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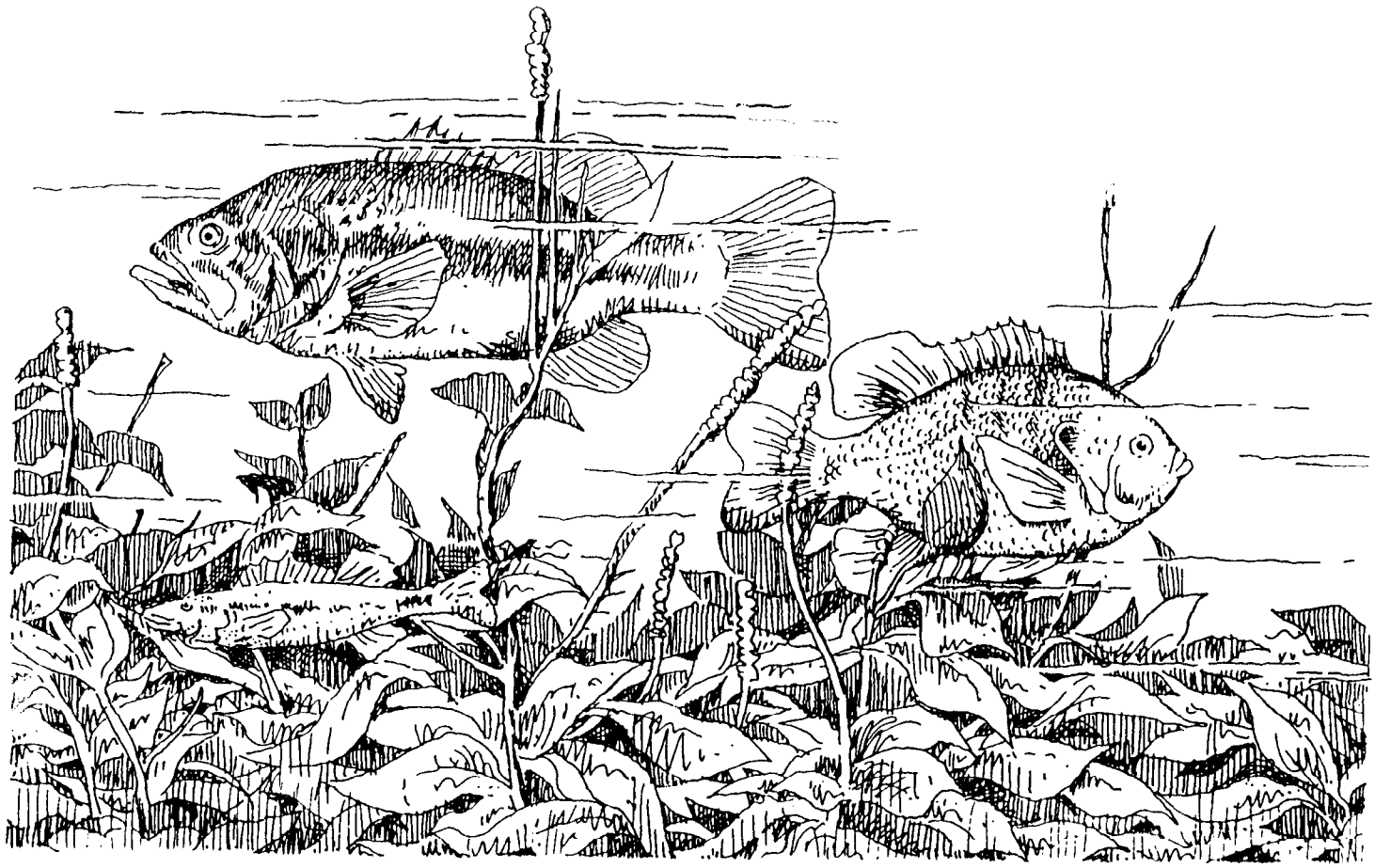
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT (R-16F)
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

COTTONWOOD ISLAND HABITAT REHABILITATION AND ENHANCEMENT



JUNE 1996

US Army Corps
of Engineers
Rock Island District

POOL 21
MISSISSIPPI RIVER
MILES 328.5 - 331.0
LEWIS AND MARION COUNTIES, MISSOURI

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:
CENCR-PD-W

UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM DEFINITE PROJECT REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 328.5 THROUGH 331.0 LEWIS AND MARION COUNTIES, MISSOURI

JUNE 1996

ACKNOWLEDGMENT

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EXECUTIVE SUMMARY

The 463-acre Cottonwood Island Habitat Rehabilitation and Enhancement Project (HREP) lies on the right descending bank of the Mississippi River between River Miles (RM) 328.5 and 331.0, approximately 4 miles upstream of Lock and Dam 21 in Lewis and Marion Counties, Missouri. The project area encompasses all of Cottonwood Island and the riparian land between the Fabius Levee and Drainage District levee and Cottonwood Chute. All project lands are in Federal ownership.

Cottonwood Island has been managed by the Missouri Department of Conservation (MDOC) since 1954, under a cooperative agreement with the U.S. Fish and Wildlife Service (USFWS). The U.S. Army Corps of Engineers (Corps) and MDOC site management includes forest management and crop production. Forest management promotes age diversity of trees for wider animal usage, while crop production benefits deer, squirrels, and migratory birds. Opportunities exist to increase overall preferred habitat quality and quantity at this location.

The goals of the proposed project are to restore aquatic overwintering, main channel border, and wetland habitats. The following objectives have been identified to meet these goals: (1) improve water quality for fish; (2) provide overwintering habitat for fish; (3) provide flowing water habitat for fish; (4) provide additional habitat and substrate for benthic and aquatic organisms (5) increase food, shelter, and breeding habitat for wildlife; and (6) improve bottomland hardwood diversity and quality.

Three project management measures and their associated plans were considered to achieve the project goals and objectives (the No Action option was assessed for each measure):

A. Restore Aquatic Overwintering Habitat

1. Mechanically dredge the lower 4,900 feet of Cottonwood Chute to a 7-foot depth with 3 deep holes 15 feet deep.

2. Mechanically dredge the lower 4,900 feet of Cottonwood Chute to a 7-foot depth with 4 deep holes 15 feet deep.

3. Mechanically dredge the lower 7,500 feet of Cottonwood Chute to a 7-foot depth with 5 deep holes 15 feet deep.

4. Mechanically dredge the 11,500-foot length of Cottonwood Chute to a 15-foot depth.

B. Restore Wetland Habitat

1. Plant mast-producing trees on Forest Management Area (FMA) #7 and construct one 1-acre pothole.

2. Plant mast-producing trees on the dredged material.

3. Plant mast-producing trees on FMA #5 and construct one 1/2-acre pothole.

4. Plant mast-producing trees on FMA #6 and construct one 1/2-acre pothole.

5. Plant mast-producing trees on the agricultural field and construct two 1-acre potholes.

C. Restore Main Channel Border Habitat

1. Notch Wing Dam #9, 100 feet.

2. Notch Wing Dam #8, 100 feet.

3. Notch Wing Dam #5, 100 feet.

4. Notch Wing Dam #6, 100 feet.

5. Notch Wing Dam #29, 100 feet.

6. Notch Wing Dam #30, 100 feet.

7. Notch Wing Dam #15, 100 feet.

Evaluation of the project enhancement features and construction options was accomplished through application of two habitat quantification methodologies and annualization of outputs and costs. Existing habitat conditions and the effects of planned habitat management features were evaluated using the Aquatic Habitat Appraisal Guide (AHAG) and a bottomland hardwood habitat evaluation model (BLH). Both evaluation methodologies quantify habitat output in the form of habitat units (HUs). The HU values were subsequently used in conjunction with project cost data and functional life expectancy to compare the construction options of the proposed enhancement features. This incremental analysis identifies which combinations of enhancement features would be cost efficient and cost effective.

The recommended plan (shown on Figure ES-1) includes mechanically dredging the lower 4,900 feet of Cottonwood Chute to a 7-foot depth with 4 deep holes 15 feet deep and the dredged material placed on the Cottonwood Island bankline for mast tree planting; planting mast-producing trees on the dredged material, FMA's 6, 7, and 5, and the agricultural field; excavating 4 acres of potholes; and notching Wing Dams 8, 5, 6, 29, 30 and 15 100 feet to the original river bottom at staggered locations.

Mechanically dredging Cottonwood Chute would provide overwintering habitat for fish in the dredged deep holes. Planting mast-producing trees such as pin oak, bur oak, swamp white oak, pecan, and sycamore would enhance habitat value by introducing a mast-producing component into a forest dominated by silver maple and cottonwood. Excavating potholes would restore sloughs and depressions impacted by

sedimentation and provide secluded habitat for migratory bird nesting and feeding. It is anticipated that flow would increase in the vicinity of the notches, deepening the pool behind the wing dams. The change in flow at one wing dam may also stimulate an in-stream meander to the next wing dam. A meander would create deeper areas, which would attract a diverse benthic community and fishery.

Implementation of the recommended plan would provide increased management flexibility and the capability to optimize the quality and quantity of preferred habitat at this location. The project outputs meet site management goals and objectives and support the overall goals and objectives of the UMRS-EMP, the North American Waterfowl Management Plan, and the Partners In Flight program.

The U.S. Army Corps of Engineers will 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.

Section 906 (e) of the 1986 Water Resources Development Act (WRDA) specifies that first cost funding for enhancement features "located on lands managed as a national wildlife refuge" will be 100 percent Federal. All project features will be located on federally owned lands managed through a cooperative agreement with the MDOC.

Per Section 107(b) of the 1992 WRDA, project operation and maintenance at an estimated average annual cost of $6,006 will be accomplished by the MDOC, the non-Federal project sponsor.

The District Engineer has reviewed the project outputs and determined that the implementation of the selected plan is justified and in the Federal interest. Therefore, construction approval for the Cottonwood Island enhancement project is recommended by the Rock Island District Engineer at an estimated Federal expense of $872,328. Total Federal cost, including general design, is $1,544,328.

UMRS
EMP

COTTONWOOD ISLAND ENHANCEMENT PROJECT

FIGURE ES-1

Metric Conversions

To Convert	Into	Multiply by
acres	hectares	0.4047
centimeters	inches	0.3937
feet	meters	0.30480
square feet	square meters	0.0929
cubic yards	cubic meters	0.76456
cubic feet/second	cubic meters/second	0.02831685

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1. INTRODUCTION

a. Purpose. The purpose of this report is to present a detailed proposal for the rehabilitation and enhancement of Cottonwood Island. This report provides planning, engineering, and sufficient construction details of the selected plan to allow final design and construction to proceed subsequent to approval of this document.

b. Resource Problems and Opportunities. The project area formerly provided important wetland habitat in the low swales present on Cottonwood Island and deep water aquatic habitat in Cottonwood Chute. Sedimentation has greatly reduced the quantity and quality of these habitat areas and has been especially acute in the chute's upper end and in forested portions of the island bordering the Mississippi River. In the chute's shallow areas, dissolved oxygen values have fallen to critical levels and fish species diversity has decreased.

The opportunity exists in the study area to enhance overall wetland and terrestrial habitat value by improving water depths in Cottonwood Chute, improving flows in the main channel border, and providing food sources on Cottonwood Island. Reestablishing deep water areas by dredging Cottonwood Chute and the inclusion of mast tree plantings and pothole development on Cottonwood Island would allow the study area to realize greater benefits to local wildlife and continental migratory species.

c. Scope of Study. Cottonwood Island is a wildlife management area located on the right descending bank of the Mississippi River approximately 4 miles upstream of Lock and Dam 21, between River Miles (RM) 328.5 and 331.0. It is located in Lewis and Marion Counties, Missouri, approximately 2 miles northwest of Quincy, Illinois. Plate 1 provides vicinity and general location maps for Cottonwood Island. Plate 2 shows a site-specific plan.

The scope of this study focuses on proposed project features that would improve aquatic and wetland habitat and enhance overall resource values. The project is consistent with agency management goals and was planned for the benefit of resident and migratory birds and fish and other wildlife.

Field surveys, aerial photography, and habitat quantification procedures were completed to support the planning and assessment of proposed project alternatives. Hydrographic soundings were performed in developing sedimentation estimates and estimating excavation quantities. Soil borings were taken to determine sediment types and excavation difficulty. Bulk sediment tests were performed to determine the chemical characteristics of the material to be dredged. Baseline water quality monitoring was performed to define present water quality conditions/problems.

Wildlife and resident fish observations within the study area have been made by the Missouri Department of Conservation (MDOC). These observations, along with future studies and monitoring, will assist in evaluating project performance.

d. Format of Report. The report is organized to follow a general problem-solving format. The purpose and problems are presented in Section 1. Section 2 provides an overview of how and why Cottonwood Island was selected as a project within the Environmental Management Program. Section 3 establishes the baseline for existing resources. Section 4 provides the objectives of the project. Sections 5, 6, and 7 propose and evaluate project alternatives, and Section 8 describes the selected plan in accordance with the National Environmental Policy Act. Section 9 provides general design and construction considerations. Section 10 assesses the environmental effects from the proposed plan. Section 11 summarizes project accomplishments and outputs. Sections 12, 13, and 14 describe estimated operation and maintenance considerations, performance monitoring, and detailed cost estimates for both initial construction and annual operation and maintenance. Sections 15, 16, 17, and 18 provide a summary of implementation requirements and coordination. Sections 19 and 20 present the conclusions and recommendations. A Finding of No Significant Impact follows the main report.

Drawings (plates) have been furnished to provide sufficient detail to allow review of the existing features and the proposed plan. Plate 1 shows the project location and the Pool 21 environs. Plates 2 and 3 show the existing conditions site plan and the recommended plan. Plate 4 shows potential enhancement features not evaluated. Plate 5 shows potential features evaluated. Plates 6, 7, and 7A provide soil boring locations and logs which were used to evaluate foundation effects and excavation/fill methods. Typical sections are presented on plates 8, 9, and 10. Typical cross sections are shown on plate 11. The project monitoring plan and sedimentation transects are shown on plates 12 through 14.

e. Authority. The authority for this report 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). The proposed project would be funded and constructed under this authorization. Section 1103 is summarized as follows:

Section 1103. UPPER MISSISSIPPI RIVER PLAN

(a) (1) This section may be cited as the Upper Mississippi River Management Act of 1986.

(2) To ensure the coordinated development and enhancement of the Upper Mississippi River System (UMR), 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 this system provides a diversity of opportunities and experiences.

The system shall be administered and regulated in recognition of its several purposes.

(e) (1) The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, is authorized to undertake, as identified in the Master Plan -

(A) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement;

(B) implementation of a long-term resource monitoring program;

(C) implementation of a computerized inventory and analysis system;

(f) (1) implementation of a program of recreational projects;

(2) assessment of the economic benefits generated by recreational activities in the system; and

(h) (1) monitoring of traffic movements on the system.

2. GENERAL PROJECT PROCESSING

a. Eligibility Criteria. A design memorandum did not exist at the time of the enactment of Section 1103. Therefore, the North Central Division, U.S. Army Corps of Engineers, completed a "General Plan" for the implementation of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP) in January 1986. The U.S. Fish and Wildlife Service (USFWS), Region 3, and the five affected states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) participated through the Upper Mississippi River Basin Association. Programmatic updates of the General Plan for budget planning and policy development are accomplished through Annual Addenda.

Coordination with the States and the USFWS during the preparation of the General Plan and Annual Addenda led to an examination of the *Comprehensive Master Plan for the Management of the Upper Mississippi River System.* The Master Plan, completed by the Upper Mississippi River Basin Commission in 1981, was the basis of the recommendations enacted into law in Section 1103. The Master Plan and General Plan identify examples of potential habitat rehabilitation and enhancement techniques. Consideration of the Federal interest and Federal policies has resulted in the following conclusions:

(1) First Annual Addendum. The Master Plan report and the authorizing legislation do not pose explicit constraints on the kinds of projects to be implemented under the UMRS-EMP. For habitat projects, the main eligibility criteria should be that a direct relationship should exist between the project and the central problem as defined by the Master Plan, i.e., the sedimentation of backwaters and side channels of the UMRS. Other criteria include geographic proximity to the river (for erosion control), other agency missions, and whether the condition is the result of deferred maintenance.

(2) Second Annual Addendum. The types of projects that are definitely within the realm of Corps of Engineers implementation authorities include the following:

- backwater dredging
- dike and levee construction
- island construction
- bank stabilization
- side channel opening/closures
- wing and closing dam modifications
- aeration and water control systems
- waterfowl nesting cover (as a complement to one of the other project types)
- acquisition of wildlife lands (for wetland restoration and protection)

(3) Subsequent Annual Addenda. Subsequent annual addenda, of which the Sixth Annual Addendum (dated May 1991) is the most recent, provide a vehicle for reporting program progress, communicating policy guidance, and ensuring thorough coordination among the participating State and Federal agencies.

b. General Selection Process. The following steps provide an overview of the process of project selection. The steps are interactive with communication in both directions and occur through a continual process.

(1) State/USFWS Project Nomination. Projects are nominated for inclusion in the Rock Island District's habitat program by the respective State conservation agencies and the USFWS based on agency management objectives. Rock Island District assists the States and USFWS agencies in proposing habitat projects through an in-house task force that includes staff members from the Planning, Engineering, Operations, and Construction Divisions. As projects are being conceptualized, this group meets on site with State and USFWS personnel to examine as fully as possible what site-specific enhancements would be both environmentally desirable and engineering feasible.

(2) Fish and Wildlife Interagency Committee (FWIC) Ratings. To assist in the project formulation process, the FWIC, a group composed of State and Federal biologists who are assigned to aquatic and terrestrial projects (refuges, wildlife areas) along the Mississippi and Illinois Rivers, has convened a series of meetings starting in 1986 to consider critical habitat needs along the Mississippi and Illinois Rivers. At these meetings, the available habitat is evaluated on a pool-by-pool basis. These analyses reveal deficiencies (such as feeding, resting, and loafing areas for migratory waterfowl, absence of deep water off the main channel for diving ducks and fish) as well as types of habitat in abundant supply (e.g., mature bottomland hardwood). (With this information, projects being considered can most accurately reflect broader regional needs in addition to representing the best site-specific choices.)

Projects then are ranked by the FWIC according to the biological benefits that they could provide. Each project is considered and evaluated relative to increasing habitat benefits for fish, waterfowl, and other wildlife. Every project is ranked according to the outputs provided as high, medium, or low. Figure 2-1 provides a comprehensive summary of the FWIC rankings for all current and future Rock Island District habitat projects.

(3) River Resources Coordinating Team (RRCT) Rankings. The FWIC rankings also are forwarded to the RRCT, an interagency policy group which meets to coordinate Mississippi and Illinois River activities. The RRCT examines the FWIC rankings and includes consideration of the broader policy perspectives of the agencies submitting the projects. The RRCT makes a recommended ranking.

(4) U.S. Army Corps of Engineers District Ranking. The FWIC and RRCT recommended rankings are evaluated by the District. The District then formulates a recommended program consistent with the EMP program guidance and District requirements.

FIGURE 2-1

FWIC Rankings for CENCR HREPs

FWIC Rankings for CENCR HREPs

Projects completed/underway			*FWIC Priority List 3/*		*Projects ranked; not prioritized*		
Project Name	**Points**	**Rank**	**Project Name**	**Points**	**Project Name**	**Points**	**Rank**
Monkey Chute, MO		(not ranked)	1. Gregory Landing, MO 2/	22	Elk River, IA	23	Medium
Andalusia Refuge, I L		(not ranked)	2. Pool 12 Overwintering, IL 2/	26	Turkey River Bottoms, IA	20	Low
Brown's Lake, IA		(not ranked)	3. Sanganois, IL 2/	26	Chautauqua Lake, IL (Phase II)	24	High
Bertom/McCartney, WI		(not ranked)	4. Blackhawk Bottoms, IA 2/	27	Mud Lake, IA	22	Medium
Big Timber, IA		(not ranked)	5. Huron Island, IA 2/	26/27	Quincy Bay, IL	20	Low
Potters Marsh, IL	27	High	6. Eagle Fill, IL 2/	18	Turkey/Otter Islands, IA	20/21	Low
Peoria Lake, IL	25	High	Smith's Creek, IA 2/	24	Sny Side Channel, IL	21	Low
Bay Island, MO	23	Medium			Bunker Chute, IA	20	Low
Chautauqua Lake, IL	24	High			Middle Sabula, IA	19	Low
Spring Lake, IL 1/	24/27	High			Pin Island, IA	20	Low
Lake Odessa, IA	23	Medium			Keithsburg Refuge, IL	22	Low
Cottonwood Island, MO	26	High			Miller's Lake, IL	26	High
Gardner Division, IL	25	High			Credit Island, IA	25	High
Banner Marsh, IL	29	High			Beaver Island, IA	26	High
Rice Lake, IL	27	High			Emiquon, IL	27	High
Princeton Refuge, IA	27	High					
Pool 11 Islands, WI	25	High					
Peosta Channel, IA	27	High					
Pleasant Creek, IA	26	High					
Molo Slough, IA	27	High					
Ranked projects completed via other programs							
Green Island, IA	23	Medium					

1/ Ranked as two phases subsequently rescoped to a single project.

2/ Baseline monitoring underway.

3/ Within list order reflects priority as agreed to at the 4 May 1995 FWIC meeting.

(5) U.S. Army Corps of Engineers, North Central Division Prioritizing. The District then submits a recommended program to the North Central Division. Additional coordination by the Division through the Environmental Management Program Coordinating Committee (EMP-CC) is effected. North Central Division then submits project fact sheets to the Chief of Engineers and Assistant Secretary of the Army for Civil Works for approval. Fact sheets and schedules are subsequently published, thereby completing the project selection process.

c. Specific Site Selection. After considering resource needs and deficiencies pool by pool, the Cottonwood Island HREP was recommended and supported by the above selection process as providing significant aquatic and wetland benefits with opportunities for habitat enhancement. Enhanced capability to manage the project area for migratory bird, fish, and wildlife use will only be achieved by implementing the proposed project enhancement features.

Recognition of changes occurring in habitat composition and subsequent declines in migratory bird, wildlife, and fisheries habitat quality and availability along the Mississippi River prompted the proposal of several projects by Federal and State agencies responsible for natural resource management in the Pool 21/22 area. The Gardner Division, Illinois, project, located upstream at RM 332.5 - 340.2, is currently in the general design phase. The Monkey Chute, Missouri (RM 326.0) and Bay Island, Missouri (RM 311.0 - 312.0) projects have been completed.

The following points were major considerations, along with the FWIC ranking, in selecting this project for the HREP program:

1. The Cottonwood Island project is a high priority of the MDOC.

2. The Cottonwood Island area has historically provided good overwintering habitat for fish and supported a high value fishery.

3. The opportunity exists to capitalize on present habitat interspersion—a mixture of aquatic, agricultural, and forest.

3. ASSESSMENT OF EXISTING RESOURCES

a. Resource History and Description of Existing Features. Historically, the Cottonwood Island complex was formed with alluvial deposits made by unregulated flows of the river. Cottonwood Chute cut the island from the main shoreline and offered a place for fish to migrate during the winter to avoid the stronger flows of the main channel. Flood flows created shallow sloughs on the island which provided quiet ponds for broods of ducks to forage, and for frogs and salamanders to escape into or deposit their eggs. Although seasonally flooded, mast-bearing trees such as pecan (*Carya illoensis*) and pin oak (*Quercus palustus*) were very predominate on the island. Seeds such as acorns and pecans provided local wildlife as well as migrating ducks with high energy food, enabling better winter survival into the spring breeding and gestation periods. Main channel border habitat was used by river fishes to forage for food and offered a gravel and cobble bottom for some species, like walleye, to spawn over and a place for larval fish to grow.

Today, Cottonwood Island is a typical Mississippi River island comprised mostly of a monotypic bottomland forest dominated by silver maple (*Acer saccharinum*) and cottonwood (*Populus deltoides*). The waters between the island and the main channel contain seven wing dams with a silty sand bottom. Cottonwood Chute is filling in with sediments deposited during high water periods. Over time, these three habitats, bottomland forest, main channel border, and side channel, are quickly losing their diversity and thus their value to many wildlife species. The decline in habitat quality can be attributed to many events over the last 100 years.

Prior to European settlement, the Upper Mississippi River bottomlands consisted of large contiguous areas of forest cover. The settlers soon recognized the agricultural potential of the Mississippi River Valley's rich alluvial soils and began clearing the forest land for agriculture. The rate of agricultural clearing was considerable despite the constraints of frequent flooding. In the study area, which includes surrounding habitats as well as the specific project site, both forested and non-forested wetlands have declined due to agricultural clearing. Once cleared, farming continued in place of regeneration of trees.

As the Upper Midwest developed, river commerce grew and with it grew the need to ensure safe and reliable navigation. Wing dams were constructed so that flows in the main channel border and backwaters were diverted to the main channel. As the flows were reduced, sediment settled in these habitats, either creating a more silty and even bottom or accelerating accretion of lands between the wing dams.

As navigation developed in the 1930s, the pooling of the river permanently flooded island habitats and altered the hydrology by reducing the effects of flooding/drying of the floodplain wetlands. Watershed development increased runoff and erosion, introducing increased sediment loads in the river system. Floodplain development cut off the river from its floodplain in many places, thereby reducing the natural contributions of the floodplain to the overall river system. Urban and industrial pollution has also negatively impacted river habitats. The combination of these developments has greatly impacted the dynamics of the river. Species that have

evolved to adjust to the river dynamics or to depend upon them for survival either have been reduced to these monotypic habitats or have been replaced with less desirable species such as carp, shad, pink papershell, and raccoon.

b. Land Use and Current Area Management Objectives. Figures 3-1 and 3-2 show the dominant vegetation types in the Cottonwood Island area. Most lands along the river encompass typical bottomland hardwood wetland habitat, some emergent and other wetland habitats, and aquatic habitats associated with the main river channel. Landward of the levees, agricultural production dominates the floodplain.

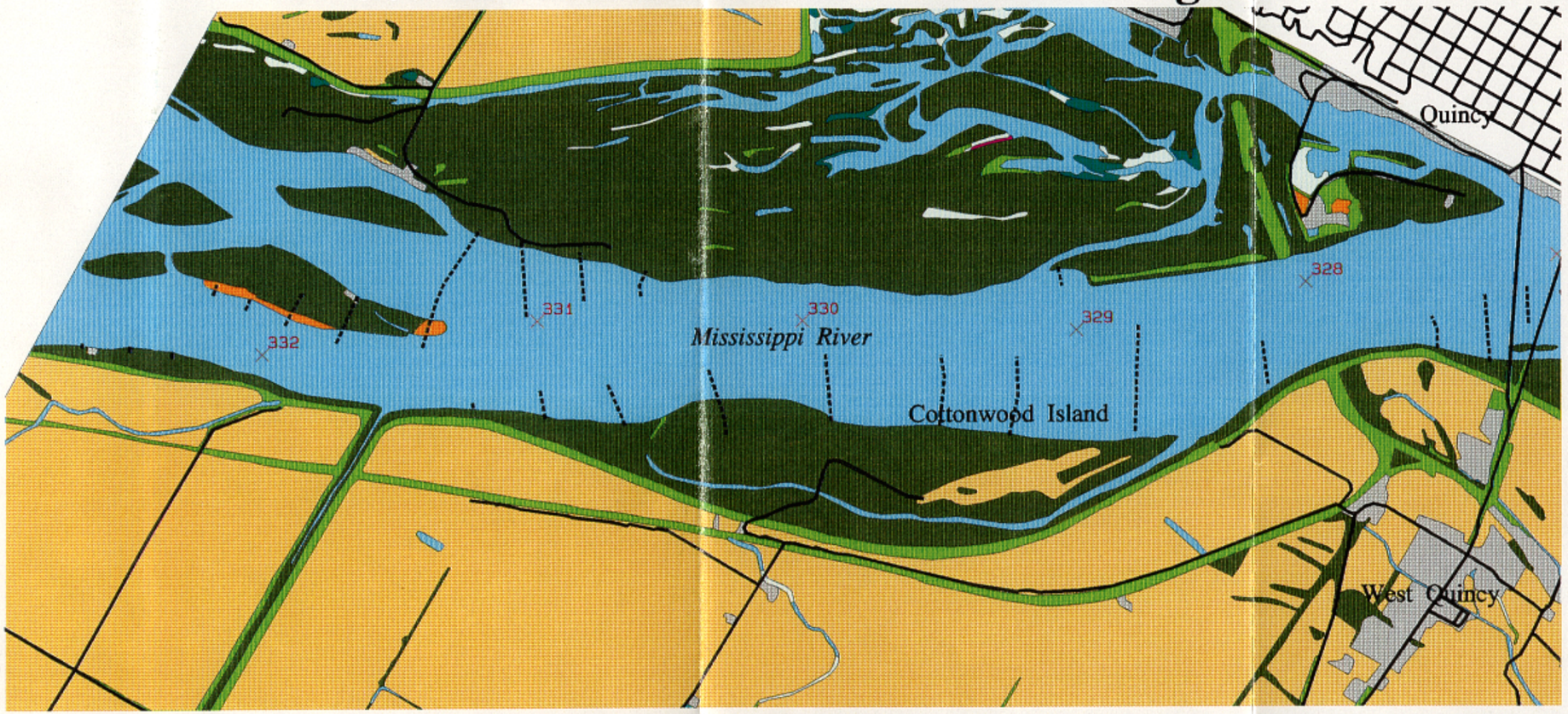
The Corps of Engineers has primary administrative responsibility for 463 acres. Management of these lands was subsequently transferred to the Department of the Interior, U.S. Fish and Wildlife Service (USFWS) for fish and wildlife purposes under a Cooperative Agreement between the Department of Interior, the USFWS, and the U.S. Army Corps of Engineers, dated February 14, 1963. The USFWS administers these project lands through the MDOC under a cooperative agreement between the USFWS and the MDOC. Management practices by the Corps and the MDOC include even-age forest management and crop production. Even-age forest management promotes age diversity among forest stands by clearing areas and allowing new trees to germinate and grow, attracting a wider variety of animals. Crop production provides a food source for deer, squirrels, and migratory birds.

c. Main Channel Border Habitat Resources. Seven wing dams extend from Cottonwood Island to the main channel. The area between the wing dams is considered main channel border habitat. River flows are slower than those in the main channel due to the effectiveness of the wing dams. This area is shallow, flat, and comprised of a silty/sand substrate as a result of lower flows. However, directly downstream of each structure is a turbulent area where water cascading over each structure has scoured a deeper area.

Benthic species found within this dike field are papershell mussel species, tubeflex worms, mayfly larvae, and other small invertebrates. Fish species found in this habitat are catfish, freshwater drum, and carp. In or near the deeper areas, walleye and other game species will forage for food and use this habitat to avoid the main channel currents. Herons and cormorants may forage for fish in the shallow water near the wing dams or perch on an exposed tree that has been washed into the area.

d. Terrestrial Habitat Resources. The project area displays typical silver maple association forest cover. Silver maple is the dominant species, which produces an edible seed in the spring, but does not provide any hard or soft mast for wildlife consumption in the summer or fall months. Due to the agricultural clearing and changed hydrologic conditions, mast-producing tree species such as oak, hickory, pecan, and walnut have declined in the Rock Island District portion of the Upper Mississippi River. Hard mast-producing species such as oak or pecan are practically

1989 Land Cover/Land Use, Pool 21
Cottonwood Island and Surroundings



- Open Water
- Submergents
- Submerged-Rooted Floating Aquatics
- Rooted Floating Aquatics
- Emergents
- Emergent-Grasses/Forbs
- Grasses/Forbs
- Woody Terrestrial
- Agriculture
- Urban/Developed
- Sand/Mud

- Roads
- Wing Dams
- River Mile

2000 0 2000 4000 6000 Feet

1000 0 1000 Meters

Location

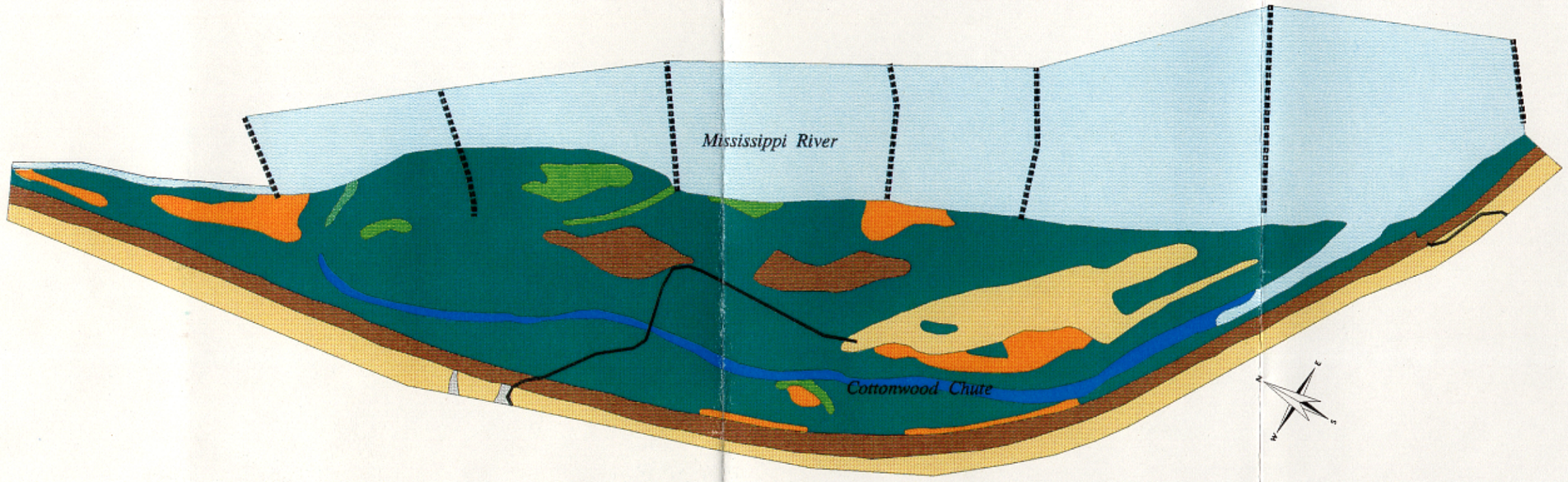
Land Cover Data from Environmental Management Technical Center (EMTC), National Biological Service, Onalaska, Wisconsin
Cartographer: Kevin Anderson

Universal Transverse Mercator Projection, Zone 15, NAD 27

US Army Corps of Engineers
Rock Island District

FIGURE 3-1

1989 Land Cover/Land Use
Cottonwood Island, Pool 21



- Open Water
- Shallow Water
- Mixed forbs and/or grasses
- Brush
- Forest-mesic (moist soil species)
- Populus
- Shrub/grass/forbs
- Rdside-levee/grass/forbs/shrub
- Agriculture
- Developed
- Roads
- Wing Dams

	Acres	Percent
Open Water	412	40
Shallow Water	14	1
Mixed forbs and/or grasses	1	--
Brush	20	2
Forest mesic (moist soil species)	356	35
Populus	32	3
Shrub/grass/forbs	13	1
Roadside-levee/grass/forbs/shrub	64	6
Agriculture	114	11
Developed	1	--
Totals	1027	100

(Data from Environmental Management Technical Center, National Biological Service, Onalaska, Wisconsin, with local adjustments by Rock Island District Corps of Engineers)

1000 0 1000 2000 3000 Feet

200 0 200 400 600 800 1000 Meters

Universal Transverse Mercator Projection, Zone 15, NAD 27

US Army Corps of Engineers
Rock Island District

Cartographer: Kevin Anderson

FIGURE 3-2

non-existent on Cottonwood Island. Soft mast-producing species such as hackberry, sugarberry, and sycamore are not abundant and have had their numbers severely reduced by mortality resulting from severe flooding in 1993. River biologists and foresters are concerned about the future availability of mast as a winter food source for wildlife in the floodplain forests in the region.

Through the Corps natural resource management practices, three forest management sites were cleared to promote regeneration of trees. This was done to add age diversity to the forest stand. When the areas were cleared in the 1980s, high water prevented seedlings from germinating. In their place, brush and wild cucumber covered these sites, thereby reducing almost all opportunities for seedlings to germinate in the future.

Although Cottonwood Island once had a mosaic of forest and shallow sloughs, most of these sloughs have silted in. In the remaining sloughs, wood ducks forage for duck weed and invertebrates during the migration and brooding periods of the year. Other species using these sites are raccoons, deer, frogs, green herons, and warblers.

One agricultural field remains on the island. A certain percentage of crops is left each year as wildlife food. Squirrels and deer utilize this food throughout the winter. Ducks and geese may use the field to forage for any waste grain remaining after harvest. In many years, the crop field is not planted due to spring floodwaters. In these years, nettles and other invasive plant species dominate the site. Little wildlife value is derived at this site during those years.

e. Side Channel Habitat Resources. Cottonwood Chute was at one time a free-flowing channel. Once wing dams were constructed and the navigation pools were in place, the side channel slowly silted in. Today, the side channel is a shallow, stagnant water body. While this habitat has good invertebrate production, its historic fishery value has essentially been lost. Fishes will seek side channel and backwater habitats in the winter so that they can rest rather than expending energy on maintaining their position in the main channel. Those fish with low energy reserves in the spring will be less likely to have healthy and successful spawn, maturation of their eggs, and emergence of fry. While the depths of Cottonwood Chute are less than 1 to more than 7 feet deep and capable of supporting fish, over time the amount of available habitat will decline.

f. Water Quality. In the past, Cottonwood Chute was a flowing side channel which provided deep, productive, aquatic habitat; however, sedimentation, particularly in the upper portion of the chute, has diminished the quality of this habitat in recent years. Baseline monitoring results indicate that water quality within Cottonwood Chute is adequate to support indigenous aquatic life during most periods. Water quality monitoring performed by the Corps has shown that on occasion the dissolved oxygen concentration in the chute falls below the 5 mg/l Missouri State Standard for the Protection of Aquatic Life. Previous researchers also have found this to be true, especially in the upper reaches of the chute. A more detailed analysis of baseline water quality monitoring results can be found in Appendix F.

g. Endangered Species. The following is a list of federally endangered species known to possibly occur in Lewis and Marion Counties:

Status	Common Name	Scientific Name
T	Bald Eagle	*Haliaeetus leucocephalus*
E	Fat Pocketbook Pearly Mussel	*Potamilus capax*
E	Higgins' Eye Pearly Mussel	*Lampsilis higginsi*
E	Indiana Bat	*Myotis sodalis*
T	Decurrent False Aster	*Boltonia decurrens*

Bald eagles use the Mississippi River corridor area near Cottonwood Island as a migratory route, as well as a nesting area in the past. Although an aerie was made on Long Island just upstream of Cottonwood Island, it has not been used recently. The eagles concentrate at the lock and dam sites near Canton, Missouri, and Quincy, Illinois, during the winter.

Fat pocketbook pearly mussels and Higgins' eye pearly mussels usually inhabit coarse gravel, cobble substrate. Because of the dominance of sand and silty materials in the project area, these species are not likely to occur here.

Indiana bats forage over streams and raise their young in riparian forests in this part of Missouri.

Additional species the State of Missouri has identified as species of concern include the mooneye (*Hiodon tergisus*), elusive clubtail (*Stylurus notatus*), and pallid sturgeon (*Scaphirhynchus albus*). The mooneye and elusive clubtail have been found downstream at RM 326.7. Pallid sturgeons are big river fish that may range widely in the Mississippi River and Missouri River systems.

h. Historic Properties. The Cottonwood Island project area contains approximately 463 acres (Figure 3-3). A report entitled *Geomorphological and Archaeological Investigations for the Cottonwood Island Habitat Rehabilitation Project, Upper Mississippi River System, Environmental Management Program, Mississippi River Pool 21, Lewis and Marion Counties, Missouri* (Stanley and Anderson 1994) documents the recent deposition that has formed most of the modern island. Deposits of historical or post-settlement alluvium (PSA) ranging in thickness from 50 centimeters to well over 2 meters cover, or make up, the entire island (Figure 3-4) and mask evidence of all but the most recent mid-20th century activity.

Stanley and Anderson (1994) documented no prehistoric cultural features. Based on geomorphological data, most of the project area has no potential for containing prehistoric archaeological remains (Figure 3-5). The single area of moderate potential for prehistoric archaeological sites lies along center of the southern portion of the island and is covered by 50 centimeters or more of recent alluvium. No part of the area has high potential for prehistoric archaeology.

Geomorphological evidence indicates varied potential for buried historic sites (Figure 3-6). Two areas of high potential were identified. One corresponds to the moderate potential identified for prehistoric sites (Figure 3-5), while the second lies along the shoreline from RM 329 to 330. In all cases, these areas are covered by 50 centimeters to more than 2 meters of recent alluvium.

Stanley and Anderson (1994:20-21) identified a closing dike, wing dam, and wreck from late-19th century cartography. No evidence of these features exists on the island's surface today. The wing dam and closing dike were early structures placed by the Corps of Engineers in order to improve navigation. These have been masked by sediment and by the increased water levels following lock and dam construction. In any case, these features are not considered as potentially eligible for inclusion in the National Register of Historic Places (NRHP).

The wreck is potentially eligible for the NRHP, but inspection of the present shoreline revealed no evidence of it. Any remaining wreckage not salvaged shortly after the accident would be deeply buried. Its location is near but riverward of the modern shoreline in an area of sediment accumulation downstream of a modern wing dam. No disturbance of sediments in the location of the wreck will take place for this project (see Figure 9-1).

Borrow pits from modern levee construction are still visible along the western margin of the project area but are considered to have no significance as NRHP sites.

i. Sedimentation. A sedimentation study was conducted to evaluate Cottonwood Island sedimentation during the period 1938 through 1994. (See Appendix G.) The scope of this study consisted of determining net sedimentation from 1938 (pre-lock and dam) through 1994, and evaluating proposed project impacts on sedimentation.

Baseline elevations were established from 1938 plane table topographic maps. Additional sections were taken by survey crews in 1994. These sections were extended by combining the 1994 data with elevations obtained from 1977 photographic mapping. The 1938 elevations were compared with the 1994/1977 elevations to show net changes in elevation. Six ranges were used to construct composite cross sections of this area (see plates 13 and 14).

The average total sedimentation rate for the overall Cottonwood Island area has been approximately 0.46 inch/year, or 2.16 feet over 56 years. Sedimentation varies greatly through the project site, with the majority of the sediment deposition occurring above the causeway. The area of greatest sediment deposition, the upstream-most end of Cottonwood Island near Wing Dam 9, averages 1.20 inch/year. The area of least sediment deposition, the lower 5,000 feet of Cottonwood Chute, averages 0.11 inch/year. Average sedimentation rates for Cottonwood Island are shown in Table 3-1. (See plate 2 for site plan.)

FIGURE 3-3

Cottonwood Island Project Location
for Cultural Resource Analysis

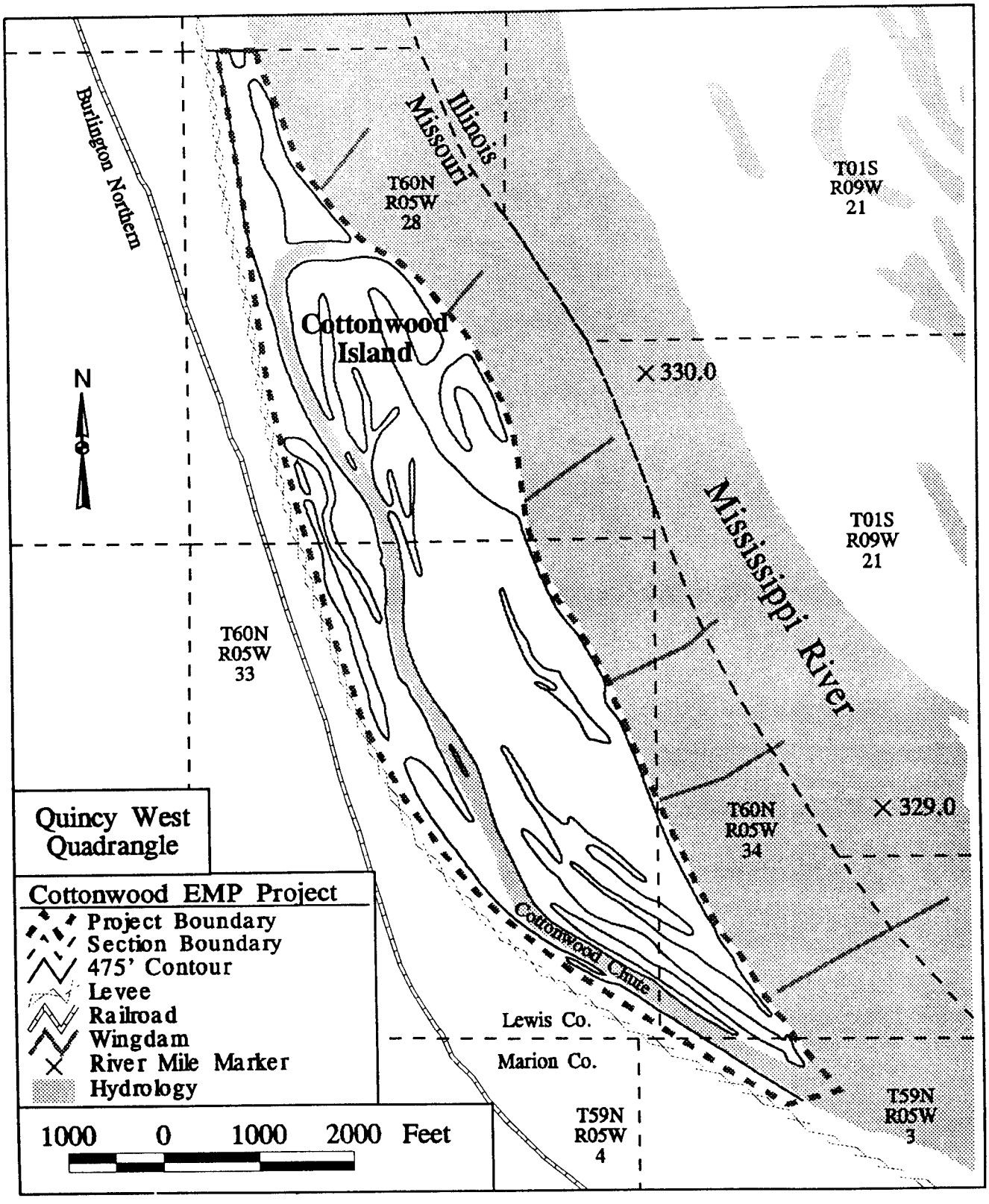


FIGURE 3-4

Estimated Historical Alluvium Depths

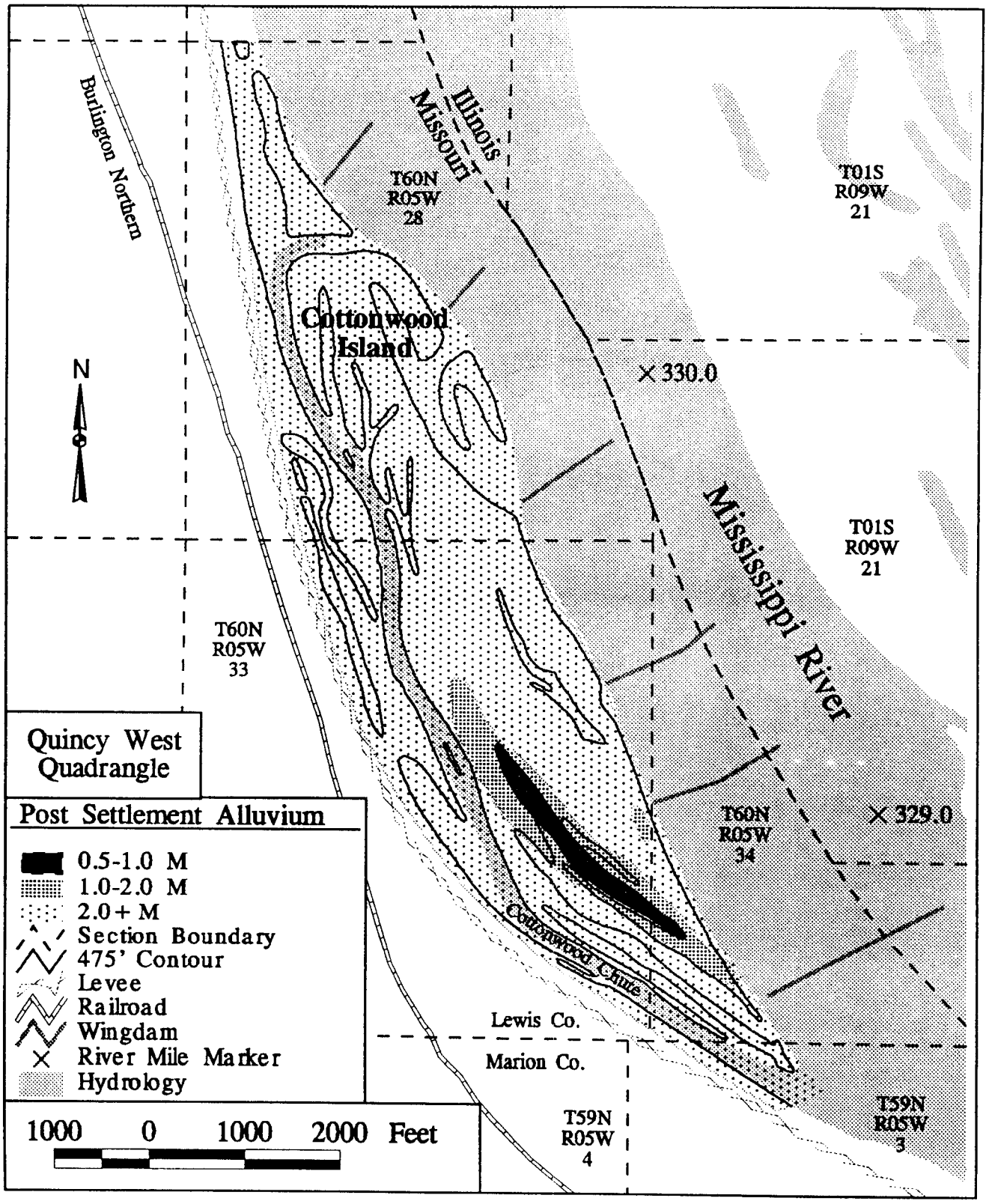


FIGURE 3-5

Geomorphologically Derived Areas
of Prehistoric Site Potential

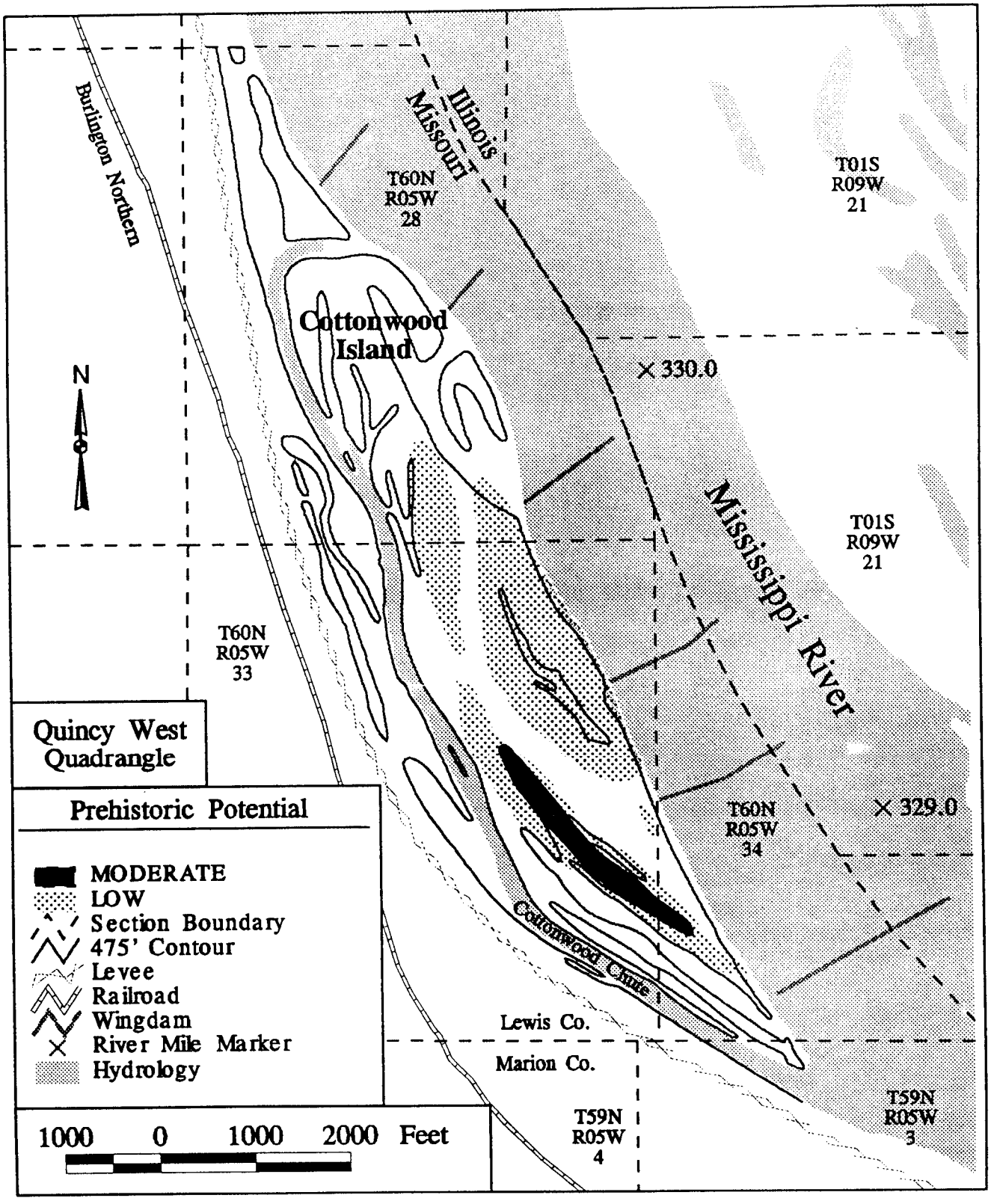


FIGURE 3-6

Areas of Historical Site Potential

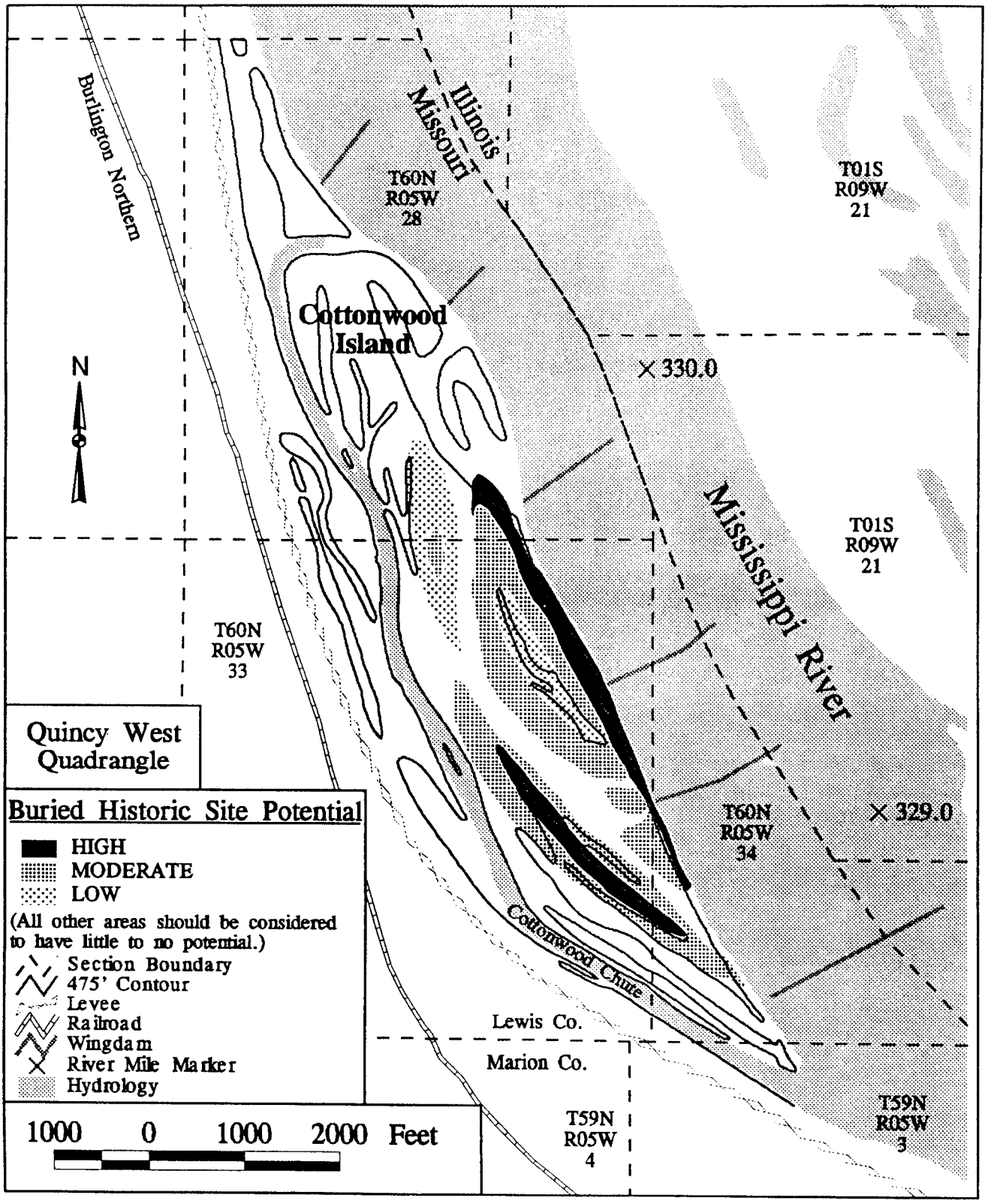


TABLE 3-1

Cottonwood Sedimentation Rates

Location	Average Sedimentation Rate Inch/Yr.	Average 50-Year Sedimentation (ft)
Upstream end of Cottonwood Island near Wing Dam 9	1.20	5.0
Upstream end of Cottonwood Island near Wing Dam 8	0.46	1.9
Cottonwood Chute - above existing causeway	0.76	3.2
Cottonwood Chute - below existing causeway	0.16	0.7
Cottonwood Chute - below island	0.11	0.5

j. 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 hazardous, toxic, or radioactive waste contamination within the project area.

4. PROJECT OBJECTIVES

a. Objectives and Potential Enhancement Features. The project goals, objectives, and potential enhancement features are summarized in Table 4-1. In developing the potential enhancement features, consideration was given to satisfying project objectives while maximizing utilization of resource opportunities. A potential enhancement feature is intended to satisfy at least one objective, either singularly or in combination with other enhancement features.

Enhancement features are to be components of an overall alternative which will satisfy the project goals and objectives. The enhancement features are described and assessed in Sections 5 and 6.

TABLE 4-1

Project Goals, Objectives, and Potential Enhancement Features

Goal	Objective	Potential Enhancement Features
Restore Aquatic Overwintering Habitat	Improve Water Quality for Fish	Create New Chute Opening
	Provide Overwintering Water Habitat for Fish	Flow Control Structure
		Sediment Barrier (Land-Based)
		Chute Restoration and Enhancement
		Create Deep Holes
		Remove Causeway
		Remove Logjam
Restore Main Channel Border Habitat	Improve Water Quality for Fish	Sediment Barrier (Emergent Rock Dike)
	Provide Flowing Water Habitat for Fish	Anchor Cedar Tree Clumps in Backwater Area behind Emergent Dike
	Provide Additional Habitat and Substrate for Benthic and Aquatic Organisms	Notch Wing Dams
		Rock Placement Below Wing Dams
Restore Wetland Habitat	Increase Food, Shelter, and Breeding Habitat for Wildlife	Potholes
	Increase Bottomland Hardwood Diversity and Quality	Establish Hardwood Trees in Existing Forest Management/Crop Areas
		Establish Hardwood Trees on Elevated Ridges

b. Criteria for Potential Enhancement Features. Table 4-2 presents general and specific criteria developed to assess potential enhancement features.

TABLE 4-2

Potential Enhancement Features Development Criteria

Item	Purpose of Criteria
A. General Criteria	
Locate and construct features consistent with EMP directives	Comply with program authorities
Construct features consistent with Federal, State, and local laws	Comply with environmental laws
Develop features that can be monitored	Provide baseline for project effects (e.g., sedimentation, stability, water quality)
Design features to facilitate operation and maintenance	Minimize operation and maintenance costs
Locate and construct features consistent with best planning and engineering practice	Provide basis for project evaluation and alternative selection
Construct features which meet one or more project objectives	Meet project goals and objectives
B. Sediment Barrier	
Provide reliable sediment barrier consistent with management goals	Provide protection from sediment deposition to meet seasonal/annual reliability goals
Locate sediment barrier consistent with natural river dynamics	Ensure navigation channel is not affected
C. Water Control	
Limit flow into Cottonwood Chute	Decrease amount of sediment-laden water entering head of Cottonwood Chute
Minimize on-site maintenance requirements	Realize MDOC personnel limitations and project accessibility
D. Chute Restoration and Enhancement	
Increase depth of chute	Ensure fisheries access to the main channel throughout the year
Provide deep holes	Ensure adequate dissolved oxygen and depths during winter and summer stress periods
E. Notch Wing Dams	
Stagger notch locations	Stimulate in-stream meander through dike field
Rock placement below wing dams	Increase habitat diversity through the dike field

TABLE 4-2 (Cont'd)

Item	Purpose of Criteria
F. Mast Tree Planting	
Locate plantings in existing forest management/crop areas	Increase bottomland hardwood diversity
Locate plantings on high ground	Maximize tree survival rate
G. Potholes	
Locate in interior sloughs and depressions	Improve existing habitat suitability and availability for migratory birds and non-game species

5. POTENTIAL FEATURES OF ALTERNATIVES

The purpose of this section is to describe and assess a preliminary number of potential enhancement features. Once these features are evaluated in this section, Section 6 will formulate alternatives based on combinations of features.

Potential enhancement features were determined based on their ultimate contribution to the project goals and objectives, engineering considerations, and local restrictions or constraints. These development criteria are summarized in Table 4-2. Enhancement features which were not feasible or did not meet the criteria of Table 4-2 were not subject to further evaluation. Once the initial screening was completed, the remaining potential enhancement features were optimized to fully or partially satisfy the project objective(s). The optimized potential enhancement features were combined to make up alternatives which meet the project goals and objectives of Table 4-1. For project planning purposes, project life was established as 50 years.

a. Side Channel Improvements. Cottonwood Chute historically served as an overwintering site for fish. Sedimentation has reduced water depths to levels unusable by fish in all but the downstream-most section of the chute. Since a logjam closed the upper end of the channel, flow through Cottonwood Chute is limited to high water periods, when overland flows submerge most of Cottonwood Island upstream of the logjam. During these periods, dissolved oxygen levels and depths are at or above the Missouri State Standard of 5 mg/l and 6 feet, respectively. However, during most years, dissolved oxygen levels and depths in the upstream end of the chute are below this level and are too low to sustain a fishery. At present, the upstream end of Cottonwood Chute above the causeway consists of 15 acres of stagnant water ranging from approximately 6 inches to a little more than 2 feet in depth.

To reduce Cottonwood Chute sedimentation and ensure sufficient year-round dissolved oxygen levels, several features were considered individually and in combination. These features include pilot channel construction, construction of a flow control structure, sediment barrier construction, and chute restoration and enhancement.

(1) Pilot Channel Excavation. This feature consists of excavating an existing slough, as shown on plate 4. Re-opening this slough to the river would ensure fresh, oxygenated water in Cottonwood Chute. Pilot channel excavation depths would range from 8 to 11 feet below flat pool (elevation 470 feet NGVD 1912 - Quincy Highway Bridge Gage 11.41). Pilot channel excavation depths were determined based on historic sedimentation rates. (See Appendix G.)

Flow through Cottonwood Chute was calculated using the HEC-2 computer program. With a typical Mississippi River winter discharge of 40,000 cubic feet per second (cfs), flow through Cottonwood Chute under existing conditions is 0.1 cfs. Pilot channel excavation would provide a flow of approximately 142 cfs to Cottonwood Chute. The pilot channel is similar to the entrance channel of the Brown's Lake Rehabilitation and Enhancement project (Corps 1987). Five years of monitoring at Brown's Lake

indicates that the head end of the entrance channel has become clogged with debris and heavy sediment deposition has occurred. To regulate inflow and decrease sediment and debris deposition typical of open head end channels, a flow control structure should be constructed at the head end of the pilot channel.

(2) Flow Control Structure. This feature consists of a flow control structure at the head end of the pilot channel, as shown on plate 4. The flow control structure would decrease sediment and debris deposition in the pilot channel and regulate flow to provide acceptable levels of dissolved oxygen to Cottonwood Chute.

A technical/hydraulic study was conducted to determine the flow necessary to maintain a dissolved oxygen concentration of 6 mg/l throughout Cottonwood Chute. The results of the technical/hydraulic study indicate that a minimum flow of 40 ft/sec. is necessary to maintain this dissolved oxygen concentration (see Appendix F - Water Quality).

Several types of flow control structures capable of providing this minimum flow were evaluated, such as gated concrete box culverts, concrete culverts of varying diameters, and a rock filter structure. Operation and maintenance requirements for flow control structures would include opening and closing gates as required by river flow conditions (gated concrete box culverts), and periodic debris removal (all structures). Due to personnel limitations and project accessibility, the MDOC requested that operational and maintenance requirements be as minimal as possible. Consequently, flow control structures were eliminated from further consideration. Without the flow control structure, the pilot channel would be an open head end channel subject to the aforementioned sediment and debris deposition experienced at Brown's Lake. Maintenance requirements would include periodic dredging or debris removal to maintain depth and flow through Cottonwood Chute. Because of these maintenance requirements, pilot channel excavation also was eliminated from further consideration.

(3) Sediment Barrier. To provide adequate side channel depths for the life of the project, several sediment barrier alignments were proposed to divert heavy silt loads from the restored Cottonwood Chute and the pilot channel during high river flows. The proposed alignments are shown on plate 4. Sediment barrier alignments include: a closing levee upstream of the entrance to the pilot channel and tying into the Fabius River Drainage District levee; a riverbank sediment barrier downstream of the entrance to the pilot channel to just past the historic opening to Cottonwood Chute; and an emergent off-shore sediment barrier. The sediment barriers could be constructed as independent or combined features.

The closing levee and riverbank sediment barrier would be constructed to elevation 485 feet (NGVD 1912 - Quincy Highway Bridge Gage 26.41), a 25-year level of protection at river Mile 330.6, and have a 10-foot crown with 3 horizontal to 1 vertical side slopes. These sediment barriers would not keep floodwaters off the low-lying upper end of Cottonwood Island since the sediment barriers do not tie into the Fabius levee at the downstream end. However, for floods up to the 25-year event, these barriers would prevent water from flowing continuously through the area, decreasing

sediment deposition in the pilot channel. With the elimination of the flow control structure and pilot channel excavation from further consideration, the need for flood protection for these features also was eliminated. Consequently, the closing levee and riverbank sediment barriers were not subject to further evaluation.

The emergent off-shore sediment barrier would be constructed of large derrick stone, constructed to the highest elevation on Cottonwood Island, elevation 476 feet (NGVD 1912), approximately a 2-year level of protection, have a 6-foot crown with 1 horizontal to 1 vertical side slopes. Flows behind the emergent sediment barrier would be reduced, encouraging sediment deposition and shallow water conditions beneficial for plant growth and waterfowl use. During high flows, fish could enter this area to avoid the velocities in the main channel as well as use the plants as escape and forage habitat. Although this feature would stimulate diversity and provide added value to the ecosystem, its initial cost estimates ($7 million), decreased sediment protection, and proximity to the 9-foot channel (and possible impacts to navigation) precluded further consideration.

(4) Chute Restoration and Enhancement. Chute restoration and enhancement features consist of channel and deep hole dredging as shown on plates 5 and 8. The main purpose of this dredging would be to restore fish habitat and create habitat for over-wintering fish. Chute restoration and enhancement plans include dredging depths of 7 to 15 feet below flat pool (elevation 470 feet NGVD 1912). Three of these plans also include dredging three to five 300-foot-long, 15-foot-deep holes to restore over-wintering fish habitat. Dredging depths were determined based on historic sedimentation rates. (See Appendix G.)

b. Anchor Cedar Tree Clumps. This feature consists of anchoring cedar tree clumps in the backwater area created by the emergent rock dike, as shown on plate 4. With the elimination of the emergent rock dike from further consideration, this feature will not be evaluated.

c. Remove Logjam. As shown on plate 4, this feature consists of removing the logjam at the head end of Cottonwood Chute. Logjam removal would create an open head end channel subject to sediment and debris deposition described in subparagraph: **Pilot Channel Excavation**. To minimize sediment deposition and chute restoration and enhancement maintenance requirements, the logjam will remain in place.

d. Potholes. This feature consists of constructing up to 4 acres of potholes, as shown on plate 5. Sites identified as having potential for rehabilitation include interior sloughs and depressions as well as the area upstream of the causeway. The sloughs and depressions, once recharged with nutrients and water by seasonal flooding, have experienced accelerated sedimentation and accompanying loss of benefits to wildlife. The 4 acres of potholes would be mechanically excavated to a depth of 3 to 4 feet below flat pool. Pothole side slopes would be benched to promote littoral zone emergent vegetation and to enhance growth of moist soil plants. See plate 10 for typical sections.

e. Mast Tree Plantings. This feature consists of planting mast-producing trees at the locations shown on plate 5. Mast trees would be planted on dredged material and on material excavated for pothole construction, as shown on plates 8 and 10. In addition, four other sites have been identified as prime areas to plant mast trees: the existing 33-acre cropfield and three open areas that have been cleared as part of the Corps of Engineers forest management program (Forest Management Areas 5, 6, and 7). The Forest Management Areas 5, 6, and 7 and the agricultural field on Cottonwood Island are ideal for mast tree establishment because minimal site preparation would be required. A timber sale would be conducted for the dredged material placement site prior to project construction. The objective of the proposed tree planting would be to enhance the habitat value of the forest resource by introducing a component of mast-producing species into a forest dominated by silver maple and cottonwood. Species to be planted would include pin oak, swamp white oak, bur oak, pecan, and sycamore. To increase survival, larger trees that are at least 1/2-inch caliper and 4 feet in height would be planted. Trees would be located on the higher areas of the planting sites that can best support trees that are moderately tolerant of flooding.

f. Wing Dam Notching. This feature consists of notching up to 7 wing dams, as shown on plate 5. Each notch would be approximately 100 feet wide. Removed material would be placed downstream of the notch, creating interstices and promoting invertebrate colonization, thus promoting fish foraging. It is anticipated that flow will increase in the vicinity of the notch, deepening the pool behind the wing dams. The change in flow at one wing dam may also stimulate an in-stream meander to the next wing dam. A meander would create deeper areas, attracting a more diverse benthic community and fishery. In technical report E-84-4 titled, *Environmental Guidelines for Dike Fields,* by Carey Burch, *et al.* (1984), notching emergent wing dams resulted in holes being eroded in the sediment downstream of the notch. The wing dams in their study extended from the channel bottom to above normal water level (i.e., emerged wing dams). The Cottonwood Island wing dams are submerged. In contrast, a hydraulic study modeling notching submerged wing dams (see Appendix H) did not reveal significantly higher velocities capable of eroding holes or scouring paths connecting the notches. However, a 1980 wing dam study performed by the Iowa Department of Natural Resources (IADNR) on 595 wing dams observed that, 9 times out of 10, a wing dam blowout (or natural notch) would have an accompanying scour hole. It was also observed that the closer the wing dam was to the water surface, the greater the scour. The IADNR velocity measurements at the wing dam and 100 feet upstream of the wing dam were proportional to the hydraulic model velocities, i.e., the velocity at the wing dam was approximately twice the velocity 100 feet upstream of the wing dam. (John Pitlo, IADNR, pers. comm. 4-4-96) The Cottonwood wing dams are all considered to be close to (within 1 to 2 feet of) the water surface. The performance of the Cottonwood Island wing dam notches will be monitored for comparison with the hydraulic model, the monitoring results discussed in the Carey Burch, *et al.,* report, and the IADNR wing dam study.

6. EVALUATION OF FEASIBLE PROJECT FEATURES

This section describes the features that met the goals and objectives of the project. Each feature was analyzed using Habitat Evaluation Procedures (HEP) to determine its restoration or enhancement potential. Cost associated with each feature was also derived for all the feasible project features.

Environmental Output Evaluation.

a. Background. A habitat evaluation was completed for the Cottonwood Island project, with a project goal of enhancing wetland and aquatic habitats. For a detailed analysis of the HEP methodology, refer to Appendix D.

Two HEP procedures were chosen for habitat evaluation. One, the Aquatic Habitat Appraisal Guide (AHAG) (Mathias, *et al.*, unpublished) is a model that has been specifically developed to evaluate fish habitat in the Upper Mississippi River System. Aquatic habitats, the side channel restoration, and main channel border were analyzed using the AHAG. Fish species evaluated in the AHAG include white bass, emerald shiner, river darter, northern pike, smallmouth buffalo, walleye, largemouth bass, and bluegill. Each species represents a guild, or array, of fishes that exploit the same environmental resources (e.g., habitats) in similar ways (Root 1967).

To assess the proposed features aimed at restoring terrestrial habitats in the project area, a second model was used. This model is a bottomland hardwood (BLH) model being developed by the Corps of Engineers Waterways Experiment Station (WES) (COE 1992). This model has been designed to assess biological functions of BLH wetlands in the southern United States. The model was slightly modified to accurately assess Upper Mississippi River BLH conditions.

Both the AHAG and BLH models use the equation,

HSI x Acres = HUs

Where,

HSI = habitat suitability index (a quality measurement)
Acres = area (a quantity measurement)
HU = habitat units

as a measurement to quantify habitat output in the form of HUs. Because the project would be a habitat restoration effort and not mitigation for habitat losses occurring elsewhere, there were no numerical goals per se as part of the objectives. Although optimal conditions would be welcomed at Cottonwood Island, these conditions are neither physically attainable nor affordable. The goal of this project is to produce the highest environmental output at a reasonable and acceptable cost to the Corps of Engineers, the USFWS, and the MDOC.

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of

the project. Cumulative HUs are annualized and averaged. This calculation determines what is known as Average Annual Habitat Units (AAHUs). AAHUs are used as the output measurement to compare all the features and project as a whole.

b. Feasible Project Features.

(A) - Restore Aquatic Overwintering Habitat. This management measure consists of the following options:

(1) **No Action (A0).** No action would result in no additional management efforts above the existing practices. No AAHU gain or loss would be realized than what may occur naturally. However, it is anticipated that the Cottonwood Island resources would benefit from the proposed project. If no action were to take place, it is anticipated that the side channel would eventually silt in completely, affording no benefit to overwintering fishes in this area of the river. It is recognized that bottomland wetland vegetation such as silver maple would eventually dominate these sites.

(2) **Side Channel/3 Deep Holes (A1).** As shown on plate 5, this option consists of dredging the lower 4,900 feet of Cottonwood Chute (to just below the island) to a depth of 7 feet below flat pool (elevation 470 feet NGVD 1912) and includes three 300-foot-long deep holes for overwintering fish. The deep holes would be dredged to a depth of 15 feet below flat pool.

(3) **Side Channel/4 Deep Holes (A2).** As shown on plate 5, this option consists of dredging the lower 4,900 feet of Cottonwood Chute (to just below the island) to a depth of 7 feet below flat pool (elevation 470 feet NGVD 1912) and includes four 300-foot-long deep holes for overwintering fish. The deep holes would be dredged to a depth of 15 feet below flat pool.

(4) **Side Channel/5 Deep Holes (A3).** As shown on plate 5, this option consists of dredging the lower 7,500 feet of Cottonwood Chute (to just below the causeway) to a depth of 7 feet below flat pool and includes five 300-foot-long deep holes for overwintering fish. The deep holes would be dredged to a depth of 15 feet below flat pool.

(5) **Deep Side Channel (A4).** As shown on plate 5, this option consists of dredging the entire 11,500-foot length of Cottonwood Chute to a depth of 15 feet below flat pool and removing the causeway. Because the 15-foot depth would provide suitable habitat for overwintering fish, this option does not include additional deep holes for overwintering fish.

(B) - Restore Wetland Habitat (Mast Tree Planting and Potholes). Pothole and mast tree planting locations are shown on plate 5. Pothole construction would utilize interior sloughs and depressions. A typical section is shown on plate 10. The total area to be planted in mast is approximately 70 acres, each acre would be planted with 53 trees. This management measure consists of the following options:

(1) **No Action (B0).** No action would result in no additional management efforts above the existing practices. No AAHU gain or loss would be realized than what may occur naturally. However, it is anticipated that the Cottonwood Island resources would benefit from the proposed project. If no action were to take place, it is anticipated that the BLH habitat would not regenerate mast-bearing trees on its own and that shallow depressions would continue silting in, further reducing their already low value. Again, species like silver maple and cottonwood trees would eventually dominate these areas.

(2) **Plant mast-producing trees on Forest Management Area (FMA) #7 and construct one 1-acre pothole (B1).** This option consists of planting mast trees on FMA #7 and constructing a pothole in a degraded slough near this clearcut area.

(3) **Plant mast-producing trees on the dredged material (B2).** This option consists of planting mast trees on the dredged material from the side channel cleanout.

(4) **Plant mast-producing trees on FMA #5 and construct one 1/2-acre pothole (B3).** This option consists of planting mast trees on FMA #5 and constructing a 1/2-acre pothole on the upper end of the island.

(5) **Plant mast-producing trees on FMA #6 and construct one 1/2-acre pothole (B4).** This option consists of planting mast trees on FMA #6 and constructing a 1/2-acre pothole near the existing agricultural field.

(6) **Plant mast-producing trees on the agricultural field and construct two 1-acre potholes (B5).** This option consists of planting mast trees on the agricultural field and excavating two 1-acre of potholes. The pothole locations would be in two low areas in the field.

(C) - Restore Main Channel Border Habitat. This alternative consists of the following options:

(1) **No Action (C0).** No action would result in no additional management efforts above the existing practices. No AAHU gain or loss would be realized than what may occur naturally. It is anticipated that the Cottonwood Island resources would benefit from the proposed project, however. If no action were to take place, it is anticipated that the existing main channel border would perpetuate low habitat value and would not realize higher values naturally.

(2) **Notch Wing Dam #9 (C1).** This option consists of notching one wing dam (Wing Dam #9) to original river bottom. The notch width would be 100 feet. The notch would be located no closer than 100 feet from the shoreline.

(3) **Notch Wing Dam #8 (C2).** This option consists of notching Wing Dam #8 with the notch located no closer than 100 feet from the shoreline.

(4) **Notch Wing Dam #5 (C3).** This option consists of notching Wing Dam #5 with the notch located no closer than 100 feet from the shoreline.

(5) **Notch Wing Dam #6 (C4).** This option consists of notching Wing Dam #6 with the notch located no closer than 100 feet from the shoreline.

(6) **Notch Wing Dam #29 (C5).** This option consists of notching Wing Dam #29 with the notch located no closer than 100 feet from the shoreline.

(7) **Notch Wing Dam #30 (C6).** This option consists of notching Wing Dam #30 with the notch located no closer than 100 feet of the shoreline.

(8) **Notch Wing Dam #15 (C7).** This option consists of notching Wing Dam #15 with the notch located no closer than 100 feet of the shoreline.

c. Cost Estimates for Habitat Improvement Measures. Table 6-1 summarizes the output and costs associated with each management measure. A breakdown of costs is outlined in Section 14 - Cost Estimates.

TABLE 6-1

Environmental Output and Costs of Each Feature

Feature	Symbol	Output*	Cost**	Annualized Cost***
Side Channel and Deep Hole Dredging				
No Action	A0	0	0	0
3 Deep Holes and Adjacent Side Channel	A1	679	321	25.5
4 Deep Holes and Adjacent Side Channel	A2	858	340	27
5 Deep Holes and Adjacent Side Channel	A3	926	545	43.3
Entire Deep Channel	A4	990	1524	121.0
Mast Tree Planting and Potholes				
No Action	B0	0	0	0
Plant Mast Trees on FMA #7/1 Acre Pothole	B1	7.79	58	4.6
Plant Mast Trees on Dredged Material	B2	7.15	49	3.9
Plant Mast Trees on FMA #5/.5 Acre Pothole	B3	11.42	88	7.0
Plant Mast Trees on FMA #6/.5 Acre Pothole	B4	11.94	84	6.7
Plant Mast Tress on Ag Field/2 -1 Acre Potholes	B5	27.49	199	15.8
Wing Dam Notching				
No Action	C0	0	0	0
Notch Wing Dam 9	C1	8	12.8	1.02
Notch Wing Dam 8	C2	18	12.8	1.02
Notch Wing Dam 5	C3	34	12.8	1.02
Notch Wing Dam 6	C4	44	12.8	1.02
Notch Wing Dam 29	C5	67	12.8	1.02
Notch Wing Dam 30	C6	84	12.8	1.02
Notch Wing Dam 15	C7	89	12.8	1.02

* Outputs are calculated as Average Annual Habitat Units.

** All costs in $1,000s.

*** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate.

7. FORMULATION AND EVALUATION OF ALTERNATIVES

a. General Discussion. In restoration and enhancement projects like the Cottonwood Island project, cost effectiveness analysis has been used to evaluate and determine what management measures should be built based on habitat benefit outputs that meet the goals and objectives of the project and at the same time are the most cost effective. The Corps of Engineers has incorporated cost effectiveness analysis into its planning documents for some time, mostly in mitigation planning. A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of output. After the cost effectiveness of the alternatives has been established, subsequent incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

Cost effectiveness and incremental analysis is basically a three-step procedure: (1) calculate the environmental outputs of each feature; (2) determine a cost estimate for each feature; and (3) combine the features to evaluate the best overall project alternative based on habitat benefits and cost. While cost and environmental output are necessary factors, other factors such as constructibility and meeting the goals and objectives (Tables 4a, 4b) of the sponsor are very important in deciding the preferred alternative.

Several steps were taken to incrementally analyze this project. This project was evaluated using guidance prepared by the Corps of Engineers' Institute for Water Resources (Robinson, *et al.*, 1995).

b. Potential Alternatives. Each management measure's various alternatives were evaluated separately to determine the most cost-efficient and effective plans. For the side channel restoration, the incremental cost per AAHU was calculated and presented in Table 7-1 and Figure 7-1.

Tables 7-2 through 7-4 present the island restoration incremental cost analysis. The methodology used is described in Robinson, *et al.*, 1995. This methodology was used because the island restoration features identified are independent (i.e., could stand alone as a plan) yet combinable to form other plans. By looking at all the identified plans in an additive fashion, the most efficient plan in production can be identified.

By scanning the average cost per unit column in Table 7-2, the alternatives can be reordered by their production efficiencies (average cost) (Table 7-3). Because each alternative would produce the same type of output, all other considerations aside, the management measure which is the most efficient in production would be implemented first. The subsequent plans were formulated by adding costs and outputs of the next successive cost-efficient plan (Table 7-4). Incremental cost analysis was based on the additive character of each plan. Table 7-4 and Figure 7-2 present the incremental costs for each plan.

The main channel border enhancement feature was analyzed in the same fashion as the island restoration. Tables 7-5 through 7-7 and Figure 7-3 present the steps used to determine the incremental cost of habitat output each plan would produce.

TABLE 7-1

Side Channel and Deep Hole Dredging
Incremental Cost Analysis

Features	Symbol	Annual Cost**	Output AAHUs*	Incremental Cost	Incremental Output	Incremental $/AAHU
No Action	A0	0	0	0	0	0
Side Channel/3 Deep Holes	A1	25.5	679	25.5	679	0.038
Side Channel/4 Deep Holes	A2	27	858	1.5	179	0.008
Side Channel/5 Deep Holes	A3	43.3	926	16.3	68	0.240
Deep Side Channel	A4	121	990	77.7	64	1.214

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

TABLE 7-2

Island Restoration
Output, Cost, and Average Cost for Each Feature

Features	Plan	Annual Cost**	Output, AAHUs*	Average Cost, $/AAHU
No Action	B0	0.00	0.00	0
Plant FMA 7/1 Acre of Potholes	B1	4.60	7.79	0.59
Plant Dredged Material	B2	3.90	7.15	0.55
Plant FMA 5/1/2 Acre of Potholes	B3	7.00	11.42	0.61
Plant FMA 6/1/2 Acre of Potholes	B4	6.70	11.94	0.56
Plant Ag Field/2 Acres of Potholes	B5	15.80	27.49	0.57

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

TABLE 7-3

Island Restoration
Output, Cost, and Average Cost for Each Feature
Ranked by Production Efficiency

Features	Plan	Annual Cost**	Output, AAHUs*	Average Cost, $/AAHU
No Action	B0	0.00	0.00	0
Plant Dredged Material	B2	3.90	7.15	0.55
Plant FMA 6/1/2 Acre of Potholes	B4	6.70	11.94	0.56
Plant Ag Field/2 Acres of Potholes	B5	15.80	27.49	0.57
Plant FMA 7/1 Acre of Potholes	B1	4.60	7.79	0.59
Plant FMA 5/1/2 Acre of Potholes	B3	7.00	11.42	0.61

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

TABLE 7-4

Island Restoration
Plans with Incremental Cost Per Unit

Plan	Annual Cost**	Output, AAHUs*	Average Cost, $/AAHU	Incremental Cost ($1,000)	Incremental Output, AAHUs	Incremental Cost, $/AAHU
B0	0	0	0	0	0	0
B2	3.90	7.15	0.55	3.90	7.15	0.55
B2+B4	10.60	19.09	0.56	6.70	11.94	0.56
B2+B4+B5	26.40	46.58	0.57	15.80	27.49	0.57
B2+B4+B5+B1	31.00	54.37	0.57	4.60	7.79	0.59
B2+B4+B5+B1+B3	38.00	65.79	0.58	7.00	11.42	0.61

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

TABLE 7-5

Main Channel Border Enhancement
Output, Cost, and Average Cost for Each Feature

Features	Symbol	Annual Cost**	Output AAHUs*	Average Cost
No Action	C0	0	0	
Wing Dam 9	C1	1.02	5	0.204
Wing Dam 8	C2	1.02	10	0.102
Wing Dam 5	C3	1.02	16	0.064
Wing Dam 6	C4	1.02	10	0.102
Wing Dam 29	C5	1.02	23	0.044
Wing Dam 30	C6	1.02	17	0.060
Wing Dam 15	C7	1.02	8	0.128

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

TABLE 7-6

Output, Cost, and Average Cost for Each Feature
Main Channel Border Enhancement
Ranked by Production Efficiency

Features	Symbol	Annual Cost**	Output AAHUs*	Average Cost
No Action	C0	0	0	
Wing Dam 29	C5	1.02	23	0.044
Wing Dam 30	C6	1.02	17	0.060
Wing Dam 5	C3	1.02	16	0.064
Wing Dam 8	C2	1.02	10	0.102
Wing Dam 6	C4	1.02	10	0.102
Wing Dam 15	C7	1.02	8	0.128
Wing Dam 9	C1	1.02	5	0.204

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

TABLE 7-7

Main Channel Border Enhancement
Plans with Incremental Cost Per Unit

Feature	Annual Cost**	Output*	Average Cost	Incremental Cost ($1,000)	Incremental Output, AAHUs	Incremental Cost, $/AAHU
No Action	0	0		0	0	0
C5	1.02	23	0.044	1.02	23	0.04
C5+C6	2.03	40	0.051	1.02	17	0.06
C5+C6+C3	3.05	56	0.054	1.02	16	0.06
C5+C6+C3+C2	4.07	66	0.062	1.02	10	0.10
C5+C6+C3+C2+C4	5.08	76	0.067	1.02	10	0.10
C5+C6+C3+C2+C4+C7	6.10	84	0.073	1.02	8	0.13
C5+C6+C3+C2+C4+C7+C1	7.11	89	0.080	1.02	5	0.20

* Output is Average Annual Habitat Units.
** Annualized cost is initial construction cost based on a 50-year project life, 7-3/4% interest rate. Costs are $1,000.

FIGURE 7-1

Side Channel and Deep Hole Dredging
Incremental Cost Analysis

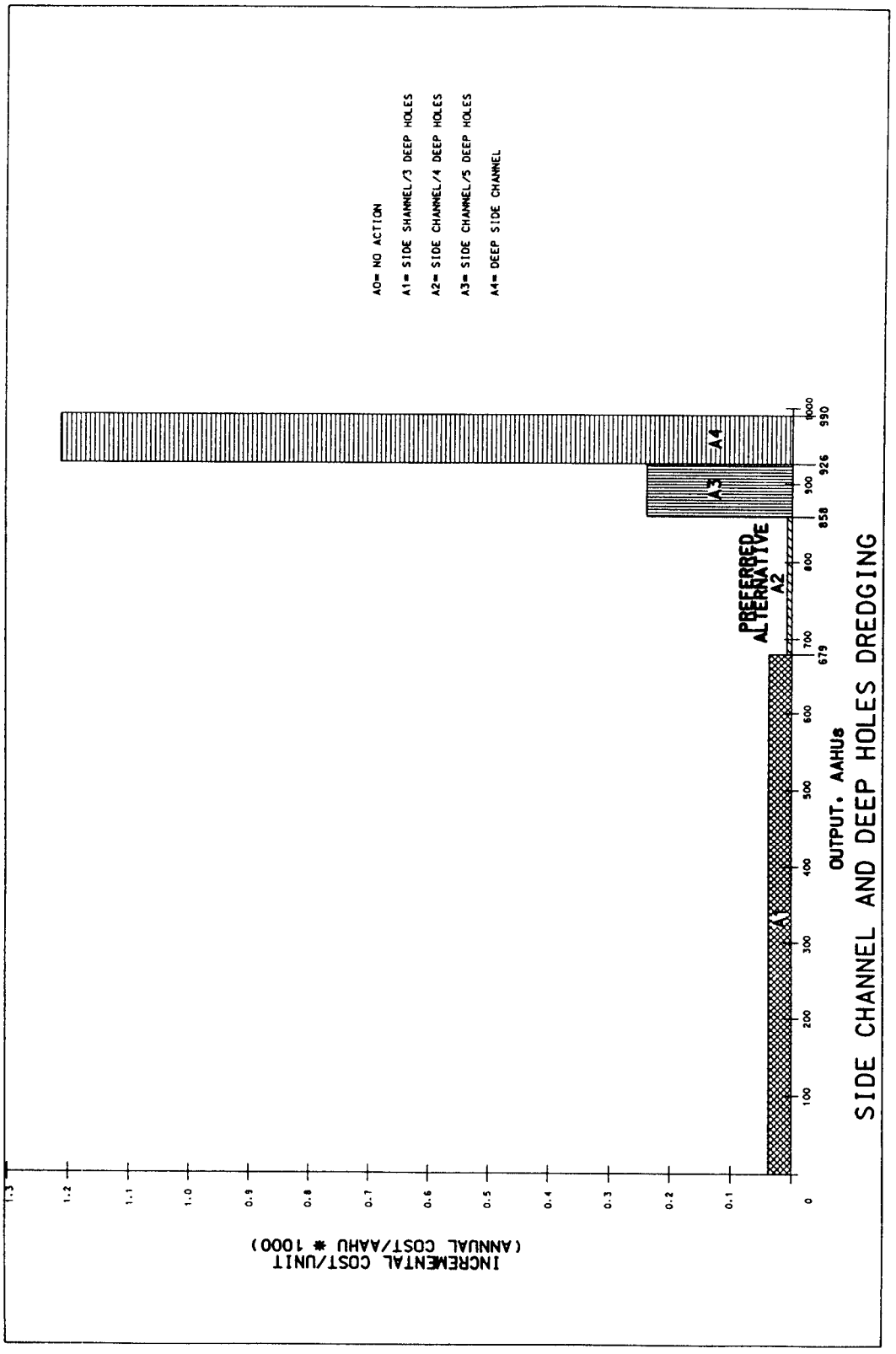


FIGURE 7-2

Island Restoration
Incremental Cost Analysis

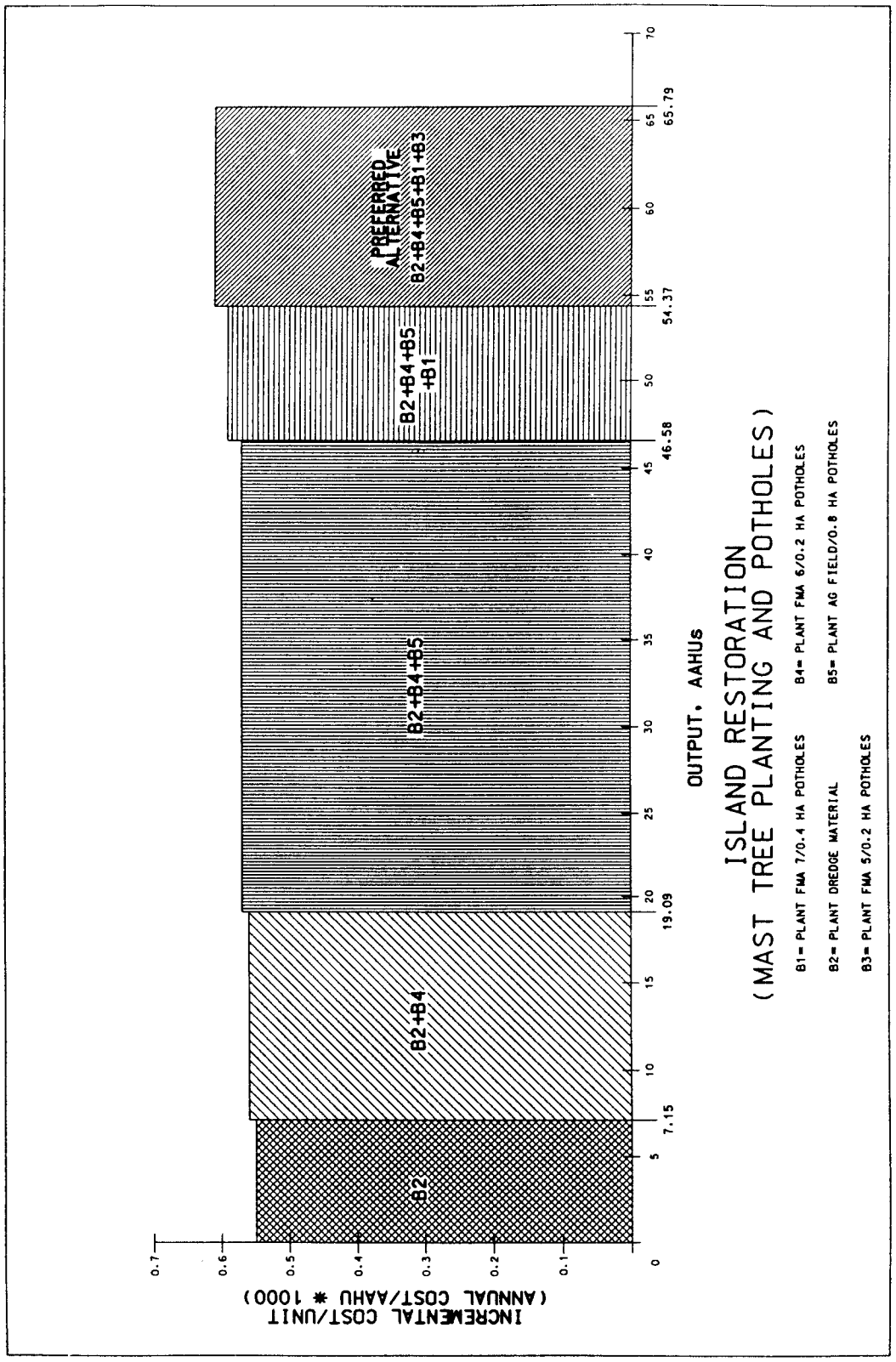
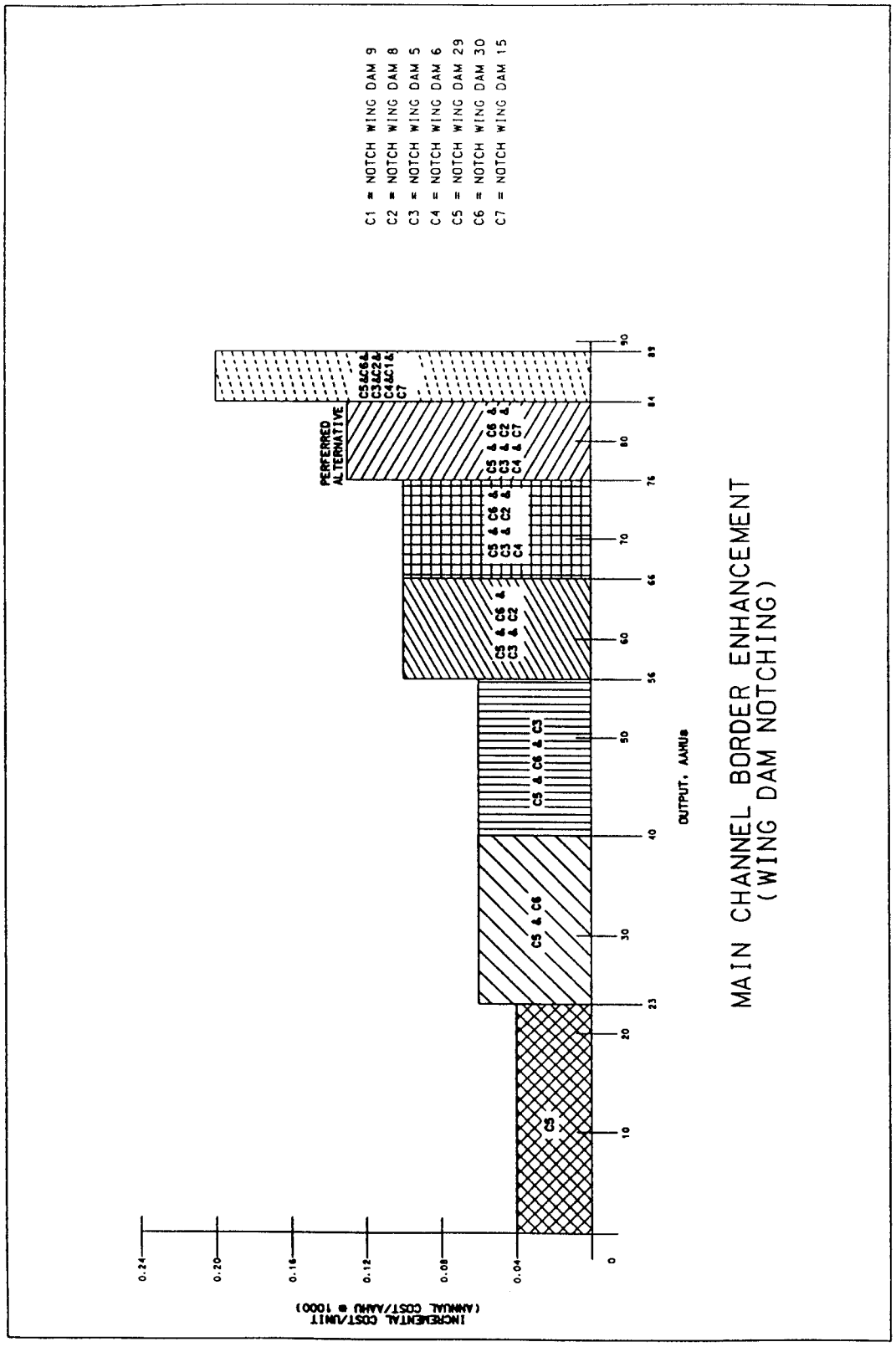


FIGURE 7-3

Main Channel Border Enhancement
Incremental Cost Analysis



c. Incremental Analysis Summary. 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 that "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 outputs are not measured in dollars, as is the case in planning for restoration and mitigation (Robinson, *et al.*, 1995).

Neither cost effectiveness analysis nor incremental cost analysis include a plan selection rule similar to the NED rule. In the absence of such a decisionmaking rule, neither analysis indicates what choice to make. However, the information developed by both analyses will help to make better informed decisions, and, once a decision is made, they will help to better understand its consequences in relation to other choices.

While incremental cost analysis identified those alternatives that are the most cost effective and, as stated above, provides information to the decision maker, this procedure should not be the sole source on which to base a decision. Other factors considered in this analysis were landscape of the site, management objectives of the resource agencies, critical needs of the region, and ecosystem needs of the Upper Mississippi River System.

The lowest cost alternative that met the objective of restoring aquatic overwintering habitat was to dredge three deep holes and associated side channel areas. The MDOC, the USFWS, and the Corps felt that dredging a fourth deep hole was worthwhile as the incremental cost per AAHU was small ($8/AAHU). However, the group did not feel that the incremental cost of dredging a fifth deep hole was justified ($240/AAHU).

The incremental costs per unit for the island restoration alternatives were tightly grouped, ranging from $550-$610/AAHU. The MDOC, the USFWS, and the Corps felt it was worth maximizing island restoration because food, shelter, and breeding habitat on the island was very limited and there was very little difference in incremental cost per unit. Alternative B2+B4+B5+B1+B3 was selected as the preferred alternative.

The most effective and efficient way to provide flowing water habitat is to notch a group of contiguous wing dams. The most cost-effective alternative that notches a group of contiguous wing dams was Alternative C5+C6+C3+C2+C4. The MDOC, the USFWS, and the Corps felt that the additional habitat benefits gained by including the next increment (notching Wing Dam No. 15) (Alternative C5+C6+C3+C2+C4+C7) was worth the added cost ($130/AAHU) as it would result in flowing water habitat along the entire length of the island. The group did not feel that inclusion of the final increment, Alternative C5+C6+C3+C2+C4+C7+C1, was justified due to the smaller area enhanced by notching Wing Dam No. 9 (C1), which is farthest upstream

($200/AAHU). Therefore, Alternative C5+C6+C3+C2+C4+C7 was selected as the preferred alternative.

In summary, the preferred alternative for the project is dredging four deep holes and associated side channel areas; planting mast trees on the dredged material, agricultural field, and three forest management areas with five potholes (4 acres total); and notching six (contiguous) wing dams.

8. SELECTED PLAN WITH DETAILED DESCRIPTION

a. General Description. The preferred alternative for the project is dredging four deep holes and associated side channel areas; planting mast trees on the dredged material, agricultural field, and three forest management areas with five potholes (4 acres total); and notching six wing dams.

b. Side Channel Dredging Depths and Equipment. This feature consists of mechanically dredging the lower 4,900 feet of Cottonwood Chute, as shown on plate 3. The side channel would be dredged to a depth of 7 feet below flat pool and a width of 50 feet. Included in this feature are four 15-foot deep holes for overwintering fish, each 50 feet wide and 300 feet long. Dredged material would be sidecast on Cottonwood Island. Dredged material would be placed to a height no greater than 6 feet above existing grade and rough-graded to create a 60-foot-wide crown. This crown would be planted in mast trees.

c. Pothole Excavation. Five potholes would be mechanically excavated in interior sloughs and depressions at the approximate locations shown on plate 3. The potholes would be mechanically excavated to elevation 467, a depth of 3 feet below flat pool. Pothole side slopes would be benched to promote littoral zone emergent vegetation and to enhance growth of moist soil plants. All side slopes would be 1:3. Plate 10 shows a typical section. Excavated material would be placed to a depth no greater than 2 feet above existing grade and planted in mast trees. The pothole locations were located in the field with the assistance of MDOC personnel. The locations utilized existing low areas. In response to public comment, an on-site meeting with a concerned citizen resulted in the relocation of the two upstream-most potholes. The 1-acre pothole was moved north to an old slough. Because it is not in the old side channel, it should be less prone to sedimentation than the original proposed location. The 1/2-acre pothole was located slightly eastward to a cleared depressional area to reduce tree-clearing and excavation requirements.

d. Mast Tree Planting. Several sites have been selected for planting throughout the project area (see plate 3). Restoration of a mast-producing tree component to these areas would provide wildlife with an additional winter food source for a period of up to 100 years. Pin oak, swamp white oak, bur oak, pecan, and sycamore would be planted on a 30-foot spacing. Species would be intermixed at each site to avoid solid blocks of individual species.

Large stock seedlings greater than 4 feet in height would be planted to introduce a component of mast-producing trees to the project area. The tree plantings would be spaced and distributed to allow for a natural appearance. This enrichment planting technique differs from a plantation tree culture, where the objective would be to make mast-producing trees the dominant species. Instead, enrichment plantings are designed to introduce a component of mast-producing trees to create a mixed forest stand.

Plants conforming to the species designated in Table 8-1 would be planted at designated locations at each planting site. Planting rates per acre are in the following table.

TABLE 8-1

Planting Rates Per Acre

Common Name	Scientific Name	Location: Forest Management Segment 5	Forest Management Segment 6	Forest Management Segment 7	Agricultural Field	Potholes	Dredged Material
Pin Oak	*Quercus palustris*	15	15	15	15	15	15
Sycamore	*Platanus occidentalis*	8	8	28	8	8	8
Bur Oak	*Quercus macrocarpa*	10	10	0	10	10	10
Northern Pecan	*Carya illoensis*	10	10	0	10	10	10
Swamp White Oak	*Quercus bicolor*	10	10	10	10	10	10
Total/Acre		**53**	**53**	**53**	**53**	**53**	**53**

Ground disturbance for mast tree planting occurring on previously harvested forest management areas would consist of cutting and removing all woody vegetation within 6 feet of the center point for the planted tree and then excavating a planting hole 2 feet in depth and 3 feet in diameter. Tree planting operations within the present agricultural field would involve disking to a depth of 4 inches, followed by excavation of planting holes. The forest management areas would maintain a natural appearance throughout the establishment process, as only the vegetation directly surrounding the seedling would be controlled. On the dredged placement site, soil disturbance for tree planting would be limited to the newly placed material only.

A cover crop of red top grass and annual grains would be established in the tree planting sites to help control unwanted weed species. Herbicides would be used, if necessary, to control any competing vegetation which threatens the survival of the planted trees by either overtopping or shading. Following a 3-year establishment period, the surrounding ground in all planting areas will be allowed to assume natural regrowth.

e. Wing Dam Notching. As shown on plate 3, this feature consists of staggering notches in six wing dams adjacent to Cottonwood Island. Each notch would be 100 feet wide at the base, with 1:2 side slopes, and located no closer than 100 feet from the shoreline. Notch construction will include removal of wing dam material (varying quantities of riprap, sand, and brush) to original river bottom. A typical section is shown on plate 9. It is anticipated that material would be removed

with a barge-mounted clamshell and placed downstream and landward of the notch to create interstices and promote invertebrate colonization. It is anticipated that flow will increase in the vicinity of the notch, creating a scour hole behind the wing dams. The change in flow at one wing dam also may stimulate an in-stream meander to the next wing dam. A meander would create deeper areas, attracting a more diverse benthic community and fishery.

9. DESIGN AND CONSTRUCTION CONSIDERATIONS

a. Existing Site Elevations. The entire Cottonwood project area is located within the Mississippi River floodplain. Due to the pervious substrata materials at the site, ground water elevations are highly influenced by river levels as well as rainfall. Flat pool elevation is 470.0. The land surface elevation throughout the project area ranges from 472 to 476. Pothole construction can be accomplished using traditional earth-moving equipment during flat pool conditions. It is anticipated that mobilization of construction equipment would be accomplished by barge when river levels are at or above flat pool. Project access via the existing causeway would be at the contractor's option and would probably require improvements to the causeway. Should the contractor choose to access the project by the existing causeway, the contractor would be responsible for coordinating and obtaining project access from adjacent landowners and the Fabius River Drainage District.

b. Dredging Depths and Equipment. With the exception of selected deep hole dredging, dredging depth was based on water clearance as shown in Table 9-1.

TABLE 9-1

Basis of Channel Dredging/Excavation

Elevation (feet NGVD 1912)	Description
470.0	Pool 21 flat pool
0.0	Present low-flow winter regulation
-6.0	Maintained water depth [1]
-0.5	50 years of sediment (0.11 inch per year) [2]
463.5	Minimum dredging depth [3]

[1] A depth of 6 to 8 feet is typical of existing side channels.

[2] The estimated sediment deposition for the deep holes was increased to 5 feet to offset a trap effect as flow velocities through the deep holes will be less than that of the channel due to their increased depth (Appendix G).

[3] Actual dredging depths will be rounded down to the nearest foot (463). Deep holes will be dredged to elevation 455.

The shallow depths and narrow widths of Cottonwood Chute limit hydraulic dredge equipment to mudcat-type (8-inch-diameter pipeline) dredges. Mudcat dredge and mechanical dredge production rates are similar, both averaging about 100 cubic yards/hour. Channel obstructions will require removal with mechanical equipment. Cottonwood Chute channel obstructions include a significant number of fallen trees, and abandoned wing dams could potentially be encountered. Because of the number of channel obstructions, mechanical dredging was selected for restoration and enhancement of Cottonwood Chute.

Approximately 49,900 cubic yards of material would be removed, based on typical sections shown on plate 8, which shows vertical sides. To decrease dredging costs, the specifications will require the contractor only to maintain the 50-foot bottom width. Shaping of the channel sides to a specified slope would not be required. It is presumed that the sides of the dredged area will slump to their natural angle of repose as the material is being dredged. Based on borings at the project site, the material is a fat clay. (See Appendix E.) The natural angle of repose is expected to be between a 2H to 1V and 2.5H to 1V slope. Dredged material placement quantities of 85,000 cubic yards are based on a 2.5H to 1V slope, from which corresponding clearing, grading, and shaping quantities were calculated. Dredged material would be sidecast no closer than 50 feet from the dredge cut edge for deep fish holes, and no closer than 35 feet from the dredge cut edge for channel dredging, as shown on plate 8. The adjacent shoreline would serve as the dredged material placement site. This area will be cleared and grubbed. The cleared trees would be removed from the site as part of a timber sale. Uncompacted dredged material would be placed to an approximate height of 6 feet above existing grade. The dredged material would be rough bladed to provide a 60-foot crown for mast tree planting.

c. Pothole Construction. Using explosives to construct the potholes was considered, but was not further explored for two reasons:

(1) Material excavated for pothole construction could be used to raise current ground elevations by 1 to 2 feet adjacent to the potholes and planted in mast trees. This would meet the project objective of increasing bottomland hardwood diversity and quantity.

(2) This option could not cost effectively meet the desired final grade to meet the objective of littoral zone construction.

Potholes would be mechanically excavated with a dragline/clamshell or backhoe. An equipment path for access to each pothole location may need to be cleared. Excavated material will be placed around the perimeter of the pothole, as shown on plate 10.

d. Mast Tree Planting. The survival of newly planted trees is affected by many factors, including weather, competition from competing vegetation, and animal damage. Previous reforestation efforts within the Mississippi River floodplain have shown that the survival of planted trees is positively correlated with the size and health of the seedling that is planted. At a minimum, trees planted shall be at least 1/2-inch caliper and 4 feet in height. The contractor would have the option of planting container-grown or balled and burlapped (B&B) trees. Container-grown trees shall have a minimum container size of 5 gallons. Trees shall have been grown within 300 miles of the project site. Trees will be planted either in the spring between March 1 and May 15, or in the fall after October 1 and before December 10.

Because of differences at each planting site in terms of the soil conditions and the type of competing vegetation already present, site preparation and competition control would differ by site. At the forest management and pothole sites, a planting site would be prepared by cutting and removing all woody vegetation within 6 feet of

the point designated as the center point for the planted tree. At the agricultural field, the site shall be disked a minimum of two times (disked and cross disked), to a minimum depth of 4 inches.

Past failures in reforestation efforts can be attributed to an over-abundance of competing vegetation following planting. Abandoned crop fields and other disturbed sites often become dominated by annual weed species such as giant ragweed and cucumber vine, which can kill young trees by quickly overtopping and shading the planted trees within a short period of time. A rapid influx of cucumber vine on dredged material at the Big Timber, Iowa (RM 443.5-445.0) project required remedial applications of herbicide to protect planted trees. To help alleviate this problem, all planting areas would be sprayed with a pre-emergent herbicide to a 6-foot-wide band around each tree immediately after planting. Additionally, a cover crop of red top grass and annual grains would be temporarily established on the tree planting sites to help control unwanted species. Additional herbicide applications would be used, if necessary, to control any competing vegetation which threatens the survival of the planted trees. Follow-up spraying would be performed during the following growing season if the trees are threatened by competing vegetation. Following a 3-year establishment period, the surrounding ground in all planting areas would be allowed to assume a natural regrowth.

Young trees are also vulnerable to damage by wildlife. Domestic animals, deer, mice, rabbits, squirrels, and beaver can destroy young tree seedlings. The MDOC indicated that deer browse may be a potential threat to the success of the planting project. Deer browsing was cited as the primary reason for the poor success of a similar planting effort at Cuivre Island, Missouri (RM 233-239). Several potential protective measures for planted trees on Cottonwood Island were discussed by MDOC and Corps specialists. Due to a lack of experimental data, the effectiveness and economic efficiency of any of the proposed protection methods is unknown. For this reason, an experiment would be implemented to test the effectiveness of two of the proposed animal protection measures. One-third of the planted trees would be protected by temporarily installing 6-foot fencing around planted trees, to be removed after three growing seasons. A commercial deer repellent would be applied annually to one-third of the planted trees for the first three growing seasons. Additionally, one-third of the planted trees would not receive any animal protection in order to adequately test the efficacy of the experimental treatments in terms of the effects on tree growth and survival.

Despite good planting techniques, animal protection, and control of competing vegetation, some tree mortality within the first year after tree planting is inevitable. Similar tree stock planted at the Bay Island, Missouri (RM 311.0-312.0) project, for example, experienced less than 1 percent mortality after 1 year. Unavoidable mortality due to natural causes would not be expected to exceed 10 percent. For this reason, the tree planting density was increased from a design number of 48 trees per acre to 53 trees per acre to account for a potential 10 percent mortality during the first year.

e. Storm Water Pollution/Erosion Control. The potential for storm water pollution during construction is minimal for this project. Storm water runoff from nearly all construction activity would be contained within the confines of Cottonwood Island. Temporary stabilization measures would be employed on disturbed areas of the side channel until stabilization occurs. Stabilization practices may include mulching, temporary seeding, and/or the erection of silt fencing. Overall, the long-term storm water runoff characteristics of the site are not expected to change. All disturbed areas would reseed through natural succession with similar vegetation types as before project conditions.

f. Construction Sequence. The probable construction sequence is summarized in Table 9-2; however, no sequence will be contractually required.

TABLE 9-2

Probable Construction Sequence

Sequence	Construction Work Item	Instructions	Purpose
1.	Tree Sale/Clearing and Grubbing	Accomplish tree removal-related work between September 1 and April 30.	Avoid impacts to Indiana bats.
2.	Side Channel and Deep Hole Dredging	Place dredged material 50 feet from edge of dredge cut for deep holes and 35 feet from edge of dredge cut for channel dredging.	Minimize storm water pollution potential.
3.	Notch Wing Dams	Notch during high water.	Allows for placement of notch closer to shore.
4.	Potholes	Summer construction.	Access to potholes during potentially driest conditions.
5.	Mast Trees	Plant between March 1 and May 15 or after October 1 and before December 10.	Increase survival.

g. Permits. A public notice, as required by Section 404 of the Clean Water Act, will be made prior to submission of this report for final approval. A Section 401 water quality certificate from the State of Missouri and a Section 404(b)(1) Evaluation will be included in the final submission of this report. Because all land disturbances associated with this project are addressed in the 404(b)(1) Evaluation, a National Pollutant Discharge Elimination System (NPDES or Section 402) permit for storm water discharges will not be required.

h. Historic Properties. Various portions of Cottonwood Island have significant potential for containing buried archaeological sites—both prehistoric and

historic in origin. However, the island is covered by recent alluvium which varies in depth. Given these facts, limits have been placed on how deep soil disturbance can extend on different parts of the island.

One area just east of the island in recent sediments below a wing dam cannot be disturbed at all due to the location of an old wreck marked on historic maps.

Soil disturbance on the island surface shall be limited as set out below:

(1) Soil disturbance will extend no deeper than 50 centimeters (20 inches) from the surface in areas so coded on Figure 9-1.

(2) Soil disturbance will extend no deeper than 100 centimeters (40 inches) from the surface in areas so coded on Figure 9-1.

(3) Soil disturbance will extend no deeper than 200 centimeters (80 inches) from the surface in areas so coded on Figure 9-1.

(4) No limit is placed on the remaining parts of the island's surface—soil may be disturbed to any depth required (Figure 9-1).

The area keyed "No Disturbance Allowed" at RM 329.4 on Figure 9-1 is the location of a wreck identified on an old river chart. This area of sediment accumulated below a wing dam shall not be disturbed in any way. This zone of no disturbance was taken into account in planning the location of the wing dam 29 notch.

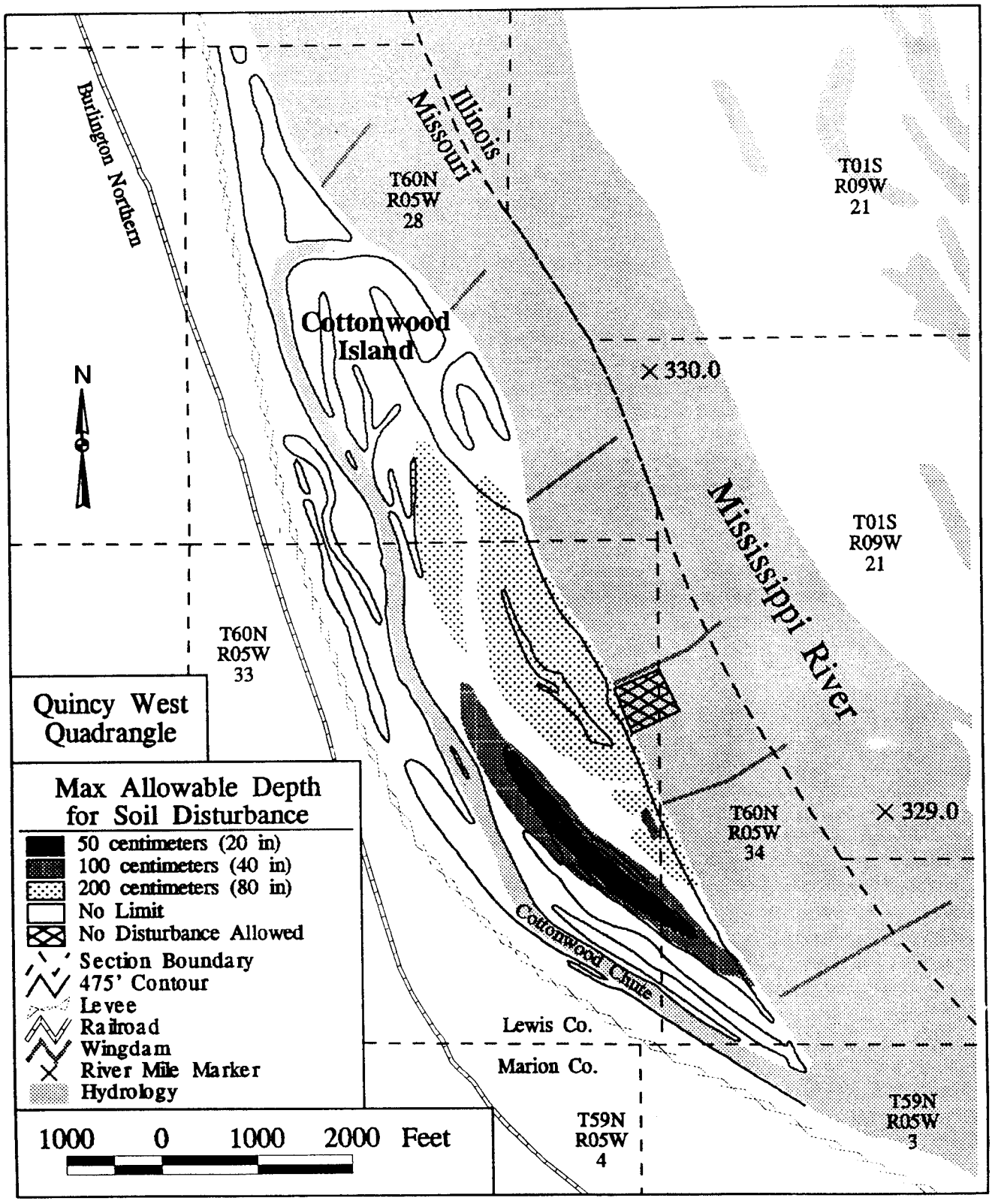
Dredged material or other excavated soil may be placed or spread anywhere on the island as long as the soil disturbance restrictions set out in Figure 9-1 are not violated.

Mechanical clearing (bulldozing, etc.) of trees or other vegetation shall not occur in the area with a maximum allowable depth for soil disturbance of 50 centimeters (20 inches) as shown on Figure 9-1.

Despite these limitations on disturbance, if this project uncovers an item or items which might be of archaeological, historical, or architectural interest, or if important data come to light in the project area, the Corps will ensure that reasonable efforts to avoid or minimize harm to the property are made until the significance of the discovery can be determined as provided for in 36 CFR 800.11.

FIGURE 9-1

Design and Construction Considerations
for Historic Properties



10. ENVIRONMENTAL EFFECTS

a. Summary of Effects. Cottonwood Island is a large, complex site with a variety of resources that vary in quantity and quality. The goal for the site is to raise the quality and quantity of some of these resources, but usually this occurs at the expense of other habitats (i.e., overwintering fish habitat in place of shallow aquatic habitat). In most cases, the trade-off for quality habitat is a loss in lower quality habitat. In other cases, because of the landscape, habitats of similar quality may be altered in order to carry out management objectives to meet the agencies' goals for the site [i.e., loss of cropfield for bottomland hardwood (BLH) habitat].

The primary objectives of the Cottonwood Island HREP are to improve main channel border diversity by notching six wing dams, restore BLH diversity by planting a variety of hard mast-producing trees and excavating 4 acres of potholes, and restore overwintering fish habitat by deepening Cottonwood Chute.

The management measures planned for this project are consistent and support the goals of the North American Waterfowl Management Plan and Partners In Flight program.

b. Economic and Social Impacts.

Community and Regional Growth. No short- or long-term impacts to the growth of the community or region would be realized as a result of the proposed plan.

Community Cohesion. The proposed habitat restoration project would not significantly impact community cohesion.

Displacement of People. The project would not result in any residential relocations.

Property Values and Tax Revenues. The project would have no direct impact on property values or related tax revenues. The land is owned by the Corps of Engineers, and managed by the U.S. Fish and Wildlife Service and the State of Missouri for wildlife management.

Public Facilities and Services. The proposed habitat restoration and enhancement project allows for increased recreation potential by providing opportunities for hunting and fishing, as well as the non-consumptive recreational enjoyment of wildlife.

Life, Health, and Safety. The proposed project poses no threats to the life, health, or safety of recreationists or others in the area.

Business and Industrial Activity. Changes to business and industrial activities during project construction would be insignificant; no long-term impacts would result. The project would require no business relocations.

Employment and Labor Force. There could be a slight increase in short-term employment opportunities resulting from project construction. There would be no effect on permanent employment or labor force in Lewis and Marion Counties, Missouri.

Farm Displacement. The small agricultural field on the island is currently used as a food source for wildlife management. As part of the proposed project, this field would be planted in mast trees. No farms would be displaced as a result of the project.

Aesthetics. The project would create habitats for fish and other aquatic organisms, plus food and shelter for wildlife, all of which would enhance the aesthetic environment of Cottonwood Island.

Noise Levels. Project construction would generate a temporary increase in noise levels; however, the project is located on an island, away from any sensitive receptors or residential development.

c. Natural Resources Impacts. Effects of the project on natural resources, particularly terrestrial and wetland resources, were evaluated using AHAG (Mathias, *et al.*, unpublished) and a BLH model (Corps 1992) methodologies. These habitat evaluation methods were used during project planning to evaluate various features in terms of increased benefits to wildlife resources. Optimization of habitat units (HUs) in relation to project costs for target species is considered the goal of feature selection. Results of the habitat evaluations are summarized in Table 6-1, with a more detailed analysis in Appendix D. Assessment of project impacts also was based on experience and sound management practices.

(1) Side Channel Habitat. Additional discussion of aquatic and water quality impacts is contained in Appendix B - Clean Water Act, Section 404(b)(1) Evaluation.

Short-term construction activities would increase turbidity in Cottonwood Chute and in the Mississippi River. Much of the material from the side channel excavation would be placed along the island's shoreline. The increased turbidity would have negligible impact considering the existing turbidity levels of the river. Construction in the side channel would disrupt benthic organisms, but the new substrate should be recolonized quickly.

It is anticipated that fish response would drastically increase as a result of the project. For many fish species, winter is the critical time of the year. In order to conserve on energy, fish like bass and bluegill seek quiet backwaters that have the following requirements:

* rich oxygenated water (6 milligrams per liter is preferred)
* zero velocity
* deep enough so that ice cover does not block exits or decreases the availability for dissolved oxygen to enter the area

Fish seek these areas to avoid the strong water velocities of the main channel. Winter conditions force the fish not only to expend energies on maintaining their position in the current, but on maintaining body temperature. Another benefit from good overwintering habitat is the overall condition of the fish coming out of the winter. The better the condition in which the fish come through the winter, the more successful will be the spawn and egg maturation.

(2) Wetland and Terrestrial Resources. Dredged material would be placed on a cleared area adjacent to the side channel. The trees removed would become part of a timber sale. Other clearing and grubbing may take place for pothole construction and haul road construction on the island. Removed trees would be sold. The cleared areas would be planted with mast-bearing trees.

By planting mast-producing trees and increasing the ratio of small potholes to forest lands, the overall quality would improve to local fauna as well as migrating species. Local animal populations would seek out mast (acorns) as a source of high protein food. This food base is absent or declining from almost all riverine forest on the Upper Mississippi River.

The overall health and condition of the ecosystem would improve with a more robust habitat stimulated by pothole construction. Invertebrates would thrive in the small, quiet pools and would be the basis of food for animals like frogs, wood ducks, insects, and a host of other species. Although not evaluated, these potholes would serve as spawning habitat for fish when certain hydraulic conditions exist.

Migratory birds would not only benefit from a more reliable food source, but nesting and rearing habitat would increase. Species benefiting from this project would include ducks, songbirds, and neotropical migrants (those bird species migrating annually, usually to Central America or South America).

Obviously, a project of this scope cannot be expected to benefit all evaluation species. Overall, the range of the evaluation reflects the positive changes expected from increased habitat diversity.

(3) Main Channel Border Habitat. The main channel border along Cottonwood Island is very uniform, with the exception of the wing dams and their deeper areas immediately downstream of each structure. Between the wing dams lies a shallow, flat, sandy/silty substrate with a rather uniform water flow that is slower than that of the main channel thalweg. Notching the wing dams is anticipated to modify the downstream deeper areas by linearly extending it towards the next wing dam. This would modify the substrate by scouring a small channel through the dike field. Fish are now attracted to the existing wing dam deeper areas and, with the project, a larger area will mimic what is now a rather localized habitat. Areas between the wing dams would benefit by distributing nutrients, thereby increasing productivity of vegetation, invertebrates, and ultimately mussels and fish.

(4) Endangered Species. The following is a list of federally listed species possibly found in Lewis and Marion Counties, Missouri:

T	Bald Eagle	*Haliaeetus leucocephalus*
E	Fat Pocketbook Pearly Mussel	*Potamilus capax*
E	Higgins' Eye Pearly Mussel	*Lampsilis higginsi*
E	Indiana Bat	*Myotis sodalis*
T	Decurrent False Aster	*Boltonia decurrens*

The federally endangered bald eagle (*Haliaeetus leucocephalus*) occurs in the vicinity of Cottonwood Island during the winter. The USFWS, in their Coordination Act Report (Appendix A), stated the proposed project would not affect bald eagles or their habitats.

Fat pocketbook pearly mussel and Higgins' eye pearly mussels usually inhabit coarse gravel, cobble substrate. Because of the dominance of sand and silty materials in the project area, these species are not likely to occur here, and, therefore, the project is not likely to impact these mussel species.

Although Indiana bats forage over streams and raise their young in riparian forests in this part of Missouri, construction would take place outside the breeding and rearing period of the summer. See Table 9-2 for specific construction dates. It is anticipated the project would have no impacts on this species.

The decurrent false aster is a floodplain plant that inhabits recently flooded and disturbed soils on large river systems like the Mississippi. Since this plant species has not been found in Lewis or Clark Counties, it is anticipated that the project would not affect individual plants or the population in general.

Additional species the State of Missouri has identified as species of concern include the mooneye (*Hiodon tergisus*), elusive clubtail (*Stylurus notatus*), and pallid sturgeon (*Scaphirhynchus albus*). The mooneye and elusive clubtail have been found downstream at RM 326.7. Pallid sturgeons are big river fish that may range widely in the Mississippi River and Missouri River system. It is anticipated that the project would not have any negative impacts to these fish species. In fact, by diversifying the main channel border habitat, conditions should improve for these riverine fishes.

d. Historic Properties. The report entitled *Geomorphological and Archaeological Investigations for the Cottonwood Island Habitat Rehabilitation Project, Upper Mississippi River System, Environmental Management Program, Mississippi River Pool 21, Lewis and Marion Counties, Missouri* (Stanley and Anderson 1994) was sent to the Missouri State Historic Preservation Office (SHPO) for review (Appendix A: Corps letter dated May 24, 1994). The undertaking was determined to have "no effect" on significant cultural resources and to be in compliance with Section 106 of the National Historic Preservation Act (Appendix A: Missouri Department of Natural Resources, Historic Preservation Program, Cultural Resource Assessment Section 106 Review, dated December 13, 1994). Pothole

construction was coordinated separately with the SHPO (Appendix A - Corps letter dated December 8, 1995, and Missouri SHPO letter dated December 29, 1995).

If this project uncovers an item or items which might be of archaeological, historical, or architectural interest, or if important data come to light in the project area, the Corps will ensure that reasonable efforts to avoid or minimize harm to the property are made until the significance of the discovery can be determined as per 36 CFR 800.11.

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

f. Cumulative Impacts. Although short-term impacts are likely to occur to local and migratory animals during construction, no cumulative impacts are expected. Habitat alterations should have long-term benefits to the fish and wildlife resources utilizing the site. This project, in concert with other EMP projects in the Upper Mississippi River System, 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. Unavoidable adverse impacts are limited to clearing vegetation for dredged material placement along the side channel, clearing for pothole construction, and for temporary haul roads to the pothole sites. These areas would be cleared as little as possible to avoid removing established trees, and the sites would be planted to mast-bearing trees upon completion of the dredging and clearing.

h. Short-Term Versus Long-Term Productivity. During construction, impacts would disrupt wildlife as well as human use.

Long-term productivity would be enhanced as numbers of mast trees and potholes increase. Constructing wing dam notches would disrupt rather quiet waters in the main channel border area, however, added diversity in flows would attract river fishes to this currently less productive area. Construction of deep holes for overwintering fish would disrupt the current use of the area, but would attract more species and numbers of fish to the area. This site-specific improvement would have significant off-site benefits as well [see paragraph 10.c.(1), Side Channel Habitat] when the overwintering fish can leave these areas to return to shallow backwaters in better condition, thereby having healthier maturation of eggs and spawns. Overall habitat diversity would be increased, and both game and nongame wildlife species would benefit. In turn, both consumptive and nonconsumptive users would realize heightened opportunities for recreational use of the Cottonwood Island area.

The Cottonwood Island area has been impacted by human development directly and indirectly for over 100 years and has slowly degraded. By constructing the project, this degradation would be slowed and, in fact, would be reversed so that habitat benefits will increase over time.

i. Irreversible or Irretrievable Resource Commitments. Materials and human resources used in proposed construction or upgrading are the sole irreversible commitments envisioned.

j. Relationship of the Proposed Project to Land-Use Plans. The proposed project is in agreement with the Land Use Allocation Plan (Corps 1989). The proposed project is not in conflict with any land-use plans currently being used for the site.

k. Compliance With Environmental Quality Statutes. Compliance with applicable statutes is summarized in Table 10-1.

(1) Endangered Species Act of 1973, as amended. The project would not impact any endangered species. Construction dates have been established to avoid any impacts to Indiana bats.

(2) National Historic Preservation Act of 1966, as amended. See page 52, paragraph d., Historic Properties.

(3) Federal Water Project Recreation Act. Recreational opportunities on the site would be reduced during construction, but would probably increase over present levels after construction.

(4) Fish and Wildlife Coordination Act. Project plans have been coordinated with the U.S. Fish and Wildlife Service and MDOC. Corps of Engineers coordination with these agencies, as well as others, appears in Section 18, Coordination, Public Views, and Comments; and Appendix A, Correspondence.

(5) Wild and Scenic Rivers Act of 1968, as amended. The Mississippi River is not listed in the National Rivers Inventory (NRI). The NRI is used to identify rivers that are designated by Congress to be component rivers in the National Wild and Scenic Rivers Systems.

(6) Executive Order 11988 Flood Plain Management. The project would not directly or indirectly induce growth (construction of structures and/or facilities) in the floodplain. Therefore, the project, as proposed, is judged to be in full compliance with this statute.

(7) Executive Order 11990 (Protection of Wetlands). The Cottonwood Island project would involve restoring or enhancing existing degraded wetland habitat. While some impacts may occur (i.e., placement of dredged material in wetland habitat), overall quantity of wetlands would not be reduced and quality of the wetlands should increase.

(8) Clean Water Act (Sections 401 and 404), as amended. Certification under Section 401 of this act from the State of Missouri has been received and is included in Appendix A. Water quality would not be adversely impacted. Concurrent with the public review period for this document, a Joint Public Notice for Section 404

of this act was circulated for public review. Additionally, a Section 404(b)(1) Evaluation has been prepared and is contained in this document (Appendix B).

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

(10) Farmland Protection. Existing cropland encompasses 33 acres. The primary crop is corn when a crop is planted (in many years, spring floods prevent the site from being farmed). This land is farmed as a wildlife management site whereby a certain percentage of the field is unharvested, targeting animal species such as ducks, deer, and squirrels. The proposed project would eliminate row crop production. Because the agricultural field is being altered and the farmed soil is listed as prime farmland (Chequest silty clay loam is considered prime farmland when drained), a U.S. Department of Agriculture Form AD-1006 was submitted to the Natural Resources Conservation Service (NRCS) for review. Since no prime farmland soils exist on the island, full compliance under the Farmland Protection Policy Act has been approved (see Appendix A, Correspondence).

(11) National Environmental Policy Act of 1970, as amended. The compilation of this document fulfills NEPA compliance.

(12) National Economic Development (NED) Plan. The NED Plan is that which best satisfies the Federal planning objectives of increasing the nation's output of goods and services and produces the most improvement to the national economic efficiency. Since this project is an environmental restoration project, monetary (dollars) and non-monetary outputs (average annual habitat units) were used to quantify all possible plans and alternatives for this project. The most cost-efficient plans were selected for the preferred alternative.

In addition, the proposed project would not undermine the economic base of this or any other rural or urban area. The implementation of the project would not result in increases in costs or processes for consumers, individual industries, or Federal or State, or local governmental agencies, nor would it impair, in any way, the ability of the United States to compete with foreign-based companies in domestic or export markets. The proposed plan is considered the best to fulfill the NED objective.

TABLE 10-1

Compliance of the Preferred Plan with WRC-Designated Environmental Statutes

Federal Policies	Compliance
Archeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full compliance
Clean Air Act, as amended, 42 U.S.C. 165h-7, et seq.	Full compliance
Clean Water Act (Federal Water Pollution Control Act), 33 U.S.C. 1251, et seq.	Full compliance
Coastal Zone Management Act, 16 U.S.C. 1451, et seq.	Not applicable
Endangered Species Act, 16 U.S.C. 1531, et seq.	Full compliance
Estuary Protection Act, 16 U.S.C. 1221, et seq.	Not applicable
Executive Order 11988, Floodplain Management	Full compliance
Executive Order 11990, Protection of Wetlands	Full compliance
Federal Water Project Recreation Act, 16 U.S.C. 460-1(12), et seq.	Full compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq.	Full compliance
Farmland Protection Act, Agriculture and Food Act of 1981, P.L. 97-98	Full compliance
Land and Water Conservation Fund Act, 16 U.S.C. 4601, et seq.	Full compliance
Marine Protection Research and Sanctuary Act, 33 U.S.C. 1401, 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. 401, et seq.	Full compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Full compliance
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Not applicable

NOTES:

a. Full compliance. Having met all requirements of the statute for the current stage of planning (either preauthorization or postauthorization).

b. Partial compliance. Not having met some of the requirements that normally are met in the current stage of planning. Partial compliance entries should be explained in appropriate places in the report and referenced in the table.

c. Noncompliance. Violation of a requirement of the statute. Noncompliance entries should be explained in appropriate places in the report and referenced in the table.

d. Not applicable. No requirements for the statute required; compliance for the current stage of planning.

11. SUMMARY OF PROJECT ACCOMPLISHMENTS

The proposed project consists of side channel and deep hole dredging, excavating potholes, notching wing dams, and planting mast trees.

Side channel and deep hole dredging would improve fish entrance and egress to Cottonwood Chute and provide critical habitat for wintering fish.

Pothole excavation would provide secluded open water for migratory bird feeding, rearing, and nesting habitat. The potholes also would support a thriving population of invertebrates which, in turn, would provide a food source for a variety of other species.

Wing dam notching would increase flowing water fish habitat, and the removed rocky material would provide additional habitat and substrate for benthic and aquatic organisms. Notching also would benefit the areas between the wing dams by distributing nutrients that would increase productivity of vegetation, invertebrates, mussels, and fish.

Mast tree plantings would provide food resources for multiple migratory and resident species and increase overall habitat diversity.

The proposed enhancement features would reduce the impacts of sedimentation and provide a desirable mix of open water, emergent vegetation, and littoral zone conditions, as well as increase habitat diversity by planting mast-producing trees. Implementation of the proposed enhancement features is projected to result in AAHU gains of 1,008.

12. OPERATIONS, MAINTENANCE, AND REHABILITATION CONSIDERATIONS

a. Project Data Summary. Table 12-1 presents a summary of project data.

TABLE 12-1

Cottonwood Island Project Data Summary

Feature	Measurement	Unit of Measure
Side Channel Dredging		
Length	4,900	Feet
Depth below flat pool	7	Feet
Bottom width	50	Feet
Side slopes	Vertical	--
Deep Holes (included in total length of channel dredging)		
Number of holes	4	Holes
Length	300	Feet
Depth below flat pool	15	Feet
Bottom width	50	Feet
Side slopes	Vertical	--
Total Excavation/Dredging (vertical sides):	49,900	Cubic Yards
Additional Excavation/Dredging (assume dredged channel sloughs to 2.5:1 slope)	35,100	Cubic Yards
Total Excavation/Dredging:	85,000	Cubic Yards
Dredged Material Placement		
Length	4,900	Feet
Width	80	Feet
Height of Dredged Material Berm	5.9	Feet
Grading & Shaping (60-foot width)	32,700	Square Yards
Clearing/Grubbing (80-foot width)	9	Acres
Potholes		
Number of Potholes	5	Each
Total Area	4	Acres
Depth below flat pool	3	Feet
Bottom width	20	Feet
Bench width	10	Feet
Side slopes	3:1	Horizontal:Vertical
Clearing/Grubbing	6	Acres
Total Excavation:	28,000	Cubic Yards

TABLE 12-1 (Continued)

Feature	Measurement	Unit of Measure
Mast Trees		
Pin Oak	737	Trees
Sycamore	480	Trees
Bur Oak	446	Trees
Northern Pecan	446	Trees
Swamp White Oak	491	Trees
Wing Dam Notching		
Number	6	Notches
Length	100	Feet
Depth below flat pool	Varies	Feet
Bottom width	Varies	Feet
Side slopes	1:2	Horizontal:Vertical
Total Excavation/Dredging:	8,000	Cubic Yards

b. Operation. This project has no general operating requirements.

c. Maintenance. The proposed features have been designed to ensure low annual maintenance requirements. The estimated annual maintenance costs are presented in Table 14-2. These quantities and costs may change during final design.

13. PROJECT PERFORMANCE ASSESSMENT

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 13-1 presents overall types, purposes, and responsibilities of monitoring and data collection.

Table 13-2 presents actual monitoring and data parameters grouped by project phase, as well as data collection intervals.

Table 13-3 presents sedimentation transect assignment to project objectives for post-construction monitoring.

Table 13-4 presents the post-construction evaluation plan, which displays the specific parameters and the levels of enhancement which the project hopes to achieve.

TABLE 13-1

Monitoring and Performance Evaluation Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Implementation Instructions
Pre-Project	Sedimentation Problem Analysis	System-wide problem definition. Evaluate planning assumptions.	USFWS	USFWS (EMTC)	LTRM	--
	Pre-Project Monitoring	Identify and define problems at HREP site. Establish need of proposed project features.	Sponsor	Sponsor	Sponsor	--
	Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field Station or Sponsor through Cooperative Agreements or Corps	HREP/-Sponsor	See Table 14-2.
Design	Data Collection for Design	Include quantification of project objectives, design of project, and development of performance evaluation plan.	Corps	Corps	HREP	See Table 14-2.
Construction	Construction Monitoring	Assess construction impacts; assures 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)	Field Station or Sponsor through Cooperative Agreement, Sponsor through O&M, or Corps	HREP/-Sponsor	See Table 13-3.
	Biological Response Monitoring	Evaluate predictions and assumptions of habitat unit analysis. Studies beyond scope of performance evaluation.	Corps	Corps	HREP	This is an overall EMP program element, carried out at select project sites. Cottonwood is not included among these sites.

TABLE 13-2

Resource Monitoring and Data Collection Summary [1/]

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar								
POINT MEASUREMENTS														
Water Quality Stations [2/]													COE	
Turbidity			2W	M	2W	M								
Secchi Disk Transparency	2W		2W	M	2W	M								
Suspended Solids	2W		2W	M	2W	M								
Dissolved Oxygen	2W		2W	M	2W	M								
Specific Conductance	2W		2W	M	2W	M								
Water Temperature	2W		2W	M	2W	M								
pH	2W		2W	M	2W	M								
Total Alkalinity	--		2W	M	2W	M								
Chlorophyll	2W		2W	M	2W	M								
Velocity	--		2W	M	2W	M								
Water Depth	2W		2W	M	2W	M								
Water Elevation	2W		2W	M	2W	M								
Percent Ice Cover				M		M								
Ice Depth				M		M								
Percent Snow Cover				M		M								
Snow Depth				M		M								
Wind Direction			2W	M	2W	M								
Wind Velocity			2W	M	2W	M								
Wave Height			2W	M	2W	M								
Air Temperature			2W	M	2W	M								
Percent Cloud Cover			2W	M	2W	M								
Bulk Sediment Sampling [3/]			1											
Column Settling Stations [4/] Column Settling Analysis								1					COE	
Boring Stations [5/] Geotechnical Borings								1					COE	
Fish Stations [6/] Electrofishing										1	1	1	MDOC	
Benthic Surveys										1	1	1	MDOC	

TABLE 13-2 (Cont'd)

Resource Monitoring and Data Collection Summary [1/]

Type Measurement	Water Quality Data						Engineering Data			Natural Resource Data			Sampling Agency	Remarks
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar	Apr-Sep	Oct-Mar								
TRANSECT MEASUREMENTS														
Sedimentation Transects [7/] Hydrographic Soundings							1		5Y				COE	
AREA MEASUREMENTS														
Mast Tree Survey [8/]												5Y	COE	
Mapping [9/]														
Aerial Photography/ Remote Sensing										1		5Y	COE	

LEGEND

W = Weekly
M = Monthly
Y = Yearly
nW = n-Week interval
nY = n-Yearly interval
1,2,3, --- = number of times data is collected within designated project phase

TABLE 13-2 (Cont'd)

1/ See plate 12 for active monitoring sites.

2/ Water Quality Stations

W-M328.7B
W-M329.3B

3/ Bulk Sediment Sampling Stations (Design Phase)

E-M330.1A
E-M328.7B
E-M329.6A

4/ Column Settling Analysis (Design Phase)

Station Code	Geotechnical Boring
C-M330.4A	C-94-2, EMP #1
C-M329.2A	C-94-2, EMP #2

5/ COE Geotechnical Borings

Station Code	Geotechnical Boring	Date
C-M330.4A	C-94-1	02-08-94
C-M329.2A	C-94-2	02-08-94
B-M330.8D	C-94-3	11-29-94
B-M330.7C	C-94-4	11-30-94
B-M329.7A	C-94-5	11-30-94
B-M330.0H	C-94-6	11-30-94
B-M330.2H	C-94-7	11-30-94
B-M330.5H	C-94-8	12-01-94
B-M330.5B	C-94-9	12-01-94
B-M330.3D	C-94-10	12-01-94
B-M330.5M	C-94-11	12-01-94
B-M330.8H	C-94-12	12-01-94
B-M 328.7B	C-95-1	12-05-95
B-M 328.9B	C-95-2	12-05-95
B-M 329.2B	C-95-3	12-05-95

6/ Fish Stations

7/ Sedimentation Transects

Design Phase

S-M328.7A to S-M328.7C
S-M329.2A to S-M329.2B
S-M329.5A to S-M329.5C
S-M330.0G to S-M330.0I
S-M330.2A to S-M330.2B
S-M330.2H to S-M330.2I
S-M330.6D to S-M330.6D
S-M330.7B to S-M330.7D
S-M330.9D to S-M330.9E

Post-Construction Phase - See Table 13-3

8/ Mast Tree Survey (Post-Construction Phase. Test of treatment effects for alternative deer exclusion methods will be evaluated by an analysis of variance for tree growth.)

9/ Mapping (Post-Construction Phase)

TABLE 13-3

Cottonwood Island Rehabilitation and Enhancement Project
Sedimentation Transect Project Objectives Evaluation

	Project Objectives to Be Evaluated			
Transect	Improve Water Quality for Fish	Provide Overwintering Water Habitat for Fish	Provide Flowing Water Habitat for Fish	Increase Food, Shelter, and Breeding Habitat for Wildlife
Cottonwood Chute [1/]	X	X		
S-M328.7A to S-M328.7C		X		
S-M329.2A to S-M329.2B		X		
Wing Dam Notches [1/]			X	
Potholes [1/]				X

[1/] Additional transects (Cottonwood Chute) will be obtained during the Plans and Specifications phase. Pothole and wing dam transects will be surveyed post-construction.

TABLE 13-4

Post-Construction Evaluation Plan

Goal	Objective	Enhancement Feature	Unit	Year 0 Without Alternative	Year 0 With Alternative	Year X With Alternative[1]	Year 50 Target With Alternative	Feature Measurement (Ref. Table 13-2)	Annual Field Observations by Site Manager
				Enhancement Potential					
Restore Aquatic Over-wintering Habitat	Improve Water Quality for Fish	Chute Restoration and Enhancement	mg/l D O	<5	>5		>5	Perform water quality tests at W-M328.7B W-M329.3B	Describe presence of fish stress or kills
		(Depth ≥ 6' < 10')	acre	1.9	4.5		4.5	Sediment Transects	Describe presence or absence of debris snags, channel sedimentation or vegetation
	Provide Over-wintering Water Habitat for Fish	Create Deep Holes (Depth ≥ 10')	acre/hole	0	0.3		0.3	Sediment Transects	Describe presence or absence of debris snags, channel sedimentation or vegetation
			Fish Numbers	--			--	Electrofishing Winter Creel Survey	Qualitative observations
Restore Main Channel Border Habitat	Provide Flowing Water Habitat for Fish	Notch Wing Dams	ft/sec					Flow/Velocity Measurements	Describe presence or absence of debris snags, channel sedimentation or vegetation
		(100' Upstream of Wing Dam)		0.3[2]	0.35[2]/0.50[2]		0.35[2]		
		(At Wing Dam)		1.0[2]			0.50[2]		Qualitative observations
		(100' Downstream of Wing Dam)		0.3[2]	0.40[2]		0.40[2/3]		
		(Areal Extent of Scour ≥ 1')	ft²	0	[3]			Sediment Transects	
	Provide Add'l Habitat and Substrate for Benthic and Aquatic Organisms	Rock Placement Below Wing Dams	Number of Benthic and Aquatic Organisms	--				Benthic Surveys Fishery Surveys	
Restore Wetland Habitat	Increase Food, Shelter, and Breeding Habitat for Wildlife	Potholes	Water Surface Area ft²	0	[3]		[3]	Pothole Sedimentation Transects	Areal survey of Wildlife Use, Vegetation Types and Density, Invertebrate Studies
	Increase Bottomland Hardwood Diversity and Quality	Establish Hardwood Trees in Existing Forest Management, Crop, and Dredge Placement Areas	Percent Survival	0	100%		20%	Tree count/Random Sample (Deer Exclusion Study)	Estimate Effective Acreage and Wildlife Use
			m² (Basal Area)	0		[3]	[3]	Random Sample	Presence or Absence of Mast
			m² (Crown Area)					Random Sample	

[1] This column is completed for the year the enhancement feature is monitored.

[2] From Hydraulic Study at a discharge of 40,000 ft³/s (see Appendix H).

[3] To be determined post-construction.

14. COST ESTIMATES

A detailed estimate of project design and construction costs is presented in Table 14-1. A discussion of the basis for project element and contingency costs is presented in Appendix I. A detailed estimate of operation, maintenance, and rehabilitation costs is presented in Table 14-2. Table 14-3 presents the estimated annual monitoring costs as described in Section 13. Quantities may vary during final design.

TABLE 14-1

Cottonwood Island Habitat Rehabilitation and Enhancement
Project Cost Summary
April 1996 Price Level

ACCOUNT	FEATURE	CURRENT WORKING ESTIMATE (CWE)	[2] FULLY FUNDED ESTIMATE (FFE)
01	LANDS AND DAMAGES	$ 5,000	$ 5,000
06.	FISH AND WILDLIFE FACILITIES	$ 872,328	$ 955,286
30.	PLANNING, ENGINEERING AND DESIGN	$ 567,000	$ 631,922
31.	CONSTRUCTION MANAGEMENT	$ 100,000	$ 111,450
	PROJECT COSTS SUBJECT TO COST SHARING[1]	$ 1,544,328	$ 1,703,658
	NON-FEDERAL COSTS	$ -	$ -
	NON-FEDERAL LANDS & DAMAGES	$ -	$ -
	REQUIRED NON-FEDERAL CASH CONTRIBUTIO	$ -	$ -
	FEDERAL COST	$ 1,544,328	$ 1,703,658
	GENERAL DESIGN, DEFINITE PROJECT REPOR	$ (448,000)	$ (448,000)
	REMAINING FEDERAL COSTS	$ 1,096,328	$ 1,255,658

NOTES:

1. PROJECT FEATURES ARE ON FEDERAL LAND AND 100% FEDERAL FUNDED
2. CONSTRUCTION SCHEDULED FOR APRIL 97 - MAY 99. FULLY FUNDED ESTIMATE (FFE) IS BASED ON MIDPOINT OF CONSTRUCTION OF MAY 1998, RESULTING IN INFLATION FACTORS OF 1.1145 FOR SALARIES AND 1.0951 FOR ALL OTHER COSTS PER CECW-B MEMO, 25 JAN 93, SUBJECT: FACTORS FOR UPDATING STUDY/PROJECT COST ESTIMATES FOR THE FY 1995 BUDGET SUBMISSION.

TABLE 14-1 (Cont'd)

Cottonwood Island Habitat Rehabilitation and Enhancement
Project Cost Estimate
April 1996

Acct Code	Item	Quantity	Unit	Unit Price	Amount	Contingency	Con %
01.	**LANDS AND DAMAGES**						
01.	Real Estate	1	LS	$5,000.00	$ 5,000.00	$ -	0%
06.	**FISH AND WILDLIFE FACILITIES**						
06.	**CHANNEL DREDGING**						
06.	GRADING & SHAPING	32,700	SY	$ 2.00	$ 65,400.00	$ 13,080.00	20.0%
06.	DREDGING	49,900	CY	$ 4.00	$ 199,600	$ 39,920	20.0%
06.	CLEARING (W=80')	9	ACRE	$2,000.00	$ 18,000	$ 3,600	20.0%
	TOTAL				$ 283,000	$ 56,600	
06.	**POTHOLES**						
06.	CLEARING	6	Acre	$2,000.00	$ 12,000	$ 2,400	20.0%
06.	EXCAVATION	28,000	CY	$ 2.00	$ 56,000	$ 11,200	20.0%
	TOTAL				$ 68,000	$ 13,600	
06.	**MAST TREE PLANTING**						
06.	FOREST MANAGEMENT AREAS	1,110	Trees	$ 128.00	$ 142,080	$ 28,416	20.0%
06.	AGRICULTURAL AREA	1,490	Trees	$ 114.00	$ 169,860	$ 33,972	20.0%
	TOTAL				$ 311,940	$ 62,388	
06.	**WING DAM NOTCHING**						
06.	NOTCH WING DAM	8,000	CY	$ 8.00	$ 64,000	$ 12,800	20.0%
	TOTAL				$ 64,000	$ 12,800	
					$ 726,940	$ 145,388	
06.	**FISH AND WILDLIFE FACILITIES TOTAL COST**				$ 872,328		
30.	**PLANNING, ENGINEERING, AND DESIGN**						
	DEFINITE PROJECT REPORT				$ 448,000		
	PLANS AND SPECIFICATIONS				$ 95,000		
	ENGINEERING DURING CONSTRUCTION				$ 24,000		
30.	**PLANNING, ENGINEERING, AND DESIGN TOTAL COST**				$ 567,000		
31.	**CONSTRUCTION MANAGEMENT**						
	CONSTRUCTION ADMINISTRATION				$ 60,000		
	REVIEW OF SHOP DRAWINGS				$ 10,000		
	INSPECTION AND QUALITY ASSURANCE				$ 30,000		
31.	**CONSTRUCTION MANAGEMENT TOTAL COST**				$ 100,000		

TABLE 14-2

Estimated Annual Operation and Maintenance Costs1/
(June 1995 Price Level)

	Quantity	Unit	Unit Price ($)	Total Cost ($)
Operation				2/
Maintenance				
Inspection	32	Hours	25.00	800
Debris Removal (Side channel and wing dam notches)	40	Hours	50.00	2,000
Apply Herbicide (if necessary - first two years) 3/	2600	Tree	0.49	1,276
Remove Deer Protection (after third growing season 4/	867	Tree	0.60	516
Spray Deer Repellent (year 1 and 2) 5/	867	Tree	0.48	413
Subtotal Maintenance:				5,005
Rehabilitation 6/				
			Subtotal:	5,005
Contingencies (20%)				1,001
			TOTAL:	6,006

1/ Interest rate = 7-3/4%. Period is 50 years.

2/ No operation costs are identified.

3/ Annualized cost for herbicide application is based on a present worth cost of $3.09/tree.

4/ Annualized cost for deer protection removal is based on a present worth removal cost of $7.50/tree.

5/ Annualized cost for spray deer protection is based on a present worth cost of $3.00/tree.

6/ Rehabilitation work cannot be accurately estimated. Rehabilitation is reconstructive work that significantly exceeds the annual operation and maintenance requirements identified above and which is needed as the result of major storm events.

TABLE 14-3

Estimated Post-Construction Annual Monitoring Costs ($) (July 1995 Price Level)

Item	Annual Cost ($)
Engineering Data [1/]	3,000
Natural Resource Data [1/]	2,000
Subtotal	5,000
Contingencies (20%)	1,000
Subtotal	6,000
Planning, Engineering, Design [2/]	1,500
Total	7,500

[1/] Reference Tables 14-2 and 14-3.
[2/] Includes cost of annual evaluation report.

15. REAL ESTATE REQUIREMENTS

a. The Missouri Department of Conservation (MDOC) is the local sponsor of the project.

b. There are an estimated 463 land acres in the project area.

c. Federally owned lands.

(1) The project would be located on federally owned lands.

(2) The project lands of the Cottonwood Island Wildlife Management Area are managed under a cooperative agreement between the Department of the Interior-USFWS, and the U.S. Army Corps of Engineers, dated 14 February 1963. The USFWS administers these project lands through the MDOC under a cooperative agreement between the USFWS and the MDOC.

(3) The federally owned lands were acquired subject to existing easements for public utility lines, pipelines, railroads, and public roadways. Therefore, the local sponsor must obtain permission as required.

d. There are no proposed P.L. 91-646 relocations as there are no acquisitions required.

e. Project Cooperation Agreement (PCA). No PCA is required because lands are 100% federally owned and funding is 100% Federal.

f. Funds for the initial construction of the proposed project are proposed for 100 percent Federal funding. The Cottonwood Island project features are located on federally owned General Plan land under Corps of Engineers administration. The Water Resources Development Act of 1986 (Public Law 99-662) is the basis for the first cost Federal funding and provides:

> Section 906. FISH AND WILDLIFE MITIGATION
>
> (e) ... the first cost of such enhancement shall be a Federal cost when - such activities are located on lands managed as a national wildlife refuge.

A draft agreement between the Corps of Engineers and the USFWS is included as Appendix C. Estimated operation and maintenance costs can be found in Section 14.

g. The estimated cost of the project indicates Federal administrative costs of $5,000. It is possible that landward access may be required to construct the project. However, this would only occur if the contractor was unable or unwilling to access the project by water. The cost estimates reflect this possibility. If the landward access is not required, the costs shown will likely be significantly less.

h. There is no known presence of HTRW issues or other environmental circumstances affecting the project.

16. SCHEDULE FOR DESIGN AND CONSTRUCTION

Table 16-1 presents the schedule of project completion steps.

TABLE 16-1

Project Implementation Schedule

Requirement	Scheduled Date
Submission of Draft DPR to Corps of Engineers, North Central Division, for Review	Aug 95
Distribution of DPR for Public and Agency Review	Jan 96
Submission of Final and Public Reviewed DPR to North Central Division	Jun 96
Receive Plans and Specifications Funds	Jun 96
Construction Approval by Commander, North Central Division	Jul 96
Submit Final Plans and Specifications for Internal Technical Review and Approval	Nov 96
Obtain Approval of Plans and Specifications	Dec 96
Advertise and Award Timber Sale Contract	Aug 96
Advertise Contract	Jan 97
Award Contract	Apr 97
Complete Construction	May 99

17. IMPLEMENTATION RESPONSIBILITIES AND VIEWS

a. Corps of Engineers. The Corps of Engineers, Rock Island District, is responsible for project management and coordination with the USFWS, the State of Missouri, and other affected agencies. The Rock Island District will submit the subject definite project report; program funds; finalize plans and specifications; complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration.

b. U.S. Fish and Wildlife Service. The USFWS is the Federal sponsor of the project and will determine that all project features are compatible with refuge purposes. The recommendations provided via the Coordination Act Report are the result of extensive interagency coordination efforts throughout the planning process. These recommendations will be fully incorporated in the final design and implementation of this project.

c. Missouri Department of Conservation. Operation and maintenance of the project, as described in Table 14-2, is the responsibility of the MDOC in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580. These functions will 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 sponsor. The MDOC is the non-Federal sponsor of the project.

18. COORDINATION, PUBLIC VIEWS, AND COMMENTS

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

Missouri Department of Conservation
Missouri Historic Preservation Agency
Missouri Department of Natural Resources
Missouri Department of Transportation
Natural Resources Conservation Agency
U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency

a. Coordination Meetings. Ongoing coordination between the Corps, the U.S. Fish and Wildlife Service (USFWS), the Missouri Department of Conservation (MDOC), and the general public was demonstrated by the following meetings:

(1) November 22, 1991. Plan formulation meeting with the Corps, the USFWS, and the MDOC.

(2) October 21, 1992. Baseline WHAG meeting with the Corps, the USFWS, and the MDOC.

(3) March 2, 1993. General project discussion with the Corps, the USFWS, the MDOC, and the Illinois Department of Conservation.

(4) May 19, 1993. Corps in-house meeting; general project discussion.

(5) November 2, 1994. General project discussion with the Corps, the USFWS, and the MDOC.

(6) February 9, 1995. General project discussion with the Corps, the USFWS, and the MDOC.

(7) March 8, 1995. General project discussion with the Corps, the USFWS, and the MDOC.

(8) June 7, 1995. General project discussion with the Corps, the USFWS, and the MDOC.

(9) September 21, 1995. On-site meeting with the MDOC to discuss locations for pothole placement.

(10) September 26, 1995. General project discussion with the Corps, the USFWS, and the MDOC to discuss the draft report.

(11) March 7, 1996. Meeting with Mississippi Valley Hunters and Fishermen Association to discuss draft report.

(12) March 27, 1996. On-site meeting with concerned citizens on pothole relocation.

b. Coordination by Letters and Telephone Conversations. To date, the following letters and phone conversations have been received (see Appendix A - Correspondence):

(1) Letter dated March 11, 1987, from the MDNR with a supporting letter from the MDOC outlining their conceptual proposal for the Cottonwood Island project.

(2) Letter dated January 14, 1993, from the Rock Island District to project proponents transmitting the project appraisal report for their review and comment.

(3) Letter dated February 4, 1993, from the MDOC providing comments on the project appraisal report.

(4) Letter dated April 12, 1993, from the MDOC providing a revised conceptual project proposal based on the March 2, 1993, coordination meeting.

(5) Letter dated May 24, 1994, from the Rock Island District to the MHPA forwarding the results of the projects geomorphological and archeological investigation.

(6) Phone conversation, dated August 17, 1995, from the Natural Resources Conservation Service detailing information concerning prime and unique farmland.

(7) Fish and Wildlife Coordination Act Report from the U.S. Fish and Wildlife Service, Rock Island Field Office, dated August 28, 1995.

(8) Letter and enclosure (Form AD-1006) dated August 31, 1995, from the Natural Resources Conservation Service stating no prime farmland soils exist on the island.

(9) Phone conversation, dated November 28, 1995, with the MDOC concerning relocation of a deep hole in the side channel dredging feature.

(10) Phone conversation, dated April 12, 1996, with MDOC concerning placement of potholes.

19. CONCLUSIONS

The recommended project features (Cottonwood Chute dredging, mast tree planting, potholes, and wing dam notching) are designed to meet the project's goal of enhancing wetland and aquatic habitats by providing flowing water and critical overwintering habitat for fish; increasing food resources for multiple migratory and resident species; creating secluded open water for migratory bird rearing and nesting; and increasing overall habitat diversity.

Assessment of the future with-project scenario shows definite increases in total habitat units over the 50-year life for the target species, as well as a majority of other wetland dwelling species considered. These increases represent quantification of the projected outputs: improved habitat quality and increased preferred habitat quantity.

This project is consistent with and fully supports the overall goal and objectives of the UMRS-EMP, the North American Waterfowl Management Plan, and the Partners In Flight program.

20. 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 Secretary of the Army for Civil Works approve the proposed project to include: dredging the lower 4,900 feet of Cottonwood Chute to a 7-foot depth with 4 deep holes 15 feet deep; planting mast-producing trees on the dredged material, agricultural field, and three forest management areas, and excavating two 1/2-acre and three 1-acre potholes; and notching 6 wing dams.

The current estimated Federal construction cost of this project is $872,328. Total Federal estimated project cost, including general design, is $1,544,328. All project costs will be 100 percent Federal.

At this time, I further recommend that funds in the amount of $95,000 be allocated for the preparation of project plans and specifications.

Charles S. Cox
Colonel, U.S. Army
District Engineer

21. 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 enhancement project at Cottonwood Island, in Lewis and Marion Counties, Missouri, 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 measures was considered in which alternatives were derived. The measures are:

a. No Federal Action

b. Side Channel Restoration

c. Bottomland Hardwood Habitat Restoration

d. Main Channel Border Enhancement

The primary objectives of the Cottonwood Island HREP are to improve main channel border diversity by notching six wing dams, restore bottomland hardwood diversity by planting a variety of hard mast-producing trees and excavating two 1/2-acre and three 1-acre potholes, and finally, restore overwintering fish habitat by dredging four deep holes and their associated side channel in Cottonwood Chute.

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

a. The project is anticipated to improve the value of the Cottonwood Island area for resident wildlife, migratory birds, and fish.

b. Aside from temporary disturbance, no long-term adverse impacts to natural or cultural resources are anticipated. No endangered species, either State or Federal, would be affected by the project action.

c. Land use after the project should remain unaltered, and no significant economic impacts to the project area are envisioned.

d. The project will comply with Sections 401, 402, and 404 of the Clean Water Act.

13 June 1996
Date

Charles S. Cox
Colonel, U.S. Army
District Engineer

CORRESPONDENCE

APPENDIX A

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
REHABILITATION AND ENHANCEMENT
POOL 21, MISSISSIPPI RIVER MILES 328.5 TO 331.0
LEWIS AND MARION COUNTIES, MISSOURI

APPENDIX A
CORRESPONDENCE

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MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS:
P.O. Box 180
Jefferson City, Missouri 65102-0180

STREET LOCATION:
2901 West Truman Boulevard
Jefferson City, Missouri

Telephone 314/751-4115
LARRY R. GALE, Director

50 YEARS of CONSERVATION
1937 • 1987

February 24, 1987
Rec'd 2-26-87

Dr. Frederick A. Brunner, Director
Missouri Department of Natural Resources
P. O. Box 176
Jefferson City, Missouri 65102

Dear Dr. Brunner:

Enclosed is a conceptual habitat rehabilitation project for Cottonwood Island located in Pool 21, Lewis County. Please forward this proposal to the Rock Island District, Corps of Engineers for inclusion in the 1987 General Plan Addendum of the Upper Mississippi River System Environmental Management Program. As with previously submitted projects, it is our recommendation that the engineering and design work on this proposal be done by the Corps of Engineers.

Please note that Cottonwood Island should be included as the third priority project for Missouri in the Rock Island District.

St. Louis District (LMS)
1. *Clarksville Refuge
2. *Dresser Island
3. *Pharrs Island
4. *Osborne Side Channel
5. *Pools 25 and 26 Wetland Habitat Rehabilitation
6. *Pool 25 Island

Rock Island District (NCR)
1. *Monkey Chute
2. *Bay Island
3. Cottonwood Island

*Indicates conceptual habitat rehabilitation project forwarded previously.

Questions or comments regarding any of the aforementioned matters should be directed to Mr. Norman P. Stucky at the above address.

Sincerely,

Larry R. Gale

LARRY R. GALE
DIRECTOR

cc: Andy Bruzewicz, Rock Island District, Corps of Engineers
U. S. Fish and Wildlife Service, Rock Island, IL

Upper Mississippi River System
Environmental Management Program
General Plan Appendix
Request for Engineering and Design Funds

Conceptual Proposal for COTTONWOOD ISLAND HABITAT REHABILITATION

Pool 21, Upper Mississippi River
Lewis County, Missouri

February 24, 1987

Project Authority

Public Law 95-502 authorized the construction of a new dam and 1200-foot lock at Alton, Illinois, and directed the Upper Mississippi River Basin Commission to prepare a Comprehensive Master Plan for the Management of the Upper Mississippi River System (Master Plan). The Basin Commission completed the Master Plan report and submitted it to Congress on December 31, 1981. The report recommended an environmental management program that included construction of habitat rehabilitation and enhancement projects.

The 1985 Supplemental Appropriations Bill (P.L. 99-88) and the 1986 Water Resource Development Act (P.L. 99-662) provides authorization/funds for the Corps of Engineers (COE) to proceed with implementation of the Master Plan Environmental Management Program (EMP).

Project Purpose

Rehabilitate prime wetland/deepwater aquatic habitat on the 463 acre Cottonwood Island, Pool 21, Lewis County, Missouri. Conceptually, this proposed project would include construction of about 2.3 miles of levee, inflow and outflow water control structures, and dredging an estimated 40 acres of chute or slough habitat to an average depth of 5 feet.

Project Area and Background

Cottonwood Island is located along the right bank of the Mississippi River in Pool 21 between approximate river miles 329-331 (Fig. 1). Historically, Cottonwood Chute provided deep, productive, flowing water habitat. Likewise the numerous low swales on the interior of the island provided important wetland habitat. However, siltation has greatly reduced both the quality and quantity of these important habitats. Sedimentation is particularly acute in the upper end of the chute and in the timbered portion of the island which fronts the river's main channel.

Studies by Ellis, Missouri Department of Conservation in 1975-76 showed dissolved oxygen levels to be less than 3 mg/l in the shallow upper portion. Associated with the shallow water was a lack of fish species diversity. Sampling in the lower end produced numerous fish species and deep, well oxygenated water.

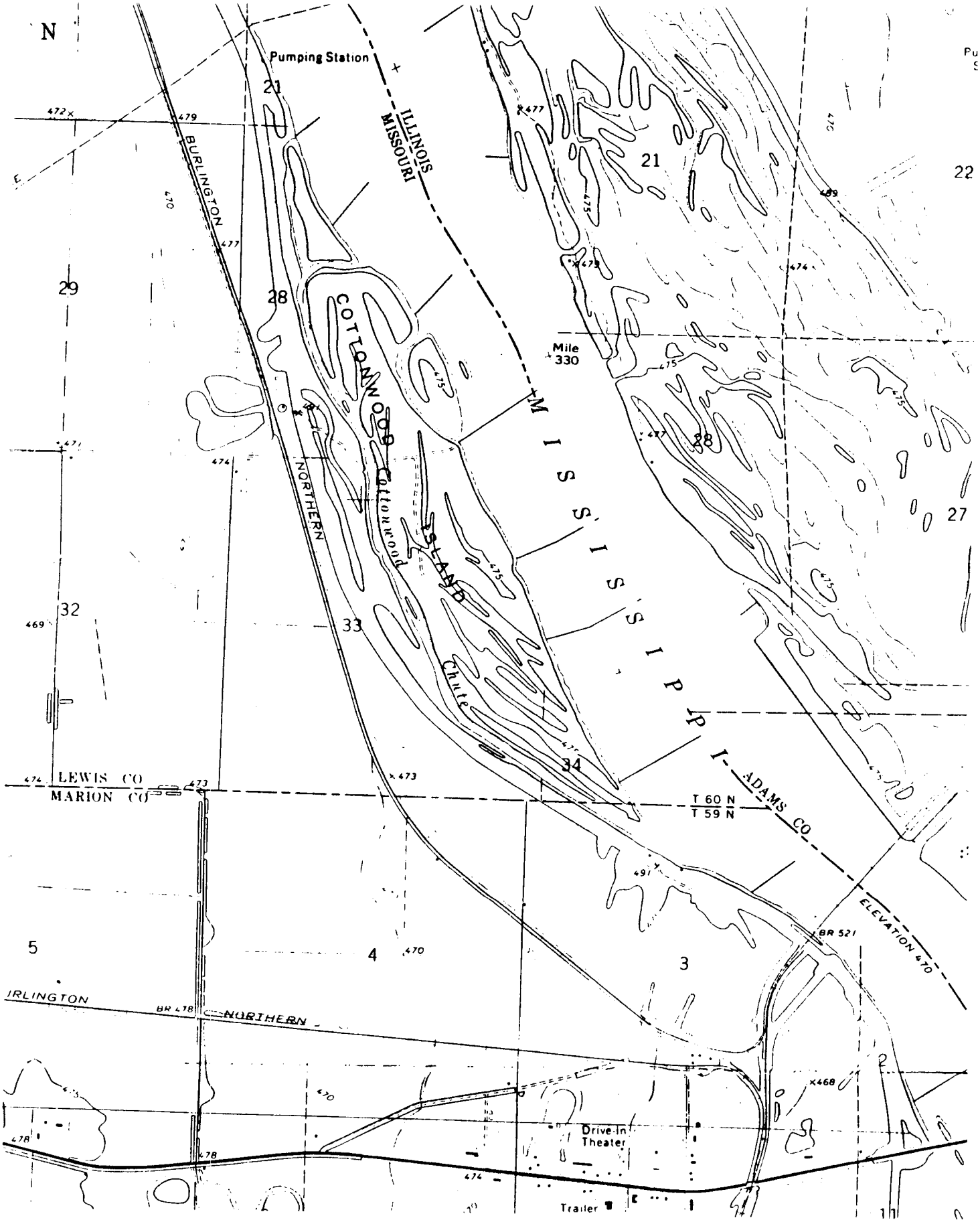


Fig. 1 - Upper Mississippi River, Pool 21, Cottonwood Island

The flowing chute and interior wetland habitat is used extensively by migratory waterfowl and other wetland wildlife species. Tall cottonwood trees along the chute and main channel border are favorite roosting/feeding sites for wintering bald eagles.

The island's timber resource consists almost entirely of cottonwood and soft maple species. The Rock Island District, Corps of Engineers has attempted limited forest management which includes several small clear cuts. Approximately 35 acres on the island's interior are agriculturally share cropped. Corn is the primary feed grain that is produced. Waterfowl, deer, turkey, squirrels and numerous nongame wildlife species benefit from that portion of the crop that is not harvested.

Proposed Project

Conceptually, the major components of the proposed plan include the following:

a. Approximately 2.3 miles of levee which provide protection from a 10-15 year flood event (est. elevation 480' m.s.l.) should be constructed along that portion of the island which fronts the river's main channel (Fig. 2). The purpose of this levee would be twofold: (1) primarily it would prevent additional sediment from entering the chute/wetlands causing further habitat degradation; and (2) provide the opportunity to hold and manage water levels in the chute and on the island's interior wetlands independent of river stage. The levee should be set back from the river a minimum of 100 ft. to protect the valuable riparian timber which is protecting the shoreline.

b. Construction of a water control structure at the upper and lower end of Cottonwood Chute and at the upper and lower end of the small chute at river mile 330 (Fig. 2). By taking advantage of the approximate 1 foot head differential between river miles 329-331, gravity flow instead of pumps can be used on the source of water to manage water levels on island independent of river stage.

c. Dredging an estimated 40 acres (Fig. 2) of chute or slough habitat to an average depth of 5 feet to restore productive fisheries habitat. A number of deep holes (10 ft. in depth) should be dredged in the two mile long Cottonwood Chute to assure that fishery resources are sustained throughout the winter.

d. Cottonwood/Silver maple species dominate the bottomland timber resource on Cottonwood Island. Many wildlife species would benefit if hardwood, mast producing trees could be reestablished on this island. This could be accomplished by using a tree spade to move a minimum of 100 trees (various hardwood species) which are 4 to 6 inches in diameter. These trees should be planted in the clear cuts and other open areas present on the island.

e. Habitat diversity on the island could be further enhanced by clearing and agriculturally cropping an additional 30 acres near the upper end (Fig. 2).

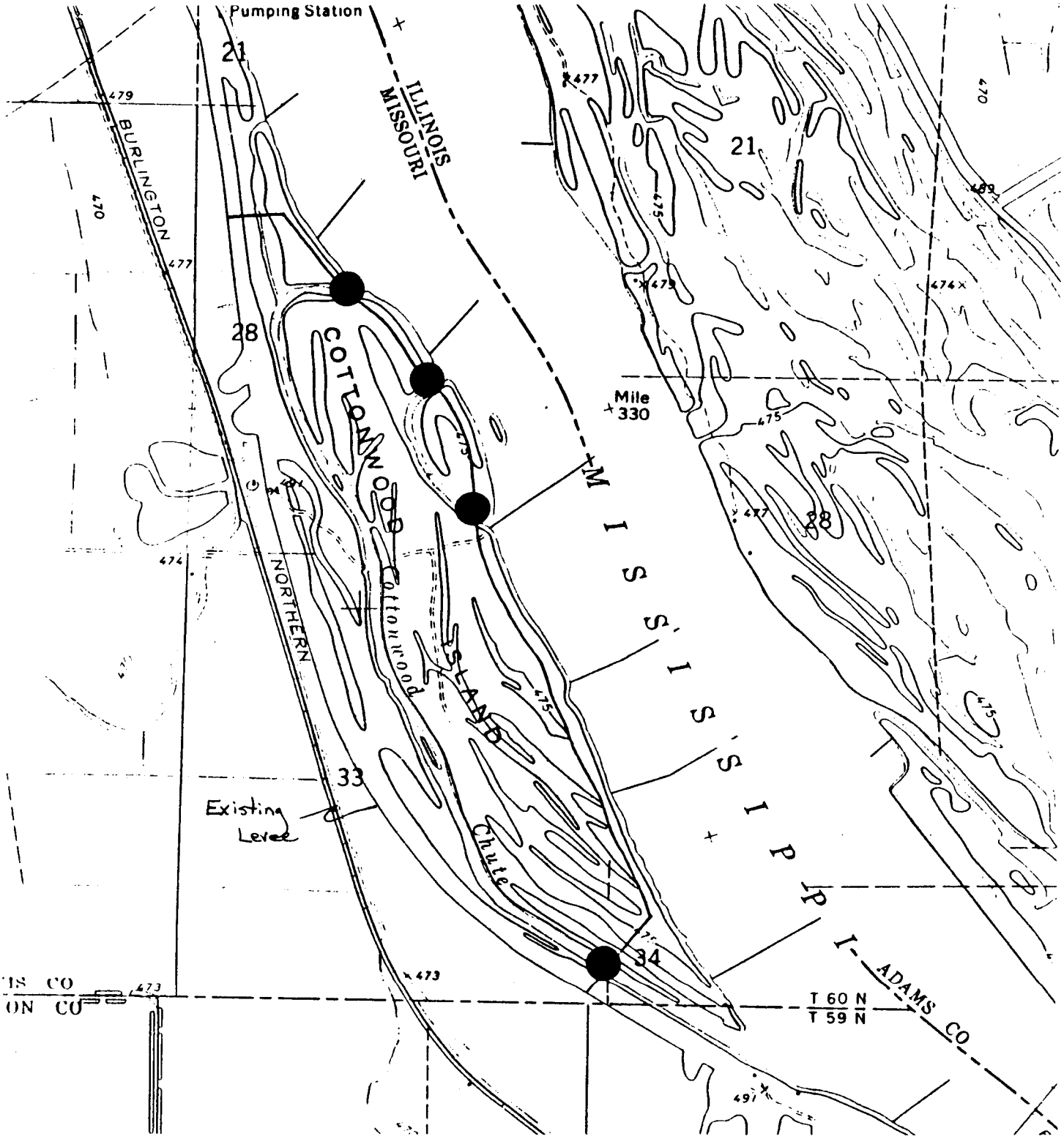


Fig. 2 - Cottonwood Island, Pool 21, Lewis County, Missouri
Components of Conceptual Rehabilitation Project

Levee Alignment —

Inflow Structures ●

Outflow Structures ●

Area to be Dredged

Area to be Cleared and Cropped

Project Cost

The following preliminary cost estimates are subject to change pending completion of advanced engineering design.

Advanced Engineering Design	$120,000
Levee Construction 8 ft. wide berm 1 to 3 slope Estimated 5' high (480' m.s.l.) 51,700 yds.^{3} @ $4/yd	206,800
Seeding/Stabilization of levee slopes 5 acres @ $1000/acre	5,000
Water Control Structures Screw Gate at the upper end of Cottonwood Chute	5,000
36' stop log structures at the lower end of Cottonwood Chute	5,000
Dredging 40 acres (average depth 5') Estimated 300,000 yds^3 @ $2/yd.	600,000
Tree planting with tree spade 100 hardwood trees (4-6" dia.) @ $150/tree	15,000
Clearing to increase agricultural cropping management opportunities 30 acres @ $1000/a.	30,000
Contingency	50,000
Operation and Maintenance costs unknown pending completion of advanced engineering design	- 0 -
	$1,036,800

The estimated total construction cost for this proposed project is $1,036,800. Actual cost may vary depending on final engineering design. To complete the engineering and design work, a total of $120,000 is requested for FY '88/'89. It is anticipated that this project will be ready to include in the FY '90 request for construction.

As with other UMR Master Plan Habitat Rehabilitation Projects, it is anticipated that the Rock Island District, Corps of Engineers will do the engineering and design work on this project.

Local Cooperation/Cost Sharing Agreement

This project, located on land belonging to the federal government, will primarily benefit nationally important species; therefore, it is recommended that it be entirely federally financed. The State of Missouri, Department of Conservation agrees to:

- Coordinate with the Rock Island District, Corps of Engineers to assure that habitat rehabilitation objectives are met.

- Assume management responsibilities, including the annual operation and maintenance costs when the project is complete.

I recommend that engineering and design funds be allocated for the proposed project under the Upper Mississippi River System Environmental Management Program.

Neil A. Smart
Colonel, Corps of Engineers
District Engineer

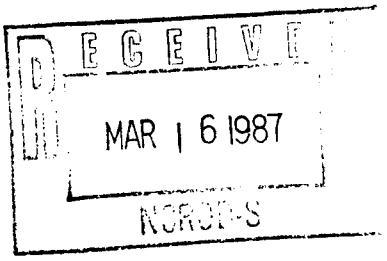
JOHN ASHCROFT
Governor

FREDERICK A. BRUNNER
Director

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES

Division of Energy
Division of Environmental Quality
Division of Geology and Land Survey
Division of Management Services
Division of Parks, Recreation,
and Historic Preservation

OFFICE OF THE DIRECTOR
P.O. Box 176
Jefferson City, Missouri 65102
Telephone 314-751-4422



March 11, 1987

Colonel Neil A. Smart,
District Engineer
Rock Island District
U. S. Army Corps of Engineers
Clock Tower Building
P. O. Box 2004
Rock Island, IL 61204-2004

Dear Colonel Smart:

Attached is the conceptual project proposal for Cottonwood Island Habitat Rehabilitation and the supporting letter from the Missouri Department of Conservation. Cottownwood Island is located in Pool 21, Mississippi River, Lewis County, Mo. This proposal is for engineering and design funds and includes a request that the work be done by the Corps of Engineers. This proposal is submitted for inclusion in the Upper Mississippi River System Environmental Management Program, General Plan, Second Annual Addendum.

Federal, state, and local permits are to be obtained by the implementing agency.

An initial interdepartmental review of these proposals was made and comments include:

> In addressing water quality concerns, as detailed planning progresses, and hopefully before Section 401 Water Quality Certification is requested, this department needs to know specifically how the dredging would be accomplished. If by hydraulic dredge, then a settling basin would be necessary as well as a NPDES permit for any return water discharge. If some other means of dredging will be used, such as a clam shell, we need to know so we can assess water quality impacts. It is recommended that as the wetlands are designed, water quality functions are considered where and when possible for

restoration and maintenance of water quality. This is of prime concern for areas where water levels will be manipulated for water foul purposes.

The priority and list of active projects from Missouri in your District includes:

1. Monkey Chute
2. Bay Island
3. Cottonwood Island

The above habitat rehabilitation and enhancement projects are a vital part of our efforts to provide for the coordinated development and enhancement of the Upper Mississippi System.

Sincerely,

DEPARTMENT OF NATURAL RESOURCES

for Frederick A. Brunner, Ph.D., P.E.
Director

FAB:cme

Attachment

cc: Mr. Donald Vonnahme

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

JANUARY 14, 1993

Planning Division

SEE DISTRIBUTION LIST

The Rock Island District of the U.S. Army Corps of Engineers has enclosed for your review and comment a copy of the Upper Mississippi River System Environmental Management Program Project Appraisal Report, Cottonwood Island Habitat Rehabilitation and Enhancement, Pool 21, River Miles 328.5 Through 331.0, Lewis County, Missouri, dated December 1992.

The purpose of this report is to assure thorough coordination of and concurrence with the project goals, objectives, and potential enhancement features formulated by the participating Federal and State agencies. A summary of resource monitoring and data collection activities (under way and proposed) in support of the Cottonwood Island project is included in the report for your consideration.

Questions regarding the enclosed document should be directed to Mr. Jerry Skalak, Technical Manager, Rock Island District Habitat Projects, telephone 309/788-6361, Ext. 6605. Written comments should be sent to the following address no later than 30 days from the date of this letter.

District Engineer
U.S. Army Engineer District, Rock Island
ATTN: Planning Division
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204-2004

Sincerely,

ORIGINAL SIGNED BY
PATRICK T. BURKE, P.E.

Dudley M. Hanson, P.E.
Chief, Planning Division

Enclosure

DISTRIBUTION LIST

COTTONWOOD ISLAND, MISSOURI
HABITAT REHABILITATION AND ENHANCEMENT

Mr. Bill Donels
Illinois Department of Conservation
Lincoln Tower Plaza
524 South 2nd Street
Springfield, Illinois 62706

Mr. Michael Bornstein
U.S. Fish and Wildlife Service
R.R. 1, Box 75
Wapello, Iowa 52653

Mr. Milo Anderson
U.S. Environmental Protection Agency
Environmental Review Board, 5ME-16
230 South Dearborn Street
Chicago, Illinois 60604

Mr. Wayne Fischer
U.S. Fish and Wildlife Service
4469 - 48th Avenue Court
Rock Island, Illinois 61201

Mr. Norm Stucky
Missouri Department of Conservation
Box 180
Jefferson City, Missouri 65102

Ms. Pam Thiel
U.S. Fish and Wildlife Service
Environmental Management Technical Center
575 Lester Drive
Onalaska, Wisconsin 54650

Mr. Troy LaRue
Missouri Department of Conservation
Upper Mississippi Wildlife Area
Box 13
Ashburn, Missouri 63433

Mr. Gordon Farabee
Missouri Department of Conservation
Big Rivers Coordinator
Box 180
Jefferson City, Missouri 65102

Mr. Jack Boyles
Missouri Department of Conservation
Mississippi River District Office
Box 428
Hannibal, Missouri 63401

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS
P.O. Box 180
Jefferson City, Missouri 65102-0180

STREET LOCATION
2901 West Truman Boulevard
Jefferson City, Missouri

Telephone: 314/751-4115
Missouri Relay Center 1-800-735-2966 (TDD)
JERRY J. PRESLEY, Director

February 4, 1993

Mr. Dudley M. Hanson
Chief, Planning Division
Rock Island District, Corps of Engineers
Clock Tower Bldg.
P.O. Box 2004
Rock Island, IL 61204-2004

Attention: Planning Division

Dear Mr. Hanson:

Thank you for providing our staff opportunity to review and comment on the proposed "Cottonwood Island Habitat Rehabilitation and Enhancement Project" located in Pool 21, River Miles 328.5 to 331.0. We have appreciated the close coordination with the Rock Island District over the past several years to assure maximum habitat benefits will be realized from this project. The report accurately details the various components that have been discussed to date for this project.

In light of Washington's request for a more thorough incremental analysis of proposed habitat projects, we would like to suggest an alternative alignment for the sediment deflection levee. There is a critical shortage of backwater habitat in this river reach. An emergent rock dike constructed offshore (see attached map) would serve not only as a sediment deflection levee, but also to create a large productive backwater area. Could a cursory analysis of feasibility and cost of this alternative be conducted to determine resulting habitat benefits?

Again, we appreciate the opportunity to work with the Rock Island District to implement the Environmental Management Program. Please direct further coordination on this project to Mr. Norm Stucky at the above address.

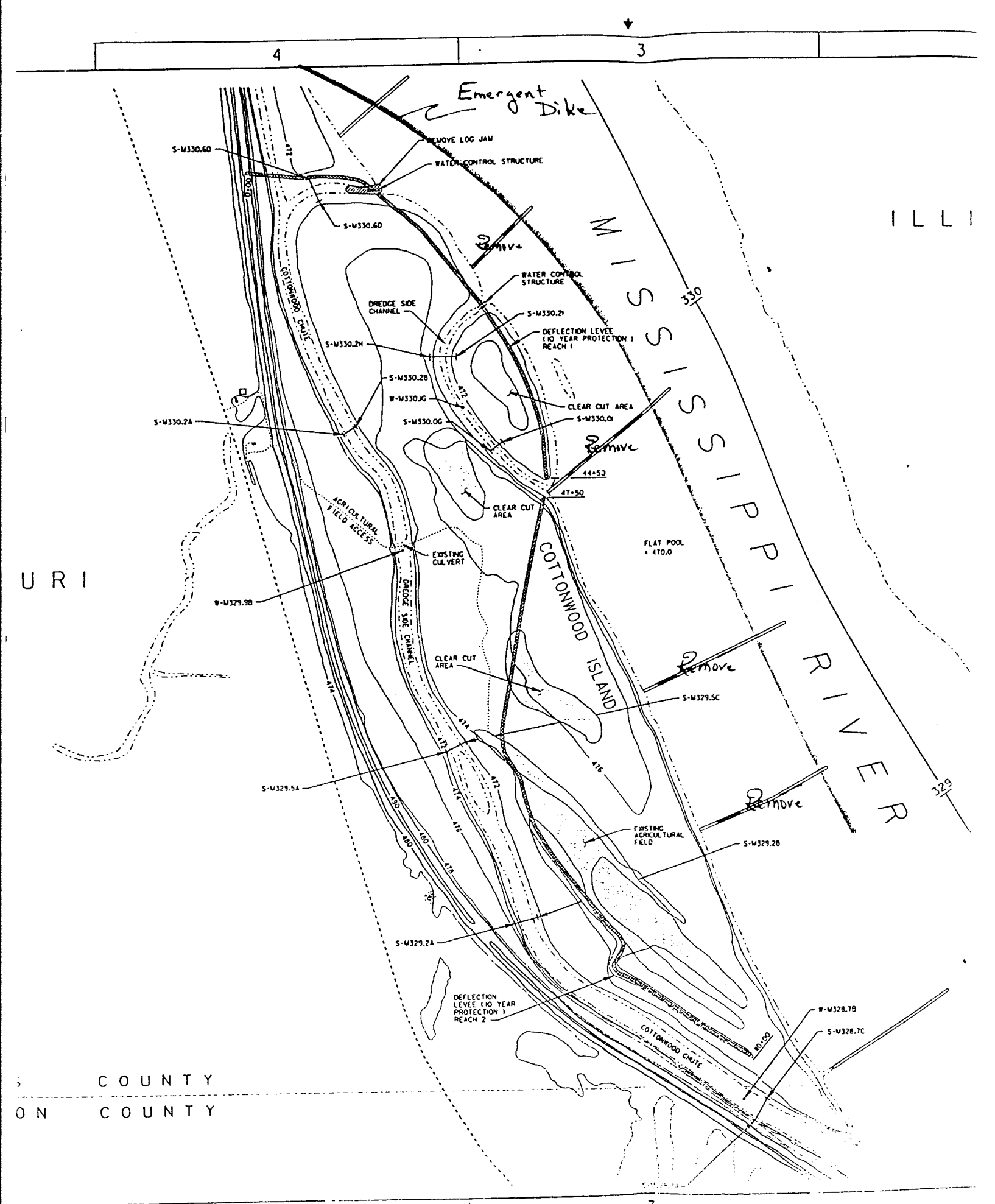
Sincerely,

Dan F. Dickneite

DAN F. DICKNEITE
PLANNING DIVISION CHIEF

Enclosure

cc: Michael Bornstein
U. S. Fish and Wildlife Service


Emergent Dike
REMOVE LOG JAM
WATER CONTROL STRUCTURE
S-M330.60
S-M330.60
Remove
WATER CONTROL STRUCTURE
DREDGE SIDE CHANNEL
S-M330.2H
S-M330.2H
DEFLECTION LEVEE (10 YEAR PROTECTION) REACH 1
S-M330.2B
W-M330JG
CLEAR CUT AREA
S-M330.2A
S-M330.0G
S-M330.0I
Remove
44+53
47+50
CLEAR CUT AREA
AGRICULTURAL FIELD ACCESS
EXISTING CULVERT
W-M329.9B
FLAT POOL
= 470.0
COTTONWOOD ISLAND
DREDGE SIDE CHANNEL
CLEAR CUT AREA
Remove
S-M329.5C
S-M329.5A
Remove
EXISTING AGRICULTURAL FIELD
S-M329.2B
S-M329.2A
DEFLECTION LEVEE (10 YEAR PROTECTION) REACH 2
W-M328.7B
S-M328.7C
COTTONWOOD CHUTE
MISSISSIPPI RIVER
330
329
472
474
476
478
480
460
450
440
60.00
ILLI
URI
COUNTY
ON COUNTY

MISSOURI DEPARTMENT OF CONSERVATION

MAILING ADDRESS
P.O. Box 180
Jefferson City, Missouri 65102-0180

STREET LOCATION
2901 West Truman Boulevard
Jefferson City, Missouri

Telephone: 314/751-4115
Missouri Relay Center 1-800-735-2966 (TDD)
JERRY J. PRESLEY, Director

April 12, 1993

Mr. Jerry Skalek
EMP Coordinator
Rock Island District, Corps of Engineers
Clock Tower Building - P. O. Box 2004
Rock Island, Illinois 61201

Dear Mr. Skalek:

Members of our staff appreciated the opportunity to participate in the March 2, 1993 meeting in Rock Island to discuss the scope of work for the proposed Cottonwood Island habitat rehabilitation project. The attached conceptual proposal was prepared at a subsequent internal meeting of resource biologists. It is offered to aid in analyzing various project components to assure the recommended project is cost effective and maximizes restored habitat units.

We believe this project has several unique, experimental features that will further knowledge and understanding of how the riverine ecosystem can be restored and protected. We look forward to continued cooperation with you in preparing the Definite Project Report for this project.

Please direct questions, comments or the need for additional information to Mr. Norm Stucky at the above address.

Sincerely,

Dan L. Dickneite

DAN DICKNEITE
PLANNING DIVISION CHIEF

Enclosure

cc: Michael Bornstein, Fish and Wildlife Service
Bob Clevenstine, Fish and Wildlife Service

Cottonwood Island HREP

Conceptual Proposed Project

Side Channel Restoration

Step 1: Remove access causeway. Recreational users will be adversely impacted; however, this causeway is a key culprit in loss of aquatic habitat in the chute.

Step 2: Use energy of river to flush out silt and flocculent sediment. The following options should be evaluated:

Option A. Remove logjam at the head end of the chute; use a temporary structure (i.e.dike or perhaps even an anchored, sunken barge) to capture and divert additional flow down the chute.

Option B. During high flow period, use a small towboat to resuspend sediment and allow energy of river to flush out the chute.

Option C. Leave the log jam in place and dredge a pilot channel north to create a new chute opening at approximate river mile 330.8 (Figure 1). The 1971 USGS topo map shows an existing remnant channel. The additional head pressure at this location could make it more feasible to direct sufficient flow and energy down the side channel to flush out sediment.

Step 3: Evaluation. For a one-year period monitor bottom contour of the chute to determine whether the objective of restoring depth to the chute is being accomplished using river's energy. If not, or, in order to create deep holes in portions of the chute, go to Step 4.

Step 4: Use a hydraulic dredge to remove sediment from the side channel. Two options for dredging should be evaluated. The dredge cut in both options would be approximately 1.5 miles long by a maximum width of 50'. (Note: We believe a 30' maximum width is more reasonable.) The difference in cost between a 1:1 slope and a 2:1 slope could also be evaluated (Figure 2). Material should be disposed in small (3-5 acre) containment areas constructed on the island, east of the side channel. These areas should then be planted to mast producing hardwood trees.

Option A. The chute should be broken down into 1/4 mile segments. The depth of the dredge cut between segments should

alternate between 6' and 10'. Fifty percent of the chute would therefore be 10' deep and 50 percent would be 6' deep.

Option B. The chute should be broken down into seven reaches, four of which would be approximately 1,400' long and three would be approximately 800 feet in length. The former reaches should be dredged to a maximum depth of 6' and the latter a maximum depth of 10'. This would result in 70 percent of the chute being approximately 6' deep and 30 percent approximately 10' deep.

Sediment Deflection Levee

- Most of the sediment enters the chute from the upper end. Therefore if a sediment deflection levee is constructed on the island, it should probably be no more than 1/4 mile in length and extend from the mainline agriculture levee around the head of the chute and then a short distance downstream.

  We recommend the levee on the island be eliminated in favor of an emergent dike (use large Grade A stone) above the entrance to the chute (river mile 330.8 if a new entrance is constructed) which will provide the added benefit of creating productive backwater habitat. Note: It may be necessary to construct a short levee to tie the emergent dike into the mainline levee.

  We further recommend the water control structure be eliminated. This is a high dollar item, not only in upfront construction costs but also operation and maintenance.

Wing Dam Notching

- All dikes that are rooted to the island should be notched at the beginning of the project. Width and depth of notches should be determined by a hydraulic engineer. The objective is to encourage creation of a scour hole downstream of the notch to provide increased habitat diversity. Deep scour holes are particularly valuable as wintering habitat for riverine fishes. A hydraulic engineer should also evaluate the possibility of constructing the notches in a staggered formation to encourage a natural meander and development of a secondary side channel or thalweg. Rock removed to create the notches should be placed in deep water below the dike to provide additional habitat diversity and substrate for benthic organisms. Some rock could also be placed on the dike on both sides of the notch to serve as markers for boaters.

Emergent Rock Dike

- Construction of an emergent rock dike which would serve both as a sediment deflection levee to protect the investment of deepening the chute; and to create a protected backwater area should be thoroughly evaluated. An elevation that will provide protection for a ten-year flood event would probably be sufficient. A suggested location of the dike is presented in Figure 1. Various other designs should be looked at to maximize the area of backwater habitat that would be created. To provide additional habitat diversity and substrate for aquatic organisms, cedar tree clumps should be anchored in backwater area behind dike.

Sediment Deflection Levee

- The levee on the island should be constructed only if it is not feasible to construct the emergent rock dike. If constructed, it should extend only a short distance below the mouth of the chute. Alignment should be coordinated with resource foresters to avoid high quality timber.

Potholes

- We strongly endorse creation of potholes at selected locations on the island.

Mast Tree Plantings

- Opportunities to improve the forest composition on Cottonwood Island should be evaluated.

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

May 24, 1994

Planning Division

Mr. Michael S. Weichman
State Historic Preservation Office
Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

Dear Mr. Weichman:

The Rock Island District of the U.S. Army Corps of Engineers (Corps) is forwarding the Bear Creek Archeology, Inc., draft report (enclosure 1) entitled Geomorphological and Archaeological Investigations for the Cottonwood Island Habitat Rehabilitation and Enhancement Project, Upper Mississippi River System, Environmental Management Program, Mississippi River Pool 21, Lewis and Marion Counties, Missouri, (BCA #292) dated April 1994. The report was prepared under Corps Contract DACW25-92-D-0008, Work Order No. 6.

We request your review and comments on this draft report. The required Missouri Summary Sheet will be included with the final report.

If you have questions regarding this matter, please call Mr. Ron Pulcher of our Environmental Analysis Branch, telephone 309/794-5384, or you may write to our address above, ATTN: Planning Division.

Sincerely,

SIGNED BY
BURKE, P.E.

Dudley M. Hanson, P.E.
Chief, Planning Division

Enclosure

Copy Furnished:

Mr. David G. Stanley
President
Bear Creek Archeology, Inc.
P.O. Box 347
Cresco, Iowa 52136 (wo/enclosure)

CULTURAL RESOURCE ASSESSMENT
Section 106 Review

CONTACT PERSON/ADDRESS:

Mr. Ron Pulcher
Environemntal Analysis Branch
Rock Island District, Corps of Engineers
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

C.

David G. Stanley

PROJECT:

Cultural Resources Investigations, Cottonwood Island Habitat Project, Contract No. DACW25-92-D-0008

FEDERAL AGENCY:

COE

County:

Lewis and Marion Counties

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

[ ] The project area has been previously disturbed or has a low potential for the occurrence of cultural resources. A cultural resource survey, therefore, is not warranted.

[ ] None of the structures involved are eligible for inclusion in the National Register of Historic Places.

[ ] The proposed undertaking will have "no effect" on properties listed on or determined eligible for listing in the National Register of Historic Places.

[X] An adequate cultural resource survey of the project area has been made. We agree that the proposed undertaking will have "no effect" on significant cultural resources.

[ ] An adequate cultural resource survey of the project area has been made. We agree with the report's recommendation that the following potentially eligible sites should be avoided. If these sites are avoided, the proposed undertaking will have "no effect" on significant cultural resources.

Sites:

For the above checked reason, the Historic Preservation Program 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: Deputy SHPO **Date:** December 13, 1994

MISSOURI DEPARTMENT OF NATURAL RESOURCES
HISTORIC PRESERVATION PROGRAM
P.O. Box 176, Jefferson City, Missouri 65102
(314) 751-7958

CONVERSATION RECORD

TIME	DATE
1345	17 Aug 95

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

Location of Visit/Conference:

ROUTINE	
NAME/SYMBOL	INI

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO:
Mr. Bruce Thompson	Nat. Res. Cons. Serv.	(314) 876-0907

SUBJECT

Prime and Unique Farmland Conversion

Cottonwood Island EMP-HREP, Lewis Co, MO

SUMMARY

1. I described the project to Mr. Thompson which includes converting a 33 acre ag field to mast tree production.

2. The land is classified as Chequest silty clay loam which is on the Prime Farmland list for this county. It meets the prime farmland condition only when drained.

3. Since the project is not technically taking the land and converting it; i.e. it can revert back to ag land relatively easy, and the site is not drained, the site is probably not considered as prime farmland.

4. Mr. Thompson requests that I still send him the Farmland Conversion Impact Rating form (AD-1006), but he will state on it , there are no problems with the project.

ACTION REQUIRED

Send the AD-1006 to Mr. Thompson

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Joe Jordan	Joe Jordan	17 Aug 95

ACTION TAKEN

SIGNATURE	TITLE	DATE

United States
Department of
Agriculture

Soil
Conservation
Service

Parkade Center, Suite 250
601 Business Loop 70 West
Columbia, Missouri 65201

August 31, 1995

RE:
Lewis and Marion Counties, Missouri
Cottonwood Island EMP Habitat Restoration
Forest Management (tree planting)
Farmland Conversion Impact Rating

Dudley M. Hanson, P.E.
Chief, Planning Division
Department of the Army
Rock Island District Corps of Engineers
Clock Tower Building - P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Hanson:

The farmland conversion impact rating for the site referenced above is attached.

Sincerely,

Bruce W. Thompson

BRUCE W. THOMPSON
State Soil Scientist

Attachment

* U.S. GOVERNMENT PRINTING OFFICE: 1984 451-159/1324

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request: 18 August 1995
Name Of Project: Cottonwood Island EMP Habitat Restoration	Federal Agency Involved: Corps of Engineers
Proposed Land Use: Forest Management (tree planting)	County And State: Lewis and Marion Counties, Missouri
PART II *(To be completed by SCS)*	Date Request Received By SCS: 8-30-95
Does the site contain prime, unique, statewide or local important farmland? (If no, the FPPA does not apply – do not complete additional parts of this form.) Yes ☐ No ☒	Acres Irrigated / Average Farm Size
Major Crop(s)	Farmable Land In Govt. Jurisdiction: Acres: %
Name Of Land Evaluation System Used	Name Of Local Site Assessment System
	Amount Of Farmland As Defined in FPPA: Acres: %
	Date Land Evaluation Returned By SCS: 8-31-95

PART III *(To be completed by Federal Agency)*	Alternative Site Rating: Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	33			
B. Total Acres To Be Converted Indirectly	0			
C. Total Acres In Site	33			
PART IV *(To be completed by SCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland				
B. Total Acres Statewide And Local Important Farmland				
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted				
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value				
PART V *(To be completed by SCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*				

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use					
2. Perimeter In Nonurban Use					
3. Percent Of Site Being Farmed					
4. Protection Provided By State And Local Government					
5. Distance From Urban Builtup Area					
6. Distance To Urban Support Services					
7. Size Of Present Farm Unit Compared To Average					
8. Creation Of Nonfarmable Farmland					
9. Availability Of Farm Support Services					
10. On-Farm Investments					
11. Effects Of Conversion On Farm Support Services					
12. Compatibility With Existing Agricultural Use					
TOTAL SITE ASSESSMENT POINTS	160				
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100				
Total Site Assessment *(From Part VI above or a local site assessment)*	160				
TOTAL POINTS *(Total of above 2 lines)*	260				

Site Selected: | Date Of Selection | Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

Since the cropping is basicly the only change (crops to tree species), the land will not be permanently removed from an agriculture potential. Therfore, the rating form has been checked NO. We consider this site to be frequently flooded, which means there is no prime farmland soils on the Island.

(See Instructions on reverse side)

Form AD-1006 (10-83)

CENCR-ED-DN

28 November 1995
Ms. Kool/sf/5623

MEMORANDUM FOR RECORD

SUBJECT: Cottonwood Island, Missouri, Habitat Restoration and Enhancement Project, Telephone Conversation with Norm Stucky, Missouri Department of Conservation

1. On 13 November 1995, Mr. Norm Stucky returned a telephone call to Ms. Celia Kool regarding Cottonwood Island.

2. Ms. Kool discussed the location of the 4th deep hole proposed for inclusion in the side channel and deep hole dredging feature. The additional deep hole was to be located immediately upstream of the small island in Cottonwood Chute and would increase benefits to overwintering fish.

3. The presence of the small island would narrow the width of the dredge cut from 50 feet to 35 feet or less. If the contractor proposes a land-based dredging operation, he would have to dredge on the Cottonwood Island side of the small island. The existing channel on the Cottonwood Island side of the small island is not as wide as the land side channel, and dredging widths would have to be further decreased. The resulting dredging widths would be similar to an hour glass, with a narrow constriction as the dredge cut passes the small island.

4. Big Timber post-construction monitoring of a similar hour-glass shaped dredged channel indicates nearly 3' of sediment deposition in the narrow-width stretch of the channel, which is equivalent to 80 years of sediment deposition at the expected rate of 0.5 inch/year sediment accretion. The decreasing water depth will ultimately eliminate year-round habitat access to the interior portions of the Big Timber project during the winter months.

5. Cottonwood Island has a similar objective: to provide overwintering and flowing water habitat for fish. If a deep hole is excavated above the small island and the dredged channel adjacent to the small island experiences sediment deposition similar to the Big Timber project, winter egress from the upstream-most hole would be limited to periods of little to no ice cover.

6. Ms. Kool proposed relocating the fourth hole to just below the small island. Mr. Stucky agreed with the proposed relocation of the fourth hole. The revised cost estimate may be found at Enclosure 1. Comments concerning the relocation of the fourth deep hole to just below the small island are requested by 8 December 1995.

7. Any questions regarding this matter can be directed to Ms. Celia Kool, ED-DN, 309/794-5623.

Celia Kool

Encl

CELIA KOOL
Environmental Engineering Section

DISTRIBUTION LIST:

Mr. Joe Slater
U.S. Fish and Wildlife Service
4469 48th Avenue Court
Rock Island, IL 61201
(Telephone: 793-5800)

Messrs. Ross Adams/Dick Steinbach
U.S. Fish and Wildlife Service
1704 North 24th Street
Quincy, IL 62301-3304
(Telephone: 217/224-8580)

Mr. Jerry Olmstead
Mark Twain National Wildlife Refuge
U.S. Fish and Wildlife Service
HCR Box 107
Brussels, IL 62013
(Telephone: 618/883-2524)

Ms. Carol Ridder
U.S. Fish and Wildlife Service
1704 North 24th Street
Quincy, IL 62301-3304
(Telephone: 217/224-8580)

CENCR-ED-DN
SUBJECT: Cottonwood Island, Missouri, Habitat Restoration and Enhancement Project, Telephone Conversation with Norm Stucky, Missouri Department of Conservation

Mr. Gordon Farabee
Missouri Department of Conservation
Box 180
Jefferson City, MO 65102
(Telephone: 314/751-4115 x595)

Mr. Ken Brummett
Hannibal Service Center
Missouri Department of Conservation
Box 428, 653 Clinic Road
Hannibal, MO 63401-0428
(Telephone: 573/248-2530)

Mr. Ken Dalrymple
Missouri Department of Conservation
Box 201
Elsberry, MO 63343
(Telephone: 314/898-5905)

Mr. Norm Stucky
Missouri Department of Conservation
Box 180
Jefferson City, MO 65102
(Telephone: 314/751-4115 x358)

Mr. Dave Neuswanger
Missouri Department of Conservation
2500 South Haliburton
Kirksville, MO 63501
(Telephone: 816/785-2420)

CF:
PD (Dist File)
PD-W (Niles)
PD-E (Jordan)
ED-DN (Kool/51128CTN.DOC)
ED-G (Davila)
ED-H (Staley)
PP-M (Kowalczyk)
RE (Riddell)
OD-T (Porteck)
OD-MN (Swenson

COTTONWOOD ISLAND
REHABILITATION AND ENHANCEMENT EMP
PROJECT COST ESTIMATE
JUNE 1995

Acct Code	Item	Quantity	Unit	Unit Price	Amount	Contingency	Con %
01.	**LANDS AND DAMAGES**						
01.	Real Estate	1	LS	$5,000.00	$ 5,000.00	$ -	0%
06.	**FISH AND WILDLIFE FACILITIES**						
06.	**CHANNEL DREDGING**						
06.	GRADING & SHAPING	32,700	SY	$ 2.00	$ 65,400.00	$ 13,080.00	20.0%
06.	DREDGING	49,900	CY	$ 4.00	$ 199,600	$ 39,920	20.0%
06.	CLEARING (W=80')	9	ACRE	$2,000.00	$ 18,000	$ 3,600	20.0%
	TOTAL				$ 283,000	$ 56,600	
06.	**POTHOLES**						
06.	CLEARING	6	Acre	$2,000.00	$ 12,000	$ 2,400	20.0%
06.	EXCAVATION	28,000	CY	$ 2.00	$ 56,000	$ 11,200	20.0%
	TOTAL				$ 68,000	$ 13,600	
06.	**MAST TREE PLANTING**						
06.	FOREST MANAGEMENT AREAS	1,200	Trees	$ 128.00	$ 153,600	$ 30,720	20.0%
06.	AGRICULTURAL AREA	1,500	Trees	$ 114.00	$ 171,000	$ 34,200	20.0%
	TOTAL				$ 324,600	$ 64,920	
06.	**WING DAM NOTCHING**						
06.	NOTCH WING DAM	8,000	CY	$ 8.00	$ 64,000	$ 12,800	20.0%
	TOTAL				$ 64,000	$ 12,800	
					$ 739,600	$ 147,920	
06.	**FISH AND WILDLIFE FACILITIES TOTAL COST**				$ 887,520		
30.	**PLANNING, ENGINEERING, AND DESIGN**						
	DEFINITE PROJECT REPORT				$ 338,000	$ 67,600	20.0%
	PLANS AND SPECIFICATIONS				$ 95,000	$ 9,500	10.0%
	ENGINEERING DURING CONSTRUCTION				$ 24,000	$ 4,800	20.0%
	TOTAL				$ 457,000	$ 81,900	
30.	**PLANNING, ENGINEERING, AND DESIGN TOTAL COST**				$ 538,900		
31.	**CONSTRUCTION MANAGEMENT**						
	CONSTRUCTION ADMINISTRATION				$ 60,000	$ 12,000	20.0%
	REVIEW OF SHOP DRAWINGS				$ 10,000	$ 1,000	10.0%
	INSPECTION AND QUALITY ASSURANCE				$ 30,000	$ 6,000	20.0%
	TOTAL				$ 100,000	$ 19,000	
31.	**CONSTRUCTION MANAGEMENT TOTAL COST**				$ 119,000		

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:

December 8, 1995

Planning Division

Ms. Claire Blackwell
Historic Preservation Program
Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

Dear Ms. Blackwell:

The Rock Island District of the U.S. Army Corps of Engineers (Corps) previously furnished a final report by Bear Creek Archeology, Inc., entitled Geomorphological and Archeological Investigations for the Cottonwood Island Habitat Rehabilitation Project, Upper Mississippi River System, Environmental Management Program, Mississippi River Pool 21, Lewis and Marion Counties, Missouri, (BCA #292) dated August 1994.

The Corps is proposing to place 1-acre potholes for wildlife habitat (Enclosure 1) at two locations where pothole excavations will exceed the depths of soil disturbance recommended as allowable (Enclosure 2) in the above report.

Because any potential cultural resource sites are predicted to be small, short-term occupations from the late prehistoric and historic periods, we propose to have a qualified archaeologist monitor these excavations and conduct data recovery for any remains that may be encountered.

We request your comments on this matter within 30 days from the date of this letter. If we do not hear from you within this time, we will proceed with monitoring.

If you have questions regarding this project, please call Mr. Ron Pulcher of our Environmental Analysis Branch, telephone 309/794-5384, or write to our address above, ATTN: Planning Division.

Sincerely,

ORIGINAL SIGNED BY
P. BURKE

Dudley M. Hanson, P.E.
Chief, Planning Division

Enclosures

STATE OF MISSOURI Mel Carnahan, Governor • David A. Shorr, Director
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF STATE PARKS
P.O. Box 176 Jefferson City, MO 65102-0176 (314)751-2479
FAX (314)751-8656

29 December 1995

Dudley M. Hanson, P.E.
Chief, Planning Division
Rock Island District, Corps of Engineers
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 65102

Re: Wildlife Habitat Project (USCOE) Lewis and Marion Counties, Missouri

Dear Mr. Hanson:

Staff of the Historic Preservation Program, Missouri Department of Natural Resources have reviewed the information provided in your letter dated 8 December 1995. We have no objections to the placement of 1-acre potholes for wildlife habitat as long as a qualified archaeologist monitors the excavations and conducts data recovery for any cultural materials that may be encountered during project activities.

If you have any questions, please write or call Judith Deel at 314/751-7862.

Sincerely,

HISTORIC PRESERVATION PROGRAM

Mark A. Miles

for Claire F. Blackwell, Director and
State Historic Preservation Officer

c John Madras
Ron Pulcher

IN REPLY REFER TO:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Rock Island Field Office (ES)
4469 - 48th Avenue Court
Rock Island, Illinois 61201

COM: 309/793-5800
FAX: 309/793-5804

January 23, 1996

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

Dear Colonel Cox:

This letter constitutes our revised draft Fish and Wildlife Coordination Act (FWCA) report for the Cottonwood Island Habitat Rehabilitation and Enhancement Project (HREP) in Pool 21, Mississippi River, Lewis and Marion Counties, 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 Fish and Wildlife Service's Mitigation Policy. This draft incorporates the metric conversion of habitat values at the request of your planning staff.

The Cottonwood Island 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."

DESCRIPTION OF THE PROJECT AREA

The study area is a 192 hectare forested wetland and floodplain island complex located adjacent to the right descending bank of the Mississippi River between river miles 328.5 and 331 near the City of Quincy, Illinois.

The island remnant lies riverward of the Fabius Levee and Drainage District, separated from land by Cottonwood Chute. A typical silver maple/cottonwood forested wetland dominates the island. A logjam at the upper end of Cottonwood chute restricts

flow in the side channel to periods of high water on the river. At the upper reaches of the island, the original inlet to the side channel has silted in and is overgrown with willows and silver maples. Another portion of the island forest has been cleared and is farmed in years when flooding does not interfere with cropping practices. In addition, three forest clearcuts were conducted on the island, but have not revegetated to the satisfaction of the foresters and will be evaluated as part of the HREP. The remaining forest is comprised of an older, mature silver maple, green ash and cottonwood component and a younger secondary willow growth component with a high density of understory shrubs.

Situated between two drainage district's mainstem levees, Cottonwood Island is flooded regularly by the Mississippi River. Sediment laden floodwaters negatively affect the remaining side channel habitat by depositing layers of silt, filling in the channel and causing the water to become turbid. The shallow water and lack of current in the side channel results in lower dissolved oxygen levels and summer stagnation. As the shallows dry out, woody species dominated by willow, cottonwood, and silver maple encroach into the channel. During subsequent floods, the water in the side channels is slowed even more due to the woody encroachment and more sediment is dropped out - accelerating the conversion of habitats from aquatic to terrestrial.

PROJECT OBJECTIVES

The goals of the Cottonwood Island HREP are to rehabilitate, enhance, and protect aquatic, forested and nonforested wetlands habitats for fish, and both resident and migratory birds.

To evaluate the area for potential improvements, the project area was divided into an aquatic (fishery) component, a waterfowl (ducks and geese) component, and a nongame component (herons, songbirds, amphibians, etc.). Specific objectives for each of the above species components were developed according to the management plans and input of State and Federal biologists. Several alternatives were considered for each component to determine the best way to meet the project objectives.

The array of alternatives includes combinations of construction features and management practices that will (1) improve the local fishery by restoring side channel overwintering habitat for fish and (2) improve main channel border habitats for fish by notching a series of wingdam structures. Improvements to forested wetland habitats to increase nesting, brood, feeding, and loafing areas for waterfowl and nongame species will be accomplished by replanting the clear-cut areas and crop field to mast producing

trees and by creating shallow depressional areas for seasonal ponding of floodwaters. The overall terrestrial objective is to reduce the forest fragmentation of the island and increase the diversity with interspersed shallow wetland areas.

METHODOLOGY

Habitat analysis of existing study area conditions, future conditions without the project and impacts of the several proposed alternatives and increments was accomplished using the Aquatic Habitat Appraisal Guide (AHAG) procedures developed by the Corps of Engineers Waterways Experiment Station (WES) and Utah State University, and a community-based bottomland hardwood model recently developed by WES. The analysis employed a multi-agency team approach with representatives from the Corps of Engineers, the Missouri Department of Conservation, and the U. S. Fish and Wildlife Service. The team felt that the community-based approach would evaluate the project at an ecosystem level incorporating parameters for amphibians and small mammals in addition to game and waterfowl species like white-tailed deer and mallards.

The analysis involves a numerical system for evaluating the quality and quantity of particular habitats for species selected by the 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 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. The quantitative component of the analysis is the measure of hectares 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 Acreage = HU's).

Existing habitat conditions were evaluated on-site by the team, whereas future conditions with and without the project were estimated using the expertise of team members. The team considered wetland and aquatic habitats and both game and nongame species aspects 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. Habitat suitability indices (HSI) and average annual habitat

units (AAHU's) for each evaluation species were calculated to reflect expected habitat conditions over the life of the project.

Previous HREP projects have utilized the Wildlife Habitat Appraisal Guide (WHAG) analysis to quantify habitat values. While WHAG, and its aquatic counterpart, AHAG, work well with large acreage values that involve major changes in habitat types, they fall somewhat short in measuring subtle, yet very critical modifications to existing habitat types that result in benefits to a wide range of species (i.e. the forested wetland community). Past quantification attempts include calculating benefits for selected target species and then adding the values together prior to analyzing the number over the project life. Even though the target species represent a guild or group of species, many other species are left unaccounted for. Consequently, the study team decided to try a newly developed draft model that evaluates bottomland forests at the community level. This model is consistent with the U.S. Fish and Wildlife Service's ecosystem approach to management of our natural resources and wildlife.

Selected data will be presented in this report with reference to the habitat analysis but to avoid duplication of tables, we refer the reader to the Habitat Evaluation and Quantification Appendix in the main body of the Draft Definite Project Report for the complete tabular results of HSI and AAHU values for each of the project features.

THREATENED AND ENDANGERED SPECIES

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the Fish and Wildlife Service information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action.

Therefore, we are furnishing you the following list of species which may be present in the concerned area:

Classification	Common Name	Scientific Name	Habitat
Threatened	Bald eagle	Haliaeetus leucocephalus	Winters along major rivers and reservoirs
Threatened	Decurrent false aster	Boltonia decurrens	Disturbed alluvial soil

Classification	Common Name	Scientific Name	Habitat
Endangered	Indiana bat	Myotis sodalis	Caves and riparian corridors
Endangered	Fat pocketbook pearly mussel	Potamilus capax	Mississippi river
Endangered	Higgins' eye pearly mussel	Lampsilis higginsi	Mississippi river

Bald eagles winter along the Mississippi River, including Pool 21. Suitable perch trees where eagles can loaf and perch are numerous on Cottonwood Island. The scope of this project will not affect the larger trees used by the eagles. However, the larger, scaly bark of some mature silver maple trees may provide nursery habitat for female Indiana bats and their young. To avoid disturbing the bats, tree clearing should be restricted to the time period between September 1 and April 30. If this is not feasible with construction schedules, a mist net bat survey will be required to determine if Indiana bats are in the project area before clearing can begin.

The decurrent false aster is a floodplain plant that inhabits recently flooded and disturbed soils on the large river systems like the Mississippi. Monitoring of the construction site will be required to see if plants germinate in response to the earthmoving activities of dredging and excavation.

Suitable habitat to support a mussel bed containing fat pocketbook or Higgins' eye mussel species is not likely to exist in the dike field. However, if mussels are encountered during dredging operations the Service should be notified immediately.

With the inclusion of the 'No Cut' window/survey for Indiana bats, the proposed HREP project will not adversely affect endangered species or their habitats. This precludes the need for further action on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. Should this project be modified or new information indicate endangered species may be affected, consultation should be initiated.

EXISTING FISH AND WILDLIFE RESOURCES

Wildlife values on Cottonwood island are typical of those found in large river floodplain forested wetlands. Surrounded by intensive agriculture, the remaining marginal habitats are of significant value to resident wildlife populations.

The results of the AHAG analysis for existing conditions of the fishery resource in the Cottonwood side channel indicate a broad range of values for the evaluation species, reflective of the variety of habitat requirements for those species (Table 1).

Table 1. Cottonwood Island side channel existing habitat suitability and corresponding Habitat Unit values.

SPECIES	HSI	HU
White bass	0.46	46
Emerald shiner	0.50	50
River darter	0.50	50
Northern pike	0.50	50
Smallmouth buffalo	0.57	57
Walleye	0.61	61
Largemouth bass	0.43	43
Bluegill	0.50	50

Output generated by the AHAG model is consistent with the on-site visits and discussions with local field biologists who manage the area. The HSI values indicate that the side channel is of value to both game and nongame species at present. However, since these values fall in the middle of the range, by TY50 they will decline in value as more aquatic habitat is degraded by sedimentation. This will be discussed in the next section.

Existing habitat values for the fishery resource associated with the wingdam structures along the main channel border of Cottonwood Island are presented in Table 2.

Table 2. Cottonwood Island wingdam existing habitat suitability and corresponding Habitat Unit values.

SPECIES	HSI	HU
White bass	0.56	100
Emerald shiner	0.70	125
River darter	0.51	91
Northern pike	0.56	100
Smallmouth buffalo	0.54	96

SPECIES	HSI	HU
Walleye	0.53	95
Largemouth bass	0.40	71
Bluegill	0.49	21

The qualitative value (HSI) of the wingdam habitats are similar to what was found in the side channel. The higher habitat units are a result of the larger area available to those fish species (41 hectares of side channel vs. 178 hectares of channel border/wingdam habitat).

Habitat values for the forested wetland component of the HREP were computed using the community-based model mentioned above. An overall HSI value of 0.28 was generated for the approximately 200 hectares of timber between the levee and the river. Forest maturity, interspersion of water regimes, canopy cover, and tree species diversity were key parameters evaluated by the model. The lower HSI value is indicative of a forested wetland that is fragmented and has lost part of the natural hydrology due to sedimentation. Many of the older channel remnants are filled with sediments and have become colonized by willows, maples and cottonwood. Clearing of the trees for farming has opened the forest canopy and increased the percentage of forest edge considerably.

FUTURE WITHOUT PROJECT

The No Federal Action alternative is considered the future without the project condition allowing the area to continue to function as a floodplain wetland. Without active management, successional changes in habitat and further degradation by sedimentation will result in Cottonwood chute being filled with sediments. As trees encroach into the channel, the aquatic habitat will gradually be converted to terrestrial, and the fishery resource in the side channel will be lost.

Since availability of overwintering habitat has a pool-wide affect on the fishery resource, loss of this side channel habitat affects aquatic acreage on a scale much greater than the actual side channel dimensions. A conservative acreage value of 100 hectares (considering that largemouth bass will travel several miles to reach suitable overwintering sites within a pool) was used to calculate Average Annual Habitat Units. Over the 50-year life of the project, it was estimated that the 100 hectare figure would be reduced by an order of magnitude to only 10 usable hectares remaining by TY50. A greater number of snags in the

channel and a greater percentage of aquatic vegetation would boost the HSI slightly as the channel depth shallows even further and the riparian trees mature and fall into the channel. The corresponding 122 AAHU's includes this slight improvement in habitat quality at TY25, but an overall decrease in qualitative value by TY50.

The without project analysis for the wingdam habitats showed little change over time from the present values. This is due in part to the artificial stability of the main channel created by the rock wingdam structures. As a result, HSI values and acreage will be the same over time. Some accretion of sediments behind the wingdams will result in minor shifts of water depths but this will not affect the overall value of the area for fish.

Evaluation of the forested wetland component without project determined that with no local source of mast trees on the island, the silver maple-cottonwood complex will dominate the canopy. While not inherently negative, the increased diversity of mast tree plantings interspersed on the island would provide much better wildlife habitat. Forest diversity is especially critical since the surrounding landscape has been manipulated or is in agricultural production. Annual flood events will continue to fill the remnant channels as well as Cottonwood side channel. The seasonal oxbows and meander scars that temporarily hold water will be replaced by trees and understory growth. As a result, the existing HSI score of 0.23 will decrease to 0.14 by TY25 and to 0.04 by TY50, translating into a low Average Annual Habitat Unit value of 10 under the without project condition.

FUTURE WITH PROJECT

Enhancement options for the Cottonwood Island project included increasing the quality of existing habitat types, increasing the acreage of a particular habitat type(s), or a combination of both. Several increments of each alternative feature were evaluated to determine the best management of the habitat types at the most reasonable cost.

- Sediment deflection levee.

Construction of a sediment deflection levee would function to keep sediment laden floodwaters away from the island and Cottonwood chute by deflecting flows back towards the main river channel. Since the deflection levee would be constructed offshore as an emergent rock dike, secondary benefits would also be realized by creating a protected backwater area in the shadow of the levee. Benefits to fish and wildlife resources include spawning, nursery, feeding, and refuge areas for fish like largemouth bass and bluegill. Aquatic vegetation would become

established in the wind shadow providing food and refuge for resident and migrating waterfowl and nongame species like great blue herons and egrets. However, a cost-benefit analysis determined that the construction cost for that feature alone would be above the total budget for the project and consequently the feature was dropped from the project.

- Side channel dredging.

Dredging of the side channel would be the most beneficial aspect of the Cottonwood Island HREP. Overwintering habitat for fish within the river pool is very limited so removing sediments from all or a portion of the channel is an important component of restoring the area. Largemouth bass, for example will travel long distances (up to nine miles) to find the appropriate backwaters that have little or no flow, ample oxygen and do not freeze solid during the winter. Dredging of Cottonwood chute would restore just such habitat. In addition, the increased side channel water depths will improve the fishery resource year around by providing deeper, more oxygenated water during low flow periods as well. The team evaluated increments of dredging including: dredging the old pilot channel to reestablish open flow through the entire channel; dredging the entire length of Cottonwood chute to a predetermined depth; and only dredging selective deep holes in the lower reaches of the side channel. Habitat analysis for the above increments determined that a linear relationship of benefits for overwintering fish developed proportionate to the length of channel dredged. The more channel dredged, the greater the benefit for fish. Compared to the no action AAHU value of 150 for all species combined, a series of four, connected deep holes dredged in the lower reach of Cottonwood chute generates 679 AAHU's. Although higher AAHU values can be achieved by dredging more channel (926 and 990 for five deep holes and the entire length respectively) the incremental cost of dredging more than four holes outweighs the benefits gained. Therefore, the preferred alternative of four deep holes was selected.

The side channel dredging also results in secondary benefits for wildlife from the placement of dredged material along the banks. These spoil banks will be planted with selected mast trees that will not be subject to regular flooding. Additional mast tree plantings include reforestation of an agricultural field and three clearcut areas. These plantings will diversify the island forest and the mast will provide a reliable food resource for wildlife and waterfowl as well as a seed source to revegetate the island with mast trees. Tree planting options include planting balled and burlapped, and/or special container trees that are fast growing and yield mast in a fraction of the time it normally takes to produce acorns.

- Wingdam notching.

Notching of the wingdam structures along Cottonwood Island will create a secondary channel with year around flow and access to the main channel. Created by the scouring action of the notches in the wingdams, the new channel will extend from notched structure to notched structure. Bordered by the shallower waters caused by the wingdam accretions, the scoured channel will increase the diversity of the approximate 174 hectares of water encompassed by the wingdams. With flows year-round, the habitat can be utilized for spawning, nursery/rearing, and adult fish. Incremental analysis evaluated notching one through all seven of the wingdams to determine the additive AAHU values of notching each additional wingdam. It was calculated that notching all seven structures would achieve the most cumulative environmental benefit per increment of cost. The created channel will extend the entire length of the dike field.

Secondary benefits for waterfowl and wading birds will be realized with this feature. The shallow water areas adjacent to the new channel provide feeding sites for herons and egrets. Mussels could potentially inhabit the channel and its borders. However, these benefits depend on the amount of channel scouring that occurs between the wingdams. Ideally, a meandered channel with scour holes and varying contours would create the most diversity. Since this is an experimental feature, it is difficult to quantify potential benefits.

- Pothole/oxbow reconstruction.

Similar difficulties quantifying benefits were encountered with the forested wetland component of the project. The island topography is scarred with old meanders and cut off oxbows that are all but lost to sedimentation. Restoration of these areas would involve excavating the sediments along a lower contour elevation. The material would be placed adjacent to the excavation to create berms or stockpiles. Mast trees would be planted on these higher elevations where they will not be regularly flooded. The excavated areas, or potholes, will be deep enough to have permanent or semi-permanent water, allowing a plant community of aquatic and emergent vegetation to become established. The value to individual wildlife species is difficult to quantify numerically since the acreage is small, but the benefits accrued within the whole bottomland community are significant. Functioning as natural oxbows, the excavations create spawning grounds for amphibians as well as nesting/rearing areas for wood ducks. Herons and egrets benefit from trapped fish and abundant amphibian populations that would be produced seasonally. The community based model was found to be sensitive enough to measure the subtle incremental changes like pothole improvements and the proposed tree plantings discussed below.

- Reforestation of crop fields and clearcuts with mast trees.

The study team evaluated the existing crop field on the island for potential habitat improvements. With intensive agriculture practices bordering the project area there is sufficient cropfield habitat nearby for resident populations of wildlife. The team felt that reforestation of the cropfield and the clearcuts would greatly enhance the Cottonwood Island HREP. Two major benefits will be realized through reforestation. In addition to reducing fragmentation of the existing forested wetland, the replanting offers a large scale opportunity to reintroduce mast producing trees on the island.

The community model measured the qualitative improvements made by the addition of mast species in conjunction with the large acreage to be planted and the interspersion of potholes discussed above. The results more than a doubled the AAHU's for bottomland species from 10, without project, to a range of 17 to 76, depending on the total acreage and density of trees planted. Subsequent analysis resulted in selection of mast tree plantings and interspersion of 1.6 hectares of pothole excavations as the preferred feature.

DISCUSSION

The primary goal of the Cottonwood HREP is to increase overwintering habitat for fish. With the projected fishery value of Cottonwood Chute expected to decline over the next 25-50 years, the ideal solution would be to dredge the entire length of the channel and then protect it from sedimentation. The high costs of dredging prohibit restoring the entire channel, so the increment of four deep holes connected to the main channel becomes the most economical alternative. A sediment deflection levee was considered to divert sediment laden flows away from the channel, but this feature would require an emergent rock dike structure running the length of the island. Deemed infeasible due to the high cost of derrick stone it was dropped from the project. The selected alternative of dredging four deep holes not only meets the project objective of increasing overwintering habitat for fish, but the improved channel will provide year around benefits for spawning and rearing of fish species like bluegill and crappie. In addition, other wildlife species, including wood ducks and herons will benefit from the channel improvements and the tree plantings associated with post-dredging revegetation.

Wingdam structures have provided structure for fish for many years. The scouring action behind the ends of the dikes creates deep holes out of the main channel current. The rock surfaces and crevices of the dike shelter juvenile fish and promote

invertebrate production. The team decided that an opportunity existed at Cottonwood Island to diversify the wingdam habitats since the sediment accretions behind the dikes created shallow water of limited value to fish. By notching the dikes, the hydraulic force of the water would scour a secondary channel between each dike. A net increase in fishery benefits was realized for each dike notched (a total of 89 AAHU's for all 7 dikes). A potential exists for colonization of the channel by mussels, depending on the resultant current velocities after the channel stabilizes. The rubble from the dike will be left below the notch to provide bottom structure for fish like walleye and bass. Currents flowing around and over the rubble will scour and fill the bottom contours. The greater the hydraulic action, the more diverse the channel topography. Since the channel is adjacent to the main river channel, fish will be able to move easily between habitat types year-round.

Forest fragmentation negatively affects the bottomland forest dwelling community of neotropical birds by opening up the tree canopy and increasing the percentage of edge within a tract. Increased parasitism by cowbirds and displacement by edge-tolerant species are two primary adverse affects resulting from fragmentation. As an island remnant, the forested wetland is already bordered primarily by water, and a cropland field makes up the remaining border. Reforestation of the interior island crop field will restore the large block of forested wetland that was once on the island. By planting the faster growing container trees either exclusively or in combination with balled and burlapped trees, mast production would occur in 3-5 years. This is of great benefit for species of waterfowl and resident wildlife that use mast in their diet, and it also generates a seed source to further propagate mast trees in much less time than a normal growing oak tree, for example. Additional trees are to be planted on spoil banks where the risk of prolonged flooding will be much lower, and the chances of seedling survival are much greater on these higher sites.

Habitat values for the bottomland community are maximized by the interspersion of semipermanent water, like oxbows or meander scars. The highest HSI scores are attained when permanent or semipermanent water is within sixty to ninety meters at any point in the project. Strategic placement of the constructed potholes in conjunction with excavating sediments from existing depressional areas with lower elevations results in a low cost enhancement with maximum benefits. Mast tree plantings further diversify the site while the potential exists for emergent vegetation to become established if water can be ponded long enough in the potholes.

It was concluded that planting the clearcuts, agricultural fields, and dredged material placement sites with mast trees and

constructing 3 0.5-hectare, and 2 0.2-hectare potholes are the optimum ratios of hydrology and vegetation.

CONCLUSIONS AND RECOMMENDATIONS

The Cottonwood Island HREP offers a unique multi-faceted opportunity to restore and enhance a floodplain wetland community and a diverse fishery resource. In addition, the proposed HREP will 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:

1. The selective dredging at four sites in Cottonwood chute with placement of the material adjacent to the channel. The higher elevations should be planted with mast trees.

2. The notching of the wingdam structures to create a flowing side channel.

3. The agricultural field and clearcut areas should be reforested with a mixture of mast tree plantings.

4. The restoration of oxbow and meander habitats by selective excavation and placement of material. Mast trees should be planted on the higher contours.

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

Sincerely,

for Wayne A. Fischer

Richard C. Nelson
Supervisor

cc: USFWS (EMP Coordinator)

JS:sjg

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:

February 7, 1996

Engineering Division
Environmental Engineering Section

Ms. Terri Ely
Water Pollution Control Program
Missouri Department of Natural Resources
Post Office Box 176
Jefferson City, Missouri 65102

Dear Ms. Ely:

Enclosed is a completed application for a Department of the Army Permit and a copy of the draft Definite Project Report for the Cottonwood Island Habitat Rehabilitation and Enhancement project at Pool 21, Upper Mississippi River Miles 328.5 through 331.0 in Lewis and Marion Counties, Missouri. The report contains a 404(b)(1) evaluation of the proposed action of dredging a channel in Cottonwood Chute, tree planting and pothole creation on the island, and wing dam notching in the main channel border to restore aquatic overwintering and flowing water and wetland habitat.

Following your review of these documents, we request a water quality certification or waiver only pursuant to the provisions of Section 401 of the 1977 Clean Water Act. Issuance of the Section 404 public notice is scheduled for February, 1996. Timely consideration of this matter would be appreciated.

Thank you for your assistance in processing this application. If you have any questions, please contact Ms. Celia Kool at telephone (309) 794-5623.

Sincerely,

/s/

Robert W. Kelley, P.E.
Chief, Engineering Division

Enclosures

United States Department of the Interior

Fish and Wildlife Service
Mark Twain National Wildlife Refuge
1704 N. 24th Street
Quincy, Illinois 62301

February 29, 1996

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

Dear Mr. Niles:

Thanks for providing us the opportunity to comment on the draft Definite Project Report on the Cottonwood Island Habitat Restoration and Enhancement Project in Pool 21 near Quincy, Illinois. Overall, the project appears well planned and designed to accomplish the listed objectives. Once the project is completed, the enhanced flow through the notched wing dikes should maintain the improved fisheries habitat. Operations and maintenance costs for the remaining features of the project should be relatively low.

Reference to the agreement dates on page 9.b. may be confusing to the public. It appears that the Service signed an agreement with MDOC before the Corps transferred management responsibility to the Service. I suggest deleting one or both dates.

I am enclosing a copy of local press coverage of the project proposal and a citizen response. Hope all goes well on your meeting in Quincy on March 7. Dave Ellis, Project Leader of the Annada District of the Mark Twain Refuge may be able to attend the meeting to field any questions anyone may have on the Gardner Division.

Sincerely,

Ross Adams

Ross Adams
EMP Coordinator

Enclosure

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters
2901 West Truman Boulevard, P.O. Box 180, Jefferson City, Missouri 65102-0180
Telephone: 314/751-4115 ◆ Missouri Relay Center: 1-800-735-2966 (TDD)

JERRY J. PRESLEY, Director

March 5, 1996

Colonel Charles Cox
District Engineer
Rock Island District, Corps of Engineers
Clock Tower Building
PO Box 2004
Rock Island, IL 61201

Dear Colonel Cox:

Members of my staff have worked closely with the Rock Island District, Corps of Engineers in preparation of the Definite Project Report for the Upper Mississippi Environmental Program, Cottonwood Island Habitat Rehabilitation Project. We are confident that construction of this project will result in a significant increase in both the quantity and quality of wetland habitat in the Cottonwood Island area.

The Department is prepared to serve as the non-federal sponsor and will cooperate with the U.S. Fish and Wildlife Service to assure that operation and maintenance activities, as described in the final Definite Project Report and any mutually agreed upon rehabilitation, will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986.

We look forward to a construction start on this project at the earliest possible date. To that end, members of my staff are available to lend assistance. Please do not hesitate to contact Mr. Norman P. Stucky at the above address to further discuss this matter.

Sincerely,

Jerry J. Presley

JERRY J. PRESLEY
DIRECTOR

CULTURAL RESOURCE ASSESSMENT
Section 106 Review

ONTACT PERSON/ADDRESS:

Charles S. District Engineer
Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

C.

John Madras
Jody Staebell

PROJECT:

Cottonwood Island Habitat Rehabilitation & Enhancement Project, COE No. CENCR-OD-313570

FEDERAL AGENCY:

COE-404

County:

Lewis & Marion Counties

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

[X] The project area has been previously disturbed or has a low potential for the occurrence of cultural resources. A cultural resource survey, therefore, is not warranted.

[ ] None of the structures involved are eligible for inclusion in the National Register of Historic Places.

[ ] The proposed undertaking will have "no effect" on properties listed on or determined eligible for listing in the National Register of Historic Places.

[ ] An adequate cultural resource survey of the project area has been made. We agree that the proposed undertaking will have "no effect" on significant cultural resources.

[ ] An adequate cultural resource survey of the project area has been made. We agree with the report's recommendation that the following potentially eligible sites should be avoided. If these sites are avoided, the proposed undertaking will have "no effect" on significant cultural resources.

Sites:

For the above checked reason, the Historic Preservation Program 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: Claire F. Blackwell March 13, 1996

Claire F. Blackwell, Deputy State Historic Preservation Officer A-46 Date

MISSOURI DEPARTMENT OF NATURAL RESOURCES
HISTORIC PRESERVATION PROGRAM
P.O. Box 176, Jefferson City, Missouri 65102
For additional information, please contact Judith Deel, (573) 751-7862

STATE OF MISSOURI
Mel Carnahan, Governor • David A. Shorr, Director
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176 Jefferson City, MO 65102-0176

March 18, 1996

U.S. Army Corps of Engineers
Rock Island District
ATTN: CENCR-OD-S (313570)
Ms. Jody Staebell
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

RE: Cottonwood Island

Dear Ms. Staebell:

The Department of Natural Resources, Water Pollution Control Program, has reviewed Public Notice 313570. The Cottonwood Island Habitat Rehabilitation and Enhancement project includes dredging in the side channel, tree planting and pothole creation on the island, and wingdam notching in the main channel border. These improvements will benefit both game and nongame wildlife as well as enhance overall habitat diversity. The proposed action will require existing vegetation along the shoreline be cleared and material placed on the site on 9 acres of cleared land. Material will be placed at a depth of 6 feet. Please refer to the public notice dated February 29, 1996, for project details.

The project is located in Sections 28, 33 and 34, Township 60 north, Range 5 west, and Section 3, Township 59 north, Range 5 west; on the right descending bank of the Mississippi River (approximate miles 328.5-331.0) in Lewis and Marion Counties, Missouri. Cottonwood Island is just north of Quincy, Illinois.

We offer the following comments:

1. Wetlands were once a significant component of Missouri's natural heritage, accounting for almost 11 percent of its surface area. As of 1980, 87 percent of Missouri's original 4.8 million acres of wetlands have been eliminated by activities such as land clearing, draining and filling, channelization and damming. Missouri far exceeds the national rate of 53 percent wetland loss.

2. Any land disturbance activities may require a water pollution control permit. In this regard, please contact the Department of Natural Resources, Northeast Regional Office at (816) 385-2129.

3. Best management practices should be utilized in order to minimize sedimentation into the river.

4. This activity should be conducted during periods of low water and outside of the major spawning season for fish.

5. Channel modification or alteration should not result from completion of this project.

6. Care should be taken to keep machinery out of the waterway as much as possible. Excessive crossings will cause increased erosion and turbidity to the chute.

7. The quality of downstream water supplies should not be adversely affected by this project.

Thank you for the opportunity to comment on this project. If you have any questions, please call Terri Ely of the Planning Section or me at (573) 751-7428.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

John Madras

John Madras, Chief
Planning Section

JM:tep

FLENTJE FARM SERVICES
OUR SOIL ★ OUR STRENGTH
(217) 228-3276
Laurence F. Flentje AFM
529 Hampshire - Suite 311
Quincy, Illinois 62301

March 22, 1996

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

Dear Sir:

I'm writing about this "Cottonwood Island Habitat Rehabilitation and Enhancement Project".

My view is from three perspectives. First, I am a Professional Farm Manager and manage several acres of river bottom land. Secondly, I'm a commissioner on the Gregory Drainage District's board, and finally, I'm a taxpayer.

As a tax payer, there really isn't any way to politely say how dumb this project is! As a farm manager, I've worked hard at managing land to conserve soil and enhance wildlife. As a drainage board commissioner, it is really depressing to see funds wasted on this type of project when there are real needs in all districts that go unfunded because they fall through the cracks of bureaucracy!

Seems to me that the real threatened species is man and the only environment that is really being trashed is the one that feeds the world because all of the rules restrict common sense and all the money gets spent to satisfy the environmentalists extreme desires.

There are levees that need protection, not just to prevent farmland over flow but to make navigation possible, and there are stream bank erosions being ignored.

Just seems to me that cost benefit criteria should apply to this project too!

Sincerely,

Laurence F. Flentje, AFM

'FF:bas

AFM - Accredited Farm Manager of The American Society of Farm Managers & Rural Appraisers, Inc.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Denver Federal Center, Building 56, Room 1003
P.O. Box 25007 (D-108)
Denver, Colorado 80225-0007

March 29, 1996

ER 96/102

Colonel Charles S. Cox
Rock Island District Engineer
U.S. Army Corps of Engineers
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

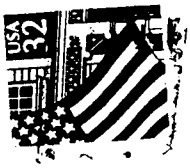
Dear Colonel Cox:

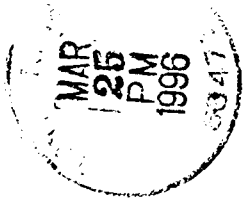
The Department of the Interior (Department) has reviewed the draft Definite Project Report with integrated Environmental Assessment for the Cottonwood Island Habitat Rehabilitation and Enhancement Project, Pool 21, Mississippi River Miles 328.5 - 331.0, Lewis and Marion Counties, Missouri. The U.S. Fish and Wildlife Service has been involved at all stages of planning for this proposed project, and provided a Draft Fish and Wildlife Coordination Act (FWCA) Report on August 28, 1995, and a revised Draft FWCA Report on January 23, 1996. The subject document for the proposed project adequately addresses the environmental concerns of the Department, and we have no other comments on the document.

We appreciate the opportunity to review the document and provide comments.

Sincerely,

Robert F. Stewart
Regional Environmental Officer





Taylor, Mo.
Mar. 25, 1996

Dear Colonel Charles Cox,

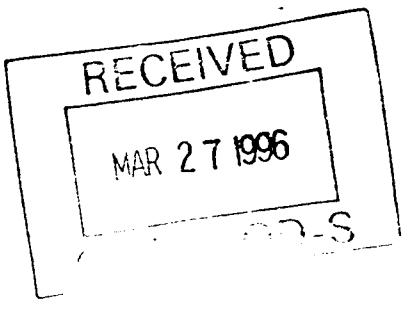
The farmers and land owners in the Fabius River Drainage Dist. feel this project is not necessary and a waste of the tax payers money.

Before the project is started I would hope a public hearing would be considered.

Sincerely,

Norman Haerr
Fabius River Drainage Dist.

Norm Haerr
Fabius River Drainage Dist.
201 C.R. 313
Taylor, Mo. 63471



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

April 1, 1996

Operations Division

SUBJECT: CENCR-OD-S-313570

Mr. Norman Haerr
Fabius River Drainage District
201 C. R. 313
Taylor, Missouri 63471

Dear Mr. Haerr:

We have received your letter dated March 25, 1996, concerning the Cottonwood Island Habitat Rehabilitation and Enhancement.

We have included your letter in our official file on the project. Your concerns will be considered in our decision making process. At this time we have made no decision on your public hearing request. Should the decision be made to hold a public hearing on the project, you will be notified of the time and place.

Should you have any questions, please contact me by letter, or telephone me at 309/794-5378.

Sincerely,

Wayne Hannel

Wayne Hannel
Project Manager
Regulatory Branch

STATE OF MISSOURI · Mel Carnahan, Governor • David A. Shorr, Director
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176 Jefferson City, MO 65102-0176

April 15, 1996

U.S. Army Corps of Engineers
Rock Island District
Colonel Albert Kraus
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Lewis and Marion Counties
313570

RE: Cottonwood Island

Dear Colonel Kraus:

The Department of Natural Resources, Water Pollution Control Program, has reviewed your request for Water Quality Certification. The Cottonwood Island Habitat Rehabilitation and Enhancement project includes deep hole dredging in the side channel, tree planting and pothole creation on the island, and wingdam notching in the main channel border. These improvements will benefit both game and nongame wildlife as well as enhance overall habitat diversity. The proposed action will require existing vegetation along the shoreline be cleared and material placed on the site on 9 acres of cleared land. Material will be placed to a depth of 6 feet. Please refer to the Public Notice dated February 29, 1996, for project details.

The project is located in Sections 28, 33 and 34, Township 60 north, Range 5 west, and Section 3, Township 59 north, Range 5 west; on the right descending bank of the Mississippi River (approximate miles 328.5-331.0) in Lewis and Marion Counties, Missouri. Cottonwood Island is just north of Quincy, Illinois.

This office certifies that the ongoing activity 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 following conditions are met:

1. Any land disturbance activities may require a water pollution control permit. In this regard, please contact the Department of Natural Resources, Water Pollution Control Program at (573) 526-2929.

2. Best management practices shall be utilized in order to minimize sedimentation into the river.

3. This activity shall be conducted during periods of low water and outside of the major spawning season for fish.

4. Care shall be taken to keep machinery out of the waterway as much as possible. Excessive crossings will cause increased erosion and turbidity to the chute.

5. The quality of downstream water supplies shall not be adversely affected by this project.

Water Quality Standards must be met during the operation. If compliance with Water Quality Standards is not maintained, the Corps of Engineers will be notified and the certification may be withdrawn.

This certification is being issued under Section 401 of Public Law 95-217, The Clean Water Act of 1977. If you have any questions, please contact Terri Ely of the Planning Section at (573) 751-7428.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

Edwin D. Knight
Director

EDK:tep

c: Jody Staebell, Rock Island District, Corps of Engineers
Celia Kool, Rock Island District, Corps of Engineers
Department of Natural Resources, Northeast Regional Office

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

April 17, 1996

Engineering Division
Environmental Engineering Section

Mr. Darryl McCullough
Missouri Department of Natural Resources
1709 Prospect Drive
Macon, Missouri 63552

Dear Mr. McCullough:

Our application for the Cottonwood Island Rehabilitation and Enhancement project Section 401 water quality certification was approved by the Missouri Department of Natural Resources (MDNR) Water Pollution Control Program on April 15, 1996 (copy of MDNR certification enclosed). The application included a copy of the draft Definite Project Report for the Cottonwood Island project, which included a 404(b)(1) evaluation of the proposed action. Because the project is regulated under Section 404 of the Clean Water Act and was evaluated under Section 404(b)(1) for all land disturbances associated with it, a NPDES or Section 402 permit for stormwater discharge is not required. We request your concurrence in this exemption.

The proposed Cottonwood Island Rehabilitation and Enhancement project is in Pool 21, Upper Mississippi River Miles 328.5 through 331.0 in Lewis and Marion Counties, Missouri. Project construction activities include dredging a channel in Cottonwood Chute, tree planting and pothole creation on the island, and wing dam notching in the main channel border to restore aquatic overwintering and flowing water and wetland habitat. The Section 404 public notice is also enclosed to provide a more detailed description of project features.

Thank you for your assistance. If you have any questions, please contact Ms. Celia Kool at telephone (309) 794-5623 or fax (309) 794-5404.

Sincerely,

Robert W. Kelley, P.E.
Chief, Engineering Division

Enclosures

STATE OF MISSOURI
Mel Carnahan, Governor • David A. Shorr, Director
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176 Jefferson City, MO 65102-0176

April 23, 1996

U.S. Army Corps of Engineers
Rock Island District
Colonel Charles Cox
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

Lewis County
Marion County
313570

RE: Cottonwood Island

Dear Colonel Cox:

The Department of Natural Resources, Water Pollution Control Program, has reviewed your request for a revision to the Water Quality Certification dated April 15, 1996. The Cottonwood Island Habitat Rehabilitation and Enhancement project includes deep hole dredging in the side channel, tree planting and pothole creation on the island, and wingdam notching in the main channel border. These improvements will benefit both game and nongame wildlife as well as enhance overall habitat diversity. The proposed action will require existing vegetation along the shoreline be cleared and material placed on the site on 9 acres of cleared land. Material will be placed to a depth of 6 feet. Please refer to the Public Notice dated February 29, 1996, for project details.

The project is located in Sections 28, 33 and 34, Township 60 north, Range 5 west, and Section 3, Township 59 north, Range 5 west; on the right descending bank of the Mississippi River (approximate miles 328.5-331.0) in Lewis and Marion Counties, Missouri. Cottonwood Island is just north of Quincy, Illinois.

This revision affects only condition number three which currently reads:

3. "This activity shall be conducted during periods of low water and outside of the major spawning season for fish".

It is revised as follows:

3. When possible, this activity shall be conducted during periods of low water and outside the major spawning season for fish.

This will allow for work during higher water when high water is necessary to move equipment.

Water Quality Standards must be met during the operation. If compliance with Water Quality Standards is not maintained, the Corps of Engineers will be notified and the certification may be withdrawn.

This certification is being issued under Section 401 of Public Law 95-217, The Clean Water Act of 1977. If you have any questions, please contact Terri Ely of the Planning Section at (573) 751-7428.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

Edwin D. Knight
Director

EDK:tep

c: Jody Staebell, Rock Island District, Corps of Engineers
Celia Kool, Rock Island District, Corps of Engineers
Department of Natural Resources, Northeast Regional Office

STATE OF MISSOURI Mel Carnahan, Governor • David A. Shorr, Director
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176 Jefferson City, MO 65102-0176

May 3, 1996

Robert Kelley
Chief Engineering Division
Department of the Army, Rock Island District, Corps of Engineers
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004

RE: Cottonwood Island Rehabilitation and Enhancement Project

Dear Mr. Kelly:

Darryl McCullough requested that I respond to your letter of April 17, 1996, in which you requested an exemption for the above-referenced project.

There is no exemption in the storm water regulations for projects permitted under Section 404 of the Clean Water Act, nor for projects that have received 401 Water Quality Certification. Because your project will disturb over five acres of land and it does not qualify under any of the exemptions listed under 10 CSR 20-6.200 (1)(B)8., you are required to apply for a storm water discharge permit for land disturbance activities.

I have enclosed Forms E and G, required for this permit. Please return them, along with the $150 permit fee and a map, to the attention of Richard Laux, Permits Unit Chief.

If you have any further questions, please contact Evangeline Bays of my staff at 573-526-2928.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

Linda S. Vogt

Linda S. Vogt
Storm Water Permits Coordinator

LSV:mn

Enclosure

c: Darryl McCullough, Northeast Regional Office
Diana Fawks, WPCP

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

May 16, 1996

Engineering Division
Environmental Engineering Section

Mr. Richard Luax
Chief of Permits Unit
Water Pollution Control Program
Department of Natural Resources
State of Missouri
P.O. Box 176
Jefferson City, Missouri 65102-0176

Dear Mr. Luax:

The MDNR letter, copy enclosed, responding to our letter of April 17, 1996, refers to the absence of any "exemptions" in your regulations for projects permitted under Section 404 of the Clean Water Act (CWA). Congress intentionally established two separate programs under the CWA regulating discharges. Section 404 discharges are not Section 402 discharges. The distinction is noted in Environmental Protection Agency's (EPA) 40 CFR 122.3(b). As stated there, discharges of dredged or fill material into waters of the United States which are regulated under Section 404 of the CWA do not require an NPDES storm water permit. Nevertheless, in order to proceed with this project on a timely basis, we are applying for the permit strictly on a voluntary basis as a matter of comity.

The proposed Cottonwood Island Rehabilitation and Enhancement project in Pool 21, Upper Mississippi River Miles 328.5 through 331.0 in Lewis and Marion Counties, Missouri, involves discharges associated with tree clearing, dredged material placement, pothole construction, and mast tree planting activities regulated under Section 404 of the Clean Water Act and evaluated under Section 404(b)(1) for all land disturbances associated with it. Project construction activities include dredging a channel in Cottonwood Chute, tree planting and pothole creation on the island, and wing dam notching in the main channel border to restore aquatic overwintering and flowing water and

wetland habitat. The dredged material will be placed adjacent to Cottonwood Chute. Prior to placement of the dredged material, standing timber will be cleared through a timber sale.

Enclosed are completed Forms E and G, the $150 permit fee, and maps of the project site. In order to meet the project schedule, expedient processing of this application would be greatly appreciated. Should you need further information, please contact Ms. Celia Kool at telephone (309) 794-5623 or fax (309) 794-5404.

Sincerely,

ORIGINAL SIGNED BY

Robert W. Kelley, P.E.
Chief, Engineering Division

Enclosures

Copy Furnished (w/o enclosures):

Ms. Linda S. Vogt
Storm Water Permits Coordinator
Water Pollution Control Program
Department of Natural Resources
State of Missouri
P.O. Box 176
Jefferson City, Missouri 65102-0176

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

May 23, 1996

Engineering Division
Environmental Engineering Section

Mr. Richard Luax
Chief of Permits Unit
Water Control Program
Department of Natural Resources
State of Missouri
P.O. Box 176
Jefferson City, Missouri 65102

Dear Mr. Luax:

Pursuant to your telephone conversation of May 21, 1996, with Ms. Celia Kool of our office, the following is provided in further clarification of our permit request:

The proposed Cottonwood Island Rehabilitation and Enhancement project in Pool 21, Upper Mississippi River Miles 328.5 through 331.0 in Lewis and Marion Counties, Missouri, includes dredging a channel in Cottonwood Chute, tree planting and pothole creation on the island, and wing dam notching in the main channel border to restore aquatic overwintering and flowing water and wetland habitat. The wing dam notching and dredging activities are regulated under Section 404 of the Clean Water Act and have been evaluated under Section 404(b)(1). Land disturbance activities include storm water discharges associated with tree and vegetation clearing, pothole construction and mast tree planting. Prior to placement of the dredged material, standing timber will be cleared through a timber sale.

Completed Forms E and G, the $150 permit fee, and maps of the project site have been previously provided. In order to meet the project schedule, expedient processing of this application

would be greatly appreciated. Should you need further information, please contact Ms. Kool at telephone (309) 794-5623 or fax (309) 794-5404.

Sincerely,

ORIGINAL SIGNED BY

Robert W. Kelley, P.E.
Chief, Engineering Division

Enclosures

Copy Furnished (w/o enclosures):

Ms. Linda S. Vogt
Storm Water Permits Coordinator
Water Pollution Control Program
Department of Natural Resources
State of Missouri
P.O. Box 176
Jefferson City, Missouri 65102-0176

Cottonwood Island Habitat Project
Lewis County
MO-R109172

STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL QUALITY
P.O. Box 176 Jefferson City, MO 65102-0176

June 7, 1996

Dept. of the Army, Corps of Engineers
Clock Tower Building
Rock Island, IL 61204

Dear Permittee:

Pursuant to the Federal Water Pollution Control Act, under the authority granted to the State of Missouri and in compliance with the Missouri Clean Water Law, we have issued and are enclosing a General State Operating Permit to Discharge from Cottonwood Island Habitat Project.

Please read your permit and attached Standard Conditions. They contain important information on monitoring requirements, effluent limitations, sampling frequencies and reporting requirements.

Monitoring reports that may be required by the special conditions must be submitted on a periodic basis. Copies of the necessary report forms, if required, are enclosed and should be mailed to the regional office listed below. Please contact this office for additional forms.

This General Permit is both your Federal discharge permit and your new state operating permit. In all future correspondence regarding this facility, please refer to your General Permit number and facility name as shown on page one of the permit.

If you have questions concerning this permit, please do not hesitate to call this office or our Northeast Regional Office,1409 Prospect Drive, Macon, MO 63552, telephone (816) 385-2129.

Sincerely,

WATER POLLUTION CONTROL PROGRAM

Daniel R. Schuette
Chief of Permit Section

DRS:mn

Enclosure

c: Northeast Regional Office
Cottonwood Island Habitat Project

STATE OF MISSOURI

DEPARTMENT OF NATURAL RESOURCES

MISSOURI CLEAN WATER COMMISSION

MISSOURI STATE OPERATING PERMIT
WATER POLLUTION CONTROL PROGRAM

In compliance with the Missouri Clean Water Law, (Chapter 644 R.S. Mo. as amended, hereinafter, the Law) and the Federal Water Pollution Control Act (Public Law 92-500, 92nd Congress) as amended.

Permit No. MO-R109172

Owner: Dept. of the Army, Corps of Engineers

Owner's Address: Clock Tower Building
Rock Island, IL 61204

Operating Authority: Same

Operating Authority Address: Same

Facility Name: Cottonwood Island Habitat Project

Facility Address: Lewis County
Montecello, MO 63448

Legal Description: Sec. 33/34, T60N, R5W, Lewis County

Receiving Stream & Basin: Mississippi River,
(Mississippi R. & N. Tributaries Basin), (07110001-04-00)

is authorized to discharge from the facility described herein, in accordance with the effluent limitations and monitoring requirements as set forth herein:

SIC #1629

FACILITY DESCRIPTION

Land Disturbance Activities which impact over five acres.

This permit authorizes discharge of storm water within 1,000 feet of waters classified as L1, Outstanding National or State Resource Waters, streams designated for cold-water sport fishery (see 10 CSR 20-7 Water Quality Standards, Table C), and any lake for which the community or management association is participating in the Environmental Protection Agency's 'Clean Lakes Program.'

(continued)

This permit authorizes only wastewater, including storm waters, discharges under the Missouri Clean Water Law and the National Pollutant Discharge Elimination System; it does not apply to other regulated areas. This permit may be appealed in accordance with Section 644.051.6 of the Law.

June 12, 1992 June 7, 1996
Effective Date Issue Date

John A. Young
John A. Young
Director, Division of Environmental Quality

June 11, 1997
Expiration Date

Director of Staff, Clean Water Commission

MO 780-1481 (7-94)

ACILITY DESCRIPTION (continued)

This permit also authorizes the discharge of storm water within 100 feet of waters classified as L_2 or P (except the Missouri and Mississippi Rivers).

This permit also authorizes the discharge to sinkholes, losing streams or any other topographical feature which would constitute a direct conduit to ground water.

Applicability

This permit authorizes the discharge of storm water runoff from construction sites to waters of the state of Missouri.

Holders of current individual NPDES permits who desire to apply for inclusion under this general permit should contact the department for application requirements.

If more than one (1) acre of the land disturbed is defined as a wetland by either the Missouri Department of Natural Resources, Department Of Conservation, Soil Conservation Service, Environmental Protection Agency, Fish & Wildlife Service or Corps of Engineers, this permit will not apply until approval has been granted by the Corps of Engineers. Proof of such approval shall be submitted with the application for this permit, in the form of either a 404 permit or a letter stating wetland determination has been made.

Exemptions

1. If at any time the Missouri Department of Natural Resources determines that the quality of waters of the state may be better protected by requiring the owner of a construction site to apply for an individual NPDES permit, the department may do so.

2. If at any time the owner of a construction site should desire to apply for an individual NPDES permit, the owner may do so.

3. This permit does not authorize the discharge of waters other than storm waters.

4. This permit does not apply to sites where activities other than construction take place.

5. This permit is not transferable to other owners or operators.

Requirements

Note: These requirements do not supersede nor remove liability for compliance with county and other local ordinances.

1. Discharges shall not cause violations of the general criteria in the Water Quality Standards 10 CSR 20-7.031(3).

2. All involved personnel shall be trained by the owner in material handling and storage, and housekeeping of maintenance areas.

3. Site preparation such as grading, surface roughening, top soiling, tree preservation and protection, and temporary construction entrances are required where appropriate.

Requirements (continued)

4. Surface stabilization such as temporary seeding, permanent seeding, mulching, sodding, ground cover including vines and shrubs, riprap, and geotextile fabric is required if necessary to ensure that Requirement 1 is achieved and effluent limitations contained herein are met. Mulches may be hay, straw, fibermats, netting, wood cellulose, corn or tobacco stalks, bark, ground or shredded corn cobs, wood chips, or other suitable material which is reasonably clean and free of noxious weeds and deleterious materials. Grasses used for temporary seeding shall be a quick growing species (such as rye grass, Italian rye grass, or cereal grasses) suitable to the area and which will not compete with the grasses sown later for permanent cover.

5. Runoff control measures such as temporary diversion dikes or berms, permanent diversion dikes or berms, right-of-way or perimeter diversion devices, retention and detention basins, sediment traps and barrriers are required if necessary to ensure that Requirement 1 is achieved and effluent limitations contained herein are met.

6. Runoff conveyance measures such as grass-lined channels, riprap and paved channels, temporary slope drains, paved flumes or chutes are required if necessary to ensure that Requirement 1 is achieved and effluent limitations contained herein are met. Slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, bituminous concrete, plastic sheets, or other materials that will adequately control erosion.

7. Inlet and outlet protection is required if necessary to ensure that Requirement 1 is achieved and effluent limitations contained herein are met.

8. Where the area to be disturbed is larger than ten acres, a written erosion control plan must be prepared.

Effluent Limitations

The runoff from land disturbance areas under this permit shall not exceed 0.5 ml/l/hr of settleable solids.

Sampling Requirements

The permittee shall collect and analyze one sample per calendar quarter, during which the land disturbance activity occurs. The sample shall be analyzed for settleable solids and the results shall be maintained by the permittee for five years, and shall be supplied to the Department of Natural Resources upon request. If the results show a violation of the effluent limitations, the permittee shall notify the Department of Natural Resources within five days of notification of analytical results. The notification shall indicate the date(s) samples were collected, the analytical results, permit number and shall indicate what steps have been taken to eliminate the violation in the future. A repeat sample shall be collected of discharge resulting from the next rainfall greater than 0.3 inches occuring after a violation has been reported. This data shall also be submitted to the Department of Natural Resources.

Termination of Permit

When all areas covered by this permit have been stabilized (by seeding and mulching, paving, landscaping, sodding, etc.) this permit shall be terminated. The permittee shall submit Form H, Termination of a General Permit.

APPENDIX B

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 328.5 THROUGH 331.0
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SECTION 1 - PROJECT DESCRIPTION

LOCATION

The proposed project is located on the right descending bank of the Mississippi River (River Miles 328.5-331.0) in Lewis and Marion Counties, Missouri. Cottonwood Island is just north of Quincy, Illinois.

Cottonwood Island is owned by the U.S. Army Corps of Engineers (Corps) but is managed by the U.S. Fish and Wildlife Service and the Missouri Department of Conservation for the propagation of both game and nongame wildlife species. The study area comprises approximately 463 acres of bottomland hardwood wetlands, agricultural lands, and aquatic habitat. See plates 1 and 2 of the Definite Project Report (DPR).

GENERAL DESCRIPTION

By definition and Federal regulatory jurisdiction, much of the site is classified as wetland or as "waters of the United States" and is therefore subject to evaluation and regulation under Section 404 of the Clean Water Act. Physical parameters have been monitored and some of the information is stated in this evaluation. More detailed descriptions of the monitoring efforts are located in Appendix F - Water Quality.

The Cottonwood Island Habitat Rehabilitation and Enhancement project includes deep hole dredging in the side channel, tree planting and pothole creation on the island, and wing dam notching in the main channel border. These improvements

would benefit both game and nongame wildlife as well as enhance overall habitat diversity.

Four deep holes would be dredged at the lower end of Cottonwood Chute. These features would be 15.24 meters by 91.44 meters by 4.572 meters (50 feet x 300 feet x 15 feet) and provide overwintering habitat for fish. Deepening the channel would prevent total ice coverage and provide a slack water area capable of sustaining suitable dissolved oxygen levels over the 50-year life of the project. Material removed would be placed on a cleared area on Cottonwood Island adjacent to the dredging. Mast (oak, pecan) trees would be planted on the placement sites.

On the island, additional mast trees would be planted on the existing agricultural field and on three forest management sites failing to respond to natural regeneration measures by the Corps. Five potholes would be excavated at various locations on the island (DPR plate 3). Three of the five potholes would be .40 hectares (1 acre), and the remaining two potholes would be .20 hectares (1/2 acre) in size. Removed material from the potholes would be placed on adjacent land and planted to mast trees.

Notching six wing dams on the Mississippi River side of the island would involve removing a section of the wing dam and placing the material immediately downstream of each structure. Flows through the notches should diversify flows, thereby increasing habitat diversity in this area of the river.

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). Section 1103 is summarized in 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 U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

GENERAL DESCRIPTION OF DREDGED AND FILL MATERIAL

Sediment surveys and boring results indicate the material removed from the side channel would be clay to sand (DPR plates 6 and 7). DPR plate 3 identifies the placement site for the dredged material. It is anticipated that approximately 65,000 cubic meters (m^3) [85,000 cubic yards (yd^3)] of material would be removed and placed on the adjacent island shoreline.

For pothole construction, material would be mechanically placed adjacent to the pothole. This material is alluvial sediment typically found on river islands. Boring logs indicate this material is clayey to sand (DPR plates 6 and 7). The estimated quantity of removed material is 21,400 m^3 (28,000 yd^3).

Other materials being placed in this bottomland hardwood wetland include approximately 2,600 mast-producing trees. This vegetative material can be considered exempt from this evaluation.

Material removed from each wing dam for the construction of each notch is primarily clean quarried limestone. Some plant material (willow) that was used as a base may be removed as well. A total of 6,116 m^3 (8,000 yd^3) will be displaced. Removed material would be placed immediately downstream of each structure.

DESCRIPTION OF PROPOSED DISCHARGE SITES

DPR plate 3 shows the discharge sites for the three elements of this project.

The discharge site for the side channel excavation is the adjacent unconfined shoreline on the island. This area is typical bottomland habitat with tree species dominating the site. Silver maple and cottonwood are the most common. Other tree species include elm, mulberry, and green ash. Other features of this site include fallen trees and standing dead trees.

The proposed action would require that existing vegetation along the shoreline be cleared and material be placed on the site on 3.6 hectares (9 acres) of cleared land. Material would be placed to a depth of 1.8 meters (6 feet).

Placement of dredged material from pothole excavation would be on land adjacent to each pothole. These placement sites are either currently in agriculture, cleared forest management areas, or typical bottomland forest habitat. For those sites in bottomland forests, clearing of vegetation would be required at the placement sites. Removed material would be placed to a depth of approximately 0.61 meters (2 feet) (DPR plate 10). Material is composed primarily of alluvial sediment consisting of clayey sand/silt. Approximately .40 hectares (1 acre) of adjacent land would be impacted by the placement of removed pothole material at each site.

By notching each of the six wing dams proposed, existing material would be removed and placed just downstream of each structure. These areas are characterized by shallow, uniform, open water habitat. Substrate is primarily sand with clay (DPR plates 6 and 7).

DESCRIPTION OF PLACEMENT METHOD

Construction activities are anticipated to last at least one construction season (May through October). If bad weather or other circumstances arise, construction would carry on to the next season.

Material would be excavated by mechanical means, using backhoe and clamshell bucket, and then placed on the adjacent placement sites.

SECTION 2 - FACTUAL DETERMINATIONS

PHYSICAL SUBSTRATE DETERMINATIONS

Dredged material from the side channel is similar in character (type, grain size, and compaction properties) to the alluvial deposited soils on the island. An elevational change would occur at the placement site (DPR plate 8). Approximately 65,000 m^3 (85,000 yd^3) of material would be placed uncompacted to a height of 1.8 meters (6 feet) and rough-graded to produce a 18.3 meter (60 foot) wide crown. Mast-bearing trees would be planted on the berm upon completion. It is anticipated that natural ground vegetation will germinate on the site after construction.

Removing the side channel material would result in four holes with the dimensions 15.24 meters by 91.44 meters by 4.572 meters (50 feet x 300 feet x 15 feet). Associated side channel dredging would be to a depth of 2.1 meters (7 feet) below flat pool (elevation 463 MSL). Over the life of the project, slumping of the sides would occur to some degree, and normal flood flows would reintroduce sediment to the dredged areas.

Pothole construction impacts would be very similar to the side channel excavation. Removed material would be placed on adjacent lands, thus impacting about 2.8 hectares (7 acres) of agriculture and 2.4 hectares (6 acres) of bottomland hardwood habitat. Material removed would be bermed as shown on DPR plate 8. Again, the berms would be revegetated with trees. Newly constructed contours in the potholes would be tiered, but may eventually slump to an even grade.

Although the proposed project would affect wetland habitat, it is anticipated that these changes would promote wildlife benefits beyond what currently exists in the project area and what would be lost due to short-term construction impacts.

Removed wing dam material would be placed on dissimilar substrate just downstream of each structure. Physical dynamics of the notch would change the aquatic substrate between wing dams by scouring a small channel through fairly uniform, flat substrate. Although material and benthic organisms may be lost, recolonization of benthic biomass should occur quickly.

WATER CIRCULATION, FLUCTUATION, AND SALINITY DETERMINATIONS

WATER

Construction activities would increase turbidity in existing water bodies in the short term. By planting the discharge sites, erosion should be minimized. Wing dam alterations involve placing clean material in the water column. With the introduction of increased flows in this area, the site may be disrupted until it reaches equilibrium. It is anticipated that impacts would be short-term and minor in nature. Short-term rises in turbidity may occur, but should not have a detrimental effect on water quality or plant and animal life.

Water clarity, color, odor, taste, and dissolved gas levels should not be permanently impacted by this project. Other water quality parameters may be altered by the project. Nutrient and eutrophication levels may increase with the construction of four potholes.

CURRENT PATTERNS AND CIRCULATION

Proposed side channel and bottomland hardwood manipulations should not significantly alter current patterns and water circulation either on site or cumulatively. By notching six wing dams, it is hoped the existing current patterns will change so that increased flows are directed into this area. By increasing flows, better habitat diversity would be promoted for the subsequent benefit of riverine organisms.

NORMAL WATER LEVEL FLUCTUATIONS

Normal fluctuations occur as a result of discharge changes and the response rate of the lock and dam system. Ordinarily, daily fluctuations are limited to 0.15 meter (.5 foot) over or under an established pool elevation at each dam. Seasonal fluctuations vary widely with weather conditions in the Upper Mississippi River watershed. Based on cross-sectional hydraulic analysis, the proposed project would have no effect on normal Mississippi River stages or flood heights.

SALINITY GRADIENTS

This consideration is not applicable.

ACTIONS TAKEN TO MINIMIZE IMPACTS

Dredged material would be placed to remove as little vegetation as possible. The final grade of the placement sites would naturally revegetate and would be planted with mast-bearing trees.

Construction would take place outside the typical spring high-water period. This would avoid higher levels of turbidity.

SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

Suspended particulates and elevated turbidity would likely be limited to the vicinity of construction activities, but in the case of wing dam notching, downstream impacts may arise as increased velocity may carry material from this area into the downstream water column. Because of the size of the river system and anticipated effects, impacts should be very minimal.

Light penetration, dissolved oxygen, toxic metals and organics, pathogens, and aesthetics would not be permanently changed as a result of this project. Effects on biota, such as photosynthesis and sight and filter feeders would be short term due to construction activities and should not be negatively impacted. In fact, this project should become a benefit to the site and regional ecosystem, creating deep water habitat, isolated wetlands, and a diversity of flow in the main channel border.

CONTAMINANT DETERMINATIONS

Appendix F, Table F-2, contains the results from the bulk sediment analyses. Concentrations of cadmium, chromium, copper, lead, mercury, and zinc were all below the elevated concentration. All PCB aroclors and insecticide concentrations were less than their respective detection limits. Ammonia nitrogen, COD, and manganese were determined to be acceptable by the Missouri Department of Conservation (Appendix F).

Possible introduction of equipment or construction-related contaminants would be controlled by adherence to runoff monitoring plans during construction activity. No toxic materials would be introduced to the area as a result of construction activities. Appropriate measures, such as hay bales or silt fences, would be implemented to control stormwater discharge. Should any such discharges occur, they would be contained on site.

These measures are designed to constitute compliance with point source discharge (S. 402) requirements of the Clean Water Act. Stormwater pollution prevention measures are discussed in Section 9 of the main report.

AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

Review and consideration of 40 CFR, Section 230, Subparts D, E, F, and G involved analysis of the following effects:

A. Effects on Plankton.
B. Effects on Benthos.
C. Effects on Nekton.
D. Effects on Aquatic Food Web.
E. Effects on Special Aquatic Sites Found in the Project Area or Placement Sites.
   (1) Sanctuaries and Refuges
   (2) Wetlands
   (3) Mud Flats
   (4) Vegetated Shallows
   (5) Coral Reefs (not found in project area)
   (6) Riffle and Pool Complexes (were not considered in this project)
F. Threatened and Endangered Species
G. Other Wildlife

Based on the nature and location of the project, no effects are anticipated on A through E above, as enhancement of wetland habitat values is to be emphasized.

Elements E(1) through (4) are found in the project area. Projects goals and features have been coordinated to match the management objectives of the U.S. Fish and Wildlife Service and the Missouri Department of Conservation, and these elements are expected to be enhanced by implementation of the project.

Project planning considered to the full extent the minimization of wetland loss, and it is intended that wetland values and extent would be improved as a result of project implementation.

Correspondence from the U.S. Fish and Wildlife Service and the Missouri Department of Conservation (see Appendix A) indicates that no impacts are envisioned to threatened or endangered species. Other wildlife is generally expected to benefit from this project due to increased overall habitat diversity.

PROPOSED PLACEMENT SITE DETERMINATIONS

While this project would involve dredging, every attempt would be made to reduce any negative impacts to the placement site, adjoining wetlands, mixing zone, and the aquatic habitats in the vicinity of the project. DPR plates 3, 8, 9, and 10 show the discharge sites for each project feature.

Prior to any construction activities, compliance with Missouri water quality standards would be met. It is not anticipated that any municipal or private water supply would be impacted by this project. Although fishing (commercial and recreational) opportunities may increase as a result of the project, consumptive use is not a primary purpose of this project. Other water-based recreation should not be impacted by the project.

Aesthetics of the site and region should not be impacted. Short-term construction activities would be offset by long-term maturity of the potholes and mast tree habitat. Dredged material placement sites would be planted with trees and should quickly become overgrown with natural ground vegetation. This would reduce any construction impacts to the aesthetics of the area.

No parks, national and historic monuments, national seashores, wilderness areas, research sites, or other preserves exist in the project area.

DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

The project would have positive benefits to aquatic resources found on the site. Temporary turbidity impacts may occur on and off site but would be short-term in duration. No cumulative negative impacts are anticipated to occur. Beneficial impacts are anticipated to occur on site for wetlands, wetland animals, and fish. Long-term productivity would be ensured with the habitat improvements that are proposed.

DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

Any negative impacts are expected to remain localized and short-term in nature. Minor downstream impacts may occur if the wing dams are notched and flows in this area increase as desired. Scoured material from this area may be resuspended into the water column and carried off site. However, because of the expanse of the river system, the additional material resuspended by the project would not contribute to any significant impacts. In addition, bulk sediment testing indicates acceptable levels of all parameters measured (Appendix F).

SECTION 3 - FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

1. No significant adaptations of the guidelines were made relating to this evaluation.

2. Alternatives which were considered for the proposed action were as follows:

Alternative A - No Federal action beyond current management practices.

Alternative B - Preferred Alternative. Dredge four deep holes and associated side channel for overwintering fish; plant mast-bearing trees and construct 1.6 hectares (4 acres) of potholes on Cottonwood Island; notch 6 wing dams that are adjacent to the island in the main channel border of the Mississippi River.

Alternative C - Management features considered but not selected. Several management features were considered for construction but not selected based on engineering feasibility, environmental impacts, and/or cost. These features did not meet the goals and objectives of the Corps, the U.S. Fish and Wildlife Service, and the State of Missouri for Cottonwood Island. These features include dredging Cottonwood Chute in its entirety, planting mast trees and constructing potholes in different ratios from the preferred alternative, and notching up to seven wing dams.

3. Certification under Sections 401 and 402 of the Clean Water Act has been obtained from the Missouri Department of Natural Resources and is included in Appendix A. The project is thus in compliance with the water quality requirements of the State of Missouri.

4. The project would not introduce toxic substances into nearby waters or result in appreciable increases in existing levels of toxic materials.

5. No significant impact to federally listed endangered species would result from this project. This determination is supported by the U.S. Fish and Wildlife Service, Ecological Services Office, Rock Island, Illinois.

6. The project is located along a freshwater inland river system. No marine sanctuaries are involved or would be affected.

7. No municipal or private water supplies would be affected. There would be no adverse impact to recreational fishing. While Cottonwood Island can be classified as a special aquatic site, environmental improvements would outweigh the ongoing habitat degradation caused by siltation and short-term construction impacts. No long-term adverse changes to the ecology of the river system would result from this action.

8. Project construction materials would be chemically and physically stable. No contamination of the river is anticipated.

9. No other practical alternatives have been identified. The proposed project is in compliance with the guidelines for Section 404(b)(1) of the Clean Water Act, as amended. The proposed project would not significantly impact water quality or the integrity of the aquatic ecosystem.

10. On the basis of the guidelines, the proposed placement site for the discharge of dredged material is specified as complying with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystem.

13 June 1996
Date

Charles S. Cox
Colonel, U.S. Army
District Engineer

APPENDIX C

DRAFT MEMORANDUM OF AGREEMENT

DRAFT

MEMORANDUM OF AGREEMENT
BETWEEN
THE UNITED STATES FISH AND WILDLIFE SERVICE
AND
THE DEPARTMENT OF THE ARMY
FOR
ENHANCING FISH AND WILDLIFE RESOURCES
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AT
COTTONWOOD ISLAND WILDLIFE MANAGEMENT AREA, MISSOURI

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 Cottonwood Island Wildlife Management Area (CIWMA), Missouri, separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

a. The project lands of the Cottonwood Island Wildlife Management Area are managed under a cooperative agreement between the Department of the Interior, USFWS, and the U.S. Army Corps of Engineers, dated 14 February 1963. Management of these project lands has been assumed by the Missouri Department of Conservation under a cooperative agreement between the USFWS and the Missouri Department of Conservation dated 5 May 1954.

b. 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. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662,

all construction costs of those fish and wildlife features for the Cottonwood Island Wildlife Management Area, Missouri are 100 percent Federal and pursuant to Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580, all costs of operation and maintenance for the Cottonwood Island Wildlife Management Area, Missouri are 100 percent non-Federal.

III. GENERAL SCOPE

The project to be accomplished pursuant to this MOA shall consist of, dredging the lower 4,800 feet of Cottonwood Chute staggered notching of existing wing dams, excavating potholes, and the planting of mast-producing hardwood trees on dredge disposal material and in existing open areas on the island.

IV. RESPONSIBILITIES

a. DOA is responsible for:

1. Construction. Dredging Cottonwood Chute, notching of existing wing dams, excavating potholes, and planting of mast producing hardwood trees.

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 Fish and Wildlife Enhancement Project of the Cottonwood Island Wildlife Management Area, Missouri as described in the Upper Mississippi River System Environmental Management Program Definite Project Report (R-16F) with Integrated Environmental Assessment Cottonwood Island Wildlife Management Area dated April 1996, 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 order 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. USFWS Responsibilities. Upon completion of construction as determined by the District Engineer, Rock Island, the USFWS shall accept the Project as part of the Mark Twain National Wildlife Refuge of the Cottonwood Island, Wildlife Management Area, Missouri.

c. Non-Federal Responsibilities. In accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580, 100 percent of all costs associated with the operation, maintenance, and repair of the Cottonwood Island, Wildlife Management Area, Missouri will be borne by the Missouri Department of Conservation.

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.

FWS: 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 **THE U.S. FISH AND WILDLIFE SERVICE**

BY: _____
CHARLES S. COX
Colonel, U.S. Army
District Engineer

BY: _____
WILLIAM HARTWIG
Regional Director
U.S. Fish and Wildlife Service

DATE: _____

DATE: _____

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HABITAT EVALUATION AND QUANTIFICATION

D

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

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HABITAT EVALUATION AND QUANTIFICATION

PURPOSE

Habitat Evaluation Procedures (HEP) were used to evaluate the potential benefits of alternative habitat improvement features at Cottonwood Island in Lewis and Marion Counties, Missouri. Active participants included biologists and engineers from the Rock Island District, U.S. Army Corps of Engineers; the U.S. Fish and Wildlife Service, Rock Island Ecological Service Office and Mark Twain Wildlife Refuge; and the Missouri Department of Conservation.

BACKGROUND

The need for quantification of HREP outputs 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.

Habitat Units (HUs) were calculated from the HEP models. HUs are a measure of habitat quality [Habitat Suitability Indices (HSI) and quantity (area)]. Annualization of HUs can then be used to determine changes brought about by project features/alternatives over time. This annualization computes Average Annual Habitat Units (AAHUs). 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. 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 to without-project benefits.

For this evaluation, only those features identified in the cost/incremental analyses were evaluated. While other features could be implemented on Cottonwood Island, it was felt by the interested agencies that the features evaluated were fiscally acceptable and met the goals and objectives of their policies and practices. Table D-1 shows the features analyzed for this project.

TABLE D-1

Features Analyzed

A Side Channel Restoration
A0 No Action
A1 3 Deep Holes and Associated Side Channel
A2 4 Deep Holes and Associated Side Channel
A3 5 Deep Holes and Associated Side Channel
A4 Entire Side Channel Dredged

B Bottomland Hardwood Restoration
B0 No Action
B1 Plant FMA#7/Construct 0.4 hectare (1 acre) pothole
B2 Plant mast trees on the dredged material
B3 Plant FMA#5/Construct a 0.2 hectare (1/2 acre) pothole
B4 Plant FMA#6/Construct a 0.2 hectare (1/2 acre) pothole
B5 Plant the ag field/Construct two 0.4 hectare (1 acre) potholes

C Main Channel Border Enhancement (Wing Dam Notching)
C0 No Action
C1 Notch Wing Dam 9
C2 Notch Wing Dam 8
C3 Notch Wing Dam 5
C4 Notch Wing Dam 6
C5 Notch Wing Dam 29
C6 Notch Wing Dam 30
C7 Notch Wing Dam 15

METHODOLOGY

Primary project objectives for habitat rehabilitation and enhancement include increasing overwintering opportunities for fish, restoring a mast component and diversifying terrestrial habitat on the island, and enhancing flows through the main channel border between the island and main channel of the Mississippi River. Benefits would accrue to fish, migratory and upland birds, furbearers, and game as well as nongame species. These objectives led the study team to select evaluation models for wetland and aquatic habitats.

Prior to site sampling, the study team reviewed aerial photography, topographic maps, and preliminary design drawings to select representative sample sites for the evaluation. During site sampling, assumptions were developed regarding existing conditions and projected post-project conditions relative to limiting factors and management practices. Two HEP procedures were used in this evaluation; the Aquatic Habitat Appraisal Guide (AHAG) (Mathias, *et al.*, unpublished), and a Bottomland Hardwood (BLH) model developed by the Corps of Engineers Waterway Experiment Station (Corps 1992).

The AHAG was developed for the Environmental Management Program because, at the time, a dynamic, flexible model was not available to predict and quantify aquatic variables of big rivers such as the Upper Mississippi and Illinois Rivers. For this project, the AHAG evaluated habitat conditions for three life stages of eight fish species (white bass, emerald shiner, river darter, northern pike, smallmouth buffalo, walleye, largemouth bass, and bluegill). It can be used to evaluate up to five life stages of any animal species, given the proper variable inputs, and is flexible enough that a variety of habitat variables for species other than fish can be evaluated.

The BLH model was developed from a study done on the Cache River, Arkansas. This model was developed as part of the Wetland Evaluation Technique (WET) (Adamus 1987) BLH component and evaluates BLH habitat on a holistic community basis. This community-based model was designed to rate the quality of wildlife habitat in BLH and wooded swamps in the southeastern United States. This model has been slightly modified for Mississippi River conditions. Model output is a score ranging between 0.0 and 1.0, with a score of 1.0 corresponding with the habitat that supports the maximum species richness of birds, mammals, reptiles, and amphibians in BLH communities. It does not evaluate single animal species, but assumes a linear relationship between habitat quality and the number of species in the evaluation area. The output should not be interpreted in relation to abundance of individuals, although it is generally true that as the number of species increases, so does the abundance of individual species.

Results of the habitat evaluation are provided as calculated HSI (0.0 being limiting or low quality; 1.0 being optimal) and estimated total HU values for the forested and aquatic components of the project. Habitat units were annualized for target years using the USFWS HEP 80 (USFWS 1980) program in order to evaluate changes in project features over time. After existing conditions were determined, the study team reviewed the habitat appraisal guides to determine where habitat quality can be improved.

Habitat quality ratings can be improved by: (1) increasing area for particular habitat types that may be limited or lacking; (2) altering a limiting factor, such as unpredictable water levels; (3) altering a management strategy, such as cropping practice or cover crop composition; or (4) a combination of the preceding, depending on management goals, target species requirements, or available funds.

GENERAL ASSUMPTIONS

Several assumptions have been made regarding model performance, changes in habitat conditions over time, and future management practices.

a. **Model Performance.** The BLH model was originally designed for bottomland conditions in the southern United States. Some of the habitat variables were adjusted to more accurately reflect conditions at a more northern latitude and the linear characteristics of the river.

b. **Changes in Habitat Conditions Over Time.** Habitat conditions are not static. Either through natural processes or human induced, habitat evolves and may change in either 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, 1, 25, and 50 are sufficient to annualize HUs and characterize habitat changes over the estimated project life.

c. **Future Management Use - Without Project.** It was assumed that the 13.4 hectare cropfield would be converted from crop production to mast-producing trees in year 25. Although this was anticipated, a general decline in habitat is reflected in HSI scores based on continual sedimentation in Cottonwood Chute. Bottomland hardwood and main channel border habitats would generally remain as they are now—relatively low value.

d. Proposed improvements would result in desired changes in landscape contour and vegetative composition and distribution so that animals will positively respond; habitat benefits would accrue.

SPECIFIC MODEL ASSUMPTIONS, FIELD DATA INPUT, AND RESULTS

This section describes the HSI scores for each feature and resulting AAHU scores that were used in the cost/incremental analysis discussed in the main report. For each feature, the no action, or without-project, condition is also addressed.

A. **Side Channel Restoration.** Four features were evaluated: three deep holes, four deep holes, five deep holes, and the entire side channel dredged. For all the features, only wintering habitat conditions were evaluated and, therefore, only the adult life stage of the target species was used.

Habitat variables and field measurements used are listed in Table D-2. Variables such as average annual water temperature are very difficult to predict for years 25

and 50. It was assumed for the baseline conditions that a general decline in habitat quality and quantity would continue. Model performance, therefore, is dependent upon field data and an overall prediction of the quality of the habitat in the outlying years of analysis. It was assumed that habitat suitability among the with-project conditions would not change, but the area of influence would (Table D-3).

TABLE D-2

Backwater Dredging - Without Project

Habitat Variable	TY: 0	TY: 1	TY: 25	TY: 50
Average water temperature (C°)	6.00	4.00	4.00	2.00
Minimum daily dissolved oxygen, (mg/l)	6.00	6.00	3.00	1.00
Percent surface with visible cover	20.00	20.00	30.00	40.00
Percent surface with aquatic vegetation	10.00	10.00	20.00	30.00
Variation in water depth, depth > 1m	0.00	0.00	0.00	0.00
Percent area with water depth > 1m	75.00	75.00	40.00	5.00
Percent backwater overwintering habitat	75.00	75.00	30.00	5.00

Backwater Dredging - With Project

Habitat Variable	TY: 0	TY: 1	TY: 25	TY: 50
Average water temperature (C°)	6.00	6.00	6.00	6.00
Minimum daily dissolved oxygen, (mg/l)	6.00	6.00	6.00	6.00
Percent surface with visible cover	20.00	5.00	10.00	20.00
Percent surface with aquatic vegetation	10.00	0.00	0.00	5.00
Variation in water depth, depth > 1m	0.00	80.00	80.00	60.00
Percent area with water depth > 1m	75.00	100.00	100.00	100.00
Percent backwater overwintering habitat	75.00	100.00	100.00	100.00

TABLE D-3

Habitat Suitability Index Values

	Present	Future Without			Future With		
	YR 0	YR 1	YR 25	YR 50	YR 1	YR 25	YR 50
Species	HSI	HSI	HSI	HSI	HSI	HSI	HSI
White Bass	0.46	0.46	0.57	0.32	0.93	0.86	0.86
Emerald Shiner	0.50	0.50	0.75	0.54	0.89	0.86	0.86
River Darter	0.50	0.50	0.43	0.29	0.64	0.61	0.61
Northern Pike	0.50	0.50	0.64	0.50	0.75	0.79	0.79
Smallmouth Buffalo	0.57	0.57	0.64	0.43	0.93	0,89	0.89
Walleye	0.61	0.61	0.68	0.46	0.93	0.93	0.93
Largemouth Bass	0.43	0.43	0.54	0.46	0.71	0.75	0.75
Bluegill	0.50	0.50	0.64	0.50	0.79	0.82	0.82

For this evaluation, off-site area was added to the on-site area to take into account the off-site benefits that this feature would create. Species like largemouth bass have been documented to travel up to 14.5 kilometers (9 miles) between overwintering habitat and other seasonal areas (IDNR 1992). Fish would travel to the dredged sites, overwinter, and then return to spawning sites in better condition than if they overwintered in marginal habitat. The HEP team felt that the side channel dredging would impact more than the area to be dredged [approximately 1.2 hectares (3 acres)], but that the entire Pool 21 acreage was too great to be used. Although it is unknown exactly how much area to analyze, it was felt that 75 to 175 hectares (185 to 432 acres) was a very fair, yet conservative size. Without the project, the area impacted would go down as the side channel slowly fills in. With-project conditions would go up and remain for the life of the project. Table D-4 shows how area was used in this analysis.

TABLE D-4

Area (Hectares) Influenced by the Side Channel Restoration Features

Feature	TY 0	TY 1	TY 25	TY50
No action	75	50	25	10
3 deep holes/adjacent side channel	75	120	120	120
4 deep holes/adjacent side channel	75	150	150	150
5 deep holes/adjacent side channel	75	160	160	160
Entire channel length dredged	75	175	175	175

Both costs of the project and habitat benefits were quantified and annualized. Average annual habitat units calculated for the project are in Table D-5.

TABLE D-5

Average Annual Habitat Units for Side Channel Restoration

	White Bass	Emerald Shiner	River Darter	Northern Pike	SM Buffalo	Walleye	LM Bass	Bluegill	Net Total
A0	14	17	12	16	16	17	14	16	122
A1	117	86	61	77	91	93	74	80	678*
A2	126	112	80	100	118	121	97	105	858*
A3	138	120	86	108	127	130	104	113	926*
A4	138	133	95	120	140	144	115	105	990*

* Net Total = An - A0

B. Bottomland Hardwood Restoration. Five levels of BLH restoration were evaluated. The agencies' objectives for this restoration were to plant mast trees and construct potholes to add to the area's food diversity and habitat diversity. Various planting quantities and pothole numbers were manipulated to develop a sound management strategy for the site. With each subsequent feature, the number of areas planted and the number of potholes constructed varies. With this, it is assumed that as more areas are planted, the greater variety of trees will mature to bear acorns and other types of mast. As the number of potholes increases, it was assumed that a greater diversity of habitat and home ranges may be established with resulting improved habitat conditions.

Tables D-6 through D-10 are the habitat variables and field values for the "without project" conditions. Also listed are the AAHU values for each of the BLH features analyzed. Table D-11 summarizes the AAHU values for all the BLH features.

The BLH model took into account 202 hectares (500 acres) of this habitat. The island itself is approximately 172 hectares (425 acres) and the Missouri shoreline encompasses about 30 hectares (75 acres). It was assumed the overall manipulations on the island will boost the overall quality of the area.

TABLE D-6

Bottomland Hardwood Restoration Cottonwood Island, Missouri (B1)

		Field Measurements / Suitability Indices													
		Baseline		Without Project						With Project					
		TY 0		TY 1		TY 25		TY 50		TY 1		TY 25		TY 50	
Plot Variables		*	si	*	si	*	si	*	si	*	si	*	si	*	si
PV1	Tree diameter dbh (cm)	25	0.6	25	0.6	30	0.8	30.5	0.8	25	0.6	30	0.8	33	0.9
PV2	Overstory cover %	80	1	80	1	80	1	80	1	80	1	85	1	90	1
PV3	Mast types and variety	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	9	1	9	1
PV4	Old-growth elements # of	10	0.6	10	1	12	0.7	15	0.9	10	0.6	15	0.9	15	0.9
PV5	Moisture regime/flood tolerance	2.5	0.3	2.5	0.3	2.5	0.3	2.5	0.3	3	0.5	4.5	1	4.7	1
PV6	Understory cover % 1-3m	10	0.4	10	0.4	10	0.4	10	0.4	10	0.4	20	1	20	1
PV7	Ground layer elements	6	0.7	6	0.7	6	0.7	6	0.7	7	0.8	7	0.8	7	0.8
PV8	Interspersion of moisture regimes (m)	200	0.5	225	0.4	250	0.35	300	0.1	50	1	50	1	50	1
Tract Variables															
TV1	Core area factor (ha)	121	N/A	121	N/A	121	N/A	121	N/A	162	N/A	162	N/A	162	N/A
TV2	Isolation factor	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
TV3	Effective area (ha)	121	0.6	121	0.6	121	0.65	121	0.7	162	0.65	162	0.65	162	0.65
TV4	Water quality factor	0.4	N/A	0.4	N/A	0.4	N/A	0.4	N/A	0.6	N/A	0.6	N/A	0.6	N/A
TV5	Disturbance factor	0.8	N/A	0.8	N/A	0.8	N/A	0.8	N/A	1	N/A	1	N/A	1	N/A

from Corps of Engineers, 1992

* field measurement as defined in the above reference (si: corresponding suitability index - scale 0.0- 1.0)

21.65

Calculations								
Plot variables SI	0.368	0.37	0.36	0.292	0.495	0.913	0.931	
Tract variables SI	0.192	0.19	0.21	0.224	0.39	0.39	0.39	
HSIs	0.28	0.28	0.28	0.26	0.44	0.65	0.66	
Area (hectares)	24.25	24.3	24.3	24.25	24.25	24.25	24.25	
HUs	6.794	6.86	6.84	6.2567	10.73	15.79	16.01	net AAHUs
AAHUs				**6.67**			**14.46**	**7.79**

TABLE D-7

Bottomland Hardwood Restoration Cottonwood Island, Missouri (B2)

		Field Measurements / Suitability Indices													
		Baseline		Without Project						With Project					
		TY 0		TY 1		TY 25		TY 50		TY 1		TY 25		TY 50	
Plot Variables		*	si	*	si	*	si	*	si	*	si	*	si	*	si
PV1	Tree diameter dbh (cm)	25	0.6	25	0.6	30	0.8	30.5	0.8	25	0.6	30	0.8	33	0.9
PV2	Overstory cover %	80	1	80	1	80	1	80	1	80	1	85	1	90	1
PV3	Mast types and variety	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	9	1	9	1
PV4	Old-growth elements # of	10	0.6	10	1	12	0.7	15	0.9	10	0.6	15	0.9	15	0.9
PV5	Moisture regime/flood tolerance	2.5	0.3	2.5	0.3	2.5	0.3	2.5	0.3	3	0.5	4.5	1	4.7	1
PV6	Understory cover % 1-3m	10	0.4	10	0.4	10	0.4	10	0.4	10	0.4	20	1	20	1
PV7	Ground layer elements	6	0.7	6	0.7	6	0.7	6	0.7	7	0.8	7	0.8	7	0.8
PV8	Interspersion of moisture regimes (m)	200	0.5	225	0.4	250	0.35	300	0.1	50	1	50	1	50	1
Tract Variables															
TV1	Core area factor (ha)	121	N/A	121	N/A	121	N/A	121	N/A	162	N/A	162	N/A	162	N/A
TV2	Isolation factor	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
TV3	Effective area (ha)	121	0.6	121	0.6	121	0.65	121	0.7	162	0.65	162	0.65	162	0.65
TV4	Water quality factor	0.4	N/A	0.4	N/A	0.4	N/A	0.4	N/A	0.6	N/A	0.6	N/A	0.6	N/A
TV5	Disturbance factor	0.8	N/A	0.8	N/A	0.8	N/A	0.8	N/A	1	N/A	1	N/A	1	N/A

from Corps of Engineers, 1992

* field measurement as defined in the above reference (si: corresponding suitability index - scale 0.0- 1.0)

Calculations								
Plot variables SI	0.368	0.37	0.36	0.292	0.495	0.913	0.931	
Tract variables SI	0.192	0.19	0.21	0.224	0.39	0.39	0.39	
HSIs	0.28	0.28	0.28	0.26	0.44	0.65	0.66	
Area (hectares)	22.26	22.3	22.3	22.26	22.26	22.26	22.26	
HUs	6.236	6.29	6.28	5.7433	9.853	14.5	14.7	net AAHUs
AAHUs				6.12			**13.27**	**7.15**

TABLE D-8

Bottomland Hardwood Restoration Cottonwood Island, Missouri (B3)

		Field Measurements / Suitability Indices													
		Baseline		Without Project						With Project					
		TY 0		TY 1		TY 25		TY 50		TY 1		TY 25		TY 50	
Plot Variables		*	si	*	si	*	si	*	si	*	si	*	si	*	si
PV1	Tree diameter dbh (cm)	25	0.6	25	0.6	30	0.8	30.5	0.8	25	0.6	30	0.8	33	0.9
PV2	Overstory cover %	80	1	80	1	80	1	80	1	80	1	85	1	90	1
PV3	Mast types and variety	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	9	1	9	1
PV4	Old-growth elements # of	10	0.6	10	1	12	0.7	15	0.9	10	0.6	15	0.9	15	0.9
PV5	Moisture regime/flood tolerance	2.5	0.3	2.5	0.3	2.5	0.3	2.5	0.3	3	0.5	4.5	1	4.7	1
PV6	Understory cover % 1-3m	10	0.4	10	0.4	10	0.4	10	0.4	10	0.4	20	1	20	1
PV7	Ground layer elements	6	0.7	6	0.7	6	0.7	6	0.7	7	0.8	7	0.8	7	0.8
PV8	Interspersion of moisture regimes (m)	200	0.5	225	0.4	250	0.35	300	0.1	50	1	50	1	50	1
Tract Variables															
TV1	Core area factor (ha)	121	N/A	121	N/A	121	N/A	121	N/A	162	N/A	162	N/A	162	N/A
TV2	Isolation factor	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
TV3	Effective area (ha)	121	0.6	121	0.6	121	0.65	121	0.7	162	0.65	162	0.65	162	0.65
TV4	Water quality factor	0.4	N/A	0.4	N/A	0.4	N/A	0.4	N/A	0.6	N/A	0.6	N/A	0.6	N/A
TV5	Disturbance factor	0.8	N/A	0.8	N/A	0.8	N/A	0.8	N/A	1	N/A	1	N/A	1	N/A

from Corps of Engineers, 1992

* field measurement as defined in the above reference (si: corresponding suitability index - scale 0.0- 1.0)

Calculations								
Plot variables SI	0.368	0.37	0.36	0.292	0.495	0.913	0.931	
Tract variables SI	0.192	0.19	0.21	0.224	0.39	0.39	0.39	
HSIs	0.28	0.28	0.28	0.26	0.44	0.65	0.66	
Area (hectares)	35.55	35.6	35.6	35.55	35.55	35.55	35.55	
HUs	9.959	10.1	10	9.1722	15.74	23.15	23.47	net AAHUs
AAHUs				9.78			**21.20**	**11.42**

TABLE D-9

Bottomland Hardwood Restoration Cottonwood Island, Missouri (B4)

		Field Measurements / Suitability Indices													
		Baseline		Without Project						With Project					
		TY 0		TY 1		TY 25		TY 50		TY 1		TY 25		TY 50	
Plot Variables		*	si	*	si	*	si	*	si	*	si	*	si	*	si
PV1	Tree diameter dbh (cm)	25	0.6	25	0.6	30	0.8	30.5	0.8	25	0.6	30	0.8	33	0.9
PV2	Overstory cover %	80	1	80	1	80	1	80	1	80	1	85	1	90	1
PV3	Mast types and variety	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	9	1	9	1
PV4	Old-growth elements # of	10	0.6	10	1	12	0.7	15	0.9	10	0.6	15	0.9	15	0.9
PV5	Moisture regime/flood tolerance	2.5	0.3	2.5	0.3	2.5	0.3	2.5	0.3	3	0.5	4.5	1	4.7	1
PV6	Understory cover % 1-3m	10	0.4	10	0.4	10	0.4	10	0.4	10	0.4	20	1	20	1
PV7	Ground layer elements	6	0.7	6	0.7	6	0.7	6	0.7	7	0.8	7	0.8	7	0.8
PV8	Interspersion of moisture regimes (m)	200	0.5	225	0.4	250	0.35	300	0.1	50	1	50	1	50	1
Tract Variables															
TV1	Core area factor (ha)	121	N/A	121	N/A	121	N/A	121	N/A	162	N/A	162	N/A	162	N/A
TV2	Isolation factor	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
TV3	Effective area (ha)	121	0.6	121	0.6	121	0.65	121	0.7	162	0.65	162	0.65	162	0.65
TV4	Water quality factor	0.4	N/A	0.4	N/A	0.4	N/A	0.4	N/A	0.6	N/A	0.6	N/A	0.6	N/A
TV5	Disturbance factor	0.8	N/A	0.8	N/A	0.8	N/A	0.8	N/A	1	N/A	1	N/A	1	N/A

from Corps of Engineers, 1992

* field measurement as defined in the above reference (si: corresponding suitability index - scale 0.0- 1.0)

Calculations								
Plot variables SI	0.368	0.37	0.36	0.292	0.495	0.913	0.931	
Tract variables SI	0.192	0.19	0.21	0.224	0.39	0.39	0.39	
HSIs	0.28	0.28	0.28	0.26	0.44	0.65	0.66	
Area (hectares)	37.88	37.9	37.9	37.88	37.88	37.88	37.88	
HUs	10.61	10.7	10.7	9.7734	16.77	24.67	25.01	net AAHUs
AAHUs				10.26			**22.21**	**11.94**

TABLE D-10

Bottomland Hardwood Restoration Cottonwood Island, Missouri (B5)

		Field Measurements / Suitability Indices													
		Baseline		Without Project						With Project					
		TY 0		TY 1		TY 25		TY 50		TY 1		TY 25		TY 50	
Plot Variables		*	si	*	si	*	si	*	si	*	si	*	si	*	si
PV1	Tree diameter dbh (cm)	25	0.6	25	0.6	30	0.8	30.5	0.8	25	0.6	30	0.8	33	0.9
PV2	Overstory cover %	80	1	80	1	80	1	80	1	80	1	85	1	90	1
PV3	Mast types and variety	1	0.1	1	0.1	1	0.1	1	0.1	1	0.1	9	1	9	1
PV4	Old-growth elements # of	10	0.6	10	1	12	0.7	15	0.9	10	0.6	15	0.9	15	0.9
PV5	Moisture regime/flood tolerance	2.5	0.3	2.5	0.3	2.5	0.3	2.5	0.3	3	0.5	4.5	1	4.7	1
PV6	Understory cover % 1-3m	10	0.4	10	0.4	10	0.4	10	0.4	10	0.4	20	1	20	1
PV7	Ground layer elements	6	0.7	6	0.7	6	0.7	6	0.7	7	0.8	7	0.8	7	0.8
PV8	Interspersion of moisture regimes (m)	200	0.5	225	0.4	250	0.35	300	0.1	50	1	50	1	50	1
Tract Variables															
TV1	Core area factor (ha)	121	N/A	121	N/A	121	N/A	121	N/A	162	N/A	162	N/A	162	N/A
TV2	Isolation factor	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A	0	N/A
TV3	Effective area (ha)	121	0.6	121	0.6	121	0.65	121	0.7	162	0.65	162	0.65	162	0.65
TV4	Water quality factor	0.4	N/A	0.4	N/A	0.4	N/A	0.4	N/A	0.6	N/A	0.6	N/A	0.6	N/A
TV5	Disturbance factor	0.8	N/A	0.8	N/A	0.8	N/A	0.8	N/A	1	N/A	1	N/A	1	N/A

from Corps of Engineers, 1992

* field measurement as defined in the above reference (si: corresponding suitability index - scale 0.0- 1.0)

Calculations								
Plot variables SI	0.368	0.37	0.36	0.292	0.495	0.913	0.931	
Tract variables SI	0.192	0.19	0.21	0.224	0.39	0.39	0.39	
HSIs	0.28	0.28	0.28	0.26	0.44	0.65	0.66	
Area (hectares)	105.04	106.3	106.3	106.32	106.32	106.32	106.32	
HUs	29.43	30.1	30	27.431	47.06	69.24	70.2	net AAHUs
AAHUs				**24.68**			**52.16**	**27.49**

TABLE D-11

Bottomland Hardwood Restoration
Average Annual Habitat Units

Feature	Net Total*
B0	0.00
B1	7.79
B2	7.15
B3	11.42
B4	11.94
B5	27.49

* Net Total = Bn - B0.

C. **Main Channel Border Enhancement.** Seven wing dams lie offshore from Cottonwood Island. These structures define the main channel border. A goal of this project is to enhance water flows across the area. It is assumed that by diversifying the flows, the substrate will begin to diversify, and, in turn, increase its use by aquatic wildlife such as fish and mussels. The total area in the dike field was divided into plots delineated by an upstream wing dam and the wing dam immediately downstream. By notching the upstream wing dam, the entire area to the next one would be impacted. It was assumed that the more wing dams notched, the more area would be influenced and, thus, higher benefits.

Habitat variables and field measurements used are listed in Table D-12. Again, habitat variables were based on model performance and possible changes the project may effect. Because of the uniformity of the entire area it was assumed that habitat suitability (Tables D-13 and D-14) among the with-project conditions would not change, but the area of influence would (Table D-15).

TABLE D-12

Main Channel Border Restoration
Project Without

Habitat Variable	TY: 0	TY: 1	TY: 25	TY: 50
Average water temperature (C°)	6.00	6.00	6.00	6.00
Minimum daily dissolved oxygen, (mg/l)	6.00	6.00	6.00	6.00
Dominant substrate type	2.00	2.00	2.00	2.00
Variation in water depth, depth > 1m	5.00	5.00	5.00	5.00
Percent area with water depth > 1m	10.00	10.00	10.00	10.00
Average water velocity (cm/sec)	6.00	6.00	6.00	6.00
Average depth of thalweg (m)	1.00	1.00	1.00	1.00
Percent backwater overwintering habitat	0.00	0.00	0.00	0.00

TABLE D-12 (Continued)

Main Channel Border Restoration
Project With

Habitat Variable	TY: 0	TY: 1	TY: 25	TY: 50
Average water temperature (C°)	6.00	8.00	8.00	8.00
Minimum daily dissolved oxygen, (mg/l)	6.00	7.00	7.00	7.00
Dominant substrate type	2.00	3.00	3.00	3.00
Variation in water depth, depth > 1m	5.00	20.00	20.00	20.00
Percent area with water depth > 1m	10.00	30.00	30.00	30.00
Average water velocity (cm/sec)	6.00	12.00	12.00	12.00
Average depth of thalweg (m)	1.00	2.00	2.00	2.00
Percent backwater overwintering habitat	0.00	10.00	10.00	10.00

Habitat suitability indexes were calculated for the same eight species as in the side channel evaluation. The HEP team agreed that by altering the flows through the dike field, benefits would accrue throughout the year. While some species may benefit during the spawning season, others may realize benefits during the winter. For this reason, the entire year was evaluated with one season not being more important than another. Habitat suitability indexes were calculated for three life stages: spawning, rearing, and juvenile/adult. For each species, the HSI scores for each life stage were then averaged to determine an overall HSI. Tables D-13 and D-14 present the HSI data.

TABLE D-13

Main Channel Border Restoration
Habitat Suitability Indices

	Present	Future Without			Future With		
	YR 0	YR 1	YR 25	YR 50	YR 1	YR 25	YR 50
Species	HSI	HSI	HSI	HSI	HSI	HSI	HSI
White Bass S*	0.54	0.54	0.54	0.54	0.64	0.64	0.64
White Bass R**	0.54	0.54	0.54	0.54	0.64	0.64	0.64
White Bass J/A***	0.59	0.59	0.59	0.59	0.69	0.69	0.69
White bass average	0.56	0.56	0.56	0.56	0.66	0.66	0.66
Emerald Shiner S	0.61	0.61	0.61	0.61	0.71	0.71	0.71
Emerald Shiner R	0.71	0.71	0.71	0.71	0.75	0.75	0.75
Emerald Shiner J/A	0.78	0.78	0.78	0.78	0.88	0.88	0.88
Emerald Shiner average	0.70	0.70	0.70	0.70	0.78	0.78	0.78
River Darter S	0.39	0.39	0.39	0.39	0.50	0.50	0.50
River Darter R	0.57	0.57	0.57	0.57	0.64	0.64	0.64
River Darter J/A	0.56	0.56	0.56	0.56	0.66	0.66	0.66
River Darter average	0.51	0.51	0.51	0.51	0.60	0.60	0.60
Northern Pike S	0.46	0.46	0.46	0.46	0.46	0.46	0.46
Northern Pike R	0.71	0.71	0.71	0.71	0.75	0.75	0.75
Northern Pike J/A	0.50	0.50	0.50	0.50	0.53	0.53	0.53
Northern Pike average	0.56	0.56	0.56	0.56	0.58	0.58	0.58
Smallmouth Buffalo S	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Smallmouth Buffalo R	0.64	0.64	0.64	0.64	0.75	0.75	0.75
Smallmouth Buffalo J/A	0.56	0.56	0.56	0.56	0.62	0.62	0.62
Smouth Buffalo average	0.54	0.54	0.54	0.54	0.60	0.60	0.60
Walleye S	0.64	0.64	0.64	0.64	0.57	0.57	0.57
Walleye R	0.46	0.46	0.46	0.46	0.50	0.50	0.50
Walleye J/A	0.50	0.50	0.50	0.50	0.59	0.59	0.59
Walleye average	0.53	0.53	0.53	0.53	0.55	0.55	0.55
Largemouth Bass S	0.32	0.32	0.32	0.32	0.46	0.46	0.46
Largemouth Bass R	0.43	0.43	0.43	0.43	0.54	0.54	0.54
Largemouth Bass J/A	0.44	0.44	0.44	0.44	0.50	0.50	0.50
Lmouth bass average	0.40	0.40	0.40	0.40	0.50	0.50	0.50
Bluegill S	0.43	0.43	0.43	0.43	0.46	0.46	0.46
Bluegill R	0.57	0.57	0.57	0.57	0.61	0.61	0.61
Bluegill J/A	0.47	0.47	0.47	0.47	0.56	0.56	0.56
Bluegill average	0.49	0.49	0.49	0.49	0.54	0.54	0.54

* Spawning
** Rearing
*** Juvenile/Adult

TABLE D-14

Main Channel Border Restoration
Habitat Suitability Indices
(Summary)

	Present	Future Without			Future With		
	YR 0	YR 1	YR 25	YR 50	YR 1	YR 25	YR 50
Species	HSI	HSI	HSI	HSI	HSI	HSI	HSI
White Bass average	0.56	0.56	0.56	0.56	0.66	0.66	0.66
Emerald Shiner average	0.70	0.70	0.70	0.70	0.78	0.78	0.78
River Darter average	0.51	0.51	0.51	0.51	0.60	0.60	0.60
Northern Pike average	0.56	0.56	0.56	0.56	0.58	0.58	0.58
Smouth Buffalo average	0.54	0.54	0.54	0.54	0.60	0.60	0.60
Walleye average	0.53	0.53	0.53	0.53	0.55	0.55	0.55
Lmouth Bass average	0.40	0.40	0.40	0.40	0.50	0.50	0.50
Bluegill average	0.49	0.49	0.49	0.49	0.54	0.54	0.54

For the main channel border analysis, the entire dike field was considered because, like the BLH scenario, it was felt that the entire area would benefit from the wing dam notches. Ancillary benefits from the varied flow velocities would have an eddy effect throughout this area. It was assumed that each wing dam would influence the area immediately downstream to the next wing dam. For the last wing dam, the area of influence went to the next wing dam (#45) immediately downstream on the Missouri shoreline. Table D-15 displays the associated acreage for each wing dam notch.

TABLE D-15

Main Channel Border Restoration Area (Hectares)

		Cum.
Between Wing Dams 9 & 8	16	16
Between Wing Dams 8 & 5	20	36
Between Wing Dams 5 & 6	30	66
Between Wing Dams 6 & 29	20	86
Between Wing Dams 29 & 30	44	110
Between Wing Dams 30 & 15	34	144
Below Wing Dam 15	8	152

AAHUs calculated for the project are in Table D-16.

TABLE D-16

Main Channel Border
Average Annual Habitat Units

	C1	C2	C3	C4	C5	C6	C7
White Bass	0.8	2.0	3.0	2.0	4.4	3.4	1.6
Emerald Shiner	0.6	1.6	2.4	1.6	3.5	2.7	1.3
River Darter	0.7	1.8	2.7	1.8	3.9	3.0	1.4
Northern Pike	0.2	0.4	0.6	0.4	0.9	0.7	0.3
Smallmouth Buffalo	0.5	1.2	1.8	1.2	2.6	2.0	1.0
Walleye	0.2	0.4	0.6	0.4	0.9	0.7	0.3
Largemouth Bass	0.8	2.0	3.0	2.0	4.4	3.4	1.6
Bluegill	0.4	1.0	1.5	1.0	2.2	1.7	0.8
Total	4.1	10.3	15.4	10.3	22.7	17.5	8.2

DISCUSSION

Results of the HEP application were compared as increments to costs where applicable. This incremental analysis is discussed in Section 7 (Formulation and Evaluation of Alternatives) of the main report.

The proposed project for Cottonwood Island involves three primary restoration and enhancement features: side channel excavation, mast tree planting and pothole construction on the island, and notching wing dams in the main channel border. These project features are not only important to the natural resources in the Cottonwood Island area, but could play an important role in the Mississippi River ecosystem.

Analyzing the project area with and without the project conditions using habitat evaluation procedures is a good way to organize and lay out different planning scenarios. However, it cannot be the only tool used to weigh various alternatives in the planning process. Professional judgment by the fish and wildlife biologists, engineers, foresters, and the public are key in the decision making process. In the Cottonwood Island planning process, all of these resources were used in the feature selection, habitat evaluation model selection, and model performance.

The following are some observations of the results of the habitat evaluation.

Side Channel

- The more overwintering habitat created, the more benefits will accrue. However, even the lowest amount proposed to be dredged significantly improved habitat conditions over without-project conditions.

Bottomland Hardwoods

- A draft model prepared by the Corps of Engineers Waterway Experiment Station was used to evaluate BLH habitat. This model, although adjusted slightly for Upper Mississippi River conditions, generally performed well. The model balances a variety of habitat conditions in the study area as well as the overall area. This balance did not pick up subtle changes this project proposes; 1.6 hectare (4 acres) of scattered potholes and planting mast trees in five separate areas. However, it was concluded that this model reflected existing conditions and with-project conditions more accurately than other available models.

Main Channel Border Enhancement

- Habitat suitability index values did not appreciably change for the evaluation species. Like the terrestrial BLH model, subtle changes within this habitat type may not have been detected. These subtle changes may be the critical or key element to a successful enhancement project. It has been found that when habitats are changed from one type to another, great HU differences occur in the model. When changes are just improvements within habitat types, model performance may not reflect real life expectations. Still, the model was not manipulated or over sensitized to present data based solely on conjecture or gut feeling. It is felt, however, that by improving the flows through the dike field, valid and worthwhile benefits will occur.

In conclusion, the HEP analysis indicates that the preferred alternative of four deep holes of overwintering habitat for fish, planting mast trees/1.6 hectares (4 acres) of potholes on the island, and notching six wing dams would provide overall benefits above the present conditions in the Cottonwood Island area. Model performance was sound and accurate. These facts provide decision makers and planners a good foundation to use in evaluating this project.

APPENDIX E

GEOTECHNICAL CONSIDERATIONS

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ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
REHABILITATION AND ENHANCEMENT
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APPENDIX E
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PURPOSE AND SCOPE

This appendix presents the general geology and specific geotechnical analysis pertinent to the project. The geological information contained in this report has been obtained and condensed from Missouri Geological Survey reports, bulletins, and circulars, and from a review of the Lewis County Soil Survey. The geotechnical information has been determined from soil borings obtained by the Rock Island District Geotechnical Branch, who also performed a laboratory analysis and an interpretation.

The plan view of the proposed dredge cut locations along Cottonwood Chute is shown on DPR plate 3. Dredging would be limited to below a small island at River Mile (RM) 329.4. Water depths north of this island are 3 feet or less, while depths south of the island are 4 to 6 feet.

The cut would be 50 feet wide and 1 to 3 feet deep. The total proposed length of the dredge cut is approximately 4,900 feet. Within the above cut, four deep holes would be dredged to 15 feet below flat pool (elev. 470 feet, 1912 NGVD), making the cut 9 to 11 feet deep in these areas. Each hole would be 50 feet wide and 300 feet long.

The mechanically dredged material would be sidecast to the east side of the channel and planted in mast trees (see DPR plate 3). The dredged material would be placed to a maximum height of 6 feet and rough-graded to create a berm with a 60-foot crown. With the exception of the rough grading for the crown, the dredged material would not be compacted (see DPR plate 8). The dredged volume would be approximately 85,000 cubic yards.

In addition, five potholes would be mechanically excavated as shown on DPR plate 10. Three 1-acre and two 1/2-acre potholes would be excavated to approximately 3 feet below flat pool with "steps" at 1-foot intervals to encourage a mixture of aquatic and emergent plants.

LOCATION

The Cottonwood Island Habitat Rehabilitation and Enhancement Project is located in eastern Lewis and Marion Counties, Missouri, between Mississippi River Miles (RM) 328.6 and 331.0. The 463-acre site is just north of Quincy, Illinois.

PHYSIOGRAPHY

The project area is situated within the Dissected Till Plains Section of the Central Lowlands Province of the Interior Plains. The project area has little topographic relief and consists of shallow backwaters, bottom land, and islands which are subjected to permanent high water tables and annual flooding.

GEOLOGY

Cottonwood Island lies along the western edge of the present Mississippi River channel which at this point impinges on the eastern valley wall. This area of the valley has been a glacial sluiceway since the early stages of glaciation and until recently was a part of the Iowa River channel system. Flow volumes, perhaps 10 times that of present, have carved a 6-mile-wide valley. The eastern valley wall is geologically recent and exposures of Mississippian age limestone are apparent throughout the Quincy area in bluffs, rising 100 feet above the river. These bluffs are capped by silt picked up by westerly winds from the alluvium and deposited as loess. The western valley edge is more gentle and less well defined, of a lower elevation. The valley was initially filled with glacial outwash sands and gravels deposited in valley trains and alluvial terraces which formed as the glacial meltwater volume decreased and allowed deposition. These deposits become increasingly coarse grained with depth, in some areas exceeding 100 feet. During flood stages, the present river is believed to erode as much as 50 feet deep in the active channels.

This post-glacial fluvial reworking of the upper portion of the deposits, combined with upland erosion, has left the modern valley filled with relatively more fine-grained materials consisting of finer sands and gravels with much silt, clay, and clayey sand with wood and shell fragments. Lenses of sand and gravel are locally common but generally have a high silt content; the degree of sorting varies but is generally poor. The surface soils of the island belong to either the Fatima silt loam or the Chequest silty clay loam, consisting predominantly of lean to medium clays with occasional sand. Permeability is moderate to moderately slow, and drainage is moderate to poor.

SUBSURFACE EXPLORATIONS

An extensive subsurface exploration was conducted to determine the composition and engineering characteristics of the soils. DPR plate 6 shows the location of the borings. DPR plates 7 and 7A contain the boring logs for the project. Note in particular the three borings located on plate 7A. These borings, 23 to 26 feet below flat pool (elevation 470, NGVD) were taken at three of the four proposed deep dredged holes. Vane shear cohesive shear strength results of representative clays are shown with the appropriate borings in the boring logs.

Vane shear tests were performed on clays at Borings C-94-3, C-94-4, C-94-6, C-94-7, and C-95-2. Plate E-1 indicates the vane shear analysis performed. This was compared with plate E-5, a graph plotting cohesive shear strengths versus water content of alluvial soils for the Mississippi River valley. It was determined that in each case the vane shear results were more conservative.

Borings C-94-1 and C-94-2 were completed during February 1994. These hand auger borings were taken along Cottonwood Chute in about 2 feet of water. During November and December 1994, Borings C-94-3 through C-94-12 were completed (also hand auger borings).

Borings C-95-1 through C-95-3 were taken December 5, 1995, with a drill rig mounted on a small barge. Vane shear tests for Boring C-95-2 were performed by hand (through ice) on 28 December.

Borings C-94-1 through C-94-5 were taken to identify the characteristics for channel dredging and disposal along Cottonwood Chute and the Pilot Channel. The scope changed later so that the proposed dredging would occur only on the south end of Cottonwood Chute (see PURPOSE AND SCOPE on page E-1). The borings indicate that, for the most part, there is a fat clay layer of about 5 feet over a clayey sand. In some cases, a sand or lean clay overlays the fat clay. The lean clay has a cohesive strength of about 245 pounds per square foot (psf). The fat clay at Boring C-94-4 indicates a cohesive strength of 60 psf.

Borings C-94-6 through C-94-10 were taken to identify the suitability of the material for construction of potholes at the north end of the island. These borings indicated at least a 5-foot layer of medium to lean clay which is the proposed depth of the potholes. The lean clay indicated a cohesive strength of 180 psf. This is sufficient to maintain the flat slopes the potholes will require to encourage aquatic and emergent plants.

Borings C-94-11 and C-94-12 were off-shore hand augers and were taken to identify whether 5,000-pound riprap could be placed offshore without it sinking into the existing soil. This part of the project has since been eliminated.

Borings C-95-1 through C-95-3 were taken to determine the material that is to be excavated from the proposed deep dredged holes. They also were taken to determine the anticipated natural angle of repose for these holes. The borings indicate that the material to be excavated is a gray fat clay.

The clay's moisture content indicates a saturated unit weight that increases from 98 pounds per cubic foot (pcf) at elevation 465 to 104 pcf at elevation 461 (plate E-2). As expected from the moisture contents, the clay is very soft at the surface and increases in firmness as the depth increases. The clay tested at a cohesive strength of 40 pounds per square foot (psf) at elevation 465 followed by 90 psf at elevation 463. The clay tested at a cohesive strength of 180 psf or better below elevation 461 (note the chart on plate E-3).

SLOPE STABILITY

The stability of slopes was analyzed in accordance with EM 1110-2-1902, "Engineering Design Stability of Earth and Rockfill Dams," dated 1 April 1970.

The 6-foot-high berm with 4H to 1V slopes that will be constructed from the dredged material was not analyzed since it is much more stable than the four deep holes within the dredge cut area. Since each hole will be 15 feet deep after dredging, this was considered to be the most critical slope area.

Borings C-95-1 through C-95-3 (DPR plate 7) provided representative soils information for the selected critical embankments. See the "SUBSURFACE EXPLORATIONS" on page E-3 for properties of the gray fat clay encountered at these locations.

A slope stability analysis was run at the 2.5H to 1V slope using the UTEXAS3 software program (plate E-3). Spencer's Procedure for Circular Arc Slope Stability Analysis was utilized. Four failure circles were analyzed. The worst resulting factor of safety was 1.6 at failure circle 4.

Although a minimum factor of safety of 1.3 is normally acceptable, engineering judgment indicates that a higher factor of safety should be sought in this instance due to the variable results that a vane shear test can sometimes provide.

As a comparison, an infinite slope analysis for cohesionless soils was used assuming a conservative clayey coarse to fine sand (plate E-4). The analysis indicates a factor of safety of 1.4 for a 2.5H to 1V slope.

RECOMMENDATIONS

It is recommended that the side slopes of the dredged area be allowed to slump to their natural angle of repose as the material is being dredged. This slump is expected to be between 2H to 1V and 2.5H to 1V. Dredged material quantities will be based on this assumption.

There is no advantage in specifying exact slopes in this case as long as the 50-foot dredged channel bottom width is maintained (DPR plate 8). A disadvantage to specifying an exact slope is the added cost of shaping the sides.

COTTONWOOD EMP: VANE SHEAR TEST RESULTS (2/96)

BORING	ELEVATION (meters MSL)	SOIL TYPE	MOISTURE CONTENT (%)	TORQUE (in-lbs)	LL / PL	PI	C^c (psf)	λ^d	C_{adj} (psf)
C-94-3[a]	469.2	CL	46	200		26	290	.94	270
	467.2	CL	49	180		26	262	.94	245
	465.2	CH	54		59 / 26	33		.87	
C-94-4[a]	464.8	CH	46	50		39	73	.85	60
	460.3	CH	31		59 / 20	39		.85	
C-94-6[a]	467.4	CL	40	75		26	109	.94	100
C-94-7[a]	466.8	CL	41	200		26	290	.94	270
C-95-2[b]	464.9	CH	73	80	67 / 25	42	49	.83	40
	462.9	CH	63	170	59 / 25	34	104	.87	90
	460.9	CH	58	330	71 / 29	42	203	.83	170
	459.9	CH	58	360	71 / 29	42	221	.83	180
	455.4	CH	61			42		.83	
	450.9	CH	63		72 / 28	44		.82	

NOTES:

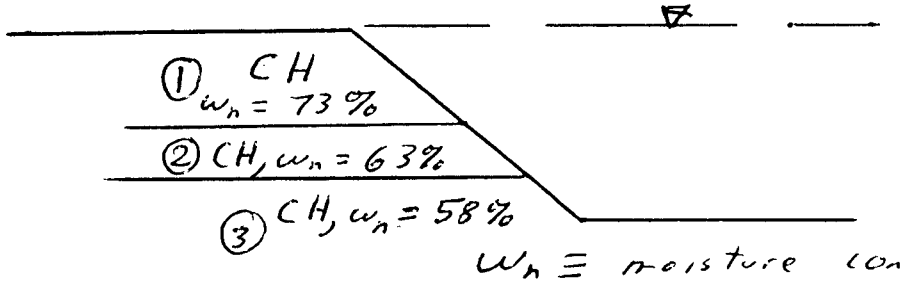
a. Vane Shear Test performed using 3" x 6" (76mm x 152mm) vane shear on November 29-30, 1994.
b. Vane Shear Test performed using 4" x 8" (102mm x 203mm) vane shear on December 28, 1995.
c. Cohesion computed using Formula 3-7, p. 68, "Soils and Foundations", 3rd Ed., by C. Liu and J. B. Evett.
d. Correction factor, λ, taken from Figure 3-14, p. 69, "Soils and Foundations", 3rd Ed., by C. Liu and J. B. Evett.

Computed By: N. Davila
Checked By: K. Landwehr
file "COT2-VNE.DOC"

PLATE E-1

COTTONWOOD EMP

Subject	Date
SATURATED UNIT WT. CALCULATIONS	1/20/96
Computed by: N DAWLA	Checked by:
	Sheet 1 of 1



$w_n \equiv$ moisture content

Degree of Saturation = 100 %

Specific Gravity of Solids = G_s

$$\gamma_{sat} = \text{Saturated Unit Wt} = \frac{(1+w_n)\,\gamma_w}{w_n + 1/G_s}$$

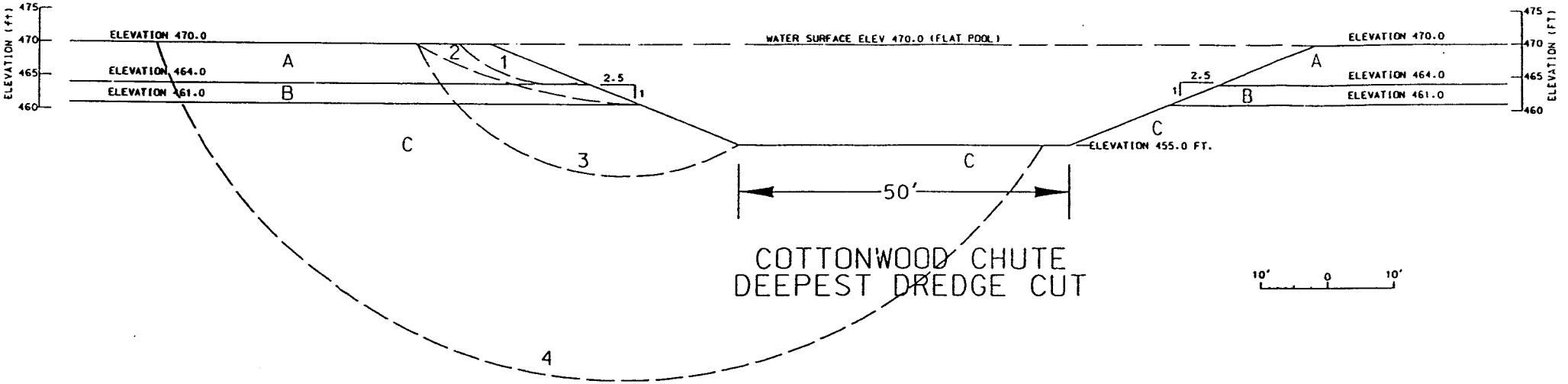
γ_w = unit wt of water = 62.4 pcf

① $$\gamma_{sat} = \frac{(1+0.73)\,62.4}{0.73 + 1/2.7} = 98 \text{ pcf}$$

② $$\gamma_{sat} = \frac{(1+0.63)\,62.4}{0.63 + 1/2.7} = 102 \text{ pcf}$$

③ $$\gamma_{sat} = \frac{(1+0.58)\,62.4}{0.58 + 1/2.7} = 104 \text{ pcf}$$

note: moisture contents from Plate E-1



MATERIAL			*SATURATED UNIT WEIGHT (PCF)	**COHESION (PSF)	PHI (DEGREES)
GRAY FAT CLAY (SOFT) ELEV 464.0 TO 470.0	CH	A	98	40	0
GRAY FAT CLAY (FIRMER) ELEV 461.0 TO 464.0	CH	B	102	90	0
GRAY FAT CLAY (FIRMER) BELOW ELEV 461.0	CH	C	104	168	0

* FROM PLATE E-2
** FROM PLATE E-1

FAILURE CIRCLE	FACTOR OF SAFETY	CENTER OF CIRCLE X (ft)	CENTER OF CIRCLE Y (ft)	RADIUS OF CIRCLE (ft)
1	1.8	10.0	485.0	21.000
2	2.6	25.0	540.0	79.040
3	1.8	20.0	485.0	34.731
4	1.6	20.0	495.0	75.000

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: NDD
Drawn by: CJK
Checked by: NDD
Reviewed by: GJN
Approved by: CHARLES S. COX COL., CORPS OF ENGINEERS

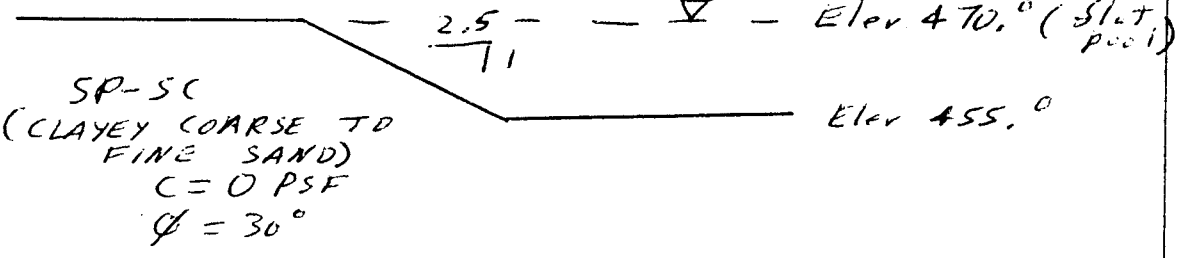
UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

SLOPE STABILITY ANALYSIS
End-of-Construction Condition

Scales:
Dates: 17 APR 96
Drawing Code:
Sheet reference numbers:
Solicitation Numbers:
Sheet of

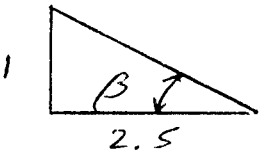
Subject		Date
COTTONWOOD EMP: INFINITE SLOPE ANALYSIS		7/31/95
Computed by: N DAVILA	Checked by:	Sheet 1 of 1

The following slope stability analysis is as per EM 1110-2-1902, Appendix V, dated 1 April 1970 (Infinite Slope Analysis for Cohesionless Soils)



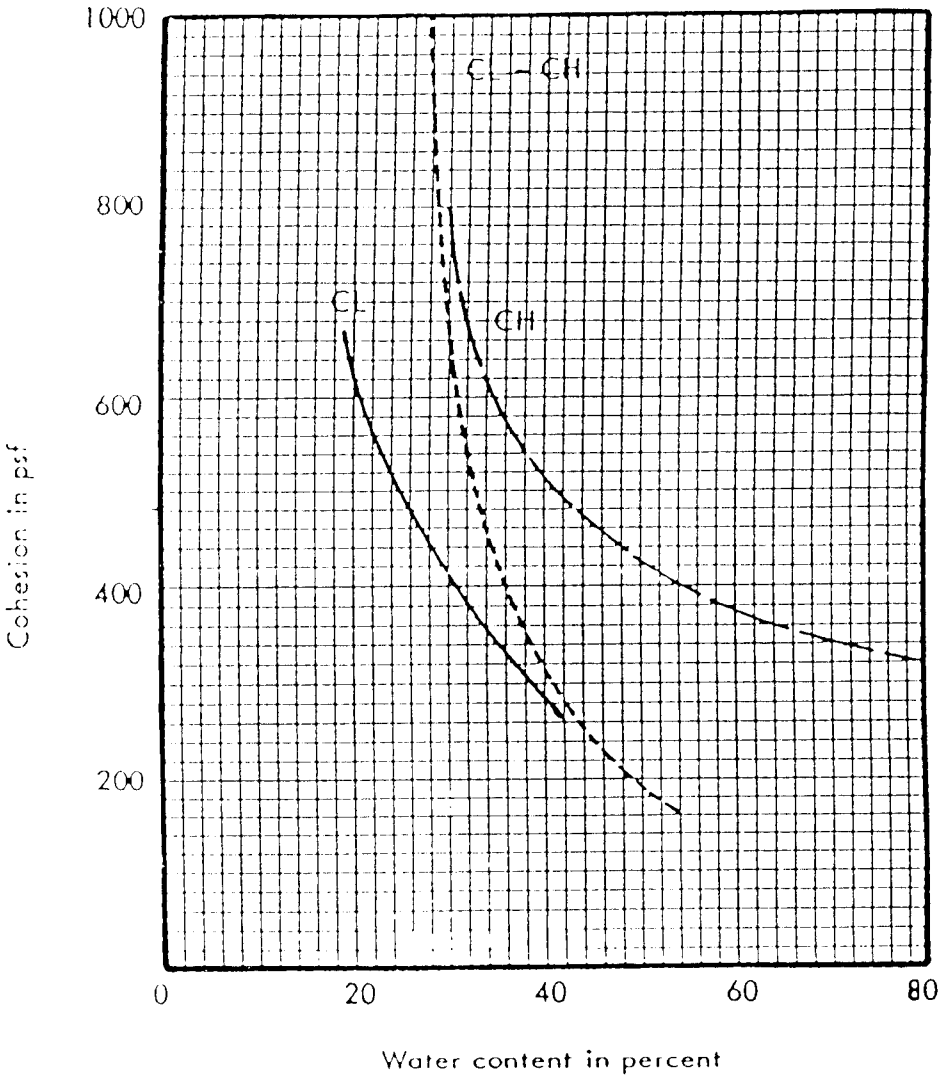
The analysis assumes no seepage forces exist.

$$\text{Factor of Safety} = F.S. = b \tan\phi = (\cot\beta)(\tan\phi)$$



$$F.S. = \left(\frac{2.5}{1}\right) \tan 30^\circ$$

$$\boxed{F.S. = 1.44}$$



NOTE:

1. Cohesive shear strength curves derived from shear strength data supplied by Rock Island District for Mississippi River alluvial soils in the District.

COHESIVE SHEAR STRENGTH VS
WATER CONTENT

APPENDIX F

WATER QUALITY

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT REHABILITATION AND ENHANCEMENT POOL 21, MISSISSIPPI RIVER MILES 328.5 THROUGH 331.0 LEWIS AND MARION COUNTIES, MISSOURI

APPENDIX F
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APPENDIX F
WATER QUALITY

PURPOSE

The purpose of this appendix is threefold: to discuss the results of bulk sediment analyses performed on samples representative of potential dredge cuts; to address the results of baseline water quality monitoring; and to present the results from a dissolved oxygen assessment.

In order to evaluate the impacts of dredging and to procure Section 401 water quality certification, bulk sediment analyses were performed on samples collected at sites representative of potential dredge cuts. The bulk sediment test is used to determine the chemical characteristics of the material to be dredged.

Baseline water quality monitoring was performed in an effort to define present water quality conditions/problems. Upon project completion, a post-project water quality monitoring program will be implemented. Project-induced water quality impacts will be determined by comparing pre-project and post-project data.

A dissolved oxygen assessment was performed in order to determine the flow rate necessary to maintain a dissolved oxygen concentration of 6 mg/l throughout Cottonwood Chute.

GENERAL

As recent as 1956, Cottonwood Chute was a flowing side channel (Dorris *et al.*, 1963) which provided deep, productive, aquatic habitat. However, sedimentation, particularly in the upper portion of the chute, has diminished the quality of this habitat in recent years. Also, dissolved oxygen concentrations in the upper reaches of the chute which were below the 5 mg/l Missouri State Standard for the Protection of Aquatic Life were reported by Ellis (1978) and Neuswanger (1980).

These two factors have contributed to the decline in fish species diversity seen in the upper portion of the chute.

BULK SEDIMENT TEST

The bulk sediment test was utilized to determine the chemical characteristics of material to be dredged. In order to evaluate the impacts of dredging and to procure Section 401 water quality certification, bulk sediment analyses were performed on samples collected at sites representative of potential dredge cuts.

Sediment samples were collected by Corps Water Quality and Sedimentation Section personnel on October 27, 1993. A minimum of three subsamples each were collected at sites E-M330.1A, E-M329.6A and E-M328.7B (see plate 11) with a 36-inch, plastic-lined core sampler. The subsamples from each site were placed in a stainless steel basin and mixed to form a homogeneous composite sample. The mixture was then placed into glass sample bottles which were stored in an ice chest.

Sediment samples were shipped to ARDL, Inc., Mount Vernon, Illinois, for chemical analysis. These analyses were performed according to the U.S. Environmental Protection Agency and U.S. Army Corps of Engineers (1981). Grain size analyses were performed by Corps Geotechnical Branch personnel in accordance with the U.S. Army Corps of Engineers (1970).

Results from grain size analyses are found in Table F-1. Samples from sites E-M329.6A and E-M328.7B were classified as fat clay, while the sample from site E-M330.1A was classified as sandy, medium clay. The quantity of material passing a #230 sieve ranged from 88.5 percent at E-M330.1A to 99.5 percent at E-M328.7B.

Table F-2 contains the results from the bulk sediment analyses. Sediment quality standards do not exist; therefore, sediment concentrations were compared against levels determined to be elevated by Kelly and Hite (1984). The evaluation of Illinois stream sediment data by Kelly and Hite is a statistical evaluation and does not indicate toxicity. The concentrations of cadmium, chromium, copper, lead, mercury and zinc were all below the elevated concentration. All PCB aroclors and insecticide concentrations were less than their respective detection limits. Ammonia nitrogen, COD and manganese were not addressed by the Kelly and Hite study; however, the concentrations of these parameters were determined to be acceptable by Missouri Department of Natural Resources personnel (personal communication with Diana Fawks).

BASELINE MONITORING

Baseline water quality monitoring data were collected by Corps Water Quality and Sedimentation Section personnel. At each sampling site a water sample was collected just below the surface. In general, sampling date, time, water depth, Secchi disk depth, water velocity, wave height, air temperature, percent cloud cover, and wind speed and direction were recorded in the field. The following measurements were also taken in the field: pH, water temperature, dissolved oxygen and conductivity. Samples for laboratory analysis were placed on ice and shipped to ARDL, Inc., Mt. Vernon, Illinois or EIS Environmental Engineers, Inc., South Bend, Indiana. Sample collection/preservation and field/laboratory analytical procedures were performed according to the American Public Health Association, *et al.* (1989 or 1992) or the U.S. Environmental Protection Agency (1983).

In general, quality control procedures for the number of field duplicates, replicate analyses, spiked samples, control samples, and blanks run followed the guidelines of the U.S. Environmental Protection Agency (1979) or U.S. Environmental Protection Agency (1986).

The results from baseline monitoring are given in Tables F-3 and F-4. Sampling commenced on April 7, 1992, at site W-M328.7B and on December 6, 1994 at site W-M330.1A. Sampling was discontinued at site W-M330.1A in July 1995 when it was determined that dredging of the upper portion of Cottonwood Chute was no longer a viable alternative. Sampling will commence at site W-M329.3B in the spring of 1996. The location of each sampling site is shown in Plate 11. Samples were collected approximately biweekly from May through October and monthly from November through April. A limited number of samples were collected during 1993 due to the Great Flood.

The results from pH and dissolved oxygen measurements found in Tables F-3 and F-4 were compared against Missouri Water Quality Standards. One pH value was outside the accepted range of 6.5 to 9.0. On March 14, 1995 the pH at Site W-M328.7B was 9.03. This value was apparently due to algal photosynthesis, as evidenced by the supersaturated dissolved oxygen concentration of 22.70 mg/l. The Missouri water quality standard for dissolved oxygen states the concentration shall not be less than 5 mg/l for the protection of aquatic life. A review of the data indicates the dissolved oxygen concentration was below 5.0 mg/l on three occasions: August 13, 1992, at W-M328.7B (4.52 mg/l), August 27, 1992, at W-M328.7B (2.96 mg/l) and January 10, 1995 at W-M330.1A (4.62 mg/l).

In addition to the data collected by the Corps, a limited amount of dissolved oxygen data were collected from Cottonwood Chute by Ellis (1978) and Neuswanger (1980). Both researchers measured dissolved oxygen concentrations in the upper reaches of the chute which were below the 5 mg/l Missouri State Standard for the Protection of Aquatic Life.

DISSOLVED OXYGEN ASSESSMENT

A dissolved oxygen assessment was performed in order to estimate the minimum flow requirements into Cottonwood Chute for maintaining dissolved oxygen at a concentration sufficient to support aquatic life.

A dissolved oxygen mass balance was performed for both winter and summer conditions. Calculations were used to determine the minimum flow which left a balance of 6 mg/l of dissolved oxygen as water exited the chute at the downstream end. A detailed description of these calculations can be found in the addendum beginning on page F-18. The following chute morphometry was utilized: 12,370-foot length; 50-foot bottom width; trapezoidal cross section; 2:1 side slope; 6-foot depth except for four 400-foot-long sections of 8-foot depth.

The mass balance computations required that sources and users ("sinks") of oxygen be defined. The sources that were defined included the oxygen present in the river water flowing into the chute and during the summer the atmospheric recharge of oxygen. Photosynthesis was not considered. The sinks included water column biochemical oxygen demand (BOD), fish respiration, and sediment oxygen demand (SOD).

The data used for the mass balance computations were obtained from relevant literature. Many assumptions were necessary in order to use the data to make the mass balance computations. The data and assumptions used for winter included:

- Complete ice cover over Cottonwood Chute.
- BOD_5 = 5 mg/l, based on values observed at other river locations.
- SOD = 8g/m^2/day at 20 degrees Celsius, a conservative estimate based on backwater lake measurements.
- Fish respiration rate = 0.0119 ml O_2/hr (Leidy and Jenkins, 1977).
- Standing crop of fish = 56 g/m^2 (Leidy and Jenkins, 1977).
- Water temperature = 4 degrees Celsius, a conservative estimate.
- Initial dissolved oxygen is at 80% of saturated value = 10 mg/l, a conservative estimate based on observations.
- 1.7 = fish active/standard metabolism ratio (Leidy and Jenkins, 1977).

The data and assumptions used for summer included:

- BOD_5 = 5 mg/l, based on values observed at other river locations.
- SOD = 8g/m^2/day at 20 degrees Celsius, a conservative estimate based on backwater lake measurements.
- Fish respiration rate = 0.0119 ml O_2/hr (Leidy and Jenkins, 1977).
- Standing crop of fish = 56 g/m^2 (Leidy and Jenkins, 1977).
- Water temperature = 35 degrees Celsius (95 degrees Fahrenheit).
- Initial dissolved oxygen is at 100% of saturated value = 6.88 mg/l.
- 1.7 = fish active/standard metabolism ratio (Leidy and Jenkins, 1977).
- The oxygen transfer coefficient (KLa) = exp(6.79), from Whittemore (1991).

The calculation procedure used for winter was as follows:

- Calculate the ultimate BOD. This is the demand that would result over an extended time period such as 6 months.
- Calculate the BOD for any time in days at 4 degrees Celsius.
- Calculate the sediment oxygen demand.
- Calculate the fish respiration.
- Calculate the time of travel for a water column through the chute.
- Calculate the dissolved oxygen level by subtracting the sinks from the sources.

The calculation procedure used for summer was as follows:

- Determine the time of travel for each 100-foot section.
- Determine whether the flow is turbulent. This step is necessary to determine whether stratification will occur. If the flow is turbulent, then stratification will be less likely to occur and the bottom will receive oxygen from the surface.
- Calculate the BOD and SOD for each 100 feet section. Because the atmospheric recharge rate is dependent on the sinks which change throughout the chute, the recharge rate also changes continuously throughout the chute.

Therefore, it would be inaccurate to calculate one rate for the entire chute. In order to increase accuracy, the chute was broken down into 100 feet sections. At each of these sections BOD and SOD were calculated. These were then used in calculating the atmospheric recharge rate.

- Calculate the atmospheric recharge rate. This first requires estimating an oxygen transfer coefficient which was based on values found in the literature. Calculating the recharge rate is made more complex because it changes continuously throughout the chute. Another complexity is that the recharge rate is dependent on the dissolved oxygen concentration present in each segment and the dissolved oxygen concentration is also dependent on the recharge rate. Therefore, an iterative equation was developed which calculated the recharge rate based on the average dissolved oxygen concentration throughout each 100 feet segment. This iterative process was performed at each 100 feet section stepwise throughout the length of the chute until the final dissolved oxygen concentration was calculated at the end of the chute. At each segment if a value higher than the saturated dissolved oxygen value was computed, the saturated value was still used.

Using the assumptions and procedures described previously, the recharge rate during summer was found to be high enough that the dissolved oxygen concentration remained at saturated levels throughout the chute even at flow rates as low as 10 cfs. However, in winter, during extended periods of complete ice cover, the lowest flow rate that would provide 6 mg/l of dissolved oxygen is 40 cfs.

DISCUSSION AND CONCLUSIONS

Bulk sediment analyses were performed in order to evaluate the impacts of dredging and to procure Section 401 water quality certification. The concentration levels of the constituents analyzed are comparable to the levels typically seen in fine-grained Mississippi River sediments. No unusually high values were observed. It is anticipated mechanical dredging will be utilized and the material will be side cast; therefore, the amount of return water will be relatively small. Considering the dredging method and the observed contaminant levels, it is anticipated there will be little impact to water quality. Minimal increases in suspended solids and ammonia nitrogen concentrations can be expected; however, these would be localized and temporary in nature.

Baseline monitoring studies performed by the Corps have shown that on occasion the dissolved oxygen concentration in the chute falls below the 5 mg/l Missouri State Standard for the Protection of Aquatic Life. Previous researchers have also found this to be true. Any rehabilitation alternative which would allow for the diversion of main stem flow through the chute would help alleviate this problem.

Also, deepening the chute would allow for a greater volume of oxygen which would be especially beneficial to aquatic life during extended periods of ice cover.

A dissolved oxygen assessment was performed in order to estimate the minimum flow requirements into Cottonwood Chute for maintaining dissolved oxygen at a concentration sufficient to support aquatic life. Using reasonable assumptions, measured values, and literature derived coefficients, it was determined the most critical time for dissolved oxygen depletion is during extended periods of complete ice cover. During this time period, 40 cfs are required to maintain a level of 6 mg/l of dissolved oxygen. Therefore, any water control structure which would allow for main stem flow diversion should be designed to handle a minimum flow of 40 cfs.

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Table F-1. Grain size analysis results from samples collected at sites E-M330.1A, E-M329.6A and E-M328.7B on October 27, 1993

MISSISSIPPI RIVER
SITE: COTTONWOOD ISLAND
SAMPLE DATE: 27 OCTOBER 1993

GRAIN SIZE ANALYSIS OF SEDIMENT SAMPLES

SUMMARY OF TESTING

PERCENT FINER BY WEIGHT

U.S. Standard Sieve Size or Number	E-M330.1A	E-M329.6A	E-M328.7B
# 4	100.0		
# 8	99.3	100.0	100.0
# 16	98.3	99.9	100.0
# 30	97.1	99.7	99.9
# 50	94.0	99.4	99.9
# 70	91.7	99.2	99.9
# 100	90.4	99.1	99.8
# 200	88.9	98.2	99.6
# 230	88.5	97.7	99.5
Classification:	(a)	(b)	(b)

Notes:

1. Visual classification of soils as stated below is in accordance with "The Unified Soils Classification System (USCS)"

   (a) CL-CH Gray sandy medium clay
   (b) CH Gray fat clay

2. Laboratory testing was performed in accordance with EM 1110-2-1906 dated 30 Nov 70, revised 1 May 80 and 20 Aug 86. All samples were oven dried at 110 degrees centigrade.

TABLE F-2. Bulk sediment analysis results from samples collected at sites E-M330.1A, E-M329.6A and E-M328.7B on October 27, 1993

PARAMETER	UNITS	ELEVATED* CONCENTRATION	LOCATION E-M330.1A	E-M329.6A	E-M328.7B
Ammonia Nitrogen	mg/kg	-	95.6	128	199
COD	mg/kg	-	18,500	>18,600	22,300
Cadmium	mg/kg	>1.0	<0.72	<0.65	<0.85
Chromium	mg/kg	>23	13.3	12.0	20.4
Copper	mg/kg	>60	14.2	13.3	20.9
Lead	mg/kg	>38	18.8	14.8	22.4
Manganese	mg/kg	-	548	458	698
Mercury	mg/kg	>0.17	<0.14	<0.11	<0.16
Zinc	mg/kg	>100	52.2	46.7	78.8
Chlordane	mg/kg	>0.006	<0.380	<0.340	<0.450
Dieldrin	mg/kg	>0.006	<0.054	<0.048	<0.064
Aroclor 1016	mg/kg	**	<1.400	<1.300	<1.700
Aroclor 1221	mg/kg	**	<1.400	<1.300	<1.700
Aroclor 1232	mg/kg	**	<1.400	<1.300	<1.700
Aroclor 1242	mg/kg	**	<1.400	<1.300	<1.700
Aroclor 1248	mg/kg	**	<1.400	<1.300	<1.700
Aroclor 1254	mg/kg	**	<2.900	<2.600	<3.400
Aroclor 1260	mg/kg	**	<2.900	<2.600	<3.400

* Elevated level for stream sediments in Illinois according to Kelly and Hite (1984)

** The elevated level for total PCBs is >0.050 mg/kg

Table F-3. Baseline water quality monitoring results from samples collected at site W-M328.7B

DATE	WATER DEPTH (FT)	VELOCITY (FT/SEC)	WAVE HEIGHT (FT)	AIR TEMP. (°C)	CLOUD COVER (%)	WIND SPEED (MPH)
4/7/92	6.45	*	0.1	13	95	8
5/5/92	10.60	0.216	0.0	12	5	3
5/19/92	6.30	0.086	0.0	27	30	0
7/23/92	6.70	0.057	0.0	27	100	0
8/13/92	5.85	0.047	0.0	18	50	3
8/27/92	5.90	0.168	0.0	21	95	4
9/17/92	6.05	0.271	0.0	24	85	7
10/27/92	5.70	0.105	0.0	13	0	3
11/24/92	11.15	0.240	0.0	4	100	0
1/25/93	6.50	0.000	**	-1	5	0
10/27/93	6.65	0.116	0.0	15	10	5
11/10/93	6.20	0.125	0.0	6	10	0
2/8/94	4.95	0.000	**	18	100	8
3/23/94	7.25	0.127	0.2	17	20	18
4/19/94	6.80	0.075	0.1	21	15	3
5/10/94	8.35	0.053	0.0	24	0	2
5/24/94	6.40	0.078	0.1	28	70	5
6/14/94	4.40	0.117	0.2	34	10	7
7/7/94	6.05	*	0.2	29	80	4
7/19/94	6.15	0.142	0.1	31	20	5
8/9/94	5.00	0.000	0.0	28	25	2
8/30/94	5.30	0.152	0.1	24	40	4
9/13/94	5.00	0.074	0.1	31	10	7
10/4/94	5.40	0.000	0.0	19	25	0
10/25/94	4.80	0.220	0.2	9	5	6
12/6/94	5.60	0.130	0.0	1	100	0
1/10/95	4.85	0.000	**	-2	100	3
2/15/95	4.70	0.010	**	2	100	4
3/14/95	5.25	0.150	0.0	21	40	1
4/11/95	12.20	0.155	0.2	3	100	11
5/2/95	11.00	0.325	0.0	17	80	0
5/16/95	10.60	0.882	0.0	27	95	0
6/13/95	7.75	0.046	0.0	29	15	3
7/11/95	5.70	*	0.1	34	10	4
7/25/95	5.30	0.000	0.0	29	30	0
8/29/95	5.80	*	0.0	34	15	1
9/12/95	5.50	0.000	0.1	24	60	3
9/27/95	5.55	0.000	0.0	24	0	0
10/10/95	6.10	0.000	0.0	24	5	0
10/24/95	5.00	0.000	0.0	12	30	2
11/7/95	6.20	0.160	0.1	6	100	3
MIN.	4.40	0.000	0.0	-2	0	0
MAX.	12.20	0.882	0.2	34	100	18
AVG.	6.51	0.117	0.1	19	46	3

* Meter malfunction

** Not applicable, ice cover

*** Field/Laboratory accident

Table F-3 (Cont.). Baseline water quality monitoring results from samples collected at site W-M328.7B

DATE	WIND DIRECTION	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL ALKALINITY (MG/L as $CaCO_3$)
4/7/92	NW	11.4	10.96	7.97	196
5/5/92	W	15.8	8.56	8.18	164
5/19/92	-	26.6	15.10	8.92	150
7/23/92	-	26.5	8.96	8.22	165
8/13/92	NW	25.1	4.52	7.55	201
8/27/92	N	24.7	2.96	7.52	197
9/17/92	W	23.8	6.11	*	156
10/27/92	SE	13.7	8.62	7.95	161
11/24/92	-	5.7	*	7.88	108
1/25/93	-	0.7	11.30	8.35	197
10/27/93	NW	12.3	5.78	7.95	254
11/10/93	-	6.7	20.40	8.98	185
2/8/94	NE	0.4	9.92	8.04	205
3/23/94	S	11	9.63	8.17	162
4/19/94	NW	18.3	12.34	8.69	157
5/10/94	5	17.7	7.62	7.42	123
5/24/94	SW	26.1	7.14	7.91	170
6/14/94	S	29.8	6.70	8.02	179
7/7/94	SE	29.8	8.69	8.24	172
7/19/94	S	30.3	9.35	8.21	225
8/9/94	S	29.1	12.94	8.81	178
8/30/94	S	25.8	8.81	8.19	180
9/13/94	S	26.1	12.03	8.63	***
10/4/94	-	21.2	10.42	8.46	152
10/25/94	NW	14	8.46	8.48	181
12/6/94	-	5.5	11.48	8.23	201
1/10/95	SE	0.3	17.70	8.90	200
2/15/95	NW	1.7	20.70	*	147
3/14/95	SE	14	22.70	9.03	154
4/11/95	S	6.4	9.74	7.84	143
5/2/95	-	13.7	7.76	8.38	227
5/16/95	-	17.9	7.70	7.72	151
6/13/95	SW	24.7	6.72	7.97	189
7/11/95	SE	30.6	9.75	8.38	152
7/25/95	-	31.6	14.31	8.63	226
8/29/95	SE	32.8	12.99	8.59	177
9/12/95	S	23.0	8.39	*	192
9/27/95	-	18.9	12.62	*	145
10/10/95	-	18.2	9.53	8.26	***
10/24/95	W	11.8	7.87	8.10	183
11/7/95	NW	6.3	8.46	8.00	189
MIN.	-	0.3	2.96	7.42	108
MAX.	-	32.8	22.70	9.03	254
AVG.	-	17.8	10.39	-	177

* Meter malfunction

** Not applicable, ice cover

*** Field/Laboratory accident

Table F-3 (Cont.). Baseline water quality monitoring results from samples collected at site W-M328.7B

DATE	SPECIFIC CONDUCTANCE (µMHOS/CM @ 25°C)	SECCHI DISK DEPTH (FT)	TURBIDITY (NTU)	SUSPENDED SOLIDS (MG/L)
4/7/92	478	0.95	22.0	36.0
5/5/92	438	0.85	23.0	49.0
5/19/92	478	1.10	19.0	49.0
7/23/92	475	1.15	17.0	34.2
8/13/92	497	0.85	27.0	50.0
8/27/92	494	0.95	31.0	53.3
9/17/92	415	0.75	32.0	44.5
10/27/92	423	1.00	23.0	38.2
11/24/92	261	0.40	105.0	120.0
1/25/93	430	**	12.0	20.8
10/27/93	537	1.00	28	6.0
11/10/93	410	1.40	13	18.6
2/8/94	310	**	9	15.0
3/23/94	395	0.75	26	43.0
4/19/94	397	0.70	59	78.0
5/10/94	330	0.20	66	65.0
5/24/94	438	0.90	23	40.0
6/14/94	468	0.65	33	52.0
7/7/94	482	0.95	15	40.0
7/19/94	468	0.90	17	26.0
8/9/94	442	0.90	10	20.0
8/30/94	445	0.60	24	59.0
9/13/94	434	0.90	***	35.0
10/4/94	411	0.90	23	39.0
10/25/94	430	0.85	21	36.0
12/6/94	408	1.85	13	20.0
1/10/95	398	**	8	14.0
2/15/95	339	**	8	9.0
3/14/95	364	1.00	18	53.0
4/11/95	275	0.20	140	220.0
5/2/95	483	1.00	25	41.0
5/16/95	359	0.15	100	100.0
6/13/95	501	0.70	28	31.0
7/11/95	456	0.70	31	45.0
7/25/95	455	1.10	19	24.0
8/29/95	443	0.90	22	35.0
9/12/95	403	0.90	30	45.0
9/27/95	384	0.85	20	40.0
10/10/95	407	0.90	17	20.0
10/24/95	388	0.50	45	68.0
11/7/95	361	1.00	22	33.0

MIN.	261	0.15	8.0	6.0
MAX.	537	1.85	140.0	220.0
AVG.	420	0.85	30.6	45.5

* Meter malfunction

** Not applicable, ice cover

*** Field/Laboratory accident

Table F-3 (Cont.). Baseline water quality monitoring results from samples collected at site W-M328.7B

DATE	CHLOROPHYLL a (MG/M3)	CHLOROPHYLL b (MG/M3)	CHLOROPHYLL c (MG/M3)	PHEOPHYTIN a (MG/M3)
4/7/92	19.0	1.4	2.6	10.0
5/5/92	15.0	8.0	24.0	4.9
5/19/92	40.0	36.0	1.5	28.0
7/23/92	37.0	11.0	8.1	19.0
8/13/92	33.0	6.6	7.8	10.4
8/27/92	20.7	2.2	2.5	124.0
9/17/92	21.9	10.1	1.5	1.8
10/27/92	67.8	1.5	48.3	21.4
11/24/92	29.1	39.8	56.6	10.3
1/25/93	20.8	15.3	31.2	32.2
10/27/93	43.4	5.4	2.2	2.7
11/10/93	8.2	2.8	5.1	2.7
2/8/94	45.2	1.3	1.6	2.7
3/23/94	38.0	1.0	2.4	66
4/19/94	110.0	1.0	9.7	1
5/10/94	17.0	2.1	2.8	1
5/24/94	15.0	2.2	1.0	12
6/14/94	14.0	1.4	1.0	1.2
7/7/94	29.0	7.8	6.1	1
7/19/94	33.0	25.0	1.0	3.4
8/9/94	56.0	7.7	4.6	1
8/30/94	86.0	6.5	5.1	1.1
9/13/94	96.0	2.1	1.5	15
10/4/94	53.0	6.2	4.8	2.9
10/25/94	18.0	<1	1.2	12
12/6/94	16.0	<1	<1	<1
1/10/95	44.0	<1	6.5	16
2/15/95	65.0	30.0	<1	10
3/14/95	***	***	***	***
4/11/95	8.9	<1	<1	2.8
5/2/95	20.0	<1	<1	<1
5/16/95	4.0	<1	<1	3.5
6/13/95	8.1	<1	<1	15.0
7/11/95	24.0	3.8	2.8	<1
7/2595	51.0	4.6	<1	<1
8/29/95	31.0	1.8	<1	<1
9/12/95	34.0	2.9	<1	4.6
9/27/95	31.0	6.2	6.4	<1
10/10/95	12.0	<1	<1	<
10/24/95	16.0	<1	3.3	3.1
11/7/95	9.8	<1	<1	<1

MIN.	4.0	<1	<1	<1
MAX.	110.0	39.8	56.6	124.0
AVG.	33.5	-	-	-

* Meter malfunction

** Not applicable, ice cover

*** Field/Laboratory accident

Table F-4. Baseline water quality monitoring results from samples collected at site W-M330.1A

DATE	WATER DEPTH (FT)	VELOCITY (FT/SEC)	WAVE HEIGHT (FT)	AIR TEMP. (°C)	CLOUD COVER (%)	WIND SPEED (MPH)
12/6/94	2.50	0.049	0.0	1	100	1
1/10/95	2.25	0.000	**	-2	100	1
2/15/95	2.00	0.000	**	2	100	1
3/14/95	2.25	0.090	0.0	21	50	0
4/11/95	10.00	0.560	0.0	4	100	2
5/2/95	9.00	0.500	0.0	17	65	1
5/16/95	15.00	1.322	0.0	27	95	3
6/13/95	4.05	0.062	0.0	28	15	0
7/11/95	2.35	*	0.0	34	5	0
MIN.	2.00	0.000	0.0	-2	5	0.00
MAX.	15.00	1.322	0.0	34	100	3.00
AVG.	5.49	0.323	0.0	15	70	1.00

Table F-4 (Cont.). Baseline water quality monitoring results from samples collected at site W-M330.1A

DATE	WIND DIRECTION	WATER TEMP. (°C)	DISSOLVED OXYGEN (MG/L)	pH (SU)	TOTAL ALKALINITY (MG/L as CACO3)
12/6/94	NW	5.9	8.17	7.81	186
1/10/95	SE	2.7	4.62	7.48	222
2/15/95	NW	1.4	13.86	*	211
3/14/95	-	17.8	7.64	7.61	149
4/11/95	S	6.3	9.90	7.91	155
5/2/95	N	12.2	9.78	8.26	205
5/16/95	S	17.9	7.02	7.66	158
6/13/95	-	23.0	6.09	7.94	193
7/11/95	-	29.9	6.12	8.23	161
MIN	-	1.4	4.62	7.48	149
MAX	-	29.9	13.86	8.26	222
AVG.	-	13.0	8.13	-	182

* Meter malfunction
** Not applicable, ice cover
*** Field/Laboratory accident

Table F-4 (Cont.). Baseline water quality monitoring results from samples collected at site W-M330.1A

DATE	SPECIFIC CONDUCTANCE (µMHOS/CM @ 25°C)	SECCHI DISK DEPTH (FT)	TURBIDITY (NTU)	SUSPENDED SOLIDS (MG/L)
12/6/94	345	1.00	23	40.0
1/10/95	396	**	14	24.0
2/15/95	432	**	10	9.0
3/14/95	311	0.60	46	81.0
4/11/95	268	0.20	180	520.0
5/2/95	481	0.65	43	120.0
5/16/95	343	0.40	130	290.0
6/13/95	521	0.70	31	39.0
7/11/95	369	0.40	65	66.0
MIN.	268	0.20	10	9.0
MAX.	521	1.00	180	520.0
AVG.	385	0.56	60	132.1

Table F-4 (Cont.). Baseline water quality monitoring results from samples collected at site W-M330.1A

DATE	CHLOROPHYLL a (MG/M3)	CHLOROPHYLL b (MG/M3)	CHLOROPHYLL c (MG/M3)	PHEOPHYTIN a (MG/M3)
12/6/94	7.5	1.6	<1	5.7
1/10/95	10.0	<1	1.7	12.0
2/15/95	65.0	30.0	<1	10.0
3/14/95	46.0	5.2	3.2	19.0
4/11/95	14.0	<1	3.9	<1
5/2/95	14.0	<1	<1	4.2
5/16/95	6.7	2.6	1.5	<1
6/13/95	11.0	<1	<1	<1
7/11/95	27.0	2.8	<1	13.0
MIN	6.7	<1	<1	<1
MAX	65.0	30.0	3.9	19.0
AVG.	22.4	-	-	-

* Meter malfunction

** Not applicable, ice cover

*** Field/Laboratory accident

ADDENDUM - DISSOLVED OXYGEN MASS BALANCE CALCULATIONS

Determine: Flow necessary to maintain DO concentration of 6 mg/Liter throughout the chute.
Length = 12,370 ft.
Proposed channel: 50 ft. bottom width; Trapezoidal cross section; 2:1 side slope; 6 ft. depth except for four 400 ft. long sections of 8 ft. depth.

Winter Conditions

Data & Assumptions

- complete ice cover over Cottonwood Chute
- BOD5 = 5 mg/Liter, based on values observed at other river locations.
- SOD = 8g/m^2/day @ 20 degrees Celsius, conservative estimate based on backwater lake measurements.
- Fish Respiration Rate = 0.0119 ml O2/hr (Leidy, 1977)
- Standing crop of fish = 56 g/m2 (Leidy, 1977)
- Water temperature = 4 degrees Celsius, conservative estimate
- Initial DO is at 80% of saturated value = 10mg/Liter, conservative estimate based on observation
- 1.7 = fish active/standard metabolism ratio (Leidy, 1977)

Step 1: Calculate ultimate BOD = (L)
K@ 20deg. Celsius = 0.23day^{-1}
BOD5 = L - L* exp(-K*time)
5mg/L = L(1-exp(-0.23*5days) ∴ L = 7.32mg/Liter

Step 2: Calculate BOD for any time in days @ 4 degrees Celsius.
K(t) = K@ 20deg. Celsius * ($1.067^{(T-20)}$)
@ 4 degrees Celsius, K(t) = 0.23*($1.067^{(4-20)}$) = 0.0815
BOD at any time (t) = L - L*exp (-K*time)
BOD = 7.32 - 7.32 *exp (-0.0815*time)

Step 3: Calculate SOD
@20 degrees Celsius SOD = 8 gram O2 /m2/day
@4 degrees Celsius SOD = 8*($1.067^{(4-20)}$) = 2.83 gram O2 /m2/day
SOD(mg/Liter) = 2.83*(.3048m/ft.)^2 * (1/6ft.depth throughout section)* (1cubic foot/28.32liters)*1000mg/g*#days
SOD(mg/Liter) = 1.55 * #days

Step 4. Fish Respiration

500lbs./acre* 1acre/43560ft2 *0.0119mlO2/g/hour*1.7*1.6*10^{-7} moles O2/mlO2 * 24hr/day * 32g/mole * 1/6ft. depth * 454g/lb * 1000mg/g

Fish respiration = 2.16*10^{-3}* #days

Step 5: #days = length of shoot / velocity; velocity is a function of flow rate

Step 6: DO remaining = 10 - Fish respiration - SOD - BOD

Example Calculation

discharge = 30cfs
velocity = 0.08 fps
travel time = 2.2 days
BOD = 7.32 - 7.32 *exp (-0.0815*2.2) = 1.20mg/Liter
SOD = 1.55 * 2.2 = 3.41
Fish Respiration = 2.16*10^{-3}* 2.2 = 0.00475
Fish respiration + SOD + BOD = 4.614
DO remaining = 10 -4.614 = 5.39mg/Liter

With 5 mg/Liter BOD5 SOD @ 8g/m2/day

	fps		mg/L	mg/L	mg/L			
Discharge	velocity	Travel Time	BOD	SOD	Fish resp.	total sinks	Water @ 80% Saturation	Net DO
10	0.03	6.7	3.080012	10.385	0.014472	13.47948	10	-3.47948
20	0.05	3.6	1.861302	5.58	0.007776	7.449078	10	2.550922
30	0.08	2.2	1.201541	3.41	0.004752	4.616293	10	5.383707
40	0.11	1.7	0.947064	2.635	0.003672	3.585736	10	6.414264
50	0.14	1.3	0.735882	2.015	0.002808	2.75369	10	7.24631
60	0.16	1.1	0.627682	1.705	0.002376	2.335058	10	7.664942
70	0.18	0.92	0.528782	1.426	0.001987	1.956769	10	8.043231
80	0.21	0.9	0.517703	1.395	0.001944	1.914647	10	8.085353

Flow required for 6mg/liter DO ≈ 40cfs under winter conditions with complete ice cover.

Summer Conditions

Assumptions

- BOD5 = 5 mg/Liter, based on values observed at other river locations.
- SOD = 8g/m^2/day @ 20 degrees Celsius, conservative estimate based on backwater lake measurements.
- Fish Respiration Rate = 0.0119 ml O2/hr (Leidy, 1977)
- Standing crop of fish = 56 g/m2 (Leidy, 1977)
- Water temperature = 35 degrees Celsius (95 degrees Fahrenheit)
  Saturated DO concentration = 6.88 mg/liter
- 1.7 = fish active/standard metabolism ratio (Leidy, 1977)

Example Calculations done for each 100 foot segment. See the row at 200 feet for these calculations.

Step 1: Travel time in #days = length of shoot / velocity; velocity is a function of flow rate.
Travel time at 200 feet = 200/0.03fps = 0.08 days.

Step 2: Determine whether flow is turbulent.
In laminar flow conditions, such as those often found in lakes and reservoirs, thermal stratification can occur. This can result in a layer of water at the bottom with depleted oxygen levels. However, if the flow is turbulent mixing occurs which prevents stratification. The Reynolds # equation can be used to determine whether flow in the Cottonwood Chute would be turbulent or laminar.
key equation

Reynolds # = (velocity * Depth)/kinematic viscosity

◆The boundary value between laminar and turbulent flow can be anywhere between 320 (***Hutchinson, 1975)*** and 18,000 (UIUC CE 356 Class notes 1994).

	fps	
Discharge	velocity	Reynolds #
10	0.03	18000
20	0.05	30000
30	0.08	48000
40	0.11	66000
50	0.14	84000
60	0.16	96000
70	0.18	108000
80	0.21	126000

The Reynold's #'s shown in the chart vary from 18,000 @ 10cfs to 126,000 @ 80 cfs. Therefore, only at a discharge below 10 cfs could the flow in the chute be laminar. With the mixing characterics present in turbulent flow there probably would be no gradient in the chute throughout its depth for temperature and dissolved oxygen levels. Thus hypolimnetic oxygen depletion often found in lakes & reservoirs is not a concern for the Cottonwood Chute.

Step 3: Calculate BOD & SOD.

Calculate ultimate BOD = (L)
K@ 20deg. Celsius = $0.23day^{-1}$
BOD5 = L - L* exp(-K*time)
5mg/L = L(1-exp(-0.23*5days) ∴ L = 7.32mg/Liter

Calculate BOD for any time in days @ 35 degrees Celsius.
$K(t) = K@ 20deg. Celsius * (1.067^{(T-20)})$
@ 35 degrees Celsius, $K(t) = 0.23*(1.067^{(35-20)}) = 0.608$
BOD at any time (t) = L - L*exp (-K*time)
BOD = 7.32 - 7.32*exp (-0.608*time) @ 0.08 days = 0.34 mg/L. To find the 100 foot segment amount. Subtract 0.34 from 0.17 to get 0.17 for net BOD.

Calculate SOD
@20 degrees Celsius SOD = 8 gram O2 /m2/day
$@35 degrees Celsius SOD = 8*(1.067^{(35-20)}) = 21.2$ gram O2 /m2/day
$SOD(mg/Liter) = 21.2*(.3048m/ft.)^2$ * (1/6ft.depth throughout section)* (1cubic foot/28.32liters)*1000mg/g*#days
SOD(mg/Liter) = 11.57 * #days. 11.57 * 0.08 = 0.01; 0.01- 0.0 = 0.01.
Total sinks = 0.18mg/Liter

Step 4: Oxygen Reaeration Rate.
In the summer if the oxygen is depleted below the saturated level, oxygen will diffuse from the atmosphere into the water.
Equation 6-54 (Metcalf & Eddy, 1991)
dc/dt = kla(cs - c)
dc/dt = rate of oxygen transfer
cs = saturated oxygen
c = concentration of oxygen
kla = oxygen transfer coefficient

Possible kla values

Whittemore, 1991, discusses techniques for determining stream reaeration rates without field measurements and gives a range of possible values. With a value for stream reaeration coefficient the rate of atmospheric recharge can be calculated and compared to values for depletion. The range for reaeration coefficients varies from exp(278/day) to zero for all weather and hydraulic conditions with the average value being exp (6.79/day). With higher coefficients more oxygen recharge occurs and vice versa.

Based on inspection of the extreme values for weather and hydraulic conditions in Whittemore, 1991, the conditions at Cottonwood would be about midrange for the conditions used to calculate the aeration coefficients. Therefore, use the average value of exp(6.79/day) for reaeration coefficient can be used to calculate DO levels.
@ kla = exp(6.79/day)

APPENDIX G

SEDIMENTATION

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
REHABILITATION AND ENHANCEMENT

POOL 21, MISSISSIPPI RIVER MILES 328.5 THROUGH 331.0
LEWIS AND MARION COUNTIES, MISSOURI

APPENDIX G
SEDIMENTATION

INTRODUCTION

A sedimentation study was conducted to evaluate Cottonwood Island sedimentation during the period 1938 through 1994. The scope of this study, as presented in this appendix, consisted of determining net sedimentation from 1938 through 1994.

COMPUTATIONS

To determine Cottonwood Island total net sedimentation, baseline elevations were established from 1938 plane table topographic maps. Additional sections were taken by survey crews in 1994. These sections were extended by combining the 1994 data with elevations obtained from 1977 photographic mapping. The 1938 elevations were compared with the 1994/1977 elevations to show net changes in elevation. Six ranges were used to construct composite cross sections of this area (see plates 12 and 13, main report). Calculations are shown on plate G-1.

RESULTS

The average total sedimentation rate for the overall Cottonwood Island area has been approximately 0.46 inch/year, or 2.16 feet over 56 years. Sedimentation varies greatly through the project site, with the majority of the sediment deposited above the causeway. Sedimentation deposition in the upstream end of Cottonwood Island, near Wing Dam 9, has been 1.20 inch/year and 0.46 inch/year in the upstream end of Cottonwood Island near Wing Dam 8. Sediment deposition in Cottonwood Chute above the causeway averages 0.76 inch/year and 0.16 inch/year below the causeway. See Table G-1 for sedimentation rates and dredging depths, plate 2 of the main report for Cottonwood Island Site Plan, and plates 12 and 13 of the main report for

composite sedimentation cross sections. Channel depths at the end of the project life (50 years) are estimated to be 6 feet, and 10 feet for the deep fish holes. The estimated sediment deposition for the deep holes was increased to offset a trap effect as flow velocities through the deep holes will be less than that of the channel due to their increased depth. Dredging depths will be 7 feet for the channel and 15 feet for the deep fish holes. Dredging depths are rounded to the nearest foot.

TABLE G-1

Area Sedimentation Rates

Sedimentation Source	Location	Average Sedimentation Rate Inch/Yr.	Average 50-Year Sedimentation (feet)	Excavation/ Dredging Depth (feet)
River	Upstream end of Cottonwood Island near Wing Dam 9	1.20	5.0	N/A
River	Upstream end of Cottonwood Island near Wing Dam 8	0.46	1.9	N/A
River	Cottonwood Chute - above existing causeway	0.76	3.2	N/A
River	Cottonwood Chute - below existing causeway	0.16	0.7	7 (channel) 15 (deep hole for fish)
River	Cottonwood Chute - below island	0.11	0.5	7 (channel) 15 (deep hole for fish)

The Mississippi River is the predominant sedimentation source. The project area is protected from upland erosion by the Fabius River Levee District levee. Therefore, there is no drawing showing adjacent watersheds and upland erosion in this report.

Cottonwood Chute Sedimentation

Cottonwood Chute	Station (River Mile)	Section Length (feet)	Fill Area (SF)	Average Fill Depth (feet)
	328.7	920	822	0.89
Below Island	329.2	1,980	326	0.16
Below Existing Causeway	329.5	1,950	2,447	1.25
Above Existing Causeway	330.15	1,960	5,815	2.97
Pilot Channel, D/S End	330.7	880	1,880	2.13
Pilot Channel, U/S End	330.9	550	3,067	5.58
			Total =	12.98

Sedimentation Calculations:

Average Sedimentation = 12.98'/6 = 2.16'/section
(2.16'/56 years) x (12"/1') = 0.46"/year
0.46"/year x 50 years)/12"/1' = 1.9'

Upstream End of Pilot Channel = 5.58'
(5.58'/56 years) x (12"/1') = 1.20"/year
1.2"/year x 50 years)/12"/1' = 5.0'

Downstream End of Pilot Channel = 2.13'
(2.13'/56 years) x (12"/1") = 0.46"/year
0.46"/year x 50 years)/12"/1' = 1.9'

Above Existing Causeway = (5.58' + 2.13' + 2.97')/3 = 3.56'/section
(3.56'/56 years) x (12"/1') = 0.76"/year
0.76'/year x 50 years)/12"/1' = 3.2'

Below Existing Causeway = (1.25' + 0.16' + 0.89')/3 = 0.77'/section
(0.77'/56 years) x (12"/1') = 0.16'/year
0.16'/year x 50 years)/12"/1' = 0.7'

Below Island = (0.16' + 0.89')/2 = 0.53'/section
(0.53'/56 years) x (12"/1') = 0.11/year
0.11'/year x 50 years)/12"/1' = 0.5'

APPENDIX H

HYDROLOGY AND HYDRAULICS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
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APPENDIX H
HYDROLOGY AND HYDRAULICS

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LEWIS AND MARION COUNTIES, MISSOURI

APPENDIX H
HYDROLOGY AND HYDRAULICS

INTRODUCTION AND LOCATION OF SITE

Cottonwood Island is on the Missouri side (west) of the Mississippi River between River Miles 328.5 and 331 (see plate H-1). The site is about two miles west of Quincy, Illinois. The nearest stage gage on the Mississippi River is at Quincy, Illinois (River Mile 327). Cottonwood Chute empties into the Mississippi River about 1.5 miles upstream of this gage.

This appendix summarizes the hydrologic and hydraulic evaluation of various alternatives associated with the Cottonwood Island project. The text includes a discussion of the emergent rock dike, the excavated pilot channel, flow control structures for the pilot channel, and a sediment barrier levee. These alternatives were investigated but not selected.

Work on Cottonwood Chute started with an HEC-2 model of the Chute. The model provided information on average channel velocities, and change in water level for various discharges. Work also included an examination of various control structures at the upstream junction of the chute with the Mississippi River. Studies on the Mississippi River included the evaluation of an emergent dike in the Mississippi River. Some modeling was also done to determine the influence of opening segments of each wing dam on the west side of the Mississippi between River Miles 329.1 and 330.6.

CLIMATE

Temperature and rainfall information used for the site were recorded at the Quincy weather station from 1901 to 1977 (period of record is 77 years).

The maximum average monthly temperature of 90 degrees Fahrenheit occurred in July. The minimum average monthly temperature of 19 degrees Fahrenheit occurred

in January. The average annual precipitation is 36.48 inches with a standard deviation of 7.46 inches. The average annual snowfall is 20.4 inches with a standard deviation of 9.19 inches. Monthly mean values appear in Table H-1.

TABLE H-1

Summary of Monthly Precipitation and Snowfall

Month	Rain (In.)	Snow (In.)	Month	Rain (In.)	Snow (In.)
January	1.79	5.87	July	3.51	None
February	1.53	4.51	August	3.69	None
March	2.75	3.53	September	4.27	None
April	3.62	0.87	October	2.59	0.05
May	4.17	None	November	2.14	1.10
June	4.69	None	December	1.74	4.62

MISSISSIPPI RIVER DISCHARGES AND STAGES

WINTER CONDITIONS

One goal of the project is to improve the fish habitat in Cottonwood Chute during the winter. From December to January discharges in the Mississippi River ranged from 37,000 to 45,000 cubic feet per second (cfs). Winter computations for average channel velocity in the Mississippi River and Cottonwood Chute used a total river discharge of 40,000 cfs. At this discharge the water level of the Mississippi River at the project site would fluctuate around flat pool (elevation 470 feet 1912 datum). The average discharges for several locations on the Mississippi River from December through May appear on plate H-2. The plotted values represent 5-day mean discharges for the period from 1941 through 1971. Discharges at the project site would be similar to those shown for Dam 22.

Plate H-3 shows the annual flow duration curve for Dam 21. A discharge of 40,000 cfs is equaled or exceeded about 77 percent of the time. The flow duration curve was made from a tail water stage duration curve for Dam 21. The period used for the tail water stage duration curve extended from 1940 through 1973. A rating curve was used to convert tail water stages into discharges.

FLOOD CONDITIONS

The project is not designed to operate during floods or to even withstand a flood. It is still useful to examine flood conditions at the project site. Plate H-4 shows the flood

profiles on the Mississippi River in the vicinity of the project. The stages and discharges at River Mile 330.6 appear in Table H-2. This location on the Mississippi River is between the emergent dike and the proposed inlet to Cottonwood Chute. The stage and discharge data are from a 1979 publication titled *Upper Mississippi River Water Surface Profiles River Mile 0.0 to River Mile 847.5.* This publication was prepared for the technical flood plain management task force of the Upper Mississippi River Basin Commission by the Corps of Engineers. The Corps of Engineers uses it for all work on the Mississippi River.

TABLE H-2

Discharges and Stages for Various Probability Floods on the Mississippi River

Probability	Recurrence Interval (Yrs)	Discharge in cfs	RM 330.6 Stage in(Feet)	Quincy Hwy Bridge RM 327
0.2%	500	441,000	490.8	489.75
0.5%	200	404,000	489.1	488.1
1%	100	374,000	487.6	486.55
2%	50	349,000	486.4	485.4
10%	10	277,000	482.5	481.2
20%	5	243,000	480.6	479.2

Navigation at Lock and Dam 21 stops when the tail water reaches a stage of 22 feet. This corresponds to a discharge of about 297,000 cfs and an elevation of 483.5 feet at River Mile 330.6 and an elevation of 482.2 at the Quincy Highway Bridge at River Mile 327. Such an event would have a 7 percent probability of occurring in any given year.

An event with a 4 percent probability of occurrence (25-year event) produces an elevation of 484.9 feet at River Mile 330.6 and 483.8 at the Quincy Highway Bridge (RM 327). The water level was determined by graphical methods.

STAGE HYDROGRAPHS

The Mississippi River stage is recorded at Quincy gage (River Mile 327). The U. S. Weather Bureau operates and maintains this gage. It has been in operation since 1960 at the Quincy Water Works. The stage hydrographs for the last 15 years appear on plates H-6 - H-11.

Stage duration curves for various locations in Pool 21 appear on plate H-14. The project site is just upstream of Quincy. The curves were taken from the master reservoir regulation manual for Lock and Dam 21, dated November 1980.

ALTERNATIVES INVESTIGATED BUT NOT SELECTED

EMERGENT ROCK DIKE

Bed profile measurements for streams in general have shown that the bed observed at low flows is not the same bed that exists at high flows. At high flows the bed is scoured in the channel bends and is built up in the crossings between bends. On the recession side of the flood, the process is reversed. Since the emergent dike (crest elevation 476 feet) is overtopped by all floods (see plate H-4) is it unlikely to prevent sediment deposits. It would probably trap sediment on its downstream side every time it is overtopped.

In HEC-2 analyses the dike did not cause measurable increases in the computed water levels. However, by reducing the cross-sectional area of the river, the dike did increase the average velocity of water in the navigation channel. At low Mississippi River discharges the changes in velocity are insignificant. However, the changes in velocity just before the dike would have been overtopped would have caused erosion. This conclusion is based on EM 1110-2-1601 which recommends a maximum permissible mean channel velocity of 4.0 feet per second (fps) for coarse sand. Table H-3 compares the average channel velocities at the most constricted cross section with and without the dike.

TABLE H-3

Changes in Average Channel Velocity Due to Emergent Dike

Total Discharge (cfs)	Velocity without Dike (fps)	Velocity with Dike (fps)
40,000	1.17	1.24
64,000	1.86	1.97
140,000	3.62	3.92
178,000	4.05	4.52

The dike would increase erosion within the navigation channel adjacent to the dike and increase sedimentation in the river downstream of the dike. This would intensify existing sedimentation problems in Illinois where a tributary enters at River Mile 328.9. This same channel is used by recreational boaters to enter their marina. This

condition exists for discharges above 140,000 cfs. This discharge is equaled or exceeded about 12 percent of the time.

PILOT CHANNEL EXCAVATION AND FLOW CONTROL STRUCTURES

This alternative would have increased the cross-sectional area of Cottonwood Chute. A trapezoidal channel with a bottom elevation of 463 feet (1912 datum) and a side slope of 2.5 on 1 would have been excavated for almost the entire length. The bottom width would be 30 feet above section 2.18 (plate H-1) and 50 feet downstream. Three fish holes each 300 feet long with a bottom elevation of 455 feet (1912 datum) were included with this alternative.

The flow around Cottonwood Island is a split flow situation. This condition exists with or without the channel excavation. Less than 1 percent of the total discharge in the Mississippi River upstream of the chute enters the chute. The alternative was evaluated by computing the discharge and average velocity in the chute. Three cases were evaluated. The first case modeled the existing Cottonwood Chute. The second case modeled the proposed channel excavation along Cottonwood Chute. The third case modeled the proposed channel excavation with a weir at the entrance of the chute (section 2.49 on plate H-1).

Each case used the same three total discharge values. A discharge of 40,000 cfs provided information on the average winter conditions. A discharge of 64,000 cfs provided information on the annual 50-percent duration discharge. The last discharge was 198,000 cfs. This discharge produced a computed water surface elevation that was equal to the crest of emergent dike (elevation 476).

Discharges and velocities were calculated using the HEC-2 computer program. The split flow problem was solved using standard procedures. Two input files were used to evaluate each case. One input file modeled the Mississippi River and another input file modeled Cottonwood Chute. Plate H-1 shows the cross-sectional locations for the two input files. Water surface profiles started at Mississippi River Mile 328 using a water surface elevation taken from a Quincy gage rating curve. The water level at Mississippi River section 328.6 was used for the starting water level at section 0.00 in Cottonwood Chute. The total target discharge was split between the two input files in a trial and error method until the computed water levels at Mississippi River Section 330.9 and Cottonwood Chute section 2.49 were identical. At this point, the flow split was balanced.

The existing case used surveyed cross sections for Cottonwood Chute and soundings for cross sections on the Mississippi River. Computed discharges and average velocities in the chute are shown in Table H-4. At total discharges of 40,000 and 64,000 cfs, very little water flows down the chute. This is because the minimum channel elevation at the upstream entrance of the chute is just below the water level in the Mississippi River. The model does not include the existing culvert crossing near the middle of the chute reach. The velocity in the existing channel is so slow

that the culvert is not a restriction The chute velocity is the average channel velocity of section 0.89. The "n" values were 0.034 for the chute and 0.025 for the Mississippi River. Overbank "n" values were 0.09 for both models. Expansion coefficients were 0.1 and contraction coefficients were 0.3 for both input files.

TABLE H-4

Discharges and Velocities in Cottonwood Chute for the Existing Case

Total Discharge (cfs)	Chute Discharge (cfs)	Chute Velocity (fps)
40,000	0.1	0.00
64,000	0.5	0.00
198,000	885	1.73

The channel improvement options were added to the existing case run to produce the with-project Alternative 1 (excavation in Cottonwood Chute). Since the channel bottom at the entrance to the chute was lowered 7 feet to elevation 463 the discharges in the chute increased. By increasing the amount of water flowing in the chute, the alternative also would have increased the sedimentation rate in the chute. Computed discharges for the existing case appear in Table H-4.

Submerged Weir

With-project Alternative 2 consisted of Alternative 1 with the addition of a submerged weir at the upstream entrance to the chute. This option was examined to reduce the velocity during winter to about 0.1 fps so that fish would not have to swim against a strong current. By reducing the discharge the sedimentation rate in Cottonwood Chute would also have been reduced. The weir was placed at section 2.46 on Cottonwood Chute (Mississippi River Mile 330.8). It was sized with a crest at elevation 468 feet (1912 datum) and a length of 20 feet. Table H-5 shows the reduction in discharge and velocity with and without the submerged weir. Discharges were computed with HEC-2 using the split flow method discussed previously.

TABLE H-5

Discharges and Velocities in
Cottonwood Chute for Enlarged Channel

Total Discharge (cfs)	Without Weir		With Weir	
	Chute Discharge (cfs)	Fish Hole Velocity (fps)	Chute Discharge (cfs)	Fish Hole Velocity (fps)
40,000	142	0.20	105	0.15
64,000	245	0.34	170	0.24
198,000	1590	1.08	1,350	0.92

Culverts

The results from the submerged weir analysis indicated that the weir could be replaced by culverts to reduce the velocity even more. By now the design goal had been refined to provide 4 to 6 mg/liter of dissolved oxygen in Cottonwood Chute during the winter. ED-HQ determined that this amount of oxygen could be supplied with a discharge between 30 to 40 cfs.

At a discharge of 40,000 cfs in the Mississippi River and of 40 cfs in Cottonwood Chute, the head available to force water through a submerged culvert would be about 0.1 foot. Three options were studied. A discharge of 37 cfs is possible with four concrete pipes 2.5 feet in diameter. Three concrete pipes each 3.0 feet in diameter would supply about 39 cfs. And finally one box culvert 5 feet by 5 feet would supply about 49 cfs. Rating curves for the various options are shown on plate H-5.

The computations for plate H-5 used a length of 50 feet, an "n" value of 0.12, and a square edged entrance. If the top of the culvert is 1.0 to 1.5 feet below flat pool there will be little chance of the culvert freezing. This would place the invert around elevation 466.0 feet. The desired discharge is too large to use a "trickle tube" (a smaller diameter perforated pipe). The head range of 1.6 feet covers most conditions. At a Mississippi River discharge of 140,000 cfs the available head is about 0.9 feet. This discharge is exceeded only 12 percent of the time.

SEDIMENT DEFLECTION LEVEE

The sediment deflection levee would have run parallel to the west bank of the Mississippi River from below the flow control structure upstream to the Fabius Levee. At this junction the Cottonwood levee would have a crest elevation of 485 feet while the Fabius Levee has a crest elevation of 491 feet. As the water level in the Mississippi River rises above elevation 474 water would flow from the Mississippi River over Cottonwood Island and into Cottonwood Chute. At the same time water

would flow upstream in Cottonwood Chute flooding the area behind the levee. When the levee is actually overtopped there would be water on both sides of it. This would minimize erosion of the levee when water flows over the levee crest. The levee would act like a wing dam and would not create problems for the Fabius Levee.

ALTERNATIVES INVESTIGATED AND SELECTED

INFLUENCE OF MAKING OPENINGS IN THE SUBMERGED WING DAMS

The influence of making 100-foot openings in the wing dams was modeled with FastTABS version 3.01. The openings extended from the crest of the wing dam to the present riverbed (a distance of about 3 feet). When the model was constructed, the actual location of the notches had not been agreed upon. The model was made with notches starting 100 feet from the shoreline and extending toward the navigation channel for another 100 feet. This distance was chosen to prevent the wing dams from being flanked on the shoreward side. The simulation used a typical river cross section to create a reach 10,500 feet long. The three wing dams were located in this reach using the actual spacing measured in the field. A long reach length leading to the first wing dam was used to ensure that the flow distribution was stable at the first wing dam. Later, it was decided to put the notches at a variable distance from shore but no closer than 100 feet. The notches also would extend to the base of the wing dam or 5 feet below the present riverbed. A revised model was not made because the results would have been essentially the same.

At a flow of 40,000 cfs, the velocity upstream and downstream of the wing dams was about 0.3 fps. There was only a slight difference between the velocity patterns of the models with and without openings in the wing dams. The openings started 100 feet from the shoreline and extended toward the center of the river for 100 feet. At a higher flow of 243,000 cfs, the velocity in the vicinity of the wing dams varied from 2.5 to 3.0 fps. At higher discharges, there was even less difference between the with-notch and without-notch cases.

In technical report E-84-4 titled, *Environmental Guidelines for Dike Fields,* by Carey Burch, *et al.*, notching emergent wing dams resulted in holes being eroded in the sediment downstream of the notch. The wing dams in their study extended from the channel bottom to above normal water level. In contrast, the submerged wing dams modeled for Cottonwood do not reveal significantly higher velocities capable of eroding holes or scouring paths connecting the notches. However, a 1980 wing dam study performed by the Iowa Department of Natural Resources (IADNR) on 595 wing dams observed that 9 times out of 10, a wing dam blowout (or natural notch) would have an accompanying scour hole. It also was observed that the closer the wing dam was to the water surface, the greater the scour. The IADNR velocity measurements 100 feet upstream of the wing dam, and at the wing dam, were proportional to the hydraulic model velocities, i.e., the velocity at the wing dam was approximately twice the velocity 100 feet upstream of the wing dam (John Pitlo, IADNR, pers. comm.

4-4-96). The Cottonwood wing dams are all considered to be close to the water surface (within 1 to 2 feet). The performance of the Cottonwood Island wing dam notches will be monitored for comparison with the hydraulic model, the monitoring results discussed in the Carey Burch, *et al.*, report, and the IADNR wing dam study. This evidence justifies making Cottonwood a test case for the District in contrast to the model results.

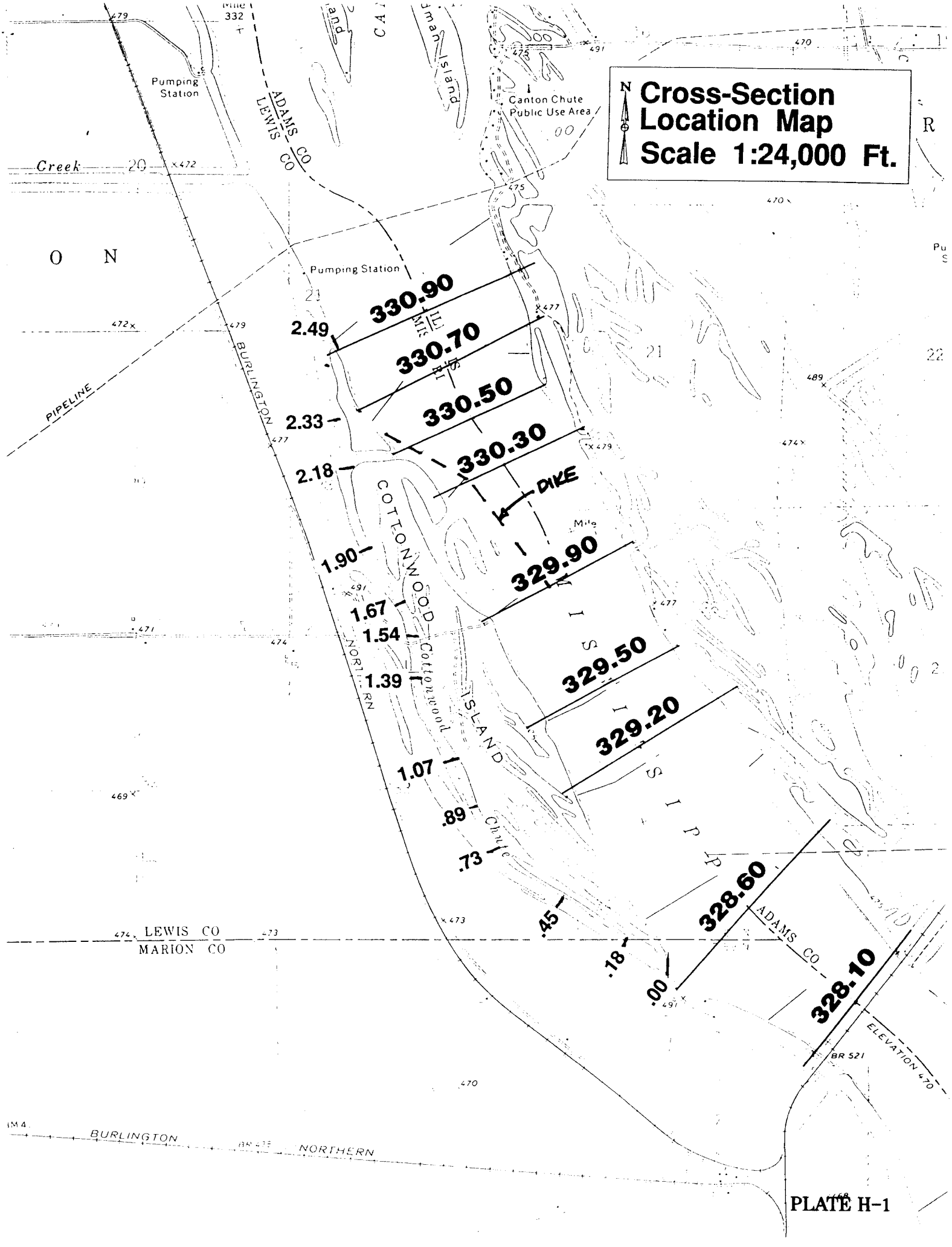

Cross-Section Location Map
Scale 1:24,000 Ft.
N
Pumping Station
ADAMS CO
LEWIS CO
Canton Chute Public Use Area
Creek
Pumping Station
330.90
330.70
330.50
330.30
DIKE
329.90
329.50
329.20
328.60
328.10
2.49
2.33
2.18
1.90
1.67
1.54
1.39
1.07
.89
.73
.45
.18
.00
PIPELINE
BURLINGTON NORTHERN
COTTONWOOD ISLAND
Cottonwood Island
SLIP
LEWIS CO
MARION CO
ADAMS CO
BR 521
ELEVATION 470
BURLINGTON NORTHERN

PLATE H-1

MISSISSIPPI RIVER FIVE DAY MEAN DISCHARGES

(1941 Through 1971)

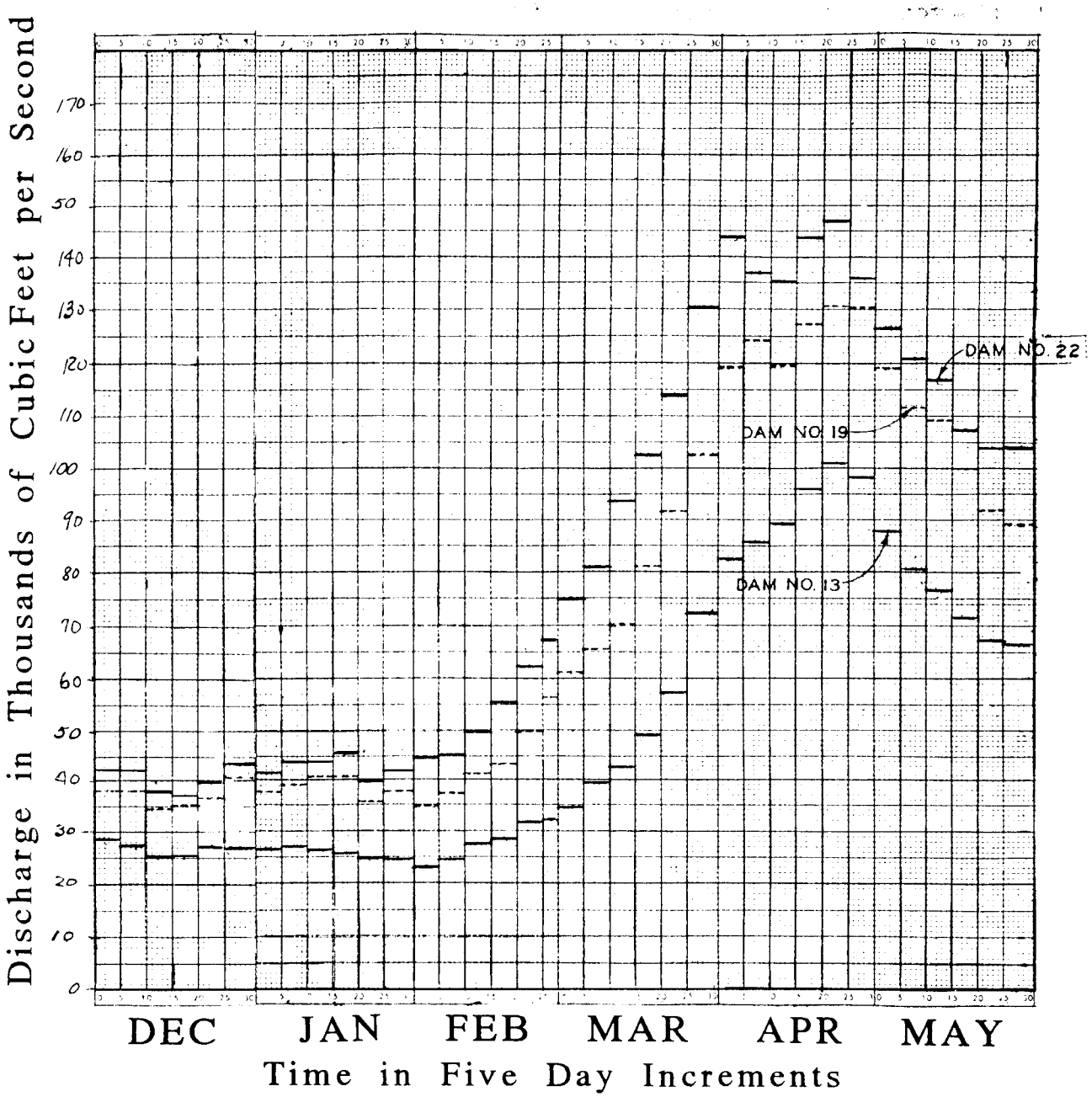


PLATE H-2

Flow Duration Curve for Dam 21

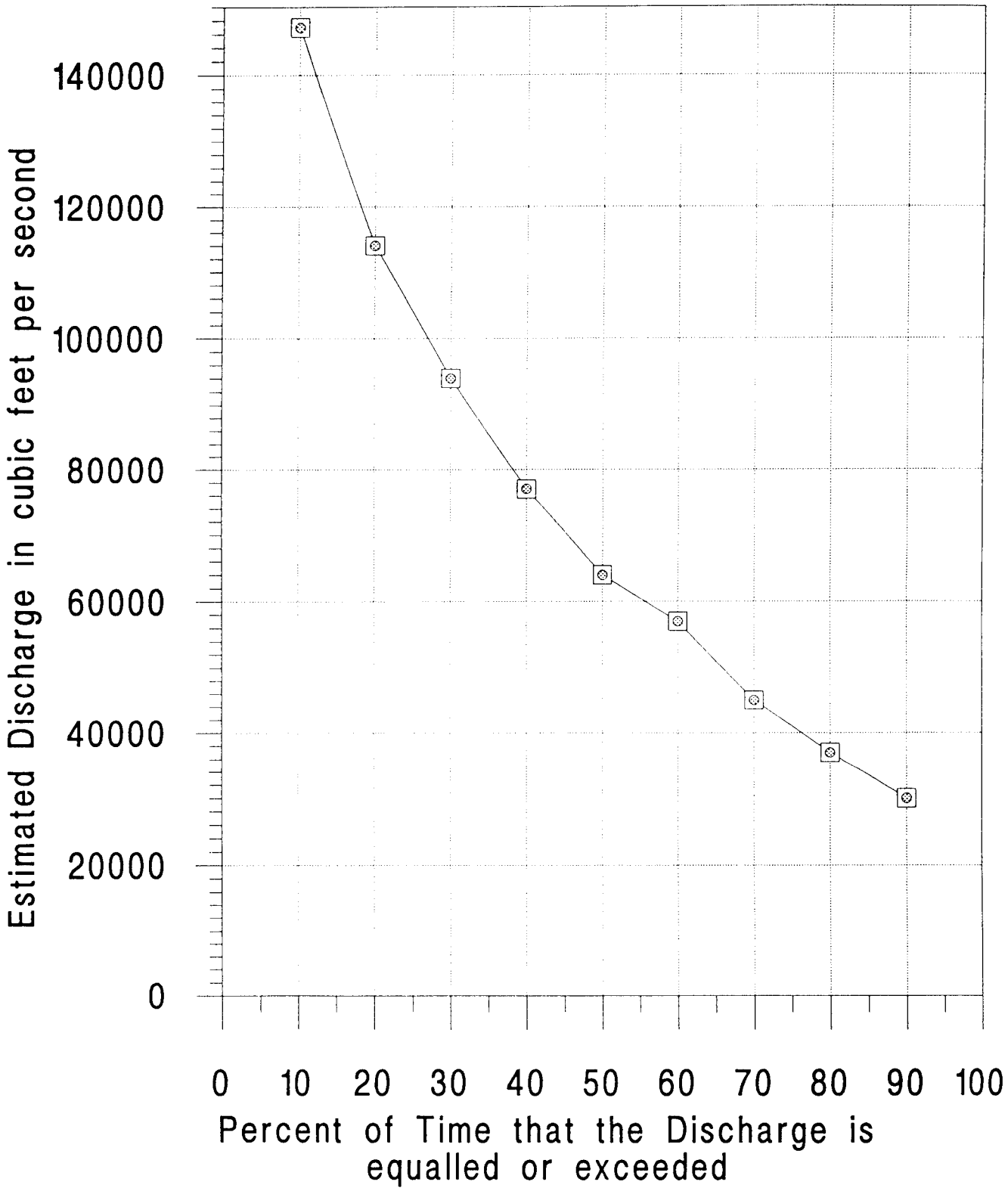


PLATE H-3

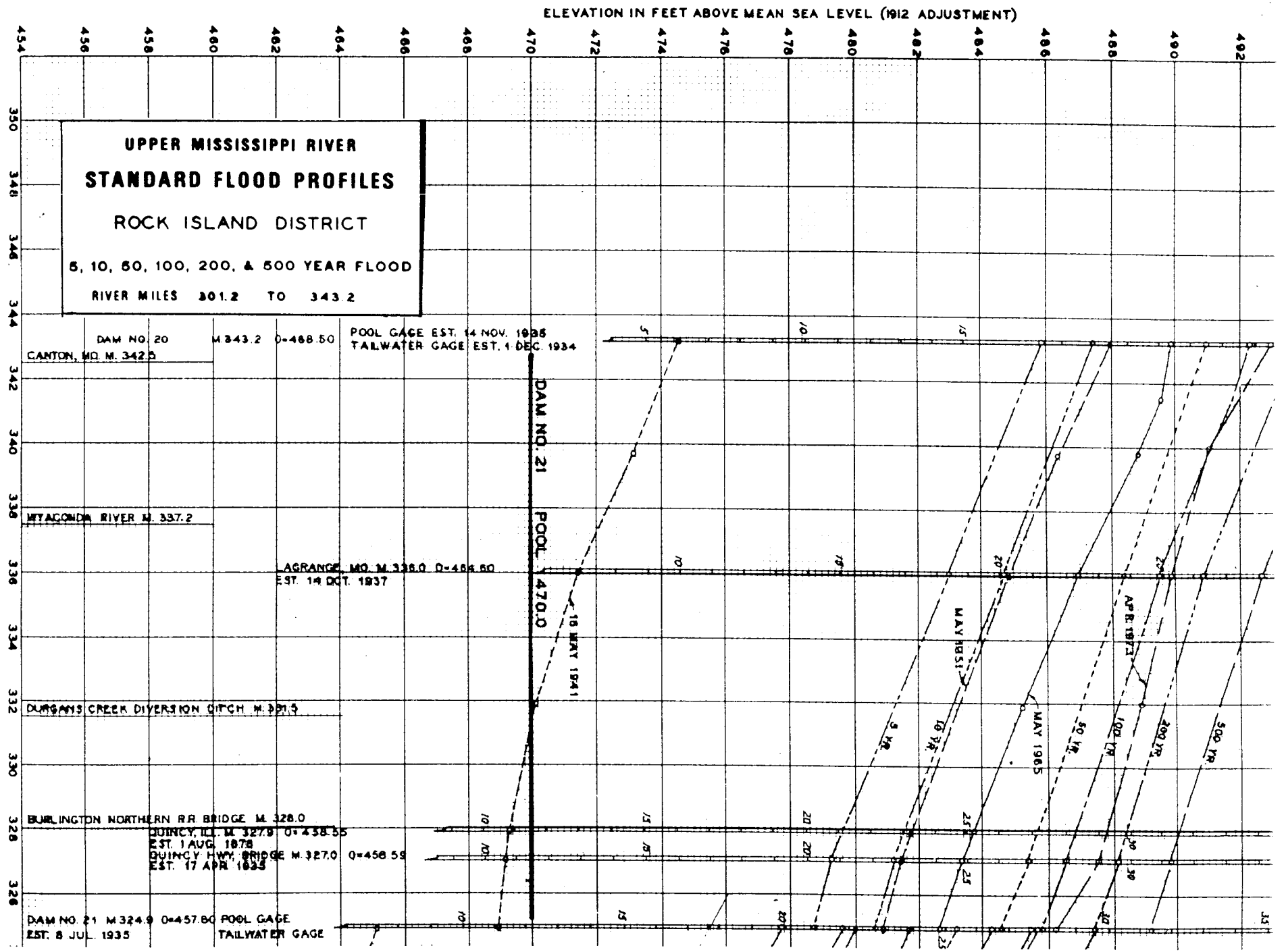

ELEVATION IN FEET ABOVE MEAN SEA LEVEL (1912 ADJUSTMENT)
454 456 458 460 462 464 466 468 470 472 474 476 478 480 482 484 486 488 490 492
350 348 346 344 342 340 338 336 334 332 330 328 326
UPPER MISSISSIPPI RIVER
STANDARD FLOOD PROFILES
ROCK ISLAND DISTRICT
5, 10, 50, 100, 200, & 500 YEAR FLOOD
RIVER MILES 301.2 TO 343.2
DAM NO. 20 M 343.2 0=468.50
CANTON, MO. M. 342.5
POOL GAGE EST. 14 NOV. 1935
TAILWATER GAGE EST. 1 DEC. 1934
DAM NO. 21 POOL 470.0
MYACONDA RIVER M. 337.2
LAGRANGE, MO. M. 336.0 0=466.60
EST. 14 OCT. 1937
DURGANS CREEK DIVERSION DITCH M. 331.5
BURLINGTON NORTHERN R.R. BRIDGE M. 328.0
QUINCY, ILL. M. 327.9 0=458.55
EST. 1 AUG. 1878
QUINCY HWY. BRIDGE M. 327.0 0=456.59
EST. 17 APR. 1935
DAM NO. 21 M 324.9 0=457.80 POOL GAGE
EST. 8 JUL. 1935 TAILWATER GAGE
18 MAY 1941
MAY 1851
APR. 1973
MAY 1965
5 YR.
10 YR.
50 YR.
100 YR.
200 YR.
500 YR.

PLATE H-4

M11

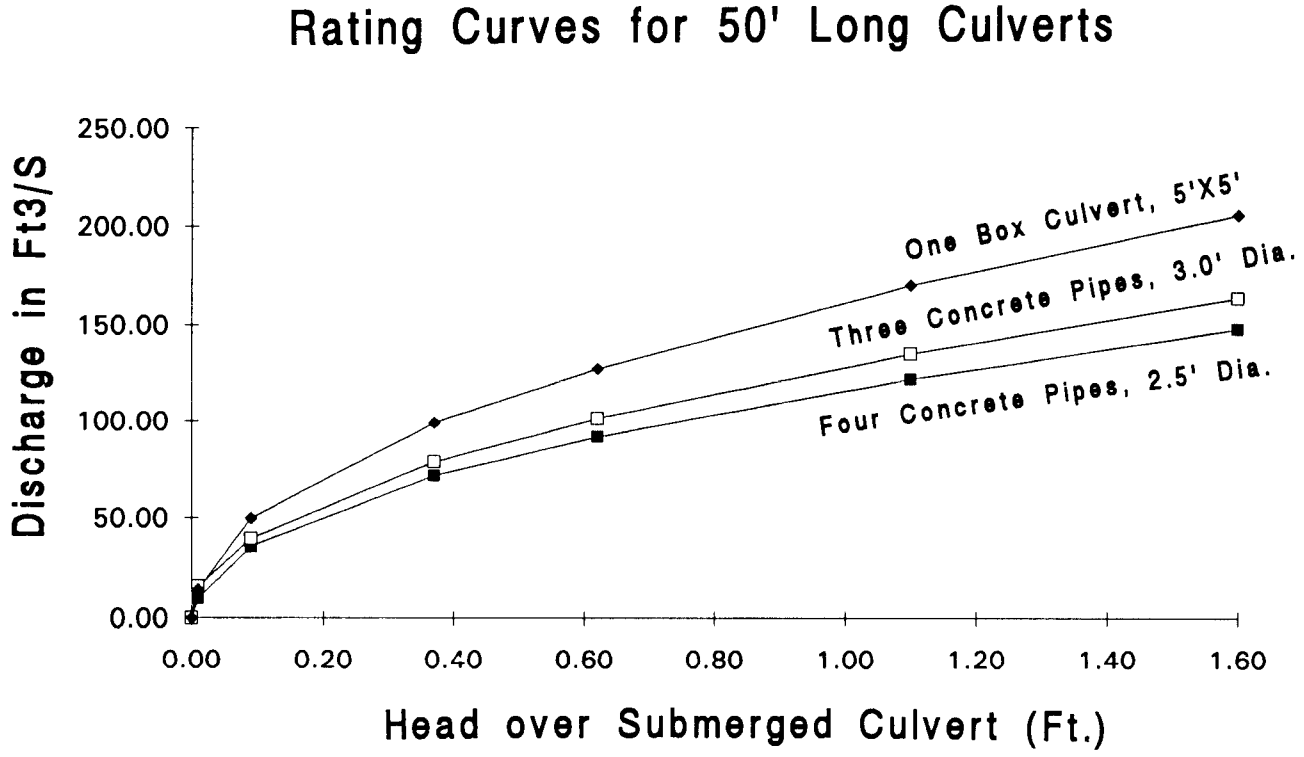
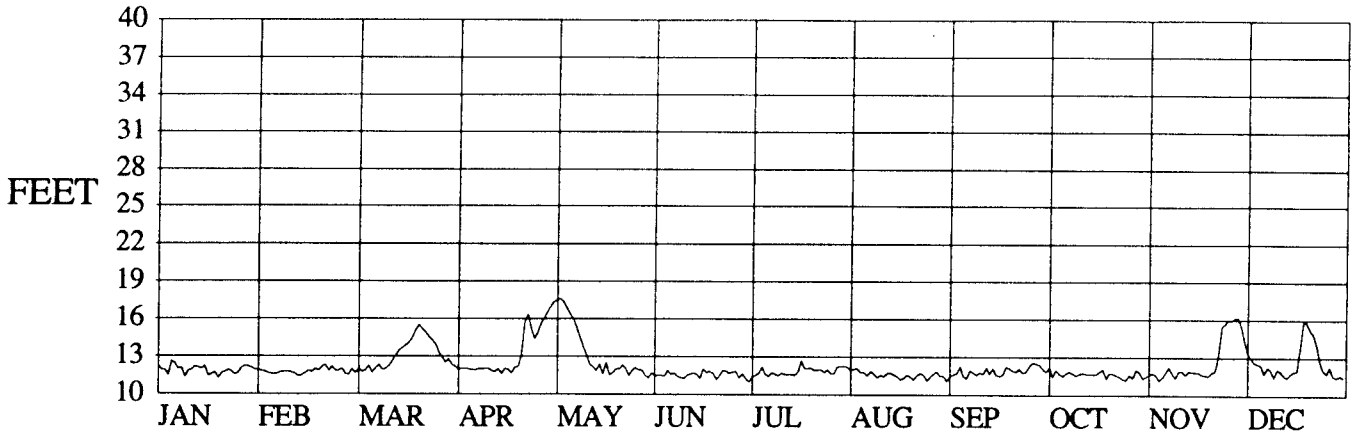
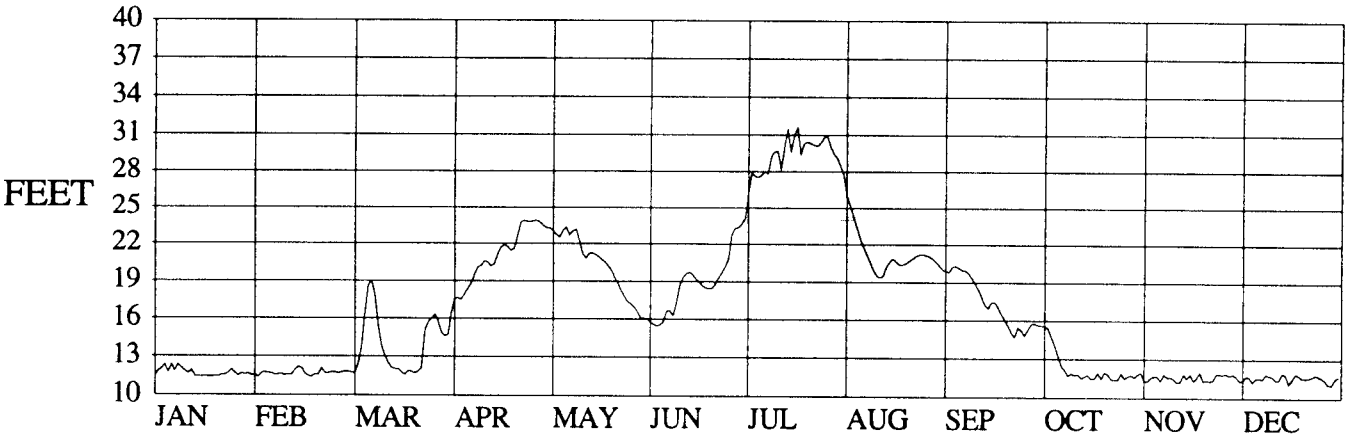

Rating Curves for 50' Long Culverts
Discharge in Ft3/S
250.00
200.00
150.00
100.00
50.00
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
Head over Submerged Culvert (Ft.)
One Box Culvert, 5'X5'
Three Concrete Pipes, 3.0' Dia.
Four Concrete Pipes, 2.5' Dia.

PLATE H-5

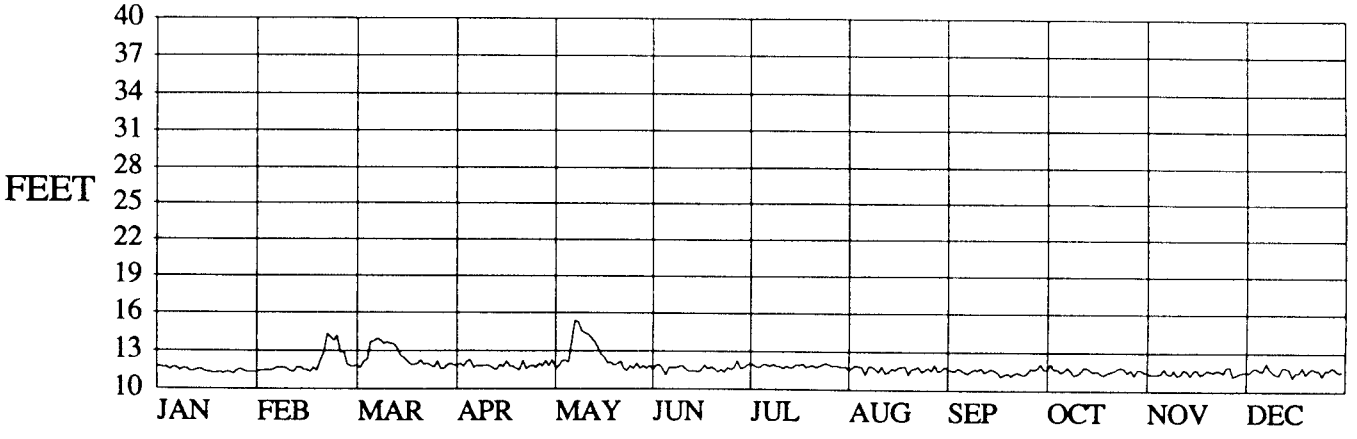
MISSISSIPPI RIVER
QUINCY, ILLINOIS RIVER MILE 327.9
1992 - 1994 GAGE ZERO = 458.59



1992



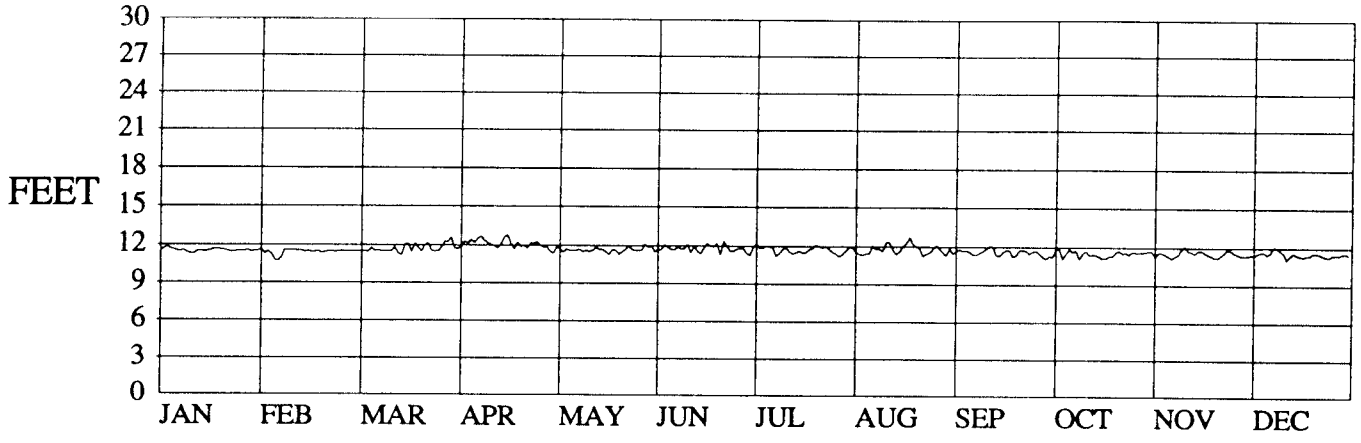
1993



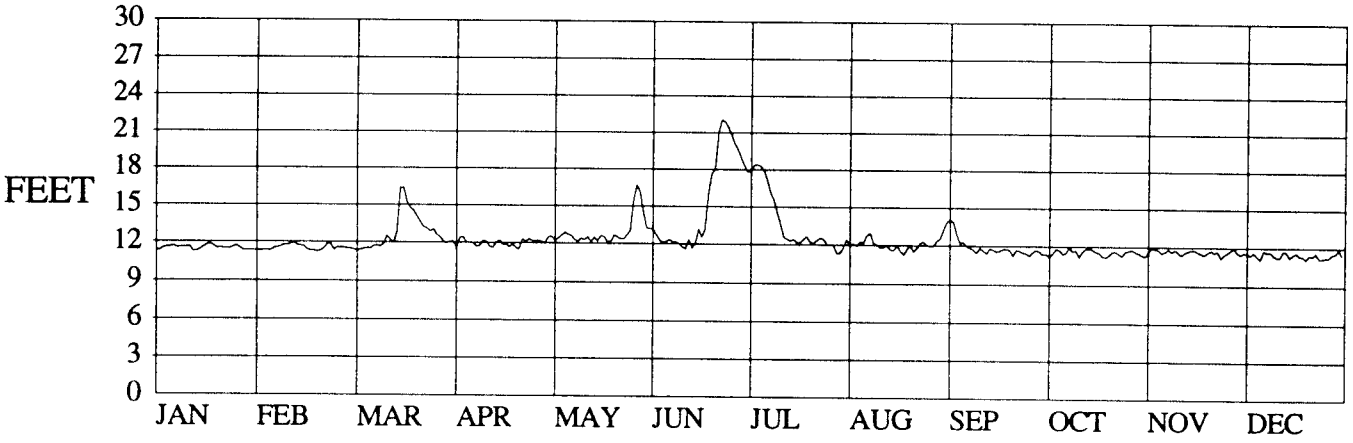
1994

PLATE H-6

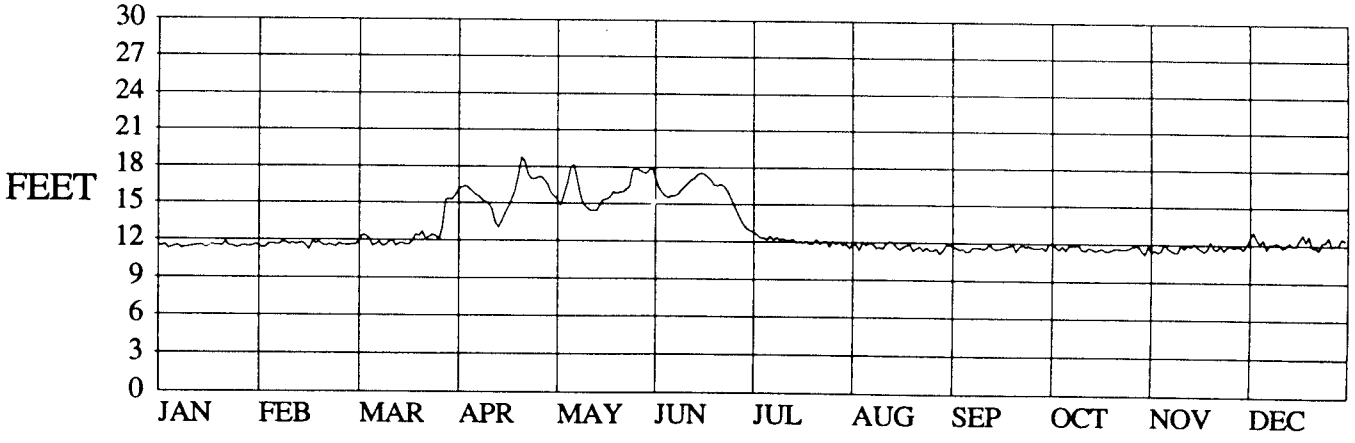
MISSISSIPPI RIVER
QUINCY, ILLINOIS RIVER MILE 327.9
1989 - 1991 GAGE ZERO = 458.59



1989



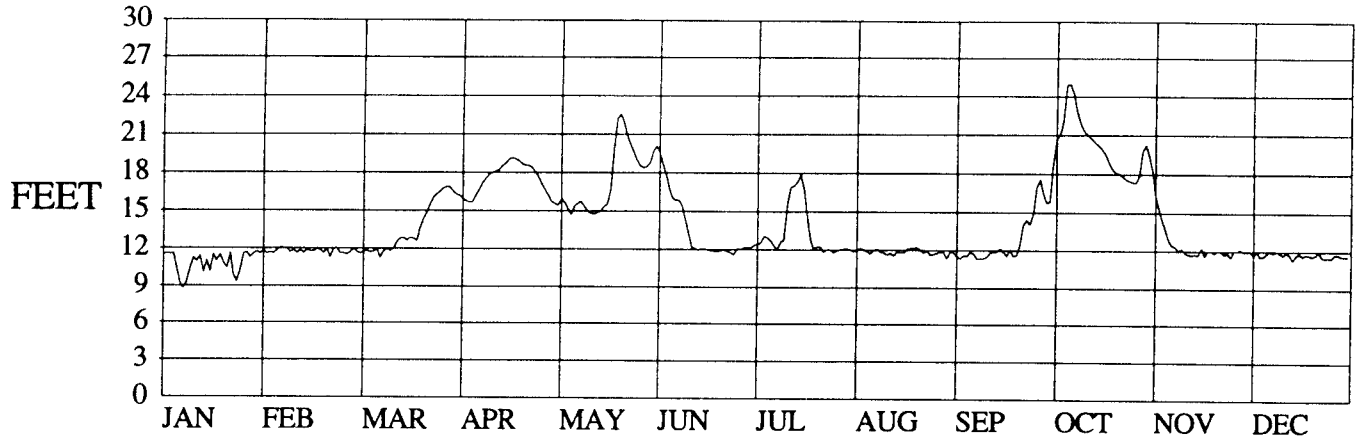
1990



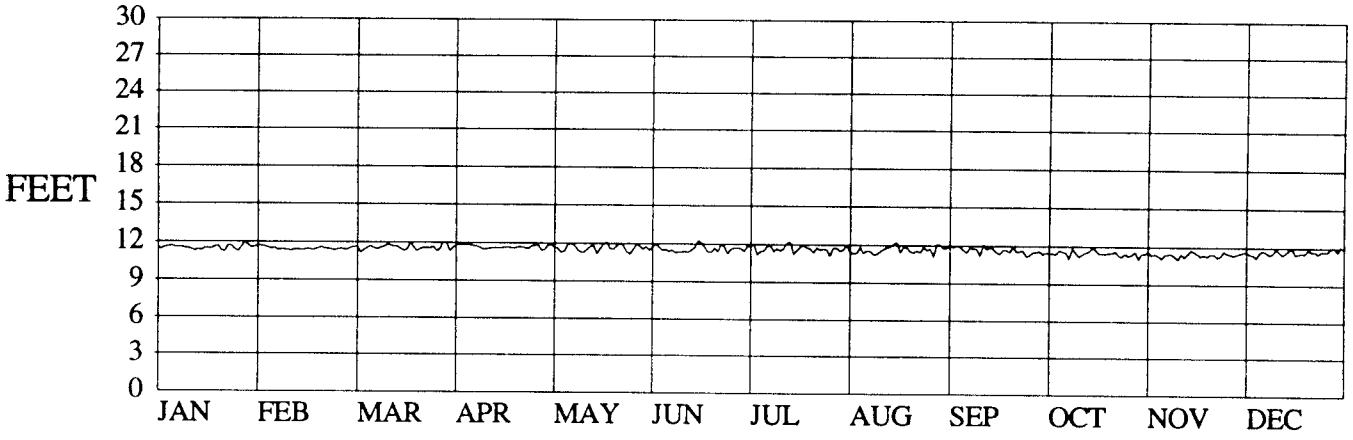
1991

PLATE H-7

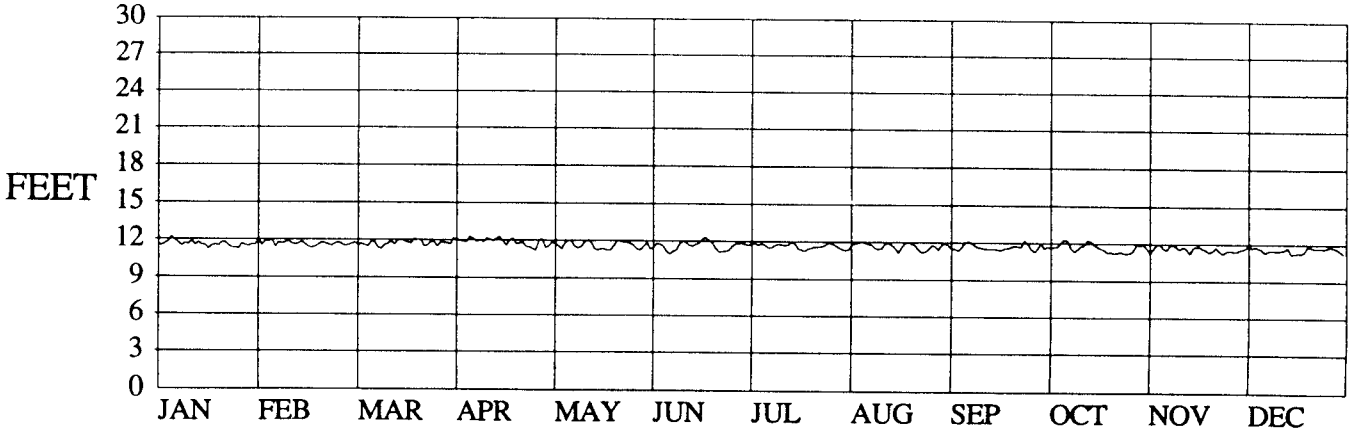
MISSISSIPPI RIVER
QUINCY, ILLINOIS RIVER MILE 327.9
1986 - 1988 GAGE ZERO = 458.59



1986



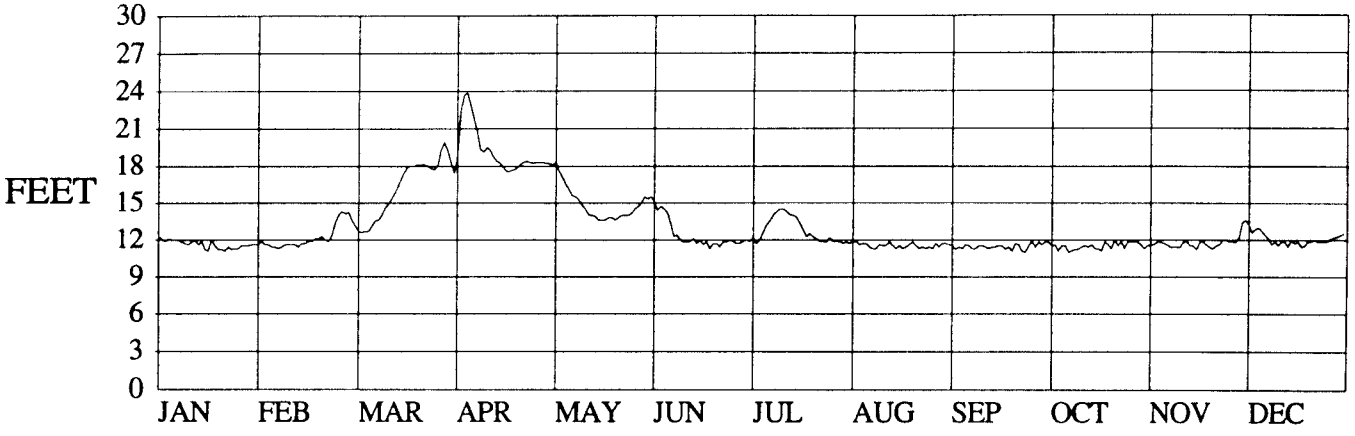
1987



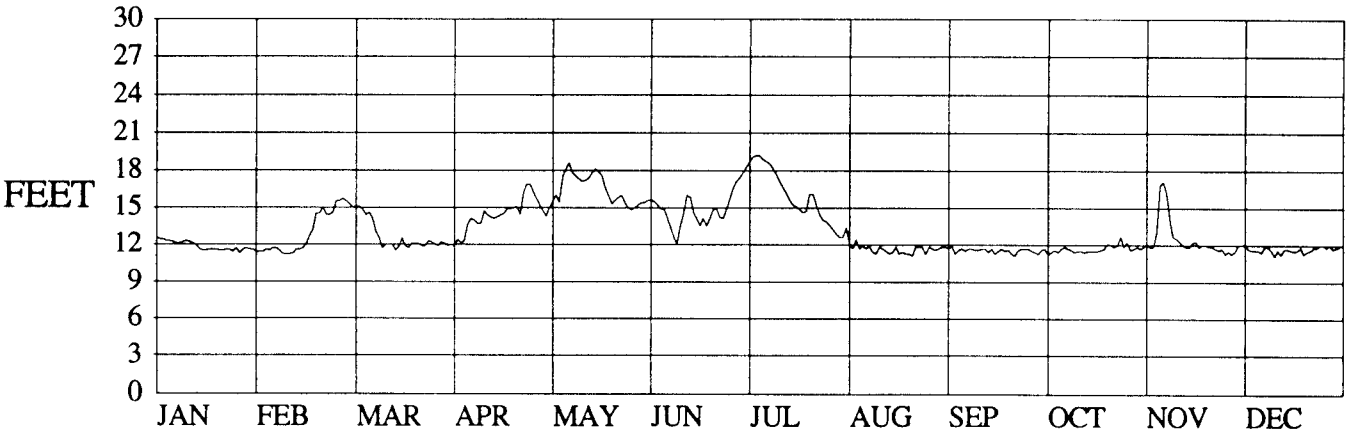
1988

PLATE H-8

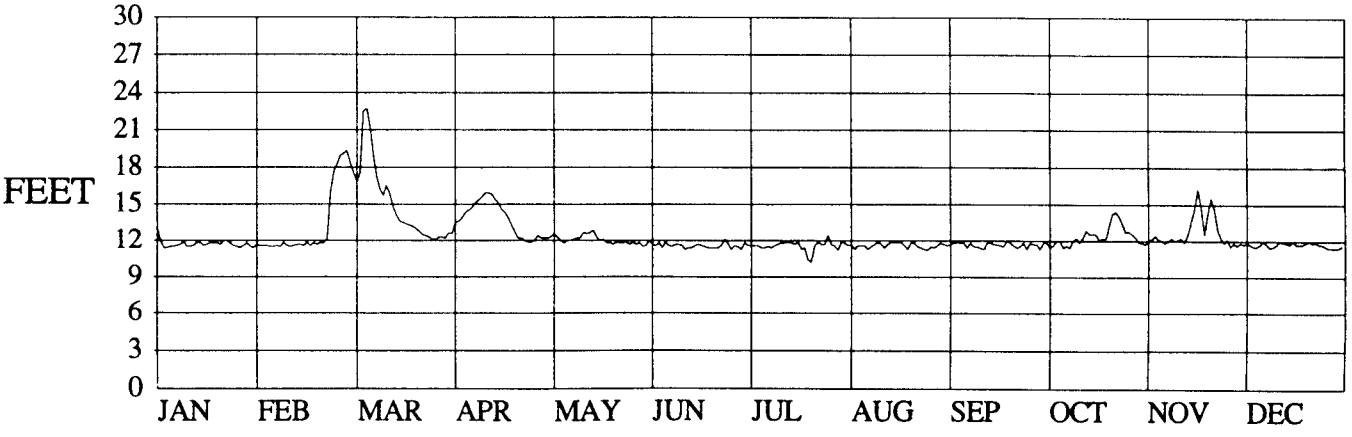
MISSISSIPPI RIVER
QUINCY, ILLINOIS RIVER MILE 327.9
1983 - 1985 GAGE ZERO = 458.59



1983



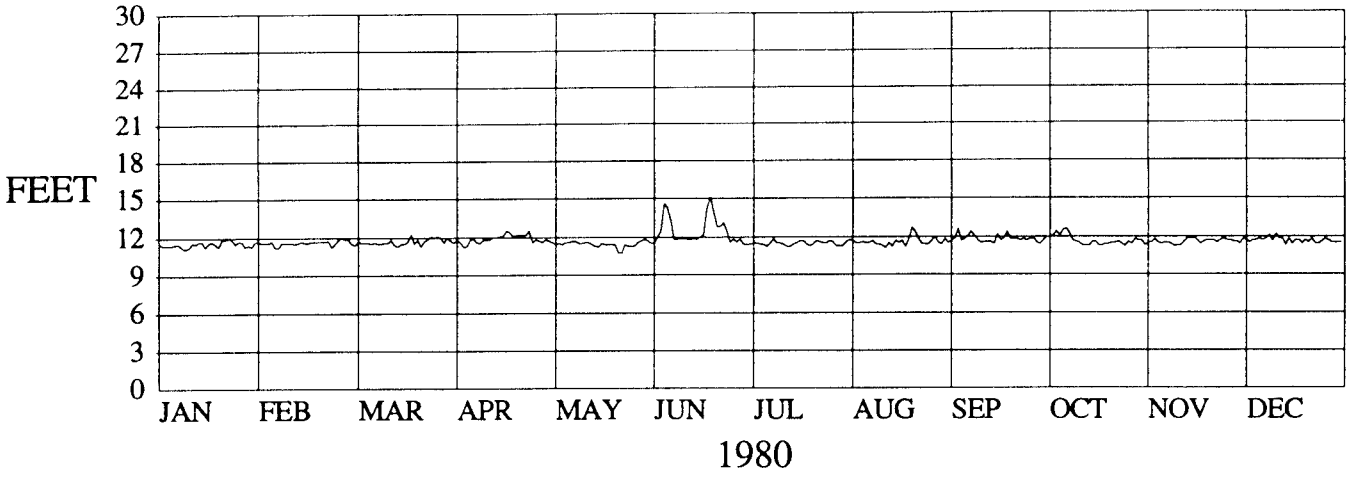
1984



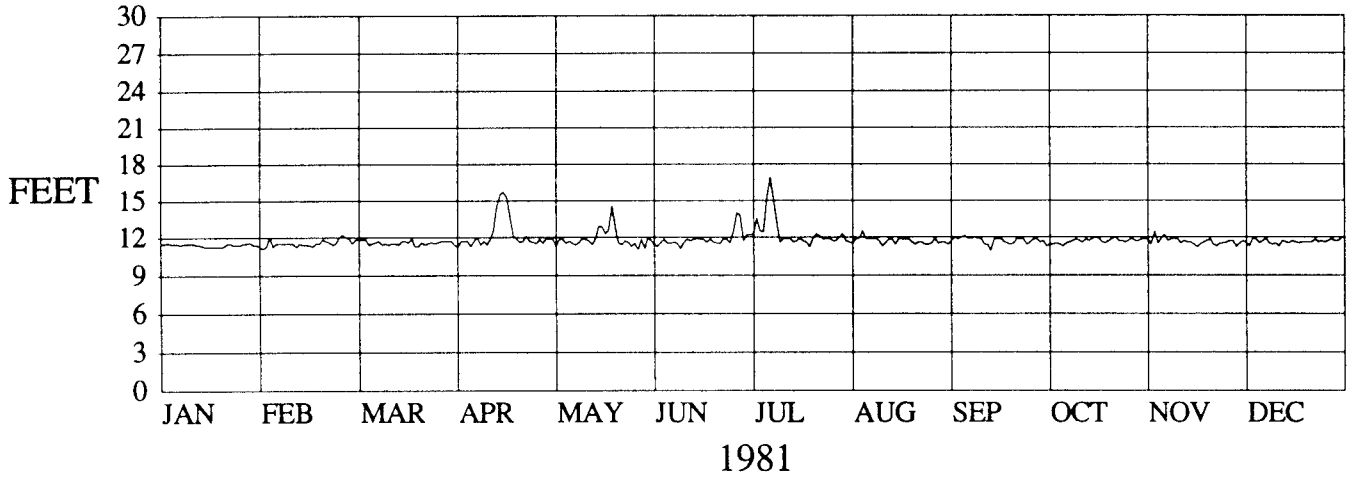
1985

PLATE H-9

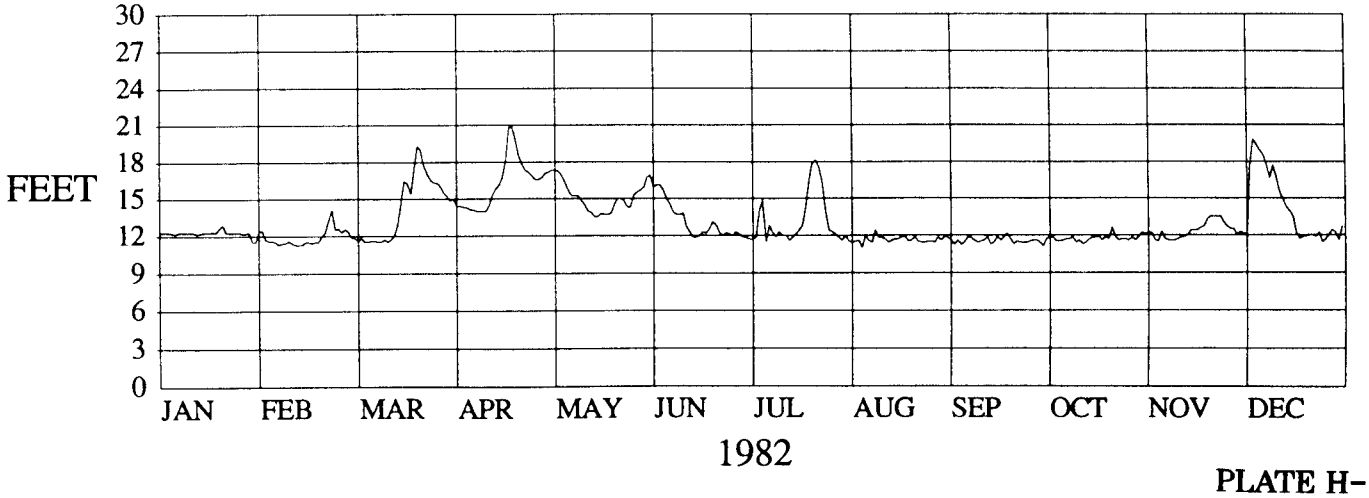
MISSISSIPPI RIVER
QUINCY, ILLINOIS RIVER MILE 327.9
1980 - 1982 GAGE ZERO = 458.59



1980



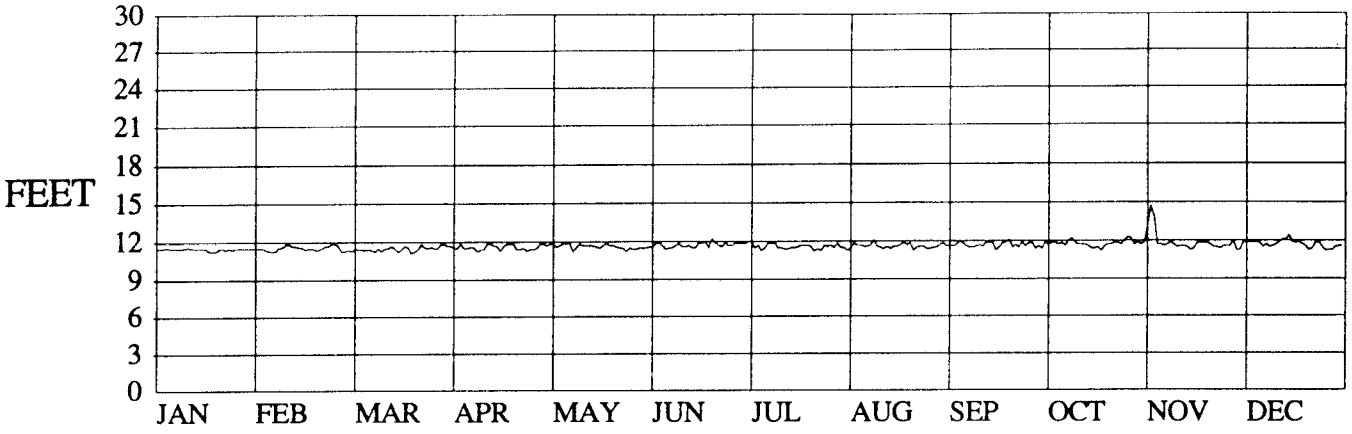
1981



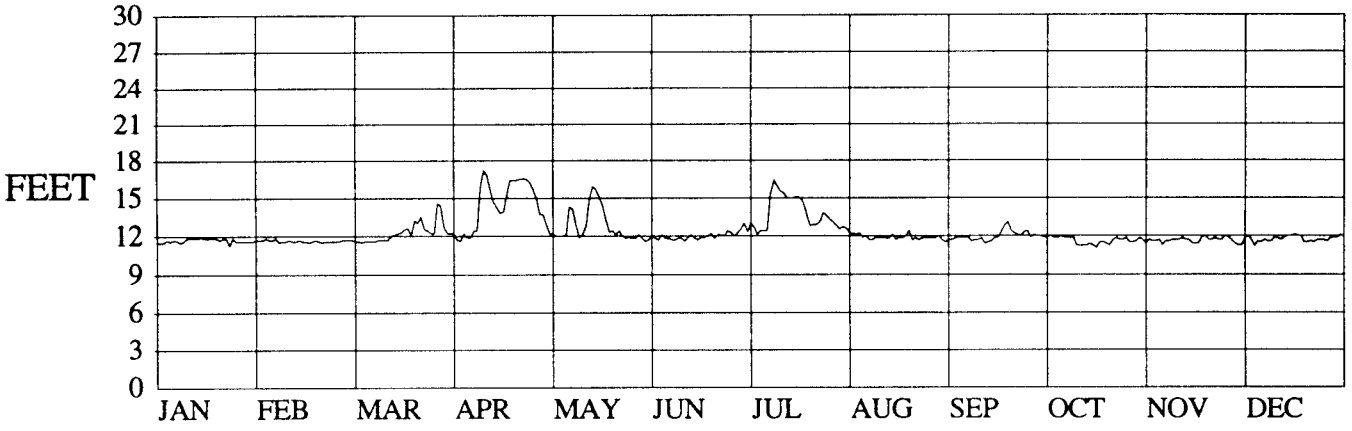
1982

PLATE H-10

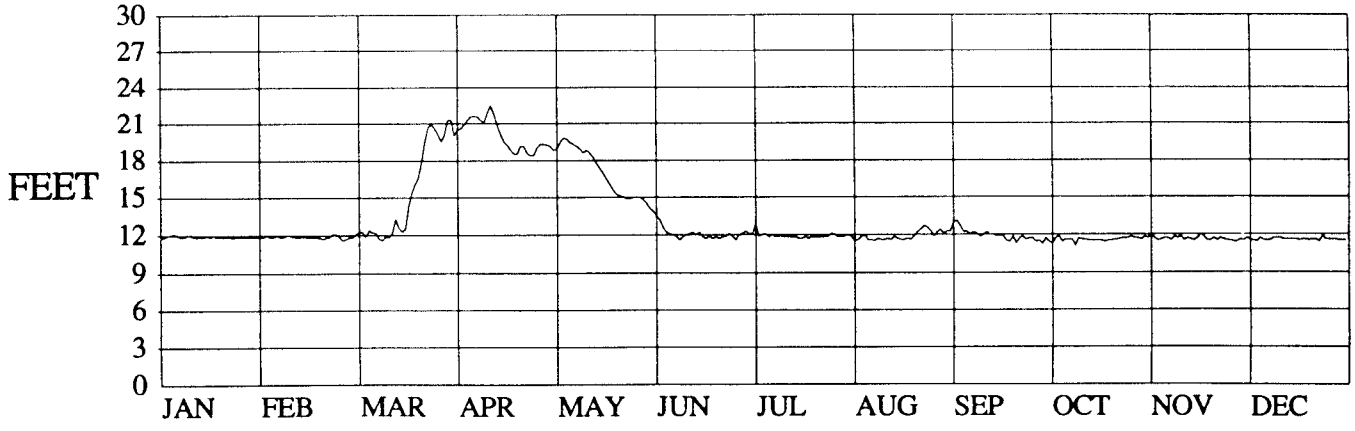
MISSISSIPPI RIVER
QUINCY, ILLINOIS RIVER MILE 327.9
1977 - 1979 GAGE ZERO = 458.59



1977



1978



1979

PLATE H-11

Cottonwood EMP
Velocity Profile through an opening of 100 feet at a discharge of 40,000 Ft3/S

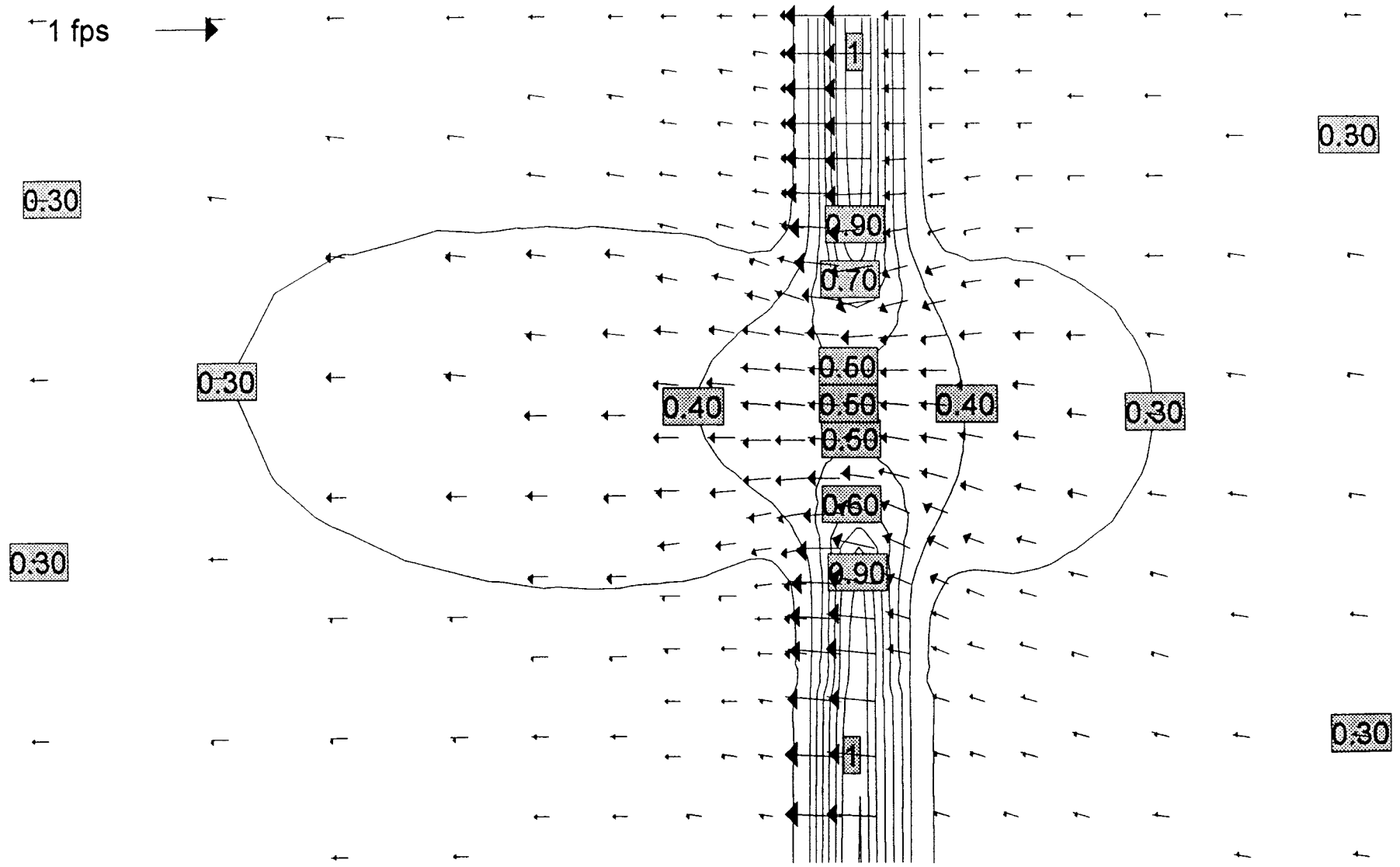


PLATE H-12

Cottonwood EMP
Velocity Profile through an opening of 100 feet at a discharge of 243,000 Ft3/S

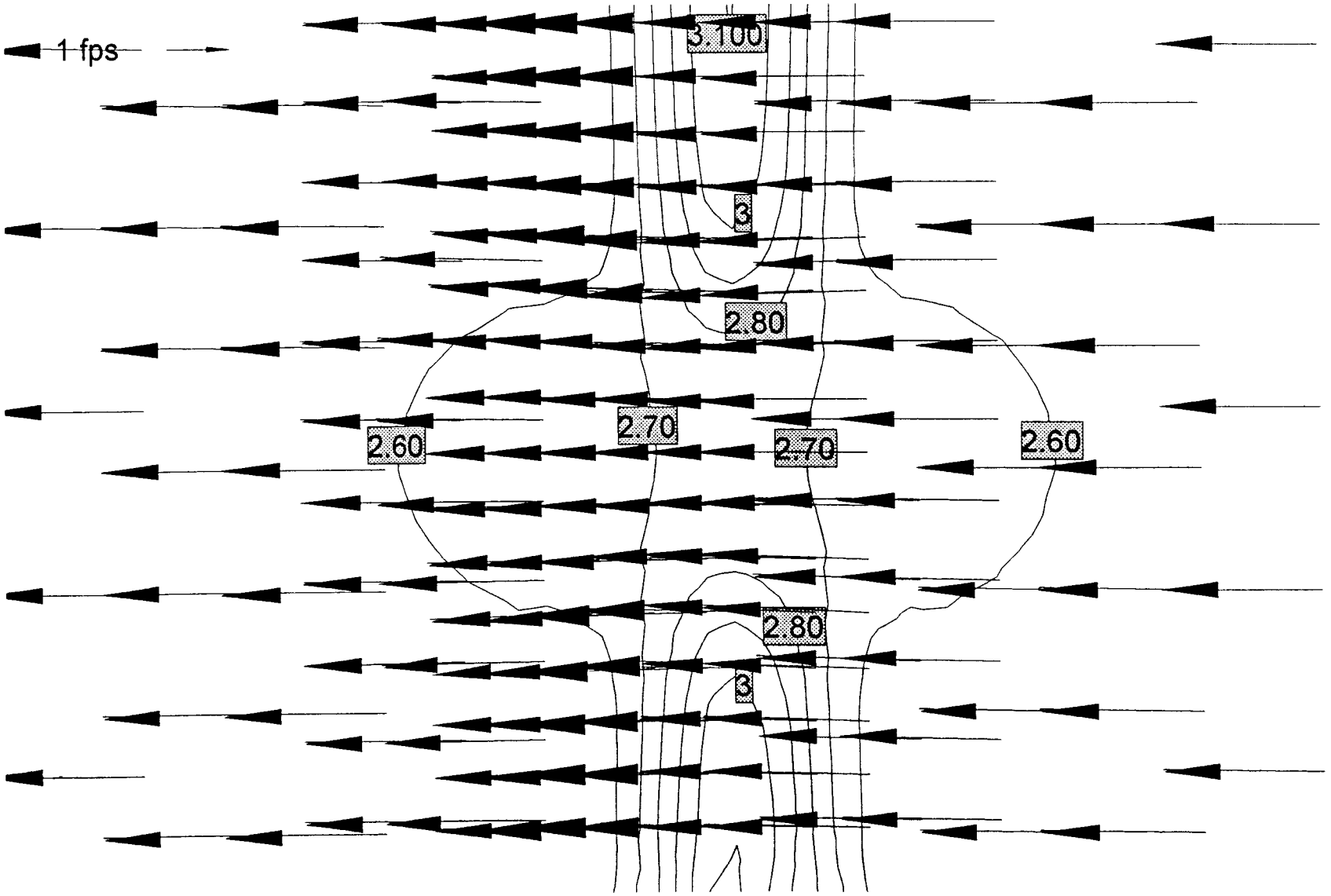
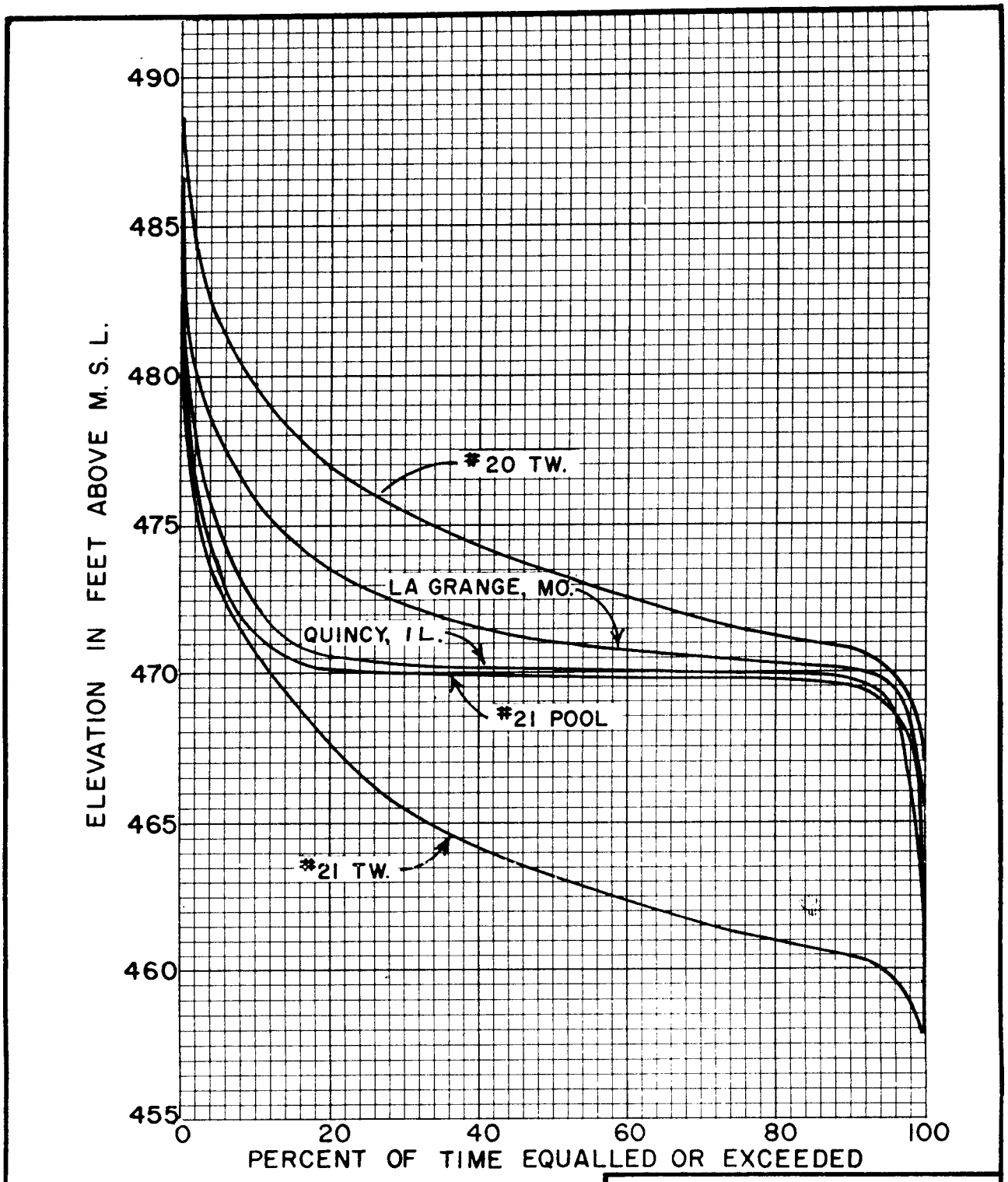


PLATE H-13



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UPPER MISSISSIPPI RIVER BASIN
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NINE FOOT CHANNEL
POOL 21
ELEVATION DURATION
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CORPS OF ENGINEERS, U S ARMY
ROCK ISLAND, ILLINOIS

ROCK ISLAND DISTRICT
MARCH 1979

PLATE H-14

COST ESTIMATE

APPENDIX I

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
REHABILITATION AND ENHANCEMENT
POOL 21, MISSISSIPPI RIVER MILES 328.5 TO 331.0
LEWIS AND MARION COUNTIES, MISSOURI

APPENDIX I
DETAILED ESTIMATE OF COST

1. **General.** Table 14-1 of the main report contains the detailed cost estimate prepared for the Cottonwood Island Rehabilitation and Enhancement Project at Mississippi River Miles 328.5 - 331, including Federal construction, planning, engineering, and design, and construction management costs. The current working estimate (CWE) prepared for this Definite Project Report (DPR) level study was developed after review of project plans, discussion with the design team members, and review of costs for similar construction projects. The Micro-Computer Aided Cost Estimating System (M-CACES), incorporating local wage and equipment rates, was utilized to assemble and calculate project element cost. Costs, including appropriate contingencies, are presented in accordance with EC 1110-2-538, Civil Works Project Cost Estimating - Code of Accounts.

2. **Price Level.** Project element costs are based on April 1996 prices. These costs are considered fair and reasonable to a well-equipped and capable contractor and include overhead and profit. Calculation of the Fully Funded Estimate (FFE) was done in accordance with guidance from CECW-B, dated 25 Jan 93, for Factors for Updating Study/Project Cost Estimates for FY 1997 Budget Submission.

3. **Contingency Discussion.** After review of project documents and discussion with personnel involved in the project, cost contingencies were developed which reflect the uncertainty associated with each cost item. Per EC 1110-2-263, these contingencies are based on qualified cost engineering judgment of the available design data, type of work involved, and uncertainties associated with the work and schedule. Costs were not added to contingency amounts to cover items which are identified project requirements. The following discussion of major project features indicates the basis for contingency selection and assumptions made. For other elements not addressed below, the assignment of contingencies was deemed appropriate to account for the uncertainty in design and quantity calculation and further discussion is not included.

a. Feature 01, Lands and Damages

The estimate for this feature is based on work required by Real Estate which is described in greater detail in the main report in Section 15 - Real Estate Requirements.

b. Feature 06, Fish and Wildlife Facilities.

The quantities for this work were developed by the Design and Cost Engineering Branches.

06 Channel Dredging. This work consists of mechanically dredging the lower 4,900 feet of Cottonwood Chute to a depth of 7 feet below flat pool, a width of 50 feet, and vertical sides. Included in this feature are four 15-foot deep holes, 50 feet wide and 300 feet long, with vertical sides for overwintering fish. Dredging will be accomplished by dragline/clamshell working from small, portable pontoon barges or from edge of bank. Dredging costs include mobilization and demobilization of the portable work barges, sidecasting dredged material no closer than 35 feet from edge of dredge cut for the 7-foot sections and no closer than 50 feet from edge of dredge cut for the 15-foot section, and placing the material to a depth no greater than 6 feet above existing grade and rough grading a 60-foot crown. No compaction is required, other than that obtained by tracked equipment working the area and rough grading the crown.

06 Potholes. This work consists of mechanically excavating five potholes in interior sloughs and depressions, including associated clearing costs. It was assumed that a dragline/clamshell will be used to excavate the potholes. An equipment path for access to each pothole location may need to be created. The potholes would be excavated to elevation 467, a depth of 3 feet below flat pool. Pothole side slopes will be benched to promote littoral zone emergent vegetation and to enhance growth of moist soil plants. All side slopes would be 1:3. Excavated material would be placed around the perimeter of the pothole to a depth no greater than 2 feet above existing grade. Compaction of excavated material is not required, other than that obtained by tracked equipment working the site.

06 Mast Tree Planting. This work consists of planting trees either in the spring or in the fall. Site preparation and competition control will differ by site. At the forest management and pothole sites, a planting site will be prepared by cutting and removing all woody vegetation within 6 feet of the point designated as the center point for the planted tree. At the agricultural field and dredged material placement sites, the sites shall be disked a minimum of two times (disked and cross disked), to a minimum depth of 4 inches. Immediately after planting, the area will be sprayed with a herbicide to a 6-foot-wide band around each tree. Tree planting density was increased from a design number of 48 trees per acre to 53 trees per acre to account for a potential 10 percent mortality during the first year. An experiment will be conducted to test the effectiveness of two animal protection measures: (1) temporarily installing 6-foot fencing around planted trees (to be removed after three growing seasons); and (2) annual application of a commercial deer repellent to one-third of the planted trees for the first three growing seasons. Additionally, one-third of the planted trees will not receive any animal protection in order to adequately test the efficacy of the experimental treatments in terms of the effects on tree growth and survival.

06 Wing Dam Notching. This work consists of creating a 100-foot-wide notch in 6 wingdams. It is assumed notching will be done using a barge-mounted clamshell/dragline, with placement of removed material downstream and landward of the notch, except for Wing Dam 29, where material will be placed riverward of the notch, to avoid disturbing an archaeological site.

The average contingency for the project's construction is 20 percent.

c. Feature 30, Planning, Engineering & Design.

The engineering and design for this project includes all planning and design work necessary to complete the Definite Project Report and construction plans and specifications. This cost also includes engineering support during construction, and preparation of asbuilt drawings and operation and maintenance manuals. The design effort for the construction was analyzed to determine the man-year effort required. This estimate is based upon money expended to date, discussions between the project engineer and project manager, and historical data and experience gained on other projects of similar nature.

d. Feature 31, Construction Management.

Construction management includes studies and analyses of project reports, plans and specification, and conferences of construction staff to become familiar with design requirements; biddability, contractibility, and operability reviews pre-award activities to acquaint prospective bidders with the nature of the work; administration of construction contracts; administration of A/E contracts which provide for supervision and inspection; establishment of bench marks and baselines required for layouts of construction, relocations, and clearing; review of shop drawings, manuals, catalog cuts, and other information submitted by the construction contractor; assure specifications compliance by supervision and inspection on construction work, conferences with the contractors to coordinate various features of the project and enforce compliance with schedules; sampling and testing during construction phase to determine suitability and compliance with plans and specifications; negotiate with the contractor on all contract modifications, including preparation of all contract documents required therefore; estimate quantities, determine periodic payments to contractors, and prepare, review and approve contract payments; review and approve construction schedules and progress charts; prepare progress and completion reports; project management and administration not otherwise identified; and district overhead. These cost may be incurred at the job site, an area office, or at the District. For the construction of the Cottonwood Island Rehabilitation and Enhancement EMP project, the estimated cost of construction management is $100,000 for a construction contract of about 2-year duration and an estimated value of $872,328.

APPENDIX J

LITERATURE CITED

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-16F)

COTTONWOOD ISLAND HABITAT
REHABILITATION AND ENHANCEMENT
POOL 21, MISSISSIPPI RIVER MILES 328.5 THROUGH 331.0
LEWIS AND MARION COUNTIES, MISSOURI

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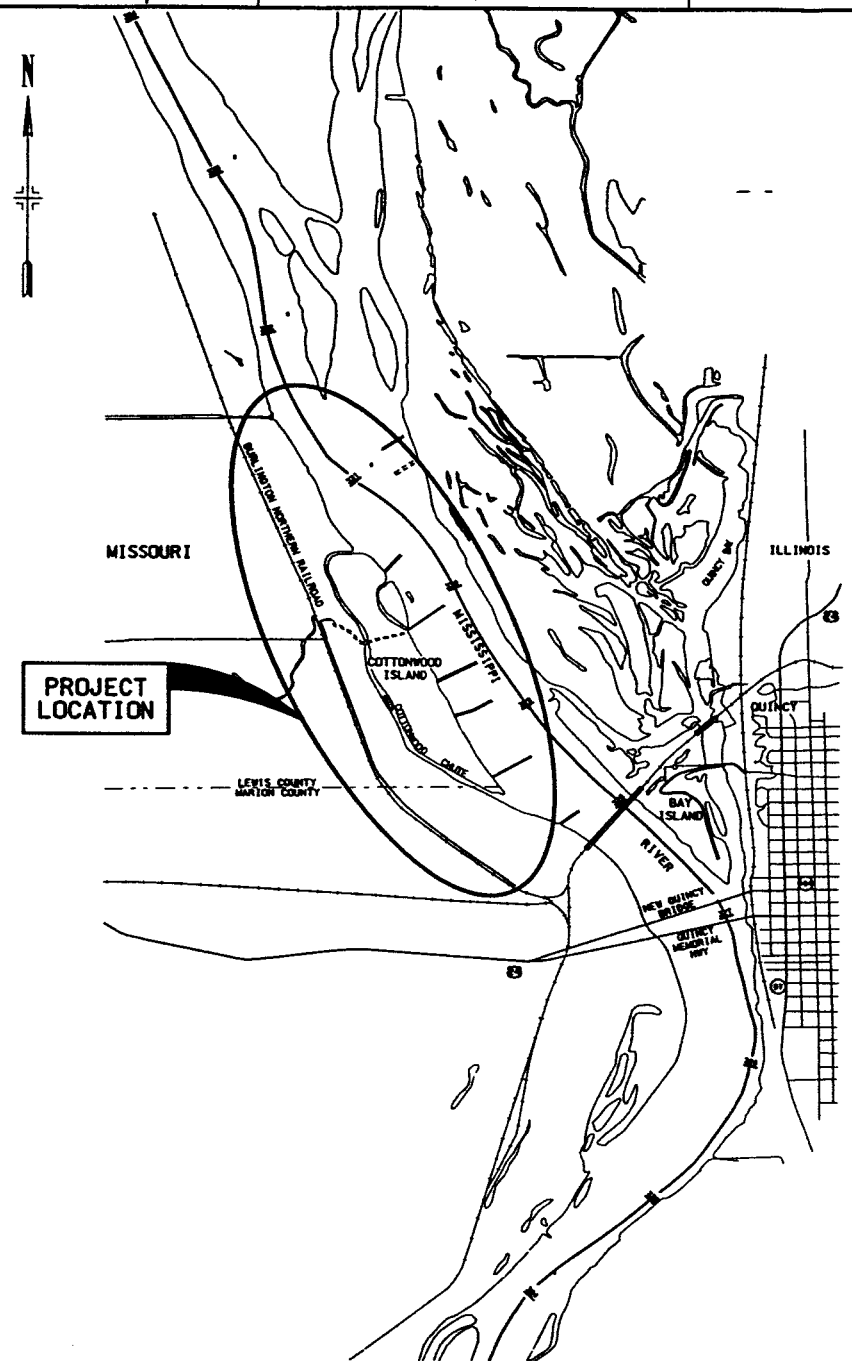
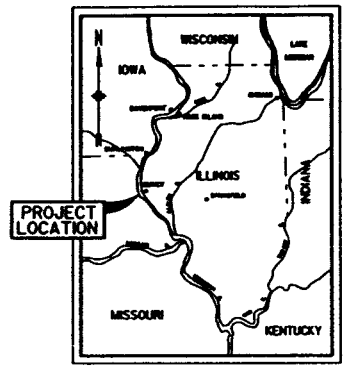
CENCR-PD-E	1	10	10	1	1	1
CENCR-PD-W (NILES)	1	1	1	1	1	1
CENCR-PD-W (SKALAK)	1	1	1	1	1	1
CENCR-PP-M (KOWALCZYK)	1	1	1		1	1
CENCR-PP-P				1		1
CENCR-RE	1	1	1			
CENCR-RE-A	1	1	1			

1/ 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





VICINITY MAP

SCALE IN MILES

2000 1000 0 2000 4000FT

SCALE

Revisions			
Symbol	Description	Date	Approved

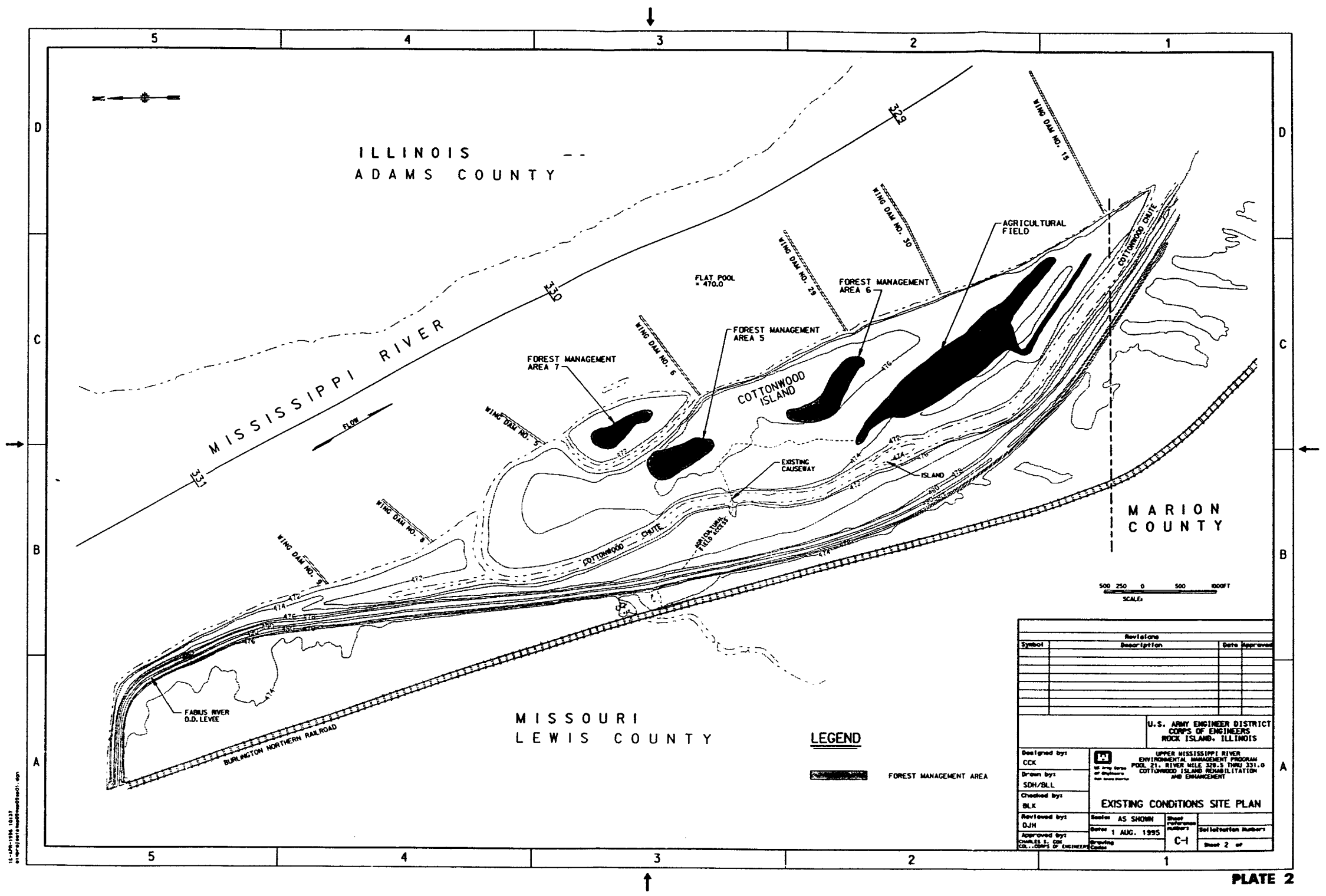
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

LOCATION PLAN AND VICINITY MAP

Designed by: CCK	Scales: AS SHOWN	Sheet reference number: X-1	Solicitation Number:
Drawn by: SDH/BLL	Dated: 1 AUG. 1995		Sheet 1 of
Checked by: BLK	Drawing Code:		
Reviewed by: DJH			
Approved by: CHARLES S. CZR COL., CORPS OF ENGINEERS			

PLATE 1



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

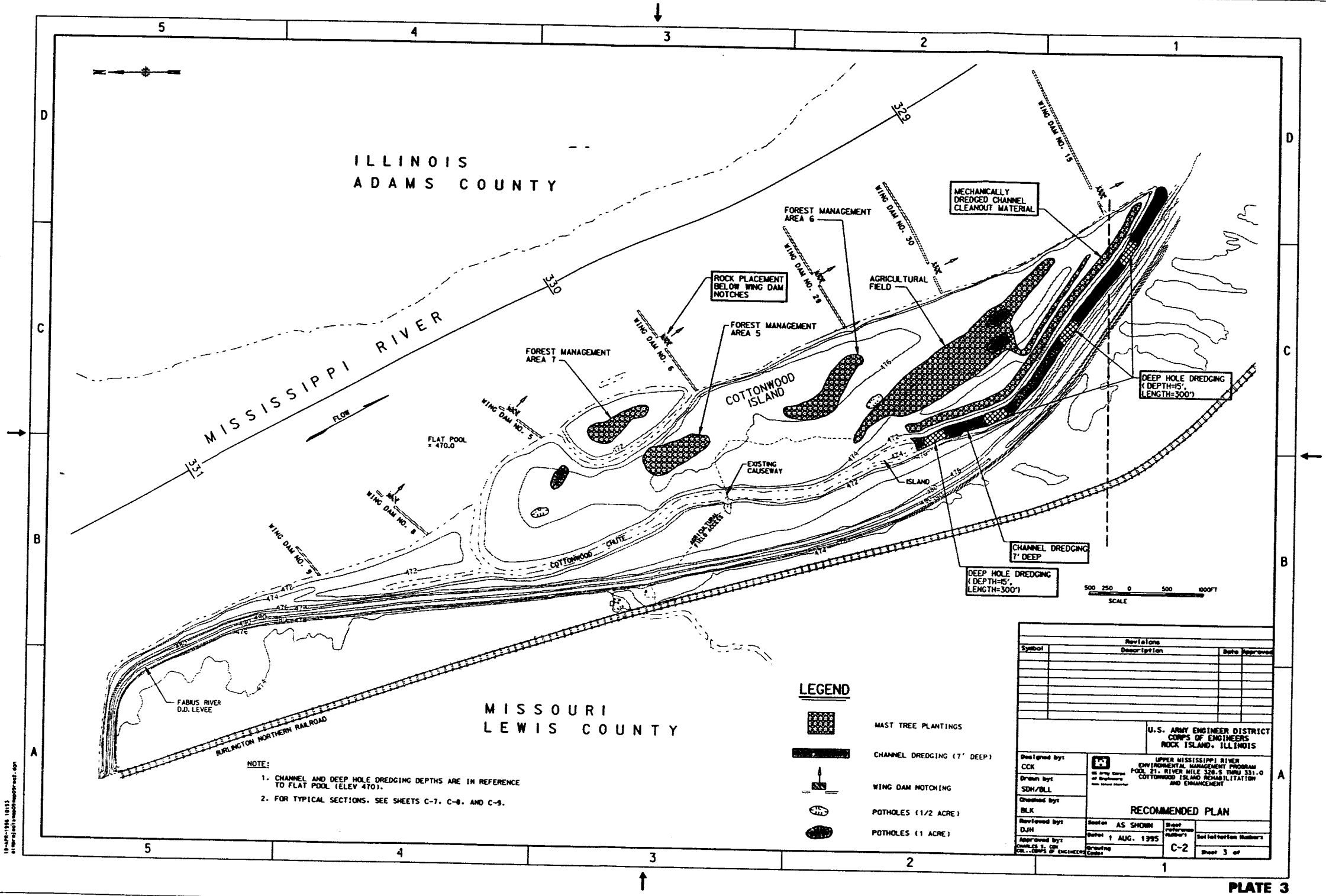
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES S. CHU, COL., CORPS OF ENGINEERS

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 329.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

EXISTING CONDITIONS SITE PLAN

Scales AS SHOWN
Dates 1 AUG. 1995
Sheet reference number C-1
Drawing Control
Solicitation Numbers
Sheet 2 of

PLATE 2



NOTE:

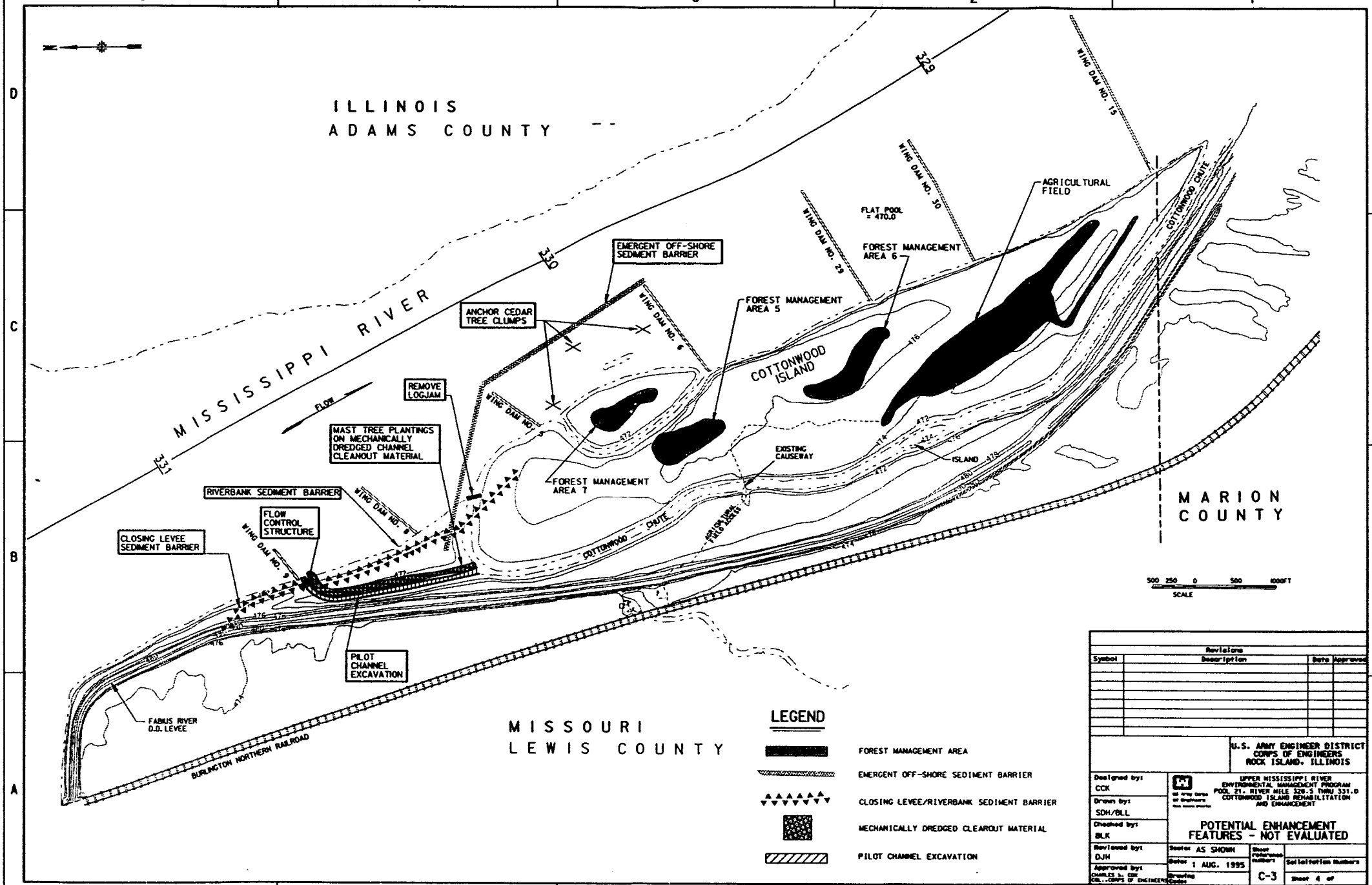
1. CHANNEL AND DEEP HOLE DREDGING DEPTHS ARE IN REFERENCE TO FLAT POOL (ELEV 470).
2. FOR TYPICAL SECTIONS, SEE SHEETS C-7, C-8, AND C-9.

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: CCK	UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21, RIVER MILE 328.5 THRU 331.0 COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT
Drawn by: SDH/BLL	
Checked by: BLK	RECOMMENDED PLAN
Reviewed by: DJH	Scales: AS SHOWN; Dates: 1 AUG. 1995
Approved by: CHARLES E. GEE, CHIEF, ...CORPS OF ENGINEERS	Drawing Codes: C-2
	Sheet reference numbers; Solicitation Numbers; Sheet 3 of

PLATE 3



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

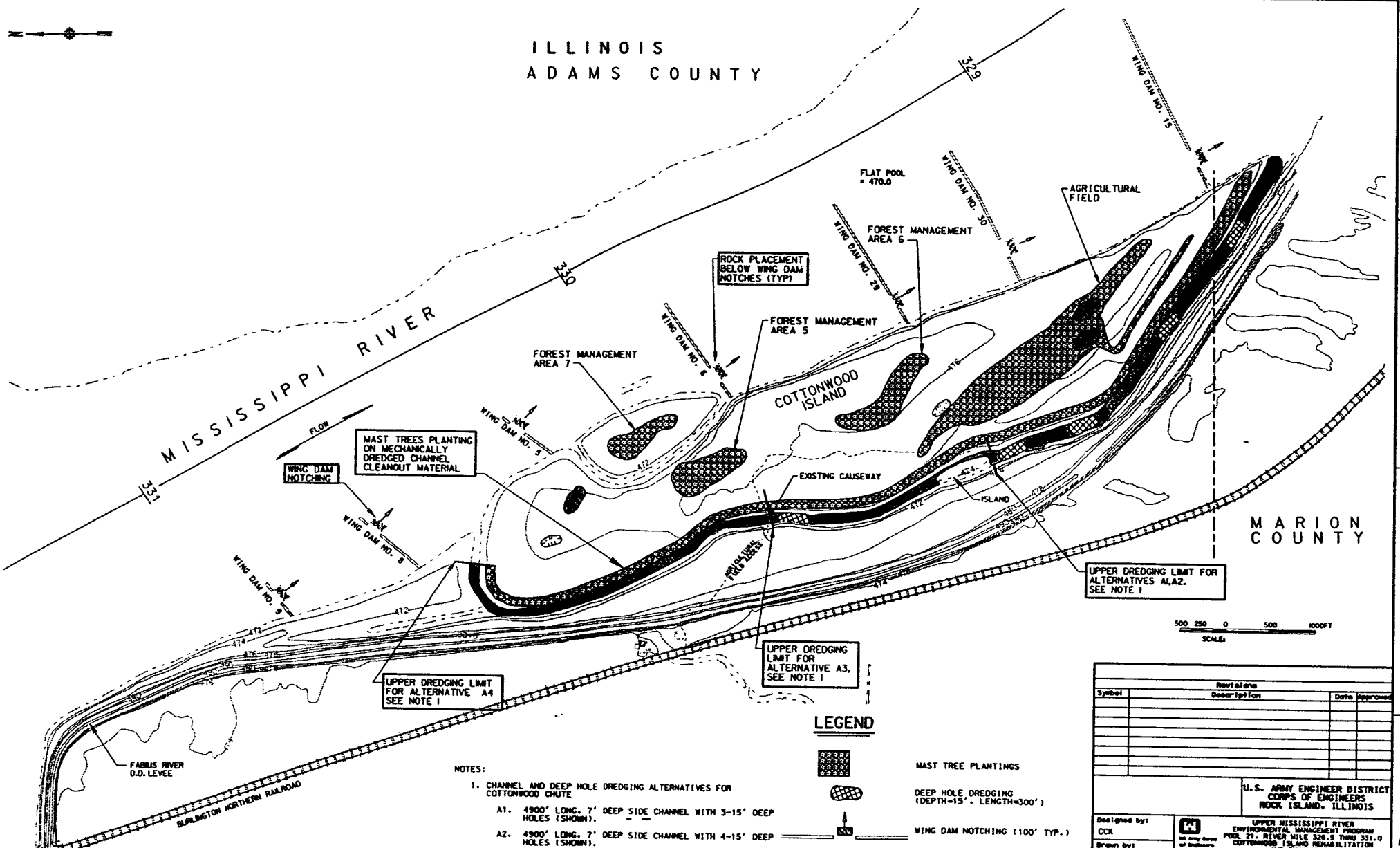
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES L. COX, COL., CORPS OF ENGINEERS

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 320.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

POTENTIAL ENHANCEMENT FEATURES - NOT EVALUATED

Scales: AS SHOWN
Date: 1 AUG. 1995
Drawing Number: C-3
Sheet reference number:
Solicitation Numbers:
Sheet 4 of

PLATE 4



LEGEND

- MAST TREE PLANTINGS
- DEEP HOLE DREDGING (DEPTH=15', LENGTH=300')
- WING DAM NOTCHING (100' TYP.)
- CHANNEL DREDGING (DEPTH VARIES) SEE NOTE 1
- POTHOLE (1/2 ACRE)
- POTHOLE (1 ACRE)

NOTES:

1. CHANNEL AND DEEP HOLE DREDGING ALTERNATIVES FOR COTTONWOOD CHUTE
   - A1. 4900' LONG, 7' DEEP SIDE CHANNEL WITH 3-15' DEEP HOLES (SHOWN).
   - A2. 4900' LONG, 7' DEEP SIDE CHANNEL WITH 4-15' DEEP HOLES (SHOWN).
   - A3. 7500' LONG 7' DEEP SIDE CHANNEL (JUST BELOW CAUSEWAY) WITH 5-15' DEEP HOLES (SHOWN).
   - A4. 11500' LONG (ENTIRE COTTONWOOD CHUTE) 15' DEEP SIDE CHANNEL. NO DEEP HOLES. REMOVE CAUSEWAY

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: CCK	UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21, RIVER MILE 328.5 THRU 331.0 COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT
Drawn by: SDH/BLL	POTENTIAL FEATURES EVALUATED
Checked by: BLK	
Revised by: DJH	Scales: AS SHOWN
Approved by: CHARLES S. CAH, COL., CORPS OF ENGINEERS	Dates: 1 AUG. 1995
	Drawing Number: C-4
	Sheet reference numbers: Solicitation Numbers: Sheet 5 of

PLATE 5

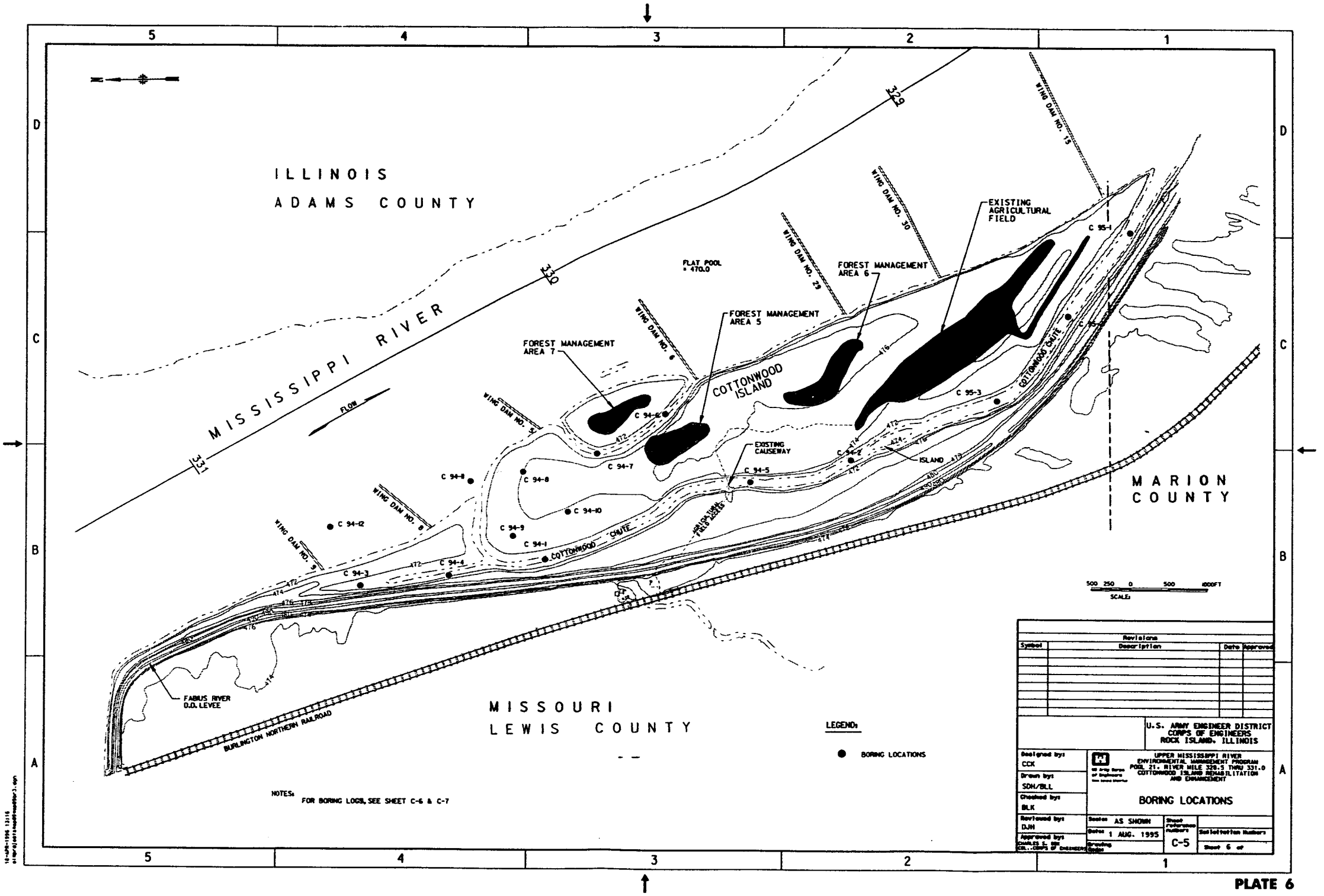

ILLINOIS
ADAMS COUNTY
MISSISSIPPI RIVER
FLOW
329
330
331
WING DAM NO. 15
WING DAM NO. 30
WING DAM NO. 29
WING DAM NO. 6
WING DAM NO. 5
WING DAM NO. 8
WING DAM NO. 9
FLAT POOL
= 470.0
EXISTING
AGRICULTURAL
FIELD
FOREST MANAGEMENT
AREA 6
FOREST MANAGEMENT
AREA 5
FOREST MANAGEMENT
AREA 7
COTTONWOOD
ISLAND
COTTONWOOD CHUTE
EXISTING
CAUSEWAY
ISLAND
HELICOPTER
PAD LOCATION
C 95-1
C 95-2
C 95-3
C 94-1
C 94-2
C 94-3
C 94-4
C 94-5
C 94-6
C 94-7
C 94-8
C 94-9
C 94-10
C 94-12
MARION
COUNTY
MISSOURI
LEWIS COUNTY
FABIUS RIVER
D.D. LEVEE
BURLINGTON NORTHERN RAILROAD
500 250 0 500 1000FT
SCALE:
LEGEND:
BORING LOCATIONS
NOTES:
FOR BORING LOGS, SEE SHEET C-6 & C-7
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Revised by: DJH
Approved by: CHARLES J. HOH
COL., CORPS OF ENGINEERS
UPPER MISSISSIPPI RIVER
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION
AND ENHANCEMENT
BORING LOCATIONS
Scales AS SHOWN
Dates 1 AUG. 1995
Grading Code
Sheet Preference Numbers
C-5
Solicitation Numbers
Sheet 6 of

PLATE 6

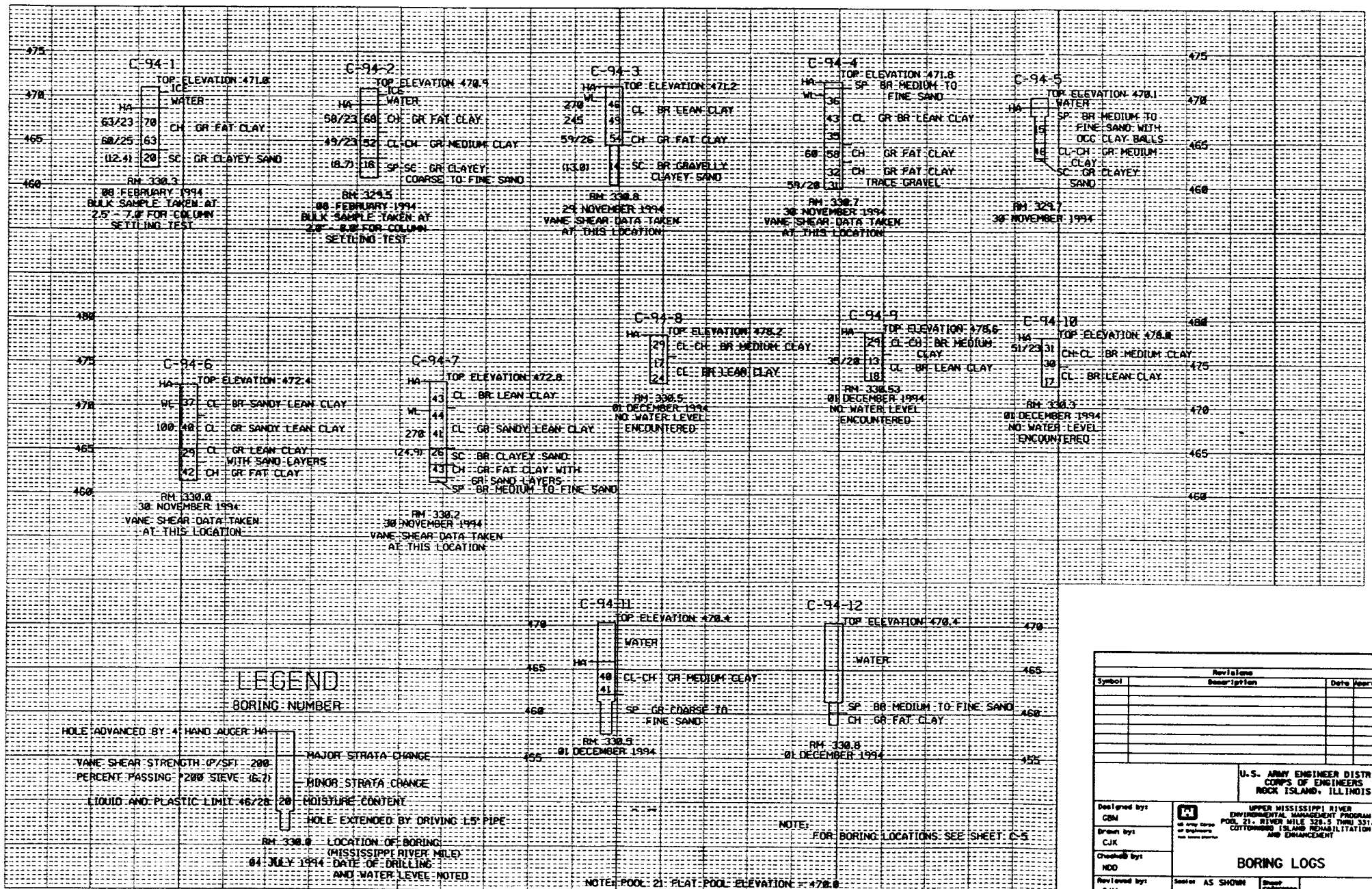
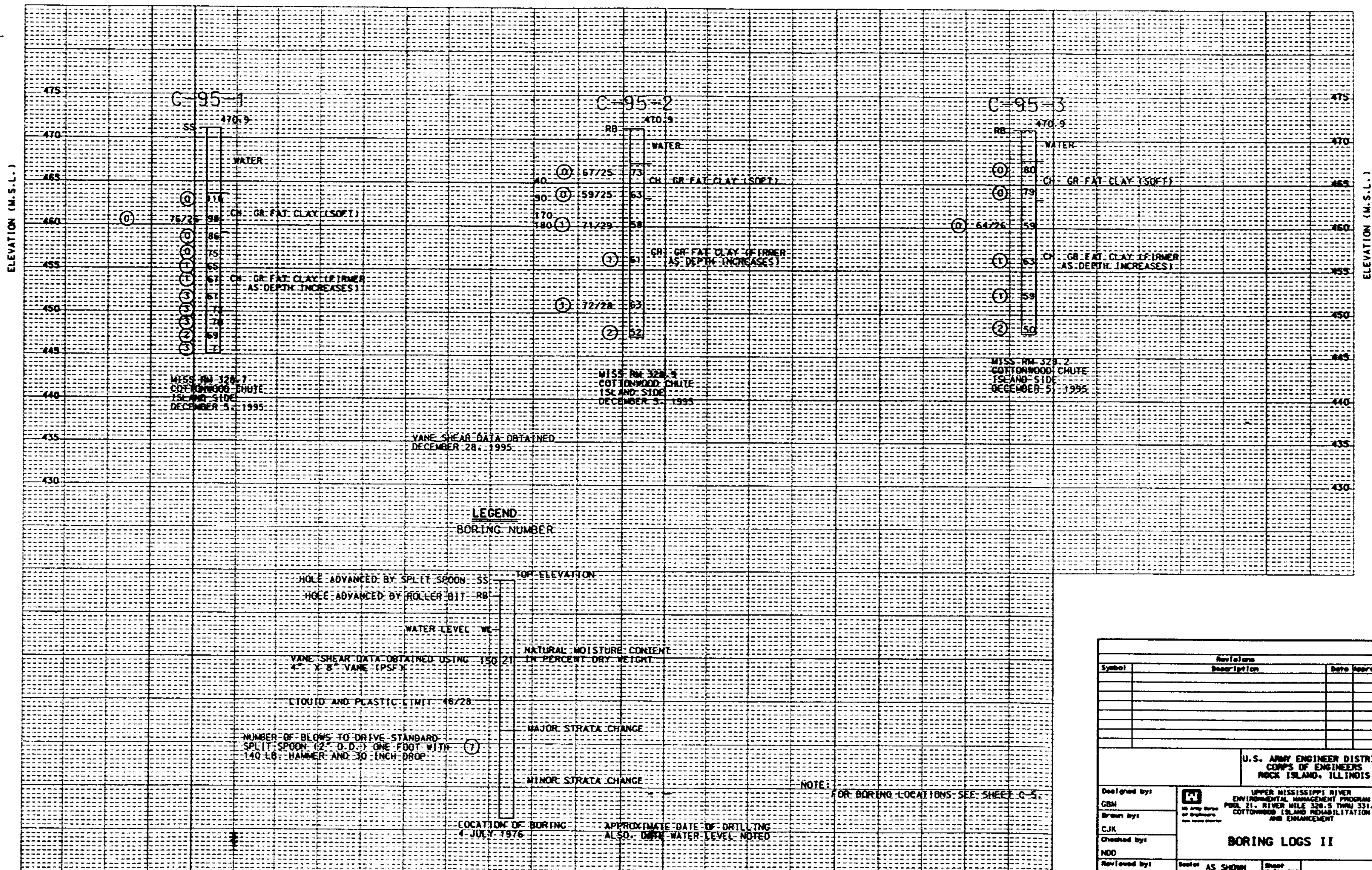

C-94-1
TOP ELEVATION 471.8
ICE
WATER
HA
63/23 70 CH GR FAT CLAY
68/25 63
(12.4) 20 SC GR CLAYEY SAND
RM 330.3
08 FEBRUARY 1994
BULK SAMPLE TAKEN AT 2.5' - 7.0' FOR COLUMN SETTLING TEST
C-94-2
TOP ELEVATION 470.9
ICE
WATER
HA
58/23 68 CH GR FAT CLAY
49/23 52 CL-CH GR MEDIUM CLAY
(8.7) 18 SP-SC GR CLAYEY COARSE TO FINE SAND
RM 329.5
08 FEBRUARY 1994
BULK SAMPLE TAKEN AT 2.0' - 5.0' FOR COLUMN SETTLING TEST
C-94-3
TOP ELEVATION 471.2
HA
WL
270 46 CL BR LEAN CLAY
245 49
54 CH GR FAT CLAY
59/26
(13.0) 14 SC BR GRAVELLY CLAYEY SAND
RM 330.8
29 NOVEMBER 1994
VANE SHEAR DATA TAKEN AT THIS LOCATION
C-94-4
TOP ELEVATION 471.8
HA
WL
SP BR MEDIUM TO FINE SAND
36
43 CL GR BR LEAN CLAY
35
60 58 CH GR FAT CLAY
32 CH GR FAT CLAY TRACE GRAVEL
59/28 30
RM 330.7
30 NOVEMBER 1994
VANE SHEAR DATA TAKEN AT THIS LOCATION
C-94-5
TOP ELEVATION 470.1
HA
WATER
SP BR MEDIUM TO FINE SAND WITH OCC CLAY BALLS
15
16 CL-CH GR MEDIUM CLAY
SC GR CLAYEY SAND
RM 329.7
30 NOVEMBER 1994
C-94-6
TOP ELEVATION 472.4
HA
WL 37 CL BR SANDY LEAN CLAY
100 40 CL GR SANDY LEAN CLAY
29 CL GR LEAN CLAY WITH SAND LAYERS
42 CH GR FAT CLAY
RM 330.0
30 NOVEMBER 1994
VANE SHEAR DATA TAKEN AT THIS LOCATION
C-94-7
TOP ELEVATION 472.8
HA
43 CL BR LEAN CLAY
WL 44
270 41 CL GR SANDY LEAN CLAY
(24.9) 26 SC BR CLAYEY SAND
43 CH GR FAT CLAY WITH GR SAND LAYERS
SP BR MEDIUM TO FINE SAND
RM 330.2
30 NOVEMBER 1994
VANE SHEAR DATA TAKEN AT THIS LOCATION
C-94-8
TOP ELEVATION 478.2
HA
29 CL-CH BR MEDIUM CLAY
17
24 CL BR LEAN CLAY
RM 330.5
01 DECEMBER 1994
NO WATER LEVEL ENCOUNTERED
C-94-9
TOP ELEVATION 478.6
HA
29 CL-CH BR MEDIUM CLAY
35/28 13 CL BR LEAN CLAY
18
RM 330.53
01 DECEMBER 1994
NO WATER LEVEL ENCOUNTERED
C-94-10
TOP ELEVATION 478.8
HA
51/23 31 CH-CL BR MEDIUM CLAY
30
17 CL BR LEAN CLAY
RM 330.3
01 DECEMBER 1994
NO WATER LEVEL ENCOUNTERED
C-94-11
TOP ELEVATION 470.4
WATER
HA
40 CL-CH GR MEDIUM CLAY
41
SP GR COARSE TO FINE SAND
RM 330.5
01 DECEMBER 1994
C-94-12
TOP ELEVATION 470.4
WATER
SP BR MEDIUM TO FINE SAND
CH GR FAT CLAY
RM 330.8
01 DECEMBER 1994
LEGEND
BORING NUMBER
HOLE ADVANCED BY 4" HAND AUGER HA
VANE SHEAR STRENGTH (P/SF) 200
PERCENT PASSING #200 SIEVE (6.7)
LIQUID AND PLASTIC LIMIT 46/28 20 MOISTURE CONTENT
MAJOR STRATA CHANGE
MINOR STRATA CHANGE
HOLE EXTENDED BY DRIVING 1.5" PIPE
RM 330.0 LOCATION OF BORING (MISSISSIPPI RIVER MILE)
04 JULY 1994 DATE OF DRILLING AND WATER LEVEL NOTED
NOTE: POOL 21 FLAT POOL ELEVATION = 470.0
NOTE: FOR BORING LOCATIONS SEE SHEET C-5
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
Designed by: GBM
Drawn by: CJK
Checked by: NDD
Reviewed by: GJM
Approved by: CHARLES E. DEM COL., CORPS OF ENGINEERS
UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21- RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT
BORING LOGS
Scales AS SHOWN
Dates 1 AUG. 1995
Drawing Number C-6
Sheet Reference Numbers
Sheet 7 of
Solicitation Numbers

PLATE 7



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

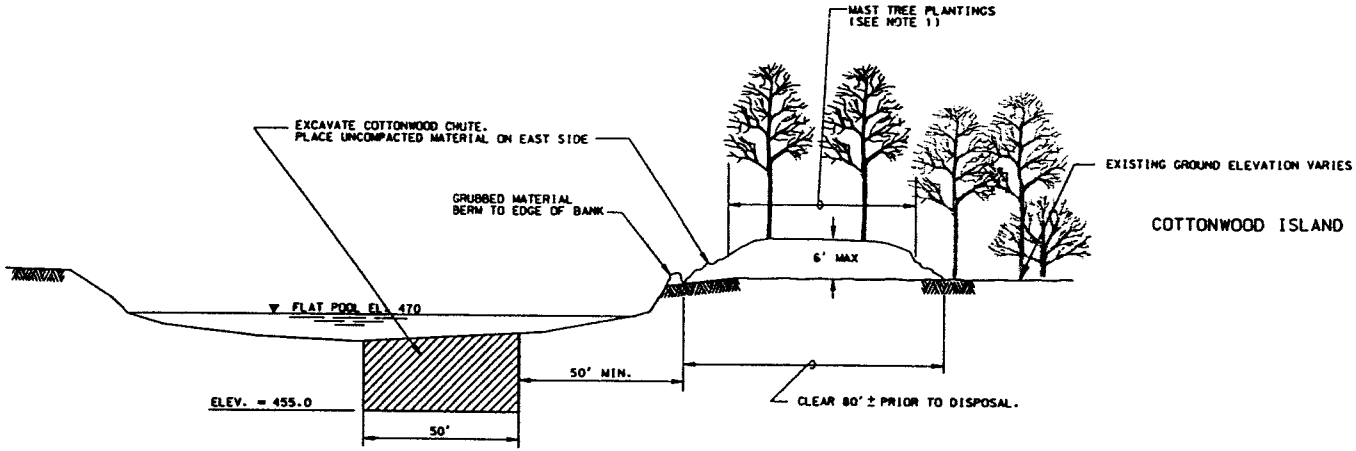
UPPER MISSISSIPPI RIVER
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION
AND ENHANCEMENT

BORING LOGS II

Designed by: CBM
Drawn by: CJK
Checked by: NDD
Reviewed by: GJM
Approved by: CHARLES S. COX CDL..CORPS OF ENGINEERS

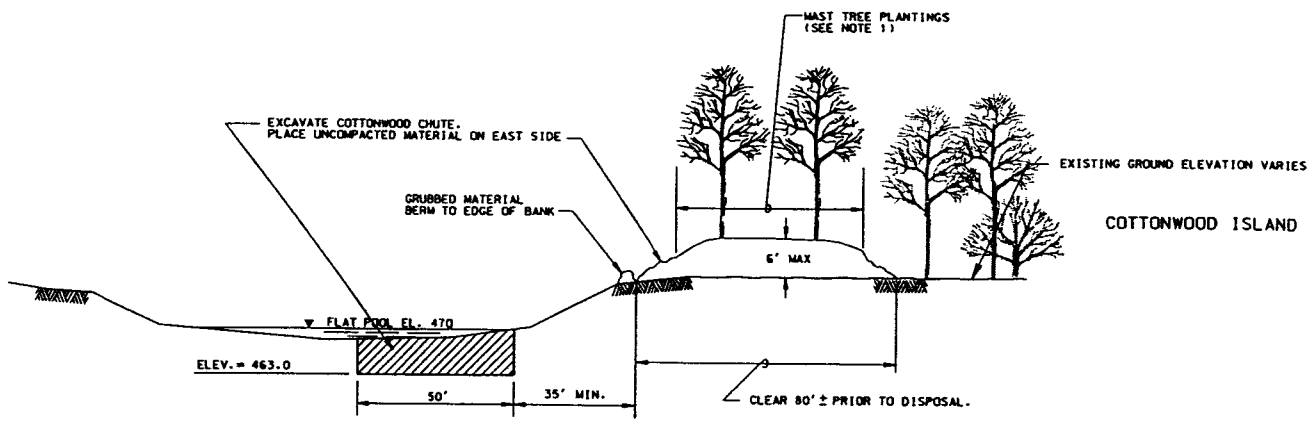
Scale: AS SHOWN
Date: APRIL 19, '96
Sheet reference number: C-7
Solicitation Number:
Sheet 8 of

PLATE 7A



DEEP HOLE DREDGING
TYPICAL SECTION

NO SCALE



CHANNEL DREDGING
TYPICAL SECTION

NO SCALE

NOTE:

1. POST-DISPOSAL GRADING AND SHAPING TO 60' WIDTH PRIOR TO TREE PLANTING.

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

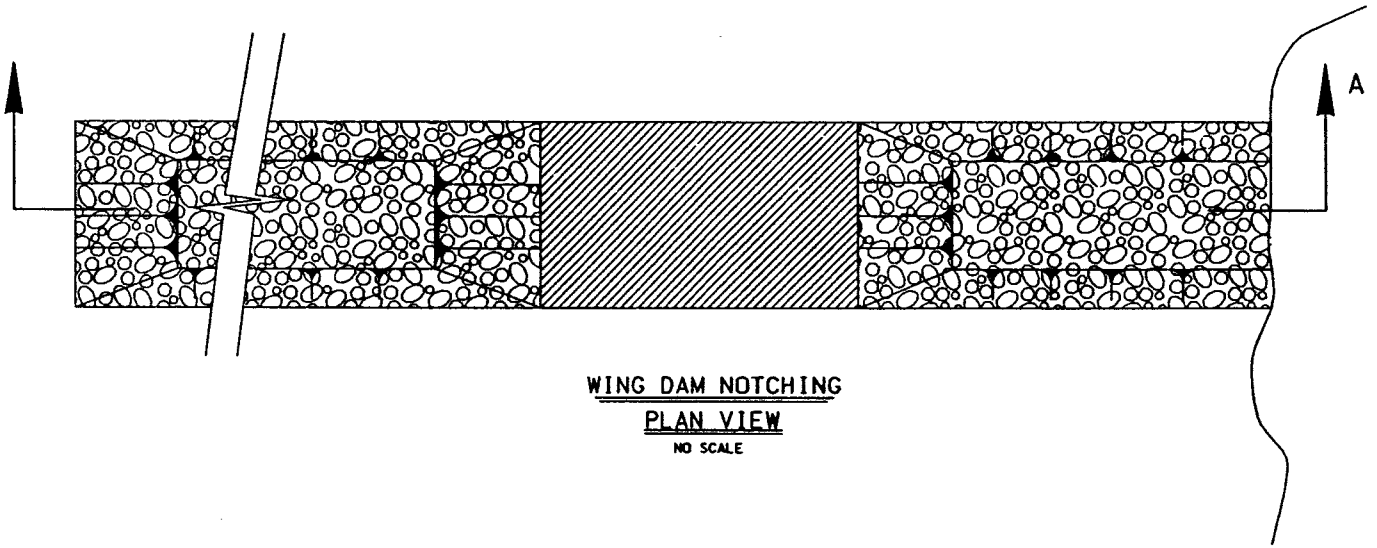
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES S. CAH, COL., CORPS OF ENGINEERS

UPPER MISSISSIPPI RIVER
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION
AND ENHANCEMENT

TYPICAL SECTIONS
CHANNEL AND DEEP HOLE DREDGING

Scale: NO SCALE
Date: 1 AUG. 1995
Drawing Code:
Sheet Reference Number: C-8
Solicitation Number:
Sheet 9 of

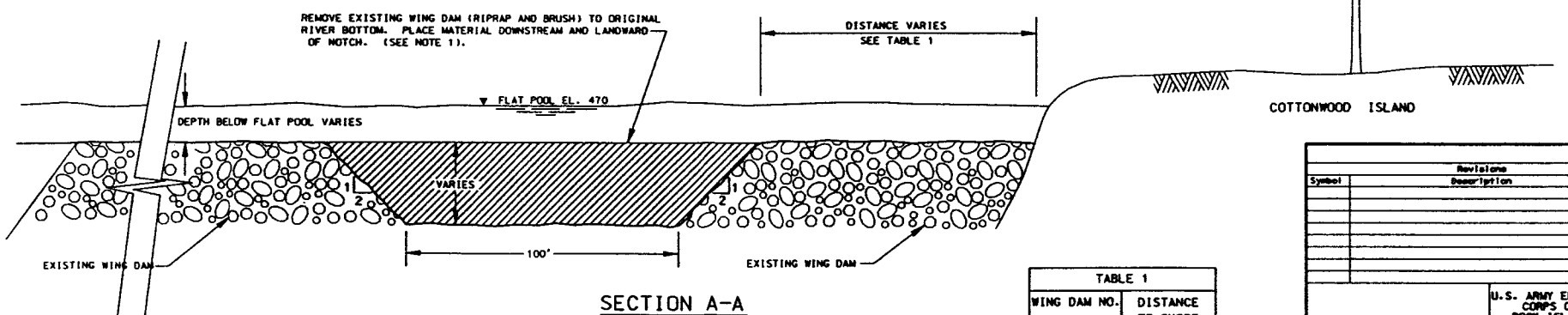
PLATE 8



WING DAM NOTCHING
PLAN VIEW
NO SCALE

NOTE:

1. MATERIAL REMOVED FROM WING DAM NO.29 TO BE PLACED DOWNSTREAM AND RIVERWARD OF NOTCH TO AVOID DISTURBING ARCHAEOLOGICAL SITE.



SECTION A-A
WING DAM NOTCHING
TYPICAL SECTION
NO SCALE

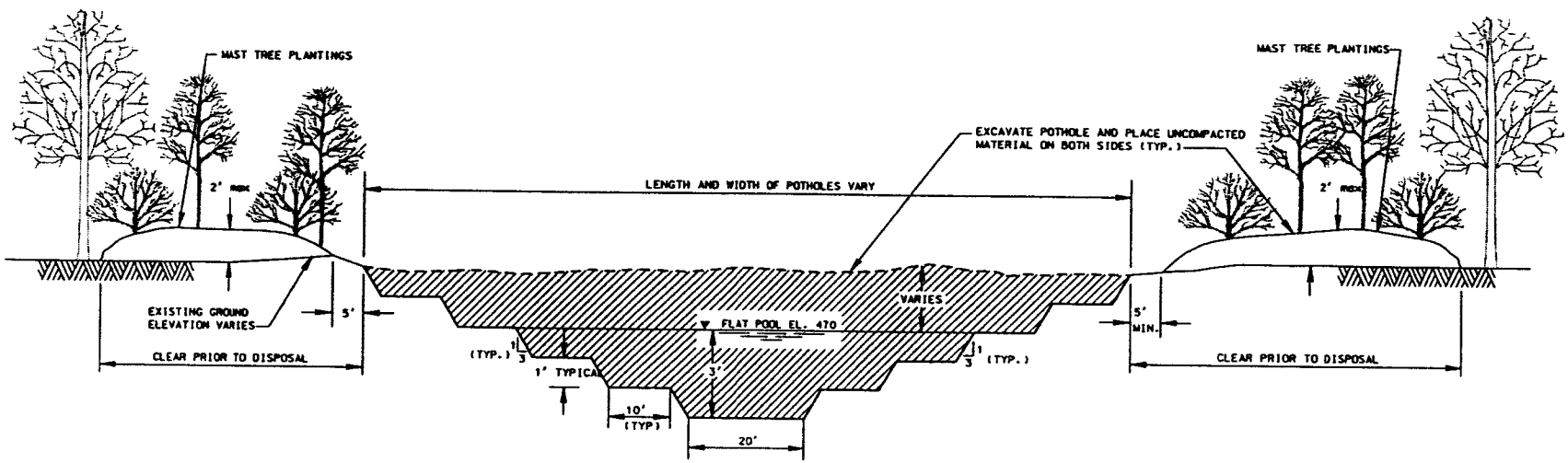
TABLE 1	
WING DAM NO.	DISTANCE TO SHORE
8	600'
5	450'
6	700'
29	650'
30	250'
15	170'

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: CCK	UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21, RIVER MILE 328.5 THRU 331.0 COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT
Drawn by: SDH/BLL	TYPICAL SECTIONS WING DAM NOTCHING
Checked by: BLK	
Reviewed by: DJH	Scales: NO SCALE; Date: 1 AUG. 1995
Approved by: CHARLES S. OSH COL., CORPS OF ENGINEERS	Drawing Number: C-9; Sheet 10 of
	Solicitation Numbers

PLATE 9



SECTION A-A (TYPICAL)
MECHANICALLY CONSTRUCTED POTHOLE

NO SCALE

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

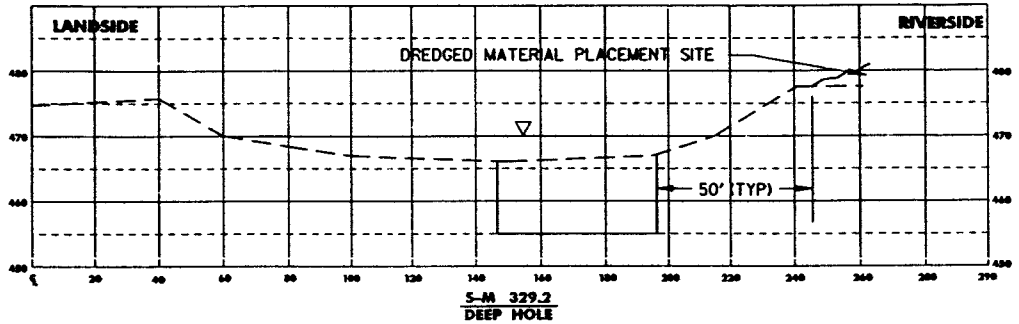
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES E. COX, CHIEF, CORPS OF ENGINEERS

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 329.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

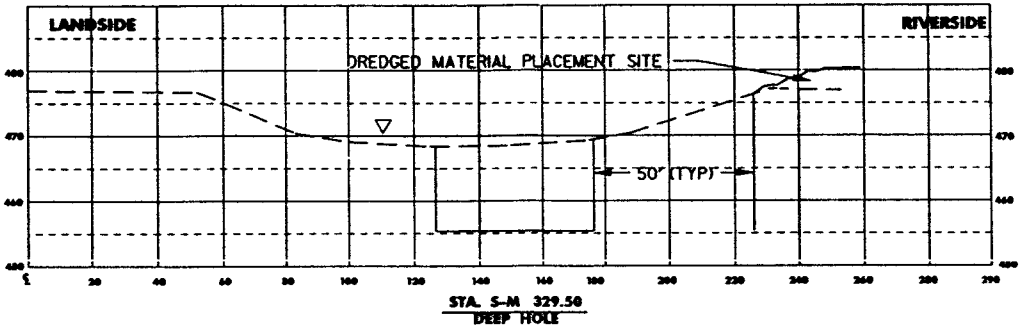
TYPICAL SECTIONS
POTHOLES

Scale: NO SCALE
Date: 1 AUG. 1995
Drawing Number: C-10
Sheet reference numbers
Solicitation Numbers
Sheet 11 of

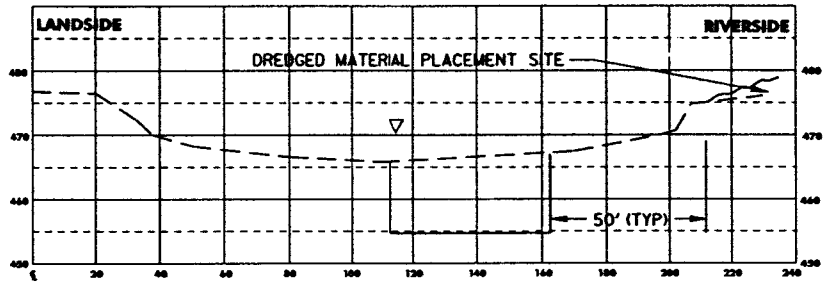
PLATE 10



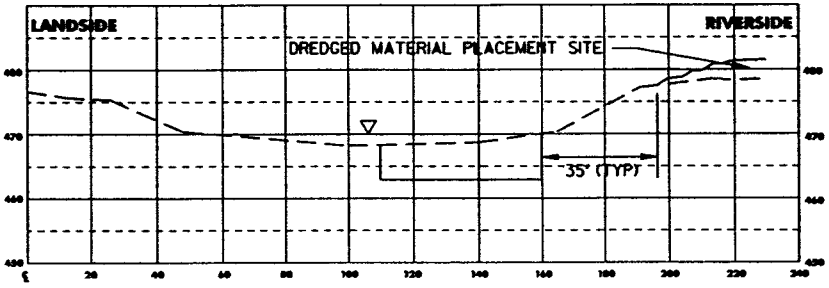
S-M 329.2
DEEP HOLE



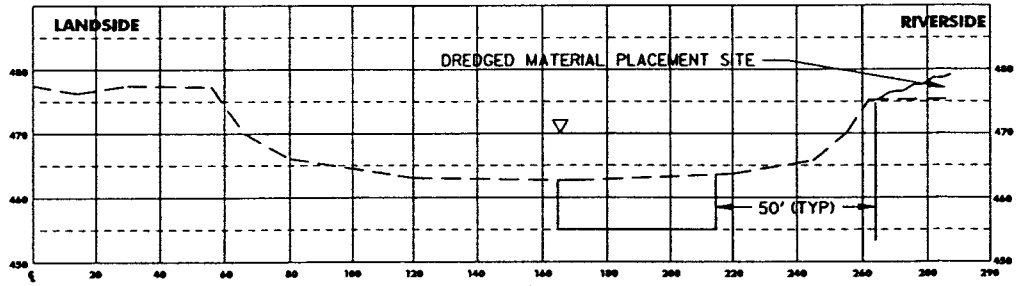
STA. S-M 329.50
DEEP HOLE



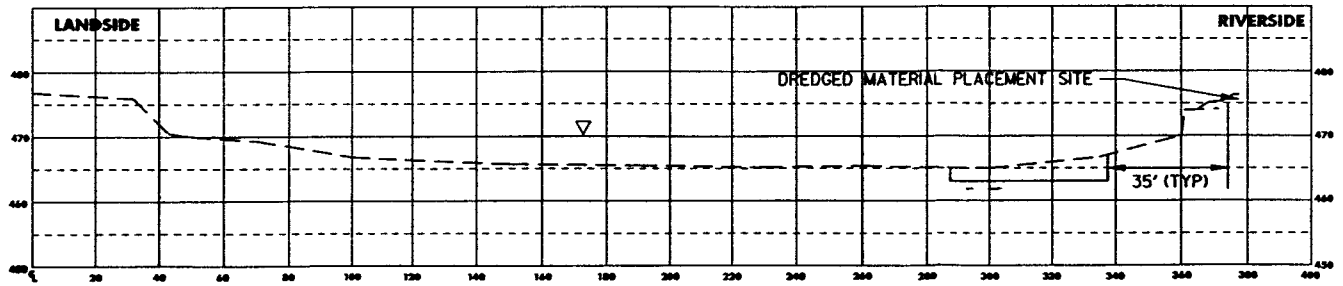
S-M 328.9
DEEP HOLE



T 329.3
CHANNEL



S-M 328.7
DEEP HOLE



T 328.6
CHANNEL

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

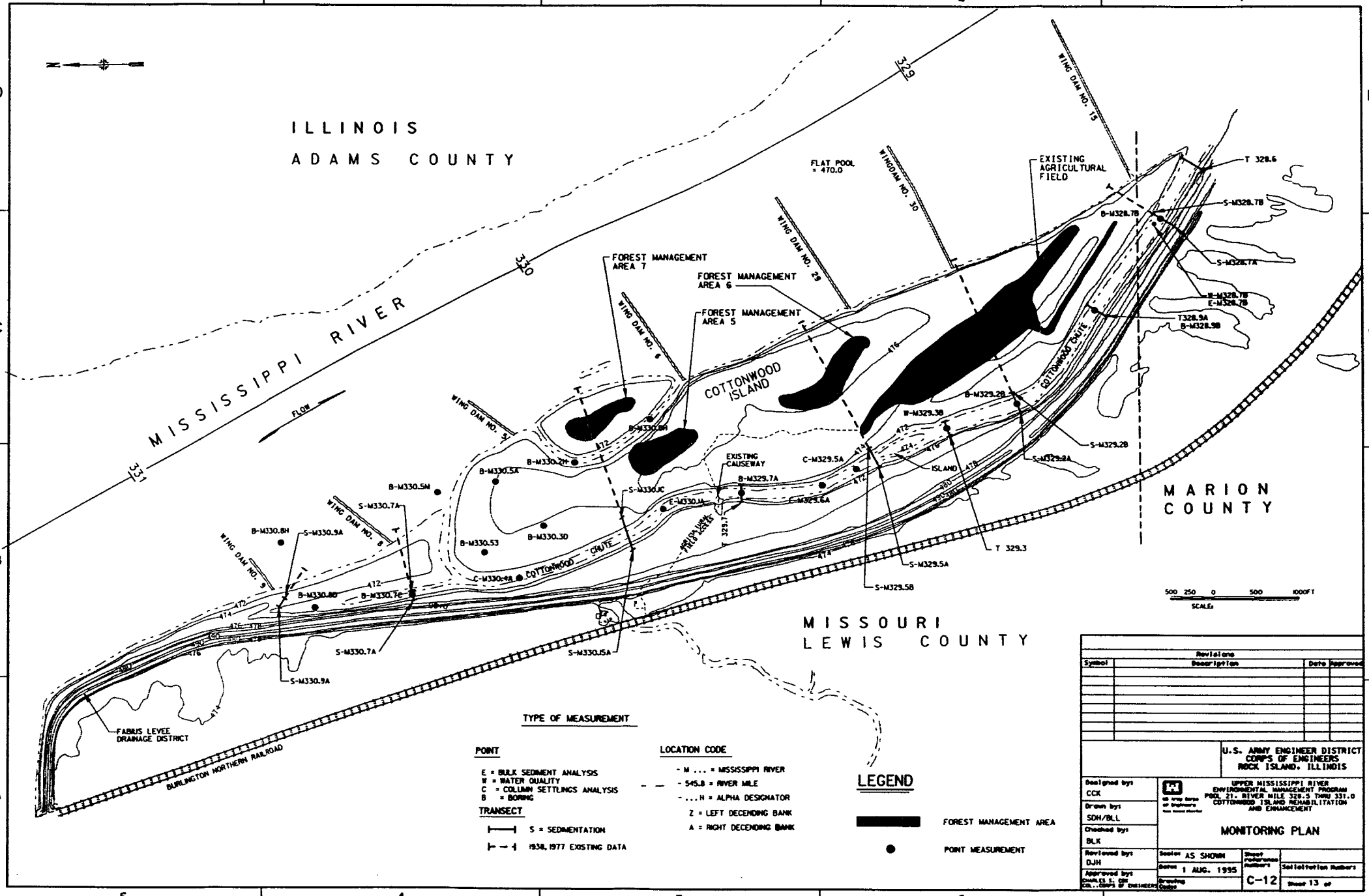
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES S. CHI, Chief, CORPS OF ENGINEERS

UPPER MISSISSIPPI RIVER
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

CHANNEL AND DEEP HOLE DREDGING
TYPICAL CROSS SECTIONS
TRANSECTS 3+28.6 THRU 3+29.5

Scale:
Date: 1 AUG. 1995
Drawing Number: C-11
Sheet Reference Number:
Solicitation Number:
Sheet 12 of

PLATE 11



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

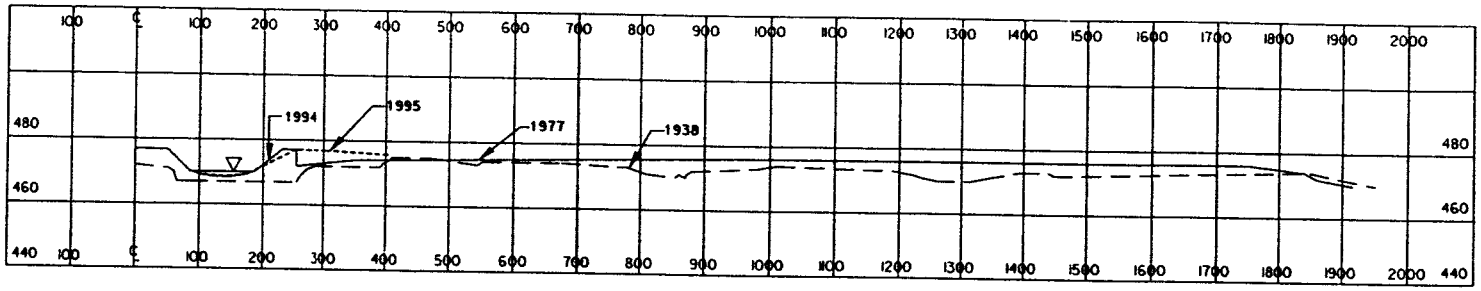
Designed by: CCK
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by: CHARLES C. CHI, COL., CORPS OF ENGINEERS

UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 328.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT

MONITORING PLAN

Scale: AS SHOWN
Date: 1 AUG. 1995
Drawing Code:
Sheet reference number: C-12
Solicitation Numbers:
Sheet 13 of

PLATE 12



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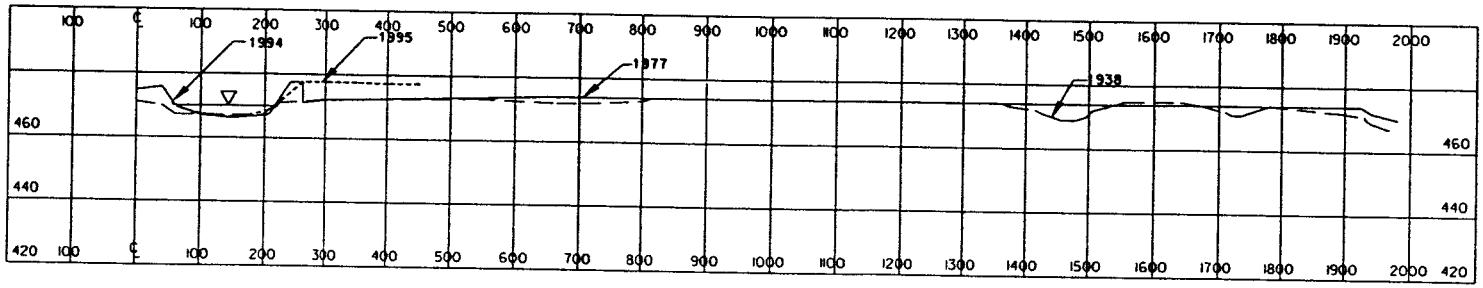

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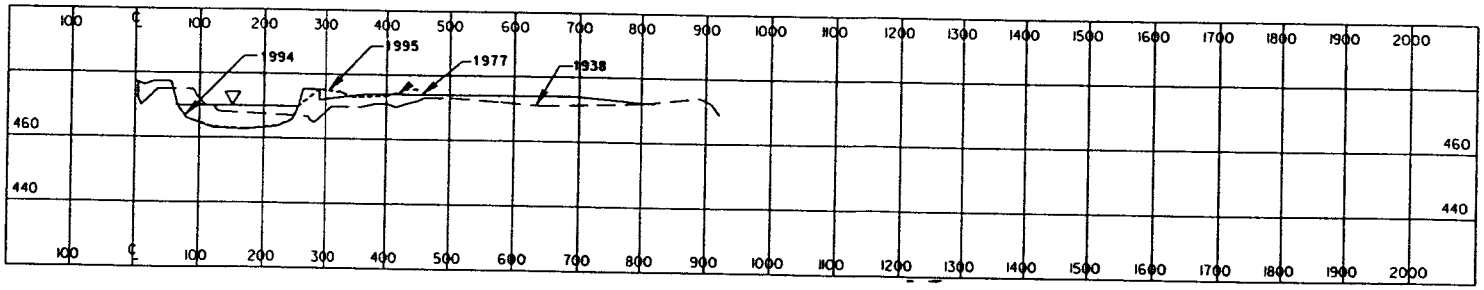


S-M 3+28.7

NOTE:

FLAT POOL IN REFERENCE TO 1994.
FIELD BOOK FC-94-36

LEGEND

1994. FIELD BOOK FC-94-36

1977. PHOTOGRAMMETRIC MAPPING
HQADD-PT-12 & HQADD-PT-13

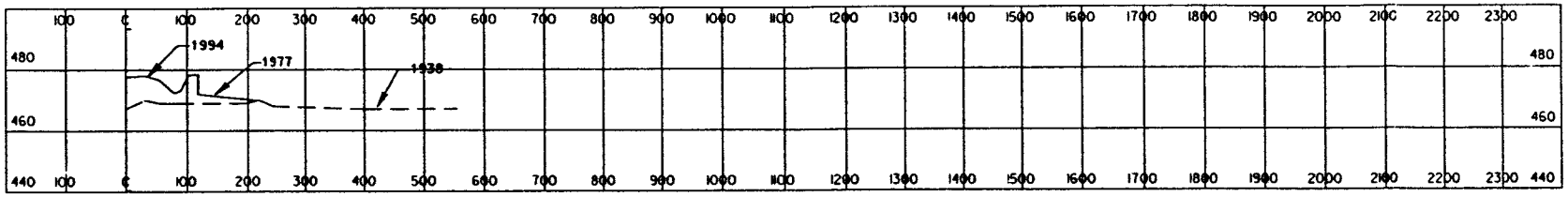
1938. PLANE TABLE SHEETS
21-PT-12 & 21-PT-13

Revisions			
Symbol	Description	Date	Approved

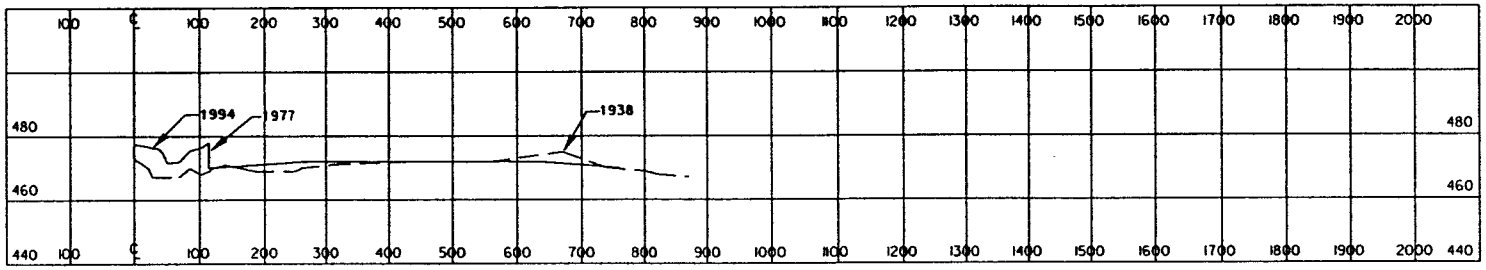
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: CCK	UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM POOL 21, RIVER MILE 328.5 THRU 331.0 COTTONWOOD ISLAND REHABILITATION AND ENHANCEMENT
Drawn by: SDH/BLL	TRANSECTS 1938.1977.1994 TRANSECT 3+28.7 THRU 3+29.5
Checked by: BLK	
Reviewed by: DJH	
Approved by: CHARLES S. CAN COL., CORPS OF ENGINEERS	Scales
	Dates 1 AUG. 1995
	Drawing Number C-13
	Sheet 14 of
	Solicitation Numbers

PLATE 13



STA. 3+30.9



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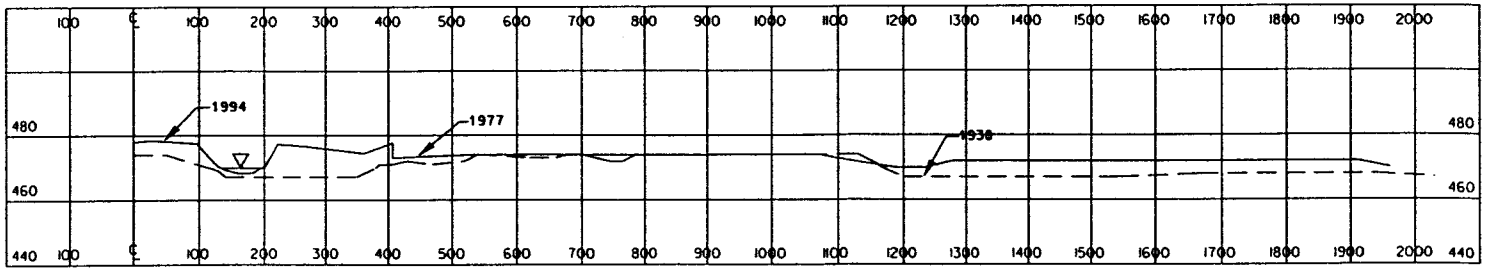

S-M 3+30.15

NOTE:

FLAT POOL IN REFERENCE TO 1994.
FIELD BOOK FC-94-36

LEGEND

1994. FIELD BOOK FC-94-36

1977. PHOTOGRAMMETRIC MAPPING
HQADD-PT-12 & HQADD-PT-13

1938. PLANE TABLE SHEETS
21-PT-12 & 21-PT-13

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: CCX
Drawn by: SDH/BLL
Checked by: BLK
Reviewed by: DJH
Approved by:

UPPER MISSISSIPPI RIVER
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 21, RIVER MILE 329.5 THRU 331.0
COTTONWOOD ISLAND REHABILITATION
AND ENHANCEMENT

TRANSECTS 1938.1977.1994
TRANSECT 3+30.15 THRU 3+30.9

Scale: 1 AUG. 1995
Drawing Number: C-14
Sheet reference number:
Solicitation Numbers:
Sheet 15 of

PLATE 14