	14.953	46 73
10.06.02.02. C2 05 Flap Gate	1.00	EA	2 843	524	269	364	40	4.040	4040 30
10.06.02 02 C2 06 Channel Excavation	1600.00	LF	17 485	3.221	1.657	2 236	246	24.845	15.53
10.06 02 02 C2. 07 Jacking under RR crossing	50 00	LF	38.972	7.180	3.692	4 984	548	55 377	1107.53
10 06 02 02 C2. 08 Road Improvements	250 00	LF	2.126	392	201	272	30	3 021	12 08
10.06.02.02 C2 09 Fuel Wagon	1.00	EA	4 681	862	444	599	66	6 652	6651 84
10.06 02 02 C2 10 Channel Lining	130 00	TN	3 375	622	320	432	47	4.796	36 89
TOTAL Pump water from Grey s Chute	1 00	JB	230.497	42 466	21.837	29 480	3.243	327 522	327522
10 06 02 02 C3 Fox R Water Control Structure									
10 06 02 02. C3 01 Excatn & Backfill for Structure	300.00	CY	13.072	2 408	1.238	1 672	184	18 575	61 92
10.06.02.02. C3 02 Channel Clearing & Excavation	1000.00	CY	1 999	368	189	256	28	2 841	2.84
10.06.02 02 C3 03 Stuctural Concrete	45.00	CY	23 111	4.258	2 189	2.956	325	32 839	729 76
10 06 02 02 C3. 04 Structural Steel & Misc Metals	1 00	JB	7.464	1.375	707	955	105	10.606	10606
10 06 02 02 C3 05 Rip Rap Erosion Protection	78.00	CY	17.589	3 240	1.666	2 250	247	24.993	320 42
TOTAL Fox R. Water Control Structure	1 00	EA	63 235	11.650	5 991	8.088	890	89 854	89854
10 06 02 02. C4 Old Lake Stoplog Structure									
10.06.02 02. C4 01 Excatn & Backfill for Structure	90 00	CY	964	178	91	123	14	1.370	15 22
10.06.02 02 C4. 02 Channel Clearing & Excavation	3230 00	CY	43.729	8.057	4 143	5.593	615	62 137	19.24
10 06 02 02 C4. 03 Structural Steel & Misc Metals	1 00	JB	6.277	1 156	595	803	88	8 919	8918 64
TOTAL Old Lake Stoplog Structure	1 00	EA	50 970	9.391	4.829	6 519	717	72.425	72425
10 06 02 02 C5 Coin Pond Stop Log Structure									

** PROJECT INDIRECT SUMMARY - Level 6 **

	QUANTY	UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
10 06.02.02. C5. 01 Excatn & Backfill for Structure	90 00	CY	964	178	91	123	14	1 370	15.22
10 06.02 02 C5 02 Channel Clearing & Excavation	4563 00	CY	39.557	7 288	3.748	5 059	557	56 209	12.32
10 06 02 02 C5 03 Structural Steel & Misc Metals	1.00	JB	6 277	1.156	595	803	88	8.919	8918 64
10.06 02 02. C5. 04 Stoplog Structure Removal	1.00	JB	276	51	26	35	4	392	392 47
TOTAL Coin Pond Stop Log Structure	1 00	EA	47.074	8.673	4.460	6 021	662	66 890	66890
10 06.02.02 C6 Upper Slim Slough Stop Log Str									
10 06 02 02 C6. 01 Excatn & Backfill for Structure	90.00	CY	964	178	91	123	14	1 370	15.22
10 06.02.02 C6 02 Channel Clearing & Excavation	370 00	CY	4.918	906	466	629	69	6.988	18 89
10 06 02 02 C6 03 Structural Steel & Misc Metals	1 00	JB	4.640	855	440	593	65	6.593	6592 58
10 06 02 02. C6. 04 Stoplog Structure Removal	1 00	JB	276	51	26	35	4	392	392 47
TOTAL Upper Slim Slough Stop Log Str.	1.00	EA	10.798	1 989	1 023	1.381	152	15 343	15343
10 06 02 02 C7 Lower Slim Slough Stop Log Str									
10 06.02 02 C7 01 Excatn & Backfill for Structure	90.00	CY	964	178	91	123	14	1 370	15.22
10 06 02 02 C7 02 Channel Clearing & Excavation	3011 00	CY	34.528	6 361	3 271	4.416	486	49 062	16.29
10 06 02 02 C7. 03 Structural Steel & Misc Metals	1 00	JB	6.277	1 156	595	803	88	8.919	8918 64
TOTAL Lower Slim Slough Stop Log Str.	1.00	EA	41 768	7.695	3.957	5 342	588	59 350	59350
TOTAL Coin Pond Slim Slough Old Lake	1 00	JB	561.329	103 417	53 180	71.793	7.897	797 616	797616
TOTAL Enhance Wetlands	1.00	JB	648 013	119.387	61.392	82 879	9 117	920.788	920788
10.06 03 Prairie Restoration									
10 06 03 01 Prairie Restoration									
10.06 03 01. D1 Prairie Restoration									
10 06.03 01 D1 01 Prairie Restoration	98 00	AC	101 782	18.752	9 643	13 018	1 432	144 626	1475 78
TOTAL Prairie Restoration	1.00	JB	101.782	18 752	9.643	13 018	1 432	144 626	144626
TOTAL Prairie Restoration	1 00	JB	101 782	18 752	9 643	13.018	1.432	144 626	144626
TOTAL Prairie Restoration	1.00	JB	101.782	18.752	9.643	13.018	1 432	144.626	144626
TOTAL FISH AND WILDLIFE FACILITIES	1.00	JB	1 206.496	222 280	114.302	154 308	16 974	1 714.359	1714359
10 30 PLANNING ENGINEERING & DESIGN									
10.30.01 PLANNING. ENGINEERING & DESIGN									

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	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
10 30.01.01 PLANNING ENGINEERING & DESIGN								
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TOTAL BASE BID	1 00 JB	2 179 496	222 280	114 302	154.308	16.974	2.687.359	2687359
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Escalation							386 625	
SUBTOTAL							3.073.984	
Contingency							205 023	
TOTAL INCL OWNER COSTS							3 279 007	

No errors detected

* * * END OF ERROR REPORT * * *

K-18

SUMMARY REPORTS SUMMARY PAGE

PROJECT OWNER SUMMARY - Level 6. 1
PROJECT INDIRECT SUMMARY - Level 6 5

No Detailed Estimate

No Backup Reports .

* * * END TABLE OF CONTENTS * * *

K-19

REAL ESTATE PLAN

APPENDIX L

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-13F)

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 353.6 THROUGH 358.5
CLARK COUNTY, MISSOURI

APPENDIX L

REAL ESTATE PLAN

1. PURPOSE OF REAL ESTATE PLAN

This Real Estate Plan (REP) is prepared in support of the Definite Project Report (DPR) of the Fox Island Division Habitat Rehabilitation and Enhancement Project. The Upper Mississippi River System – Environmental Management Program (UMRS-EMP) is currently a Federal-State partnership to plan, construct, and evaluate measures for fish and wildlife habitat improvement through Habitat Rehabilitation and Enhancement Projects. The original authority is in WRDA 1986 (PL 99-662) Section 1103. This is the only REP developed for this project.

2. DESCRIPTION OF FEATURES

The Fox Island Division Habitat Rehabilitation and Enhancement Project is based on rehabilitating and enhancing the habitat in the Great River National Wildlife Refuge (NWR), which is centrally located within the Mark Twain NWR complex. The Great River NWR stretches along 100 miles of the Mississippi River in Illinois and Missouri and is managed as four large tracts. Fox Island Division is one of the large tracts. Key management goals are to enhance the quality and diversity of fish and wildlife habitat, especially habitat for migrating birds, and to restore floodplain functions in the river corridor. It is located on the right descending bank (west side) of the Mississippi River immediately downstream of Alexandria in the SE corner of Clark County, Missouri.

Three main features are identified as most beneficial.

A. Feature 1 – Plant Hardwood Mast Trees. Container-grown stock will be planted on 215 acres while direct seeding of mast trees will occur on 60 acres. This will occur on higher ground at the north end of the Division.

B. Feature 2 – Enhance Wetlands. This is divided into two specific locations with various activities in each to enhance the wetlands.

1. Enhance Logsdon Slough. Logsdon Slough is about 25 acres in size. A new well will be installed to enhance the water level. Stop logs would be used as a water control structure.

2. Enhance Coin Pond, Slim Slough, and Old Lake on the east side of the Fox River. These three areas total about 53 acres. A new well will supply water and also a surface water pump will supply water through a force main installed beneath the railroad. Stop log water control structures will be used to manage water levels within the wetlands.

C. Feature 3 - Grassland Restoration. This will occur on 98 acres of the Logsdon Tract which is west of the Fox River Levee system.

3. SPONSOR-OWNED REAL ESTATE RIGHTS

All of the lands required for the project are owned by the Federal Government and are managed as the Great River National Wildlife Refuge by the U. S. Fish and Wildlife Service (USFWS). Some of the land in the area of Logsdon Slough has been incorporated into the Natural Resources Conservation Service (NRCS) Wetland Reserve Program (WRP). The recommended feature at Logsdon Slough should not violate that agreement, but should still be coordinated with the NRCS. A levee owned by Mississippi and Fox River Levee and Drainage District is within the project boundary. The USFWS has obtained an access easement from the Levee and Drainage District. This easement is used for ingress to and egress from the West Half of the Southeast Quarter (W½SE¼) of Section Twenty-four (24), and the West Half of the Northeast Quarter (W½NE¼) of Section Twenty-five (25), Township Sixty-four (64) North, Range Six (6) West, by U.S. Fish and Wildlife Service employees or their authorized representatives.

4. PROPOSED ESTATES AND REAL ESTATE ISSUES

In accordance with ER 405-1-12, only standard estates are proposed for the project. The fee estate is required for environmental projects and it is the estate owned by the Federal Government

An existing railroad and a Clarke County road bisect a small portion of the Federal ownership. They are located between the major portion of the project and the Mississippi River. In order to obtain additional water for the project, the plan intends to bore through the existing Railroad embankment and under the county road for a force main pipeline to the river. A permit from the Railroad and from the County will be obtained before construction begins. This technique of obtaining a permit for a pipeline through a railroad embankment was approved and used in a previous EMP for the Trempealeau, Wisconsin, National Wildlife Refuge. The EMP for the Trempealeau NWR is very similar to this project because it also had a railroad embankment separating the refuge from the Mississippi River. The Definite Project Report dated January 1994 included information on using a permit to bore through the embankment. The report was approved. The permit was signed in 1995 with a consideration of $10,000 which was paid to the railroad. Construction of the project began in 1995 and was completed in September 1999.

There is an abandoned but not vacated county road in the area of Feature 2, *Enhance Wetlands*. At this study phase it is difficult to tell exactly the impact of the project on the county road. Since the road is no longer used, the USFWS is working with the county to have the road vacated and the unencumbered ownership assigned to the Federal Government. It is expected that the country road will be vacated before the final Definite Project Report is prepared.

5. EXISTING FEDERAL PROJECT

The project is totally within an existing Federal project, The Great River National Wildlife Refuge of The Mark Twain National Wildlife Refuge Complex.

6. EXISTING FEDERAL LANDS

The Environmental Management Program is specifically developed for lands that are already under the ownership of the Federal Government.

7. NAVIGATIONAL SERVITUDE

Since this is not a navigation project, and because no project feature serves a purpose which is in aid of commerce, the navigational servitude is not available, nor is it needed, for the necessary real estate rights

8. MAPS

Maps of each feature with the necessary right-of-way outlined are included.

9. INDUCED FLOODING

One of the features for this environmental restoration project is the impoundment of water on land as part of the enhancement of the existing wetland in Logsdon Slough, Coin Pond, Slim Slough, and the Old Lake Complex. Flooding is not expected to be induced outside any other feature boundaries by the construction, operation, or maintenance of the project.

10. BASELINE COST ESTIMATE FOR REAL ESTATE

A Baseline Cost Estimate for Real Estate was not developed because the land is owned by the Federal Government and the project is not cost-shared with an agency outside of the Federal Government.

11. PUBLIC LAW (PL) 91-646 RESIDENCE/BUSINESS RELOCATIONS

There are no PL 91-646 relocations necessary for the project. No person, farms, or business will be displaced as a result of the project.

12. TIMBER AND MINERALS

Because this is an environmental enhancement project, the intention is to avoid the removal of timber whenever possible. No significant minerals are known within the project boundary.

13. NON-FEDERAL SPONSOR'S ACQUISITION CAPABILITY

Since all of the land is already owned in fee by the Federal Government., no acquisition is expected for this project. Therefore, there is no reason for this checklist.

14. ZONING ORDINANCES

The land is located within the Great River National Wildlife Refuge. Clark County has no zoning ordinances. Any villages or towns would have their own zoning, but since the project does not encompass any village or town, the project land is not zoned.

15. ACQUISITION SCHEDULE

No acquisition of land will be needed since the land is owned in fee by the Federal Government. However, the permits to bore under the railroad and under the county road may take a significant amount to time and will need to be obtained before construction starts.

16. FACILITY/UTILITY RELOCATIONS

No facilities or utilities will be relocated for this project. Although there is the existing but abandoned road within the project, there is no visible evidence of utility easements along the road. The onsite Refuge Manager is not aware of any utilities within the road easement.

17. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

No evidence of existing or potential HTRW sites was noted during an inspection of the project right-of-way. Based upon information gathered during the Corps of Engineers assessment, it is reasonable to assume that no HTRW will be encountered within or near the project. There should be no impact to real estate by HTRW. This is discussed further in Appendix F, *Hazardous, Toxic, and Radioactive Waste Documentation Report.*

18. SUPPORT OR OPPOSITION BY LANDOWNERS

Most landowners in the area support the concept of enhancing the Fox Island Division.

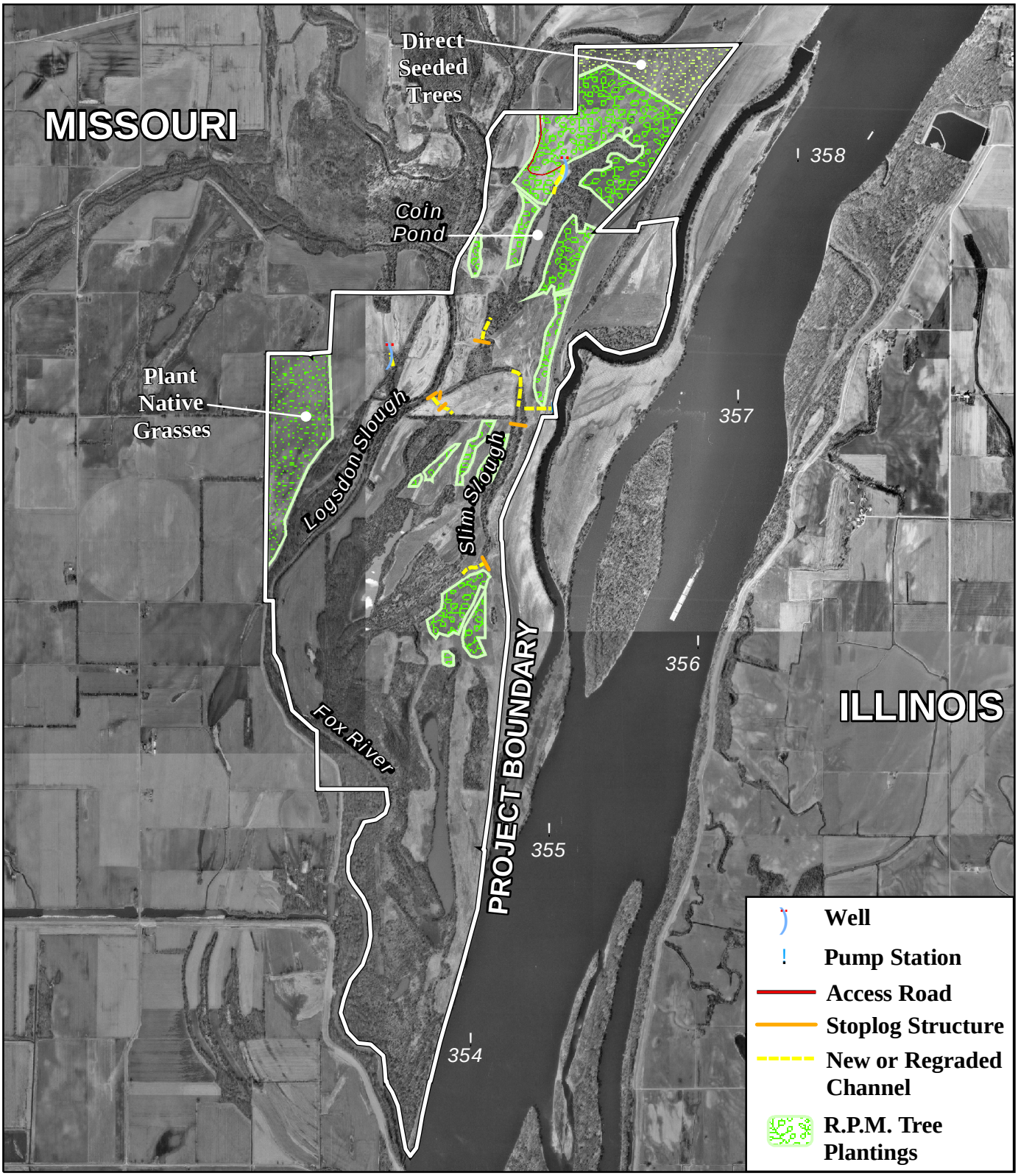
19. NOTICE TO SPONSOR REGARDING RISKS

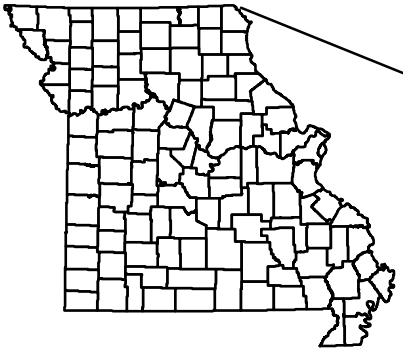
Notice to the sponsor regarding risks of acquisition prior to the signing of the agreement is not necessary since no acquisitions are expected.

20. OTHER ISSUES

There are no other issues.

RALPH J. WERTHMANN
Chief of Real Estate
Rock Island District





Fox Island Habitat Rehabilitation And Enhancement Project

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HISTORIC PROPERTIES DOCUMENTATION

APPENDIX M

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FOX ISLAND DIVISION HABITAT REHABILITATION
AND ENHANCEMENT PROJECT

POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX M
HISTORIC PROPERTIES DOCUMENTATION
REQUIRED BY 36 CFR 800.11(e)

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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POOL 20, MISSISSIPPI RIVER MILES 358.5 THROUGH 353.6
CLARK COUNTY, MISSOURI

APPENDIX M
HISTORIC PROPERTIES DOCUMENTATION
REQUIRED BY 36 CFR 800.11(e)

1. INTRODUCTION AND PURPOSE

This appendix is the repository for historic properties documentation and references cited in the integrated environmental assessment (EA). The project and historic properties documentation in main report—along with the information in this appendix and the historic properties correspondence in Appendix A—constitute the documentation required at 36 CFR 800.11(e).

2. REFERENCES

Benn, David W.
2004 *Intensive Archaeological Survey for Historic Properties at the New Pump Station, Fox Island EMP Project, Mississippi River Pool 20, Clark County, Missouri.* Report prepared under US Army Corps of Engineers, Rock Island District, Contract No. DACW25-03-D-0001, Work Order No. 0004, by Bear Creek Archeology, Inc., Cresco, Iowa (draft, April 2004, BCA #1190).

Benn, David W., and Arne Hengesteg
2002 *Archival, Historical, Archaeological, and Geomorphological Background Literature and Records Review and Research for Historic Properties at the Fox Island Division of the Great River National Wildlife Refuge, Mississippi River Pool 20, Clark County, Missouri.* Report prepared under US Army Corps of Engineers, Rock Island District, Contract No. DACW25-98-D-0001, Work Order No. 0036, by Bear Creek Archeology, Inc., Cresco, Iowa (BCA #1080).

Hoppin, Art, and David W. Benn
2004 *Phase I Archaeological Survey and Geomorphological Evaluation for Historic Properties, Fox Island EMP Project, Clark County, Missouri.* Report prepared under US Army Corps of Engineers, Rock Island District, Contract No. DACW25-03-D-0001, Work Order No. 0001, by Bear Creek Archeology, Inc., Cresco, Iowa (BCA #1149).

ARCHIVAL, HISTORICAL, ARCHAEOLOGICAL, AND GEOMORPHOLOGICAL BACKGROUND LITERATURE AND RECORDS REVIEW AND RESEARCH FOR HISTORIC PROPERTIES AT THE FOX ISLAND DIVISION OF THE GREAT RIVER NATIONAL WILDLIFE REFUGE MISSISSIPPI RIVER POOL 20 CLARK COUNTY, MISSOURI

CONTRACT NO. DACW25-98-D-0001
WORK ORDER NO. 0036

BCA #1080

THIS VOLUME CONTAINS SITE LOCATIONAL INFORMATION
NOT FOR PUBLIC DISTRIBUTION

Prepared for
U.S. Army Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Prepared by
David W. Benn
Principal Investigator
and
Arne Hengesteg

Bear Creek Archeology, Inc.
P.O. Box 347
Cresco, Iowa 52136
David G. Stanley, Director

December 2002
FINAL

MANAGEMENT SUMMARY

The purpose of this report is to present a literature review, landform and site modeling, and recommendations for Phase I archeological survey that may be required as a result of the reconnaissance study being conducted for the Fox Island Division (FID) of the Great River National Wildlife Refuge, Mississippi River Pool 20, Clark County, Missouri. The FID is located within Mississippi River Pool 20 about two miles south of Alexandria, Missouri. The study area covers 849.8 ha (2,100 ac.) bottomland and wetlands or sloughs within sections 17-20, 30, 31, and 6 of Vernon Township, T64N, R5W, within sections 24, 25, and 36 of Clay Township, T64N, R6W, and a tiny portion of Section 1, T63N, R6W in Clark County, Missouri, between river miles 353.5-358.3. Bear Creek Archeology, Inc., conducted the FID literature search for the Rock Island District, Corps of Engineers under terms of Contract No. DACW25-98-D-0001, Work Order No. 0036. Background research was accomplished in late August, 2002, at the State of Missouri State Historic Preservation Office, Jefferson City, Missouri and the State of Missouri Historical Society, Columbia, Missouri. No recorded prehistoric or historic archeological sites or standing structures are present within the study area. Landform sediment assemblages include a portion of the Kingston Terrace (KINGSA), the Early-Middle Holocene Channel belt (EMHOL2), and the Late Holocene Channel Belt (LAHOL). Archeological potential of these landforms are discussed.

Background research into the prehistory and history of the northeastern Missouri region provides evidence for human presence during the late Paleoindian (ca. 10,500 B.P.) through the Historic periods. The earliest materials that might be present within the study area belong to the Early Archaic period (ca. 9500 B.P.). Site settlement models are not available for the Mississippi River valley of northeastern Missouri, although some information comes from The Sny across the river in Illinois. Therefore, the potential for archeological sites within the study area is open to investigation. If and when adverse effects from development are planned for the Fox Island Division, intensive archeological survey is recommended for the KINGSA and EMHOL2 LSAs, while archeological reconnaissance in the form of deep probing is recommended for the LAHOL LSA.

PHASE I ARCHAEOLOGICAL SURVEY AND GEOMORPHOLOGICAL EVALUATION FOR HISTORIC PROPERTIES, FOX ISLAND EMP PROJECT CLARK COUNTY, MISSOURI

CONTRACT NO. DACW25-03-D-0001
WORK ORDER NO. 0001

BCA #1149

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Prepared for
U. S. Army Corps of Engineers, Rock Island District
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204-2004

Prepared by
Art Hoppin
and
David W. Benn
Principal Investigator

Bear Creek Archeology, Inc.
P. O. Box 347
Cresco, Iowa 52136
David G. Stanley, Director

January 2004
FINAL

MANAGEMENT SUMMARY

This report presents the findings of a Phase I archeological survey and geomorphologic evaluation of historic properties for the Fox Island EMP project in Clark County, Missouri. Bear Creek Archeology, Inc. (BCA) conducted this survey for the Rock Island District Army Corps of Engineers (RICOE) under the terms of Contract No. DACW25-03-D-0001, Work Order No. 0001. This report details the information gathering process concerning cultural resources that may exist in or near the project area, provides descriptions of the cultural resources encountered within the project area, and provides recommendations concerning the potential impacts on these cultural resources. BCA conducted the fieldwork portion of this investigation August 19-28, 2003.

The project areas are located on Fox Island District (FID) land owned and managed by the U.S. Fish and Wildlife Service as a part of the Great River National Wildlife Refuge. The FID is located within Mississippi River Pool 20 about 3.2 km (2 mi.) south of Alexandria, Missouri. The total project area is 194.2 ha (480 ac.). Within the 194.2 ha (480 ac.) area specific environmental plans include native grass plantings 32.4 ha (80 ac.), wetland enhancement 24.3 ha (60 ac.), and hard mast tree plantings 137.6 ha (340 ac.). Two landform sediment assemblage (LSA) units are found in the project area. A portion of a Kingston terrace (KINGSA) consisting of 33.6 ha (83 ac.) and landforms associated with the Early-Middle Holocene channel belt (EMHOL2) consisting of 160.6 ha (397 ac.), represent the two LSA units. Two small borrow areas are slated for a portion of the KINGSA project area.

The KINGSA was investigated by a combination of pedestrian reconnaissance and shovel testing. A total of 84 shovel tests were dug on the KINGSA and eight other shovel tests were dug to investigate historic depressions. The EMHOL2 was investigated by digging 284 bucket auger tests.

A literature review for all land in the FID was conducted and no previously recorded sites were found within the project area. Nine sites are recorded within 1.6 km (1 mi.) of the project area. Two historic sites (23CK346 and 23CK347) and one prehistoric site (23CK345) were identified in the project area by this present investigation. Neither of the two historic sites have intact foundations or subsurface features, and neither is considered eligible for the National Register of Historic Places (NRHP). The prehistoric site is situated between 70-110 cm below ground surface, well below deposits of post-settlement alluvium and the Ap horizon. Site 23CK345 is small, measuring 3 x 12 m (9.8 x 39.3 ft.). The site is intact and well preserved. This site is considered to be potentially eligible for the NRHP under Criterion D.

The proposed zone of impact at 23CK345 will be to the uppermost 20-30 cm with the planting of tree seedlings. Despite the likelihood that this site will not be impacted, BCA recommends that this site location be avoided. If avoidance is not plausible then steps should be taken to test the site further. BCA recommends that no further cultural resource work is necessary for the project area, with the exception of 23CK345 if impact to the site can not be avoided.

INTENSIVE ARCHEOLOGICAL SURVEY FOR HISTORIC PROPERTIES AT THE NEW PUMP STATION FOX ISLAND EMP PROJECT MISSISSIPPI RIVER POOL 20 CLARK COUNTY, MISSOURI

CONTRACT NO. DACW25-03-D-0001
WORK ORDER #0004

BCA #1190

THIS VOLUME CONTAINS SITE LOCATIONAL INFORMATION
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Prepared for
U.S. Army Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illlinois 61204-2004

Prepared by
David W. Benn
Principal Investigator

Bear Creek Archeology, Inc.
P.O. Box 347
Cresco, Iowa 52136
David G. Stanley, Director

April 2004
DRAFT

MANAGEMENT SUMMARY

This report presents the findings of a Phase I archeological survey and geomorphologic evaluation of historic properties for a pump station on the eastern side of the Fox Island EMP project in Clark County, Missouri. Bear Creek Archeology, Inc. conducted this survey for the Rock Island District Army Corps of Engineers under the terms of Contract No. DACW25-03-D-0001, Work Order No. 0004. This report details the information gathering process concerning cultural resources that may exist in or near the project area, provides descriptions of the cultural resources encountered within the project area, and develops recommendations concerning the potential impacts on these cultural resources. The fieldwork portion of this investigation during the period of April 19-22, 2004. A literature review for all land in the FID was conducted in 2003, and no previously recorded sites were found within the project area.

The pump station project area is located in the SW1/4 of the NE1/4 of Section 19, T64N, R5W, Clark County, Missouri, on the eastern side of the Fox Island EMP on land owned and managed by the U.S. Fish and Wildlife Service as a part of the Great River National Wildlife Refuge. This area is within Mississippi River Pool 20, 3.2 km (2 mi.) south of Alexandria, Missouri. The proposed pump station will be placed on a rectangular impact zone of about 48.8 x 121.9 m (160 x 400 ft.) positioned on the right bank of Greys Island slough. Roughly 83.8 m (275 ft.) of discharge pipe will be buried beneath the railroad grade on the western side of the pump station. The entire impact zone covers slightly less than .6 ha (about one acre).

The survey consisted of bankline examination along the slough and excavation of 19 bucket auger holes within the proposed impact zone. Limestone rocks, a fragment of barbed wire fence, and a fragment of rodent bone were recovered from the surface plowzone, post-settlement alluvium layer, and in the case of the bone from the buried soil. These materials were introduced during the historic period and are not deemed significant cultural finds. All were discarded. The report recommends that no significant cultural resources exist within the project area, and construction of the pump station and discharge pipe should proceed with no additional archeological investigations.

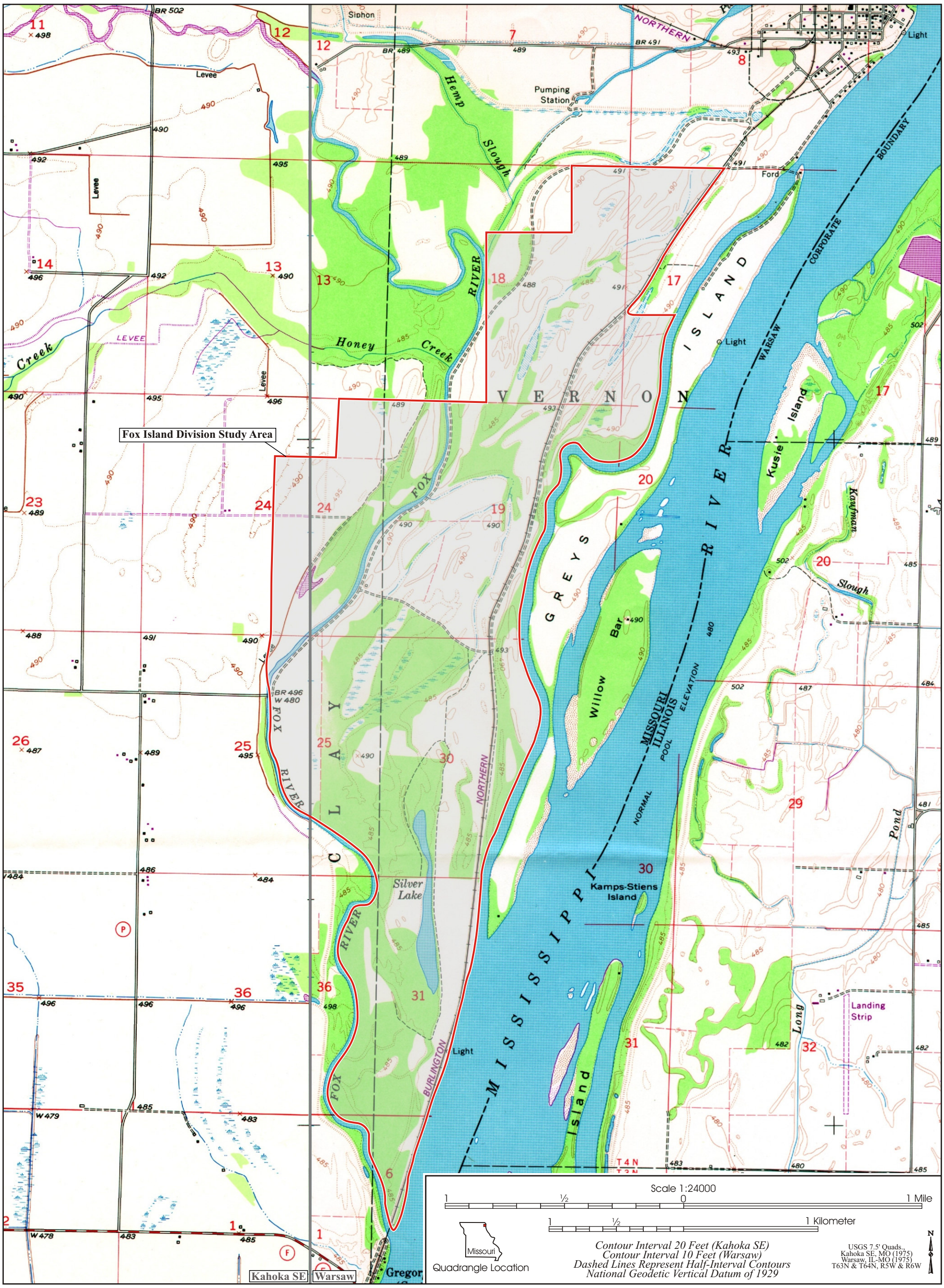

Figure 2. Fox Island Division on the Kahoka SE and Warsaw quadrangles.

BCA #1080

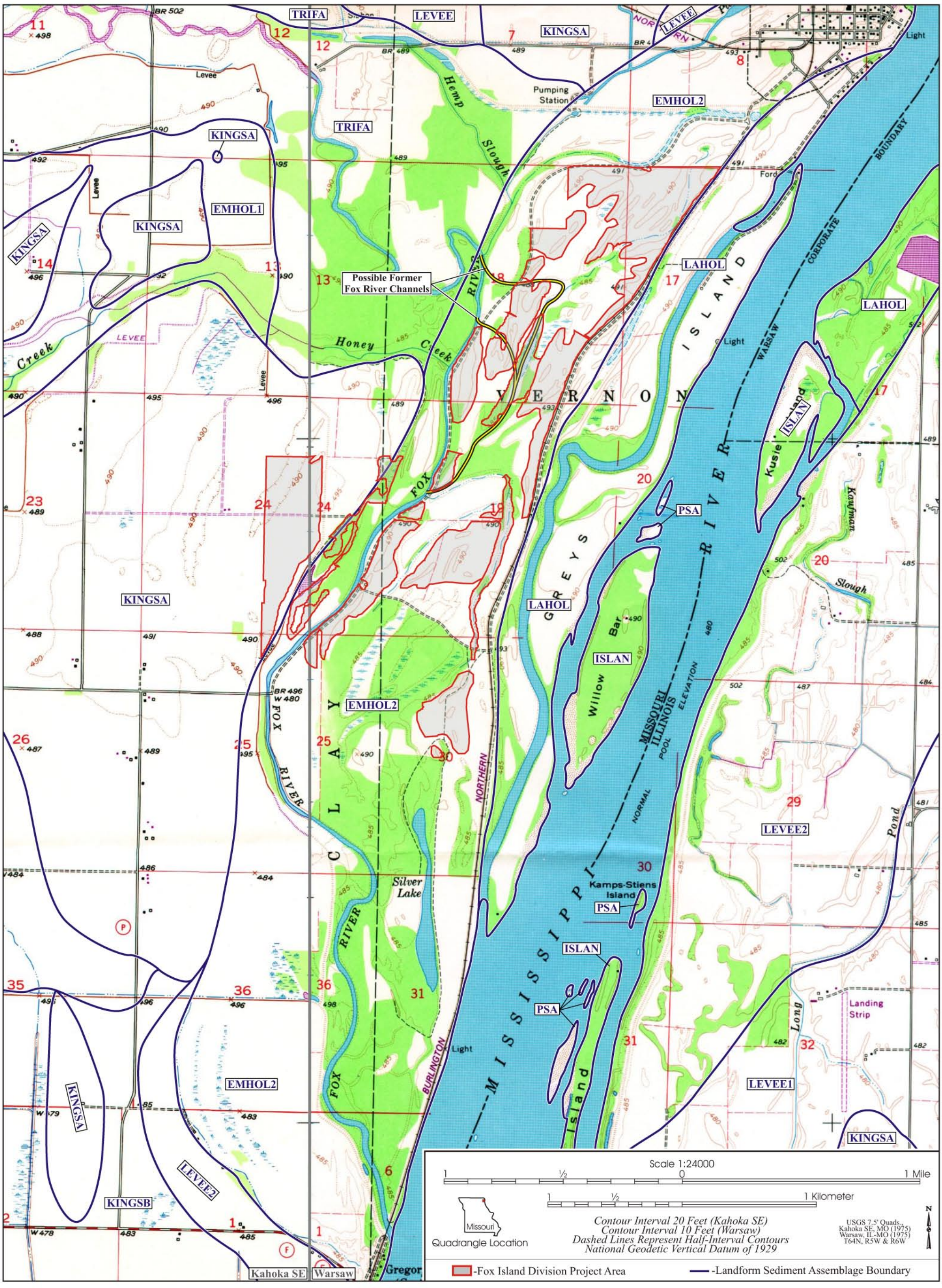

Figure 2. Landform Sediment Assemblages and possible former Fox River channels in the vicinity of the Fox Island Division project area.
Field Dates: 8/19/03-8/28/03 BCA #1149

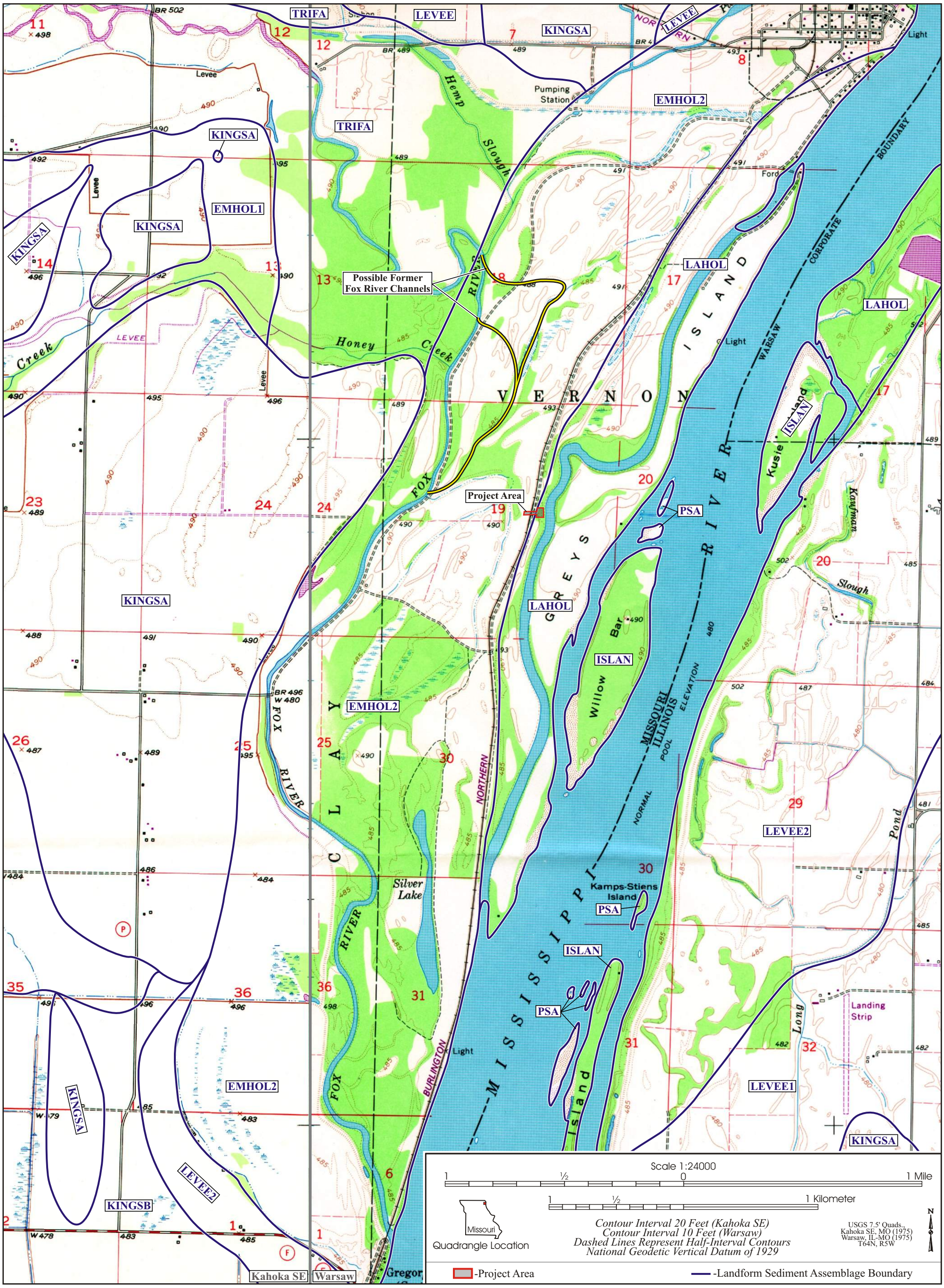

Figure 2. Landform Sediment Assemblages and possible former Fox River channels in the vicinity of the project area.
Field Date: 4/2004 BCA #1190

DISTRIBUTION LIST

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HONORABLE JIM TALENT UNITED STATES SENATOR UNITED STATES SENATE 493 RUSSELL SENATE OFFICE BLDG WASHINGTON DC 20510				1/0					
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HONORABLE KENNY HULSHOF REPRESENTATIVE IN CONGRESS-9TH DIST US HOUSE OF REPRESENTATIVES 412 CANNON HOUSE OFFICE BLDG WASHINGTON DC 20515-2509				1/0					
CLARK COUNTY FARM SERVICE AGENCY OFFICE RR 1 BO 16A KAHOKA MO 63445				1/0					

[1] Number of copies of CD's and number of paper copies to distribute (CD/Paper)

[2]

I -Draft Coordination Documents
II - Public Review Documents
III - Administration Approval Documents
IV - Construction Plans and Specifications
V - Operations and Maintenance Instructions
VI - Project Performance Evaluation Documents

	I	II	III	IV	V	VI	1/
REGIONAL FORESTER US DEPT OF AGRICULTURE - FOREST SVC 626 E WIS AVE MILWAUKEE WI 53202-4616		1/0					
DIRECTOR US DEPT OF ENERGY 1000 INDEPENDENCE AVE SW WASHINGTON DC 20585		1/0					
COMMANDER US DEPT OF HOMELAND SECURITY - US COAST GUARD 8TH DIST AUXILIARY 1222 SPRUCE ST ST LOUIS MO 63103		1/0					
DIRECTOR US DEPT OF INTERIOR 424 CLARK HALL - UNIV OF MISSOURI COLUMBIA MO 65201		1/0					
DIRECTOR (ATTN: SHEILA HUFF) US DEPT OF THE INTERIOR 1849 C ST NW MS 2349 WASHINGTON DC 20240		1/0					
USDA NATURAL RESOURCES CONSERVATION SERVICE ROUTE 1 - BOX 16A KAHOKA MO 63445		1/0					
DORIS BAUTCH GREAT LAKES REGION DIRECTOR US DEPT OF TRANSPORTATION MARITIME ADMINISTRATION 1701 E WOODFIELD RD STE 203 SCHAUMBURG IL 60173	1	1/0	1/0			1	
SHARONNE BAYLOR EMP COORDINATOR UMRF&WR US FISH AND WILDLIFE SERVICE 51 E 4TH ST RM 101 WINONA MN 55987	1	1/1	1/1		1	1	
JOHN DOBROVOLNY REG HISTORIC PRESERVATION OFCR US FISH AND WILDLIFE SERVICE - REG 3 BISHOP HENRY WHIPPLE FED BLDG - 1 FEDERAL DR FORT SNELLING MN 55111-4056	0/1	1/0	1/0		1	1	

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III - Administration Approval Documents
IV - Construction Plans and Specifications
V - Operations and Maintenance Instructions
VI - Project Performance Evaluation Documents

FOX ISLAND 91L 17 MAY 06	I	II	III	IV	V	VI	1/
JON DUYVEJONCK US FISH AND WILDLIFE SERVICE 4469 48TH AVE CT ROCK ISLAND IL 61201	1	1/0	1/0		1	1	
DAVE ELLIS US FISH AND WILDLIFE SERVICE PO BOX 88 ANNADA MO 63343	1	1/1	3/3			1	
AL FENEDICK US ENVIRONMENTAL PROTECTION AGENCY - REG 5 77 W JACKSON BLVD CHICAGO IL 60604	1	1/0	1/0			1	
JOSEPH FERNANDES US ENVIRONMENTAL PROTECTION AGENCY 1200 PENNSYLVANIA AVE NW 6406J WASHINGTON DC 20460		1/0					
JOSEPH FERRANTE US ENVIRONMENTAL PROTECTION AGENCY 1200 PENNSYLVANIA AVE NW 6406J WASHINGTON DC 20460		1/0					
BRIAN FORD BRANCH MANAGER US DEPT OF TRANSPORTATION 300 MAIN ST STE 500 KEOKUK IA 52632-5800		1/0					
ROBERT GOODWIN JR US DOT - MARITIME ADMINISTRATION 1222 SPRUCE ST STE 2.202F ST LOUIS MO 63103-2831		1/0					
JAMES GULLIFORD REGIONAL ADMINISTRATOR US ENVIRONMENTAL PROTECTION AGENCY - REG 7 901 N 5TH ST KANSAS CITY KS 66101-2907		1/0					

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RICHARD HAINJE REGIONAL DIRECTOR FEDERAL EMERGENCY MGMT AGENCY - REG VII 9221 WARD PKWY STE 300 KANSAS CITY MO 64114-3323		1/0					
MIKE JAWSON CENTER DIRECTOR US GEOLOGICAL SURVEY 2630 FANTA REED RD LA CROSSE WI 54603	1	1/0	1/0			1	
LINDA LAWSON DIRECTOR US DEPT OF TRANSPORTATION 400 7TH ST SW RM 10305 P-39 WASHINGTON DC 20590-0001		1/0					
DR KEN LUBINSKI US GEOLOGICAL SURVEY THE NATURE CONSERVANCY 2630 FANTA REED RD LA CROSSE WI 54603	1	1/0	1/0			1	
GINGER MOLITOR US FISH AND WILDLIFE SERVICE 4469 48TH AVE CT ROCK ISLAND IL 61201	1	1/0	1/0			1	
RICHARD NELSON FIELD SUPERVISOR US FISH AND WILDLIFE SERVICE 4469 48TH AVE CT ROCK ISLAND IL 61201	1	1/1	1/1			1	
DICK STEINBACH US FWS MARK TWAIN NATL WILDLIFE REFUGE 1704 N 24TH ST QUINCY IL 62301	1	1/0	1/1			1	
WILLIE TAYLOR US DEPT OF INTERIOR 1849 C ST NW WASHINGTON DC 20460		1/0					

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PAM THIEL PROJECT LEADER US FISH AND WILDLIFE SERVICE 555 LESTER AVE ONALASKA WI 54650-8552			1	1/0	1/0			1	
KAREN WESTPHALL US FISH AND WILDLIFE SERVICE 1704 N 24TH ST QUINCY IL 62301			1	1/0	1/1			1	
CHARLES WOOLEY ASST REG DIR FOR ECOLOGICAL SVCS US FISH AND WILDLIFE SERVICE 1 FEDERAL DR BHW FEDERAL BLDG FORT SNELLING MN 55111			1	1/0	1/0			1	
POSTMASTER POST OFFICE 102 N PERRY ST MONTICELLO MO 63457-9998				1/0					
POSTMASTER POST OFFICE PO BOX 9998 ALEXANDRIA MO 63430-9998				1/0					
DICK STEINBACH US FWS MARK TWAIN NATL WILDLIFE REFUGE 1704 N 24TH ST QUINCY IL 62301			1	1/0	1/1			1	
WILLIE TAYLOR US DEPT OF INTERIOR 1849 C ST NW WASHINGTON DC 20460				1/0					
PAM THIEL PROJECT LEADER US FISH AND WILDLIFE SERVICE 555 LESTER AVE ONALASKA WI 54650-8552			1	1/0	1/0			1	
KAREN WESTPHALL US FISH AND WILDLIFE SERVICE 1704 N 24TH ST QUINCY IL 62301			1	1/0	1/1			1	

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CHARLES WOOLEY ASST REG DIR FOR ECOLOGICAL SVCS US FISH AND WILDLIFE SERVICE 1 FEDERAL DR BHW FEDERAL BLDG FORT SNELLING MN 55111	1	1/0	1/0			1	
POSTMASTER POST OFFICE PO BOX 9998 CANTON MO 63435-9998		1/0					
POSTMASTER POST OFFICE PO BOX 9998 QUINCY IL 62301-9998		1/0					
POSTMASTER US POST OFFICE 113 E DES MOINES ST WAYLAND MO 63472-9998		1/0					
OWEN DUTT RIVER NAVIGATOR US ARMY ENGR DIST - ST LOUIS 1222 SPRUCE ST ST LOUIS MO 63103-2833	1	1/0	1/0			1	
DON POWELL US ARMY ENGR DIST - ST PAUL 190 5TH ST E ST PAUL MN 55101-1638	1	1/1	1/1			1	
SUSAN SMITH US ARMY ENGR DIS - MISSISSIPPI VALLEY PO BOX 80 1400 WALNUT ST VICKSBURG MS 39180-0080	10	0/10	0/10	1	1	2	
MIKE THOMPSON US ARMY ENGINEER DIST - ST LOUIS 1222 SPRUCE ST ST LOUIS MO 63103-2833	1	1/1	1/1			1	

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CHARLES WOOLEY ASST REG DIR FOR ECOLOGICAL SVCS US FISH AND WILDLIFE SERVICE 1 FEDERAL DR BHW FEDERAL BLDG FORT SNELLING MN 55111	1	1/0	1/0			1	
POSTMASTER POST OFFICE PO BOX 9998 CANTON MO 63435-9998		1/0					
POSTMASTER POST OFFICE PO BOX 9998 QUINCY IL 62301-9998		1/0					
MIKE FLASPOHLER MO DEPT OF CONSERVATION 2901 W TRUMAN BLVD PO BOX 180 JEFFERSON CITY MO 65102-0180	1	1/0	1/0			1	
MIKE GRIFFIN WILDLIFE BIOLOGIST IA DEPT OF NATURAL RESOURCES 206 ROSE ST BELLEVUE IA 52031	1	1/1	1/1			1	
JEFF JANVRIN HABITAT PROJECTS COORDINATOR WI DEPT OF NATURAL RESOURCES 3550 MORMON COULEE RD LA CROSSE WI 54601	1	1/0	1/1			1	
DAN KIRBY IA DEPT OF NATURAL RESOURCES 206 ROSE ST BELLEVUE IA 52031			1/0				
RON KUCERA DIRECTOR - INTERGOV'T COOPERATION MO DEPT OF NATURAL RESOURCES 12TH FL DIRECTOR'S OFC 205 JEFFERSON ST JEFFERSON CITY MO 65102		1/0					

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MIKE MC GHEE SUPERVISORY POLICY & COORDINATION IA DEPT OF NATURAL RESOURCES 502 E 9TH ST DES MOINES IA 50319	1	1/1	1/0			1	
MARK MILES DEPUTY STATE HISTORIC PRESERV OFCR MO DEPT OF NATURAL RESOURCES PO BOX 176 JEFFERSON CITY MO 65102		1/0					
RICK MOLLAHAN CORPS OF ENGRS ECOSYS PROG IL DEPT OF NATURAL RESOURCES ONE NATURAL RESOURCES WAY SPRINGFIELD IL 62702-1271	1	1/1	1/1			1	
JANIE MONKS MO DEPT OF NATURAL RESOURCES PO BOX 176 JEFFERSON CITY MO 65102		1/0					
TRAVIS MOORE MO DEPT OF CONSERVATION 653 CLINIC RD HANNIBAL MO 63401	1	1/0	1/0			1	
MIKE PARRISH MO DEPT OF TRANSPORTATION - RUTLEDGE MODOCK RTE 1 BOX 149 RUTLEDGE MO 63563		1/0					
TIM SCHLAGENHAFT MN DEPT OF NATURAL RESOURCES 2300 SILVER CREEK RD NE ROCHESTER MN 55906	1	1/0	1/0			1	
JANET STERNBURG CHIEF POLICY COORDINATOR MO DEPT OF CONSERVATION 2901 W TRUMAN BLVD PO BOX 180 JEFFERSON CITY MO 65102-0180	1	1/0	1/1			1	

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DARLENE SWEARINGEN MO DEPT OF CONSERVATION RR 1 BOX 98 BARING MO 63531	1	1/1	1/1			1	
JOHN TUCKER IL NATURAL HISTORY SURVEY 8450 MONTCLAIR AVE BRIGHTON IL 62012		1/0					
HONORABLE JOHN CAUTHORN SENATOR MO STATE SENATE STATE CAPITOL BLDG RM 427 JEFFERSON CITY MO 65101		1/0					
HONORABLE BRIAN MUNZLINGER MO STATE REPRESENTATIVE MO HOUSE OF REPRESENTATIVE 201 CAPITOL AVE RM 411A JEFFERSON CITY MO 65101		1/0					
COUNTY ENGINEER CLARK COUNTY COURT HOUSE KAHOKA MO 63445		1/0					
PRESIDING COMMISSIONER CLARK COUNTY COMMISSION COUNTY COURTHOUSE 111 E COURT ST STE 4 KAHOKA MO 63445		1/0					
WAYNE BLUM PRESIDING COMMISSIONER CLARK COUNTY COMMISSION 111 E CT ST KAHOKA MO 63445		1/0					
LEIH ANN HAYDEN COUNTY CLERK CLARK COUNTY 111 E CT ST STE 4 KAHOKA MO 63445		1/0					

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HONORABLE JAMES BOATMAN MAYOR CITY OF WAYLAND 105 S MAIN ST PO BOX 282 WAYLAND MO 63472				1/0					
RON BODE CITY HALL PO BOX 400 KEOKUK IA 52632				1/0					
HONORABLE HERB BUTLER MAYOR CITY OF KAHOKA 250 N MORGAN KAHOKA MO 63445				1/0					
HONORABLE JOHN J CLARK MAYOR CITY OF CANTON 106 N 5TH PO BOX 231 CANTON MO 63435				1/0					
HONORABLE ROBERT DAVIS MAYOR CITY OF ALEXANDRIA PO BOX 194 ALEXANDRIA MO 63430				1/0					
BOB DAVIS CITY OF ALEXANDRIA 103 JOSS ALEXANDRIA MO 63430				1/0					
RON GATES CITY OF ALEXANDRIA 228 CLAY ALEXANDRIA MO 63430				1/0					
HONORABLE DAVID GUDGEL MAYOR CITY OF KEOKUK PO BOX 400 415 BLONDEAU ST KEOKUK IA 52632-0400				1/0					

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HONORABLE ROY HARK MAYOR CITY OF HANNIBAL 320 BROADWAY HANNIBAL MO 63401				1/0					
HONORABLE HAROLD LUDWIG MAYOR CITY OF LA GRANGE 200 W WASHINGTON ST PO BOX 302 LA GRANGE MO 63448				1/0					
HONORABLE JOHN SPRING MAYOR CITY OF QUINCY 730 MAINE ST QUINCY IL 62301-4053				1/0					
H SCOTT SUMMERS CO ATTORNEY CLARK COUNTY 111 E CT ST STE 4 KAHOKA MO 63445-1268				1/0					
J L MORGAN CHAIRMAN DES MOINES-MISSISSIPPI LEVEE DIST #1 PO BOX 217 KEOKUK IA 52632-0217				1/0					
HENRY DIENST COMMISSIONER MISS & FOX RIVER DRAINAGE DIST NO 2 RR 1 BOX 190 ALEXANDRIA MO 63430				1/0					
CHAIRMAN CLARK COUNTY CONSERVATION BOARD COURT HOUSE KAHOKA MO 63445				1/0					
DON ABNEY PRINCIPAL CHIEF SAC AND FOX NATION OF OKLAHOMA RT 2 BOX 246 STROUD OK 74079				1/0					

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DEANNE BAHR NAGPRA COORDINATOR SAC & FOX NATION OF MO IN KS & NB 305 N MAIN RESERVE KS 66434-9723				1/0				
JOYCE BEAR NAGPRA MUSCOGEE (CREEK) NATION OF OKLAHOMA PO BOX 580 OKMULGEE OK 74447				1/0				
ROBERT BEAVER PRINCIPAL CHIEF MUSCOGEE (CREEK) NATION OF OKLAHOMA PO BOX 580 OKMULGEE OK 74447				1/0				
CHAIRMAN JOHNATHAN BUFFALO HISTORIC PRESERVATION OFFICER SAC & FOX TRIBE OF THE MISSISSIPPI IN IA 349 MESKWAKI RD TAMA IA 52339-9629				1/0				
TERRY D COLE NAGPRA COORDINATOR CHOCTAW NATION OF OKLAHOMA PO DRAWER 1210 16TH & LOCUST STREET DURANT OK 74701				1/0				
CHARLES ENYART CHIEF & NAGPRA EASTERN SHAWNEE TRIBE OF OKLAHOMA PO BOX 350 SENECA MO 64865				1/0				
SANDRA KEO DELEGATE SAC & FOX OF MISSOURI 305 N MAIN RR 1 BOX 60 RESERVE KS 66434				1/0				
MARIANNE LONG CULTURAL PRESERVATIONIST IOWA TRIBE OF OKLAHOMA RR 1 BOX 721 PERKINS OK 74059				1/0				

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SANDRA MASSEY NAGPRA COORDINATOR SAC AND FOX NATION RT 2 BOX 246 STROUD OK 74079				1/0					
PATT MURPHY NAGPRA REP IA TRIBE OF KANSAS & NEBRASKA 206 S BUCKEYE AVE ABILENE KS 67410				1/0					
CHRISTINE NORRIS TRIBAL CHIEF JENA BAND OF CHOCTAW INDIANS PO BOX 14 JENA LA 71342-0014				1/0					
JULIE OLDS CULTURAL PRESERVATION OFFICER MIAMI TRIBE OF OKLAHOMA PO BOX 1326 MIAMI OK 74355				1/0					
GEOGORY PYLE CHIEF CHOCTAW NATION OF OKLAHOMA PO BOX DRAWER 1210 1TH & LOCUST ST DURANT OK 74702				1/0					
VICTOR ROUBIDOUX CULTURAL LIAISON IOWA TRIBE OF OKALAHOMA RR 1 BOX 721 PERKINS OK 74059				1/0					
LILLIE STRANGE ENVIRONMENTAL DEPARTMENT JENA BAND OF CHOCTAW INDIANS PO BOX 14 JENA LA 71342-0014				1/0					
ALEX WALKER COUNCIL CHAIRMAN SAC & FOX TRIBE MISSISSIPPI IN IOWA 349 MESKWAKI RD TAMA IA 52339-9629				1/0					

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A C WILSON NAGPRA SAC AND FOX NATION OF OKLAHOMA RT 2 BOX 246 STROUD OK 74079		1/0				
DIRECTOR ALIANCE LIBRARY SYSTEM 515 YORK ST QUINCY IL 62301-3937		1/0	1/0			
DIRECTOR CANTON PUBLIC LIBRARY 409 LEWIS ST CANTON MO 63435-1529		1/0	1/0			
DIRECTOR CATTERMOLE MEMORIAL LIBRARY 614 - 7TH ST FORT MADISON IA 52627		1/0	1/0			
DIRECTOR HANNIBAL FREE PUBLIC LIBRARY 200 S 5TH ST HANNIBAL MO 63401-4499		1/0	1/0			
DIRECTOR KEOKUK PUBLIC LIBRARY 210 N 5TH ST KEOKUK IA 52632		1/0	1/0			
DIRECTOR LA GRANGE PUBLIC LIBRARY 114 S MAIN LA GRANGE MO 63448		1/0	1/0			
DIRECTOR PARLIN-INGERSOLL LIBRARY 205 W CHESTNUT CANTON IL 61520		1/0	1/0			
DIRECTOR QUINCY PUBLIC LIBRARY 526 JERSEY ST QUINCY IL 62301		1/0	1/0			

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DIRECTOR SEVER CLARK COUNTY LIBRARY 207 W CHESTNUT ST KAHOKA MO 63445-1403				1/0	1/0				
IZAAK WALTON LEAGUE OF AMERICA PO BOX 494 MOBERLY MO 65270				1/0					
CONSERVATION CHAIR SIERRA CLUB EASTERN MISSOURI GROUP 7164 MANCHESTER AVE ST LOUIS MO 63143-2534				1/0					
ST LOUIS AUDUBON SOCIETY PO BOX 220227 ST LOUIS MO 63128				1/0					
BILL GRANT DIRECTOR IZAAK WALTON LEAGUE OF AMERICA 1619 DAYTON AVE #202 ST PAUL MN 55104				1/0					
PAUL HANSEN EX DIRECTOR IZAAK WALTON LEAGUE OF AMERICA 1619 DAYTON AVE #202 ST PAUL MN 55104				1/0					
KEN MIDKIFF SIERRA CLUB 1005 BELLVIEW CT COLUMBIA MO 65203				1/0					
BARB NARAMORE UPPER MISSISSIPPI RIVER BASIN ASSOC (UMRBA) 415 HAMM BLDG 408 ST PETER ST ST PAUL MN 55102				1/0					
BILL REDDING ASSOCIATE REPRESENTATIVE SIERRA CLUB - MIDWEST OFFICE 214 N HENRY ST STE 203 MADISON WI 53703				1/0					

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ROGER STILL EXEC DIR MO AUDUBON SOCIETY 2620 FORUM BLVD STE C-1 COLUMBIA MO 65203		1/0					
HOLLY STOERKER DIRECTOR UPPER MISSISSIPPI RIVER BASIN ASSOC (UMRBA) 415 HAMM BLDG 408 ST PETER ST ST PAUL MN 55102	1	1/0	1/0			1	
CLARK COUNTY HISTORICAL SOCIETY PO BOX 202 KAHOKA MO 63445		1/0					
VALERIE DECARLO HISTORIC PRESERVATION SPECIALIST ADVISORY COUNCIL ON HISTORIC PRESERVATION 1100 PENNSYLVANIA AVE NW #809 WASHINGTON DC 20004		1/0					
DON KLIMA DIRECTOR -EASTERN OFC OF PROJ REVIEW ADVISORY COUNCIL ON HISTORIC PRESERVATION 1100 PENNSYLVANIA AVE NW #809 WASHINGTON DC 20004		1/0					
WITHERS GENERAL MANAGER WITHERS BROADCASTING 108 WASHINGTON ST PO BOX 427 KEOKUK IA 52632		1/0					
ROBIN DELANEY EDITOR FORT MADISON DAILY DEMOCRAT 1226 AVE H FORT MADISON IA 52627		1/0					
JEFF HANAN EDITOR THE DAILY GATE CITY - NEWS ROOM PO BOX 430 KEOKUK IA 52632		1/0					

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JOE ROBERTS EDITOR HOME TOWN JOURNAL 258 W MAIN ST KAHOKA MO 63445-1661				1/0					
KEVIN FOX THE MEDIA PO BOX 230 KAHOKA MO 63345-0230				1/0					
HAZEL SMITH EDITOR THE MEDIA PO BOX 230 KAHOKA MO 63445-0230				1/0					
KIRX KRXL FM PO BOX 130 KIRKSVILLE MO 63501				1/0					
KMEM RADIO 326 E JEFFERSON ST MEMPHIS MO 63555				1/0					
KQCA-FM RADIO PO BOX 711 2333 PALMYRA RD HANNIBAL MO 63401				1/0					
JILLYN SHOEMAKER NEWS DIRECTOR KHQA RADIO 301 S 36TH ST QUINCY IL 62301				1/0					
DIRECTOR INSIGHT COMMUNICATIONS 2930 STATE ST QUINCY IL 62301				1/0					
DIRECTOR KIRKSVILLE PUBLIC SCHOOL TELEVISION STUDIO 1515 S COTTAGE GROVE AVE KIRKSVILLE MO 63501				1/0					

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KOKX RADIO 108 WASHINGTON KEOKUK IA 52632				1/0					
DIRECTOR KTVO ABC 3 TELEVISION 15518 US HWY 63 KIRKSVILLE MO 63501-6905				1/0					
MATT SCHMIDT KHQA TV 301 S 36TH ST QUINCY IL 62301				1/0					
CHARLES POSEY PUBLISHER DEMOCRAT COMPANY PO BOX 160 FORT MADISON IA 52627-0160				1/0					
LARRY DERR 2242 350TH ST KEOKUK IA 52532					1/0				
TERESA HESH 2286 DANFORD LN KEOKUK IA 52532					1/0				
ALICE HOLTBURG 2503 245TH AVE FORT MADISON IA 52627					1/0				
EDITH JOHNSON RT 1 BOX 83 REVERE MO					1/0				

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JERRY K 402 HICKORY TERR KEOKUK IA 52632					1/0				
BERNARD LOGSDON 411 EICHEN KEOKUK IA 52532					1/0				
CHARLES RUDD 709 DONALDSON CANTON MO 63435					1/0				
STEVE SCHMAUL 2154 WHITE PLAINS RD MONTROSE IA 52639					1/0				
DONALD YOUNG 2698 253 AVE MONTROSE IA 52639					1/0				

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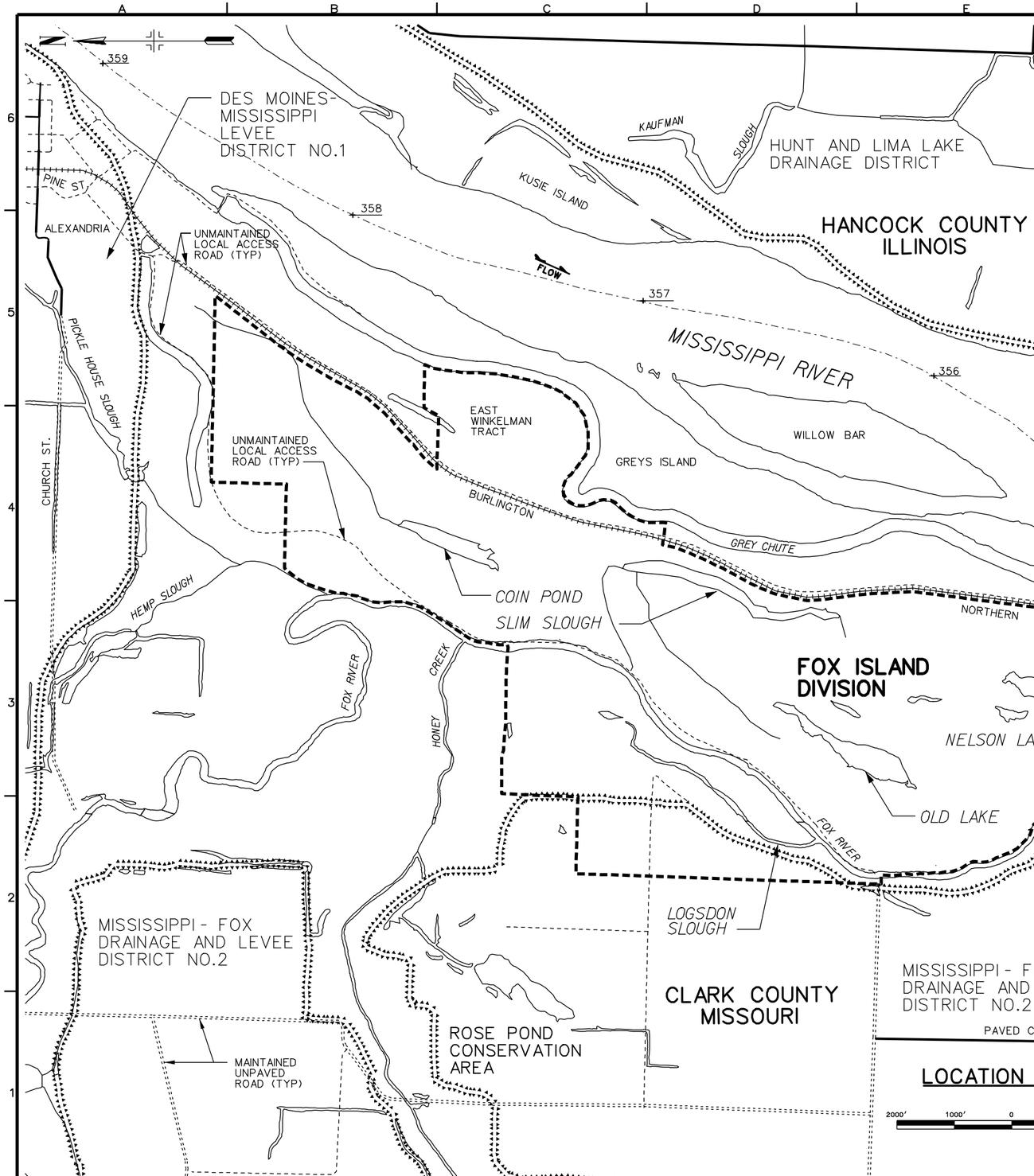
CEMVR-CD	1	1/0	1/0	11	1	1
CEMV-R-CD-C	1	1/0	1/0	1		1
CEMVR-CT	1	1/0	1/0	1		
CEMVR-EC	1	1/0	1/0	1	1	1
CEMVR-EC-C				1		
CEMVR-EC-D	1	1/0	1/0	1	1	1
CEMVR-EC-DE				5		
CEMVR-EC-DN	3	3/3	3/3	1	1	1
CEMVR-EC-G	1	1/0	1/0	1	1	1
CEMVR-EC-H	1	1/1	1/0	1	1	1
CEMVR-EC-HH	1	1/0	1/0	1	1	1
CEMVR-EC-HQ	1	1/0	1/0	1	1	1
CEMVR-EM					1	
CEMVR-IM-CL	1	1/1	2/2			
CEMVR-LM				1		
CEMVR-OC	1	1/0	1/0	1		
CEMVR-OD	1	1/0	1/0	1	1	1
CEMVR-OD-MN	1	1/0	1/0	1	1	1
CEMVR-OD-MN (LUNDH)	1	0/1	1/0	1	1	1
CEMVR-OD-SI	1	1/0	1/0	1	1	1
CEMVR-OD-T (DEVOS)	1	1/0	1/0	1	1	1
CEMVR-PA	1	1/0	1/0			1
CEMVR-PM-F	2	2/2	2/2			2
CEMVR-PM-A	1	3/3	3/3	1	1	1
CEMVR-PM-F (NILES)	1	3/3	1/1	1	1	1
CEMVR-PM-M (HUBBELL)	1	1/1	1/0		1	1
CEMVR-PM-M (GOETZMANN	)2	2/2	2/2		2	
CEMVR-RE	1	1/0	1/0			
CEMVR-RE-P	1	1/0	1/0			

Plates



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5	POTENTIAL ENHANCEMENT FEATURES - EVALUATED
6	PUMP STATION
7	FOX RIVER STOPLOG STRUCTURE - GENERAL PLAN
8	FOX RIVER STOPLOG STRUCTURE - MASONRY & REINFORCING
9	FOX RIVER STOPLOG STRUCTURE - DETAILS
10	GALVANIZED STOPLOG STRUCTURE
11	MISCELLANEOUS SECTIONS & DETAILS
12	WATER CONTROL SCHEMATIC
13	LOCATION OF SOIL BORINGS
14	SOIL BORING LOGS
15	SOIL BORING LOGS
16	POST-CONSTRUCTION EVALUATION PLAN

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK
Drawn By: GMR
Checked By: DPM
Reviewed By: DPM
Date: 27 JULY, 2004
Scale: AS SHOWN
Project Code: EP84
Solicitation Number: DACW25-01-D-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

LOCATION PLAN & VICINITY MAP

PLATE 1

30-JUN-2005 14:13
d:\EB4504\06504\Cad\EP84W-PL1.dgn

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed By: MJK	Date: 27 JULY, 2004		
Drawn By: GMR	Scale: AS SHOWN		
Checked By: DPM	Project: Coast EP84		
Reviewed By: DPM	Solicitation Number: DACW25-01-B-0008		

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

RECOMMENDED PLAN

PLATE 2

30-JUN-2005, 14:07
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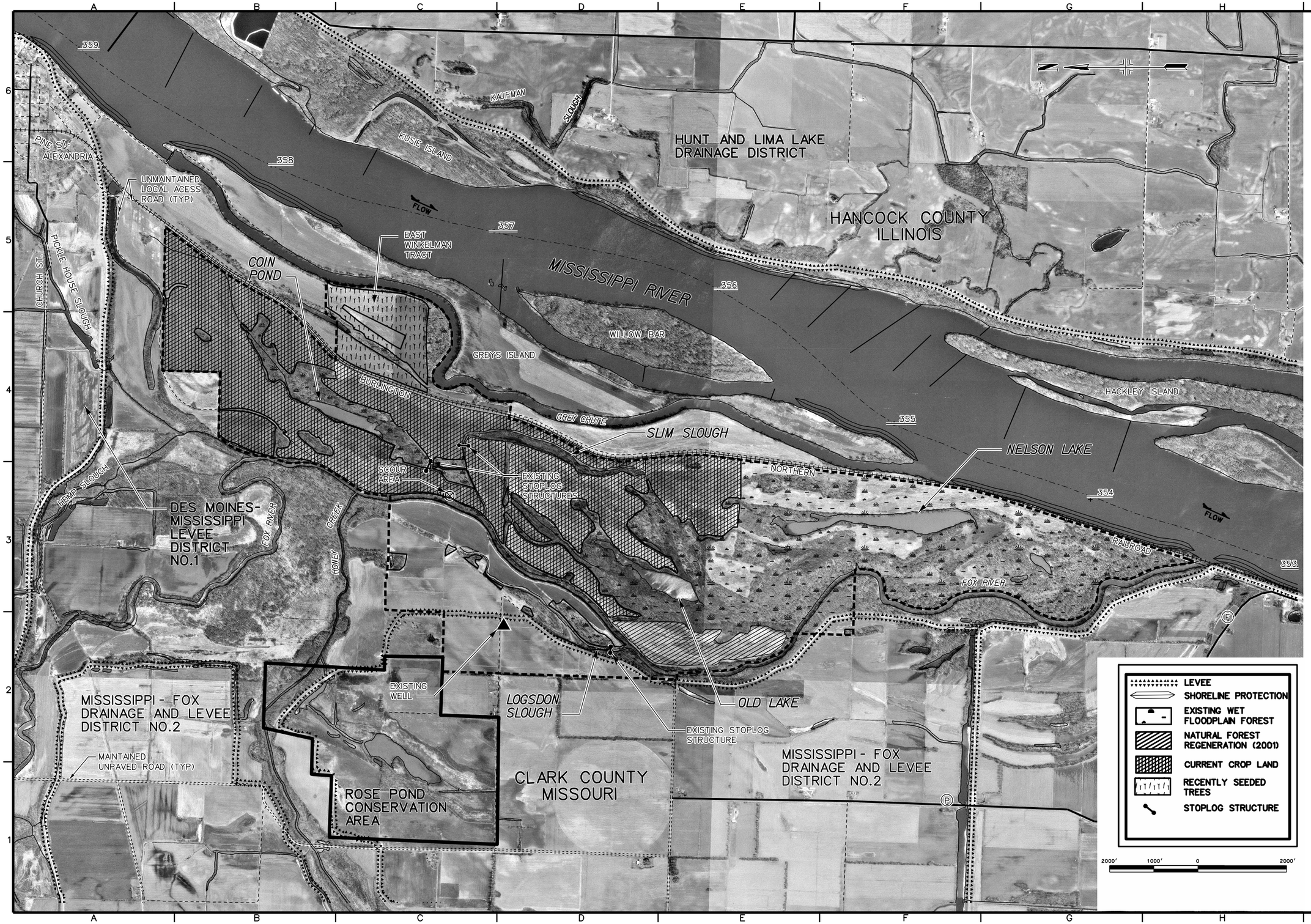

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK
Drawn By: CMR
Checked By: DPM
Reviewed By: DPM
Date: 27 JULY, 2004
Scale: AS SHOWN
Project Code: EP84
Solicitation Number: DACW25-01-D-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

EXISTING CONDITIONS SITE PLAN

PLATE 3

30-JUN-2005 14:10
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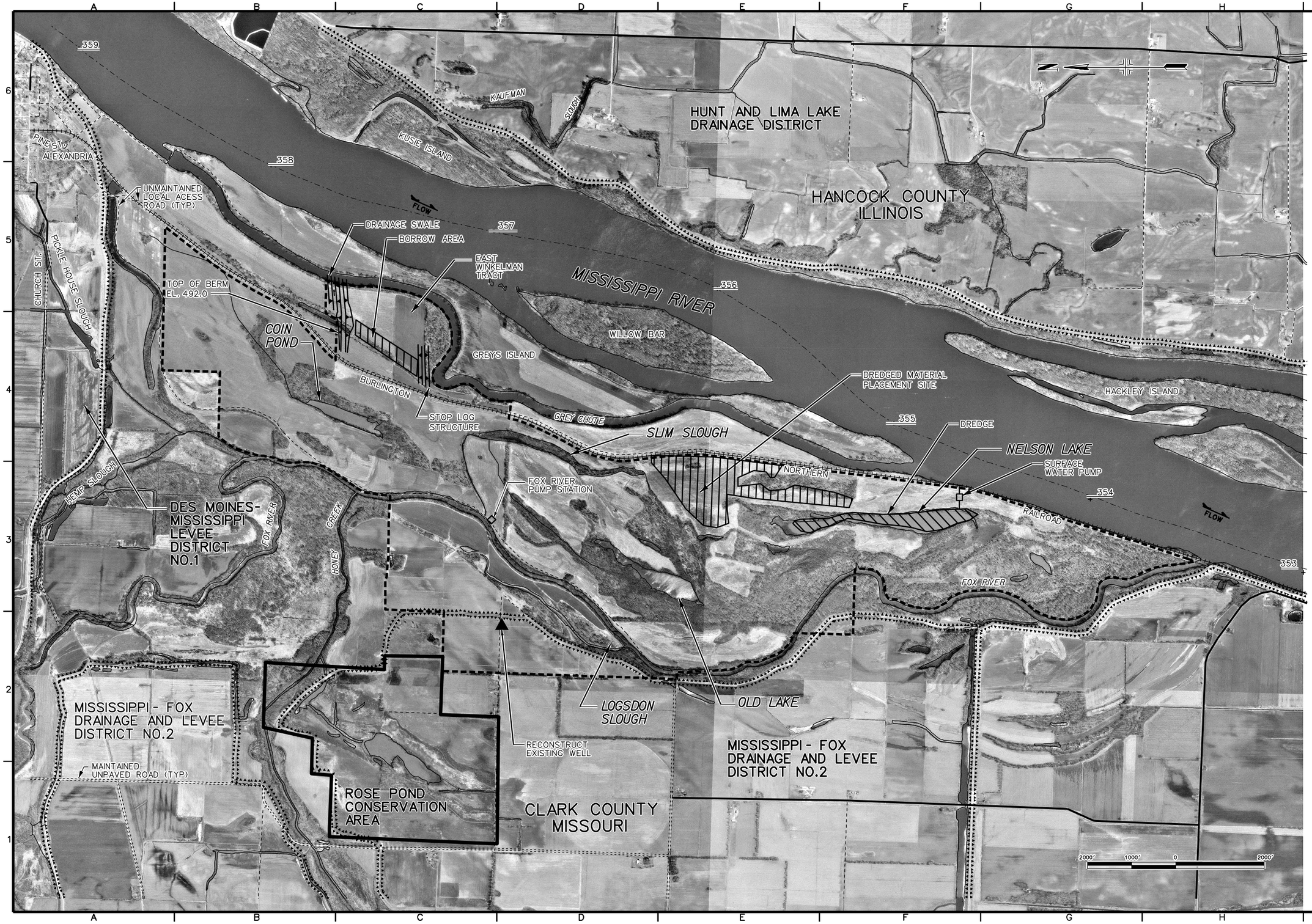

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Date: 27 JULY, 2004
Scale: AS SHOWN
Project Code: EP84
Solicitation Number: DACW25-01-D-0008

Designed By: MJK
Drawn By: GMR
Checked By: DPM
Reviewed By: DPM

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6
POTENTIAL ENHANCEMENT FEATURES NOT EVALUATED

PLATE 4

30-JUN-2005 14:22
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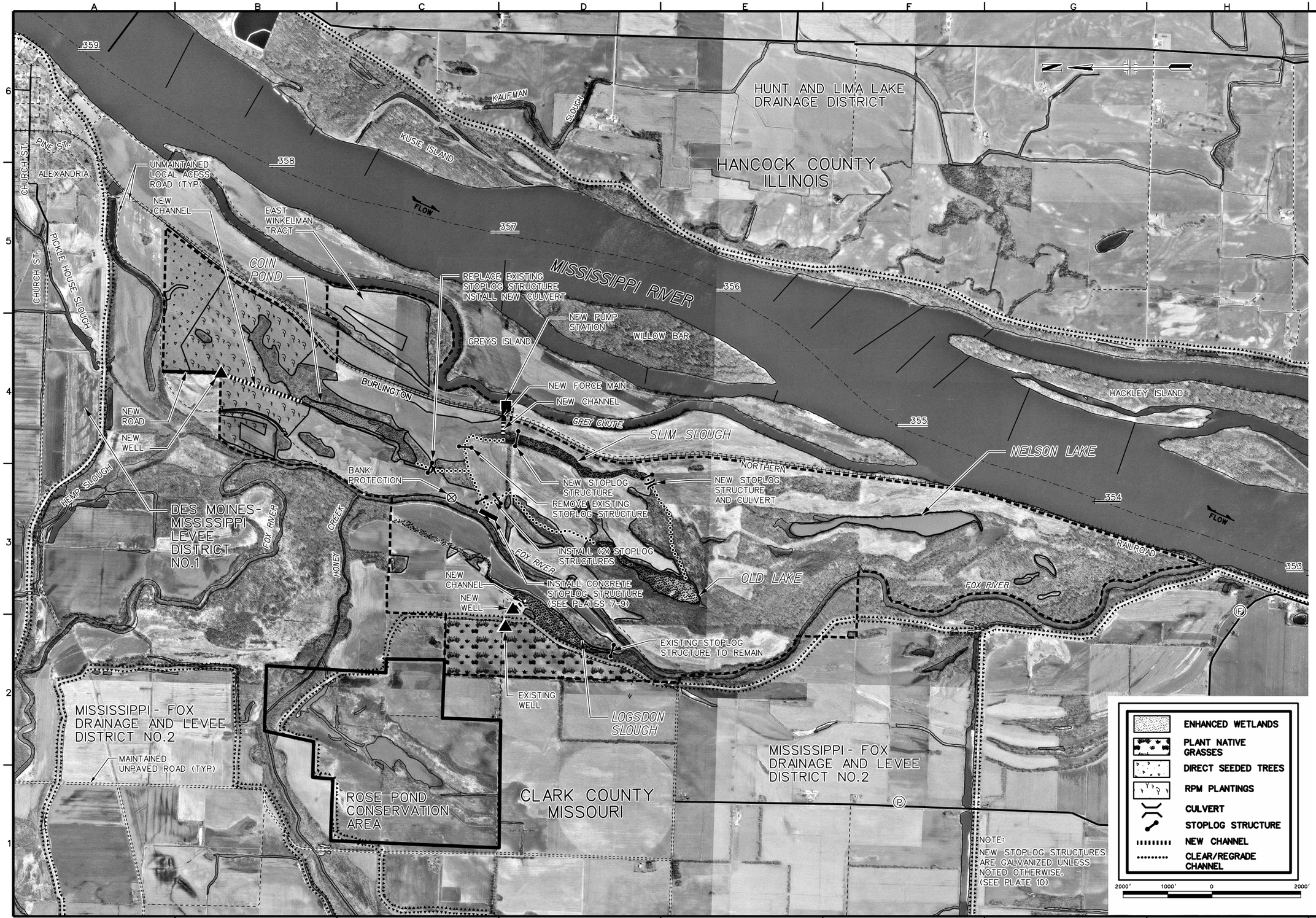

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK
Date: 27 JULY, 2004
Drawn By: GMR
Scale: AS SHOWN
Checked By: DPM
Project: Fox Island
Reviewed By: DPM
Solicitation Number: DACW25-01-D-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

POTENTIAL ENHANCEMENT FEATURES-EVALUATED

PLATE 5

30-JUN-2005 14:24
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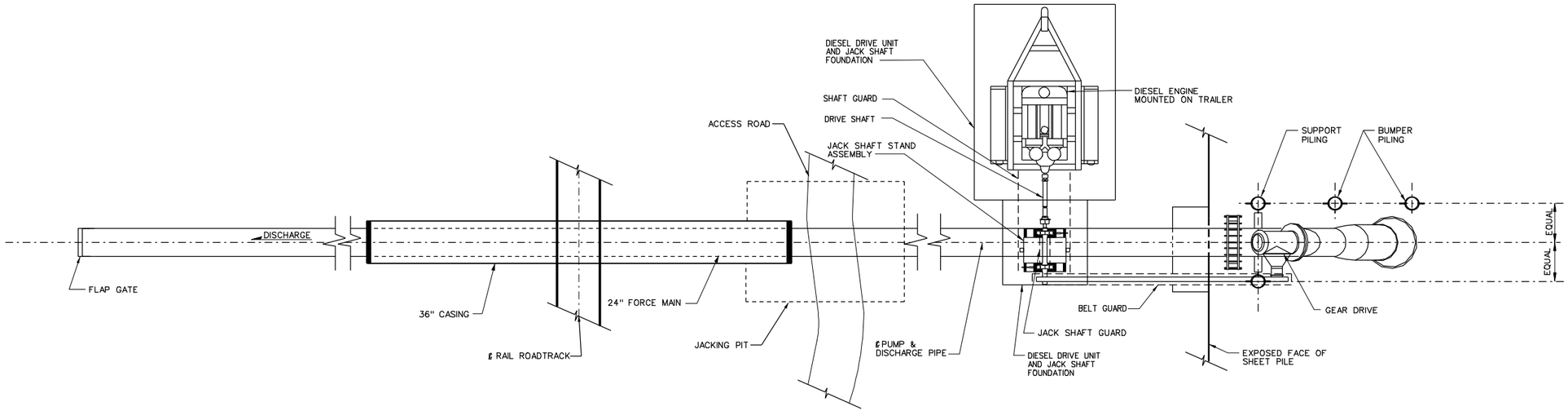
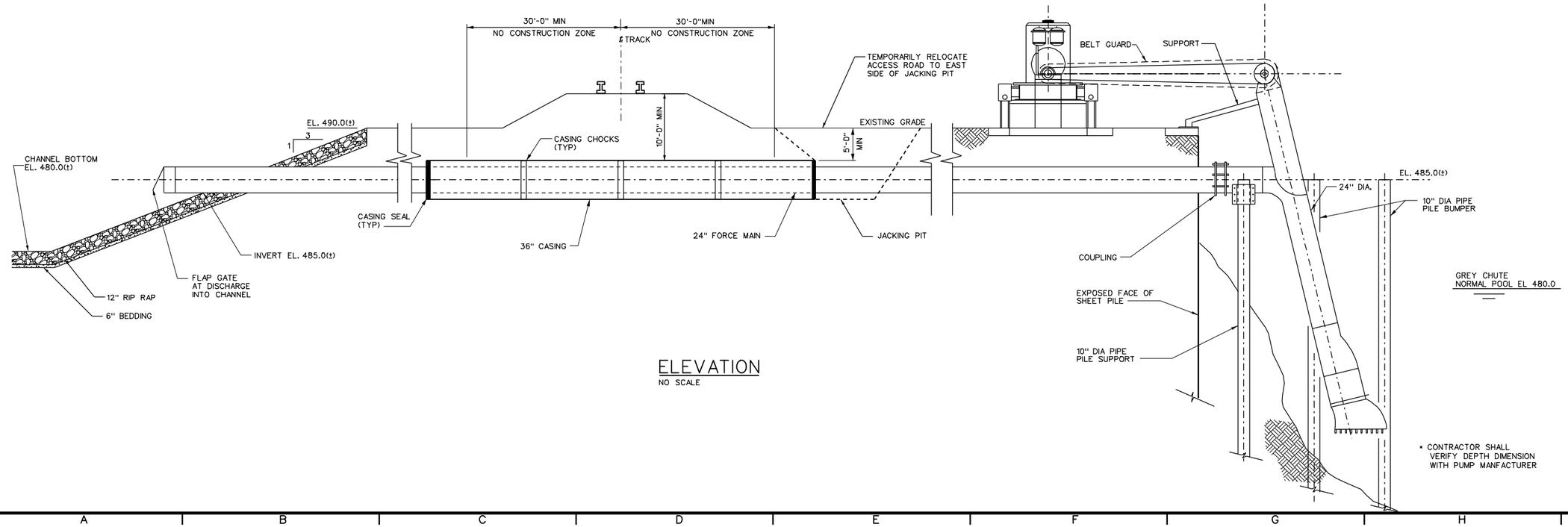


PLAN
NO SCALE

NOTE:
FOR GUARDRAILS, FENCES AND BOLLARDS, SEE CIVIL DWGS.



ELEVATION
NO SCALE

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK
Date: 27 JULY, 2004
Drawn By: GMR
Scale: AS SHOWN
Checked By: DPM
Project Code: EP84
Reviewed By: DPM
Solicitation Number: DACW25-01-B-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

PUMP STATION

PLATE 6

30-JUN-2005 14:25
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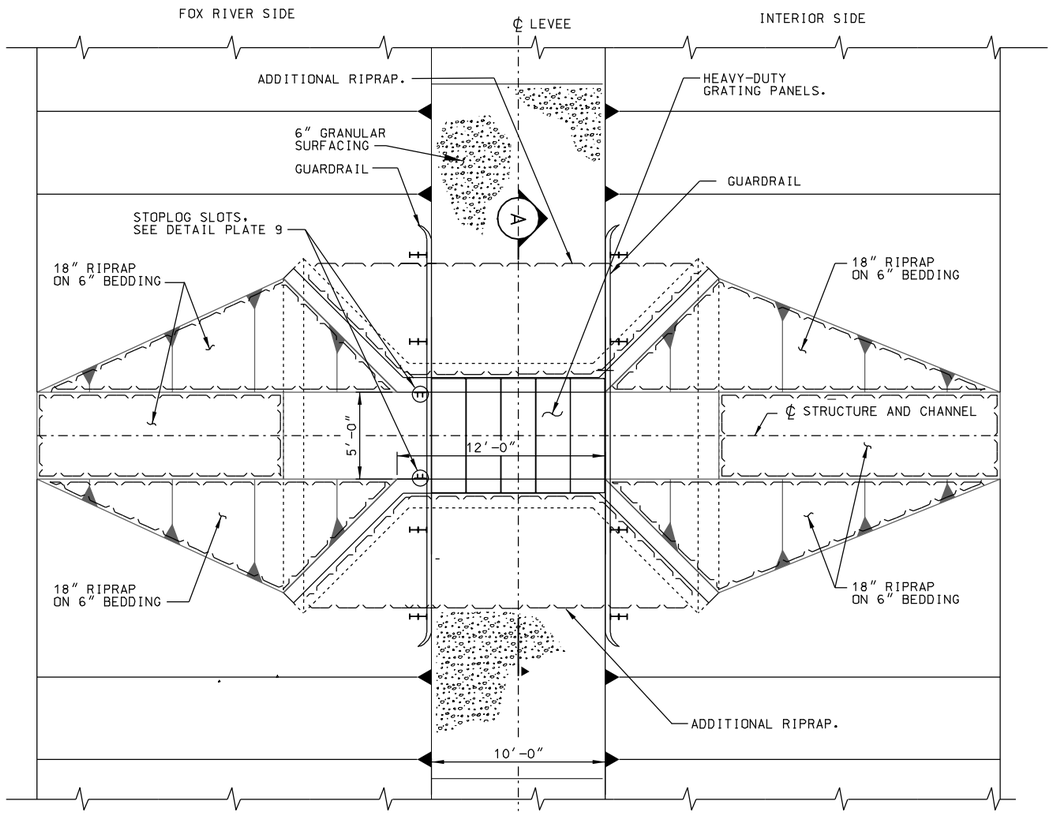
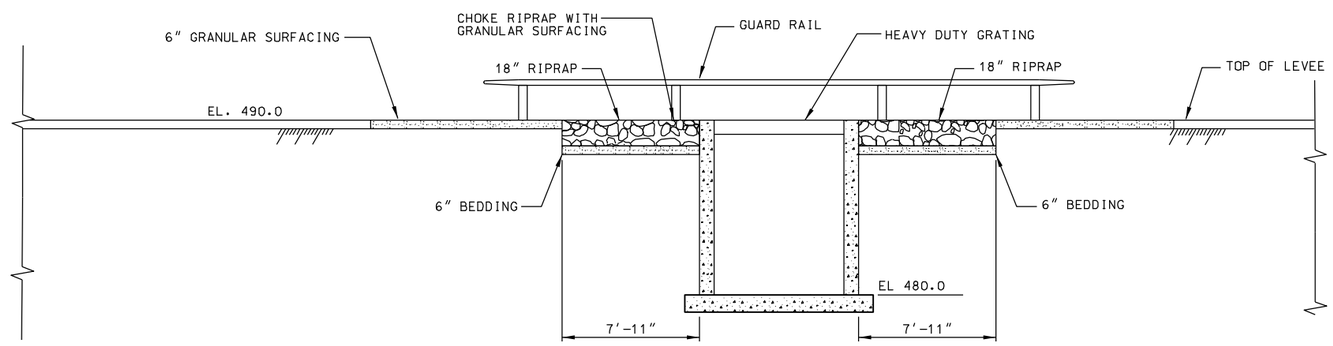


PLAN

4 0 4 8'
SCALE IN FEET



SECTION A

4 0 4 8'
SCALE IN FEET

NOTE:

FOR STOPLOG STRUCTURAL DETAILS SEE PLATE 8

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

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Drawn By: GMR
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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6
FOX RIVER
STOPLOG STRUCTURE
GENERAL PLAN

PLATE 7

30-JUN-2005, 14:26
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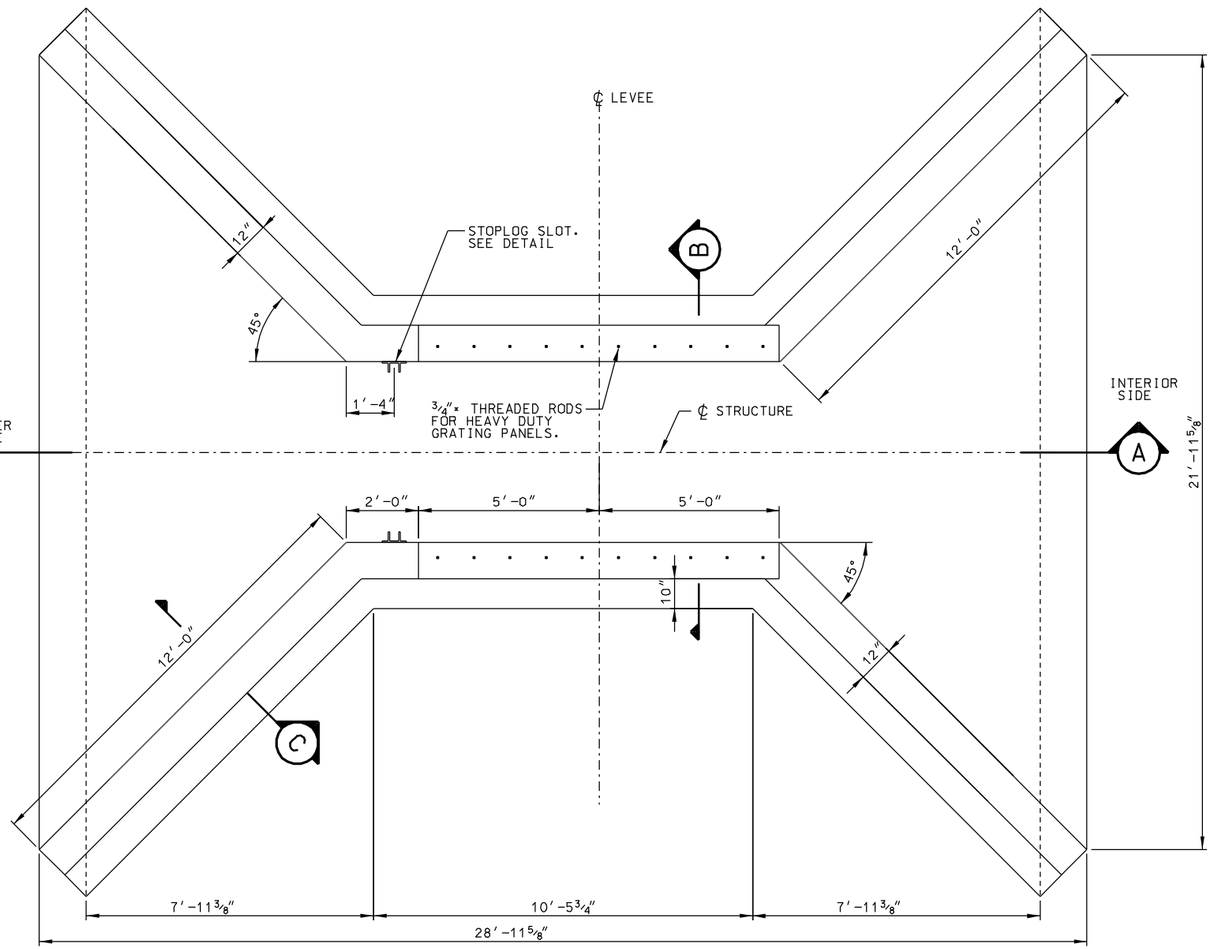
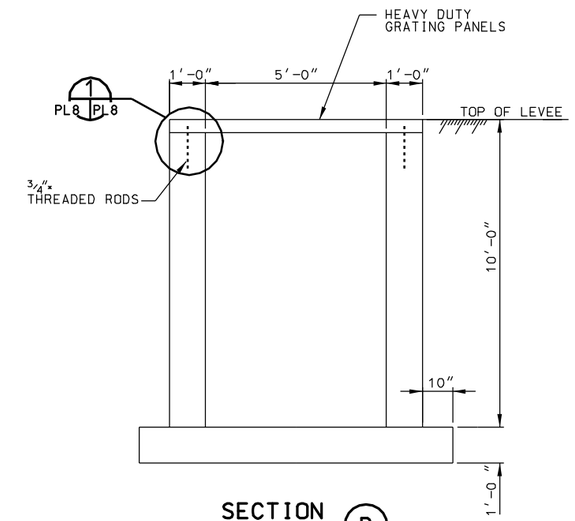


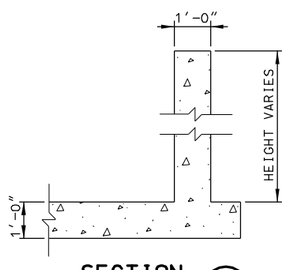
PLAN

2 0 2 4'
SCALE: IN FEET



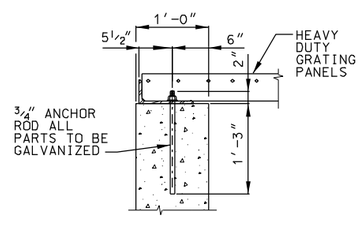
SECTION B

2 0 2 4'
SCALE: IN FEET



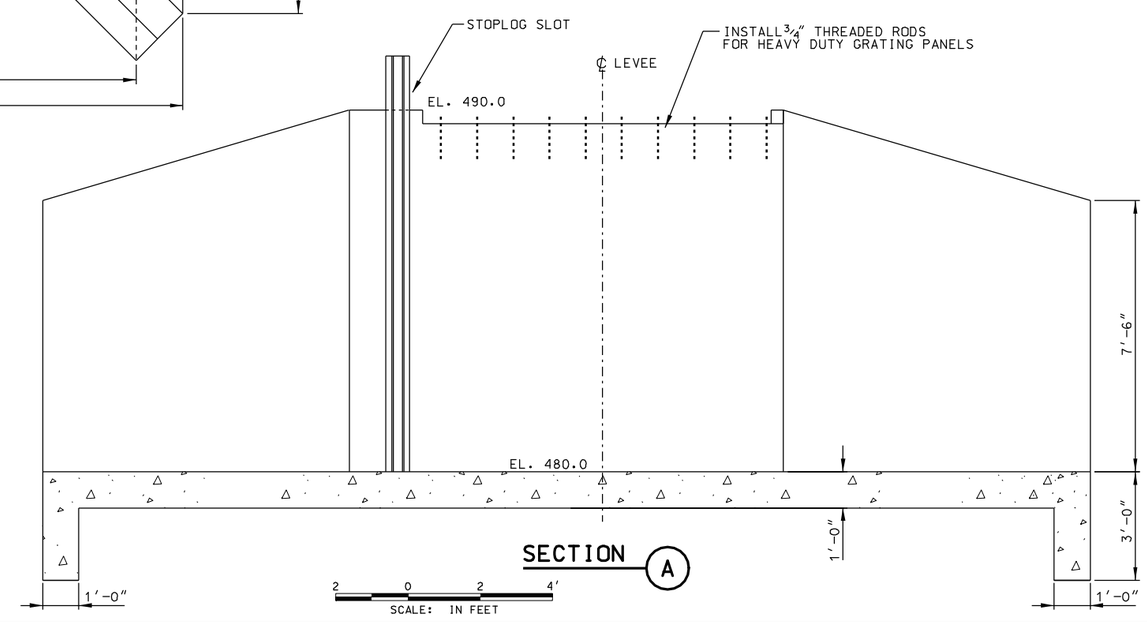
SECTION C

2 0 2 4'
SCALE: IN FEET



DETAIL 1

PL8 PL8
8 0 8 16"
SCALE: IN INCHES



SECTION A

2 0 2 4'
SCALE: IN FEET

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed By: MJK	Date: 27 JULY, 2004		
Drawn By: GMR	Scale: AS SHOWN		
Checked By: DPM	Project Code: EP84		
Reviewed By: DPM	Solicitation Number: DACW25-01-B-0008		

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6
FOX RIVER
STOPLOG STRUCTURE-MASONRY & REINFORCING

PLATE 8

30-JAN-2005 14:27
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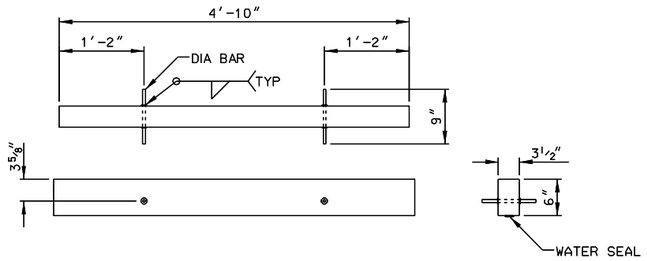
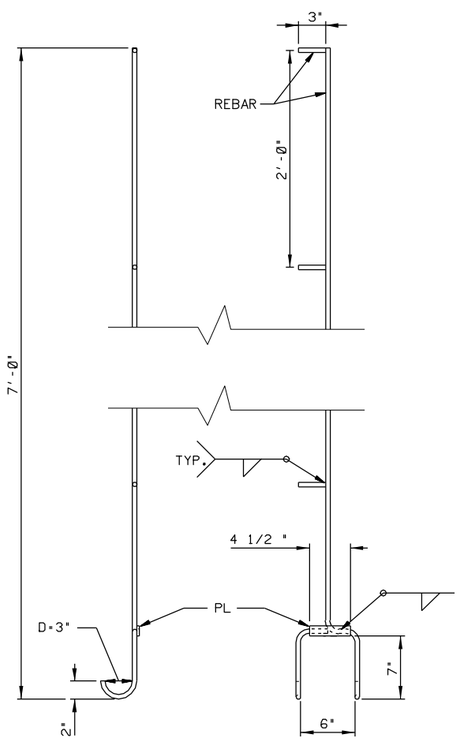


ALUMINUM STOPLOGS

(MAKE 20)

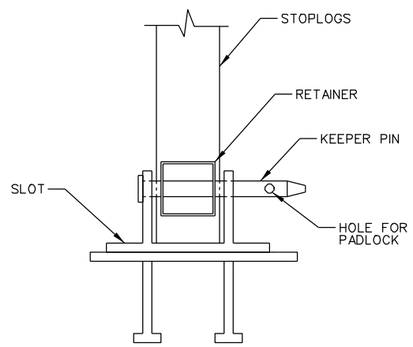
1 0 1 2'
SCALE IN FEET



STOPLOG TOOL

(MAKE 2)

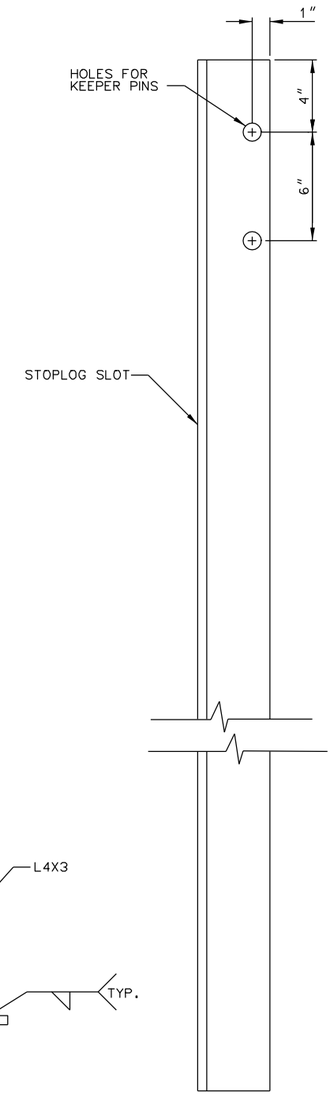
1 0 1 2'
SCALE: IN FEET

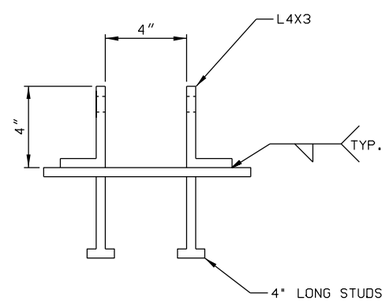


ASSEMBLY DIAGRAM

STOPLOG SLOT

4 0 4 8"
SCALE: IN INCHES





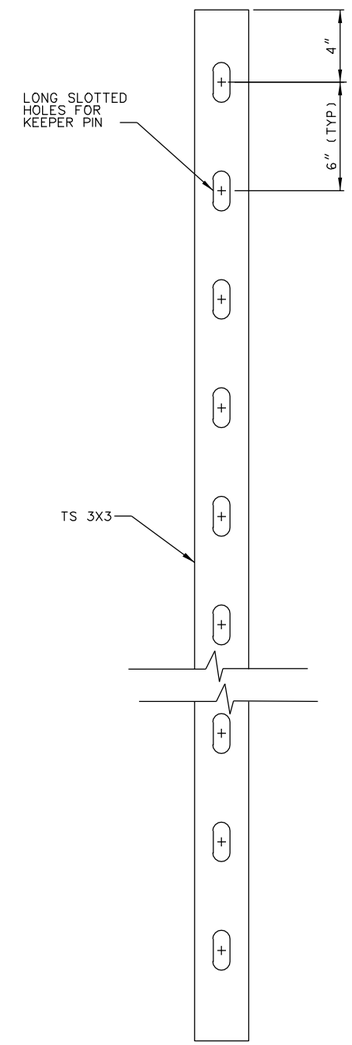
END VIEW

SIDE VIEW

STOPLOG SLOT

(MAKE 2)

4 0 4 8"
SCALE: IN INCHES



SIDE VIEW

END VIEW

STOPLOG RETAINER

ALUMINUM (MAKE 2)

4 0 4 8"
SCALE: IN INCHES

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
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Designed By: MJK
Drawn By: GMR
Checked By: DPM
Reviewed By: DPM
Date: 27 JULY, 2004
Scale: AS SHOWN
Project Code: EP84
Solicitation Number: DACW25-01-D-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6
FOX RIVER
STOPLOG STRUCTURE-
DETAILS

PLATE 9

30-JUN-2005 14:28
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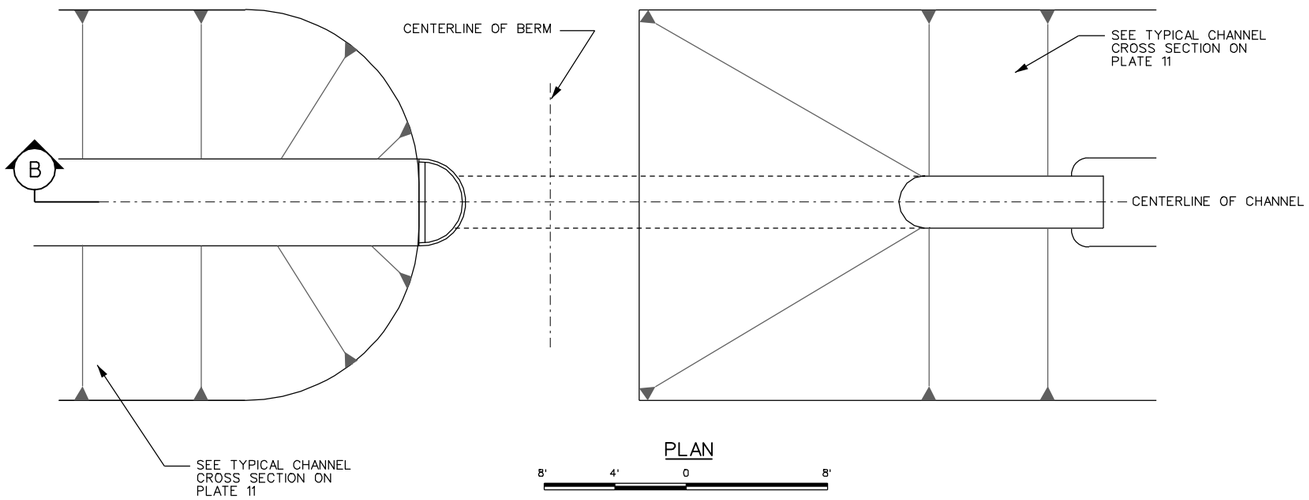
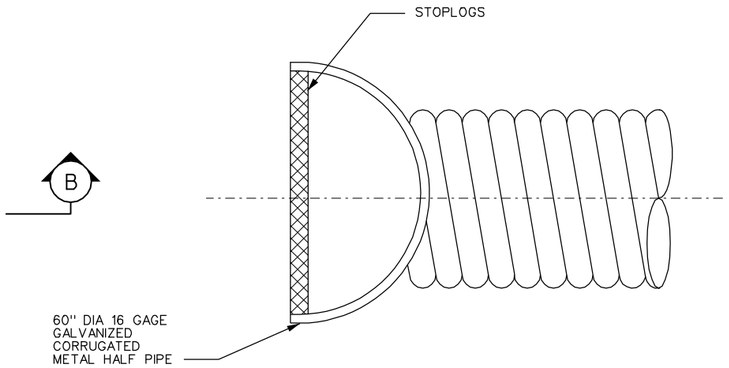
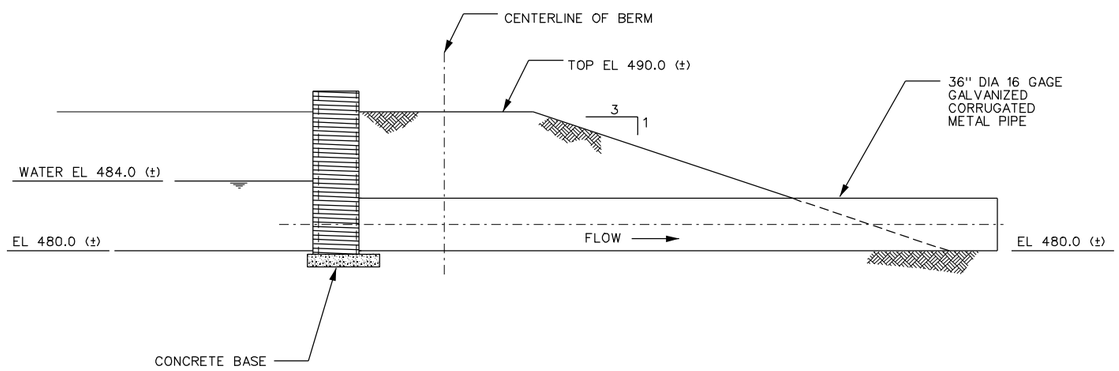


PLAN

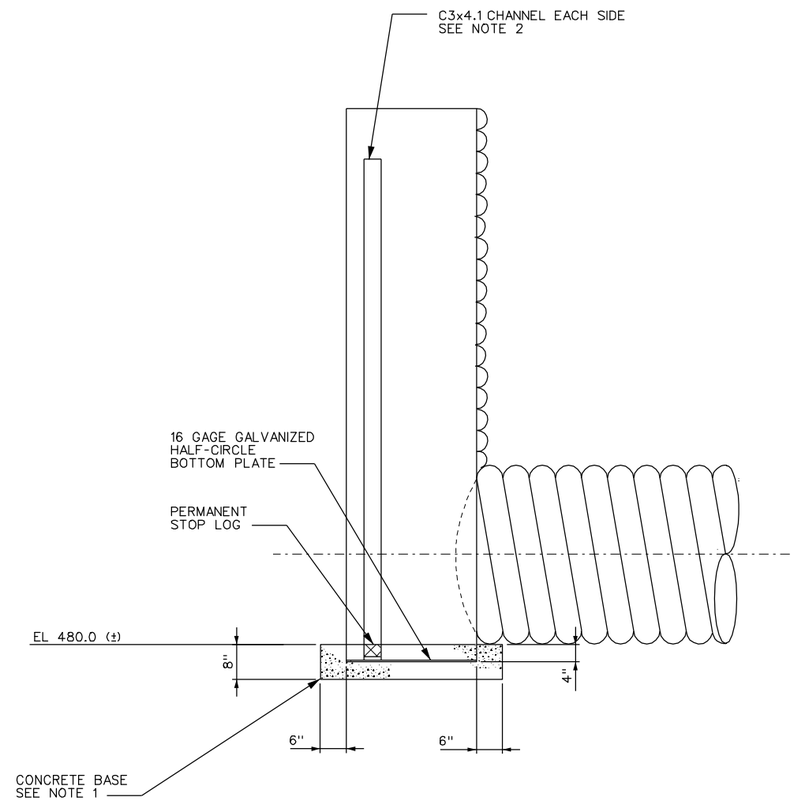


RISER TOP VIEW
NO SCALE



SECTION B

8' 4' 0 8'



RISER CROSS SECTION
NO SCALE

NOTES:

1. CONCRETE BASE REINFORCED WITH #4 BARS 12" ON CENTERS BOTH WAYS.
2. CHANNEL IS WELDED TO RISER EACH SIDE AND CAULKED SOLID TO PREVENT BYPASS OF WATER.

US Army Corps of Engineers
Rock Island District

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Date: 27 JULY, 2004
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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

GALVANIZED STOPLOG STRUCTURE

PLATE 10

30-JUN-2005 14:30
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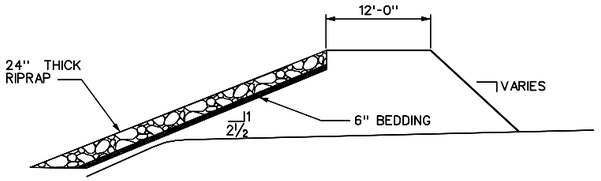
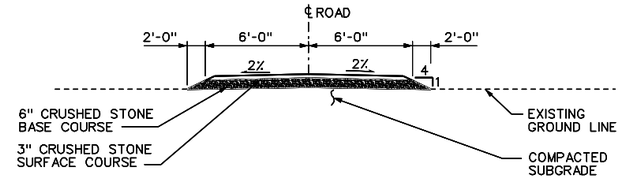


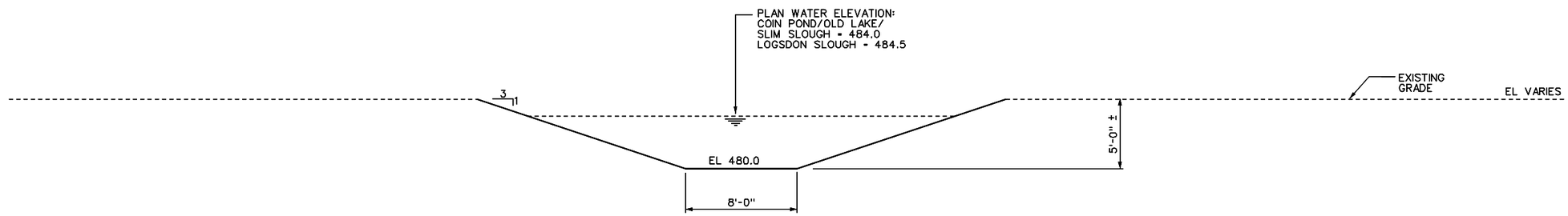
TYPICAL RIPRAP CROSS SECTION THROUGH BANK PROTECTION

NO SCALE



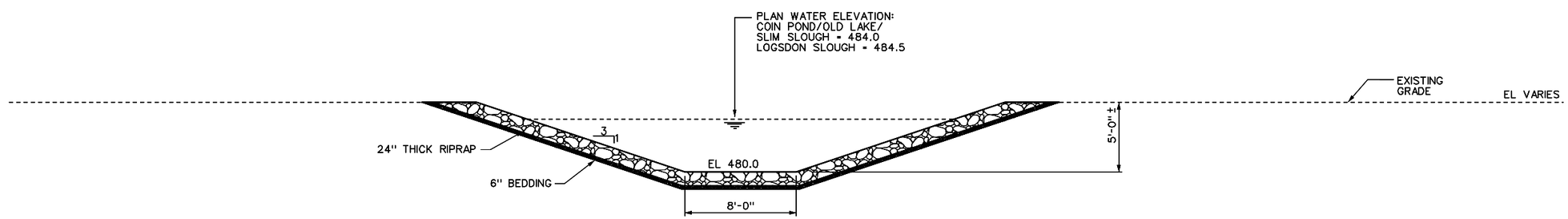
TYPICAL ROAD SECTION

NO SCALE



TYPICAL CHANNEL CROSS SECTION

NO SCALE



TYPICAL RIPRAP CHANNEL CROSS SECTION

NO SCALE

NOTE:
RIPRAP CHANNELS FOR DISTANCE OF 40' FROM PUMP DISCHARGE SITES

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
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Designed By: MJK
Date: 27 JULY, 2004
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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

MISCELLANEOUS
SECTIONS & DETAILS

PLATE 11

30-JUN-2005 14:31
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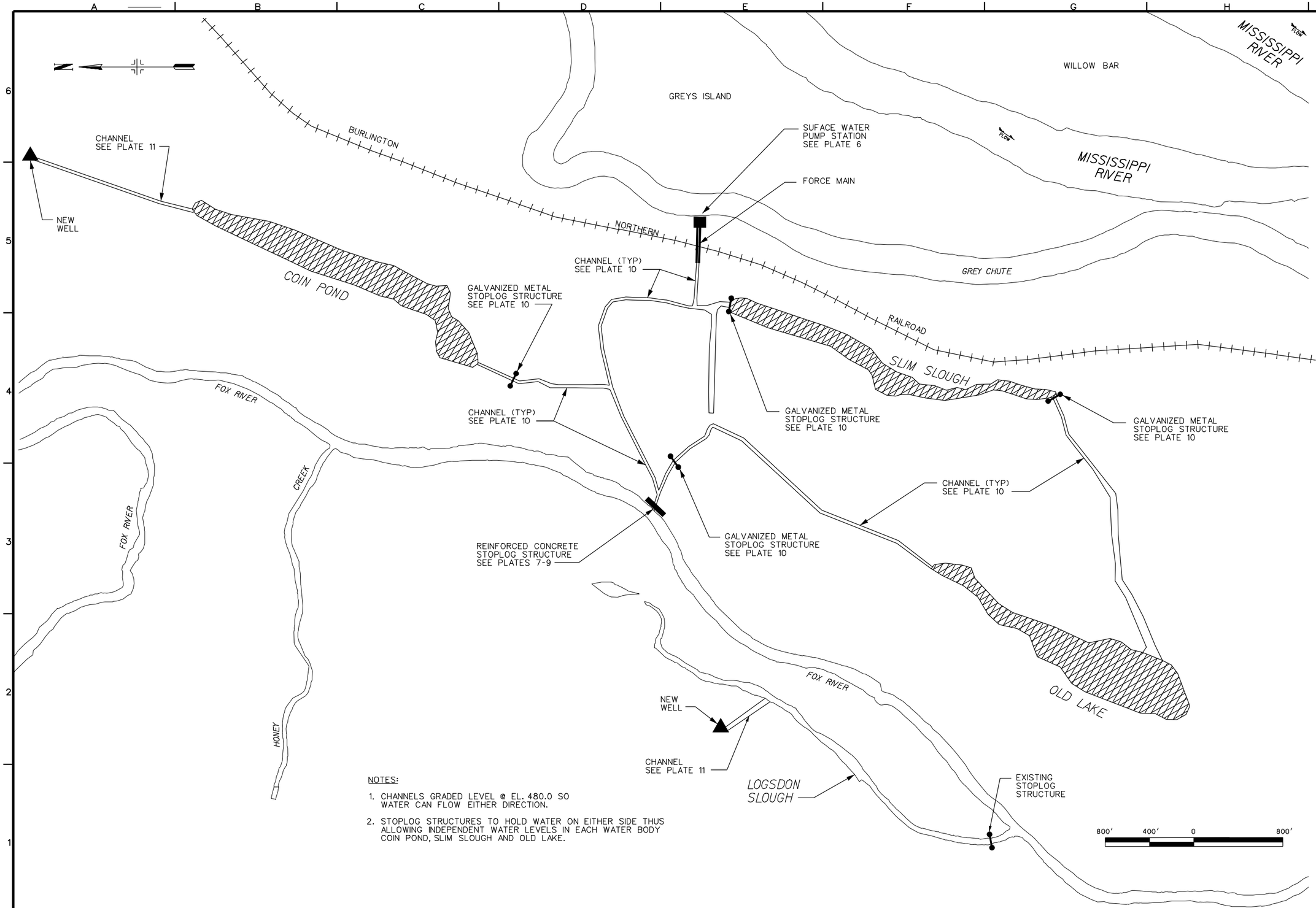

NOTES:

1. CHANNELS GRADED LEVEL @ EL. 480.0 SO WATER CAN FLOW EITHER DIRECTION.
2. STOPLOG STRUCTURES TO HOLD WATER ON EITHER SIDE THUS ALLOWING INDEPENDENT WATER LEVELS IN EACH WATER BODY COIN POND, SLIM SLOUGH AND OLD LAKE.

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: BGR	Date: 27 JULY, 2004
Drawn By: TPDWBDB	Scale: AS SHOWN
Checked By: BFRR	Project Code: EP84
Rev'Tewed By: DRM	Solicitation Number: DACW25-01-D-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

WATER CONTROL SCHEMATIC

PLATE 12

30-JUN-2005 14:32
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US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK	Date: 27 JULY, 2004
Drawn By: GMR	Scale: AS SHOWN
Checked By: DPM	Project Code: EP84
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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

LOCATION OF SOIL BORINGS

PLATE 13

30-JUN-2005, 14:34
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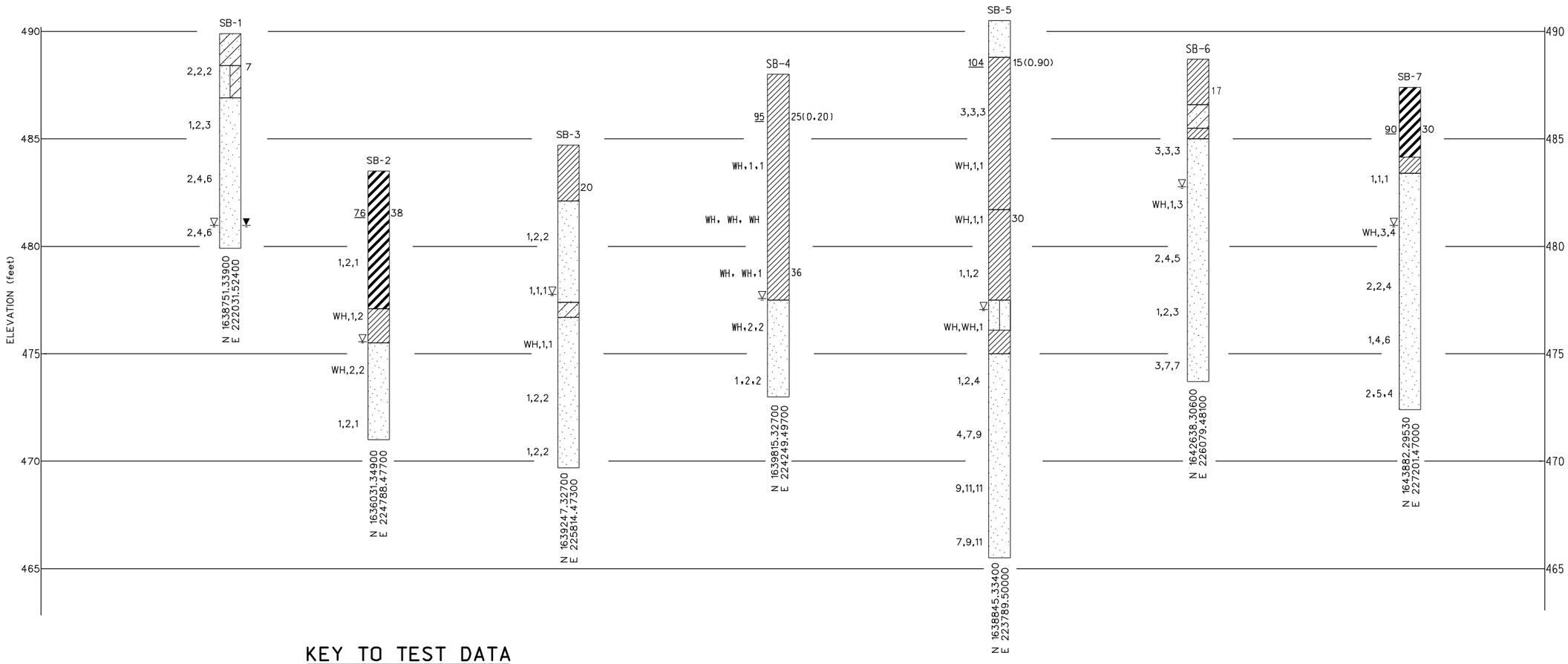

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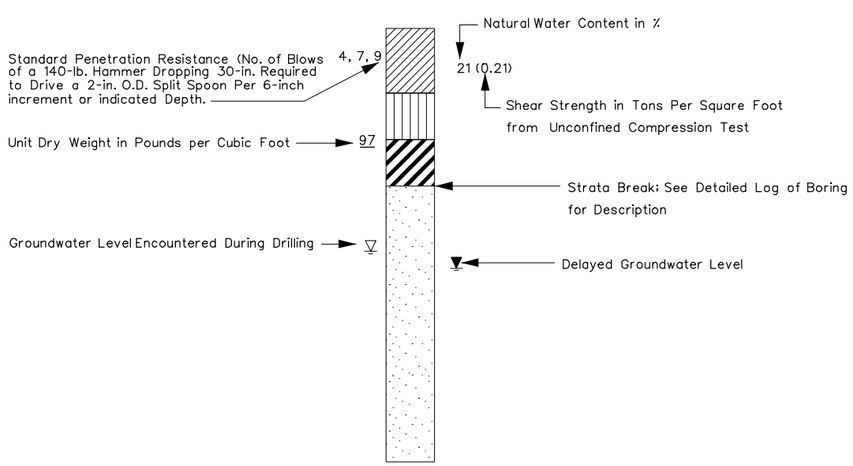

KEY TO GRAPHIC SYMBOLS

- Fat CLAY (CH)
- Poorly-graded SAND (SP)
- SAND with Lean Clay (SP-SC)
- Clayey SAND (SC)
- GRAVEL with Lean Clay (GC)
- SAND, with Silt (SM)
- Lean CLAY (CL)

NOTE:
SAMPLES COLLECTED BETWEEN OCTOBER 14 AND OCTOBER 16, 2002

US Army Corps of Engineers
Rock Island District

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

SOIL BORING LOGS

PLATE 14

30-JAN-2005 14:35
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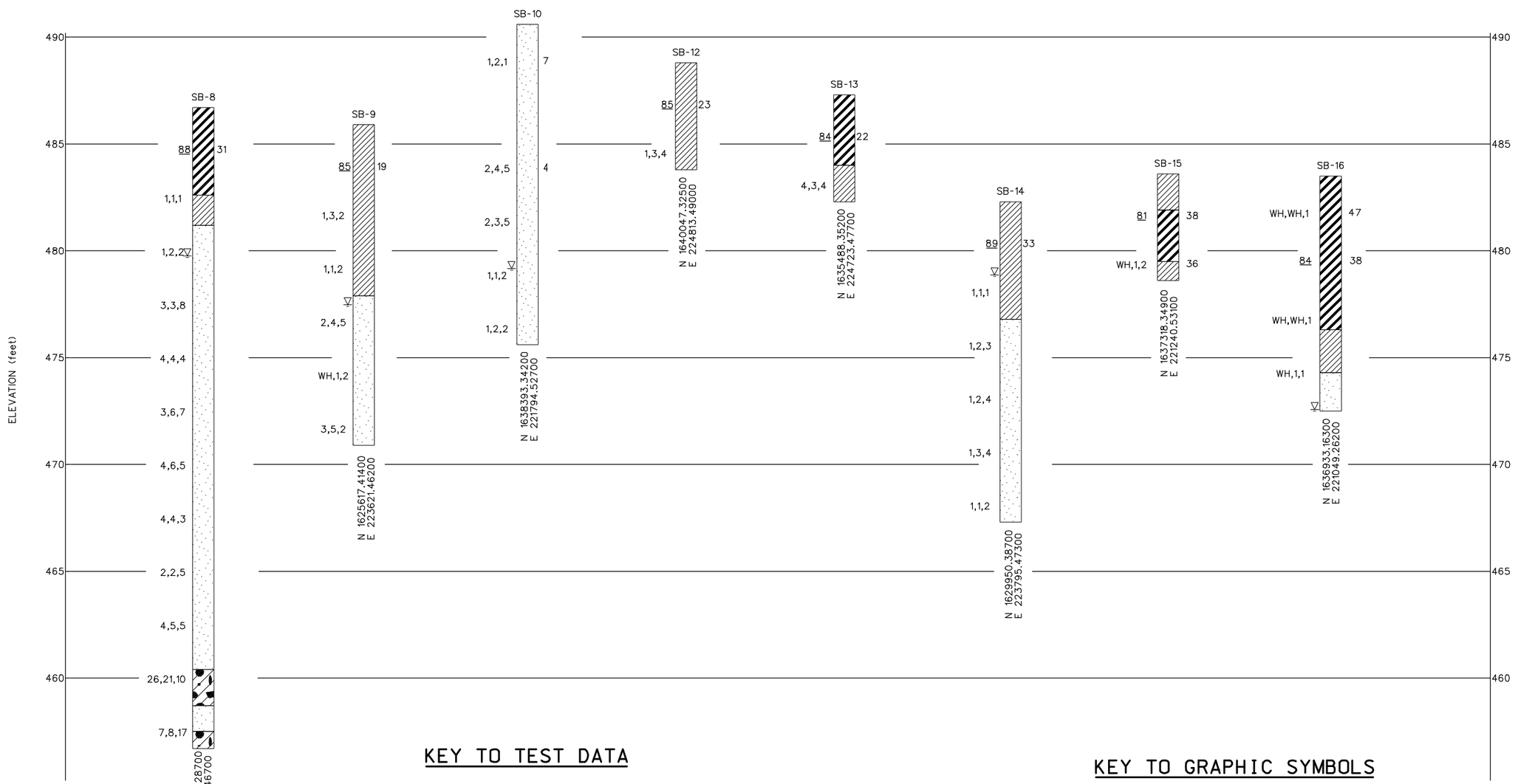

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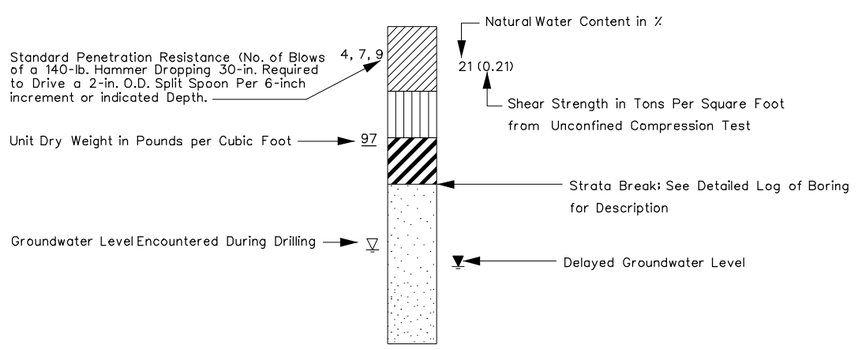

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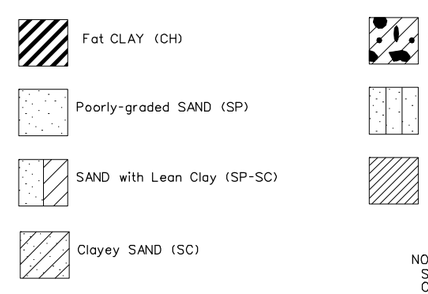

NOTE:
SAMPLES COLLECTED BETWEEN OCTOBER 14 AND OCTOBER 16, 2002

US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK
Drawn By: GMR
Checked By: DPM
Reviewed By: DPM
Date: 27 JULY, 2004
Scale: AS SHOWN
Project Code: EP84
Solicitation Number: DACW25-01-D-0008

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

FOX ISLAND DIVISION
HABITAT REHABILITATION
AND ENHANCEMENT PROJECT
POOL 20, RM 358.5 THRU 353.6

SOIL BORING LOGS

PLATE 15

30-JAN-2005 14:56
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US Army Corps of Engineers
Rock Island District

Symbol	Description	Date	Approved
	Revisions		

Designed By: MJK
Drawn By: GMR
Checked By: DPM
Reviewed By: DPM
Date: 27 JULY, 2004
Scale: AS SHOWN
Project: Coast EP84
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U.S. ARMY ENGINEER DISTRICT
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POST-CONSTRUCTION EVALUATION PLAN

PLATE 16

30-JUN-2005, 14:37A
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