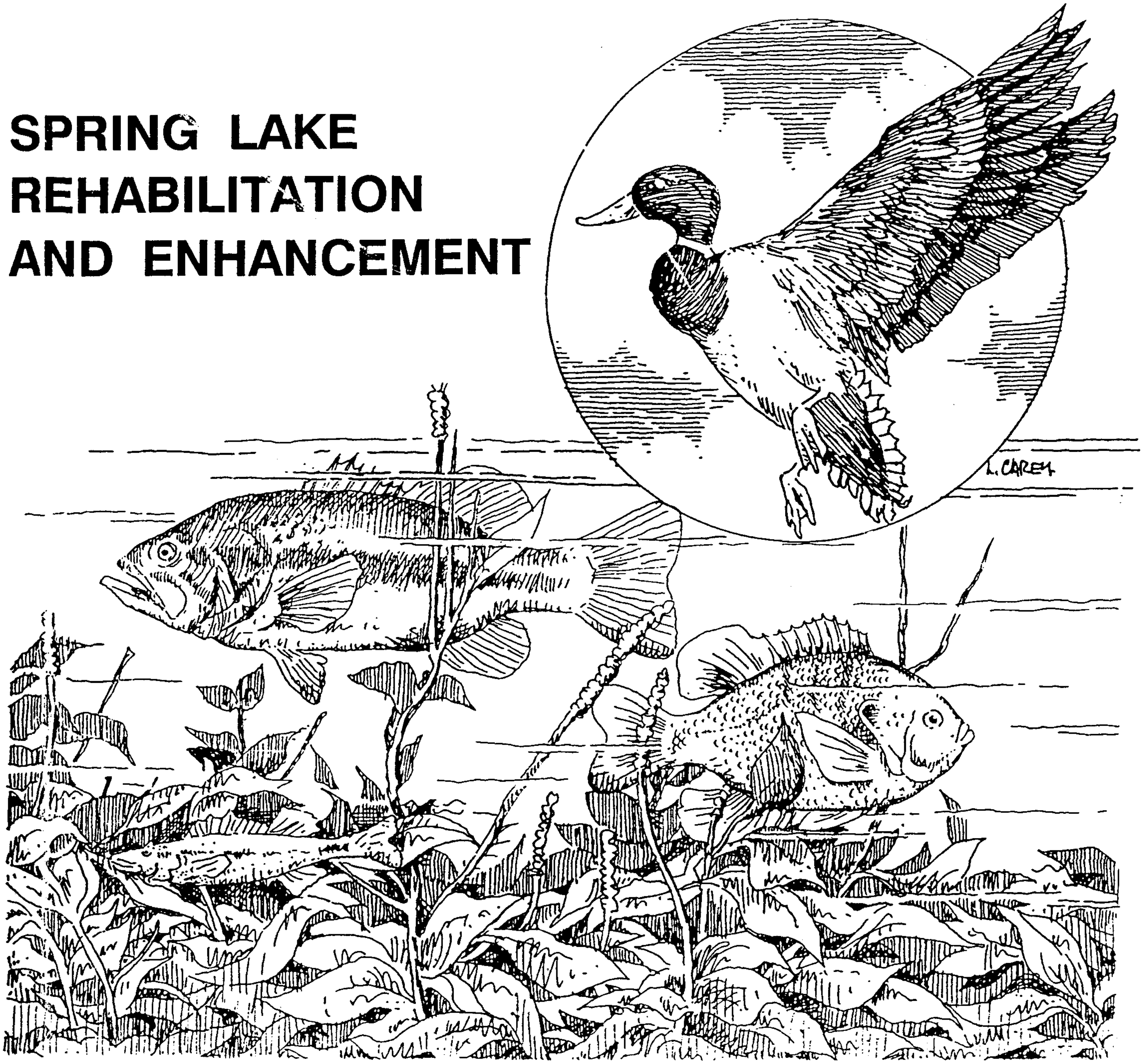
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT (R-12F)
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

SPRING LAKE REHABILITATION AND ENHANCEMENT



MAY 1993

US Army Corps
of Engineers
Rock Island District

POOL 13
MISSISSIPPI RIVER
MILES 532 - 536
CARROLL COUNTY, ILLINOIS

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
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CARROLL COUNTY, ILLINOIS

MAY 1993

ACKNOWLEDGEMENT

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US Army Corps of Engineers
Rock Island District

WE'RE PROUD TO SIGN OUR WORK

EXECUTIVE SUMMARY

Spring Lake, a 3,300-acre lake and backwater complex delimited by the natural river bank and a perimeter levee, is located on the Illinois side of the Upper Mississippi River between river miles (RM) 532.5 and 536.0, approximately 2 miles south of Savanna, Illinois (see figure 1). It is divided into an upper and lower lake by a cross dike. The area is presently managed by the U.S. Fish and Wildlife Service (USFWS) as a wildlife refuge.

Spring Lake was historically a highly productive and heavily used feeding and resting area for migratory waterfowl. However, due to breaching of the perimeter levee, deposition of sediments into Spring Lake, primarily during flood events, has caused a gradual decline in the quality and availability of aquatic habitat in Spring Lake. Breaches have prohibited annual maintenance of the perimeter levee system. Areas adjacent to breach sites also have deteriorated. Waterfowl use in the Upper Lake has diminished because of reductions in quality food plant species resulting from the invasion of woody vegetation and undesirable aquatic plants. In addition, the shallow water conditions and low flows in the Lower Lake are negatively impacting dissolved oxygen levels.

The goals for this project are the enhancement of aquatic and wetland habitats. In support of these project goals, the following design objectives have been identified: (1) improve water quality for fish; (2) maintain backwater lake; (3) provide reliable wetland vegetation/food source in Upper Lake for migratory birds; and (4) provide reliable food source in Lower Lake for migratory birds and other wetland species.

Three alternatives consisting of combinations of rehabilitation and enhancement features were considered: (A) No Federal Action; (B) Levee Restoration/Upper Lake Water Control/Inlet Structures; and (C) Levee Restoration/Upper Lake Water Control/Inlet Structures/Hemi-Marsh.

Evaluation of the project alternatives was accomplished through the application of habitat value assessment methodologies. The Wildlife Habitat Appraisal Guide (WHAG), a habitat assessment methodology designed by the Missouri Department of Conservation in cooperation with the U.S. Soil Conservation Service, was used in the analysis of wetland and terrestrial habitats. The aquatic version of the WHAG, referred to as MOFISH, was used to evaluate present and future conditions and changes in aquatic resources as a result of proposed alternatives. The alternatives were evaluated and optimized on an individual and combined feature basis. As a result of the analysis, the construction of Alternative C was recommended (see figure 1).

The proposed project consists of: establishing three independent water-controlled cells in the Upper Lake; restoring 7.1 miles of perimeter levee; constructing a gated inlet structure and gatewell structure in the Lower

Lake levee; and constructing an approximately 100-acre water-controlled hemi-marsh in the Lower Lake.

The proposed construction in the Upper Lake will accommodate a combination of moist soil and managed marsh operations. This will meet the project objective of providing reliable food resources in the Upper Lake for migratory birds. Habitat diversity for other marsh-dwelling species will be an additional output. The moist soil units will favor the targeted waterfowl specie (mallard). The managed marsh will provide habitat diversity and important habitat units for many non-targeted species such as muskrat, yellowlegs, rail, coot, and Canada geese, as well as habitat units for mallards.

The proposed gated inlet structures in the Lower Lake will provide capability to selectively introduce flow into the Lower Lake. Operation of these structures will result in increased dissolved oxygen levels in the Lower Lake and, consequently, substantially improved water quality and aquatic habitat.

The proposed hemi-marsh development will provide additional reliable marsh habitat and habitat diversity.

It is proposed that selected quantitative physical, chemical, and natural resource parameter measurements, as specified in the project report, be collected following completion of construction to evaluate project performance with respect to the stated objectives. The Corps of Engineers will have responsibility for this data collection. Additional field observations will be gathered by the USFWS and submitted to the Corps of Engineers for inclusion in the annual project performance monitoring plan.

Project operation and maintenance, at an estimated average annual cost of $33,094, will be accomplished by the USFWS, the Federal project sponsor.

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 Definite Project Report 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.

The District Engineer has reviewed the project outputs and determined that the implementation of the identified plan is justified and in the Federal interest. The project area is managed as a National Wildlife Refuge within the meaning of Section 906(e) of the 1986 Water Resources Development Act. Therefore, approval of the construction of the Spring Lake Habitat Rehabilitation and Enhancement project is recommended by the Rock Island District Engineer at 100-percent Federal expense estimated at $4,651,000. (Total project cost including general design: $5,243,000)

UMRS EMP

SPRING LAKE, IL

RIVER MILES 532 THROUGH 536

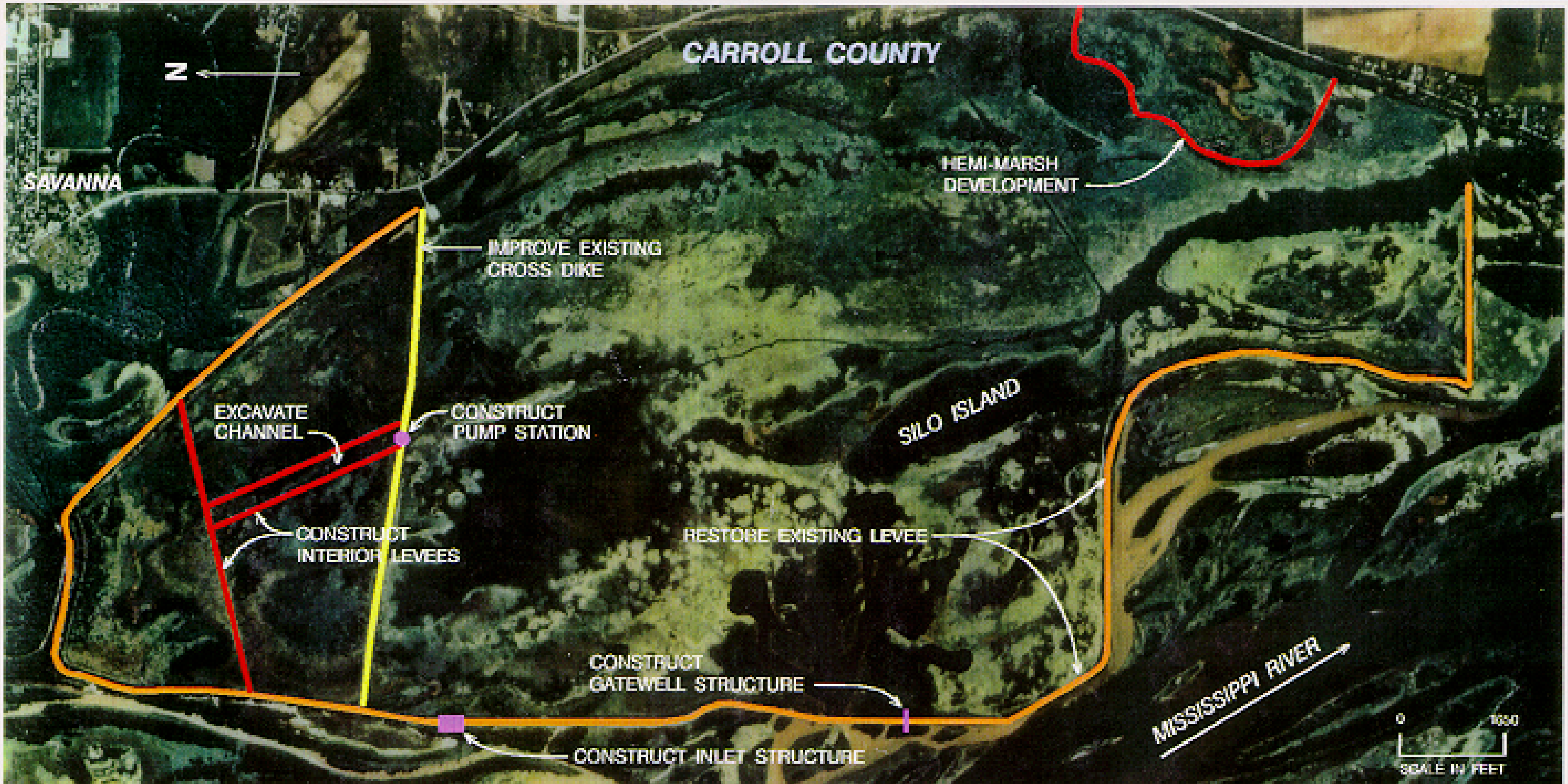

FIGURE 1

UPPER MISSISSIPPI RIVER SYSTEM
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SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

1. INTRODUCTION

a. **Purpose**. The purpose of this report is to present a detailed proposal for the rehabilitation and enhancement of the Spring Lake, Illinois, project site. This report provides planning, engineering, monitoring, 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**. Spring Lake is a 3,300-acre lake complex delimited by the natural bank of the Upper Mississippi River and a perimeter levee. It is located within the Savanna District of the Upper Mississippi River National Wildlife and Fish Refuge between river miles (RM) 532.5 and 536.0, approximately 2 miles south of Savanna, Illinois (see plate 1).

Spring Lake formerly was a highly productive and heavily used source of aquatic vegetation for migratory waterfowl. However, due to both intentional and natural breaching of the perimeter levee associated with the 1965 flood of record, sedimentation from river flows has degraded the area's aquatic habitat. Peak waterfowl use days have decreased from 113,000 to 30,000 or less.

Breaches have prohibited annual maintenance of the perimeter levee system. Areas adjacent to breach sites also have deteriorated. Deep scour holes are present at breach sites.

Opportunities for preserving/restoring habitat at this location for migratory birds, aquatic mammals, and fish have been identified. By reducing the inflow of sediments, improving water control, and increasing the level and distribution of dissolved oxygen in the Lower Lake, habitat suitability and overall value will be increased.

The north subimpoundment (Upper Spring Lake) is available for moist-soil and/or managed marsh unit enhancement. This area will provide increased habitat for surface-feeding waterfowl if reliable water level management capabilities are provided.

c. **Scope of Study**. The study has focused on the identification and assessment of habitat rehabilitation and enhancement alternatives that are consistent with refuge management objectives. Proposed alternatives will improve existing water quality, increase reliability of food resources and wetland vegetation, and restore lost aquatic habitat.

The geographical scope of the study area is shown on plates 1 and 2. Emphasis was placed on developing project features which are located on existing State or Federal lands. Although additional land could be purchased by the U.S. Fish and Wildlife Service (USFWS) or non-Federal interests, alternatives with major land acquisition were generally not pursued due to policy, scheduling, and funding considerations.

Alternatives involving upland erosion control were not studied in detail since the U.S. Soil Conservation Service has primary jurisdiction for such actions.

Field surveys were performed in developing sedimentation estimates, assessing effects near project boundaries and Government property lines, and estimating excavation and embankment quantities. Surveyed sections will be used to evaluate post-construction performance.

Soil borings were taken to assess sediment types, to determine foundation suitability for proposed structures, and to determine excavation difficulty and suitability of borrow materials.

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 Spring Lake, Illinois, 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 Sections 8 and 9 describe the selected plan. Section 10 assesses the environmental effects of the proposed plan. Section 11 provides a summary of project accomplishments and benefits. Sections 12, 13, and 14 describe estimated operation and maintenance considerations, performance monitoring, and detailed cost estimates for both initial construction and annual operation, maintenance, and monitoring. Sections 15, 16, 17, and 18 provide a summary of implementation requirements and coordination. Sections 19 and 20 present the conclusions and recommendations. The Finding of No Significant Impact and literature citations are provided as Sections 21 and 22.

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 13 environs. Plates 2 and 3 show the recommended plan and alternative plans. Plates 4, 5, and 6 provide 24 years of hydrographic record of the Mississippi River at the proposed project site. These hydrographs provide the relationship between river flood events and proposed levee heights. Plates 7, 8, and 9 provide a boring log and soil borings which were used to evaluate foundation effects and excavation/fill methods.

e. **Authority**. Figure 1-1 provides a brief historical perspective of the events and milestones which lead to the establishment of the UMRS-EMP and which have subsequently modified the program. 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 will 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.

HISTORICAL PERSPECTIVE OF EMP

Pre-1973	- St. Louis District planning for replacement of L/D #26	Pre-197
1974		1974
1975	- Environmental groups and midwestern railroads file suit against construction of L/D #26 and further expansion of river navigation claiming that the cumulative environmental and economic impacts	1975
1976	had not been evaluated and that there was no authority to expand the navigation capacity of the system.	1976
1977		1977
1978	- L/D #26 authorization - Included requirement that Upper Miss. Basin Commission prepare a Master Plan that would relate future navigation capacity to the environment and other uses. (P.L. 95-502)	1978
1979	------- Master Plan Study ------- - Master Plan recommended:	1979
1980	o Authorization of Second Lock o Program to Reduce Erosion o Habitat Enhancement Program o Recreation Projects Program and Recreation Expenditures Study o Traffic Monitoring	1980
1981	o Long Term Resource Monitoring Program o Coordination of Recommendations for Increased Lock Capacity - Upper Miss. Basin Comm. abolished	1981
1982	- Upper Miss. Basin Assoc. established	1982
1983		1983
1984		1984
1985	- Second Lock (600 foot) at L/D #26 and Environmental Management Program authorized in 1985 Supplemental Appropriations Act and in WRDA 1986 (P.L. 99-662)	1985
1986	------- EMP Authorization Included: 10-year program for: ------- o Habitat Enhancement Program o Long Term Resource Monitoring Program	1986
1987	o Computerized Inventory and Analysis System o Recreation Projects Program o Recreation Expenditures Study	1987
1988	o Navigation Traffic Monitoring	1988
1989		1989
1990	WRDA 90 (extended program 5 years), (P.L.101-640)	1990
1991	- Second Lock EIS, Plan of Study	1991
1992	- **WRDA 92 (H.R. 6167)** **o Formalized O&M Responsibility** **o Modified Funding Allocation Formula**	1992

FIGURE 1-1

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 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 openings/closings
- 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.) Note: By letter of February 5, 1988, the Office of the Chief of Engineers directed that such projects not be pursued.

(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 and ensuring thorough coordination between the participating State and Federal agencies.

b. **Project Selection**. All Mississippi River habitat projects completed or currently being designed or monitored by the Rock Island District as part of the UMRS-EMP were originally identified in the Fish and Wildlife Interagency Committee (FWIC) report entitled *Goals for Management of Fish and Wildlife Resources and Habitat Rehabilitation and Enhancement for Pools 11-22* (portions of which are provided as Attachment 1). Selected projects were subsequently submitted for FWIC ranking by the various State and Federal agencies responsible for natural resource management. The FWIC ranking process results in proposed projects being placed into one of three (high, medium, or low) prioritization categories. High category projects represent those projects having received the FWIC's highest numerical values based upon weighted criteria (see Attachment 2). To date, only high-ranked projects (with the exception of Bay Island, Missouri, and Lake Odessa, Iowa) have been scheduled for baseline monitoring, general design, or construction in the Rock Island District's HREP program. (See Figure 2-1.) Recognizing the value of the FWIC's established coordination mechanisms and biological expertise, the Rock Island District has accepted and continues to utilize the FWIC's project ranking system as the primary basis for project selection and prioritization. Figure 2-1 provides a comprehensive summary of the current FWIC rankings for all Rock Island District habitat projects being implemented.

Figure 2-2 diagrams the major habitat project processing steps. The following paragraphs further describe the early project identification, ranking, and prioritization process.

Rehabilitation and enhancement projects are nominated by the respective State conservation agency or the USFWS. To assist in the project formulation process, the FWIC convened a series of meetings in 1986 to consider critical habitat needs along the Mississippi River. At these meetings, biologists who are responsible for river management evaluated the available habitat on a pool-by-pool basis. This analysis revealed deficiencies, such as feeding, resting, and loafing areas for migratory waterfowl; absence of deep water habitat off the main channel for fish and diving ducks; as well as types of habitat in abundant supply (e.g., mature bottom land hardwood). The FWIC ranking and prioritization process assumes that projects being implemented will reflect broad regional needs in addition to the best site-specific choices.

To assist the District in the final selection of projects to be included in the program, the FWIC ranks projects according to the biological outputs that they could provide. This group, composed of biologists and other natural resource specialists who are intimately familiar with the Mississippi River and Illinois Waterway, considers each project nominated for inclusion and also suggests project alternatives to increase habitat

FWIC Rankings For CENCR HREPs

(HREPRANK.XLS, PDW3;serv6h) — Revised: 04/29/1993

Projects completed or underway			Projects ranked; not yet initiated			New projects; unranked
Project Name	**Points**	**Rank**	**Project Name**	**Points**	**Rank**	**Project Name**
Monkey Chute, MO		(not ranked)	Molo Slough, IA 2/	27	High	Thompson Lake, IL
Andalusia Refuge, IL ✓		(not ranked)	Sanganois, IL	26	High	Pool 12 overwintering habitat, IL
Brown's Lake, IA ✓		(not ranked)	Miller's Lake, IL	26	High	Beaver Island, IA
Bertom/McCartney, WI ✓		(not ranked)	Smith's Creek, IA 2/ 4/	24	High	Blackhawk Bottoms, IA
Big Timber, IA ✓		(not ranked)	Gregory Landing, MO 3/ 4/	22	High	Huron Island, IA
Potter's Marsh, IL ✓	27	High	Pleasant Creek, IA 2/ 5/	23	High	
Peoria Lake, IL ✓	25	High	Huron Pool 18, IA	26/27	High	
Bay Island, MO ✓	23	Medium	Huron Lake, IA	20	Low	
Chautauqua Lake, IL ✓	24	High	Elk River, IA	23	Medium	
Spring Lake, IL 1/ ✓	24/27	High	Middle Sabula, IA	19	Low	
Lake Odessa, IA	23	Medium	Chautauqua Lake, IL (Phase II) ✓	18	Low	
Cottonwood Island, MO	26	High	Mud Lake, IA	22	Medium	
Gardner Division, IL	25	High	Quincy Bay, IL	20	Low	
Banner Marsh, IL	29	High	Turkey/Otter Islands, IA	20/21	Low	
Rice Lake, IL	27	High	Turkey River Bottoms, IA	20	Low	
Princeton Refuge, IA ✓	27	High	Bunker Chute, IA	20	Low	
Pool 11 Islands, WI	25	High	Credit Island, IA	20	Low	
Ranked projects completed via other programs			Small projects ranked; 6/			Small projects, unranked 6/
Green Island, IA	23	Medium	Eagle Fill, IL 4/	18	Low	Green Island water control station
			Sny Side Channel, IL 4/	21	Low	modifications, IA

1/ Ranked as two phases subsequently rescoped to a single project.
2/ Baseline monitoring underway.
3/ Locational factors resulted in project being ranked high.
4/ RRCT approval of ranking is pending.
5/ High ranking reflects FWS prioritization considerations.
6/ To be accomplished under delegated authority

FIGURE 2-1

FIGURE 2-2

ROCK ISLAND DISTRICT FLOW CHART FOR THE IMPLEMENTATION OF HABITAT REHABILITATION AND ENHANCEMENT PROJECTS
Upper Mississippi River System – Environmental Management Program (EMP)

PROJECT SELECTION AND FACT SHEET	States, FWS, & LTRM identify projects; District adds to potential projects list 1	-----> Fish & Wildlife Interagency Committee (FWIC) of the River Resources Coordinating Team(RRCT) prioritizes projects 2	-----> RRCT reviews/endorses FWIC prioritized list; submits to District, States, and FWS 3	-----> District develops prioritized list based on coordination with States and FWS 4	-----> District requests information from proponent agency to prepare project fact sheet 5	-----> Proponent agency submits information for fact sheet to District 6	-----> District completes fact sheet; sends to NCD for endorsement 7
BUDGETING AND FUNDING	District prepares list of projects for budget request based on funding levels; submits to NCD in March 8	-----> NCD includes projects in annual addendum for EMP; NCD coordinates addendum with FWS, States, & others 9	-----> Budget documents prepared; submitted to HQUSACE 10	-----> HQUSACE includes EMP funding in annual budget request after coordination with ASA(CW) & OMB 11	-----> Congress appropriates funds for EMP 12	-----> OMB and ASA(CW) provide apportionments and instructions 13	-----> HQUSACE passes allotment to District thru NCD; 14
PLANNING AND GENERAL DESIGN	District receives funds for project planning and general design; forms project planning team 15	-----> Initial site visit; identify problems, opportunities, and planning constraints 16	-----> Define habitat goals and objectives for project area 17	-----> Formulate, evaluate, & compare alternatives. Prepare & coordinate Problem Appraisal Rpt. 18	-----> Select & develop proposed plan; prepare draft DPR & NEPA documents and LCA 19	-----> Review of preliminary draft documents by NCD, States, and FWS 20	-----> FWS provides formal indication of refuge compatibility (if required) 21
PUBLIC REVIEW AND PROJECT APPROVAL	Draft documents sent out for public review; 401 certification; public meeting 22	-----> District finalizes DPR & NEPA documents and forwards to NCD 23	-----> NCD reviews project documents and sends to HQUSACE for ASA(CW) approval 24	-----> HQUSACE approves funds for preparation of plans and specs by Dist and, ultimately, construction 25	-----> Prepare plans and specifications; obtain State permits for approval 26	-----> Based on DPR, ASA(CW) approves project for construction 27	-----> Local sponsor and Army representative sign LCA (if applicable) 28
PROJECT CONSTRUCTION	Determine whether to construct by contract or with government 29	-----> Local funds contributed (if applicable) 30	-----> Advertise contract and open bids 31	-----> Receive construction funds and award contract 32	-----> Construct project 33	-----> Finalize O&M manual 34	-----> Transfer project, sponsor assumes O&M responsibility; evaluation 35

KEY

States = Minnesota, Wisconsin, and/or Iowa Departments of Natural Resources
FWS = U.S. Fish and Wildlife Service
LTRM = Long Term Resource Monitoring element of EMP
NCD = North Central Division, Corps of Engineers
ASA (CW) = Assistant Secretary of the Army for Civil Works
FWIC = Fish and Wildlife Interagency Committee
RRCT = River Resources Coordinating Team
OMB = Office of Management and Budget
DPR = Definite Project Report
LCA = Local cooperation agreement
O&M = Operation and maintenance

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benefits for fish, migratory birds, and other wildlife. Each project is ranked relative to established criteria as high, medium, or low.

The FWIC rankings are forwarded to the District and to the River Resources Coordinating Team (RRCT), an interagency policy group which meets to coordinate Mississippi River activities. The RRCT examines the FWIC rankings and considers the broader policy perspective of the agencies submitting the projects. The RRCT-recommended rankings also are submitted to the District. The District then formulates and submits a recommended program based upon project rankings and District resources to the EMP program manager at North Central Division.

Projects consequently have been screened by State, USFWS, and Corps of Engineers representatives closely acquainted with the rivers. Resource needs and deficiencies have been considered on a pool-by-pool basis to ensure that regional needs are being met and that the best expertise available was and continues to be used to identify the most suitable locations with the greatest potentials for realizing cost-effective outputs.

The Rock Island District assists the State and the USFWS management agencies through use of an in-house, multi-disciplinary task force. As projects are being conceptualized, this group meets on-site with State and USFWS personnel to examine as fully as possible what site-specific rehabilitation and/or enhancements would be both environmentally desirable and engineeringly feasible.

c. **Specific Site Selection.** As a result of the above identification and prioritization process, Spring Lake has been scheduled for aquatic and wetland habitat rehabilitation and enhancement.

Recognition of changes occurring in habitat composition and subsequent declines in migratory bird and fisheries habitat quality and availability along the Mississippi River prompted the proposal and subsequent high prioritization of several habitat restoration projects by the Federal and State agencies responsible for natural resource management in the Pool 13/14 area. Three of these projects, Potters Marsh, IL (RM 522.5-526.0), Pleasant Creek, IA (RM 548.7-552.8) in Pool 13, and Princeton Refuge, IA (RM 504.0-506.4) in Pool 14 are currently in various stages of implementation under the Environmental Management Program. A fourth project, Brown's Lake, IA (RM 544.0-546.0), has essentially been completed.

All of these projects address the specific need for reliable, diverse aquatic and wetland habitats. The recently completed Brown's Lake project is providing important, off-channel fisheries habitat. Potters Marsh will provide both valuable migratory bird and fisheries habitat, while Princeton Refuge and Pleasant Creek will primarily focus upon migratory bird habitat needs. The Spring Lake Project is expected to provide high quality habitat with respect to both fisheries and migratory birds.

The following considerations in conjunction with the original FWIC ranking were key to the selection of this site for rehabilitation and enhancement:

1. Spring Lake is the only inviolate area within the Upper Mississippi River National Wildlife and Fish Refuge (UMRNWFR).

2. The Lower Spring Lake fishery has been negatively impacted by sedimentation introduced through the upper breach in the levee and subsequently a lack of flow following closure of the breach.

3. Currently, the Upper Lake is difficult to effectively manage because of its large surface area and lack of sufficient water level management capabilities.

4. The project is expected to provide migratory birds a more reliable area in which to feed and rest.

3. ASSESSMENT OF EXISTING RESOURCES

a. **Resource History and Description of Existing Features**. The Upper Mississippi River National Wildlife and Fish Refuge (UMRNWFR) is the longest wildlife refuge in the lower 48 states. It extends 261 miles along the Mississippi River from the Chippewa River in Wisconsin almost to Rock Island, Illinois. The refuge was established in 1924 to protect bottomland habitat for migratory birds and fish. It encompasses approximately 194,000 acres in parts of Minnesota, Wisconsin, Iowa, and Illinois, including parts of 19 counties and 2 Corps of Engineers districts. The Corps has primary administrative and management responsibility for more than half of the land within the refuge. Corps-administered lands are outgranted to the U.S. Fish and Wildlife Service (USFWS) for management of fish and wildlife as part of the UMRNWFR. The UMRNWFR is divided into four districts, each with a district manager. These four districts include the Winona District, the La Crosse District, the McGregor District, and the Savanna District.

Spring Lake is located within the Savanna District of the UMRNWFR between RM 532 and 536, approximately 2 miles south of Savanna, Illinois. It is a 3,300-acre lake which is divided into an upper lake and a lower lake by a cross dike. The area is delineated by the natural river bank and a perimeter levee on the Illinois side of the Upper Mississippi River navigation channel.

Immediately following World War I, the area now known as Spring Lake was diked and ditched for farming. In 1938 and 1939, the land was purchased by the Corps of Engineers for the creation of the lock and dam system. Through seepage and springs located within the perimeter levee, a 3,000-acre lake had developed by 1946. The perimeter levee was breached in two places in the flood of 1965. The west breach was repaired in 1991 and the breach on the south side remains open. Spring Lake was historically a highly productive and heavily used feeding and resting area for migratory waterfowl. However, due to breaching of the perimeter levee, deposition of sediments into Spring Lake, primarily during flood events, has caused a gradual decline in the quality and availability of aquatic habitat in Spring Lake. Waterfowl use in the Upper Lake has diminished because of the invasion of woody vegetation and undesirable aquatic plant species, thereby reducing quality food plant species. In addition, the shallow water conditions and low flows in the Lower Lake during the summer months cause dissolved oxygen levels to drop. The evaluation technique which was used to determine habitat suitability identifies lack of dissolved oxygen as a limiting factor for the fishery in the Lower Lake.

b. **Refuge Management Objectives/Current Land Use**. Spring Lake is managed for the Corps of Engineers by the Savanna District of the USFWS as a national wildlife refuge.

Figure 3-1 provides a detailed land cover/land use classification map for the general project area. (Note: This mapping was completed prior to the closing of the Lower Lake's west side levee breach.) For the purpose of habitat analysis, the project area has been classified into broader habitat types and acreages, as shown in table 3-1.

TABLE 3-1

Existing Habitat Classification

Component	Aquatic (Deep Water) Acres	Non-Forested Wetland (Shallow, Open Water) Acres	Forested Wetlands Acres	Total Acres
Upper Lake	--	540	20	560
Lower Lake	10	2,404	172	2,586
Total	10	2,944	192	3,146

Currently, the Lower Lake is being managed for fish and diving ducks such as canvasback, scaup, redheads, and goldeneye since it provides deep water habitat and aquatic vegetation such as wild celery (*Vallisneria americana)*, coontail (*Ceratophyllum demersum*), and pondweed (*Potomogeton* sp.). Attempts are being made to manage the upper unit of Spring Lake as a moist soil unit for dabbling ducks such as mallards, pintails, teal, and wood ducks. However, due to the lack of lateral ditches, size of the area, and pumping capacity, only the fringe areas provide adequate conditions to grow important food plants such as smartweed (*Polygonum* sp.), bullrush (*Scirpus* sp.), and sedges (*Carex* sp.). Due to the inability to manage the area effectively, there has been an invasion of woody species into the perimeter, while other areas are never completely drained and therefore do not produce the desired vegetation for migratory waterfowl. The levee sides provide grassland type habitat. However, due to operation and maintenance activities, such as required mowing, public recreation disturbances, and predation, nesting in this area will be limited.

The short- and long-range USFWS management goals for the Spring Lake Wildlife Closed Area, a unit of the Upper Mississippi River National Wildlife and Fish Refuge's Savanna District, are to:

(a) Provide spring and fall food reserves and sanctuary for migratory waterfowl.

(b) Provide adequate food supply and habitat diversity for fish.

(c) Provide diversity of habitat for furbearers and other aquatic organisms.

1989 LAND COVER / LAND USE, SPRING LAKE POOL 13, UPPER MISSISSIPPI RIVER

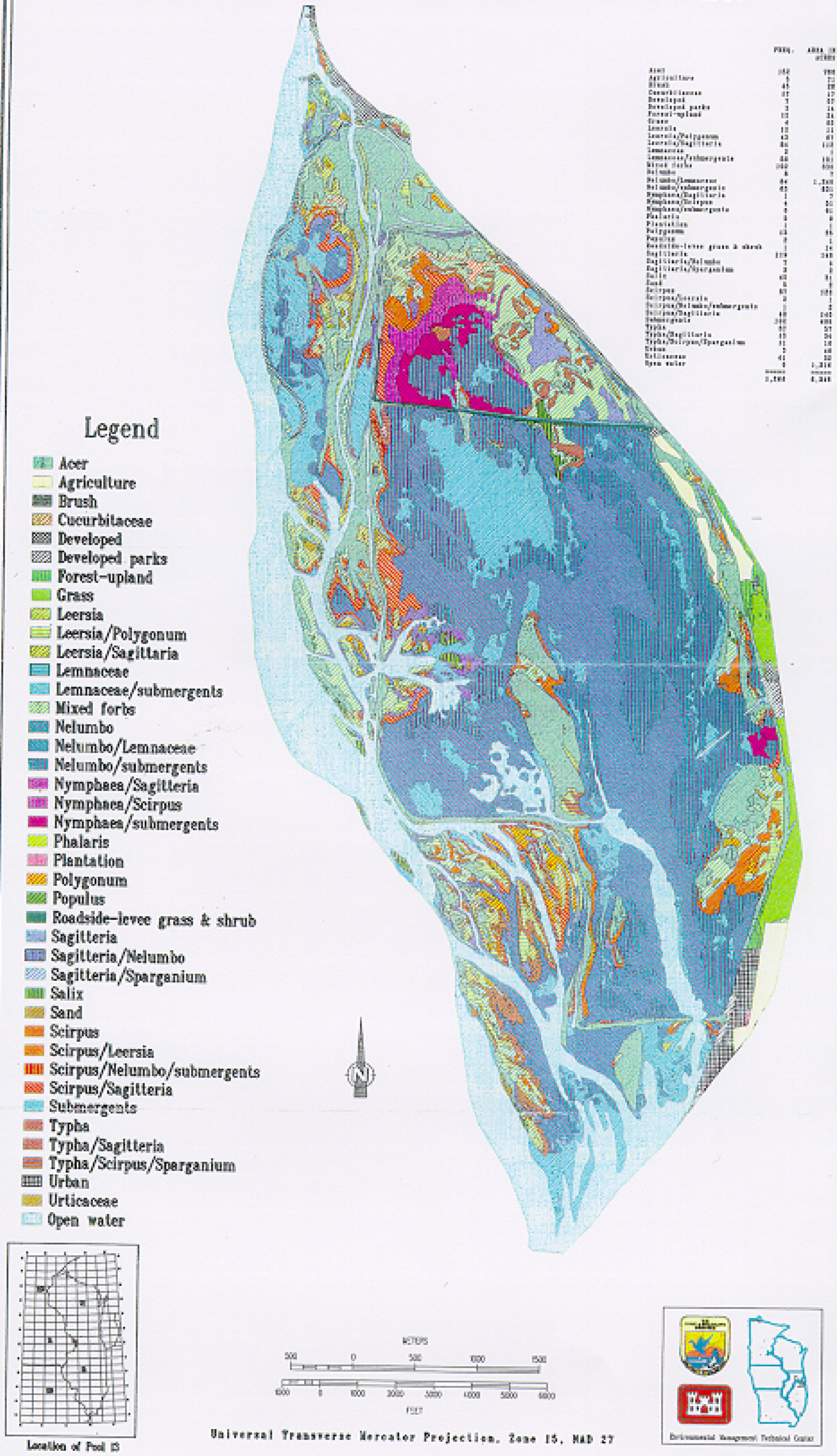


FIGURE 3-1

c. **Wetland and Waterfowl Resources**. The leveed area of Lower Spring Lake consists of about 2,404 acres of non-forested wetland, 10 acres of deep water habitat, and 172 acres of bottomland hardwoods which are located on Silo Island and other smaller islands throughout the Lower Lake. Upper Spring Lake has approximately 540 acres of non-forested wetland and 20 acres of sapling and scrub-shrub wetland (consisting mostly of silver maple, cottonwood, and river birch) not classified as bottomland hardwoods. This scrub-shrub area is located along the perimeter levee of the Upper Lake and is encroaching into the moist-soil unit. Upper and Lower lake submergent and emergent vegetation varies in both species composition and areal extent from year to year, depending upon the duration and magnitude of pool-level fluctuations and Mississippi River flood events.

Species composition of the 172 acres of bottomland hardwood in the Lower Lake is mostly silver maple, burr oak, pin oak, green ash, cottonwood, and river birch. The 20 acres of forested and scrub-shrub wetlands in the Upper Lake consist mostly of silver maple, cottonwood, and river birch.

During the spring flood of 1965, the Lower Lake perimeter levee was breached on both the west and south sides. The breach on the west side was closed in April of 1991. (This closure was accomplished through beneficial placement of dredged material resulting from a 9-foot navigation channel project maintenance dredging action). Prior to repair of the west breach, sediment from the Mississippi and Plum Rivers entered Spring Lake, forming several small islands at the breach site. Finer sediment was distributed throughout the lake decreasing water depth. Suspended sediment carried in by these floodwaters impeded submergent and emergent plant growth by decreasing light penetration and creating a soft flocculent lake bottom in some areas. The breach on the south end of Lower Spring Lake remains open. The area where this breach occurs is the deepest part of the Spring Lake system and provides valuable fish over-wintering habitat.

The average depth of the Lower Lake is approximately 2 to 3 feet. It is currently managed for diving ducks. The Upper Lake is managed as a moist-soil unit for puddle ducks. However, the production of food resources preferred by migratory waterfowl in the Upper Lake is being severely limited by encroachment of woody vegetation and the spread of plant species that do not provide food or cover. Peak waterfowl use days have decreased from 113,000 to 30,000 or less.

Existing wetland and terrestrial resources were evaluated using Wildlife Habitat Appraisal Guide (WHAG) as a modified HEP developed by the Missouri Department of Conservation. Average Annual Habitat Units (AAHUs) for existing conditions are presented in table 3-2 for all representative species considered. The mallard, chosen as a model target species by the WHAG team members, is representative of the guild (dabbling ducks) for which the Upper Lake project is intended. Other members of this guild include teal, widgeon, and pintail.

TABLE 3-2

Upper Lake Existing Conditions
AAHUs Without Project

SPECIES	HSI	HU	AAHUs
*Mallard	0.14	80.0	114.3
Canada goose	0.15	78.8	113.2
Least bittern	0.93	501.4	482.3
Lesser yellowlegs	0.43	231.9	214.6
Muskrat	0.50	268.9	259.6
King rail	0.66	357.4	351.7
Green-backed heron	0.60	334.8	340.9
Wood duck	0.10	--	3.5
Beaver	0.64	12.8	13.1
American coot	0.54	292.5	372.4
Northern parula	0.10	--	3.3
Prothonotary warbler	0.10	--	3.7

* Target species

d. **Aquatic Resources.** Historically, Spring Lake was known for its bullhead fishing. After the farmland, which is now Spring Lake, was inundated with the construction of the lock and dam system on the Mississippi River in the 1930's, the shallow water provided excellent conditions for this species. In 1968, Spring Lake was divided by the USFWS into an Upper Spring Lake, which was managed for migratory waterfowl (puddle ducks), and Lower Spring Lake which was managed for both fish and waterfowl (diving ducks). When the Lower Spring Lake levee was breached on the west and south sides by the 1965 flood, ingress and egress of other species from the river provided more diversity in aquatic life. This breach also provided the lake with an abundant supply of dissolved oxygen. Bass, bluegill, crappie, and catfish thrived in the area, along with rough fish such as carp and buffalo. With the repair of the levee in 1991, flow of dissolved oxygen through the Lower Lake was greatly diminished. This lack of dissolved oxygen is a limiting factor in the current fishery.

Commercial fishing on Spring Lake is allowed by special permit, obtained from the refuge manager. However, recent declines in commercial fishing on the refuge have been attributed to reduced accessibility (see table 3-3). Sport fishing on Lower Spring Lake has significantly decreased since the upper levee break was closed.

The aquatic version of the WHAG, referred to as MOFISH, was used to evaluate present and future conditions and the impact of the proposed project on the aquatic resource. The largemouth bass, channel catfish, and walleye were chosen as model target species for the aquatics by the

TABLE 3-3

COMMERCIAL FISHING REPORTS FOR SPRING LAKE 1982-1988

	1988	1987	1986	1985	1984	1983	1982
TOTAL CATCH IN POUNDS	940	58,362	98,345	123,612	107,649	175,159	130,311
CARP	40	37,164	47,545	100,745	62,800	118,998	66,485
BUFFALO	110	7,598	28,825	10,670	17,450	29,818	31,663
FRESHWATER DRUM	790	13,600	21,975	12,197	27,039	26,118	32,163
SPOONBILL					330	225	
GAR					30		

WHAG team members. They are representative of the different guilds of species indigenous to Lower Spring Lake. The largemouth bass represents the lentic-contiguous small fish habitat guild and the guarder type nest-spawner fish [spawn in gravel/sand substrates (litho-psammophils)] reproductive guild. The habitat guild that the walleye represents is the lotic-small fish. Their reproductive guild is the non-guarder type open substratum spawners. Fishes of this guild spawn in rock/gravel substrates (lithophils) while their rearing and juvenile stages are found to use backwater areas. The habitat guild that the channel catfish represents is the lentic-contiguous large fish. The reproductive guild represented by the channel catfish is the guarder type nest-spawners that spawn in crevices (speliophils). The model utilized limiting factors which are specific habitat requirements that must be met for the selected target species; otherwise, the qualitative index, the habitat suitability index (HSI), is driven down to 0.1 (lowest value). Only Lower Spring Lake was evaluated for aquatics since Upper Spring Lake is managed exclusively for migratory birds.

Qualitative determinations indicate that due to the lack of dissolved oxygen, the qualitative HSI value will be 0.1 for all three of the selected target species (channel catfish, largemouth bass, and walleye) at present conditions through target year (TY) 50, without the project. AAHUs are presented in table 3-4 for each of the target species. AAHUs represent an average HU value based on annualization of Habitat Units (HUs) over a series of selected target years. AAHUs account for changes in habitat values over the life of a project. An HSI value of 0.1 means that an area is unsuitable for the target species. Lower Spring Lake under current and projected conditions without the project has an HSI value of 0.1 for all target species due to a limiting factor of lack of dissolved oxygen. The 0.1 HSI value was multiplied by the surface acreage (2,414 acres) of the Lower Lake, giving a value of 241.4 AAHUs without the project. This assumption was made because Spring Lake is known to provide some minimal habitat for the target species.

TABLE 3-4

AAHUs for Channel Catfish, Largemouth Bass, and Walleye in Lower Spring Lake

Channel Catfish	241.4	AAHU
Largemouth Bass	241.4	AAHU
Walleye	241.4	AAHU

e. **Water Quality**. Water quality is possibly the single-most important factor that controls the value of the aquatic resources in Lower Spring Lake. Deposition of sediment which occurs as a result of the levee system being overtopped results in increased turbidity, loss of water depth, and low dissolved oxygen values periodically during the year. Results of baseline water quality monitoring show that water quality is generally adequate to support native fisheries. However, on occasion, dissolved oxygen concentrations have fallen to undesirable levels. During the winter months when ice covers the lake, low dissolved oxygen values within the lake could lead to fish kills due to an inadequate supply of oxygenated water reaching the lake and lack of wind mixing at the surface of the lake. A more detailed analysis of water quality and results of water quality monitoring can be found in appendix F.

f. **Endangered Species**. The federally endangered bald eagle (*Haliaeetus leucocephalus*) has been nesting on Silo Island in the Lower Lake for the past 2 years and has produced 2 young each year. The area also is used by bald eagles as a roosting area in the winter months.

The State of Illinois has listed the river otter (*Lutra canadensis*), the double-crested cormorant (*Phalacrocorax auritus*), and the yellow-headed blackbird (*Xanothocephalus xanothocephalus*) as State endangered species.

There have been several sightings of an adult river otter with two young along the perimeter dike. Also, areas where the otter had been sliding and recent droppings were observed during field reconnaissance for this project.

In past years, the yellow-headed blackbird has used the cattail marsh on the Upper Lake for nesting. This marsh area will remain as a managed marsh unit.

The double-crested cormorant has been feeding and loafing in the Lower Lake on nine telephone poles with three nesting platforms on each pole which the U.S. Fish and Wildlife Service had placed in the southwest corner of the lower unit in an attempt to provide increased nesting opportunities for this species. The cormorants have not nested on the artificial platforms as yet.

Further information regarding the status of the State and Federal threatened and endangered species in the project area is provided within the correspondence section of this report.

g. **Cultural Resources**. Two previously recorded sites (11-CA-18 and 11-CA-114) were within the impact area of the proposed project. Site 11-CA-18 lies on an island bisected by the east-west trending levee separating Upper and Lower Spring Lakes and covers approximately 8 acres. Site 11-CA-114 was recorded solely from informant information; covers approximately 265 acres of land, water, and islands; and was confused with 11-CA-18 by its recording archaeologist.

Prior to initiating Phase I archaeological work, a number of old Mississippi River maps covering the project vicinity were checked for structure locations. Buildings and farmsteads within the project area had been demolished following purchase by the Government. Photographic and cartographic information was presented in the Scope of Work for the cultural resource investigations. This information indicated that all historic structures had been destroyed and were no longer potentially eligible for inclusion within the National Register of Historic Places. The Scope of Work was reviewed and approved by the State Historic Preservation Office in a letter dated September 16, 1991 (appendix A).

Geomorphic mapping in Benn, *et al.* [1989:Volume II: Geologic Landform Maps (unpaginated): maps entitled "Geomorphic Surfaces of Pool 13" and "Pool 13 Post-Settlement Alluvium"] showed a diversity of landform surfaces in the project area. These surfaces ranged from "Late Woodfordian (10,000 -15,000 years)" to "Late Holocene (<4000 years)" and all with no post-settlement alluvium; however, Holocene alluvial fans were present in the vicinity of Upper Spring Lake. As a result of this information, Phase I survey utilized a combination of pedestrian survey and shovel testing together with deep geomorphological testing to investigate the project area.

This project was fully coordinated with the Illinois State Historic Preservation Office. By letter dated March 13, 1992, (appendix A), concurrence was reached that the project will not affect significant historic properties.

h. **Sedimentation.** A sedimentation study was conducted to evaluate sedimentation in Spring Lake. The scope of this study, as presented in this section, consisted of determining net erosion from 1937 through 1990 and evaluating proposed project impacts on sedimentation.

Baseline elevations were established from 1937 topographic maps. Additional hydrographic surveys were performed during 1990. Elevations in 1937 were compared with present elevations to determine net changes. All of the data were collected and input into a digital terrain modeling program. This program analyzes the modeled surfaces and can produce a report showing the volumetric change between the surfaces as cut (erosion) and fill (sedimentation). This analysis gives an average sedimentation rate of 0.25 inch per year in the entire lake.

i. **Adjacent Water Projects.** The proposed Spring Lake project is adjacent to the Mississippi River 9-Foot Channel, as authorized by the River and Harbor Act of July 3, 1930. The proposed project features will not affect navigation.

4. PROJECT OBJECTIVES

a. **Objectives and Potential Enhancement**. The project goals, objectives, and potential enhancement are summarized in table 4-1. Potential enhancement features were developed in consideration of improving existing habitat weaknesses and utilizing resource opportunities. A potential enhancement feature is intended to satisfy at least one objective, either singularly or in combination with other features. Enhancement features are components of an overall alternative which satisfies goals and objectives of the project. Section 5(b) describes each potential enhancement feature.

b. **Criteria for Potential Alternatives**. Table 4-2 presents general and specific criteria developed to evaluate potential alternatives. Potential alternatives are presented in Section 6 and evaluated in Section 7.

c. **Proposed Management Plans**. Tables 4-3 and 4-4 present the proposed management plans for the Upper and Lower Lakes. Table 4-5 presents the proposed management plan for the hemi-marsh. These plans were prepared by the USFWS and ILDOC biologists in conjunction with Corps of Engineers staff.

The proposed management plan for the Upper Lake is based on management practices implemented at other waterfowl refuges which have proved to be an effective strategy for establishing emergent vegetation. This management technique has been successfully used at Agassiz National Wildlife Refuge (NWR) in Minnesota, Swan Lake NWR in Missouri, and DeSoto Bend NWR in Nebraska. Water level drawdown with gradually increasing depths also is recommended as a standard management practice in Smith, *et al*. (1989). The habitat improvement for waterfowl is primarily located in the Upper Spring Lake section of the refuge. The proposed Lower Spring Lake project features primarily focus upon habitat improvement for the fishery with ancillary benefits to migratory birds.

TABLE 4-1

Project Goals, Objectives, and Potential Enhancement Features

Goal	Objective	Potential Enhancement Features
Enhance Aquatic Habitat	Improve water quality for fish	* Levee restoration
	Maintain backwater lake	* Gated inlet structure * Excavated channels * Mechanical aerators * Upper Lake water control
Enhance Wetland Habitat	Provide reliable wetland vegetation/food source in Upper Lake for migratory birds.	* Levee restoration * Hemi-marsh
	Provide reliable food source in Lower Lake for migratory birds and other wetland species	* Lower Lake water control * Upper Lake water control

TABLE 4-2

Development Criteria for Potential Alternatives

Item	Purpose of Criteria
A. General Criteria	
Features are located and constructed consistent with EMP directives.	Comply with Public Law 99-662 regarding enhancement of fish and wildlife habitat.
Features are constructed consistent with Federal, State, and local laws.	Comply with environmental laws.
Features can be monitored.	Provide baseline of project effects (e.g., sedimentation, stability, water quality).
Features are located and constructed consistent with best engineering practice.	Provide basis for project evaluation and alternative selection.
Alternatives address all of the stated project objectives.	Meet project goals and objectives.
B. Levee Restoration	
Levee construction meets engineering standards.	Ensure safety and reliability of levee system.
Levee construction is compatible with refuge environment.	Ensure some of existing trees are saved and ensure archeological sites are not affected.
Levee system is reliable, consistent with refuge management goals.	Provide flood protection to meet seasonal/annual goals.
C. Upper Lake Water Control	
Features allow independent operation of different areas of lake.	Enable management to operate Upper Lake as a moist-soil unit as well as managed marsh in a single year.

TABLE 4-2 (Cont'd)

Item	Purpose of Criteria
D. Lower Lake Water Control	
Levee system is reliable, consistent with refuge management goals.	Provide flood protection to meet seasonal/annual goals.
Features control water independent of river flows.	Improve existing habitat suitability for aquatic and wetland habitat.
Boaters have entrance to lake.	Provide consistency with existing lake usage.
E. Hemi-Marsh	
Water control is independent in Lower Lake.	Improve existing habitat suitability for wetland habitat.
F. Gated Inlet Structure	
Inlet structure is located to take advantage of river gradient.	Provide maximum flexibility for gravity inflow and hydraulic mixing.
G. Excavated Channels	
Channels are located to enhance dissolved oxygen distribution throughout lake.	Improve existing habitat suitability for fish.

TABLE 4-3

Proposed Annual Management Plan for Upper Lake

Month	Management Action	Purpose
March-September	Dewater cells by gravity within 15 days to elevation 583.5 and pump until feeder canal reaches elevation 579.0.	Establish vegetation.
September-October	Gradually increase average water depth.	Provide moist-soil/marsh plants.
October-March	Maintain water levels as high as possible (585.0) by: a. Pumping b. Capturing river flows exceeding 583	Minimize overtopping flood damage and enhance furbearer habitat.

TABLE 4-4

Proposed Management Plan for Lower Lake

River Flow Condition	Management Action	Purpose
Winter/summer low-flow	Open gates of inlet structure.	Provide fresh water to raise DO levels.
High flow/flood condition	Close gates of inlet structure.	Prevent sediment-laden waters from entering lake.
Normal flow	Slightly open gates.	Provide fresh water to lake.

TABLE 4-5

Proposed Annual Management Plan for Hemi-Marsh

Month	Management Action	Purpose
March-June	Open stoplog structure.	Provide free flow for fish spawning.
July-August	Natural draw down.	Establish marsh vegetation.
August-October	Gradually increase average water depth.	Raise water as vegetation grows.
November-February	Maintain water levels as high as possible (585.0) by: a. Pumping from well. b. Capturing river flows exceeding 583.0.	Minimize overtopping damage and enhance habitat.

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 identified and given further consideration based upon their potential contribution to the project goals and objectives, various engineering considerations, and local restrictions or constraints. These development criteria were 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. The optimized potential enhancement features were combined to make up alternatives which meet all of the project's goals and objectives.

Where appropriate, a numerical habitat appraisal methodology was used to evaluate existing conditions, to predict the future with- and without-project conditions, and to ultimately derive the Habitat Unit (HU) values used in the incremental analysis procedure. The selected methodology was developed by the Missouri Department of Conservation (MDOC) and the Soil Conservation Service and is known as the Wildlife Habitat Appraisal Guide (WHAG). WHAG incorporates concepts from a similar technique known as HEP (Habitat Evaluation Procedures) developed by the USFWS, whereby wildlife habitat value can be quantified numerically.

Qualitative and quantitative assessments of the habitat types were accomplished by the WHAG study team. The team, comprised of members from the Illinois Department of Conservation (ILDOC), USFWS, and the Corps, developed Habitat Suitability Indices (HSIs) for each habitat type based on the numeric ranking of site characteristics. The HSI values provide an indicator of the habitat quality for a particular target species based on the life requisites (food, cover, etc.) of the target species. The HUs then were generated by multiplying HSI values by the acreages of that particular habitat type.

The annual calculated HUs for each potential enhancement feature were subsequently annualized over the 50-year life of the project and compared to the summation of the annualized first cost and the estimated annual operation and maintenance costs.

a. **Perimeter Levee Restoration.** The existing 7-3/4-mile-long levee around the Upper and Lower Lakes was constructed to approximately a 50-year flood elevation. A 1.5-mile cross dike, constructed to elevation 588.0 feet MSL (mean sea level), separates the Upper and Lower Lakes. Due to both natural and intentional (to minimize damages due to flood events) breaching of the perimeter levee, annual maintenance has been severely limited. This has caused the levee to become overgrown with trees and weeds and have eroded sideslopes. Due to the deteriorated condition of the levee, future levee breaks are probable without restoration, thus making any improvements to the Upper and Lower Lakes an unwise capital improvement. When breaks occur, sediment-laden river flows enter and degrade the aquatic habitat. While the overall average sedimentation rate for the Lower Lake is reasonable at 0.25 inch per year, any levee breaks will cause substantially increased rates in localized areas.

Levee restoration consists of restoring the perimeter levee system to its original design condition, which is the 50-year flood event, approximately 595 feet MSL at the upstream end and approximately 593 MSL at the downstream end. (See plates 10 through 20 for the plan and profile of the perimeter levee.) Restoring the levee to the design elevation was based on only raising the perimeter by less than 1 foot on the average and a secondary benefit of providing aquatic habitat in the borrow ditch.

Raising the perimeter levee was briefly considered. However, minimal benefits would be realized. Levee elevations greater than a 50-year flood event have typically not been supported by cost-benefit analyses for similar projects. Raising the cross dike was considered because it does not reliably protect the Upper Lake from overtopping events. The existing 200-foot overflow spillway is currently at elevation 585.5 (less than a 2-year flood). Any proposed elevations for the cross dike are dependent upon the management strategies of the Upper Lake and are discussed in the following section. An overtopping event for the cross dike will not have a significant sediment load because the flow will be backwater from the Lower Lake.

b. **Upper Lake Management Options**. The Upper Lake has the potential for development and subsequent management of approximately 560 acres. It is presently being managed as a single-cell moist-soil management unit (MSMU) within an existing 15,000 gpm pump station. However, due to drainage and flooding problems, as well as the unreliability of the existing pump, water level control management within the MSMU is often unsuccessful.

A WHAG analysis of HSI and HU values for wetland habitat at the Upper Lake indicates that existing conditions in the area have a fair habitat value for waterfowl, but that water level control is a limiting factor. Construction of a segmented cell configuration thus becomes a feasible feature.

This enhancement feature consists of improving the Upper Lake for migratory bird habitat by improving the perimeter levee and optimizing management of the area. Based on the criteria developed for the Upper Lake and historical flood hydrographs, the perimeter levee and cross dike do not adequately prevent flood flows from entering the Upper Lake. The perimeter levee's 50-year design elevation is compatible with the desired management plan; however, the eroded condition of the sideslopes make them susceptible to levee breaks which would void any management plans. In order to implement any proposed improvements in the Upper Lake, the perimeter levee must be restored to a stable condition.

The cross dike which separates the Upper and Lower Lakes was constructed to elevation 588.0 with an overflow section at elevation 585.5 (less than a 2-year flood). Because of the number of times the Upper Lake is overtopped during the key management months, raising the cross dike was evaluated. Based on the Upper Lake management plan shown in table 4-3, it was determined that raising the cross dike overflow section by only 2.5 feet could provide a reliable system, as shown in table 5-1. It is proposed to raise the overflow section to elevation 588.0 (5-year flood frequency) and raise the entire cross dike to elevation 590.0. This would meet management objectives and provide protection for the cross dike during an overtopping event. See Appendix E - Hydrology and Hydraulics for a complete overflow analysis. See plates 12 through 14 for a plan and profile of the existing and proposed cross dike.

TABLE 5-1

Flood Overtopping Event by Month
Number of Times Overtopped in 24 Years (1)

Month (2)	Existing Overflow Spillway Elevation (585.5)	Proposed Overflow Spillway Elevation (588)
January	2	--
February	3	--
March	8	1
April	16	3
May	11	1
June	5	1
July	4	--
August	1	--
September	1	--
October	4	--
November	--	--
December	--	--

(1) Period of record 1966 - 1989 at RM 535.

(2) Month of the flood peak.

Three options for improvement to Upper Spring Lake were considered. All three were based on the assumption that the perimeter levee would be stabilized and the cross dike would be raised. The three options considered for analysis were:

Option 1. Manage the entire Upper Lake as a single managed marsh unit.

Option 2. Manage the entire Upper Lake as a single moist-soil unit.

Option 3. Manage the Upper Lake as multiple management units (moist soil units and/or managed marsh units).

Table 5-2 presents the results of the WHAG analysis.

TABLE 5-2

Upper Spring Lake Management Options
WHAG Results (AAHUs)

SPECIES	Without Project	Option 1 1 Cell Man. Marsh	Option 2 1 Cell Moist Soil	Option 3 Combin. Moist Soil-Man. Marsh
Mallard *	114.3	214.2	395.4	288.3
Canada goose	113.2	211.7	367.0	273.2
Least bittern	482.3	424.8	60.5	214.3
Lesser yellowlegs	214.6	361.0	57.8	184.0
Muskrat	259.6	439.7	58.2	217.8
King rail	351.7	391.7	59.1	198.5
Green-backed heron	340.9	375.1	58.8	191.2
Wood duck	3.5	--	--	--
Beaver	13.1	0.1	0.1	0.2
American coot	372.4	411.8	58.4	206.3
Northern parula	3.5	--	--	--
Prothonotary warbler	3.7	--	--	--

* Target species

Option 1 provides more total AAHUs than the other options; however, the target species are not significantly increased. Although Option 2 provides the most benefits for the target species and Canada goose, it does not enhance habitat for other species considered. The purpose of the project is to improve habitat for waterfowl and fish. Option 3 meets this objective and retains habitat for other species which use the area. In any project where a certain species is targeted for habitat improvement, it is to be expected that improvement of habitat for the target species will impact, to some degree, the habitat required (life requisites) of other species. Figure 5-1 shows a comparison of AAHUs for each option.

Table 5-3 presents a tabular analysis of the annualized HUs for the target species versus the annualized costs of construction and the estimated O&M for Option 1 and Option 3. Option 2 was not evaluated further because it is considered biologically unsound. The habitat declines for non-target species are considered to be unacceptable. Figure 5-2 graphically shows that Option 3 can be constructed at a lesser cost/AAHU gained and is the selected option for the Upper Lake water control feature.

A 3-cell configuration was selected for the multiple management units option. (See plate 2 for cell locations.) The existing topography of the Upper Lake readily accommodates three cells, thereby allowing a maximization of area with optimum water depth of 6 to 18 inches. Three cells also allows maximum management flexibility. With three cells, the refuge manager has the capability to take one cell out of operation for a season to control vegetation while still having a managed marsh and a moist soil unit in full operation. Because of the greater manageability of a 3-cell versus a 2-cell configuration, a 2-cell configuration was not considered further.

c. **Closure Structure for Lower Breach in Lower Lake.** This feature consists of placing a control structure in the levee break at the lower end of the lake, as shown on plate 3. This would provide water control for the 2,700-acre Lower Lake. This feature was eliminated from further consideration because of potentially negative fishery impacts, including access to and from the main channel for spawning for larval sauger and walleye and for wintering habitat. This feature also was inconsistent with the refuge policy of retaining Lower Spring Lake as a backwater of the Mississippi River.

d. **Gated Inlet Structure and Excavated Channels in Lower Lake.** These features consist of constructing a gated inlet structure and excavated channels to provide flow and dissolved oxygen to the Lower Lake. These features are shown on plates 3 and 31.

A WHAG analysis of HSI and HU values for aquatic habitat in the Lower Lake indicate that existing conditions in the area provide some habitat for fisheries; however, low DO in winter and summer stress periods is a limiting factor. Constructing a gated inlet structure and excavated channels thus became feasible features.

TABLE 5-3

Comparison of Features and Incremental Analyses

Feature	Increment	Annual Cost *1		Habitat Value Gain		Cost Per Gained Habitat Value	
		Total Annual Cost	Incremental $	AAHU	Incremental AAHU	$/AAHU	Incremental $/AAHU
Upper Lake *2 Option 1 (1 cell MM)	N/A	99,525		100		995	
Upper Lake *2 Option 3 (combination)	N/A	153,000		174		879	
Lower Lake *2 Water Control Structures	N/A	111,817		950		118	
Hemi-Marsh	2-yr w/o water control	9,956		24		415	
			12,310		218		56
	2-yr with water control	22,266		242		92	
			27,259		4		6,815
	5-yr with water control	49,525		246		201	

*1 Annualized cost includes initial construction cost and annual operations and maintenance cost based on a 50-year project life, 8.5 percent interest rate.

*2 An incremental analysis is not applicable for this feature because the feature is unique (stands alone) rather than an increment of a single plan.

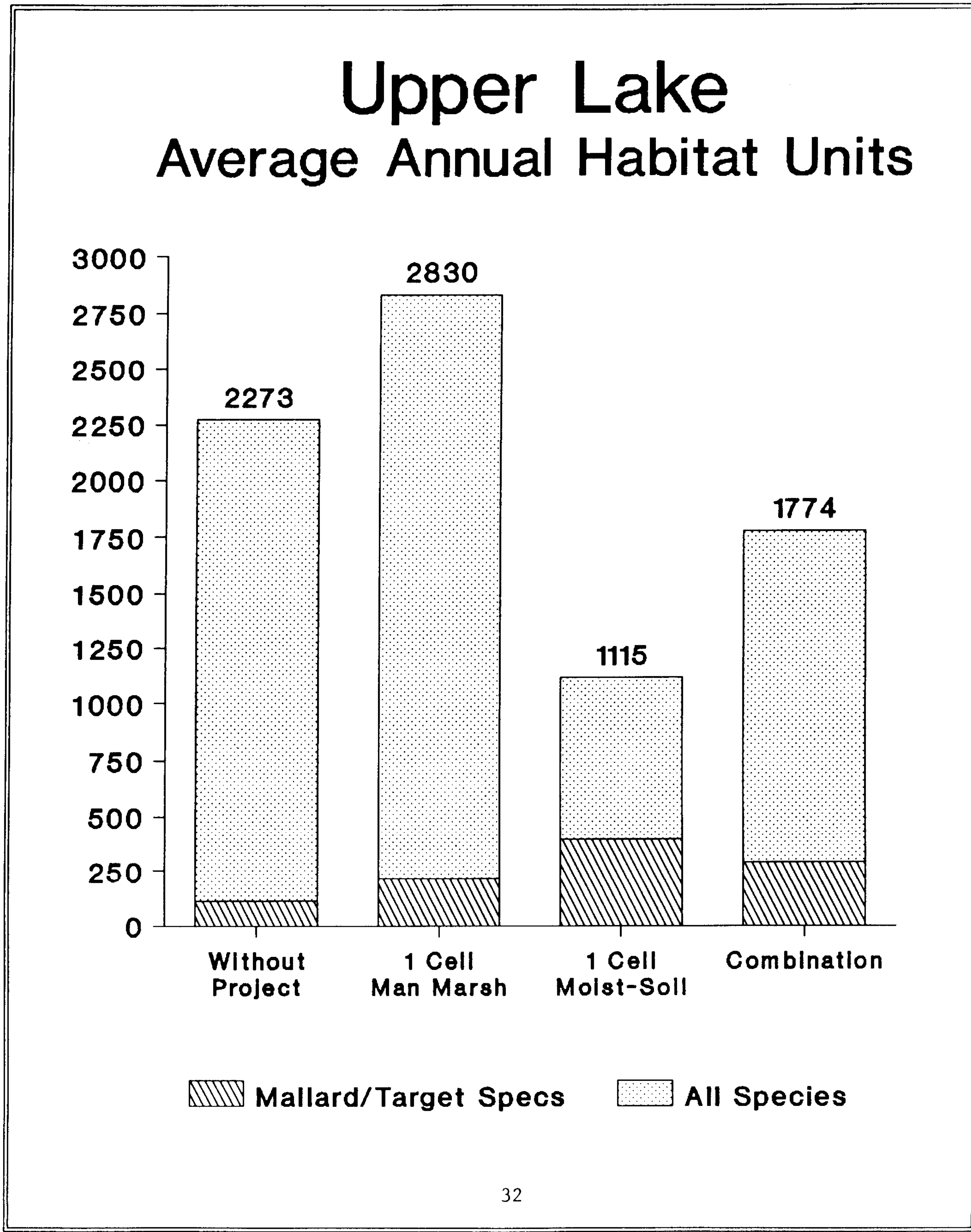

Upper Lake
Average Annual Habitat Units
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
2273
2830
1115
1774
Without Project
1 Cell Man Marsh
1 Cell Moist-Soil
Combination
Mallard/Target Specs
All Species

FIGURE 5-1

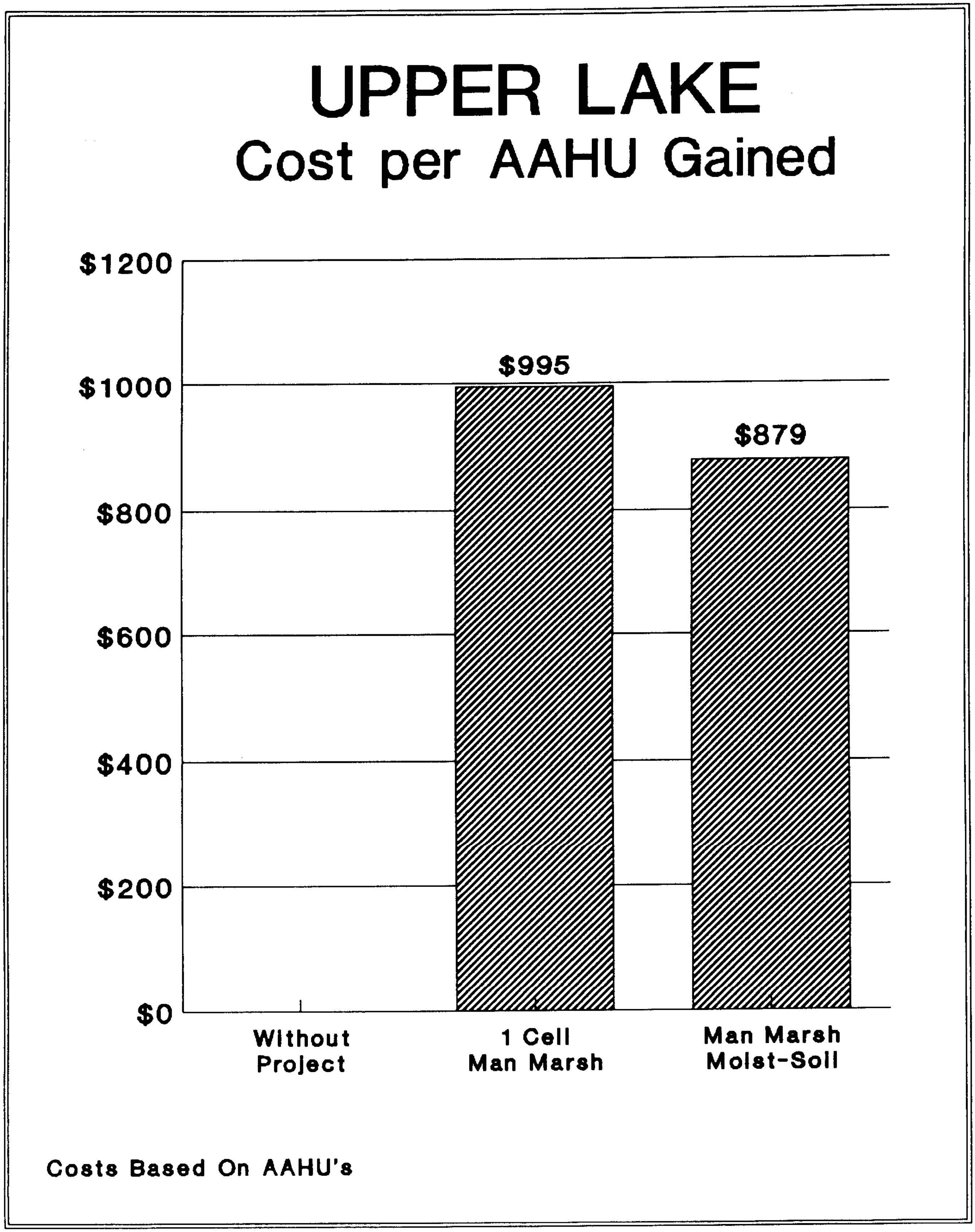

UPPER LAKE
Cost per AAHU Gained
$1200
$1000
$800
$600
$400
$200
$0
$995
$879
Without Project
1 Cell Man Marsh
Man Marsh Moist-Soil
Costs Based On AAHU's

FIGURE 5-2

The inlet structure and channel layout was based on the successful Brown's Lake EMP project design and unsteady flow modeling. At Brown's Lake, an inlet structure very similar to the proposed structure for this project was constructed. Post-construction monitoring at Brown's Lake has shown that within 3 days of opening the inlet gates during a critical winter period, oxygenated water (D.O. >10 mg/l) was found in the Brown's Lake complex 2 miles downstream of the inlet structure.

A technical/hydraulic analysis of the effects of the inlet structure and the dredged channels has been performed using the RMA-2 Two-Dimensional Flow Computer Model as presented in Appendix E. The model delineates the areas of Lower Spring Lake which will benefit by introduction of oxygenated water flow. The modeling results show that the installation of the inlet structure will reduce the area of stagnant water in Lower Spring Lake from 2,370 to 445 acres, in effect providing 1,925 acres of oxygenated water for an estimated cost of $432,000 ($225/acre). The addition of the dredged channels will further reduce the area of stagnant water to 425 acres. This only represents an addition of 20 acres of oxygenated water for an estimated cost of $779,000 ($38,950/acre). From a technical and economic standpoint, the excavated channels are not justified. Also, adequate deep water overwintering habitat is available in Lower Spring Lake; therefore, the excavated channels are not critical from a habitat standpoint.

In order to provide additional management flexibility and increased dissolved oxygen levels in the southwest region of Spring Lake, a small, 24-inch gatewell structure will be constructed, as shown on plates 2 and 23. This will allow for improved water control and water quality in that region of the lake at a substantially lower cost than dredged channels. The gatewell structure is small enough to not adversely affect the hydraulic function of the large gated inlet structure.

The inlet structure and gatewell were designed to meet the criteria in table 4-2. Figure 5-3 shows a comparison of the AAHUs for the existing conditions and with-project scenario. The cost/AAHU gained is $118, as shown in table 5-3.

e. **Mechanical Aerators**. Since low DO in stress periods was identified as a primary focus to meet the goal of enhancing aquatic habitat, various mechanical aeration systems in the Lower Lake were considered (see plate 3). This feature was not considered further because it does not meet the criteria in table 4-2 for the following reasons: (1) The large size of the Lower Lake would require numerous wind-powered aerators; (2) other powered aeration system would require excessive operational requirements; and (3) safety problems.

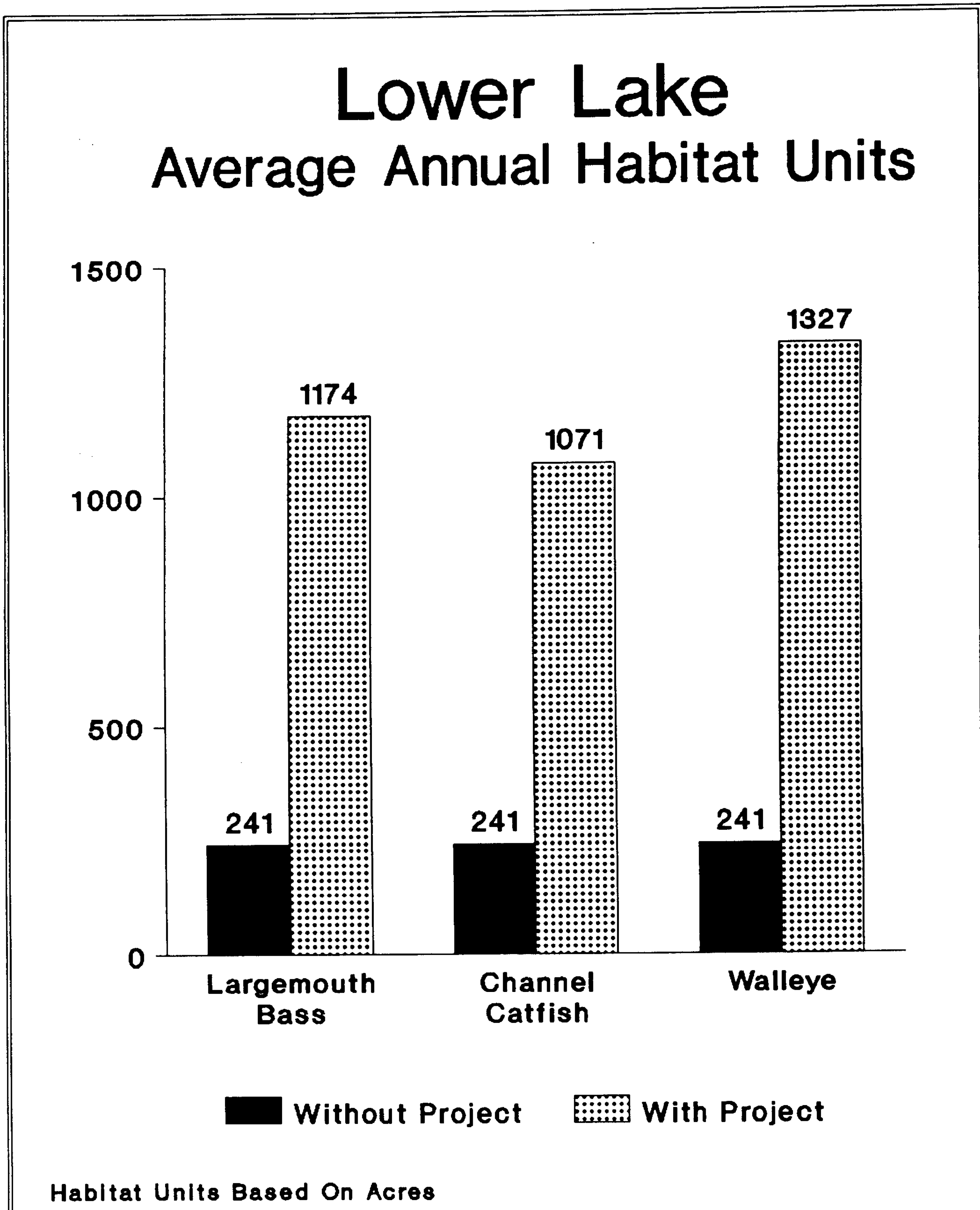

Lower Lake
Average Annual Habitat Units
1500
1000
500
0
1174
1071
1327
241
241
241
Largemouth Bass
Channel Catfish
Walleye
Without Project
With Project
Habitat Units Based On Acres

FIGURE 5-3

f. **Hemi-Marsh Options**. A hemi-marsh is an area that has 50 percent water and 50 percent marsh. The existing hemi-marsh area of Lower Spring Lake is heavily vegetated. The approximate 100-acre area is inundated with floodwaters during the spring and other high flow periods, but only a small percentage of the water remains through the fall to provide open water habitat.

Three options for hemi-marsh development were evaluated:

Option 1. A 2-year levee with no water control.

Option 2. A 2-year levee with water control. Water control would consists of a well station and stoplog structure.

Option 3. A 5-year levee with water control.

Table 5-4 presents the results of the WHAG analysis for the hemi-marsh.

TABLE 5-4

Hemi-Marsh WHAG Results (AAHUs)

		Option 1	Option 2	Option 3
SPECIES *	Without Project	2-Yr w/o Water Control	2-Yr with Water Control	5-Yr with Water Control
Mallard	--	--	24.0	26.2
Canada goose	--	--	24.4	25.9
Least bittern	89.9	94.1	73.1	65.1
Lesser yellowlegs	--	--	72.4	65.5
Muskrat	16.7	37.9	84.0	91.4
King rail	--	--	38.2	41.6
Green-backed heron	55.8	54.6	80.4	86.0
Wood duck	--	--	--	--
Beaver	--	--	--	--
American coot	81.3	81.5	88.7	87.7
Northern parula	--	--	--	--
Prothonotary warbler	--	--	--	--
TOTAL	243.7	268.1	485.2	489.4

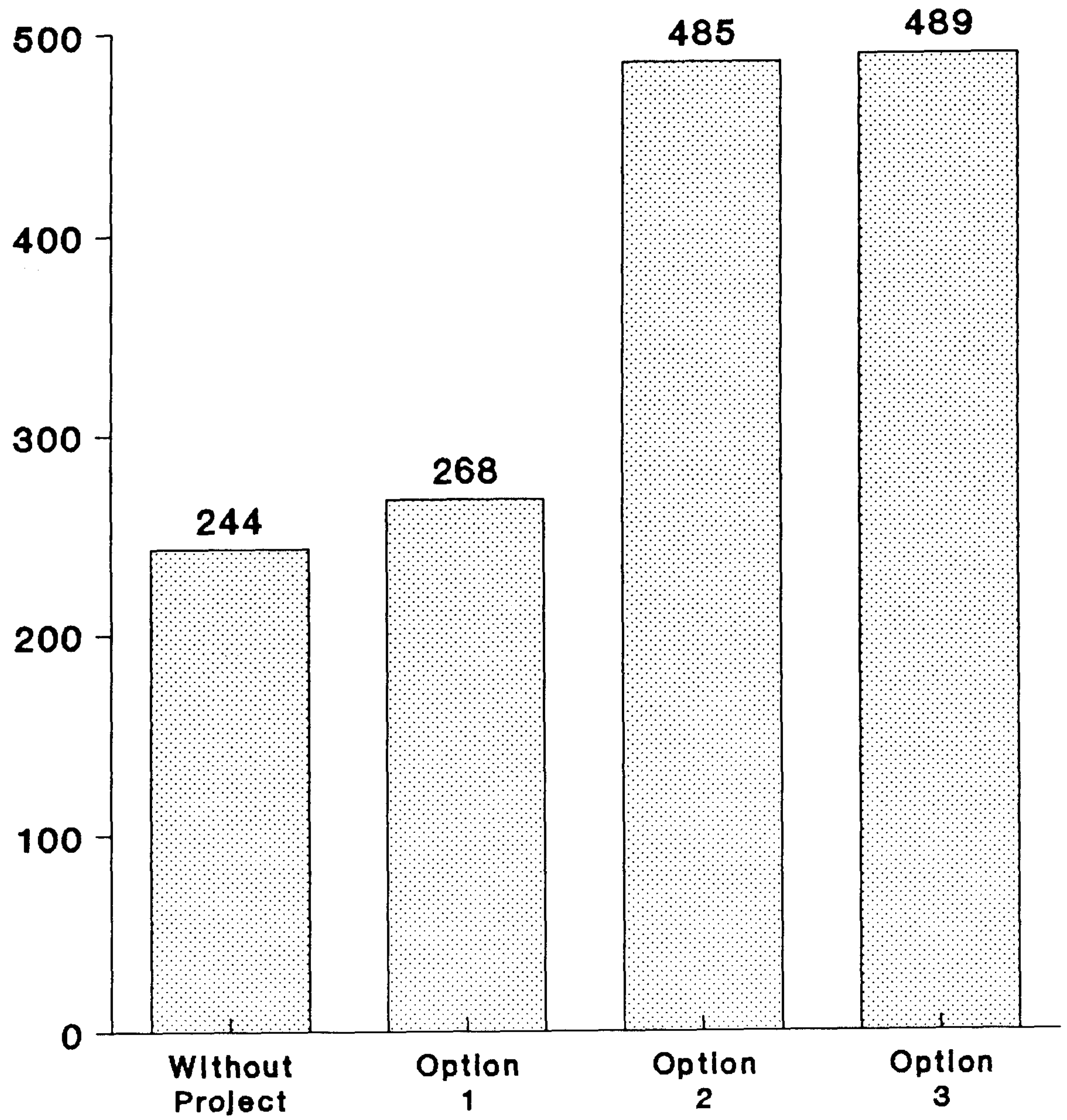
* All species in the matrix are target species.

As shown in table 5-3, the AAHUs were added for each species. This was done solely for a cost comparison between development options. Since the hemi-marsh is to be developed to increase a diverse habitat for a wide variety of wetland species, including migratory birds, total AAHUs will be used as an indicator of benefits for this option. However, since AAHUs are based upon life requisites which differ significantly between species, it should be noted that 1 AAHU for a particular species (e.g., mallard) is not the same as 1 AAHU for another species (e.g., wood duck). Therefore, the number of AAHUs for a wood duck in a certain area will not be equivalent to the number of AAHUs for a mallard in the same area. The results of the total AAHUs for all species in the matrix are shown graphically in figure 5-4.

Based on the WHAG results, the options with water control (Options 2 and 3) will provide the greatest increase in habitat for a wide range of wetland species. Option 1, a 2-year levee without water control, did not provide a significant increase in habitat because it would be totally dependent upon the rise and fall of the river.

The annual HUs calculated for each option were subsequently annualized over the 50-year life of the project and compared to the summation of the annualized first cost and the estimated annual operation and maintenance costs. The increment with the minimum cost per HU then was identified. This comparison is shown in table 5-3. Option 2, a 2-year levee with water control, provides nearly as many AAHUs as Option 3 at less than half the cost per AAHU (figure 5-5). Based on the incremental analysis, Option 2 was the selected option for hemi-marsh development.

Hemi-Marsh
Average Annual Habitat Units



AAHUs Based On All Species In Matrix

FIGURE 5-4

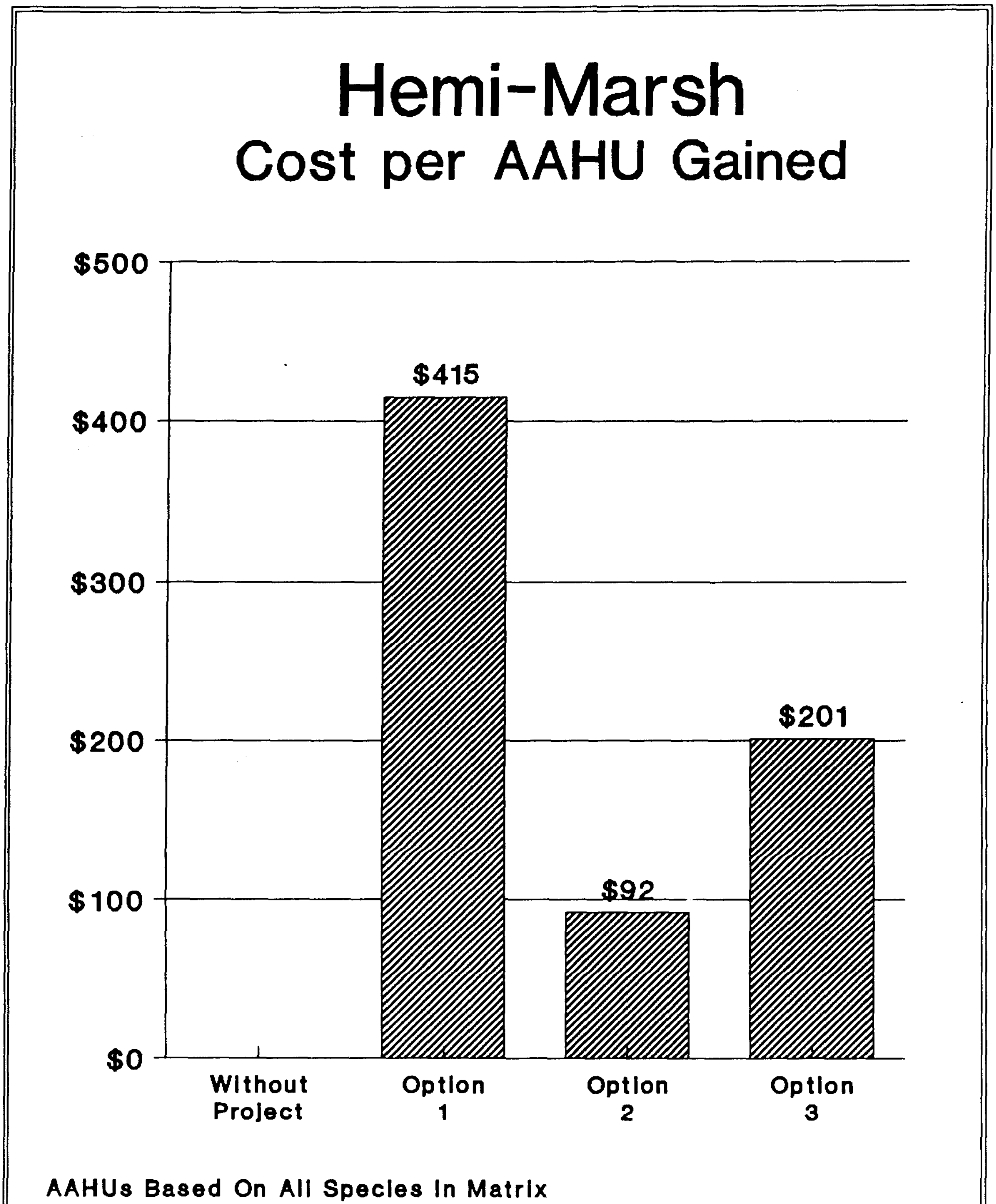

Hemi-Marsh
Cost per AAHU Gained
$500
$400
$300
$200
$100
$0
$415
$92
$201
Without Project
Option 1
Option 2
Option 3
AAHUs Based On All Species In Matrix

FIGURE 5-5

6. ALTERNATIVES

Project alternatives consist of combinations of enhancement features with appropriate management that meet specific habitat goals and objectives. Alternatives were formulated using the following process: (1) Existing habitat weaknesses and opportunities were identified through existing data or application of habitat analyses (i.e., WHAG; Section 3); (2) goals and objectives then were developed in response to these habitat weaknesses/ opportunities (Section 4); (3) potential enhancement features were developed to meet specific objectives (Section 5); and (4) alternatives then were developed to meet all the goals and objectives.

a. **Alternative A - No Federal Action**. This alternative would consist of no Federal funds being provided to meet the project purposes.

b. **Alternative B - Levee Restoration/Upper Lake Water Control/Inlet Structure**. This alternative consists of restoring the perimeter levee to the 50-year design elevation, hydraulically separating the Upper Lake into three independent reliable cells, and constructing an inlet structure.

Restoration of the perimeter levee to the 50-year design elevation would be accomplished by using adjacent ditch borrow. The resulting borrow ditch running parallel to the entire length of the perimeter levee also would serve as deep water habitat.

Hydraulically separating the Upper Lake into three independent cells would require four construction features: (1) raising the existing cross dike; (2) constructing interior levees; (3) constructing a pump station; and (4) constructing three stoplog structures.

Floodwater entry to the Upper Lake would be prevented by raising the cross dike level of protection to elevation 588.0 feet, which is considered the minimum height to meet the management plan presented in table 4-3. Adjacent ditch borrow would be used for levee construction. Two riprapped overflow sections would be provided to minimize overtopping damage.

Low-level interior levees would be constructed in order to hydraulically separate the Upper Lake into three cells. Sufficient levee height would ensure that each cell could be flooded with 18 inches of water. Adjacent ditch construction would provide borrow material for the interior levee construction and provide drainage for dewatering purposes.

Upper Lake water control would be provided by a combination of the new pump station, the center ditch, and stoplog structures. The pump station could be used to fill or dewater the Upper Lake.

This alternative also would include construction of a gated inlet water control structure and a small gatewell structure along the Lower Lake perimeter levee. The water control structures could be used to distribute water with high DO concentrations to the lake during winter or summer low-flow periods. The water control structure would be closed during high flows, preventing associated sediment loads from directly entering the lake.

c. **Alternative C - Levee Restoration/Upper Lake Water Control/Inlet Structure/Hemi-Marsh.** This alternative consists of all the enhancement features in Alternative B and adds the construction of a hemi-marsh in the Lower Lake. Providing a hemi-marsh would consist of construction features: (1) constructing a 2-year levee; (2) constructing a well; and (3) constructing a stoplog structure.

The hemi-marsh could be filled by capturing high river flows and/or pumping from the well. Dewatering would be accomplished by gravity drainage.

7. EVALUATION OF ALTERNATIVES

a. **Alternative A - No Federal Action.** Alternative A would not meet project goals and objectives for Spring Lake.

b. **Alternative B - Levee Restoration/Upper Lake Water Control/Inlet Structure.** This alternative meets all the goals and objectives described in Section 4 of this report. Constructing three controlled, reliable cells in the Upper Lake would significantly enhance habitat for migratory birds while providing secondary habitat diversification benefits for many wetland species. The proposed inlet water control structure would significantly enhance the aquatic habitat in the Lower Lake (see plate 3).

c. **Alternative C - Levee Restoration/Upper Lake Water Control/Inlet Structure/Hemi-Marsh.** This alternative meets all the goals and objectives described in Section 4 of this report. Alternative C is an expanded plan of Alternative B. All the proposed improvements described for Alternative B are included in Alternative C, plus the enhancement of the hemi-marsh area in the Lower Lake (see plate 2).

Since both Alternatives B and C meet the project goals and objectives, a comparison of costs to benefits was performed. The annual HUs for each alternative were derived by summing the AAHUs that were obtained when optimizing the enhancement features presented in Section 5 of this report. The results of this summarization are shown in figure 7-1. A summation of the annualized first cost and estimated annual operation and maintenance cost was compared to the summation of the annual HUs for each alternative. The summation of annual HUs was done strictly for a cost comparison. Due to the inherent problem of assigning a dollar value to an environmental output, this summation of HUs only should be used as a comparison for this particular project. Aquatic and wetland HUs were not combined for this comparison. Table 7-1 shows the incremental analysis for this comparison. Since the aquatic habitat enhancement was equal for each alternative, a comparison of wetland habitat gains and the associated annualized cost per AAHU was shown. The results of this incremental analysis show that Alternative C provides the least cost per AAHU while meeting project goals and objectives. Thus, Alternative C is the recommended project (see figure 7-2).

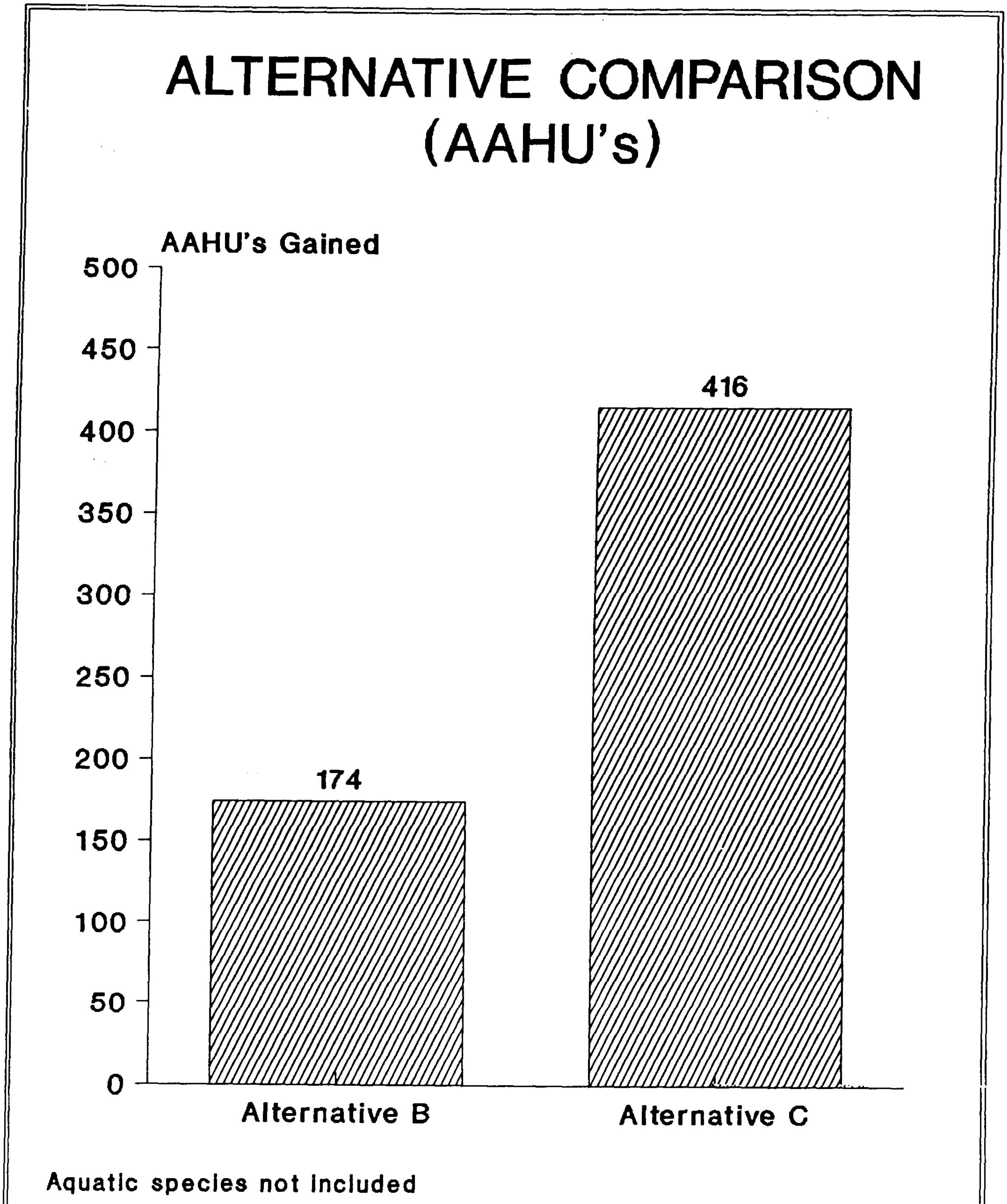

ALTERNATIVE COMPARISON
(AAHU's)
AAHU's Gained
500
450
400
350
300
250
200
150
100
50
0
174
416
Alternative B
Alternative C
Aquatic species not included

FIGURE 7-1

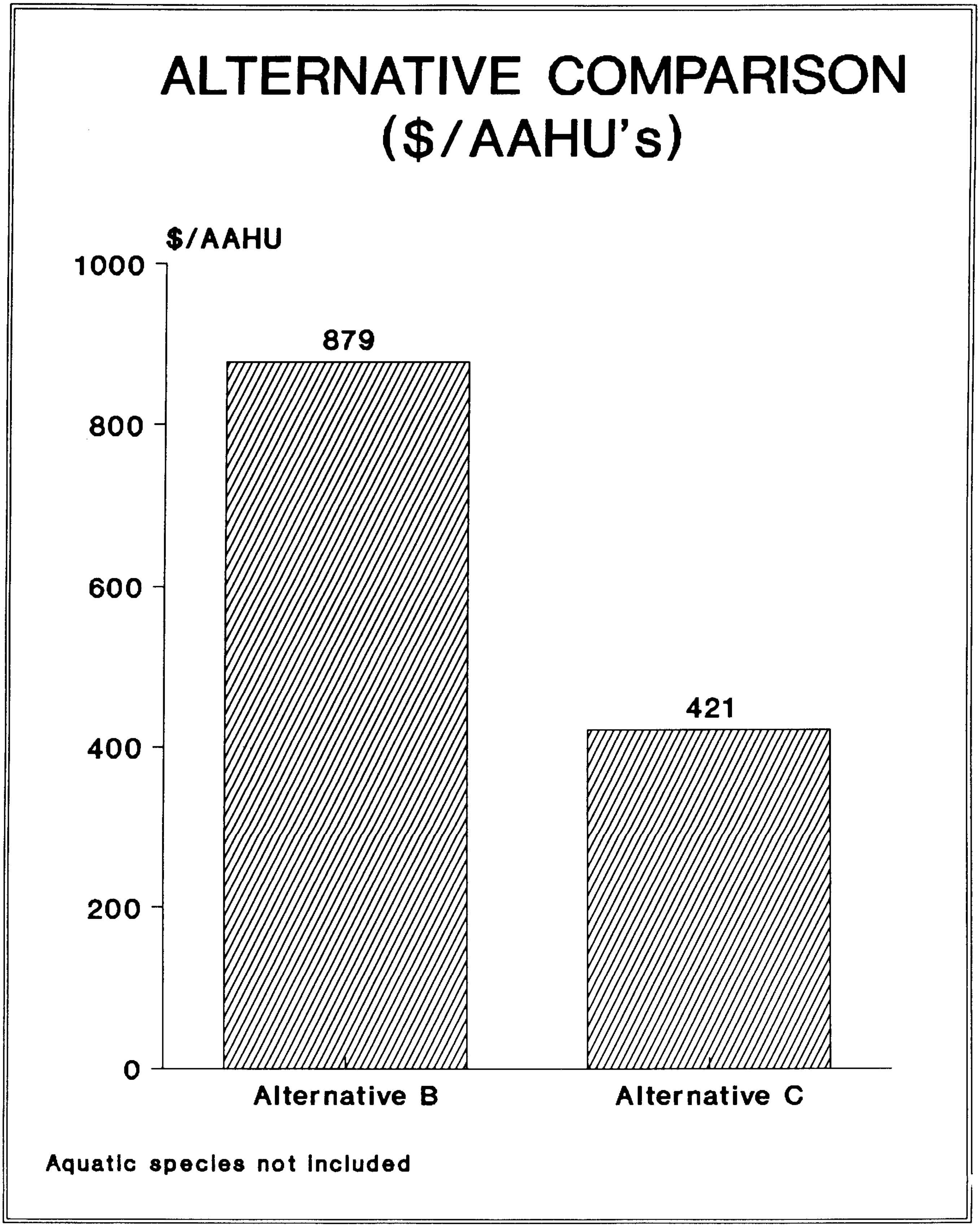

ALTERNATIVE COMPARISON
($/AAHU's)
$/AAHU
1000
800
600
400
200
0
879
421
Alternative B
Alternative C
Aquatic species not included

FIGURE 7-2

TABLE 7-1

Alternative Comparison (1)

Alternative	Total (2) Annual Cost ($)	Habitat Gain (3) (AAHU)	Cost Per Gained Habitat ($/AAHU)
Alternative B (Wetland)	153,000	174	879
Alternative C (Wetland)	175,266	416	421

(1) Aquatic habitat enhancement and associated costs were not included because they were equivalent for each alternative.

(2) Annualized cost includes initial construction cost and annual O&M costs based on a 50-year project life, 8.5 percent interest rate.

(3) Habitat gains were computed by adding the gains associated with the hemi-marsh and Upper Lake enhancement.

8. SELECTED PLAN WITH DETAILED DESCRIPTION

a. **General Description.** Alternative C was selected to be recommended for project construction. The project features of levee restoration, Upper Lake water control, gated inlet structure, and the hemi-marsh, will meet project goals and objectives and are cost-effective.

b. **Perimeter Levee Restoration.** To achieve the project goals and objectives, it is necessary to have a reliable perimeter levee. The purpose of this section is to present the selected construction plan for the perimeter levee.

It is proposed to restore the perimeter levee to the 50-year design elevation and to stabilize the sideslopes. (See plates 10 through 20 for the plan and profile sheets. The levee top width will be 12 feet and be offset to the lake side in order to reduce the amount of riverward tree clearing. The 12-foot top width is required for adequate levee stability. (See Appendix G - Geotechnical Considerations for a stability analysis.) The Mississippi River sideslope will have at least 3:1 horizontal to vertical (H:V) and the lake side will have 4:1 sideslopes. The embankment borrow will be excavated adjacent soil. The borrow ditch will be 35 feet across at the bottom and about 4 feet deep. (See plate 22 for a typical levee cross section.) A 20-foot-wide nondisturbed zone will separate the borrow edge from the levee toe. The tops and sideslopes of the completed levees will be planted with the following seed mixture:

Rice cutgrass (*Leersia oryzoides*)	6 pounds per acre
Big bluestem (*Andropogon gerardii*)	6 pounds per acre
Little bluestem (*Andropogon scoparius*)	4 pounds per acre
Indian grass (*Sorghastrum nutans*)	4 pounds per acre
Side oats gramma (*Bouteloua curtipendula*)	4 pounds per acre
Prairie cord grass (*Spartina pectinata*)	6 pounds per acre
Perennial ryegrass	20 pounds per acre

Maintenance mowing will be required on a central 25-foot-wide zone. Plates 24, 26, and 27 show existing levee sections with the recommended design section superimposed.

c. **Upper Lake Management Plan.** This feature consists of a 560-acre area bounded and divided by levees which form controlled ponding units. The proposed site plan is shown on plate 2. The principle components of the Upper Lake water control plan are summarized in table 8-1.

Because it was desired to have ponding depths of approximately 1.5 feet, a 3-celled unit was designed to take advantage of the existing topography. Water will be pumped into or out of the Upper Lake feeder channel from a new pump station located on the cross dike. The feeder channel can be used to fill or dewater any of the cells. The purpose of the stoplog structures in cells A, B, and C is to allow flexible and independent operation of each cell. The following is a detailed description of the components of the Upper Lake water control plan.

TABLE 8-1

Upper Lake Water Management Components

Item	Description	Component's Purpose
1. Cross Dike Raise	Raised dike to a 5-year elevation (590 MSL)	Provide increased flood protection.
2. Modify Existing Overflow Structure	Raise existing overflow structure to elevation 588.0 (MSL). Construct additional 100 feet of overflow structure at elevation 588.0 (MSL).	Provide floodwater access to Upper Lake prior to cross dike overtopping; reduce cross dike damage potential.
3. New Pump Station	Construct concrete gated structure with 2 (7,000 gpm) pumps.	Provide capability to (1) dewater Upper Lake; (2) pump from Lower Lake into the Upper Lake; and connect the Upper and Lower Lakes by gravity flow.
4. Interior Levees	Create 3 separate cells by construction of interior levees at elevation 587.0 MSL.	Provide capability to control water levels in each cell independent of the others.
5. Stoplog Structures	Three concrete stoplog structures each with 5-foot opening.	Provide capability to control water levels in each cell independent of the others.

(1) **Cross Dike Raise**. It is proposed to raise and strengthen the cross dike by excavating adjacent soil for placement as levee embankments. The levee top will be offset to the Upper Lake side in order to take advantage of the existing riprap on the Lower Lake sideslope. The levee top will be raised to elevation 590.0, which is approximately the 5-year flood elevation. The proposed cross dike will have a 12-foot top width and 4:1 (H:V) sideslopes. The completed embankment will have a 6-inch gravel top and the Upper Lake sideslope will be seeded as specified in Section 8b. Cross dike plan and profiles are shown on plates 12, 13, and 14. Typical sections are shown on plate 22.

(2) **Modify Existing Overflow Structure**. The proposed project includes raising the existing overflow structure to elevation 588.0 (MSL) as shown in plan and profile on plate 13. Another 100-foot overflow structure is proposed from station 116+50 to station 117+50 as shown on plate 13. Plate 25 shows the existing cross sections with the design section superimposed.

The overflow sections were designed for those areas where overtopping will first occur during flood events greater than the 2-year frequency. Once overtopping of the overflow sections occurs, the Upper Lake cells will fill prior to overtopping of the cross dike. Riprap will be provided for the Upper Lake slopes. Tree buffers and existing riprap will provide adequate protection on the Lower Lake slope. A proposed cross section is shown on plate 22.

(3) **New Pump Station**. The pump station has been sized to evacuate all three cells of the Upper Lake in approximately 15 days. This timeframe is consistent with the management objective of being able to draw down the site rapidly during critical periods to stimulate target vegetative growth. Plan views and typical sections of the proposed station are shown on plates 29 and 30.

The pump station will be furnished with two pumps. This configuration will provide the capability to dewater the Upper Lake and to pump water from the Lower Lake into the Upper Lake. The sizes of these pumps will be 7,000 gpm. The pump station will be manually energized when required and will operate automatically until de-energized. Underground electrical power will be furnished along the cross dike (see plate 33 for the pump station electrical plan).

This station is being furnished with a trash rack on both sides due to flow reversals as described. The inverts of the station have been set consistent with refuge ditching and adjacent natural ground elevations. A sedimentation zone has been provided on the Lower Lake side with an overflow weir protecting the entrance to the station to minimize sediment entering the pump station during drawdown periods.

The station also will contain a 3-foot by 3-foot sluice gate to allow passage of gravity flows. The gate will be operated by an electrically driven motor.

Both pumps and the gate will be located within a cast-in-place concrete building structure. A vandal-resistant and durable structure will be provided.

The existing pump on site will not be used to augment the new pump station because it requires extensive maintenance during operation.

(4) **Interior Levees**. Proposed sections of the levee embankments are shown on plate 23. Embankment slopes are 4:1 which will facilitate levee maintenance and reduce burrowing animal problems. The top width of the levees is 10 feet typically and 12 feet when they are being used as access to the stoplog structures and other operational requirements. The average height of the levees is approximately 5 feet. The levee height was based on providing 2 feet of ponded water in Cell A. The existing ground elevation has an average elevation of 584. The levees separating Cells B and C are used to provide a water feeder channel, so those must be at least as high as the levee for Cell A. The levees will be excavated from an adjacent borrow source, as shown on plate 23. The borrow sources have been developed to facilitate drainage for operational requirements.

(5) **Stoplog Structures**. Proposed stoplog structures are shown on plate 32. All structures will be the same type as shown on this plate and have one 5-foot opening for a total hydraulic opening of 5 feet.

The structures consist of a concrete sill with concrete dividing walls and abutments that incorporate stoplog recesses. The stoplog recesses will be used for water control of Cells A, B, and C, as previously described. A heavy duty grating will be provided across the structure to allow vehicular access.

The hydraulic opening of these structures has been determined based on hydrologic simulation of flood events and in conjunction with the overflow structures on the cross dike. The hydraulic opening size was finalized after a selected river event overtopped the proposed levees with approximately 1 foot of head differential still remaining on the interior of the cells. This sizing method was chosen to minimize overtopping damage and to allow dewatering and filling rates to be consistent with management objectives. The opening width in the water control structures is sufficient to allow the interior cells to rapidly fill such that at the overtopping point, the head differential between the exterior and the interior is approximately 1.0 foot.

d. **Gated Inlet Structure/Gatewell Structure**. This feature consists of installing a gated inlet water control structure and a small gatewell structure to provide flow and disperse dissolved oxygen throughout the Lower Lake.

(1) **Gated Inlet Structure**. The gated inlet structure was sized by determining the flow necessary to provide the amount of fresh water needed

for fish habitat. It has been determined that dissolved oxygen concentrations greater than 5 mg/l are desirable for fish. The volume of water necessary to provide 5 mg/l of dissolved oxygen was based on the area and depth of the lake and an oxygen balancing analysis. This analysis is described in full in Appendix F - Water Quality. It was determined that 175 cubic feet per second of flow is necessary. Based on typical river elevations during low-flow winter conditions, two 5-foot by 5-foot gated box culverts will be adequate to provide the necessary flow. See plate 31 for plan and elevation views of the inlet structure.

(2) **Gatewell Structure**. A small, 24-inch concrete gatewell structure will provide extra management capability to provide oxygenated water to the southwest region of the Lower Lake. The structure was sized to be small enough to operate easily and large enough to not pose a habitual maintenance problem. The majority of the structure is constructed of precast reinforced concrete pipe. The use of the precast materials should decrease in-field construction time and help minimize dewatering costs. See plate 23 for gatewell details.

e. **Hemi-Marsh Development**. This feature consists of developing an approximate 100-acre hemi-marsh located on the southeastern fringe of the refuge. It is proposed that a low-level perimeter levee, a stoplog structure, and a well station be constructed. The following paragraphs give a detailed description of these components.

(1) **Low-Level Perimeter Levee**. In order to provide the capability to control water levels in the hemi-marsh, a levee with top elevation 586.0 is proposed (see plate 2 for a plan view). The levee top elevation was based on the capability of ponding 2 feet of water in the hemi-marsh. The levee top width will be 8 feet and the sideslopes will be 4:1 horizontal to vertical (see plate 23 for a typical section). The embankment borrow will be excavated adjacent soil from the lake sides of the hemi-marsh. The sideslopes and top will be seeded. A 10-foot-wide crushed stone access road will be provided at each end of the embankment for access to the well station and stoplog structure. A typical section is shown on plate 28.

(2) **Stoplog Structure for the Hemi-Marsh**. The proposed stoplog structure is shown on plate 32. The structure will have a 5-foot opening. The purpose of the structure is to enable gravity drainage and provide a means of varying the water elevation within the hemi-marsh.

The structure consists of a concrete sill with concrete abutments that incorporate stoplog recesses. The stoplog recesses would be used for water control. A heavy duty grating would be provided across the structure to allow vehicular access.

The hydraulic opening of this structure has been determined based on hydrologic simulation of flood events. The hydraulic opening size was finalized after a selected river event overtopped the proposed levees with approximately 1 foot of head differential still remaining on the interior of the cells. This sizing method was chosen to minimize overtopping damage and to allow dewatering and filling rates to be consistent with management objectives.

(3) **Water Supply**. The well station will involve installing a shallow well for water supply (see plate 28 for a plan view and a detail). It has been estimated that 1,000 gpm of ground water could be pumped from the sand aquifer with about 9.5 feet of drawdown (see analysis in appendix G). The well will be used to raise the water level in the hemi-marsh during low river periods. A 1,000-gpm pump will provide an additional 1 foot of water on the entire 100 acres when considering evaporation, infiltration, and rainfall. A 5 hp submergible pump will be required for this well. Overhead electrical power will be furnished adjacent to the proposed access road (see the electrical plan on plate 34).

9. DESIGN AND CONSTRUCTION CONSIDERATIONS

a. **Existing Site Elevations**. The entire Spring Lake project area is located within the floodplain of the Mississippi River. Existing ground elevations for the proposed interior levee construction are below flat pool elevations in some areas. This will likely require the use of track-mounted excavation equipment for interior levee construction. Likewise, an allowance for dewatering during construction of the pump station, inlet structure, gatewell structure, and the stoplog structures also has been included in the cost estimates.

b. **Erosion Control**. Riprap is proposed on the Upper Lake side of the weir overflow sections of the cross dike levee to protect against overflow during flood events. The Lower Lake sides of the overflow sections are located in wooded areas and have existing riprap. Based on the performance of the existing riprap, additional protection will not be necessary.

The perimeter levee will be restored by building on the lake side of the levee. The river side of the levee will be left undisturbed. The majority of the river side has a good growth of trees, which will provide protection from erosion. However, it is proposed to protect an exposed 2,000-foot section on the lower perimeter levee with an 18-inch-thick riprap blanket. (See plates 22 and 18 for a typical section and plan view. Appendix E - Hydrology and Hydraulics includes the riprap design.)

c. **Well Construction**. The well will be drilled with conventional water well equipment to a depth of approximately 100 feet. A 12-inch ± steel casing will be set in the hole with a 5 hp submergible pump set at approximately 30 feet. A 4- to 6-inch ± riser pipe will be used. See plate 28 for the well station plan.

The pump was sized in order to fill the hemi-marsh with 1.0 foot of additional water in approximately 30 days and to provide makeup water for evaporation and infiltration. This will be accomplished by a 1,000-gpm pump. The effects of evaporation, infiltration, and seepage were all considered in the pump sizing. It is assumed that under less than ideal conditions rainfall during September through November will exceed evaporation. Evaporation averages approximately 0.18 foot per month during this period, while rainfall averages 0.24 foot per month. Soil infiltration will average approximately 0.15 foot per month. The 1,000-gpm pump was selected because it was the most cost-effective pump that would satisfy the USFWS requirements of keeping a minimum of 1.0 foot of water in the hemi-marsh during September through November with approximately 30 days of pump time.

d. **Borrow Sites/Construction Materials**.

(1) **Borrow Sites**. Borrow material for the perimeter and intermediate levees will come from adjacent ditch excavation and from the adjacent agricultural fields.

(2) **Construction Materials.** Only common construction materials are required for this project. Access to the pump station and water control structures will be provided by the access road construction. Crushed stone and bedding materials are available from area quarries and most likely will be trucked to the site. Once the access road is complete, construction materials, including concrete for the water control structures, can be transported using conventional equipment.

e. **Construction Sequence.** The probable construction sequence is summarized in tables 9-1, 9-2, and 9-3; however, no sequence will be contractually required.

f. **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 Illinois and a Section 404(b)(1) Evaluation will be included in the final submission of this report. A floodplain construction permit from the Illinois Department of Transportation, Division of Water Resources, will be obtained prior to advertisement. A National Pollutant Discharge Elimination System (NPDES or Section 402) permit for storm water discharges will be obtained prior to advertisement.

TABLE 9-1

Upper Lake
Probable Construction Sequence

	Construction Work Item	Instructions	Purpose
1	Excavate embankment fill for upper interior levees/ allow consolidation/repeat as necessary.	Use adjacent borrow	Multiple passes required for material standup.
2	Shape uncompacted levee.	--	--
3	Place road stone where specified.	--	--
4	Seed levees.	--	--
5	Clear specified vegetation from perimeter levees and cross dike.	Place debris in piles adjacent to toe of new embankment.	Provide slope erosion protection.
6	Excavate embankment fill for perimeter levee and cross dike/allow consolidation/repeat as necessary.	Use adjacent borrow.	Multiple passes required for material standup.
7	Shape uncompacted levee.	--	--
8	Place road stone and riprap where specified.	--	--
9	Seed levee.	--	--
--	Pump station, stoplog structures.	No sequence.	--

TABLE 9-2

Lower Lake
Probable Construction Sequence

	Construction Work Item	Instructions	Purpose
1	Clear specified vegetation from perimeter levees.	Place debris in piles adjacent to toe of new embankment.	Provide slope erosion protection.
2	Excavate embankment fill/ allow consolidation/repeat as necessary.	Use adjacent borrow.	Multiple passes required for material standup.
3	Shape uncompacted levee.	--	--
4	Place road stone and riprap where specified.	--	--
5	Seed levee.	--	--
--	Gated inlet structure, gatewell structure.	No sequence required.	--

TABLE 9-3

Hemi-Marsh
Probable Construction Sequence

	Construction Work Item	Instructions	Purpose
1	Proposed access roads.	Include road stone.	To protect roadway.
2	Excavate embankment fill for upper interior levees/ allow consolidation/repeat as necessary.	Use adjacent borrow.	Multiple passes required.
3	Shape uncompacted levee.	--	--
4	Well and stoplog construction.	--	--
5	Place road stone where specified.	--	--
6	Seed levee.	--	--

10. ENVIRONMENTAL EFFECTS

a. Summary of Effects. Overall, the project will result in an increase of waterfowl and fish habitat consistent with the management objectives of the Upper Mississippi River National Wildlife and Fish Refuge, Savanna District. It also supports the goals and objectives of the North American Waterfowl Management Plan. Increased water level control by dividing the area in the Upper Lake into managed marsh and moist-soil units will increase the acreage of moist-soil plants used by dabbling ducks (figure 10-1). By improving dissolved oxygen availability, fish habitat will be improved. Construction of the 2-year levee, water-control structure, and well in development of a 108-acre hemi-marsh area will increase habitat for all marsh-dwelling species, except the least bittern (see figures 5-4 and 10-2).

Impact of the proposed construction on aquatic, wetland, and terrestrial resources of the refuge was evaluated using a modified Habitat Evaluation Procedure (HEP) developed by the Missouri Department of Conservation and the U.S. Department of Agriculture - Soil Conservation Service. The Wildlife Habitat Appraisal Guide (WHAG) compares existing and projected future habitat values with habitat values resulting from the proposed project. The WHAG calculates both positive and negative impacts to habitat. The WHAG evaluation was performed by the USFWS and the Corps of Engineers in coordination with Illinois Department of Conservation (ILDOC) biologists. Results of the WHAG evaluation are summarized in tables 10-1, 10-2, and 10-3 for the species of primary interest, and a more detailed analysis is included in appendix D.

These improvements will impact approximately 19.1 acres of non-forested wetland (NFW). Approximately 14.6 acres of NFW will be impacted in the Upper Lake by creation of the feeder channel and cell levees. Approximately 4.5 acres of NFW will be impacted for construction of the levee for the hemi-marsh in the Lower Lake. The levees may provide limited nesting value to mallards.

In cases where habitat loss is permanent (i.e., levees, pump station, and stoplog structures), the overall improvements to wetlands overcome the short-term losses. This is clearly shown in the habitat analysis. The impacts to these resources were accounted for in the WHAG analysis. The loss of this habitat will be mitigated by the project itself, which will significantly enhance benefits to fish and wildlife.

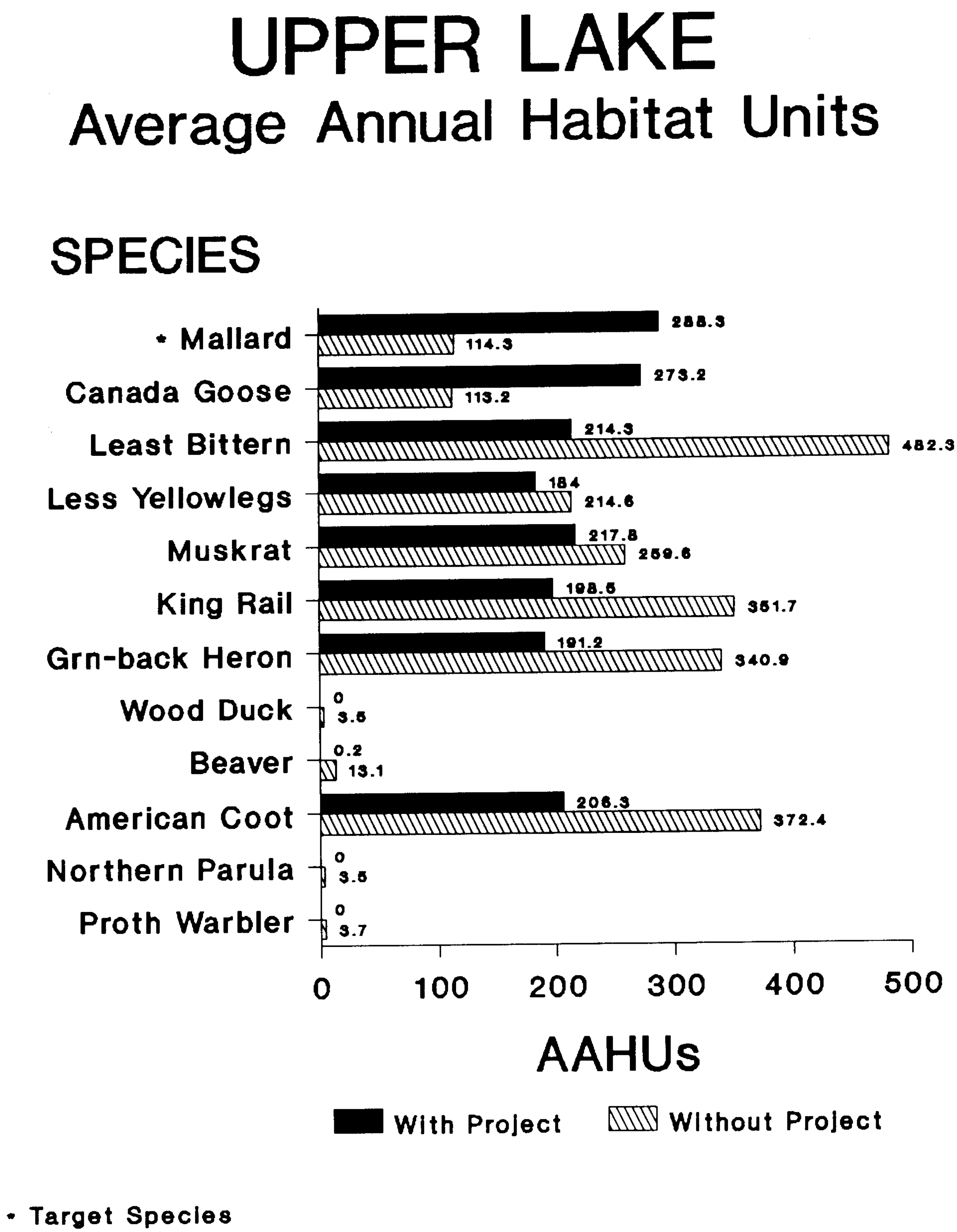
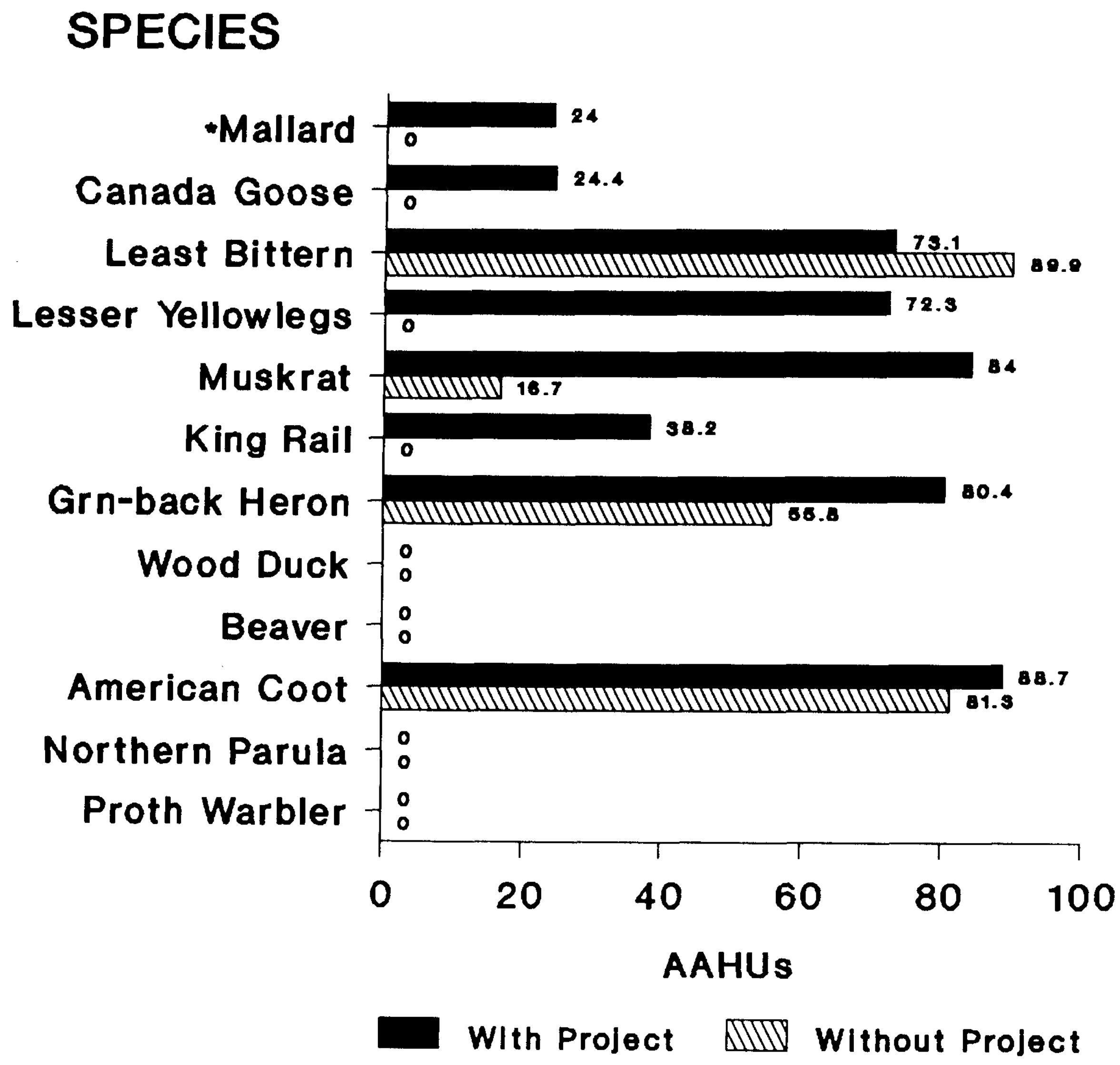

UPPER LAKE
Average Annual Habitat Units
SPECIES
* Mallard
Canada Goose
Least Bittern
Less Yellowlegs
Muskrat
King Rail
Grn-back Heron
Wood Duck
Beaver
American Coot
Northern Parula
Proth Warbler
288.3
114.3
273.2
113.2
214.3
482.3
184
214.6
217.8
259.6
198.5
351.7
191.2
340.9
0
3.5
0.2
13.1
206.3
372.4
0
3.5
0
3.7
0
100
200
300
400
500
AAHUs
With Project
Without Project
* Target Species

FIGURE 10-1

HEMI-MARSH
Average Annual Habitat Units



*Target Species

FIGURE 10-2

b. **Economic and Social Impacts.**

(1) **Community and Regional Growth.** No impacts to the growth of the community or region will be realized as a result of the project. The project will indirectly improve recreation opportunities at the Spring Lake complex, increasing the attractiveness of the area for fishing or hunting.

(2) **Displacement of People.** No residential displacements will be caused by the proposed aquatic habitat enhancement project.

(3) **Community Cohesion.** No significant impacts to community cohesion will occur. The project site is located in a rural setting with limited residential development.

(4) **Property Values and Tax Revenues.** The potential value of property within the project area could increase slightly as a result of the proposed project. This land is in Federal ownership so an increase in its value will not increase local tax revenues.

(5) **Public Facilities and Services.** The project will positively impact public facilities by enhancing aquatic habitat on Federal lands managed by the Fish and Wildlife Service. The Spring Lake project will provide opportunities for fisheries and waterfowl habitat restoration and enhancement. The project will improve existing water quality and wetland and aquatic habitats.

(6) **Life, Health, and Safety.** The Spring Lake complex poses no threats to life, health, or safety to recreationists or others in the area. The proposed project will not affect current conditions in regard to these areas of concern.

(7) **Business and Industrial Activity.** Changes in business and industrial activities during project construction will not occur. The project will require no business relocations.

(8) **Employment and Labor Force.** Project construction will slightly increase short-term employment opportunities in the project area. The project will not directly affect the permanent employment or labor force in Carroll County.

(9) **Farm Displacement.** No farms will be affected as the project site is located entirely on federally owned land.

(10) **Noise Levels.** Heavy machinery will generate a temporary increase in noise levels during project construction. This increase in noise levels will disturb wildlife and recreationists at the Spring Lake complex. The project is located in an area with limited residential or other development, and no significant, long-term noise impacts will result.

(11) **Aesthetics.** The project will have minimal effect on the aesthetic value of the area.

c. **Natural Resources Impacts**. Impact of the proposed construction on aquatic, wetland, and terrestrial resources of the refuge was evaluated using a modified Habitat Evaluation Procedure (HEP) developed by the Missouri Department of Conservation. This Wildlife Habitat Appraisal Guide (WHAG) compares existing and projected future habitat values with habitat values resulting from the proposed project. The WHAG evaluation was performed by the USFWS and the Corps of Engineers in coordination with ILDOC biologists. Results of the WHAG evaluation are summarized in tables 10-1 through 10-3 for the species of primary interest, and a more detailed analysis is included in appendix D.

(1) **Aquatic Resources**. A detailed discussion of the aquatic and water quality impacts is contained in Appendix B - Clean Water Act, Section 404(b)(1) Evaluation.

TABLE 10-1

AAHUs for Without-Project Conditions
and Three Proposed Management
Alternatives for Upper Spring Lake
(Total acreage 560 acres)

SPECIES	Without Project	Option 1*	Option 2**	Option 3***
Mallard	114.3	214.2	395.4	288.3
Canada goose	113.2	211.7	367.0	273.2
Least bittern	482.3	424.8	60.5	214.3
Lesser yellowlegs	214.6	361.0	57.8	184.0
Muskrat	259.6	439.7	58.2	217.8
King rail	351.7	391.7	59.1	198.5
Green-backed heron	340.9	375.1	58.8	191.2
Wood duck	3.5	--	--	--
Beaver	13.1	0.1	0.1	0.2
American coot	372.4	411.8	58.4	206.3
Northern parula	3.5	--	--	--
Prothonotary warbler	3.7	--	--	--

* Managed marsh
** Moist soil
*** 237 acres managed marsh; 298 acres moist soil

TABLE 10-2

AAHUs for Existing Conditions and Three Alternatives for the 108-Acre Hemi-Marsh

SPECIES	Without Project	2-Year	2-Yr/C	5-Yr/C
Mallard	--	--	24.0	26.2
Canada goose	--	--	24.4	25.9
Least bittern	89.9	94.1	73.1	65.1
Lesser yellowlegs	--	--	72.4	65.5
Muskrat	16.7	37.9	84.0	91.4
King rail	--	--	38.2	41.6
Green-backed heron	55.8	54.6	80.4	86.0
Wood duck	--	--	--	--
Beaver	--	--	--	--
American coot	81.3	81.5	88.7	87.7
Northern parula	--	--	--	--
Prothonotary warbler	--	--	--	--

TABLE 10-3

HSIs and AAHUs of the Fish Evaluation Species for Future Without- and Future With-Project Conditions
(AAHUs are represented by acres)

SPECIES	Future Without HSI	AAHUs	Future With HSI	AAHUs
Largemouth bass	0.10	241.4	0.49	1173.5
Channel catfish	0.10	241.4	0.45	1071.2
Walleye	0.10	241.4	0.55	1326.8

For the purpose of comparing AAHUs without project to AAHUs with project conditions, all HSIs of 0.1 were multiplied by the amount of available habitat. Therefore, for this analysis each evaluation species having an HSI value of 0.1 is assumed to have AAHUs of 241.4. The aquatic habitat benefits derived from implementing the project are not only substantially greater than conditions without project, but they are also unlikely to significantly decrease over time. This indicates that benefits to the aquatic habitat will extend beyond the period of analysis used for this project.

Lower Lake - The construction of a gated inlet structure and gatewell structure in the Lower Lake will benefit the nektonic fauna. The water control structures will provide dissolved oxygen throughout the lake and enhance over-wintering areas for fish (figure 5-3). The existing perimeter levee will be improved by borrowing material adjacent to and inside of the existing levee, thus creating deep water habitat in these areas. Improving the existing levee also will enhance the water quality, thereby stimulating the growth of desired aquatic vegetation (i.e., wild celery) (table 10-3). The existing cross dike will be upgraded, by addition of bedding material and crushed stone from area quarries, and used as the access road, so that construction materials can be transported using conventional equipment. The existing levee will not be raised, but strengthened and reshaped. This will not affect flood heights since all work will be within the 50-year levee surrounding Spring Lake.

(2) **Wetland Resources**. Wetlands within the project area which will be impacted are located in the Upper Lake and in the hemi-marsh.

Upper Lake - Improved water control in the Upper Lake through the creation of two moist-soil units and a managed marsh will result in an increase in plants such as smartweed, millet, pigweed, and rice cutgrass favored by dabbling ducks, thereby increasing AAHUs for target species in the Upper Lake (figure 5-1). Aquatic mammals, such as muskrats, and shorebirds, such as bitterns, rails, and herons, will be impacted due to elimination of all standing water during drawdown (table 10-1). However, the selected project meets the objectives of enhancing habitat for the target species, yet still provides habitat diversity for other marsh-dwelling species (figure 10-1). Approximately 14.6 acres of non-forested wetland (NFW) will be impacted by construction of the feeder channel and cell levees.

Hemi-Marsh - The creation of a 108-acre hemi-marsh in the Lower Lake will result in increased benefits for nearly all species included in the matrix (figures 5-4 and 10-2). The construction of a 2-year levee and placement of a water-control structure will enhance and create 108 acres of palustrine emergent wetlands within the confines of the levee providing a significant amount of habitat for a wide variety of marsh-dwelling species (table 10-2).

(3) **Bottomland Hardwoods**. There are approximately 192 acres of bottomland hardwoods within the project area. These acres vary markedly in their quality.

Upper Lake - Approximately 20 acres of bottomland hardwoods in the Upper Lake will be affected by the project. The majority of the trees in this area are sapling to pole-sized silver maple, cottonwood, and river birch. The inundation of this area over a period of years will result in their decay. This may provide habitat for wood ducks and woodpeckers while the trees are still standing. However, it is anticipated that by TY 25 the trees will be downed and the area converted to non-forested wetland.

Lower Lake - Approximately 172 acres of bottomland hardwoods is located in the Lower Lake within the project area. Silo Island has approximately 106 acres of these hardwoods of varying quality. The dominant species of trees on the island are burr oak, pin oak, green ash, silver maple, cottonwood, and river birch. The other hardwood acreage in the Lower Lake is located on smaller islands, some which were formed due to the breach in the west perimeter levee which occurred in 1965. These islands contain mostly willow and river birch. The bottomland hardwoods in the Lower Lake will not be impacted as a result of the project since the water level fluctuates with the river.

(3) **Endangered Species**. The Coordination Act Report (appendix A) provided by the USFWS, states that the endangered bald eagle (*Haliaeetus leucocephalus*) is known to breed and winter in Carroll County, Illinois. Also, the peregrine falcon (*Falco peregrinus*) uses the area during its migration. The report goes on to state that the habitats utilized by these birds in the project area will not be impacted as a result of the proposed project, and that impacts to these species are not anticipated.

In a letter dated February 24, 1992 (appendix A), the ILDOC stated that several Illinois endangered and threatened species are known to occur in the vicinity of Spring Lake. These include double-crested cormorant, bald eagle, yellow-headed blackbird, and river otter. The letter goes on to state that if nesting bald eagles and double-crested cormorants are present in 1992 and subsequent years, it may be necessary to schedule levee rehabilitation along the southern half of the lower unit to occur only between August and November and that specific recommendations for protection of the sites should be developed by those most familiar with the situation at Spring Lake. Also, if nesting by yellow-headed blackbirds is confirmed in the upper unit, there also may be a need to schedule work in this portion of Spring Lake to avoid disturbance during the most sensitive months. The ILDOC will provide 1992 data on this species to be considered in planning and scheduling levee rehabilitation.

d. **Cultural Resources**. In order to assess the potential effects of the proposed project on historic properties, a contract was awarded to Stanley Consultants, Inc., to conduct a Phase I survey of the project impact areas (figure 10-3). Work was conducted by American Resources Group, Ltd. (Ross and Anderson 1991).

Because the geomorphological information indicated some potential for buried sites, the archeological investigation combined shovel testing, pedestrian survey supplemented by hand excavation of test units on Site 11-CA-18, and deep geomorphological testing. The Scope of Work for the survey was reviewed and approved by the State Historic Preservation Office in a letter dated September 16, 1991 (Appendix A).

The Scope of Work specified that no survey will be conducted in the areas of proposed channel dredging (areas inundated by Mississippi River Pool 13). However, it did provide that potential dredging locations be reviewed and alignments placed to avoid higher points of preinundation topography.

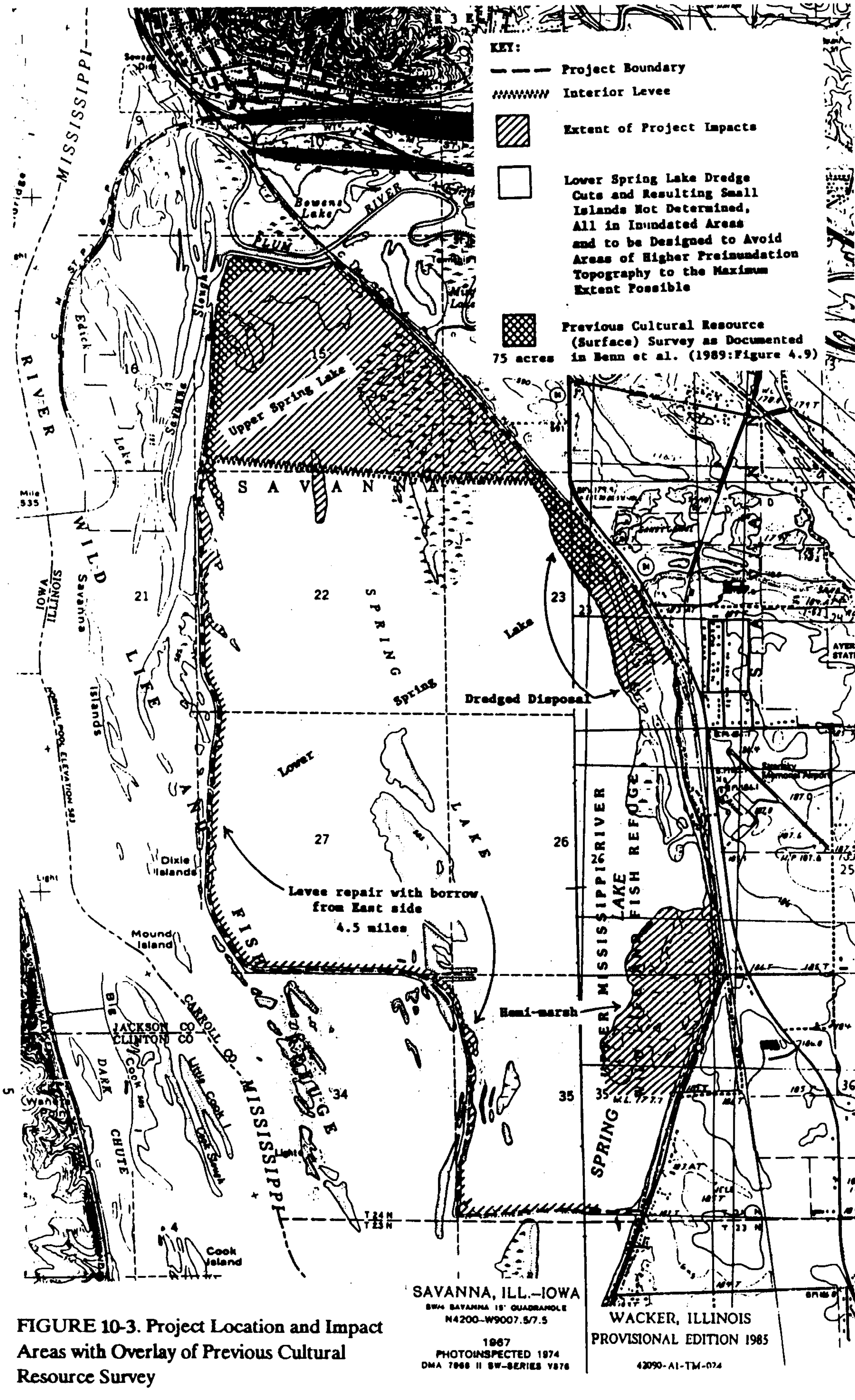


FIGURE 10-3. Project Location and Impact Areas with Overlay of Previous Cultural Resource Survey

This was accomplished in selecting the potential dredge cuts for the Proposed Plan in this Definite Project Report. Corps of Engineers land acquisition maps dating from the years just prior to lock and dam construction were used to identify more elevated topographical positions. These areas were assumed to have a higher probability of containing inundated cultural resources. The land acquisition maps contained 1-foot contour interval elevation markings. Final locations of the dredge cuts will be filed with the State Historic Preservation Office should the configuration of alignments change.

The Phase I survey located no additional historic properties within the project impact areas. Site 11-CA-114 was never relocated; site 11-CA-18 was extensively shovel tested and recommended as requiring no further work due to its lack of potential significance. Three prehistoric isolated finds, one historic isolated find, and one isolated historic feature were not recommended for further work.

Following submittal of the archeological and geomorphological findings, the proposed plan of work was designed to avoid areas of moderate to high potential for buried sites. This was done by realigning the channels and levees within Upper Spring Lake and by restricting the depth of borrow to 2.5 feet for levee rehabilitation within Cell A of Upper Spring Lake so as not to reach the depth of the buried soil which has the potential to contain--but has no documented--buried cultural sites. This information was presented to the State Historic Preservation Office and resulted in their letter (appendix A) dated March 13, 1992, stating that "no significant historic, architectural, and archaeological resources are located in the project area."

e. **Mineral Resources**. The proposed project will have no effect on mineral resources in the area.

f. **Adverse Effects Which Cannot Be Avoided**. The most significant unavoidable adverse effect is the clearing of trees in order to rehabilitate the perimeter levee. Another unavoidable impact is the placement of fill material into existing wetlands for the construction of levees. The levees will be used for water control in the moist-soil, managed marsh, and hemi-marsh areas.

g. **Short-Term Versus Long-Term Productivity**. Short-term productivity of the Upper Lake is impaired due to the inability to control water levels and thereby produce plant species favored by dabbling ducks. The creation of the moist-soil units and managed marsh in this section of the lake will allow the refuge manager to utilize the area to optimum conditions for production of food sources for dabbling ducks.

Short-term productivity of the Lower Lake is impaired by the lack of dissolved oxygen. The construction of the inlet structure and gatewell structure will provide dissolved oxygen which will be conveyed throughout much of the lake (see plate E-8).

h. **Irreversible or Irretrievable Resource Commitments.** Other than fuel, construction materials, and manpower, none of the proposed actions are considered to be irreversible.

i. **Compliance With Environmental Quality Statutes.** Table 10-4 lists environmental laws and regulations applicable to the proposed project.

(1) National Historic Preservation Act and Archaeological and Historic Preservation Act. Construction of the preferred plan will not affect any significant historic properties. This action has been fully coordinated with the Illinois State Historic Preservation Office. The project, therefore, may proceed in full compliance with all appropriate historic preservation laws.

(2) Native American Graves Protection and Repatriation Act. Among other provisions, this act requires written notification to the head of the Federal agency with primary management authority for Federal lands upon which inadvertent discoveries of Native American human remains or objects may be found during construction or other activities. Should such discoveries be made during this project, the provisions of this act will be followed.

j. **Mitigation.** The habitat evaluation (WHAG analysis) performed for this project indicates that, over the 50-year life of the project, there will be a net gain in wildlife habitat for targeted species. Although not discussed in detail (but a critical part of the WHAG analysis), the future without-project condition of the refuge indicates that a decline in non-forested wetland habitat and aquatic habitat will occur by the end of the 50 years. Much of the non-forested wetland will succeed to other habitat types of lower value to waterfowl and fish. In other words, if the project is not built, there is a strong likelihood that wetland habitat needed to meet refuge objectives at Spring Lake will decline.

The WHAG analysis was performed on target and non-target species for the Spring Lake project. These included species such as bittern, prothonotary warbler, green-backed heron, and others. This preliminary analysis gave an adequate indication of species impacts. When the consequences of the action are considered for this many species, it is inevitable that some species will gain at the expense of others. No matter how the project is designed, some species will be affected. As stated previously, even the "no action" alternative will result in species impacts. Based on the preliminary analysis, it is felt that no mitigation is needed.

TABLE 10-4

Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Policies	Compliance
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full compliance
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full compliance
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
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. 601, et seq.	Full compliance
Land and Water Conservation Fund Act, 16 U.S.C. 460/-460/-11, et seq.	Not applicable
Marine Protection Research and Sanctuary Act, 33 U.S.C. 1401, et seq.	Not applicable
National Environment Policy Act, 42 U.S.C. 4321, et seq.	Full compliance
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full compliance
River and Harbors Act, 33 U.S.C. 403, et seq.	Full compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not applicable
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Full compliance
Flood Plain Management (Executive Order 11988)	Full compliance
Protection of Wetlands (Executive Order 11990)	Full compliance
Environmental Effects Abroad of Major Federal Actions (Executive Order 12114)	Not applicable
Farmland Protection Act	Full compliance
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 11 Aug 80)	Full compliance

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.

c. Noncompliance. Violation of a requirement of the statute.

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: construction of three independent, reliable water-controlled cells in the Upper Lake; construction of a gated inlet structure and small gatewell structure in the Lower Lake; construction of a 108-acre water-controlled hemi-marsh in the Lower Lake; and restoration of 7.1 miles of perimeter levee.

The proposed construction of three cells in the Upper Lake will allow a combination moist soil and managed marsh operation plan. This will meet the project objective of providing a reliable food source in the Upper Lake for migratory birds while providing habitat diversity for other marsh-dwelling species.

The proposed gated inlet structure and gatewell structure in the Lower Lake will allow for flow and dissolved oxygen dissipation throughout the Lower Lake. This feature will substantially improve the water quality and aquatic habitat in the Lower Lake.

The proposed construction of the hemi-marsh in the Lower Lake will provide habitat for migratory birds and a wide range of other wetland dwelling species.

The restoration of the perimeter levee will ensure the successful implementation and longevity of the habitat outputs while retaining Lower Spring Lake as a backwater of the Mississippi River. Figure 11-1 shows the percent improvement of habitat units that are to be realized as a result of implementing the proposed project features.

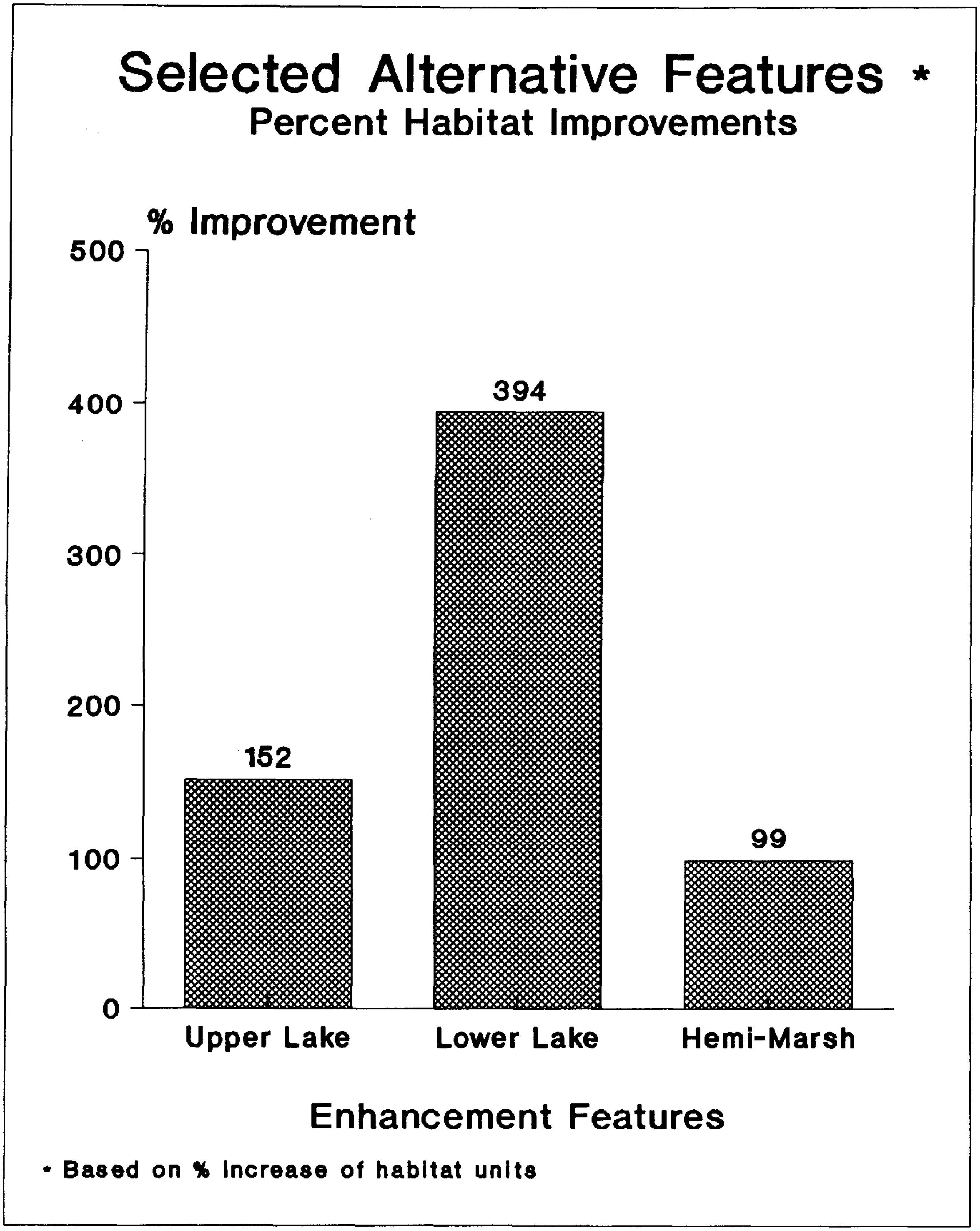

Selected Alternative Features *
Percent Habitat Improvements
% Improvement
500
400
300
200
100
0
394
152
99
Upper Lake
Lower Lake
Hemi-Marsh
Enhancement Features
* Based on % increase of habitat units

FIGURE 11-1

12. OPERATIONS, MAINTENANCE, AND REHABILITATION CONSIDERATIONS

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

b. **Operation**. Tables 12-2 and 12-3 are rating tables to be used for operating the gates on the Lower Lake inlet structure. It should be noted that actual gate settings will depend upon a variety of conditions and may be a trial and error solution.

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

TABLE 12-1

Spring Lake Project Data Summary

Feature	Measurement	Unit of Measure
Upper Lake Perimeter Levee		
Length	2.6	Miles
Crown width	12	Feet
Sideslopes	4:1	Horizontal:Vertical
Level of protection	50	Year event
Elevation	595 - 594.5	MSL
Embankment volume	41,000	Cubic yards
Upper Lake Interior Levees		
Length	7,200	Feet
Crown width	10-12	Feet
Sideslopes	4:1	Horizontal:Vertical
Elevation	587	MSL
Embankment volume	7,600	Cubic Yards
Crushed stone	1,050	Tons
Cross Dike		
Length	1.4	Miles
Crown width	12	Feet
Sideslopes	4:1	Horizontal:Vertical
Level of protection	>2	Year event
Elevation	590	MSL
Embankment volume	6,000	Cubic yards
Crushed stone	1,700	Tons

TABLE 12-1 (Cont'd)

Feature	Measurement	Unit of Measure
Cross Dike Overflow Section		
Length	400	Feet
Crown width	12	Feet
Sideslopes	4:1	Horizontal:Vertical
Elevation	588.0	MSL
Riprap	1,000	Tons
Lower Lake Perimeter Levee		
Length	4.5	Miles
Crown width	12	Feet
Sideslopes	4:1	Horizontal:Vertical
Level of protection	50	Year event
Elevation	594.5 to 593	MSL
Embankment volume	105,500	Cubic yards
Riprap	3,000	Tons
Pump Station		
Submersible pumps	2	7,000 gpm
Station invert	575	MSL
Trash racks	2	Upper & lower end
Sluice gates	1	3 feet by 3 feet
Discharge pipe	24	Inches
Power		
Electric	3	Phase
Transformer	37.5 (3-phase)	kVA
Buried primary feeder length	3,000	Feet
Riprap	280	Tons
Platform	1	Each
Elevation	595	MSL (100-yr elev)
Stoplog Structures		
Weir length per structure	5	Feet
Concrete sill elevation		
Cell A	582	MSL
Cell B	579	MSL
Cell C	579	MSL
Hemi-Marsh	581	MSL
Water Control Structure		
Type	--	(slide gate)
Gates	2	5 feet by 5 feet
Invert elevation	575	MSL
Trash racks	2	Upper & lower
Riprap	300	Tons

TABLE 12-1 (Cont'd)

Feature	Measurement	Unit of Measure
Gatewell Structure		
Gate	1	2'x2' slide gate
Elevation	580	MSL
Riprap	225	Tons
Hemi-Marsh Levee		
Length	6,100	Feet
Crown width	10	Feet
Sideslopes	4:1	Horizontal:Vertical
Level of protection	2	Year event
Elevation	586	MSL
Embankment volume	10,000	Cubic yards
Crushed stone	1,800	Tons
Well Station		
Depth	125	Feet
Casing diameter	12	Inches
PVC well screen		
Length	20	Feet
Diameter	12	Inches
Submersible pump		
Capacity	1,000	gpm
Depth	50	Feet
Discharge pipe		
Diameter	6	Inches
Length	10	Feet
Concrete splash apron		
Length	8	Feet
Width	8	Feet
Thickness	4	Inches
Power		
Electric	3	Phase
Transformer	22.5 (3-phase)	kVA
Overhead primary feeder length	2,000	Feet
Platform	1	Each
Service road		
Length	2,000	Feet
Width w/shoulder	12	Feet
Crushed stone	480	Tons

TABLE 12-2

Rating Table for Water Control Structure
Operated Between December 15 to March 31

Sabula Gage	Sabula Elev.	Feet of (1) Gate Opening >	Flow (cfs) 10	8	6	4	2
10.73	583.0		135	105	78	48	21
10.93	583.2		135	108	80	50	22
11.13	583.4		145	112	82	53	24
11.33	583.6		158	124	90	58	26
11.53	583.8		169	136	99	63	28
11.73	584.0		188	149	108	69	30
11.93	584.2		199	158	114	73	31
12.13	584.4		208	166	120	78	33
12.33	584.6		214	172	125	80	34
12.53	584.8		229	178	129	83	35
12.73	585.0		230	185	135	86	35
12.93	585.2		245	192	141	89	35
13.13	585.4		255	199	146	93	38
13.33	585.6		263	206	152	97	42
13.53	585.8		265	215	158	101	44
13.73	586.0		285	224	164	105	46

(1) Feet of gate opening is assuming both of the 5-foot gates will be opened.

TABLE 12-3

Rating Table for Water Control
Structure Operated Year-Round

Sabula Gage	Sabula Elev.	Feet of (1) Gate Opening >	Flow (cfs) 10	8	6	4	2
10.73	583.0		120	82	60	38	17
10.98	583.25		125	100	72	47	20
11.23	583.5		125	100	72	47	20
11.48	583.75		156	120	88	56	23
11.73	584.0		164	129	94	60	25
11.98	584.25		173	137	100	64	27
12.23	584.5		182	144	104	67	28
12.48	584.75		197	155	112	71	31
12.73	585.0		210	167	121	77	35
12.98	585.25		220	173	127	80	36
13.23	585.5		225	177	130	82	36
13.48	585.75		243	194	141	88	38
13.73	586.0		255	202	147	93	40

(1) Feet of gate opening is assuming both of the 5-foot gates will be opened.

13. PROJECT PERFORMANCE ASSESSMENT

The purpose of this section is to summarize monitoring of the project and to present proposed data collection for the purpose of evaluating project performance. The principal types, purposes, and responsibility of project monitoring and data collection are presented in table 13-1. The plans for post-construction field observations and quantitative measurements are present in tables 13-2 and 13-3, respectively.

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 thru Cooperative Agreements or Corps.	HREP/Sponsor	See Table 13-2.
Design	Data Collection for Design	Include quantification of project objectives, design of project, and development of performance evaluation plan.	Corps	Corps	HREP	See Table 13-2.
Construction	Construction Monitoring	Assess construction impacts; assure permit conditions are met.	Corps	Corps	HREP	See State Section 401 Stipulations.
Post-Construction	Performance Evaluation Monitoring	Determine success of project as related to objectives.	Corps (quantitative) and sponsor (field observations).	Field station or sponsor thru Cooperative Agreement, sponsor thru O&M, or Corps.	HREP/Sponsor	--
	Biological Response Monitoring	Evaluate predictions and assumptions of habitat unit analysis. Studies beyond scope of performance evaluation.	Corps	Corps	HREP	--

TABLE 13-2

Resource Monitoring and Data Collection Summary [1]

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase		Design Phase		Post-Const. Phase		Pre-Project Phase	Design Phase	Post-Const. Phase	Pre-Project Phase	Design Phase	Post-Const. Phase		
Type Measurement	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR	APR-SEP	OCT-MAR							Sampling Agency	Remarks
POINT MEASUREMENTS														
Water Quality Stations [2]													COE	
Turbidity	--	--	2W	M	2W	M								
Secchi Disk Transparency	2W	--	2W	--	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	--	2W	M	2W	M								
Percent Cloud Cover	--	--	2W	M	2W	M								

TABLE 13-2 (Cont'd)

Type Measurement	WATER QUALITY DATA: Pre-Project Phase APR-SEP	Pre-Project Phase OCT-MAR	Design Phase APR-SEP	Design Phase OCT-MAR	Post-Const. Phase APR-SEP	Post-Const. Phase OCT-MAR	ENGINEERING DATA: Pre-Project Phase	Design Phase	Post-Const. Phase	NATURAL RESOURCE DATA: Pre-Project Phase	Design Phase	Post-Const. Phase	Sampling Agency	Remarks
POINT MEASUREMENTS														
Elutriate Test Stations [3]			1										COE	
Column Settling Stations [4] Column Settling Analysis								1					COE	
Boring Stations [5] Geotechnical Borings								1					COE	
Fish Stations [6] Electrofishing										1	1	1	IDOC	
TRANSECT MEASUREMENTS														
Sedimentation Transects [7] Hydrographic Soundings							1		5Y				COE	
Vegetation Transects [8] Vegetation Survey												5Y	COE	
Levee System Cross section at even 500-foot intervals and profile of cross dike and perimeter levee.								1	5Y					
AREA MEASUREMENTS														
Mapping [9] Aerial Photography										1		5Y	COE	

Legend

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

TABLE 13-2 (Cont'd) (Notes)

1 See plate 35 for active monitoring sites

2 Water Quality Stations

W-M532.6Q
W-M534.8R
W-M536.1Q
W-M534.6V

3 Elutriate Stations

E-M532.1O
E-M533.1H
E-M534.9R
E-M534.6F

4 Column Settling Stations (Design Phase)

C-M532.9F
C-M534.5H
C-M534.7H
C-M534.7I

5 COE Technical Borings

Station Code	Geotechnical Boring
B-M531.7D	SL-90-1
B-M532.2D	2
B-M532.4E	3
B-M532.5D	4
B-M532.9F	5
B-M533.2H	6
B-M534.8L	7
B-M534.9I	8
B-M534.5H	9
B-M534.6F	10
B-M533.3J	11
B-M533.3I	12
B-M534.7F	13
B-M534.7I	14
	SL-92-1
	2
	3

TABLE 13-2 (Cont'd) (Notes)

6 Fish Stations

Station Code	USFWS#
F-M531.8Q	1
F-M533.5N	2
F-M534.8R	3
F-M532.3U	4
F-M533.5M	5
F-M531.90	6

7 Sedimentation Transects

S-M536.1Q to S-M535.6Y
S-M535.2Q to S-M535.1Y
S-M534.8N to S-M534.8Y
S-M534.5M to S-M534.6X
S-M533.9I to S-M533.9X
S-M532.2P to S-M532.2Y
S-M531.90 to S-M531.8V
S-M531.6J to S-M531.6V

8 Vegetation Transects (Post-Construction Phase)

V-M536.1Q to V-M535.6Y
V-M535.2Q to V-M535.1Y
V-M534.8N to V-M534.8Y
V-M534.5M to V-M534.6X
V-M533.9I to V-M533.9X
V-M532.30 to V-M532.4P
V-M532.2P to V-M532.2Y
V-M531.90 to V-M531.8V
V-M531.6J to V-M531.6V

Sampling locations will be at equal 1/3 increments on each vegetative range. Excluding range end points, sampling will be every 300 feet on the upstream range and every 200 feet on the downstream range for a total of 6 points, 3 on each range.

9 Mapping (Post-Construction Phase)

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

In addition to the point, transect, and areal measurements identified, the natural resource monitoring plan includes the completion of habitat assessments 5, 25, and 50 years after project completion.

TABLE 13-3

Post-Construction Evaluation Plan

Goal	Objective	Enhancement Feature	Unit	Enhancement Potential			Feature Measurement Reference Table 13-2	Annual Field Observations by Site Manager
				Year 0 Without Alternative	Year X With Alternative[1]	Year 50 Target With Alternative		
Enhance Aquatic Habitat	-Improve water quality for fish	Inlet structure/ excavated channel	DO (mg/l)	<5.0 during critical periods	--	>5.0 at all times	Perform water quality tests	Describe fishing conditions
	-Maintain backwater lake	Perimeter levee and cross dike	Lin. ft. of eroded levee	44,880	--	0	Perform levee system transects & profiles	Describe effects of erosion
Enhance Wetland Habitat	-Provide reliable food source in Upper Lake for migratory birds	Upper Lake water control	Acres of vegetation	0	--	500	Perform vegetation transects	Estimate acres of emergent/submergent vegetation
	-Provide reliable food source in Lower Lake for migratory birds	Hemi-marsh	Acres of vegetation	0	--	108	"	"

14. COST ESTIMATES

Cost estimates developed for this section of the report were based on review of the project plans, discussion with the design team members, and review of costs for similar construction projects.

a. **Project Estimate.** A detailed estimate of project design and construction costs is presented in table 14-1.

b. **Estimated Annual Operation and Maintenance Costs.** A detailed cost estimate for operation, maintenance, repair, and rehabilitation costs is presented in table 14-2.

c. **Estimated Post-Construction Monitoring Costs.** Table 14-3 shows estimated annual monitoring costs for the project.

TABLE 14-1

SPRING LAKE
REHABILITATION AND ENHANCEMENT EMP
MISSISSIPPI RIVER MILE 532 - 536

PROJECT COST SUMMARY
DIVISION OF COST

OCTOBER 1992
REVISED APRIL 1993

ACCOUNT	FEATURE	CURRENT WORKING ESTIMATE (CWE)		FULLY FUNDED ESTIMATE (FFE)	
		FEDERAL	NON-FEDERAL	FEDERAL	NON-FEDERAL
06.	FISH AND WILDLIFE FACILITIES	$3,990,000		$4,466,619	
30.	PLANNING, ENGINEERING AND DESIGN	837,000		901,264	
31.	CONSTRUCTION MANAGEMENT	416,000		525,117	
	SUBTOTAL	$5,243,000	0	$5,893,000	0

SUMMARY OF COST APPORTIONMENT

	CWE	FFE
1. TOTAL COST SUMMARY		
TOTAL PROJECT COSTS	$5,243,000	$5,893,000
NON-FEDERAL LANDS & DAMAGES	0	0
TOTAL PROJECT COSTS SEE NOTE 1.	$5,243,000	$5,893,000
2. NON-FEDERAL COSTS		
REQUIRED NON-FEDERAL CASH CONTRIBUTION	0	0
NON-FEDERAL LANDS & DAMAGES	0	0
TOTAL NON-FEDERAL COST	0	0
3. FEDERAL COST		
TOTAL FEDERAL COSTS	$5,243,000	$5,893,000
GENERAL DESIGN, DEFINITE PROJECT REPORT	(592,000)	(592,000)
REMAINING FEDERAL COSTS	$4,651,000	$5,301,000

NOTES:

1. TOTAL PROJECT COST IS 100% FEDERAL COST; PROJECT LANDS ARE GOVERNMENT OWNED.
2. CONSTRUCTION SCHEDULED FOR SEP 94 - SEP 97. FULLY FUNDED ESTIMATE (FFE) IS BASED ON MIDPOINT OF CONSTRUCTION DATE OF APR 96, RESULTING IN INFLATION FACTORS OF 1.2623 FOR SALARIES AND 1.1195 FOR ALL OTHER COSTS PER B MEMO, 7 FEB 92, SUBJECT: FACTORS FOR UPDATING STUDY/PROJECT COST ESTIMATES FOR THE FY 1994 BUDGET SUBMISSION.

TABLE 14-1 (Cont'd)

SPRING LAKE
REHABILITATION AND ENHANCEMENT EMP
PROJECT COST ESTIMATE
OCTOBER 1992 PRICE LEVEL
REVISED APRIL 1993

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	CON %	REASONS
06.	FISH AND WILDLIFE FACILITIES							
06.-.-.-	UPPER LAKE PERIMETER LEVEE REHABILITATION							
06.0.1.B	STRIPPING	15000	CY	1.45	21,750	2,175	10.0%	1,5
06.0.1.B	UNSUITABLE SOIL EXCAVATION	9000	CY	3.10	27,900	5,580	20.0%	1,5
06.0.1.B	CLEARING AND GRUBBING	24	ACR	2,965.00	71,160	10,674	15.0%	1,5
06.0.1.B	SEEDING	24	ACR	1,950.00	46,800	4,680	10.0%	3,6
06.0.1.B	EMBANKMENT FILL, PLACE AND SHAPE	41000	CY	4.25	174,250	34,850	20.0%	1
	TOTAL				341,860	57,959		
06.-.-.-	CROSS DIKE REHABILITATION							
06.0.1.B	STRIPPING	7000	CY	1.45	10,150	1,015	10.0%	1,5
06.0.1.B	UNSUITABLE SOIL EXCAVATION	4900	CY	3.10	15,190	3,038	20.0%	1,5
06.0.1.B	CLEARING AND GRUBBING	7	ACR	2,990.00	20,930	3,140	15.0%	1,5
06.0.1.B	SEEDING	8.5	ACR	1,950.00	16,575	1,658	10.0%	3,6
06.0.1.B	EMBK FILL, PLACE & SHAPE	6000	CY	7.35	44,100	8,820	20.0%	1
06.0.C.B	CRUSHED STONE	1700	CY	25.60	43,520	8,704	20.0%	1,5
06.0.A.-	MOB/DEMOB	1	LS	24,000.00	24,000	6,000	25.0%	2,5
	TOTAL				174,465	32,374		
06.-.-.-	LOWER LAKE PERIMETER LEVEE REHABILITATION							
06.0.1.B	STRIPPING	24500	CY	1.60	39,200	3,920	10.0%	1,5
06.0.1.B	UNSUITABLE SOIL EXCAVATION	16000	CY	3.45	55,200	11,040	20.0%	1,5
06.0.1.B	CLEARING AND GRUBBING	39	ACR	3,560.00	138,840	20,826	15.0%	1,5
06.0.1.B	SEEDING	39	ACR	1,950.00	76,050	7,605	10.0%	3,6
06.0.1.B	EMBANKMENT FILL, PLACE & SHAPE	105500	CY	4.30	453,650	113,413	25.0%	1
06.0.1.B	RIPRAP	2000	CY	45.25	90,500	18,100	20.0%	1,5
06.0.C.B	CRUSHED STONE	250	CY	25.60	6,400	1,280	20.0%	1,5
	TOTAL				859,840	176,184		
06.-.-.-	UPPER LAKE INTERIOR LEVEE CONSTRUCTION							
06.0.1.B	UNSUITABLE SOIL EXCAVATION	6000	CY	5.10	30,600	7,650	25.0%	1,5
06.0.1.B	EMBANKMENT FILL, PLACE & SHAPE	75700	CY	5.40	408,780	102,195	25.0%	1,5
06.0.1.B	SEEDING	2.5	ACR	1,950.00	4,875	975	20.0%	3,6
06.0.C.B	CRUSHED STONE	1050	CY	25.60	26,880	5,376	20.0%	1,5
06.0.A.-	DISASSEMBLE/ASSEMBLE FLTG PLANT	1	LS	4,500.00	4,500	900	20.0%	2,5
06.0.1.B	MOB/DEMOB PORT BARGES	1	LS	15,600.00	15,600	5,347	34.3%	2,5
	TOTAL				491,235	122,443		

TABLE 14-1 (Cont'd)

SPRING LAKE
REHABILITATION AND ENHANCEMENT EMP
PROJECT COST ESTIMATE
OCTOBER 1992 PRICE LEVEL
REVISED APRIL 1993

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	CON %	REASONS
06.-.-.-	INLET/WATER CONTROL STRUCTURE							
06.0.5.B	EMBANKMENT FILL	1100	CY	7.70	8,470	847	10.0%	1,6
06.0.5.B	EXCAVATION	1700	CY	3.55	6,035	604	10.0%	1
06.0.5.C	STRUCTURAL CONCRETE	275	CY	510.00	140,250	14,025	10.0%	6
06.0.5.B	DEWATERING	1	LS	95,100.00	95,100	19,020	20.0%	1
06.0.5.E	SLIDE GATES	2	EA	14,000.00	28,000	2,800	10.0%	5,6
06.0.5.E	TRASH RACKS	2	EA	3,810.00	7,620	1,143	15.0%	6
06.0.5.B	RIPRAP	250	CY	45.25	11,313	2,263	20.0%	1,5
06.0.5.B	TIMBER PILING	2640	LF	13.40	35,376	10,613	30.0%	4,6
06.0.5.B	SAND BEDDING	235	CY	27.65	6,498	1,300	20.0%	4,6
	TOTAL				338,661	52,613		
06.-.-.-	PRECAST 24" GATEWELL & RIPRAP							
06.0.5.B	GATEWELL AND 24"RCP & CRADLE	1	LS	76,900.00	76,900	15,380	20.0%	1,5,6
06.0.5.B	RIPRAP	140	CY	45.25	6,335	1,267	20.0%	1,5
	TOTAL				83,235	16,647		
06.-.-.-	UPPER LAKE STOP LOG STR. (CELL A)							
06.0.5.B	DEWATERING	1	LS	17,400.00	17,400	5,220	30.0%	1
06.0.5.B	EXCAVATION	650	CY	3.35	2,178	218	10.0%	1,5
06.0.5.B	STRUCTURAL BACKFILL	300	CY	13.60	4,080	816	20.0%	1,6
06.0.5.C	STRUCTURAL CONCRETE	56	CY	465.00	26,040	6,510	25.0%	5,6
06.0.5.-	STOP LOGS	1	LS	1,560.00	1,560	390	25.0%	3,6
06.0.5.E	HEAVY DUTY GRATING	81	SF	64.00	5,184	778	15.0%	6
06.0.5.E	GUARD RAIL	82	LF	53.50	4,387	658	15.0%	3,6
06.0.5.B	STAFF GAGE	1	EA	600.00	600	90	15.0%	6
	TOTAL				61,429	14,679		
06.-.-.-	UPPER LAKE STOP LOG STR. (CELL B)							
06.0.5.B	DEWATERING	1	LS	13,100.00	13,100	3,930	30.0%	1
06.0.5.B	EXCAVATION	830	CY	3.30	2,739	274	10.0%	1,5
06.0.5.B	STRUCTURAL BACKFILL	400	CY	13.10	5,240	1,048	20.0%	1,6
06.0.5.C	STRUCTURAL CONCRETE	65	CY	465.00	30,225	7,556	25.0%	5,6
06.0.5.-	STOP LOGS	1	LS	2,130.00	2,130	533	25.0%	3,6
06.0.5.E	HEAVY DUTY GRATING	81	SF	64.00	5,184	778	15.0%	6
06.0.5.E	GUARD RAIL	82	LF	53.50	4,387	658	15.0%	3,6
06.0.5.B	STAFF GAGE	1	EA	600.00	600	90	15.0%	6
	TOTAL				63,605	14,866		

TABLE 14-1 (Cont'd)

SPRING LAKE
REHABILITATION AND ENHANCEMENT EMP
PROJECT COST ESTIMATE
OCTOBER 1992 PRICE LEVEL
REVISED APRIL 1993

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	CON %	REASONS
06.-.-.-	UPPER LAKE STOP LOG STR. (CELL C)							
06.0.5.B	DEWATERING	1	LS	13,100.00	13,100	3,930	30.0%	1
06.0.5.B	EXCAVATION	830	CY	3.30	2,739	274	10.0%	1,5
06.0.5.B	STRUCTURAL BACKFILL	400	CY	13.10	5,240	1,048	20.0%	1,6
06.0.5.C	STRUCTURAL CONCRETE	65	CY	465.00	30,225	7,556	25.0%	5,6
06.0.5.-	STOP LOGS	1	LS	2,130.00	2,130	533	25.0%	3,6
06.0.5.E	HEAVY DUTY GRATING	81	SF	64.00	5,184	778	15.0%	6
06.0.5.E	GUARD RAIL	82	LF	53.50	4,387	658	15.0%	3,6
06.0.5.B	STAFF GAGE	1	EA	600.00	600	90	15.0%	6
	TOTAL				63,605	14,866		
06.-.-.-	HEMI MARSH STOP LOG STRUCTURE							
06.0.5.B	DEWATERING	1	LS	13,100.00	13,100	3,930	30.0%	1
06.0.5.B	EXCAVATION	830	CY	3.30	2,739	274	10.0%	1,5
06.0.5.B	STRUCTURAL BACKFILL	400	CY	13.10	5,240	1,048	20.0%	1,6
06.0.5.C	STRUCTURAL CONCRETE	65	CY	465.00	30,225	7,556	25.0%	5,6
06.0.5.-	STOP LOGS	1	LS	2,130.00	2,130	533	25.0%	3,6
06.0.5.E	HEAVY DUTY GRATING	81	SF	64.00	5,184	778	15.0%	6
06.0.5.E	GUARD RAIL	82	LF	53.50	4,387	658	15.0%	3,6
06.0.5.B	STAFF GAGE	1	EA	600.00	600	90	15.0%	6
	TOTAL				63,605	14,866		
06.-.-.-	HEMI MARSH LEVEE CONSTRUCTION							
06.0.1.B	UNSUITABLE SOIL EXCAVATION	4150	CY	3.10	12,865	1,930	15.0%	1
06.0.1.B	EMBANKMENT FILL, PLACE & SHAPE	10000	CY	5.00	50,000	7,500	15.0%	1,5
06.0.1.B	SEEDING	5	ACR	1,950.00	9,750	975	10.0%	3,6
06.0.C.B	CRUSHED STONE	1200	CY	25.60	30,720	6,144	20.0%	1,5
	TOTAL				103,335	16,549		

TABLE 14-1 (Cont'd)

SPRING LAKE
REHABILITATION AND ENHANCEMENT EMP
PROJECT COST ESTIMATE
OCTOBER 1992 PRICE LEVEL
REVISED APRIL 1993

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	CON %	REASONS
06.-.-.-	PUMP STATION							
06.0.5.B	DEWATERING	1	LS	111,800.00	111,800	22,360	20.0%	1
06.0.5.B	EXCAVATION	1200	CY	3.65	4,380	438	10.0%	1,5
06.0.5.C	STRUCTURAL CONCRETE	140	CY	595.00	83,300	20,825	25.0%	5,6
06.0.5.E	SLIDE GATE	1	EA	14,000.00	14,000	1,400	10.0%	6
06.0.5.E	TRASH RACK ASSEMBLIES	1	LS	6,400.00	6,400	1,280	20.0%	6
06.0.5.C	48" DISCHARGE PIPE, RCP & CRADLE	90	LF	255.00	22,950	3,443	15.0%	3,6
06.0.5.B	RIPRAP	535	CY	45.25	24,209	4,842	20.0%	1,5
06.0.5.R	BURIED PRIMARY FEEDER &TRANSFMS	1	LS	60,000.00	60,000	9,000	15.0%	3,6
06.0.5.R	MISC. ELECTRICAL	1	LS	27,600.00	27,600	4,140	15.0%	3,6
06.0.5.R	ELECTRICAL PLATFORM ASSEMBLY	1	EA	7,890.00	7,890	1,184	15.0%	3,6
06.0.5.E	SUBMERSIBLE PUMPS	2	EA	63,250.00	126,500	18,975	15.0%	3,6
06.0.5.B	TIMBER PILING	1550	LF	13.40	20,770	6,231	30.0%	4,6
06.0.5.-	MATERIAL HANDLING TO SITE	1	LS	9,700.00	9,700	970	10.0%	1,5
06.0.5.B	BACKFILL	1176	CY	7.70	9,055	1,358	15.0%	4,6
06.0.5.E	MISC. METALS	1	LS	22,670.00	22,670	3,401	15.0%	4,6
	TOTAL				551,224	99,846		
06.-.-.-	ACCESS ROAD							
06.0.1.B	CLEARING AND GRUBBING	0.6	ACR	2,965.00	1,779	267	15.0%	1,5
06.0.1.B	GRADE ACCESS ROAD	2700	SY	1.00	2,700	1,350	50.0%	1,6
06.0.C.B	CRUSHED STONE	320	CY	25.60	8,192	1,638	20.0%	1,5
	TOTAL				12,671	3,255		
06.-.-.-	NEW WELL							
06.0.5.B	NEW WELL	1	LS	47,800.00	47,800	16,730	35.0%	3,6
06.0.5.R	ELECTRICAL POWER	1	LS	32,100.00	32,100	11,235	35.0%	3,6
	TOTAL				79,900	27,965		
06.-.-.-	OVERFLOW AREAS							
06.0.1.B	RIPRAP	667	CY	45.25	30,182	6,036	20.0%	1,5
	SUBTOTAL, FISH AND WILDLIFE FACILITIES				$3,318,851			
	CONTINGENCIES; AVERAGE OF	20.2%				$671,149		
06.	TOTAL, FISH AND WILDLIFE FACILITIES				$3,990,000			

REASONS FOR CONTINGENCIES: 1. UNKNOWN SITE CONDITIONS, 2. UNKNOWN HAUL DISTANCE, 3. UNIT PRICE UNKNOWN,
4. QUANTITY UNKNOWNS, 5. DIFFICULT SITE ACCESS, 6. UNKNOWN FINAL DESIGN

TABLE 14-1 (Cont'd)

SPRING LAKE
REHABILITATION AND ENHANCEMENT EMP
PROJECT COST ESTIMATE
OCTOBER 1992 PRICE LEVEL
REVISED APRIL 1993

ACCOUNT CODE	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	CON %	REASONS
06.	TOTAL, FISH AND WILDLIFE FACILITIES				$3,990,000			
30.	PLANNING, ENGINEERING AND DESIGN				$837,000			
	DEFINITE PROJECT REPORT			592,000				
	PLANS AND SPECIFICATIONS			200,000				
	ENGINEERING DURING CONSTRUCTION			45,000				
31.	CONSTRUCTION MANAGEMENT				$416,000			
	CONTRACT ADMINISTRATION			153,000				
	REVIEW OF SHOP DRAWINGS			15,000				
	INSPECTION AND QUALITY ASSURANCE			248,000				
				TOTAL	$5,243,000			

TABLE 14-2

Estimated Annual Operation and Maintenance Costs
(March 1992 Price Level)

	Qty	Unit	Unit Cost ($)	Total Cost ($)
Operation				
Pump station energy (1)	24,018	kWh	.0583	1,400
Pump station operation	40	hr	50.00	2,000
Well station energy (1)	2,340	kWh	.0641	150
Well station operation	8	hr	50.00	400
Stoplog structure operation	40	hr	50.00	2,000
Water control structures operation	20	hr	50.00	1,000
			Subtotal	6,950
Maintenance				
Levee inspection	40	hr	23.00	920
Levee mowing (once yr. min.)	77.5	ac	45.00	3,488
Embankment erosion control	40	hr	100.00	4,000
Riprap replacement	120	ton	28.00	3,360
Access road crushed stone	20	ton	20.00	400
Debris removal	40	hr	50.00	2,000
Pump station maintenance	20	hr	100.00	2,000
Pump replacements (yr 25 annual 33K/pump)	1	job	sum	5,808
Stoplog replacement	20	ea	10.00	200
Water control structures maintenance	30	hr	100.00	3,000
Well replacement (yr 25 annual 11K/pump)	1	job	sum	968
			Subtotal	26,144
Rehabilitation (2)				--
			Total	33,094

(1) Unit cost is average cost, including basic service.

(2) Rehabilitation 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 storms or flood events.

TABLE 14-3

Estimated Post-Construction Annual Monitoring Costs ($)
(March 1992 Price Level)

Item	Annual Cost ($)
Water Quality Data [1]	6,400
Engineering Data [1]	3,000
Natural Resource Data [1]	2,000
Subtotal	11,400
Contingencies	1,710
Subtotal	13,110
Planning, Engineering, Design [2]	1,300
Contract Management	1,000
Total	15,410

[1] Reference tables 13-2 and 13-3.

[2] Includes cost of annual evaluation report.

15. REAL ESTATE REQUIREMENTS

a. **General.** All project features are located on Government-owned General Plan land under Corps of Engineers' administration, which is managed by the USFWS for fish and wildlife purposes and by the Corps of Engineers for all other purposes. These lands are managed under a Cooperative Agreement between the Department of Interior, USFWS, and the Department of the Army, dated February 14, 1963.

b. **Local Cooperation Agreements/Cost-Sharing.** Funding for the initial construction of the proposed project will be 100 percent Federal. Since the project lands are all managed as part of the Upper Mississippi River National Wildlife and Fish Refuge system, 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 -
>
> (3) such activities are located on lands managed as a national wildlife refuge.

A draft memorandum of agreement between the Corps of Engineers and the USFWS has been included in this report as Appendix C. Estimated operation and maintenance costs are presented in table 14-2.

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
Distribution of Project Appraisal Report to participating agencies for review	Dec 91
Submit Draft DPR to Corps of Engineers, North Central Division, and participating agencies for review	May 92
Formal distribution of DPR for public and agency review	Jan 93
Submit final and public-reviewed DPR to North Central Division	May 93
Receive plans and specifications funds	May 93
Obtain construction approval by Assistant Secretary of the Army (Civil Works)	Oct 93
Submit final plans and specifications to North Central Division and participating agencies for review and approval	Mar 94
Obtain approval of plans and specifications	Apr 94
Advertise contract (subject to availability of funds)	Jul 94
Award contract	Sep 94
Complete construction	Sep 97

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 Illinois, and other affected agencies. The Rock Island District will submit the subject DPR; program funds; finalize plans and specifications; complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and inspection.

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 USFWS will ensure that operation and maintenance functions, described in table 14-2 of this report, are performed 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. Authorization has been provided to the Corps of Engineers for construction on USFWS-owned lands.

The recommendations provided via the Final Coordination Act Report are the result of extensive interagency coordination efforts throughout the planning process.

c. **Illinois Department of Conservation.** The ILDOC, the non-Federal proponent of the project, has provided technical and other advisory assistance during all phases of the project and will continue to provide assistance during project implementation.

18. COORDINATION, PUBLIC VIEWS, AND COMMENTS

a. **Coordination Meetings**. Close coordination between Corps of Engineers, USFWS, and ILDOC personnel was effected during the planning period. A listing of significant meetings is shown below:

(1) August 24, 1989 - Off-site meeting conducted with CENCR, ILDOC, and USFWS, to scope proposed project.

(2) June 12, 1990 - Off-site meeting conducted with CENCR, ILDOC, and USFWS to develop design alternatives.

(3) March 29, 1990 - Off-site meeting conducted with CENCR, ILDOC, and USFWS to discuss feasibility of alternatives.

(4) October 1, 1991 - Off-site meeting conducted with CENCR, ILDOC, and USFWS to discuss feasibility of alternatives.

(5) February 5, 1992 - Off-site meeting conducted with CENCR, ILDOC, and USFWS to discuss feasibility of alternatives.

(6) November 4, 1992 - Off-site informational open house meeting conducted with CENCR and USFWS to provide the general public information of project features and status.

b. **Environmental Review Process**. This project meets the requirements of the National Environmental Policy Act, as evidenced by the Environmental Assessment which is an integral part of the report and the Finding of No Significant Impact.

19. CONCLUSIONS

Spring Lake has experienced deterioration of its habitat value due to sedimentation and water level and flow management limitations. Breaches in the perimeter levee system have prohibited annual maintenance. Areas adjacent to breach sites also have deteriorated. Waterfowl usage of this area has declined. Fisheries have been severely impacted by reduced water quality.

The proposed construction features meet the project goals of enhancing aquatic and wetland habitat. By improving water control in the Upper Lake, establishing a water-controlled hemi-marsh in the Lower Lake, and providing sources of dissolved oxygen for the Lower Lake, the project area and its environments should realize improved fisheries and expanded migratory bird usage through the 50-year project life expectancy.

Complete implementation of these project features will result in the following habitat outputs: reliable food sources for migratory birds and habitat diversity in both the Upper and Lower Lakes; improved water quality for fish in the Lower Lake; and maintenance of the Lower Lake as a backwater lake of the Mississippi River.

20. RECOMMENDATIONS

I have weighed the accomplishments to be obtained from this habitat rehabilitation and enhancement project against its cost and have considered the alternatives, impacts, and scope of the proposed project. In my judgment, this project, as proposed, justifies expenditure of Federal funds. I recommend that the Secretary of the Army for Civil Works approve construction to include: restoration of 8.5 miles of existing levee and cross dike; development of a 3-celled managed marsh and moist-soil area; water control structures; and the improvements for a hemi-marsh in the Lower Lake.

The estimated construction cost of this project is $4,651,000. Total project cost estimate, including general design, is $5,243,000. All project costs are to be 100 percent Federal costs.

At this time, I further recommend that funds in the amount of $200,000 be allocated for the preparation of plans and specifications.

for Thomas G.
Albert J. Kraus
Colonel, U.S. Army
District Engineer

21. FINDING OF NO SIGNIFICANT IMPACT

Having reviewed the information contained in this Environmental Assessment, I find that the proposed Spring Lake Rehabilitation and Enhancement project will have no significant adverse impacts on the environment. This action is not a major Federal action, and, therefore, preparation of an Environmental Impact Statement (EIS) is not required. This decision may be reevaluated if developments warrant it.

Factors that were considered in making the determination that an EIS is not required were:

a. Implementation of the selected plan will benefit nationally significant waterfowl and wetland resources.

b. The proposed action is complementary to the Spring Lake Refuge's goals and objectives.

c. There were no significant adverse comments received on the project from public review.

d. Adverse effects on fish and wildlife resources from construction are temporary.

24 May 1993
Date

Albert J. Kraus
Colonel, U.S. Army
District Engineer

22. LITERATURE CITED

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GOALS FOR MANAGEMENT OF FISH AND WILDLIFE RESOURCES AND HABITAT REHABILITATION AND ENHANCEMENT FOR POOLS 11-22

ATTACHMENT 1

DRAFT 3-2-87

GOALS FOR MANAGEMENT OF FISH AND WILDLIFE RESOURCES AND HABITAT REHABILITATION AND ENHANCEMENT FOR POOLS 11-22

The Upper Mississippi River Management Act of 1986 was enacted "to ensure the coordinated development and enhancement of the Upper Mississippi River System". The Act declared that it is the intent of Congress "to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system. Congress further recognizes that the system provides a diversity of opportunities and experiences. The system shall be administered and regulated in recognition of its several purposes". The Act specifically recommends several programs. They are a) habitat rehabilitation and enhancement, b) long-term resource monitoring, c) computerized inventory and analysis system, d) recreation projects and economic analysis, and e) navigation traffic monitoring. A second lock at Lock and Dam 26 (Replacement) is also authorized. This report will address the habitat rehabilitation and enhancement program (HREP) for pools 11 through 22 (Guttenberg, Iowa to Saverton, Missouri).

BACKGROUND

As stated in the Master Plan, "the Habitat Rehabilitation and Enhancement Program would consist of numerous enhancement efforts aimed at the implementation of techniques to preserve, protect, and restore habitat that is deteriorating due to natural and man-induced activities. The enhancement effort would extend for a ten-year period in order to adequately evaluate and understand the effectiveness of techniques and measures being applied to protect, enhance, or rehabilitate habitat". The Upper Mississippi River Basin Association (UMRBA) has recommended that the following eligibility criteria be used to develop and select habitat rehabilitation and enhancement projects:

* Projects must meet the defined program objectives of:

    a) protecting, restoring, or improving fish and wildlife habitat that has deteriorated, is threatened, or will be threatened as a result of human-induced or natural impacts;

    b) assuring that adverse impacts on the fish and wildlife resource of the river system are avoided, minimized, rectified or eliminated over time, or compensated for;

    c) address structural and nonstructural measures for environmental enhancement through long-term resource monitoring efforts and available documents;

    d) address first solutions related to navigation impacts including navigation traffic and operation and maintenance of the navigation system;

e) address second other human-induced impacts not related to navigation, and;

f) address last naturally occurring impacts.

* Projects must be located along the main channel, side channel, backwaters, or mouth of tributaries within the UMRS.

* Projects must provide public benefits and be sponsored by a federal, state, or local governmental agency.

* Projects must not involve rehabilitation of facilities for which maintenance is or could be provided under existing federal or state programs unless additional habitat benefits can be demonstrated.

* Projects which include the following characteristics should be encouraged:

a) minimal operation and maintenance costs,

b) minimal land acquisition,

c) auxiliary benefits to navigation or water quality

The above will be used by the states and the U.S. Fish and Wildlife Service in selecting projects to be submitted to the Corps of Engineers. However, the Corps are selecting projects first according to need and efficacy of the proposed project, and secondly, according to what we might be able to learn from it. They have also stated that reality demands consideration of factors such as geographic dispersion and readiness to proceed. Further the Corps of Engineers' General Plan for the Environmental Management Program states that applicable techniques are backwater dredging, dike and levee construction, island construction, bank stabilization, side channel opennings/closures, wing and closing dam modifications, aeration and water control systems, waterfowl nesting cover, and acquisition of wildlife lands. The Corps does not specifically endorse as HREP projects pool level management, altering the navigation channel, tow operation restrictions, change in dredging practices, floating breakwaters, or improved fleeting design because they fall outside their conventional activities. However, the Corps has recently acknowledged that these innovative measures might result in long-term protection of UMRS habitat. Therefore, proposed projects which include such measures will not be categorically excluded from consideration, but the policy and technical feasibility of each of these measures will be investigated on a case-by-case basis and recommended only after consideration of system wide effects.

The act authorizes appropriations of $124.6 million. The Corps of Engineers has requested that the five state conservation agencies of the UMRS and the U.S. Fish and Wildlife Service submit potential habitat rehabilitation and enhancement projects for funding. However, this piecemeal-like submission process ignors a major objective of Congress to manage the UMRS as an ecosystem. It is in this regard the Fish and Wildlife Interagency Committee has become involved.

ROLE OF FWIC

As recommended by GREAT II, the Fish and Wildlife Interagency Committee (FWIC) is to provide coordination regarding fish and wildlife matters associated with physical river modifications and river management studies and investigations. In light of this charge, the FWIC decided that their role in the HREP is to integrate ecosystem management into the project selection process. Their first task was to define fish and wildlife management objectives for Pools 11 through 22 and identify potential management objectives in these pools. This information was then used to identify potential construction alternatives for each objective. The remainder of this report summarizes the work at four regional task force meetings held in October and November 1986.

GOALS AND OBJECTIVES FOR POOLS 11-22

The FWIC will strive to preserve the Upper Mississippi River floodplain for the enjoyment and use of this and future generations. Emphasis will be placed on the protection and conservation of fish, wildlife and their habitats. [The FWIC recognizes that sedimentation is the River's greatest problem and that watershed protection and land treatment would provide the greatest benefits in protection and management of the River's fish and wildlife resources. However, the FWIC views this as a responsibility of the U.S. Department of Agriculture and not a function of the EMP.]

Goal I - Environmental Quality - To preserve and enhance the environmental quality, wild character and natural beauty of the River's floodplain ecosystem.

Goal II - Migratory Birds - To provide the life requisits of waterfowl and other migratory birds.

Goal III - Fisheries and Aquatic Resources - To provide the life requirements of fish and other aquatic plant and animal life occuring naturally along or in the Upper Mississippi River.

Goal IV - Other Wildlife - To provide the life requirements of resident wildlife species.

Goal V - Endangered Species - To conserve, restore and enhance federal and state protected species and the habitats upon which they depend.

Table 1 lists the objective for each goal, example species for management, and potential habitat projects that may contribute toward achievement of the objective.

Pool Application

After management goals and objectives were discussed, the task forces identified existing management activities and additional objectives that could be achieved in the backwater complexes of each pool. Possible construction alternatives were also identified. Tables 2-13 summarize the results of this discussion.

Summary of Habitat Management Needs in Pools 11-22

Tables 14, 15, and 16 summarize the work of the task forces. Table 14 lists the areas evaluated, potential management objectives, and relative importance of management of an area to the management of the pool. Table 15 summarizes the management alternatives identified and the management objectives they may address. Finally, Table 16 lists highly important areas for management in the Rock Island District.

Recommendations

1. The information contained in this report be used in HREP project development so ecosystem management is integrated in the program.

2. Alternatives be developed to consider reclamation of marginal lands, reducing the impacts of navigation, improving benthos habitat, and protecting threatened or endangered species.

3. Engineering research should be focused on identifying additional alternatives to achieve stated objectives.

Table 1. FWIC for fish and wildlife management objectives for Pools 11-22.

Objectives	Example Management Species	Implementation Alternatives	Relative Importance in Management of Pools (H-High, M-Medium, L-Low) 11	12-15	16-19	20-22
Goal I - Environmental Quality						
1. To reduce the adverse impacts of sedimentation and turbidity that enters the River ecosystem.	All	dredging, levees, upland sediment control, dikes, flow regulation, shoreline protection, measures to minimize tow impacts.	H	H	H	H
2. To eliminate or reduce the adverse impacts of water quality degradation.	All	flow regulation, wetland development, dredging.	H	H	H	H
3. To protect and reclaim fish and wildlife habitat from encroachments.	All	acquisition of floodplain lands, reclaim marginal agricultural lands, reclaim expired cabin lease land.	H-M	H-M	H	L-M
4. To reduce the adverse impacts of navigation and channel maintenance to the River ecosystem.	All	island creation, levees, dikes, mussel bed creation, breakwaters, shoreline protection, revegetation, improved fleeting design, water level stabilization and or control, side channel closures, flow diversion structures, main channel realignment, speed limits.	H	H	H	H
5. To preserve, create, and/or manage representative ecotypes.	See Goals II,III, IV,&V	species specific management	H	H	H	H
Goal II - Migratory Birds						
6. To support species that are in critical conditions and to achieve population and distribution objectives.	canvasback, tundra swan, see Goal V	wetland development (emersed and submersed vegetation)	H	H	H	H
7. To maintain or improve the habitat of migratory birds using the River.	All migratory birds	wetland development and management, island creation, artificial roost structures.[11/]	H	H	H	H
8. To maintain or increase the current population and distribution of colonial nesting birds.	cormorant, herons, egret, see Goal V.	forestry management, sand nesting habitat development, wetland development and management, artificial roost sites.[11/]	M-H	H	H	H
9. To increase production of historically nesting birds.	wood ducks, raptors, see Goal V.	erosion control, nesting cavity structures, artificial structures[11/] wetland development, forestry management, land acquisition, island creation.	H	H	H	L-M

Table 1, continued.

Objectives	Example Management Species	Implementation Alternatives	Relative Importance in Management of Pools (H-High, M-Medium, L-Low) 11	12-15	16-19	20-22
Goal III - Fisheries and Aquatic Resources						
10. To maintain and enhance the habitat of fish on the River.	All fish	selective dredging, substrate enhancement, wetland development and management, flow regulation, tow speed limits.	H	H	H	H
11. To maintain and enhance habitat of mussels and other invertebrates on the River.	All mussels	substrate enhancement, fleeting design.	H	H	H	H
12. To maintain and enhance the habitat of other aquatic life on the River.	aquatic plants	island creation, breakwaters, wetland development.	H	H	M	M
13. To increase critical fish wintering, spawning, and nursery habitat.	catfish, paddlefish, walleye, largemouth bass, buffalo sp.	selective dredging, flow enhancement, habitat structures, wetland development	H	H	L	H
Goal IV - Other Wildlife						
14. To maintain and enhance the habitat of furbearers on the River.	muskrats, beavers, otters, raccoons.[12/]	forestry management, wetland development and management, water level control, stocking.	H	H	H	M
15. To maintain and enhance the habitat of other resident wildlife.	reptiles, amphibians, white-tailed deer, turkey	forestry management, mast production	L	L	L	L
Goal V - Endangered Species						
16. To protect and enhance the River habitat and to maintain or increase its use by native species historically found in the area.	See Appendix A	artificial structures[11/] mussel substrate enhancement, species specific management	H	H	H	H
17. To carry out the recommendation of federal endangered or threatened species recovery plans applicable to the River.	See Appendix A	enhance eagle roost sites (i.e bank stabilization, plant tree buffers, maintain forest openning for access) enhance eagle feeding areas (i.e. improve prey habitat, increase number of perches) enhance nesting habitat (buffers, artificial structures) increase distribution of endangered mussels (i.e. translocation, substrate enhancement.	H	H	H	H

11/ Creation of natural structures through forestry management practices is preferred.
12/ Raccoon management not preferred where nuisance problems exist.

ble 10. Areas in Pools 11-22 with high relative importance for habitat management.

Pool	Area	# of Potential Management Objectives	Potential Project Submitted	Management Objectives Addressed By Proposed Project
11	Middle Pool 11	7	X	
	Lower Pool 11	6	X	
12	Nine Mile/Frentress/Tippy	6	X	
	Main Channel Border	2		
	Lower 12	5		
13	Pleasant Creek	11	X	
	Green Island	7	X	
	Brown's Lake/Pin Oak	6	X	
	Miller's Lake/Savanna Bay	8	X	
	Spring Lake	10	X	
	Thomson/Potter's Marsh	7	X	
	Elk River	11	X	
14	Middle Pool 14	6		
16	Milan Bottoms	12		
	Andalusia Island	16		
	Andalusia Refuge	12	X	
17	Louisa Division	16	X	
	Lake Odessa	16	X	
18	Boston Bay	16		
	Keithsburg Unit	16		
	Oquawka Refuge	16		
19	Land Acquisition			
20	Dam 19	1		
	Lower 20	6		
21	Gardner Division	8	X	
	Quincy Bay	3		
	Cottonwood Island	3	X	
	Monkey Chute	3	X	
22	Texas Chute/Goose Island	1		
	Beebe/Armstrong/Turtle/Whitney	5		
	Bay Island	5	X	

Table 4. Existing and potential management in Pool 13.

Area	River Mile	Existing Management	Potential Management Objectives	Possible Habitat Rehabilitation or Enhancement Project	Trade-offs	Data Needs
Upper 13/Crooked Slough	551-556.7	forestry management, contract fishing	unknown			field inspection
Pleasant Creek	548.5-551	closed area, forestry management, farm program	1. Reduce sedimentation, 2. Improve water quality, 6. Bird population objectives, 7. Improve bird habitat, 9. Increase bird nesting, 10. Enhance fish habitat, 12. Enhance aquatic habitat, 13. Increase critical habitat, 14. Increase furbearers, 15. Increase resident wildlife, 16. Enhance Endangered species.	a. dike-moist soil unit b. water control c. selective dredging d. moist soil units e. land acquisition f. increased forestry management g. create nesting cavities.	c. user conflicts	bathymetry
Maquoketa River	548.5		1. Reduce sedimentation, 2. Improve water quality	a. upland treatment b. sediment trap		
Green Island	546-548.5	moist soil, grassland, forestry management	1. Reduce sedimentation, 2. Improve water quality, 7. Improve bird habitat, 12. Enhance aquatic habitat	a. dike, moist soil units b. water control c. selective dredging		
Brown's Lake/Pin Oak ∞	542-546		1. Reduce sedimentation, 2. Improve water quality, 7. Improve bird habitat, 10. Enhance fish habitat, 12. Enhance aquatic habitat, 13. Increase critical habitat, 14. Increase furbearers.	a. deflection dike b. water control c. selective dredging d. upland treatment e. improve access to Pin Oak		
Miller's Lake/Savanna Bay	539-545	grassland management	1. Reduce sedimentation, 2. Improve water quality, 7. Improve bird habitat, 10. Enhance fish habitat, 12. Enhance aquatic habitat, 13. Increase critical aquatic habitat	a. selective dredging b. reroute creek c. move navigation channel		
Keller's Island	536-540		1. Reduce sedimentation, 2. Improve water quality, 10. Improve fish habitat, 12. Enhance aquatic habitat, 14. Increase furbearers.	a. partial closure of Running Slough b. selective dredging		
Sabula Lakes	534-536		7. Improve bird habitat, 8. Increase colonial nesters, 10. Increase fish habitat.	a. dredge middle Sabula Lake b. repair dike	possible loss of forest habitat	

Table 4, continued.

Spring Lake	531-536	closed area moist soil management, grassland management farm program, forestry management	1. Reduce sedimentation, 2. Improve water quality, 3. Reclaim habitat, 6. Distribut ducks, 7. Improve bird habitat, 8. Increase colonial nesters, 9. Increase bird nesting, 10. Increase fish habitat, 14. Increase furbearers, 15. Increase resident wildlife, 16. Enhance endangered species.	a. dike repair b. water control c. sub-impoundments d. establish emergent vegetation e. deepwater dredging f. open springs g. stabilize water levels h. remove woody vegetation i. land acquisition j. moist soil unit k. vegetation control	a. fishing access from river.	a. potential creation of a silt trap.
Elk River	526-532	closed area farm program (to be converted to grassland soon)	1. Reduce sedimentation, 2. Improve water quality, 3. Reclaim habitat, 7. Improve bird habitat, 9. Increase bird nesting, 10. Increase fish habitat, 13. Increase critical fish habitat, 14. Increase furbearers, 15. Increase resident wildlife, 16. Enhance endangered species.	a. deflection dike b. selective dredging c. water control d. riprap e. partial closure structure f. islands	loss of floodway	hydraulics
Thomson/Potter's Marsh	524-526	grassland management farm program	1. Reduce sedimentation, 2. Improve water quality, 7. Improve bird habitat, 10. Improve fish habitat, 12. Enhance aquatic habitat, 14. Maintain furbeares. 14. Maintain furbearers.	a. dredging b. blasting potholes c. develop resting cover d. alternatives to reduce sedimentation e. remove vegetation f. closure dike g. water control h. causeway redesign i. barrier islands		hydraulics sediment quality
Lower 13	522.5-524		1. Reduce sedimentation, 2. Improve water quality, 9. Increase bird nesting habitat, 12. Enhance aquatic habitat.	a. barrier islands		Evaluate

Table 14. Summary of existing and proposed management objectives for Pools 11-22.

				Goal I - Environmental Quality					Goal II - Migratory Birds				Goal III-Fisheries & Aquatic Resources				Goal IV - Other Wildlife		Goal V - Endangered Species	
				1	2	3	4	5	6	7	8	9	10	11	12	13	15	14	16	17
Pool	River Mile	Area	Relative Importance	Reduce Sedimentation and Turbidity	Improve Water Quality	Reclaim Fish & Wildlife Habitat	Reduce Impacts of Navigation	Preserve Representative Ecotypes	Supports Population or Distribution Objectives	Improve Bird Habitat	Increase Population & Distribution of Colonial Nesters	Increase Bird Nesting	Improve Fish Habitat	Improve Benthos Habitat	Enhance Other Aquatic Habitat	Increase Critical Habitat	Increase Species Diversity & Abundance of Resident Wildlife	Maintain Furbearer Populations	Protect & Enhance Native Species Habitat	Carryout Recovery Plans
11	614-615	St. Paul District	M	P	P				E	P			P							
	603.5-614	Upper Pool 11	M-L	P	P	P			E				P							
	592-603.5	Middle Pool 11	M	P	P	P	P	P	E	P			P	P						
	587-592	Lower Pool 11	M	P	P	P	P			P		P	P							
12	582-582.8	Dam/Tailwater	L										P							
	580.5-582	Ham Island/Peosta	M		P	P				P								P		
	569-580.5	Nine Mile/Trentress/Tippy	M	P	P			P				E	P				E			
	556.7-569	Lower Pool 12	M	P	P			P		P			P							
	All	Main Channel Border	M												P	P				
13	551-556.7	Upper 13/Crooked Slough	?																	
	548.5-551	Pleasant Creek	M	P	P				E	P		P	P		P	P	E	P	P	
	548.5	Maquoketa R.	M	P	P															
	546-548.5	Green Island	M	P	P				E	E			P		P	P		P		
	542-546	Borwn's Lake/Pin Oak	M	P	P					P			P		P	P				
	539-542	Miller's Lake/Savanna Bay	M	P	P					P		E	P		P	P	E			
	536-540	Keller's Island	M	P	P								P		P			P		
	534-536	Sabula Lakes	L							P	P		P							
	531-536	Spring Lake	M	P	P	P			E	E	P	E	P		P	P	E	P	P	
	526-532	Elk River	M	P	P	P			E	E		P	P			P	P	P	P	
	524-526	Thomson/Potter's Marsh	M	P	P					P			P		P		E	P		
	522.5-524	Lower 13	L	P	P							P			P					
14	513-522.5	Upper 14	M	P	P								P							
		Middle 14	M	P	P				E	P			P			P				
		Lower 14	L																	
15	483-493	Pool 15	L					P									P			
16	478-483	Upper 16	M	P	P								P		P		P			
	477-478	Milan Bottoms	M	P	P	P		P	P	P	P	P	P			P	E	P		
	476-477	Enchanted Island	L	P	P								P		P					
	463-476	Andalusia Slough	M	P	P								P	P	P		P			
	463-476	Andalusia Island	M	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	

Table 15. Summary of management objectives that could be met with example implementation alternatives in Pools 11-22.

Alternative Management	Goal I - Environmental Quality: 1 Reduce Sedimentation and Turbidity	2 Improve Water Quality	3 Reclaim Fish & Wildlife Habitat	4 Reduce Impacts of Navigation		5 Preserve Representative Ecotypes	Goal II - Migratory Birds: 6 Supports Population or Distribution Objectives	7 Improve Bird Habitat	8 Increase Population & Distribution of Colonial Nesters		9 Increase Bird Nesting	Goal III - Fisheries & Aquatic Resources: 10 Improve Fish Habitat	11 Improve Benthos Habitat	12 Enhance Other Aquatic Habitat	13 Increase Critical Habitat	Goal IV - Other Wildlife: 14 Increase Species Diversity & Abundance of Resident Wildlife	15 Maintain Furbearer Populations	Goal V - Endangered Species: 16 Protect & Enhance Species Habitat	17 Carryout Recovery Plans	# of Objectives Addressed
1. Dredging	x	x	x					x	x			x			x					7
2. Levees	x	x	x	x				x	x		x			x			x	x		10
3. Upland sediment control	x	x						x	x			x		x			x			2
4. Dikes	x	x	x	x				x	x					x			x			5
5. Flow regulation	x	x		x				x				x								4
6. Shoreline protection	x	x		x							x	x	x	x						5
7. Tow mitigation	x			x				x				x								3
8. Wetland development		x	x			x	x	x	x		x	x		x	x		x			11
9. Land Acquisition		x	x								x									2
10. Reclaim marginal agricultural land or cabin sites	x	x	x					x			x									1
11. Island creation	x	x	x	x				x	x		x	x		x		x				9
12. Mussel bed creation				x									x		x			x	x	5
13. Breakwaters	x	x	x	x				x						x						2
14. Revegetation		x	x	x				x								x				2
15. Fleeting design	x	x	x	x				x					x							2
16. Channel alignment	x	x	x	x				x												1
17. Nesting structures								x	x		x							x		4
18. Roost structures								x											x	2
19. Forestry management			x			x		x	x		x					x	x	x	x	7
20. Sand nesting development								x	x		x					x				4
21. Substrate enhancement												x	x	x	x			x	x	5
22. Mast production																x				1
23. Spawning structures												x			x					

EMP HABITAT PROJECT RANKING PROCEDURES

ATTACHMENT 2

EMP Habitat Project Ranking Procedures
(Revised)

Program Objectives

(YES or NO) Projects must meet the defined program objectives identified by the UMRBA:

1. Protecting, restoring, or improving fish and wildlife habitat that has deteriorated, is threatened, or will be threatened as a result of human-induced or natural impacts;

2. Assuring that adverse impacts on the fish and wildlife resource of the river system are avoided, minimized, rectified or eliminated over time, or compensated for;

3. Address structural and nonstructural measures for environmental enhancement through long-term resource monitoring efforts and available documents;

4. Address first solutions related to navigation impacts including navigation traffic and operation and maintenance of the navigation system;

5. Address second other human-induced impacts not related to navigation, and;

6. Address last naturally occurring impacts.

* Projects must be located along the main channel, side channel, backwaters, or mouth of tributaries within the UMRS.

* Projects must provide public benefits and be sponsored by a federal, state, or local governmental agency.

* Projects must not involve rehabilitation of facilities for which maintenance is or could be provided under existing federal or state programs unless additional habitat benefits can be demonstrated.

* Projects which include the following characteristics should be encouraged:

a) minimal operation and maintenance costs,

b) minimal land acquisition,

c) auxiliary benefits to navigation or water quality

Goals and Objectives for Pools 11-22

(YES or NO) **Projects must meet one or more of the Goals and Objectives identified by the FWIC:**

Goal I - Environmental Quality - To preserve and enhance the environmental quality, wild character and natural beauty of the River's floodplain ecosystem.

Goal II - Migratory Birds - To provide the life requisites of waterfowl and other migratory birds.

Goal III - Fisheries and Aquatic Resources - To provide the life requirements of fish and other aquatic plant and animal life occuring naturally along or in the Upper Mississippi River.

Goal IV - Other Wildlife - To provide the life requirements of resident wildlife species.

Goal V - Endangered Species - To conserve, restore and enhance federal and state protected species and the habitats upon which they depend.

Table 1 lists the objective for each goal, example species for management, and potential habitat projects that may contribute toward achievement of the objective.

Resource Problems

Projects will be assessed as to whether they do or do not address the following resource problems. For ranking purposes, projects which do address the problems will be given the points noted in the parentheses and those which do not will receive no points for that problem.

(5) **Reduce or rectify backwater sedimentation:** Backwater is interpreted to be an existing impoundment within the floodplain of the Mississippi River System. Reducing or rectifying sedimentation involves a degree of blockage of incoming sediments or deepening of the basin to set back the sedimentation rate. It includes sedimentation from all sources and causes.

(4) **Improve water quality:** Water quality improvement generally includes improving water depth or flow to result in overall higher dissolved oxygen levels and/or decreased tubidity.

(3) **Increase in important habitat:** This problem focuses on the lack of important habitat to targeted fauna such as waterfowl nesting/feeding areas, fish spawning/wintering areas. It includes increasing the productivity of existing habitat, increasing the longevity of existing habitat and/or creating habitat where previously it was limited.

(2) **Improved habitat protection:** This refers to regulatory measures which are taken to protect lands as, for example, creating a "closed area" boundary on a refuge.

(1) **Increase in public land base:** Land ownership actually changes hands under this category, going from private to public.

Ranking Factors

Projects will be assessed as to whether they address the following ranking factors ranging from a high of 3 points down to -3 points for adverse impacts.

(0-3) **Fishery benefits:** Rating 3 - Direct fishery benefits as a major project purpose including rehabilitation of a backwater through increasing flow or depth and/or placement of fish habitat improvement structures (e.g. Miller's Lake).

Rating 2 - Significant improvements to water quality, enabling spawning or prolonging nursery or overwintering benefits (e.g. Potter's Marsh).

Rating 1 - Some improvements to fish habitats by placing riprap or fish structures, for example (e.g. Elk River).

Rating 0 - No fishery benefits, no improvement of water quality (e.g. Princeton Refuge, a levee improvement project which will not reduce flood frequency or increase the interior depth through dredging for borrow).

(0-3) **Wildlife benefits:** Rating 3 - Direct wildlife benefits as a major project purpose including creation of wildlife habitat or intensive management (e.g. Turkey Bottoms, Pleasant Creek).

Rating 2 - Significant improvements to wildlife habitat including increasing the food base or prolonging the life of an area (e.g. Bay Island).

Rating 1 - Some wildlife benefits as in increased water clarity and therefore an increase in aquatic vegetation as waterfowl food source (e.g. Peosta/Molo).

Rating 0 - No wildlife benefits (no examples).

(0-3) **Habitat diversity:** Rating 3 - Major increase in habitat diversity as in flooding a farm field to create a wetland (e.g. Turkey Bottoms or island creation, Pool 11).

Rating 2 - Significant increase in habitat diversity as in dredging out potholes in shallow waters or possibly creating islands (e.g. Lower Spring Lake).

Rating 1 - Some increase in habitat diversity as in planting mast producers or putting up wood duck boxes (e.g. Gardner Division).

Rating 0 - No increase in habitat diversity (no examples).

(0-3) **Innovative/ experimental:** Rating 3 - A very innovative idea (e.g. island creation, Pool 11 or Peoria Lake).

Rating 2 - Some innovative ideas involved in the development of the project (e.g. Upper Spring Lake or Potter's Marsh).

Rating 1 - Some small attempt at a new idea (Lower Spring Lake).

Rating 0 - Tried and true (no examples).

(0-3) **Longevity:** Rating 3 - One of the project purposes is to increase the life of the habitat (e.g. all the levee protection projects).

Rating 2 - Project is not completely protected but habitats will result in a longer life span than without project (e.g. island creation, Pool 11).

Rating 1 - Not expected to last too long beyond natural conditions (e.g. Huron Island).

Rating 0 - Not worth the trouble (no examples).

(0-3) **Maintenance:** Rating 3 - Very little maintenance required (e.g. island creation, Pool 11 or Huron Island).

Rating 2 - Some maintenance required (e.g. Turkey Bottoms).

Rating 1 - Regular maintenance required (no examples).

Rating 0 - Heavy maintenance requirements (no examples).

(0-3) **Socioeconomic:** Rating 3 - High socioeconomic benefits provided, likely near populous areas, permits public access (e.g. Bay Island).

Rating 2 - Significant benefits provided, most likely in the form of increased production of fish and or waterfowl (Turkey River Bottoms).

Rating 1 - Few socioeconomic benefits provided (e.g. Pleasant Creek).

Rating 0 - No socioeconomic benefits (no examples).

[0-(-3)]**Adverse Impacts:** Rating 0 - No significant adverse impacts (e.g. Turkey River Bottoms or Bay Island).

Rating -1 - Some adverse impacts, may be due to difficulty in dredged material disposal or encroachment into wetlands from levee building (e.g. island creation, Pool 11).

Rating -2 - Adverse impacts expected, may result form changing hydraulics which may actually increase sedimentation rate (no examples).

Rating -3 - Severe adverse impacts resulting from project construction (no examples).

The ranking points will be added to those of the resource problems for an overall score. The scores are then broken into "High", "Medium" and "Low" categories and forwarded to the River Resources Coordinating Team for their approval.

..bjectives	Example Management Species	Implementation Alternatives	Relative Importance in Management of Pools (H-High, M-Medium, L-Low) 11	12-15	16-19	20-22
..ronmental Quality						
..e the adverse impacts of ..tation and turbidity that ..s the River ecosystem.	All	dredging, levees, upland sediment control, dikes, flow regulation, shoreline protection, measures to minimize tow impacts.	H	H	H	H
..o eliminate or reduce the adverse impacts of water quality degradation.	All	flow regulation, wetland development, dredging.	H	H	H	H
. To protect and reclaim fish and wildlife habitat from encroachments.	All	acquistion of floodplain lands, reclaim marginal agricultural lands, reclaim expired cabin lease land.	H-M	H-M	H	L-M
. To reduce the adverse impacts of navigation and channel maintenance to the River ecosystem.	All	island creation, levees, dikes, mussel bed creation, breakwaters, shoreline protection, revegetation, improved fleeting design, water level stabilization and or control, side channel closures, flow diversion structures, main channel realignment, speed limits.	H	H	H	H
. To preserve, create, and/or manage representative ecotypes.	See Goals II,III, IV,&V	species specific management	H	H	H	H
..oal II - Migratory Birds						
. To support species that are in critical conditions and to achieve population and distribution objectives.	canvasback, tundra swan, see Goal V	wetland development (emersed and submersed vegetation)	H	H	H	H
. To maintain or improve the habitat of migratory birds using the River.	All migratory birds	wetland development and management, island creation, artificial roost structures.[11/]	H	H	H	H
..3. To maintain or increase the current population and distribution of colonial nesting birds.	comorant, herons, egret, see Goal V.	forestry management, sand nesting habitat development, wetland development and management, artificial roost sites.[11/]	M-H	H	H	H
..9. To increase production of historically ..ing birds.	wood ducks, raptors, see Goal V.	erosion control, nesting cavity structures, artificial structures[11/] wetland development, forestry management, land acquisition, island creation.	H	H	H	L-M
Goal III - Fisheries and Aquatic Resources						
10. To maintain and enhance the habitat of fish on the River.	All fish	selective dredging, substrate enhancement, wetland development and management, flow regulation, tow speed limits.	H	H	H	H
11. To maintain and enhance habitat of mussels and other invertebrates on the River.	All mussel	substrate enhancement, fleeting design.	H	H	H	H
12. To maintain and enhance the habitat of other aquatic life on the River.	aquatic plants	island creation, breakwaters, wetland development.	H	H	M	M
13. To increase critical fish wintering, spawning, and nursery habitat.	catfish, paddlefish, walleye, largemouth bass, buffalo sp.	selective dredging, flow enhancement, habitat structures, wetland development	H	H	L	H
Goal IV - Other Wildlife						
14. To maintain and enhance the habitat of furbearers on the River.	muskrats, beavers, otters, raccoons.[12/]	forestry management, wetland development and management, water level control, stocking.	H	H	H	M
15. To maintain and enhance the habitat of other resident wildlife.	reptiles, amphibians, white-tailed deer, turkey	forestry management, mast production	L	L	L	L
Goal V - Endangered Species						
16. To protect and enhance the River habitat and to maintain or increase its use by native species historically found in the area.	See Appendix A	artificial structures[11/] mussel substrate enhancement, species specific management	H	H	H	H
17. To carry out the recommendation of ..deral endangered or threatened ..cies recovery plans applicable the River.	See Appendix A	enhance eagle roost sites (i.e bank stabilization, plant tree buffers, maintain forest openning for access) enhance eagle feeding areas (i.e. improve prey habitat, increase number of perches) enhance nesting habitat (buffers, artificial structures) increase distribution of endangered mussels (i.e. translocation, substrate enhancement.	H	H	H	H

11/ Creation of natural structures through forestry management practices is preferred.
12/ Raccoon management not preferred where nuisance problems exist.

FWIC Ranking for EMP-HREPs 1/

Ranking Year: 1988

Design Year: 1990

			RESOURCE PROBLEMS						RANKING FACTORS													
	TOTAL ACRES AFFECTED	ESTIMATED COST ($M)	SEDIMENTATION	WATER QUALITY	IMPORTANT HABITAT	HABITAT PROTECTION	PUBLIC LAND BASE		FISH BENEFITS	WILDLIFE BENEFITS	HABITAT DIVERSITY	INNOVATIVE	LONGEVITY	MAINTENANCE	SOCIOECONOMIC/RECREATION	ADVERSE IMPACTS		TOTAL SCORE	RELATIVE BENEFIT	RELATIVE SCORE	RANK	OBJECTIVES ADDRESSED
MAXIMUM VALUE			**5**	**4**	**3**	**2**	**1**		**3**	**3**	**3**	**3**	**3**	**3**	**3**	**0**						
Turkey River Bottoms			0	0	3	0	1		1	3	3	2	3	2	2	0		20			M	
Island Creation Pool 11			0	4	3	0	0		3	3	3	3	2	3	2	-1		25			H	
Upper Spring Lake			0	4	3	0	0		1	3	3	2	3	3	2	0		24			H	
Lower Spring Lake			5	4	3	0	0		3	3	2	1	3	1	2	0		27			H	
Thompson Lake (IL River)																						
Huron Pool 18			5	4	3	0	0		3	2/1	2	1	2	3	2	0		26/ 27			H	

1/ This is a partial list. All projects currently being monitored, designed, or constructed by the Rock Island District, with the exception of certain projects developed early on in the program, have been evaluated and ranked using the same procedure (see Report, Section 2, page 8).

CORRESPONDENCE

APPENDIX A

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX A
CORRESPONDENCE

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Illinois Historic Preservation Agency

Old State Capitol Springfield, Illinois 62701 (217) 782-4836

Suite 4-900 State of Illinois Center 100 W. Randolph Chicago, IL 60601 (312) 814-1409

217/785-4997

CARROLL COUNTY IHPA LOG #910621022TRW
Rehabilitation and Enhancement Project
Spring Lake
Mississippi River Pool 13

September 16, 1991

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
District Engineer
U.S. Army Engineer District, Rock Island
Attention: Planning Division
Clock Tower Building - Post Office Box 2004
Rock Island, Illinois 61204-2004

Gentlemen:

Thank you for the opportunity to comment on the Draft Scope of Work for Phase I Archaeological Survey for the Spring Lake Rehabilitation Project (EMP). Our staff has reviewed this document and have determined that adequate consideration was given to cultural resources in the planning stages of this project.

We have one recommendation for addition to the scope of work. A section stipulating that the contractor will provide a map with the location of Giddings probes and Sampling tube tests would be helpful in evaluating the Phase I work. This addition could be located in Section 5.3c.

If you have any further questions, please contact Thomas R. Wolforth, Staff Archaeologist, Illinois Historic Preservation Agency, Old State Capitol, Springfield, Illinois 62701, 217/785-1279.

Sincerely,

Theodore W. Hild
Deputy State Historic
Preservation Officer

TWH:TRW:bb1084A/85

Illinois Department of Transportation
Division of Water Resources
3215 Executive Park Drive / P.O. Box 19484 / Springfield, Illinois / 62794-9484

February 20, 1992

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

Attention: Planning Division

Gentlemen:

Thank you for your February 3, 1992 letter concerning the Spring Lake rehabilitation project being planned within the Mississippi River backwater. An Illinois Department of Transportation, Division of Water Resources (IDOT/DWR) permit will be required for this project.

The proposed construction activities within the public body of water will be permissible if determined to be in the public interest. It is anticipated that the project's impacts on public interests will be addressed in the Definite Project Report.

Maintenance and repair to preserve the design capacity and function of levees and dikes existing in serviceable condition on July 1, 1985 will not require IDOT/DWR authorization. The remaining structures should be designed and constructed in a manner that will preserve floodway conveyance and storage capacities for all floods up to and including the 100-year frequency event.

If you have any questions or comments, feel free to contact Jay Peters of my staff at 217/782-3862.

Sincerely,

Dennis L. Kennedy, P.E., Head
Technical Analysis and Permit Unit

DLK:JSP:lmt

Brent Manning
Director

John W. Comerio
Deputy Director

Bruce F. Clay
Assistant Director

Illinois Department of Conservation
life and land together

LINCOLN TOWER PLAZA • 524 SOUTH SECOND STREET • SPRINGFIELD 62701-1787
CHICAGO OFFICE • ROOM 4-300 • 100 WEST RANDOLPH 60601
[redacted]

February 24, 1992

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

RE: Spring Lake Habitat Rehabilitation and Enhancement Project

Dear Sirs:

This is in reply to your request for our preliminary comments regarding the above referenced project and information on state-listed endangered and threatened species that may be affected by the project.

Several Illinois endangered and threatened species are known to occur in the vicinity of Spring Lake. These include double-crested cormorants, bald eagle, yellow-headed blackbird, and river otter. These species use the Spring Lake area for a significant part of their life cycle. Other state-listed species, such as osprey and great egrets, are likely to be seen as migrants through the area or using Spring Lake as a feeding area.

Double-crested cormorants nest in dead trees standing in the Mississippi River just west of the lower unit levee. In 1991, the birds used a tree located in the SE 1/4 of Section 34, T24N, R3E. The Illinois Department of Conservation and U.S. Fish and Wildlife Service have placed cormorant nest structures in the southwest corner of the lower unit (SW 1/4 of Section 27) in an attempt to provide increased nesting opportunities for this species.

Bald eagles have nested at Spring Lake since at least 1988. In that year, a nest located near the center of the upper unit produced two young. This nest was destroyed in 1989 when the tree in which it was built fell during a storm. In 1990 and 1991, a pair of eagles nested in a tree on the lower unit levee in Section

34. This nest is being monitored to determine if it is active in 1992.

Male yellow-headed blackbirds were seen displaying in an emergent wetland on the northeast side of the upper unit in 1991. Nesting by this species was not confirmed in 1991. An effort will be made in the spring of 1992 to determine whether this species is reproducing at Spring Lake.

River otters use the entire Spring Lake vicinity. Most visual observations of otters have been in the upper unit. An adult otter with young was seen in the upper unit in 1988.

The work described in your February 3 letter has the potential to provide benefits for most of these state-listed species, but may also have adverse effects if it is not carefully planned and executed. Most disturbance can be avoided through timing work for periods outside of the nesting season of the three bird species. Appropriate timing may, however, preclude work in some areas during substantial portions of the year.

The bald eagle presents the greatest challenge in scheduling of work on the perimeter levee. Eagles often are present on their nesting territory as early as December and may remain in the vicinity as late as July to rear their young. If the pair of eagles that has nested on the levee occupies this territory in 1992 and subsequent years, it may be necessary to schedule levee rehabilitation along the southern part of the lower unit to occur only between August and November. Specific recommendations for protection of the eagle nesting site should be developed by those most familiar with the situation at Spring Lake.

Restrictions on the timing of work needed to protect the nesting bald eagles will likely also avoid disturbance of double-crested cormorants. The cormorants most often nest in the same general area as is occupied by the eagles. The long period of occupancy by bald eagles includes the entire season during which cormorants are likely to be sensitive to disturbance.

If nesting by yellow-headed blackbirds is confirmed in the upper unit in 1992, there may also be a need to schedule work in this portion of Spring Lake to avoid disturbance during the most sensitive months. We will provide 1992 data on this species to be considered in planning levee rehabilitation.

Direct effects on river otters are unlikely so long as den sites are not disturbed by construction activities. The creation of more diverse fish habitats should have long-term benefits for otters through enhancing their available food supply.

Thank you for allowing us to review the plans for rehabilitation of Spring Lake. We look forward to additional opportunities to provide information that will protect state-listed species in the area as the project proceeds.

Sincerely,

Carl Becker, Chief
Division of Natural Heritage

CB:GK

cc: Director Manning

Illinois Historic Preservation Agency

Old State Capitol Springfield, Illinois 62701 (217) 782-4836

Suite 4-900 State of Illinois Center 100 W. Randolph Chicago, IL 60601 (312) 814-1409

217/785-4997

CARROLL COUNTY
Rehabilitation and Enhancement Project
Spring Lake
Mississippi River Pool 13

IHPA LOG #910621022TRW
American Resources Group, Ltd.
Acres: 178.0 Sites: 0 (new sites)

March 13, 1992

Mr. Dudley M. Hanson, P.E.
Chief, Planning Division
District Engineer
U.S. Army Engineer District, Rock Island
Attention: Planning Division
Clock Tower Building - Post Office Box 2004
Rock Island, Illinois 61204-2004

Gentlemen:

Thank you for submitting the results of the archaeological reconnaissance. Our comments are required by Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties".

Our staff has reviewed the archaeological Phase I reconnaissance report performed for the project referenced above.

The Phase I survey and assessment of the archaeological resources appear to be adequate. Accordingly, we have determined, based upon this report, that no significant historic, architectural, and archaeological resources are located in the project area.

Please retain this letter in your files as evidence of compliance with Section 106 of the National Historic Preservation Act of 1966, as amended.

Sincerely,

Theodore W. Hild
Deputy State Historic
Preservation Officer

TWH:TRW:bb1179A/35

cc: Michael McNerney, ARG-Ltd.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUN 25 1992

REPLY TO THE ATTENTION OF:
ME-19J

John R. Brown, Colonel
District Engineer
U.S. Army Corps of Engineers;
Rock Island District
ATTN: Planning Division
Clock Tower Building
P.O. Box 2004
Rock Island, Illinois 61204

Dear Colonel Brown:

This is in response to your letter of May 26, 1992 requesting our review of the Upper Mississippi River System Environmental Management Program Definite Project Report (R-12D) With Integrated Environmental Assessment, involving the Spring Lake Rehabilitation and Enhancement Project, on the Mississippi River in Illinois. Based on our review we offer the following comments.

The project proposes to restore wetland and aquatic habitat in the Spring Lake Wildlife Refuge. Although the project proposes long term net benefits, the focus of this review will be assessment of the possible adverse impacts that may be foreseeable in the interim.

As a consequence to construction operations, disturbances will be inevitable. If the disturbance is abrupt, or substantial, given the high ecological diversity within areas subject to enhancements, numerous species could potentially be displaced into adjacent habitats. These species may not be adequately accommodated, either spatially, or in specific needs. Inundation of additional, or new species could stress adjacent habitats. Among the species that could be displaced are the endangered species that have been identified as residing within/near the project area, and a significant number of migratory birds that rely on Spring Lake. Therefore, the ecological capacity of adjacent habitats should be evaluated and plans should be designed to allow an easy transitional period.

Disturbances may effect critical periods for certain species. A plan should be devised to phase construction so conflict with critical periods -- e.g., migratory periods, breeding cycles, etc., can be avoided. Assessment of critical periods should emphasize the endangered species, the dominant species, and interdependent species (i.e., food chain).

The enhancement project's benefits are targeted at only a few species. Although these target species were chosen to represent a broad range of species, in terms of habitat requirements, certain species may have been excluded. Proposed enhancements will require alterations which may drastically alter existing habitats for non-target species. A specific example is the dike revetment that will encompass the inner margin of the project. This revetment could seriously disturb present shoreline habitats. Effected species may be individually significant; or may have an interdependent role with target species, or have an undetermined importance. Also, non-target species displacement could present ancillary impacts, as was discussed previously. Therefore, non-target species should be evaluated, and the proposal should consider methods to minimize impacts to such species.

In areas that will require vegetative soil stabilization (i.e., top surface of the dike, access ways, etc.), selection of vegetation should consider creating transitional zones with the structural components that boarder the project, so the barrier-effect, between habitats within the project and those adjacent to the project, might be minimized. Locally indigenous species should be assessed for this purpose.

We appreciate the opportunity to provide our comments on the Spring Lake Rehabilitation and Enhancement Project. Should you have any questions, please contact Pete Rogers, of my staff, at 312-886-9842.

Sincerely yours,

for William D. Franz, Acting Chief
Planning and Assessment Branch

United States Department of the Interior

IN REPLY REFER TO:

FISH AND WILDLIFE SERVICE
Upper Mississippi River Refuge Complex
51 East 4th Street
Winona, Minnesota 55987

July 13, 1992

Mr. Jerry Skalak
Project Manager
Rock Island District, Corps of Engineers
Clock Tower Building, P. O. Box 2004
Rock Island, Illinois 61204-2004

Dear Mr. Skalak:

Enclosed is a signed compatibility determination for the selected alternative discussed in the draft Definite Project Report with Integrated Environmental Assessment (R-12D) for the Spring Lake (Pool 13) Habitat Rehabilitation and Enhancement Project.

If you have any questions please contact Keith Beseke, Environmental Management Program Coordinator at (507)452-4232.

Sincerely,

James R. Fisher

James Fisher
Complex Manager

Enclosure

cc: Savanna District
Chuck Gibbons, RO-SS

UPPER MISSISSIPPI RIVER NATIONAL
WILDLIFE AND FISH REFUGE
Established 1924

Compatibility Study
SPRING LAKE REHABILITATION AND
ENHANCEMENT PROJECT

Establishment Authority

Public Law No. 268, 68th Congress, The Upper Mississippi River Wildlife and Fish Refuge Act.

Purpose for Which Established

"The refuge shall be established and maintained (a) as a refuge and breeding place for migratory birds included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, and (b) to such extent as the Secretary of Agriculture may, by regulations, prescribe, as a refuge and breeding place for other wild birds, game animals, fur-bearing animals, and for the conservation of wild flowers and aquatic plants, and (c) to such extent as the Secretary of Commerce may, by regulations, prescribe a refuge and breeding place for fish and other aquatic animal life."

Description of Proposed Use

The proposal is a Habitat Rehabilitation and Enhancement project authorized by the Water Resource Development Act of 1986 (Pub. L. 99-662). The proposed project will be constructed in Spring Lake, a 3,300-acre lake enclosed by a natural river bank and a perimeter levee on the Illinois side of the Upper Mississippi River. It is divided into an upper and lower lake by a cross dike. It is located between river miles (RM) 532.5 and 536.0, approximately two miles south of Savanna, Illinois.

Spring Lake was historically a highly productive and heavily used feeding and resting area for migratory waterfowl. However, due to breaching of the perimeter levee, deposition of sediments into Spring Lake, primarily during flood events, has caused a gradual decline in the quality and availability of aquatic habitat in Spring Lake. Breaches have prohibited annual maintenance of the perimeter levee system. Areas adjacent to breach sites also have deteriorated. Waterfowl use in the Upper Lake has diminished because of the invasion of woody vegetation and undesirable aquatic plant species, thereby reducing quality food plant species. In addition, the shallow water conditions and low flows in the Lower Lake during the summer months cause dissolved oxygen levels to drop. The evaluation technique which was used to determine habitat suitability identifies lack of dissolved oxygen as a limiting factor for enhancement of the fishery in the Lower Lake.

The goals for this project are the enhancement of aquatic and wetland habitats. In order to accomplish these goals, the following design objectives were identified: (1) improve water quality for fish; (2) maintain backwater lake; (3) provide reliable food source in Upper Lake for migratory birds; and (4) provide reliable food source in Lower Lake for migratory birds.

The proposed project consists of construction of three independent water-controlled cells in the Upper Lake; construction of a gated inlet structure and associated excavated channels in the Lower Lake; construction of a 108-acre water-controlled hemi-marsh in the Lower Lake; and restoration of 7.1 miles of perimeter levee.

The proposed construction in the Upper Lake will allow a combination moist soil and managed marsh operation plan. This will meet the project objective of providing a reliable food resource in the Upper Lake for migratory birds. Habitat diversity for other marsh-dwelling species will be an additional output.

The proposed gated inlet structure and associated excavated channels in the Lower Lake will allow for flow and dissolved oxygen dissipation throughout the Lower Lake. This feature will substantially improve the water quality and aquatic habitat in the Lower Lake.

The proposed hemi-marsh development will provide greater habitat diversity and reliability.

More details of the project, including maps and engineering drawings, are contained in the draft report entitled, "Upper Mississippi River System Environmental Management Program Definite Project Report With Integrated Environmental Assessment (R-120) Spring Lake Habitat Rehabilitation and Enhancement, Pool 13, Upper Mississippi River, Carroll County, Illinois," prepared by the Rock Island District, Corps of Engineers.

Anticipated Impacts on Refuge Purposes

As a result of the project fish and wildlife populations should increase which will be a direct benefit toward maintaining and accomplishing refuge purposes. The above-mentioned report contains additional information on the project's impacts.

Justification

The proposed project works toward the accomplishment of the stated objectives of the refuge.

Determination

The proposed project is compatible with purposes for which the refuge was established.

Determined by: James R. Tonnaitor (signature) 6/18/92
Project Leader — Date

Reviewed by: Richard F. Berry (signature) 6/18/92
Complex Manager — Date

Reviewed by: John P. Stasko (signature) 6/24/92
WAM-1 — Date

Concurred by: Acting Norman ... (signature) 6/30/92
Regional Director — Date

United States Department of the Interior

FISH AND WILDLIFE SERVICE

UPPER MISSISSIPPI RIVER NATIONAL WILDLIFE AND FISH REFUGE
51 E. FOURTH STREET - ROOM 101
WINONA, MINNESOTA 55987

IN REPLY REFER TO:

October 24, 1992

Colonel Albert J. Kraus
Rock Island Corps of Engineers
Clock Tower Building
Rock Island, IL 61204

Dear Colonel Kraus:

This is in response to a request from Barb Kimler (ED-DN) for information on the importance of the Spring Lake EMP project to the U.S. Fish and Wildlife Service (Service).

The Spring Lake Closed Area is a 3,300-acre unit managed by the Service as part of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge). The area is within the Mississippi Flyway and is designated as an area of major concern under the North American Waterfowl Management Plan. The Refuge EIS/Master Plan also addresses the significance of rehabilitation projects within the Spring Lake Closed Area stressing the value for canvasbacks, blue-winged teal, pintails and scaup.

Closed areas are very important not only for the food resources and wildlife habitat they provide, but especially for the sanctuary they provide during the waterfowl hunting season. The Spring Lake Closed Area is unique in being the only inviolate closed area on the Refuge excluding all entry from October 1 through the last day of the waterfowl hunting season. Other closed areas on the river allow entry by boaters for fishing, sightseeing, etc. which disturbs waterfowl and subjects them to hunting mortality outside the closed area. Any project which improves the water management capability or ultimately improves the food reserves within a closed area and especially within an inviolate closed area such as Spring Lake is extremely important.

The Spring Lake Closed Area also is unique with its diversity of water regimes and aquatic habitats within a relatively small area providing both food and shelter for a variety of wildlife species.

Through the EMP project, the Spring Lake lower unit will be improved for submerged aquatic vegetation, waterfowl (divers) and fish. The managed marsh adjacent to Goose Point Overlook will provide improved habitat for waterfowl (puddle ducks), muskrats, fish (spawning habitat), shorebirds and wading birds after water management capabilities is added by the EMP project. The Spring Lake upper unit with two cells for moist soil management will maximize natural seed production per acre for geese and waterfowl (puddle ducks), shorebirds and wading birds. While recognizing that the optimization of the upper unit for these species will result in a degradation of habitat for non-target species, the outputs of the EMP project are consistent with Service management goals for this area. In addition, the third cell as a managed marsh will continue to provide dense emergent vegetation for the state-endangered yellow-headed blackbird as well as habitat for the rails and bitterns.

Within a relatively small area, improved habitat created by the EMP project will benefit a variety of wildlife species and will provide a gradation of water regimes as well as habitat types from which wildlife can select or relocate as the season and/or water levels fluctuate.

If you have any questions regarding these comments, please give me a call at 507/452-4232.

Sincerely,

James R. Lennartson
Refuge Manager

United States Department of the Interior

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

IN REPLY REFER TO:

309/793-5800

November 16, 1992

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

Dear Colonel Kraus:

This letter constitutes our final Fish and Wildlife Coordination Act (FWCA) report for the Spring Lake Habitat Rehabilitation and Enhancement Project (HREP) in Pool 13 Upper Mississippi River, Carroll County, Illinois. It has been prepared under the authority of and in accordance with 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.

The Spring Lake HREP is a component of the Upper Mississippi River System Environmental Management Program (EMP) authorized in Section 1103 of the Water Resource 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."

The project area is owned in fee title by the Army Corps of Engineers and operated under a General Plan and Cooperative Agreement with the U.S. Fish and Wildlife Service as a part of the Savanna District, Upper Mississippi River Wildlife and Fish Refuge (UMRWFR). The National Wildlife Refuge System Administration Act requires that a compatibility study be approved and special use permits issued prior to construction. These documents are approved by our Regional Director and will be forwarded to you under a separate cover.

DESCRIPTION OF THE STUDY AREA

Spring Lake is a closed area within the UMRWFR, Savanna District, and is located on the east bank of the Mississippi River directly south of Savanna, Illinois, between River miles 531.5 and 536.0. The refuge is approximately 3,300 acres of habitat managed mainly for migratory birds and fish. It is divided into two distinct units which are physically separated by a 2-year event levee. The upper unit, approximately 560 acres in size, is managed as shallow wetlands. The existing habitat consists of heavily vegetated sections interspersed with areas of open water. Water depths vary from a few inches to one to two feet in the deeper pools. Water levels can fluctuate dramatically, depending on river levels or the management goals of the refuge staff. A water control structure located in the southeast corner of the upper unit aids in the manipulation of water levels inside the levied area. Lack of adequate lateral ditching and a non-functional pump has prevented proper management of this area in recent years. A 20 acre tract along the northwest boundary of the upper unit is bottomland forest that continues to encroach into the shallow wetlands.

The lower unit encompasses the remaining 2700 acres and is a mixture of deep and shallow water habitats. A large portion of the lower unit is shallow water, varying between 12 and 36 inches in depth. Dense stands of lotus, cattails, and bulrush dominate these shallow areas during the summer months. Deeper areas are sparsely scattered throughout the lower unit and are generally the result of past dredging or ditching activities. These pools are approximately 10 to 12 feet in depth. A number of islands are also located within the confines of the lower unit. One unique feature of the lower unit is a 100 acre hemi-marsh, located on the southeastern fringe of the refuge. This area is heavily vegetated with aquatic flora which becomes increasingly more dense throughout the summer months. The marsh is inundated with flood waters during the spring and other periods of high flow, but only a small percentage of the water remains through the fall as viable open water habitat.

As part of the Upper Mississippi River Wildlife and Fish Refuge, the project area is managed by the U.S. Fish and Wildlife Service as a wildlife refuge. Management practices focus on providing feeding and loafing areas for migratory waterfowl. The area is closed to the public for approximately two months during the annual waterfowl season. During this time it can receive large concentrations of ducks and geese. The area also serves as an important stopover site for migratory waterfowl and other birds during their spring migration.

The fisheries resource in Spring Lake is well known and the area is seasonally used by commercial and sport fishermen. During the early winter when sufficient dissolved oxygen is available, ice fishing is a popular recreational activity. Other resource based activities include: furbearer trapping, upland game hunting, wildlife viewing, hiking, and camping.

PROJECT GOALS AND OBJECTIVE

The overall objective of the Spring Lake HREP is to rehabilitate and enhance the existing fish and wildlife habitat by restoring diversity to the floral and faunal communities. This will be accomplished by structural measures that will protect the area and facilitate extensive management of the upper unit. By improving the quality of the existing habitat and providing different management alternatives (moist soil unit, managed marsh), the upper unit has the potential to become a more productive and diverse wetland. The moist soil unit would be actively managed for invertebrates and food plant species which would be utilized by large concentrations of migrating birds, including waterfowl. The managed marsh would support approximately equal amounts of open water and vegetated areas, attracting a variety of wetland species. A similar scenario is also proposed for the 100 acre hemi-marsh located in the southeast corner of the lower unit.

A secondary goal of the proposed project is to improve the aquatic habitat of the lower lake. This can be accomplished by implementing two additional project features. First, the amount of sediment reaching the lower pool could be reduced substantially by improving the existing levee surrounding the project area. This would improve water quality, provide areas of deep water habitat, and stimulate the growth of desired aquatic vegetation (i.e. wild celery). Secondly, the installation of a water control structure and the dredging of a series of deep channels would facilitate the movement of currents high in dissolved oxygen throughout the lower lake, enhancing the year-round fisheries resource.

METHODOLOGY

The analysis of the existing study area conditions, future conditions without the proposed project, and alternatives for future conditions with the proposed project were accomplished using the Wildlife Habitat Appraisal Guide (WHAG). These procedures were developed by the Missouri Department of Conservation and the USDA Soil Conservation Service. The Spring Lake analysis employed a multi-agency team approach with personnel from our field office, the Savanna Refuge office, Army Corps of Engineers, and Illinois Department of Conservation.

The WHAG analysis is a habitat evaluation system for numerically accessing the quality of a given habitat for selected target species on a 0.1 (low) to 1.0 (high) scale. This numerical value is referred to as the habitat suitability index (HSI). The HSI compares the existing and future habitat conditions to an optimal habitat condition for a selected set of evaluation species. When the HSI is multiplied by the available habitat within the project area, a measure of the available habitat quality and quantity (habitat units [HU]) is provided. The WHAG procedure also identifies limiting factors or critical life requisite for each evaluation species. In the absence of these critical life requisites, the habitat is considered to be unsuitable for that species and the HSI falls to a value of 0.1. Average Annual Habitat Units (AAHU's) calculated for each evaluation species, reflects expected changes in habitat conditions over a 50 year period of analysis.

Existing habitat conditions were evaluated on-site by the interagency team. Future conditions with and without the project were then estimated using the expertise of the team members. Several management alternatives were used to compare HSI values for future conditions with the project. For project planning and impact analysis, project life was established at 50 years. To facilitate comparison, target years (TY) were established at 0 (existing conditions), 1, 25, and 50 years.

The WHAG procedures were also employed to evaluate the aquatic habitat by using selected fish evaluation species. Similar to the HSI values for the terrestrial species, a HSI of 0.1 indicates that the habitat is of little value for the evaluated species.

ENDANGERED SPECIES

Two species protected under the Endangered Species Act of 1973, as amended, are listed as occurring in the project area. The bald eagle (*Haliaeetus leucocephalus*) is known to breed and winter in Carroll County, Illinois. The peregrine falcon (*Falco peregrinus*) uses the area only during its migration. The habitats utilized by these birds in the project area will not be impacted as a result of the proposed project, therefore, impacts to these species are not anticipated.

This precludes the need for further action on this project as required under the Endangered Species Act. Should this project be modified or new information indicate that endangered species may be affected, consultation should be initiated.

Several state endangered species, as identified by the State of Illinois, have been known to occur within the study area. We recommend the Illinois Department of Conservation be contacted to help identify these species and possible project impacts and benefits.

EXISTING FISH AND WILDLIFE RESOURCES

Terrestrial

Habitat types associated with the project site include aquatic, non-forested wetlands, and forested wetlands. These habitats are not likely to change significantly over the life of the project due to the low siltation rate of this backwater area. The upper unit currently provides marginal to excellent habitat for the WHAG evaluation species (Table 1.1).

Table 1.1. Spring lake Upper Unit HREP existing terrestrial habitat suitability index, existing HU's, and AAHU's without project.

SPECIES	HSI	HU	AAHUs
Mallard	0.14	80.0	114.3
Canada goose	0.15	78.8	113.2
Least bittern	0.93	501.4	482.3
Lesser yellowlegs	0.43	231.9	214.6
Muskrat	0.50	268.9	259.6
King rail	0.66	357.4	351.7
Green-backed heron	0.60	334.8	340.9
Wood duck	0.10	-----	3.5
Beaver	0.64	12.8	13.1
American coot	0.54	292.5	372.4
Northern parula	0.10	-----	3.3
Prothonotary warbler	0.10	-----	3.7

Species like the least bittern (*Ixobrychus exilis*) that prefer heavily vegetated areas and are better adapted for these habitat conditions have relatively high HSI values. The Canada goose and mallard, on the other hand, have comparatively low HSI values. These low values are a result of unpredictable fall water levels and the absence of food plant species.

The hemi-marsh located at the south end of the lower unit, is very similar to the present condition of the upper unit. The marsh is heavily vegetated with very little open water remaining in the area by fall. Although this situation provides habitat to some of the evaluation species, most of the HSI values for this area are extremely low. Many species are deterred from fully utilizing the available habitat due to the year round fluctuation of water levels and the dense stands of cattail and bulrush.

Aquatic

WHAG results for the existing aquatic habitat indicates poor or unsuitable habitat for the evaluation species (channel catfish, walleye, largemouth bass). The HSI values of 0.1 for all of the evaluation species are a result of shallow water conditions, which results in low concentrations of dissolved oxygen (limiting factor) during critical periods of the year. Although a rating of 0.1 usually indicates that the habitat has little value, the study area is known to provide seasonal periods of good habitat for many fish species. This is evident, in that the Spring Lake area does receive some fishing pressure during certain periods during the year.

FUTURE WITHOUT PROJECT

Terrestrial

It is not likely that the study area will experience significant successional changes over the life of the project. The vegetation in the upper unit and the hemi-marsh will continue to become more dense and encroach on areas that are now open water. Because of the levee protection, the vegetation changes will result from a buildup of decaying vegetation rather than siltation. The area is protected by a 50 year levee on the upstream end and the silt load is likely to fall out of flood waters entering from the downstream side. The encroachment of woody vegetation in the northwest portion of the upper unit will continue to expand. As a result of these conditions, the HSI's for most species show only gradual changes over the project's life.

Aquatic

The aquatic habitat of the lower unit does not show any significant changes over the life of the project according to the WHAG analysis. The insufficient amount of dissolved oxygen remains a limiting factor, keeping the HSI values at 0.1 for the evaluation species. As with the upper unit, it is unlikely that the lower unit will experience a significant loss in aquatic habitat due to siltation.

FUTURE WITH PROJECT

Terrestrial

WHAG was used to analyze three management alternatives for the upper unit of Spring Lake. The first alternative evaluates managing the entire area as a moist soil unit. The second alternative consists of managing the area as a managed marsh. The third alternative looks at dividing the area into three units and managing one of the units as a managed marsh and the other two as moist soil units. In each alternative a two-way pump would be installed to control water levels, discouraging or encouraging the growth of vegetation. In addition, with the third alternative a series of levees would have to be constructed and stoplog structures installed in order to be able to manage each of the three areas as distinct units.

Three alternatives to improve the terrestrial habitat of the hemi-marsh were also analyzed in this evaluation. The first alternative consists of constructing a two-year event levee around the area. This would increase the average water depth in the marsh by approximately two feet, storing roughly 200 acre feet of water. The second alternative includes of a two-year event levee, a water control structure, and pump. This alternative would have the same water depths and storage capacity as the first alternative, but the addition of a pump and control structure would allow for more intensive management. The third alternative consists of raising the levee to a five-year event, increasing the water depths to approximately four feet and doubling the storage capacity to 400 acre feet. A water control structure and pump would be installed to allow for the manipulation of water levels. This alternative would have similar management options as in the second alternative with the added benefit of having increased flexibility in water level management.

Aquatic

To improve the aquatic habitat of lower Spring Lake two alternatives were discussed. The first alternative is the construction of channels and the installation of an inlet structure on the upper end of lower Spring Lake. The channels will increase the amount of deep water habitat available to fish and facilitate the distribution of dissolved oxygen throughout the lower lake. The inlet structure would provide a continual supply of oxygenated water, preventing anoxic conditions during critical periods of the year.

The second alternative was discussed, but not analyzed using WHAG, nor recommended for construction. This alternative consisted of placing a control structure in the levee break at the lower end of Spring Lake, cutting it off from the main channel. This alternative was eliminated from further consideration because of potentially negative fishery impacts that include reduced access to and from the main channel for spawning, for larval sauger and walleye, and for wintering habitat. This alternative was also inconsistent with refuge policy of retaining lower Spring Lake as a backwater of the Mississippi River.

DISCUSSION

Terrestrial

Management consideration for upper Spring Lake included three alternatives that were used to calculate average annual habitat units (AAHU's) using the WHAG methodology. Each alternative was compared to without project conditions as well as to the other alternatives (Table 2.2).

Table 2.2. Average Annual Habitat Units for without project conditions and the three proposed management alternatives for the Upper Unit of Spring Lake. Total acreage is 560 acres.

SPECIES	Without Project	Alt. 1*	Alt. 2**	Alt. 3***
Mallard	114.3	214.2	395.4	288.3
Canada goose	113.2	211.7	367.0	273.2
Least Bittern	482.3	424.8	60.5	214.3
Lesser Yellowlegs	214.6	361.0	57.8	184.0
Muskrat	259.6	439.7	58.2	217.8
King rail	351.7	391.7	59.1	198.5
Green-backed heron	340.9	375.1	58.8	191.2
Wood duck	3.5	-----	-----	-----
Beaver	13.1	0.1	0.1	0.2
American Coot	372.4	411.8	58.4	206.3
Northern parula	3.5	-----	-----	-----
Proth warbler	3.7	-----	-----	-----

* Managed Marsh
** Moist Soil
*** 237 acres managed marsh; 298 acres moist soil

The first alternative consists of managing the entire upper unit as a managed marsh. AAHU's for this alternative show a sizable increase for most evaluation species when compared to the without project conditions. The second alternative consisted of managing the entire area as a moist soil unit. As expected, this alternative shows substantial increases in AAHU's for mallard and Canada goose, but AAHU's for other species drop well below that of the present habitat. The third alternative is a combination of the first two. The area would be divided into three distinct units. A series of earthen dikes and stoplog structures will be used to facilitate water control on the units. Approximately 237 acres will be maintained as a managed marsh. The other two units of 160 acres and 138 acres will be managed as moist soil units. To calculate AAHU's for this alternative a WHAG analysis using 237 acres as a managed marsh and 298 acres as moist soil was performed. The AAHU's were added together to provide the numerical information provided for alternative three in Table 2.2. This alternative shows that by actively managing upper Spring Lake partially as a managed marsh and partially as a moist soil unit, habitat can be provided for species better suited for a marsh habitat, while simultaneously enhancing the area for migratory waterfowl.

With the hemi-marsh three alternatives were compared to future without project conditions to measure the benefits derived by each alternatives. As Table 3.3 indicates each of the alternatives for the hemi-marsh show increases over the future without project scenario.

Table 3.3. Average Annual Habitat Units for the existing conditions and the three alternatives for the 108 acre hemi-marsh.

SPECIES	Without Project	2YR	2YR/C	5YR/C
Mallard	-----	-----	24.0	26.2
Canada goose	-----	-----	24.4	25.9
Least bittern	89.9	94.1	73.1	65.1
Lesser yellowlegs	-----	-----	72.4	65.5
Muskrat	16.7	37.9	84.0	91.4
King rail	-----	-----	38.2	41.6
Green-backed heron	55.8	54.6	80.4	86.0
Wood duck	-----	-----	-----	-----
Beaver	-----	-----	-----	-----
American coot	81.3	81.5	88.7	87.7
Northern parula	-----	-----	-----	-----
Prothonotary warbler	-----	-----	-----	-----

The first alternative, a two-year levee with no water control, shows only a slight increase for some of the evaluation species. The second alternative, a two-year levee with water control, indicates a substantial increase in AAHU's over the 50 year period of analysis for several species. Constructing a 5-year levee with water control, indicates similar increases in the AAHU's as the second alternative. Both of these alternatives would provide habitat for the widest range of species. Since the last two alternatives appear almost identical in the benefits derived, the construction cost of additional levee may be the deciding factor in choosing an alternative.

Aquatic

Comparison of the AAHU's calculated for the aquatic habitat analysis indicates a substantial increase in habitat for all of the evaluation species. Table 4.4 illustrates the changes in AAHU's for the aquatic species in lower Spring Lake.

Table 4.4. HSI's and AAHU's of the fish evaluation species for future without and future with project conditions.

SPECIES	Fut w/out HSI	AAHU's Acres	Future w/ HSI	AAHU's Acres
Largemouth bass	0.10	241.4	0.49	1173.5
Channel catfish	0.10	241.4	0.45	1071.2
Walleye	0.10	241.4	0.55	1326.8

For the purpose of comparing AAHU's without project to AAHU's with project conditions, all HSI's of 0.1 were multiplied by the amount of available habitat. Therefore, for this analysis each evaluation species having a HSI value of 0.1 is assumed to have AAHU's of 241.4. The aquatic habitat benefits derived from implementing the project are not only substantially greater than conditions without project, but they are also unlikely to significantly decrease over time. This indicates that benefits to the aquatic habitat will extend beyond the period of analysis used for this project.

CONCLUSIONS AND RECOMMENDATIONS

The Spring Lake project is a combination of several features under the umbrella of the perimeter levee improvement. While sedimentation is not anticipated to be a significant factor in future habitat degradation in the project area, levee improvements are needed to insure the successful implementation and longevity of the habitat benefits. The upstream levee breech, originally part of the levee improvements proposed for the Spring Lake HREP, was repaired in 1991 using dredged material from nearby channel maintenance operations.

The upper unit improvements and the hemi-marsh are oriented to wildlife, while the lower unit features will be most beneficial to fish. Both the upper unit features and the hemi-marsh provide flexibility for the management of these areas to provide benefits to a wide range of species. It is clear in the WHAG analysis that managing the entire upper lake as a single unit, or under a single management strategy is unsatisfactory in terms of objectives for migratory waterfowl and habitat diversity as well as an impractical size for intensive management. The dividing levees, stoplog structures, reversible pump, and integrated wetland management strategy provide the most flexibility and habitat benefits. The hemi-marsh feature will accomplish the same objectives and provide a demonstration and educational area for the hemi-marsh concept.

As is the case with many Mississippi River backwater areas, the lower unit of Spring Lake has limited aquatic value due to low dissolved oxygen levels at critical times of the year. The water control structure (to inlet oxygen-rich river water) and channel dredging (to facilitate dispersion of the oxygen) will alleviate the anoxic condition, and make more of the lower unit suitable for piscine use. The dredged channels will also provide additional deep water habitat and diversity in lower Spring Lake. We recognize that the lack of sufficient dissolved oxygen and depth diversity are the limiting factors in providing year-round fisheries habitat in the lower Spring Lake, we are also unable to provides specific data as to the length and depth of the proposed channel cuts. As additional data becomes available we may find that it is necessary to increase the proposed channel cuts in length and/or depth to provide sufficient dissolved oxygen to the entire backwater area. Or we may discover that the cuts were more than needed and this information can be applied to future projects.

Therefore, we recommend:

1. The perimeter levee improvements be made to protect Spring Lake and the recommended habitat improvements.

2. The three-cell alternative for the upper unit be constructed.

3. The improvements for the hemi-marsh in the lower unit be constructed to provide water depths of approximately three feet.

4. The inlet structure and deep channels be constructed in the lower unit.

5. Continue to refine the dredged channels in the lower unit as additional data becomes available.

Sincerely,

Richard C. Nelson
Field Supervisor

TR: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

March 12, 1993

Engineering Division
Environmental Engineering Section

Mr. Bruce Yurdin
Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, IL 62706

Dear Mr. Yurdin:

Enclosed is a copy of the draft Definite Project Report with integrated Environmental Assessment for the Spring Lake habitat rehabilitation and enhancement project. This project is located in Pool 13, Upper Mississippi River Miles 532 through 536 in Carroll County, Illinois. The report contains a 404 (b) (1) evaluation of the proposed project features. These features include levee rehabilitation, wetland management unit construction, mechanical channel excavation, and water control structure construction. Also, enclosed is a copy of the Joint Public Notice which was issued on March 3, 1993.

Following your review of these documents, we request a water quality certification or waiver pursuant to the provisions of Section 401 of the 1977 Clean Water Act. Early consideration of this matter would be appreciated as we are scheduled to initiate preparation of construction plans and specifications this year. Construction is scheduled to begin in the fall of 1994.

Thank you for your assistance in this matter. The point of contact for this project is Ms. Barbara Kimler, P.E., (309) 788-6361, ext. 6643.

Sincerely,

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

Enclosures

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL AFFAIRS
230 S. DEARBORN, SUITE 3422
CHICAGO, ILLINOIS 60604

ER-93/093

March 19, 1993

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

Dear Colonel Kraus:

The Department of the Interior (Department) has reviewed the Draft Definite Project Report with Integrated Environmental Assessment for the Spring Lake, Carroll County, Illinois. The subject document for the proposed project is adequate with respect to fish and wildlife resources, recreational resources, and mineral resources. The Department has no other comments on the document.

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

Sincerely,

Sheila Minor Huff
Regional Environmental Officer

State of Illinois
ENVIRONMENTAL PROTECTION AGENCY

Mary A. Gade, Director

2200 Churchill Road, Springfield, IL 62794-9276

217/782-0610

April 22, 1993

Mr. James H. Blanchar, P.E.
Chief, Operations Division
Rock Island District
Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61201

Re: Rock Island District Corps of Engineers Spring Lake EMP --
Mississippi River
Log #C-1187-92 [CoE Appl. 253770]

Dear Mr. Blanchar:

This Agency received a request on March 16, 1993, from the Rock Island District Corps of Engineers requesting necessary comments for environmental consideration concerning the rehabilitation of Spring Lake, including the construction of a pump station, the raising and modification of perimeter and cross dike levees using material excavated for adjacent channels, and the excavation of internal water distribution channels, with the excavated 126,636 cubic yards of material used to create 10 nesting islands. We offer the following comments.

Based on the information included in this submittal, it is our engineering judgment that the proposed project may be completed without causing water pollution as defined in the Illinois Environmental Protection Act, provided the project is carefully planned and supervised.

These comments are directed at the effect on water quality of the construction procedures involved in the above described project and is <u>not</u> an approval of any discharge resulting from the completed facility, nor an approval of the design of the facility. These comments do <u>not</u> supplant any permit responsibilities of the applicant towards this Agency.

This Agency hereby issues certification under Section 401 of the Clean Water Act (PL 95-217), subject to the applicant's compliance with the following conditions:

1. The applicant shall not cause:

   a. violation of applicable water quality standards of the Illinois Pollution Control Board, Title 35, Subtitle C: Water Pollution Rules and Regulations;

b. water pollution as defined and prohibited by the Illinois Environmental Protection Act; and

c. interference with water use practices near public recreation areas or water supply intakes.

2. The applicant shall provide adequate planning and supervision during the project construction period for implementing construction methods, processes and cleanup procedures necessary to prevent water pollution and control erosion.

3. Any spoil material excavated, dredged or otherwise produced must not be returned to the waterway but must be deposited in a self-contained area in compliance with all State statutes, regulations and permit requirements with no discharge to the waters of the State unless a permit has been issued by this Agency. Any back filling must be done with clean material and placed in a manner to prevent violation of applicable water quality standards.

4. All areas affected by construction shall be mulched and seeded as soon after construction as possible. The applicant shall undertake necessary measures and procedures to reduce erosion during construction. Interim measures to prevent erosion during construction shall be taken and may include the installation of staked straw bales, sedimentation basins and temporary mulching. All construction within the waterway shall be conducted during zero or low flow conditions.

   The applicant shall be responsible for obtaining an NPDES Storm Water Permit prior to initiating construction if the construction activity associated with the project will result in the disturbance of 5 (five) or more acres, total land area. An NPDES Storm Water Permit may be obtained by submitting a properly completed Notice of Intent (NOI) form by certified mail to the Agency's Division of Water Pollution Control, Permit Section.

5. The applicant shall implement erosion control measures consistent with the "Standards and Specifications for Soil Erosion and Sediment Control" (IEPA/WPC/87-012).

6. Prior to the start of construction, the applicant shall provide to the Agency plans and specifications for controlling erosion of the levee and dike slopes during construction. Plans should also address erosion control at the nesting islands.

7. This certification becomes effective when the Department of the Army, Corps of Engineers, includes the above conditions #1 through 6 as conditions of the requested permit issued pursuant to Section 404 of PL. 95-217.

This certification does not grant immunity from any enforcement action found necessary by this Agency to meet its responsibilities in prevention, abatement, and control of water pollution.

Very truly yours,

Thomas G. McSwiggin, P.E.
Manager, Permit Section
Division of Water Pollution Control

TGM:BY:dks/806v, 28-30

cc: IDOT, Division of Water Resources, Springfield
USEPA, Region V
DWPC, Records Unit
DWPC, Field Operations Section, Rockford

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MAY 14 1993

REPLY TO THE ATTENTION OF:

ME-19J

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

Dear Mr. Brown:

The information provided by Steve Peacock, Environmental Analysis Branch, through telephone correspondence with Pete Rogers of my staff on May 12,1993, has adequately addressed our comments regarding the Draft Definite Project Report (R-12D) with Integrated Environmental Assessment for the Spring Lake Rehabilitation and Enhancement. Therefore, it appears that significant impacts to the environment are not likely to result from the proposed action. However, where practicable, artificial habitat components, e.g., nesting sites, bird houses, feeders, etc., should be provided for non-target species to mitigate the habitat loss.

Thank you for allowing us to provide our comments. Should any additional information ever become available, indicating the potential for adverse impacts on the environment, we would appreciate an opportunity to conduct a subsequent review.

If you have any questions, please contact Pete Rogers of my staff at (312) 886-9842.

Sincerely yours,

for William D. Franz, Acting Chief
Planning and Assessment Branch
Planning and Management Division

cc. Steve Peacock, Biologist
Environmental Analysis Branch

TOTAL P.02

CLEAN WATER ACT
SECTION 404(b(1) EVALUATION

A P P E N D I X B

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

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

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

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

SECTION 1 - PROJECT DESCRIPTION

LOCATION

The proposed project is located on the Illinois side of the Mississippi River (River Miles 532-536) within Carroll County, Illinois. The 3,146-acre Spring Lake complex was created by the impoundment of Lock and Dam 13 and is presently managed by the U.S. Fish and Wildlife Service (USFWS) as part of the Upper Mississippi National Wildlife Refuge system.

GENERAL DESCRIPTION

By definition and Federal regulatory jurisdiction, 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.

The Spring Lake Rehabilitation and Enhancement project is an adjacent backwater enhancement project consisting of the rehabilitation and construction of levees on both the Upper and Lower Lakes, construction of a stoplog structure on the Lower Lake, construction of stoplog structures and a pump station in the Upper Lake, mechanical excavation of material from the Lower Lake, and ground leveling in the Upper Lake moist-soil units.

The perimeter levee in the Upper Lake will be rehabilitated by placement of approximately 41,000 cubic yards of material excavated from an adjacent borrow ditch. Construction of new levees for creation of moist-soil unit and managed marsh cells in the Upper Lake will involve the mechanical dredging and sidecasting of approximately 7,600 cubic yards of material. The perimeter levee in the Lower Lake will be rehabilitated by placement of approximately 105,500 cubic yards of material excavated from an adjacent borrow ditch. The cross dike will be rehabilitated by placement of approximately 6,000 cubic yards of material excavated from an adjacent borrow ditch. Approximately 10,000 cubic yards of material will be sidecast to create a levee which will surround a hemi-marsh.

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)," which includes the Illinois River. This project is the result of a coordinated planning effort between the USFWS, the Illinois Department of Conservation, and the U.S. Army Corps of Engineers.

GENERAL DESCRIPTION OF DREDGED AND FILL MATERIAL

The recent sediment deposits within Spring Lake are concentrated between where the breach occurred along the west perimeter levee in the Lower Lake and the breach in the perimeter levee on the south side. The sediment consists of sand closest to the repaired west breach and finer silt and clay particles proceeding south and east. Areas to the north and east of the repaired west breach contain little additional sediment accumulation.

The normal water surface is elevation 583.0 feet mean sea level (flat pool), and the average water depth is 1.5 feet. This figure includes only the channel to be dredged in the Lower Lake to provide DO throughout the lake and does not include the mechanical dredging of borrow material for the perimeter levees.

DESCRIPTION OF THE PROPOSED DISCHARGE SITES

Material which will be mechanically excavated along the perimeter dike will be placed on the dike to restore it to a 50-year flood condition, and the interior dike will be sloped at a 4:1 slope. The riverward side of the perimeter levee will remain unchanged. Material which will be excavated from the Upper Lake for the construction of the feeder ditch between cells B and C will be sidecast to create levees 125 feet apart through which the feeder ditch will flow. Material for the construction of the other levees in the Upper Lake will be sidecast material from an adjacent borrow area.

DESCRIPTION OF DISPOSAL METHOD

Material will be mechanically dredged by means of a dragline which will operate from land in restoration of the perimeter levees. In the Upper Lake, which could be dewatered, a dragline, scraper, and dozer may be used to construct the levees and appurtenant structures.

SECTION 2 - FACTUAL DETERMINATIONS

PHYSICAL SUBSTRATE DETERMINATIONS

Geomorphological investigations and geotechnical surveys determined that the soils within the limits of the dredging are recent alluvial deposits over 2 feet deep in places.

WATER CIRCULATION, FLUCTUATION, AND SALINITY DETERMINATIONS

WATER

Water quality condition in the Spring Lake complex is primarily affected by the shallow nature of the system, partially as a result of sedimentation, the expanse of submergent and emergent vegetation which dominates the area.

Water quality problems are related to low levels of DO during the late summer and to the lack of water and low DO levels in the winter when portions of the slough freeze down to the bottom.

CURRENT PATTERNS AND CIRCULATION

Improvements in current patterns will result from the inlet structure, but will have no overall effect on the Mississippi River current patterns.

NORMAL WATER LEVEL FLUCTUATIONS

The Mississippi River is typified by fluctuations in water levels during flood events. For example, in the Spring Lake area, flood events can cause the water levels to gradually rise from a normal pool level of 583.0 to a flood level of 587.9 for a 5-year flood event, or a flood level of 597.2 for a rare 500-year event. During non-flood periods, water levels in the Spring Lake area do not fluctuate significantly because the area is a short distance upstream of Lock and Dam 13. Water levels remain below elevation 583.5 approximately 70 percent of the time.

SALINITY GRADIENTS

The Mississippi River is an inland freshwater system. Therefore, salinity gradients were not considered in this project.

ACTIONS TAKEN TO MINIMIZE IMPACTS

Several measures to minimize impacts at each of the project features will be implemented during and after construction.

The removal of trees to facilitate construction will be only those required for removal within the corridor of the rehabilitated levees. Bottomland hardwoods located in the Upper Lake within the proposed moist-soil unit (cell A) will remain.

SUSPENDED PARTICULATE/TURBIDITY DETERMINATIONS

In an effort to assess existing water quality conditions in the vicinity of the proposed project, a monitoring program was initiated in 1987 by personnel in the Rock Island District, Corps of Engineers, Water Quality and Sedimentation Section (ED-HQ) (see appendix F). The monitoring program called for the collection of water samples on a biweekly basis during the summer months at four sites.

Grain Size Analyses

Grain size analyses were performed on sediment samples collected at each site. The percent sediment passing a No. 230 sieve for each sample is given in table F-1 (appendix F). All samples contained substantial amounts of clay and silt-sized material.

Baseline Water Quality Monitoring

The results from ambient water samples collected at site SL-4 during 1991 are shown in table F-2 (appendix F).

Based on the limited data available, it appears that low DO concentrations may limit fish usage under existing conditions. These low DO levels may be related to excessive primary productivity during the spring as high pH and chlorophyll levels precede the low DO conditions.

It appears that should the proper dredging and dredged material disposal management techniques be utilized, there will be little impact on the water quality of Spring Lake. Any impacts that are noted would be temporary in nature.

CONTAMINANT DETERMINATIONS

Borrow material for rehabilitating the levee will be excavated adjacent to and inside of the existing levee. Bedding and gravel for the upgrading of the access road (cross dike) will be from a nearby quarry. There are no known contaminants contained in this material or located within Spring Lake.

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 (refer to Section 230.31)

E. Effects on Special Aquatic Sites Found in Project Area or Disposal Site.

    (1) Sanctuaries and Refuges (refer to Section 230.40)

    (2) Wetlands (refer to Section 230.41)

    (3) Mud Flats (refer to Section 230.42)

    (4) Vegetated Shallows (refer to Section 230.43)

    (5) Coral Reefs (not found in project area)

    (6) Riffle and Pool Complexes (refer to Section 230.45) were not considered for this project.

F. Threatened and Endangered Species (refer to Section 230.30)

G. Other Wildlife (refer to Section 230.32)

The project's effects on A through E above are anticipated to be of overall benefit. One of the primary purposes of the project is to restore aquatic habitat lost to sedimentation. Dredging will recreate deep and shallow water habitat, resulting in increased diversity in plankton, benthos, and the aquatic food web in the project area. Nekton, primarily fish, will benefit from increased available habitats, especially off-channel over-wintering areas with low-flow conditions and access to the main channel.

The inlet structure also would increase water exchange from the main river to the Lower Lake area, increasing DO concentration during potential critical seasonal stress periods.

E (1) through (4) are found in the project area. The project site is part of the Upper Mississippi River National Wildlife Refuge System, managed by the USFWS. The project was coordinated with USFWS and Illinois Department of Conservation staffs and has been found to be compatible with their objectives.

The federally endangered bald eagle (*Haliaeetus leucocephalus*) has been nesting on Silo Island in the Lower Lake for the past 2 years and has produced 2 young each year. The area also is used by bald eagles as a roosting area in the winter months. The State of Illinois has listed the river otter (*Lutra canadensis*), the double-crested cormorant (*Phalacrocorax auritus*), and the yellow-headed blackbird (*Xanothocephalus xanothocephalus*) as State endangered species.

There have been several sightings of an adult river otter with two young along the perimeter dike. Also, areas where the otter had been sliding and recent droppings were observed during preparation of this document.

In 1989, nine telephone poles, with three nesting platforms on each pole, were dropped into the mud bottom by helicopter to provide nesting habitat for the double-crested cormorant. To date, no nesting activity has been observed within the Spring Lake unit.

The yellow-headed blackbird has in past years used the cattail marsh on the Upper Lake for nesting. This marsh area will remain as a managed marsh unit.

The proposed project is anticipated to have no effect on either State or federally listed endangered species. This determination is supported by both the USFWS and the State of Illinois.

Other wildlife in the project area includes both game and non-game species such as white-tailed deer, squirrel, waterfowl and migratory shorebirds, numerous songbirds, small mammals, and furbearers, The proposed project is anticipated to contribute to overall habitat diversity in the project area, and thus will be of benefit to most species currently found in the project area.

PROPOSED PLACEMENT SITE DETERMINATIONS

MIXING ZONE DETERMINATION

The use of mechanical dredging equipment will minimize the amount of sediment resuspended during construction. Lack of any distinguishable current should limit any dispersion of the plume to that caused by wind-generated waves. Wind-generated waves also will resuspend existing bottom sediments so that the plume would quickly become indistinguishable from ambient conditions.

DETERMINATION OF COMPLIANCE WITH APPLICABLE WATER QUALITY STANDARDS

Concentrations for most parameters were below Illinois General Use Water Quality Standards. The only parameter to exceed the standards was ammonia nitrogen.

POTENTIAL EFFECTS ON HUMAN USE CHARACTERISTICS

Municipal and Private Water Supply

No effect anticipated.

Recreational and Commercial Fisheries

The quality of both sportfishing and commercial fishing in Lower Spring Lake will increase as a result of the increased availability of dissolved oxygen.

Water-Related Recreation

Other water-related recreation includes boating and trapping. These types of recreation will benefit from the proposed project.

Aesthetics

Placement of fill will have no long-term impact on aesthetics.

Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

The project is managed as a Federal wildlife refuge whose primary objective is to provide habitat for migratory waterfowl. The proposed fill activities will significantly improve the refuges operation in meeting these goals.

DETERMINATION OF CUMULATIVE EFFECTS ON THE AQUATIC ECOSYSTEM

The Spring Lake HREP project includes both aquatic and terrestrial components which will benefit both game and nongame species over the predicted 50-year project life. Fisheries benefits consist of improved DO levels.

DETERMINATION OF SECONDARY EFFECTS ON THE AQUATIC ECOSYSTEM

Secondary effects generated as a result of construction of this project include effects which may be associated with the drawdown of the Upper Lake during construction. This will negatively impact species which would normally use the area. However, the long-term benefits of the project outweigh this short-term negative impact.

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 in addition to the proposed action were as follows:

   a. Alternative A - No Federal Action

   b. Alternative B - Levee Restoration/Upper Lake Water Control/Inlet Structure

   c. Alternative C - Levee Restoration/Upper Lake Water Control/Inlet Structure/Hemi-Marsh (2-Year)

   d. Alternative D - Levee Restoration/Upper Lake Water Control/Inlet Structure/Hemi-Marsh (5-Year)

Alternative C was selected as the most practicable alternative since it provided the greatest benefits in the public interest at the least cost.

3. Certification under Section 401 of the Clean Water Act has been obtained from the Illinois Environmental Protection agency and is included in the final version of this report. The project is in compliance with the water quality requirements of the State of Illinois.

4. The project will 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 will result from this project. This determination is supported by the U.S. Fish and Wildlife Service, Ecological Services Office.

6. The project is located along a freshwater inland river system. No marine sanctuaries are involved or will be affected.

7. No municipal or private water supplies will be affected. There will be no adverse impact to recreational fishing, and no unique or special aquatic sites are located in the project location. No long-term adverse changes to the ecology of the river system will result from this action.

8. Project construction materials will 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 will not significantly impact water quality or the integrity of the aquatic ecosystem.

10. The project includes no features which will cause any increase in flood elevations.

24 May 1993
Date

Albert J. Kraus
Colonel, U.S. Army
District Engineer

LETTERS OF INTENT AND
DRAFT MEMORANDUM OF AGREEMENT

APPENDIX C

MEMORANDUM OF AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY
AND
THE UNITED STATES FISH AND WILDLIFE SERVICE
FOR
ENHANCING FISH AND WILDLIFE RESOURCES
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AT SPRING LAKE

I. PURPOSE

The purpose of this Memorandum of Agreement (MOA) is to establish the relationship, arrangements, and general procedures under which the Department of the U.S. Fish and Wildlife Service (USFWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, and rehabilitating the Spring Lake, Illinois, separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662. authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. The project area is managed by the USFWS and is on lands managed as a national wildlife refuge. Under conditions of Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, 100 percent of the construction costs of those fish and wildlife features at Spring Lake, Illinois, are the responsibility of (DOA), and pursuant to Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580, 100 percent of operation and maintenance for Spring Lake, Illinois project area are the responsibility of USFWS.

III. GENERAL SCOPE

The project to be accomplished pursuant to this MOA shall consist of providing 3 independent water-controlled cells in the Upper Lake; constructing a gated water inlet control structure and a gatewell structure in the Lower Lake; establishing 108 acres of hemi-marsh in the Lower Lake; and restoring 7.1 miles of the existing perimeter levee and 1.4 miles of the cross dike.

IV. RESPONSIBILITIES

A. The DOA is responsible for:

1. **Construction:** Rehabilitation of the existing perimeter levee and cross dike; construction of interior levees, 4 stoplog structures, 1 pump station, 1 water control structure, gatewell structure and 1 well station.

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, the DOA will construct the Spring Lake, Illinois, Fish and Wildlife Enhancement project as described in the Definite Project Report with Integrated Environmental Assessment, Spring Lake Rehabilitation and Enhancement, dated ______________, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of the Notice to Proceed. If the DOA encounters potential delays related to construction of the project the DA will promptly notify the 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 3 years after completion of construction of the project and resolution of all relevant claims arising therefrom, and shall make available at its evidence for inspection and audit by authorized representatives of the USFWS.

B: The USFWS is responsible for Operation, Maintenance, and Repair: Upon completion of construction as determined by the District Engineer, Rock Island, the USFWS shall accept the project and shall operate, maintain, and repair the project as defined in the Definite Project Report with Integrated Environmental Assessment, Spring Lake Rehabilitation and Enhancement, dated ______________, in accordance with Section 107(b) of the Water Resources Development Act of 1992, Public Law 102-580.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties:

USFWS: Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

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

EFFECTIVE DATE OF MOA

This MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF ARMY

BY: ____________________
ALBERT J. KRAUS
Colonel, U.S. Army
District Engineer

DATE: ____________________

THE U.S. FISH AND WILDLIFE SERVICE

BY: ____________________
SAM MARLER
Regional Director
U.S. Fish and Wildlife Service

DATE: ____________________

HABITAT EVALUATION AND QUANTIFICATION

APPENDIX D

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX D
HABITAT EVALUATION AND QUANTIFICATION

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX D
HABITAT EVALUATION AND QUANTIFICATION

PURPOSE

The purpose of this appendix is to present an overview and the results of the process used for quantification of habitat benefits for this enhancement project. Recommendations for further refinement of the models are included in the "Conclusions" section of this appendix. The method was applied by an inter-agency team composed of staff members from the U.S. Fish and Wildlife Service (USFWS), the Illinois Department of Conservation (ILDOC), and the U.S. Army Corps of Engineers.

BACKGROUND

The need for quantification of EMP-HREP outputs has been discussed by various agencies associated with the EMP as a project performance evaluation tool, a project ranking tool, and a project planning tool. This application involves quantification solely for the purpose of project planning.

The benefits to be derived from habitat rehabilitation and enhancement projects are not readily convertible to actual monetary units as is customarily required for traditional benefit-cost analyses. A method of quantification is needed to adequately evaluate project features for planning, design, and administrative purposes.

Measurable changes in habitat value can be described by suitability indices, habitat units, animal numbers, or animal use days.

The selected approach is referred to as a Habitat Unit (HU) accounting methodology. Several similar methodologies exist at this time, such as Habitat Evaluation Procedures (HEP), which was developed by the USFWS as an impact assessment tool; Habitat Evaluation System (HES), which was developed by the Corps of Engineers also as an impact assessment method; and Habitat Management Evaluation Method (HMEM), which was developed by the Bureau of Reclamation. Of the three methodologies referenced, HEP is likely to be the most familiar to all participants in the EMP.

METHODOLOGY

NOMENCLATURE

Habitat Unit-**HU** - (Acreage/Volume of a particular habitat type) * (HSI value). HUs represent a numeric estimate of usable habitat for particular species within a defined area.

Habitat Suitability Index-**HSI** - Index of habitat quality or suitability for particular species derived by a numeric ranking of life requisite characteristics at selected sample sites.

Average Annual Habitat Unit-**AAHU** - AAHUs represent an average HU value based on annualization of HUs over a series of selected Target Years (TY). AAHUs account for changes in habitat values over the life of a project.

For this project, HUs were chosen as the unit of comparison for project features or alternative plans. HUs are derived by multiplying habitat acreages or volumes by habitat quality, determined by HSIs. HSIs result from numeric ranking of site characteristics at sample sites throughout a given project area.

Numeric ranking for terrestrial and wetland habitat values was accomplished using the existing Wildlife Habitat Appraisal Guide (WHAG) field data sheets for forested and non-forested wetlands and a computer program developed by the Missouri Department of Conservation and the U.S. Soil Conservation Service. Field sheets used for WHAG analysis in bottomland hardwoods and non-forested wetland are shown on table D-4.

Aquatic habitat types and associated fisheries benefits were generated using a newly developed draft Fish Habitat Appraisal Guide (MOFISH) compiled by the Missouri Department of Conservation.

Founded on the same principles as the terrestrial habitat models, the aquatic guide is a numerical quantification of HUs based on the quality of a given aquatic habitat and the affected surface area of that habitat type.

While additional models will incorporate numerous target species and a range of aquatic habitat types, the Spring Lake project evaluated three target species: channel catfish, largemouth bass, and walleye. The characteristics for side channel habitat evaluation include a combination of physical and chemical determinations, vegetation patterns, and overall productivity (see list below). Consistent with the WHAG methodology, each habitat characteristic is ranked and assigned an associated numerical value. Calculations can then determine the existing quality of a particular aquatic habitat for specific target species of fish. The target species is representative of those species of fish which prefer similar environmental conditions and share similar life requisites, namely slack-water areas out of the main channel currents for channel catfish, for example. Vegetation, woody debris, and deeper pooled areas, access to the main channel habitats, etc., are additional factors considered for this matrix. The field sheet used for MOFISH is shown on table D-5.

Computer results are provided for estimated total HUs and calculated HSI values for the forested, non-forested, grassland, and aquatic components of the project. After existing conditions were determined, the study team reviewed the habitat appraisal guides to determine where habitat quality can be improved. HUs were annualized for target years using the USFWS's HEP 80 program in order to evaluate changes in project features over time.

Habitat quality ratings can be improved by: (1) increasing acreages for particular habitat types that may be limited or lacking; (2) altering a limiting factor, such as unpredictable water levels; (3) 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.

Project goals for habitat enhancement include increasing fisheries resources in the Lower Lake and improving wetland values for migratory waterfowl in the Upper Lake and the hemi-marsh. Therefore, the study team selected the appraisal guides for wetland habitats, with the mallard as a target species (species of emphasis). As was mentioned above, the aquatic component of the project was evaluated using the aquatic model with catfish, bass, and walleye as selected target species. Prior to site sampling, the study team reviewed aerial photography, topographic maps, and preliminary design drawings to select representative sample sites for WHAG application.

During site sampling, assumptions were developed regarding existing conditions and projected post-project conditions relative to limiting factors and management practices.

ASSUMPTIONS

a. Target years of 0, 1, 25, and 50 will be sufficient to annualize HUs and characterize habitat changes over the estimated project life.

b. Resource-partitioned guilds of fish may be represented by individual species which are suitable for evaluation of overall aquatic habitat values and changes in aquatic habitat values.

c. The life requisite information for the channel catfish, largemouth bass, and walleye is suitable for characterization of side channel and backwater habitats and may be used for evaluation of changes in Spring Lake and adjacent backwater conditions.

d. Alternatives evaluated represent available options to modify habitat suitability for migratory waterfowl, as represented by the resource categories of forested wetland, non-forested wetland, cropland, and grassland.

e. The mallard and Canada goose are suitable species of emphasis and adequately characterize life requisite requirements of the migratory waterfowl group for the purpose of incremental analysis of this project.

f. The muskrat, wood duck, green heron, bittern, yellowlegs, rail, coot, beaver, prothonotary warbler, and northern parula are suitable species for evaluation of overall wetland values and changes in wetland values resulting from construction of the hemi-marsh and managed marsh areas.

g. Encroachment of woody vegetation in the Upper Lake will continue, causing a gradual decline in the amount of available habitat for migratory waterfowl.

h. Mechanical dredging of the channel will enhance the area for fisheries by creation of deep-water and overwintering habitat as well as providing a means of conveying dissolved oxygen throughout the Lower Lake.

RESULTS

Alternatives evaluated at the Spring Lake site included Alternative A - No Action; Alternative B - Levee Restoration/Upper Lake Water Control/Inlet Structure; Alternative C - Levee Restoration/Upper Lake Water Control/Inlet Structure/Hemi-Marsh. Each alternative was made up of enhancement features which were evaluated independently. Options to the enhancement features also were evaluated. Options to the hemi-marsh feature included a 2-year levee without water control; a 2-year levee with water control; and a 5-year levee with water control. Options to the Upper Lake included the whole area as a managed marsh; the whole area as a moist-soil unit; and a combination of managed marsh and moist soil. The WHAG analysis of these options is contained in figures D-1 through D-9 and tables D-1 and D-2.

The inter-agency WHAG/HEP team assessed the existing conditions of the project area utilizing the field evaluation sheets for each of the habitat types within the project area. The results are presented as Annual Habitat Units and Average Annual Habitat Units (AAHUs) values for the selected Target Years (TY) for the Upper and Lower Lake alternatives and construction of the hemi-marsh. The WHAG analysis evaluated selected target species from both aquatic and wetland habitat types to derive a representative picture of the existing conditions at Spring Lake. Future conditions without construction of the project were predicted for TY-1, TY-25, and TY-50 based on the existing conditions, successional changes in the habitat over time, and any management practices that may be implemented with or without the proposed project.

The remainder of this section provides the numerical assessment, while the "Discussion" section provides the narrative interpretation of the analysis.

The WHAG wetland matrix was used to determine wetland habitat value of the existing conditions (without project) and the three proposed management options for the upper unit of Spring Lake. Results are presented in table D-1 and figures D-1 through D-5. The HU and AAHU values for conditions without project through TY-50 reflect a gain in habitat for migratory waterfowl, as well as gains in HUs for wood duck, northern parula, and prothonotary warbler are also seen as a result of the maturing timber in the upper unit. The first option consists of managing the entire upper unit as a managed marsh (figure D-2). AAHUs for this alternative show a sizable increase for most evaluation species when compared to the without-project conditions. The second option consists of managing the entire area as a moist-soil unit (figure D-3). As expected, this alternative shows substantial increases in AAHUs for mallard and Canada goose, but AAHUs for other species drop well below that of the present habitat. The third option is a combination of the first two. The area would be divided into three distinct units. A series of earthen dikes and stoplog structure will be used to facilitate water control on the units.

Approximately 237 acres will be maintained as a managed marsh. The other two units of 160 acres and 138 acres will be managed as moist-soil units. To calculate AAHUs for this alternative, a WHAG analysis using 237 acres as a managed marsh and 298 acres as a moist-soil unit was performed (figures D-4 and D-5). The AAHUs were added together to provide the numerical information for Alternative 3 in table D-1. This option shows that by actively managing Upper Spring Lake partially as a managed marsh and partially as a moist-soil unit, habitat can be provided for species better suited for marsh habitat while simultaneously enhancing the area for migratory waterfowl. This meets the goals and objectives of enhancing habitat for the target species, yet still provides habitat diversity for other marsh-dwelling species.

In determining the impacts that the creation of a 108-acre hemi-marsh feature would have on habitat, the WHAG wetland matrix was used. Three options were compared to future without-project conditions (figure D-6) to measure the benefits derived by each option (table D-2). The first option, a 2-year levee without water control (figure D-7), shows only a slight increase for some of the evaluation species. The second option, a 2-year levee with water control (figure D-8), indicates a substantial increase in AAHUs over the 50-year period of analysis for several species. The third option, a 5-year levee with water control (figure D-9), indicates similar increases in the AAHUs as the second option. Both of these options provide significant increases in habitat for the widest range of species. Since options 2 and 3 appear almost identical in the benefits derived and the cost in constructing the 5-year levee is three times that of constructing a 2-year levee, option 3 is not considered to be viable.

The WHAG aquatic matrix (MOFISH) was used to determine relative fisheries values of the Spring Lake area under existing conditions and future with- and without-project scenarios. The aquatic habitat in Spring Lake is limited to the Lower Lake since the Upper Lake is drawn down to grow food for migratory waterfowl. Comparison of the AAHUs calculated for the aquatic habitat analysis (figures D-10 and D-11) indicates a substantial increase in habitat for all of the evaluation species. Table D-3 illustrates the changes in AAHUs for the aquatic species in Lower Spring Lake. For the purpose of comparing AAHUs without-project to AAHUs with-project conditions, all HSIs of 0.1 were multiplied by the amount of available habitat. Therefore, for this analysis each evaluation species having an HSI value of 0.1 is assumed to have AAHUs of 241.4. The aquatic habitat benefits derived from implementing the project are not only substantially greater than conditions without project, but they are also unlikely to significantly decrease over time. This indicates that benefits to the aquatic habitat will extend beyond the period of analysis used for this project.

DISCUSSION

This section is intended to interpret the numerical results of the WHAG analysis into a narrative format that will provide insight as to how the numbers were derived and what they mean in terms of the predicted outcome of the project.

Results of WHAG application for the proposed alternatives were compared as increments to costs where applicable. This incremental analysis is discussed in the Definite Project Report in Section 7 - Evaluation of Alternatives.

The Spring Lake project is a combination of several features under the umbrella of the perimeter levee improvement. While sedimentation is not anticipated to be a significant factor in future habitat degradation in the project area, levee improvements are needed to ensure the successful implementation and longevity of the habitat benefits. The upstream levee breach, originally part of the levee improvements proposed for the Spring Lake HREP, was repaired in 1991 using dredged material from nearby channel maintenance operations.

The upper unit improvements and the hemi-marsh are oriented to wildlife, while the lower unit features will be most beneficial to fish. Both the upper unit features and the hemi-marsh provide flexibility for the management of these areas to provide benefits to a wide range of species. It is clear in the WHAG analysis that managing the entire Upper Lake as a single unit, or under a single management strategy, is unsatisfactory in terms of objectives for migratory waterfowl and habitat diversity as well as an impractical size for intensive management. The dividing levees, stoplog structures, two-way pump station, and integrated wetland management strategy provide the most flexibility and habitat benefits. Although option 1 provides more total AAHUs than other alternatives, the target species of mallard and Canada goose are not increased significantly. While option 2 provides the most benefits in AAHUs for the target species, it also eliminates habitat for other species. Option 3 meets the goals and objectives of enhancing habitat for the target species, yet still provides habitat diversity for other marsh-dwelling species.

CONCLUSION

For this project, HU accounting using WHAG/AHAG provides adequate qualification necessary to portray planning and design rationale of habitat enhancement projects.

Further modification of the AHAG models will include age class variables: spawning, rearing, adult, and development of additional aquatic models for additional lentic and lotic habitats.

In conclusion, the WHAG methodology determined that habitat improvements to the Spring Lake wetland environment via water level control through well and stoplog structure features allows the refuge managers to maximize benefits in the Upper Spring Lake area and hemi-marsh. This will provide control of unwanted vegetation, such as woody encroachment, by manipulating water levels during critical periods of the growing season. In addition, the WHAG demonstrated that the most environmentally sound option for Upper Spring Lake was creating both managed marsh and moist-soil units. This option provided significant increases in benefits for target species, while maintaining benefits for other marsh-dwelling species.

Table D-1. Average Annual Habitat Units for without project conditions and the three proposed management alternatives for the Upper Unit of Spring Lake. Total acreage is 560 acres.

SPECIES	Without Project	Alt. 1*	Alt. 2**	Alt. 3***
Mallard	114.3	214.2	395.4	288.3
Canada goose	113.2	211.7	367.0	273.2
Least Bittern	482.3	424.8	60.5	214.3
Lesser Yellowlegs	214.6	361.0	57.8	184.0
Muskrat	259.6	439.7	58.2	217.8
King rail	351.7	391.7	59.1	198.5
Green-backed heron	340.9	375.1	58.8	191.2
Wood duck	3.5	-----	-----	-----
Beaver	13.1	0.1	0.1	0.2
American Coot	372.4	411.8	58.4	206.3
Northern parula	3.5	-----	-----	-----
Proth warbler	3.7	-----	-----	-----

* Managed Marsh
** Moist Soil
*** 237 acres managed marsh; 298 acres moist soil

Table D-2. Average Annual Habitat Units for the existing conditions and the three alternatives for the 108 acre hemi-marsh.

SPECIES	Without Project	2YR	2YR/C	5YR/C
Mallard	-----	-----	24.0	26.2
Canada goose	-----	-----	24.4	25.9
Least bittern	89.9	94.1	73.1	65.1
Lesser yellowlegs	-----	-----	72.4	65.5
Muskrat	16.7	37.9	84.0	91.4
King rail	-----	-----	38.2	41.6
Green-backed heron	55.8	54.6	80.4	86.0
Wood duck	-----	-----	-----	-----
Beaver	-----	-----	-----	-----
American coot	81.3	81.5	88.7	87.7
Northern parula	-----	-----	-----	-----
Prothonotary warbler	-----	-----	-----	-----

Table D-3. HSI's and AAHU's of the fish evaluation species for future without and future with project conditions.

SPECIES	Fut w/out HSI	AAHU's Acres	Future w/ HSI	AAHU's Acres
Largemouth bass	0.10	241.4	0.49	1173.5
Channel catfish	0.10	241.4	0.45	1071.2
Walleye	0.10	241.4	0.55	1326.8

For the purpose of comparing AAHU's without project to AAHU's with project conditions, all HSI's of 0.1 were multiplied by the amount of available habitat. Therefore, for this analysis each evaluation species having a HSI value of 0.1 is assumed to have AAHU's of 241.4. The aquatic habitat benefits derived from implementing the project are not only substantially greater than conditions without project, but they are also unlikely to significantly decrease over time. This indicates that benefits to the aquatic habitat will extend beyond the period of analysis used for this project.

TABLE D-4

WILDLIFE HABITAT APPRAISAL GUIDE - NONFOREST WETLAND

WILDLIFE AREA________________________ DATE ________________
SAMPLE SITE__________________________

1 ___ PERCENT NONFOREST WETLANDS (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

2 ___ PERCENT NONFOREST WETL, ANNUALLY FLOODED CROPLD AND LAKES OR RESERVOIRS (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

3 ___ PERCENT BOTTOML HARDW, ANNUALLY FLOODED CROPLAND & NONFOREST WETLAND (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

4 ___ FALL AND WINTER WATER CONDITIONS (1)ANNUALLY - PREDICTABLE & CONTROLLED (2)MOST YEARS & CONTROLLED (3)1 OUT OF 3 YEARS & CONTROLLED (4)IRREGULAR, UNPREDICTABLE; DRY IN FALL; OR NO CONTROL WHEN PRESENT

5 ___ FALL AND WINTER FLOOD CONDITIONS (1)FOOD PLANTS UNAFFECTED BY FLOODS (2)REDUCED <25; OR 1 IN 4 YRS. (3)REDUCED 25-50; OR 2 IN 4 YRS. (4)REDUCED 50-75; OR 3 IN 4 YRS. (5)REDUCED >75; OR YEARLY

6 ___ WATER DEPTH 4-18 IN FOR FALL-WINTER (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)<25

7 ___ WATER DEPTH <4 IN MAY-JUNE (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)<25

8 ___ WATER DEPTH 4-18 INCHES BY AUGUST (1)>75 (2)50-75 (3)25-50 (4)<25

9 ___ PERMANENT WATER ENTIRE YEAR (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)<25

10 ___ PERCENT EMERGENT VEGETATION W/IN 2YDS WATER (1)>75 (2)50-75 (3)25-50 (4)<25

11 ___ WOODY INVASION (1)<10 (2)10-25 (3)25-50 (4)50-75 (5)>75

12 ___ EMERGENT VEGETATION COVERAGE (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)10-25 (6)<10

13 ___ CATTAIL AND BULLRUSH COVERAGE (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

14 ___ WETLAND SIZE-ACRES (1)>200 (2)100-200 (3)50-100 (4)25-50 (5)5-25 (6)<5

15 ___ WETLAND EDGE (% WOODY OR ADJ BOTTOML HARDW) (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

16 ___ WATER REGIME - GRADUAL DRYING WITH % WATER REMAINING BY AUG. 1 (1)>75 (2)50-75 (3)25-50 (4)<25 (5)STABLE WATER (6)RAPID DRYING; OR NO WATER AFTER JUNE 1

17 ___ IMPORTANT FOOD PLANT COVERAGE (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

18 ___ PLANT DIVERSITY (1)7 (2)4-7 (3)<4

19 ___ PERSISTENT EMERGENT AND WOODY COVERAGE (1)5-15 (2)15-25 (3)25-50 (4)<5 OR >50

20 ___ SUBSTRATE-SURFACE WATER INTERSPERSION (1)SUBSTRATE WATER INTERSPERSED (2)SHALLOW WATER AS 1 OR FEW POOLS

21 ___ PERCENT OPEN WATER (<50% CANOPY COVERAGE VEGETATION) (1)<10 (2)10-25 (3)25-50 (4)50-90 (5)>90

22 ___ WINTER WATER DEPTH OCT-MARCH (1)15-24 IN (2)10-15 (3)6-10 IN OR 30-36 IN (4)<6 IN OR >36 IN

23 ___ SEDGE CANOPY COVERAGE (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)1-25 (6)ZERO

24 ___ WETLAND SUBSTRATE (1)MUDDY (2)SANDY (3)GRAVEL

	TY	TY	TY
1			
2			
3			
4			
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MATRIX WETLAND 10-28-1991

TABLE D-4 (Cont'd)

WILDLIFE HABITAT APPRAISAL GUIDE - NONFOREST WETLAND

WILDLIFE AREA______________________ DATE ______________
SAMPLE SITE________________________

25 ___PERCENT SOIL WATERLOGGED MAY-JUNE (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)<25

26 ___PERCENT EXPOSED SUBSTRATE AND SHALLOW WATER AREAS WITH VEGETATION MAY-JUNE (1)<10 (BARE GROUND OR OPEN WATER) (2)10-25 (3)25-50 (4)50-75 (5)75-90 (6)>90 (WELL VEGETATED)

49 ___DISTANCE BOTTOMLAND HARDWOODS (1)<1/4 MI FLOODING PREDICT
(2)1/4-1/2 MI FLOOD PREDICT (3)1/2-1 MI FLOODING PREDICT
(4)<1/4 MI FLOODING PREDICT 1 OUT OF 3 YEARS
(5)1/4-1/2 MI FLOODING PREDICT 1 OUT OF 3 YEARS
(6)1/2-1 MI FLOODING PREDICT 1 OUT OF 3 YEARS
(7)>1 MI; OR <1 MI FLOODING UNPREDICTABLE

50 ___DISTANCE CROPLAND (1)<1/4 MI, UNHARV AND FLOODING PREDICT
(2)<1/4-1/2 MI, UNHARV AND FLOODING PREDICT
(3)1/2-1 MI UNHARV AND FLOODING PREDICT
(4)<1/4 MI, UNHARV AND FLOODING PREDICT 1 OUT OF 3 YEARS; OR <1/4 MI UNFLOODED RESIDUES UNDISTURB
(5)1/4-1/2 MI UNHARV AND FLOODING PREDICT 1 OUT OF 3 YEARS; OR 1/4-1/2 MI UNFLOODED RESIDUES UNDISTURB
(6)1/2-1 MI UNHARV AND FLOODING PREDICT 1 OUT OF 3 YEARS; OR 1/2-1 MI UNFLOODED RESIDUES UNDISTURBED
(7)>1 MI TO CROPFIELD; OR <1 MI UNFLOODED DISC OR PLOW

51 ___DISTANCE GRASSLAND (1)<1/2 MI <6 IN AND >40 AC
(2)1/2-1 MI <6 IN AND >40 AC (3)<1 MI <6 IN AND <40 AC
(4)>1 MI; OR >6 IN

52 ___DISTANCE STREAM OR RIVER (1)<1/4 MI (2)1/4-1/2 MI (3)>1/2 MI

53 ___DISTANCE MAJOR RIVER OR LAKE >100 AC (1)<1 MI (2)1-5 MI (3)5-10 MI (4)>10 MI

54 ___DISTANCE FALL GOOSE CONCENTRATION AREA (1)<1/4 MI (2)4-10 MI (3)10-25 MI (4)>25 MI

	TY	TY	TY
25			
26			
49			
50			
51			
52			
53			
54			

MATRIX WETLAND 10-28-1991

WILDLIFE HABITAT APPRAISAL GUIDE -BOTTOMLAND HARDWOODS-WETLAND

WILDLIFE AREA________________________ DATE__________

SAMPLE SITE____

PLAN :____

TY___ TY___ TY___ TY___ TY___

1___PERCENT NONFOREST WETLANDS (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

2___PERCENT NONFOREST WETL AND LAKES OR RESERVOIRS (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

3___PERCENT BOTTOML HARDW & NONFOREST WETL (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

4___FALL AND WINTER WATER CONDITIONS (1)ANNUALLY - PREDICTABLE & CONTROLLED (2)MOST YEARS & CONTROLLED (3)1 OUT OF 3 YEARS & CONTROLLED (4)IRREGULAR, UNPREDICTABLE; DRY IN FALL; OR NO CONTROL WHEN PRESENT

5___FALL AND WINTER FLOOD CONDITIONS (1)FOOD PLANTS UNAFFECTED BY FLOODS (2)REDUCED <25; OR 1 IN 4 YRS. (3)REDUCED 25-50; OR 2 IN 4 YRS. (4)REDUCED 50-75; OR 3 IN 4 YRS. (5)REDUCED >75; OR YEARLY

6___WATER DEPTH 4-18 IN FOR FALL-WINTER (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)<25

12___EMERGENT VEGETATION COVERAGE (1)>90 (2)75-90 (3)50-75 (4)25-50 (5)10-25 (6)<10

14___WETLAND SIZE-ACRES (1)>200 (2)100-200 (3)50-100 (4)25-50 (5)5-25 (6)<5

15___WETLAND EDGE (% WOODY OR ADJ BOTTOML HARDW) (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

17___IMPORTANT FOOD PLANT COVERAGE (1)>75 (2)50-75 (3)25-50 (4)10-25 (5)<10

18___PLANT DIVERSITY (1)7 (2)4-7 (3)<4

27___PERCENT CHANNEL WITH AQUATIC VEGETATION 1/4 MI UP & DOWN STREAM (1)>10 (2)5-10 (3)1-5 (4)NONE

28___WATER FLUCTUATION IN CHANNEL-BANK FULL PER YEAR (1)<3 (2)3-5 (3)5-7 (4)>7

35___WOODLAND TREE SPECIES (1)>50% E,W,C,S,WI,M,A (2)25-50% E,W,C,S,WI,M,A (3)<25% E,W,C,S,WI,M,A; OR <25% PIN OAK (4)25-50% PIN OAK (5)>50% PIN OAK

36___PERMANENT WATER IN WOODLAND (% FOREST FLOOR) (1)>25 (2)10-25 (3)5-10 (4)1-5 (5)ZERO

37___FOREST OPENINGS (<2 AC) (1)15-30% SCATTER (2)15-30 ONE OR FEW (3)5-15 (4)<5 OR >50

38___WOODLAND SIZE CLASS (1)SAWTIMBER-OPEN CANOPY (2)SAWTIMBER-CLOSED CANOPY (3)POLE + 25-50% SAWTIM (4)REGEN + 25-50% SAWTIM (5)REGEN (6)POLE

39___PERCENT CANOPY OLD GROWTH (DBH >16 IN) (1)>25 (2)10-25 (3)5-10 (4)1-5 (5)ZERO

40___FOREST OVERSTORY CANOPY HEIGHT (1)>80 FT (2)65-80 FT (3)40-65 FT (4)<40 FT

41___PERCENT FOREST SUBCANOPY CLOSURE (1)>75 (2)50-75 (3)25-50 (4)<25

42___WOODLAND SIZE (% W/IN 660 FT OPEN) (1)<25 (2)25-50 (3)50-75 (4)>75

43___PERCENT CANOPY ADJ <250 FT OR OVER WATER (1)>25 (2)10-25 (3)5-10 (4)<5

44___NUMBER OF SNAGS PER ACRE (DEAD TREE >6 IN DBH & >10 FT TALL (1)>4 (2)3-4 (3)1-2 (4)<1

45___NUMBER OF CAVITY TREES PER ACRE (1)>9 (2)3-9 (3)1-3 (4)ZERO

46___STEMS PER SQ. YD. SHRUBS & TREE REPRODUCTION >3 FT TALL (1)>3 (2)1-3 (3).5-1 (4)<.5

47___PERCENT WOODLAND W/IN 660 FT WATER (1)75 (2)50-75 (3)25-50 (4)<25

CONTINUED NEXT PAGE

PAGE 2- FORESTED WETLAND

PLAN :____________________________________

TY___ TY___ TY___ TY___ TY___

48___DISTANCE NONFOREST WETL, OXBOW, SLOUGH (1)<250 FT FLOODING PREDICT
(2)250 FT-1/8 MI FLOODING PREDICT (3)1/8-1 MI FLOODING PREDICT
(4)<250 FT FLOODING PREDICT 1 OUT OF 3 YEARS
(5)250 FT-1/8 MI FLOODING PREDICT 1 OUT OF 3 YEARS
(6)1/8-1 MI FLOODING PREDICT 1 OUT OF 3 YEARS
(7)>1 MI; OR <1 MI FLOODING UNPREDICT

50___DISTANCE CROPLAND (1)<1/4 MI, UNHARV AND FLOODING PREDICT
(2)<1/4-1/2 MI, UNHARV AND FLOODING PREDICT
(3)1/2-1 MI UNHARV AND FLOODING PREDICT
(4)<1/4 MI, UNHARV AND FLOODING PREDICT 1 OUT OF 3 YEARS;
OR <1/4 MI UNFLOODED RESIDUES UNDISTURB
(5)1/4-1/2 MI UNHARV AND FLOODING PREDICT 1 OUT OF 3 YEARS;
OR 1/4-1/2 MI UNFLOODED RESIDUES UNDISTURB
(6)1/2-1 MI UNHARV AND FLOODING PREDICT 1 OUT OF 3 YEARS; OR
1/2-1 MI UNFLOODED RESIDUES UNDISTURBED
(7)>1 MI TO CROPFIELD; OR <1 MI UNFLOODED DISC OR PLOW

52___DISTANCE STREAM OR RIVER (1)<1/4 MI (2)1/4-1/2 MI (3)>1/2 MI

MATRIX WETLAND 10-18-1989

TABLE D-5

WILDLIFE HABITAT APPRAISAL GUIDE

FIELD SHEET LISTING - ALL HABITAT TYPES COMBINED

1 ___ INSTREAM COVER (1) >5 (2) 4-5 (3) 2-4 (4) <2 (5) ZERO

2 ___ STREAMBANK CONDITION (1) 25-50% (2) 10-25% (3) 50-75% (4) <10% (5) >75%

3 ___ AQUATIC VEGETATION (1) 10-25% (2) 25-50% (3) 50-75% (4) <10% (5)>75%

4 ___ SUBSTRATE (1) UNCONSOLIDATED SAND (2) BEDROCK (3) GRAVEL & SAND <1INCH (4) GRAVEL & BOULDERS >1INCH (5) SILT (6) CLAY

5 ___ % AQUATIC/OPEN WATER > 4 FEET: (1)50-75% (2)75-90% (3)25-50% (4)>90% (5)10-25% (6)<10%

6 ___ AVERAGE VELOCITY FT/SEC MAY-SEPT (1)NO FLOW (2) <0.5 (3) >2.0 (4) 2-5

7 ___ PERCENT SHORELINE SHADED BY OVERSTORY TREES (1) >90% (2) 75-90% (3) 50-75% (4) 25-50% (5) <25%

8 ___ LOWEST DAILY DISSOLVED OXYGEN (1) <3 (2) 3-5 (3) >5

9 ___ WATER LEVEL STABILITY MAY-JUNE (1)RISING WATER LEVELS AND INUNDATED VEGETATION (2) STABLE WATER OR NO INUNDATED VEGETATION (3)DECLINE IN WATER LEVEL < 2 FT (4) DECLINE IN WATER LEVEL > 2 FT

10 ___ACCESS TO WATER >6 FT DEEP NOV-APR (1) YES (2) NO

11 ___PERCENT AREA WITH RIP RAP >12 IN.: (1) ABSENT (2)1-5% (3)5-20% (4)>20%

12 ___AVERAGE DEPTH OF AQUATIC HABITAT IN PROJECT AREA: (1)<1 FT. (2)1-3 FT (3)3-6 FT (4)>6 FT

13 ___AVERAGE VELOCITY DEC-FEB: (1)NO FLOW-OXYGEN NOT LIMITED (2)0-0.2 FT/SEC (3) NO FLOW-OXYGEN LIMITED

MATRIX SLFISH 02-14-1992

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

UPPER SPRING LAKE

FUTURE WITHOUT PROJECT CONDITIONS

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = UPSPLAKE	4	SPRING LAKE HREP
TARGET YR 1 = UPSPWOP	4	1NFW
TARGET YR 25 = UPSPWOP	4	1NFW
TARGET YR 50 = UPSPWOP	4	1NFW

FILE UPSPWOP CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND   TODAY'S DATE 02-13-1992

THESE DATA SETS ARE FOR FUTURE WITHOUT PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	540	540	540	540
BOTTOMLAND HARDWOODS-W	20	20	20	20
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	560	560	560	560

FIGURE D-1

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
MALL	560.0	560.0	0.0%	560.0	0.0%	560.0	0.0%
GOOS	540.0	540.0	0.0%	540.0	0.0%	540.0	0.0%
BITT	540.0	540.0	0.0%	540.0	0.0%	540.0	0.0%
YLEG	540.0	540.0	0.0%	540.0	0.0%	540.0	0.0%
MUSK	540.0	540.0	0.0%	540.0	0.0%	540.0	0.0%
RAIL	540.0	540.0	0.0%	540.0	0.0%	540.0	0.0%
HERO	560.0	560.0	0.0%	560.0	0.0%	560.0	0.0%
DUCK	20.0	20.0	0.0%	20.0	0.0%	20.0	0.0%
BEAV	20.0	20.0	0.0%	20.0	0.0%	20.0	0.0%
COOT	540.0	540.0	0.0%	540.0	0.0%	540.0	0.0%
PARU	20.0	20.0	0.0%	20.0	0.0%	20.0	0.0%
PROT	20.0	20.0	0.0%	20.0	0.0%	20.0	0.0%

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

SPECIES	PRESENT INDEX	T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
MALL	0.14	0.14	0.0%	0.22	57.3%	0.23	59.1%
GOOS	0.15	0.15	0.0%	0.23	58.6%	0.23	59.9%
BITT	0.93	0.93	0.0%	0.90	-3.1%	0.84	-9.2%
YLEG	0.43	0.43	0.0%	0.44	2.7%	0.28	-35.2%
MUSK	0.50	0.50	0.0%	0.52	4.1%	0.39	-21.9%
RAIL	0.66	0.66	0.0%	0.65	-2.2%	0.65	-2.2%
HERO	0.60	0.60	0.0%	0.61	2.5%	0.61	2.4%
DUCK	0.10	0.10	0.0%	0.10	0.0%	0.41	309.1%
BEAV	0.64	0.64	0.0%	0.67	4.9%	0.63	-1.6%
COOT	0.54	0.54	0.0%	0.75	39.2%	0.72	32.3%
PARU	0.10	0.10	0.0%	0.10	0.0%	0.40	300.0%
PROT	0.10	0.10	0.0%	0.10	0.0%	0.44	341.0%

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

FIGURE D-1 (Cont'd)

HABITAT UNITS

SPECIES	PRESENT HU	T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
MALL	80.0	80.0	0.0%	125.9	57.3%	127.3	59.1%
GOOS	78.8	78.8	0.0%	125.0	58.6%	126.0	59.9%
BITT	501.4	501.4	0.0%	486.0	-3.1%	455.1	-9.2%
YLEG	231.9	231.9	0.0%	238.2	2.7%	150.4	-35.2%
MUSK	268.9	268.9	0.0%	280.1	4.1%	210.0	-21.9%
RAIL	357.4	357.4	0.0%	349.7	-2.2%	349.7	-2.2%
HERO	334.8	334.8	0.0%	343.3	2.5%	342.7	2.4%
DUCK						8.2	100.0%
BEAV	12.8	12.8	0.0%	13.5	4.9%	12.6	-1.6%
COOT	292.5	292.5	0.0%	407.3	39.2%	387.0	32.3%
PARU						8.0	100.0%
PROT						8.8	100.0%

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-1 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	114.3
CANADA GOOSE	113.2
LEAST BITTERN	482.3
LESSER YELLOWLEGS	214.6
MUSKRAT	259.6
KING RAIL	351.7
GREEN-BACKED HERON	340.9
WOOD DUCK	3.5
BEAVER	13.1
AMERICAN COOT	372.4
NORTHERN PARULA	3.5
PROTHONOTARY WARBLER	3.7

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-1 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

UPPER SPRING LAKE FUTURE WITH PROJEC

(1) CELL MANAGED MARSH OPTION

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = UPSPLAKE	4	SPRING LAKE HREP
TARGET YR 1 = SPLUPMM	1	SPRING LAKE
TARGET YR 25 = SPLUPMM	1	SPRING LAKE
TARGET YR 50 = SPLUPMM	1	SPRING LAKE

FILE SPLUPMM CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND   TODAY'S DATE 02-27-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	540	560	560	560
BOTTOMLAND HARDWOODS-W	20			
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	560	560	560	560

FIGURE D-2

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
MALL	560.0	560.0	0.0%	560.0	0.0%	560.0	0.0%
GOOS	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
BITT	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
YLEG	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
MUSK	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
RAIL	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
HERO	560.0	560.0	0.0%	560.0	0.0%	560.0	0.0%
DUCK	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
BEAV	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
PARU	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
PROT	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%

(TARGET YEARS)

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

SPECIES	PRESENT INDEX	T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
MALL	0.14	0.27	89.3%	0.42	196.3%	0.42	196.3%
GOOS	0.15	0.27	85.0%	0.42	186.3%	0.42	186.3%
BITT	0.93	0.76	-18.5%	0.76	-18.5%	0.76	-18.5%
YLEG	0.43	0.65	50.7%	0.65	50.7%	0.65	50.7%
MUSK	0.50	0.79	58.3%	0.79	58.3%	0.79	58.3%
RAIL	0.66	0.70	5.8%	0.70	5.8%	0.70	5.8%
HERO	0.60	0.67	12.2%	0.67	12.2%	0.67	12.2%
DUCK	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
BEAV	0.64	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
COOT	0.54	0.74	36.2%	0.74	36.2%	0.74	36.2%
PARU	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
PROT	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%

(TARGET YEARS)

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

FIGURE D-2 (Cont'd)

HABITAT UNITS

SPECIES	PRESENT HU	T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
				TARGET YEARS			
MALL	80.0	151.5	89.3%	237.2	196.3%	237.2	196.3%
GOOS	78.8	151.2	91.9%	234.0	196.9%	234.0	196.9%
BITT	501.4	424.0	-15.4%	424.0	-15.4%	424.0	-15.4%
YLEG	231.9	362.4	56.3%	362.4	56.3%	362.4	56.3%
MUSK	268.9	441.4	64.1%	441.4	64.1%	441.4	64.1%
RAIL	357.4	392.0	9.7%	392.0	9.7%	392.0	9.7%
HERO	334.8	375.5	12.2%	375.5	12.2%	375.5	12.2%
DUCK							
BEAV	12.8	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	292.5	413.0	41.2%	413.0	41.2%	413.0	41.2%
PARU							
PROT							

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-2 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDTIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	214.2
CANADA GOOSE	211.7
LEAST BITTERN	424.8
LESSER YELLOWLEGS	361.0
MUSKRAT	439.7
KING RAIL	391.7
GREEN-BACKED HERON	375.1
WOOD DUCK	
BEAVER	0.1
AMERICAN COOT	411.8
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-2 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

UPPER SPRING LAKE FUTURE WITH PROJECT

(1) CELL MOIST SOIL OPTION

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = UPSPLAKE	4	SPRING LAKE HREP
TARGET YR 1 = SPLUPMS	1	SPRING LAKE
TARGET YR 25 = SPLUPMS	1	SPRING LAKE
TARGET YR 50 = SPLUPMS	1	SPRING LAKE

FILE SPLUPMS CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND TODAY'S DATE 02-27-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	540	560	560	560
BOTTOMLAND HARDWOODS-W	20			
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	560	560	560	560

FIGURE D-3

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
MALL	560.0	560.0	0.0%	560.0	0.0%	560.0	0.0%
GOOS	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
BITT	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
YLEG	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
MUSK	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
RAIL	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
HERO	560.0	560.0	0.0%	560.0	0.0%	560.0	0.0%
DUCK	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
BEAV	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	540.0	560.0	3.7%	560.0	3.7%	560.0	3.7%
PARU	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
PROT	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%

TARGET YEARS

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

SPECIES	PRESENT INDEX	T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
MALL	0.14	0.62	337.1%	0.74	418.6%	0.74	418.6%
GOOS	0.15	0.59	301.8%	0.69	369.9%	0.69	369.9%
BITT	0.93	0.10	-89.2%	0.10	-89.2%	0.10	-89.2%
YLEG	0.43	0.10	-76.7%	0.10	-76.7%	0.10	-76.7%
MUSK	0.50	0.10	-79.9%	0.10	-79.9%	0.10	-79.9%
RAIL	0.66	0.10	-84.9%	0.10	-84.9%	0.10	-84.9%
HERO	0.60	0.10	-83.3%	0.10	-83.3%	0.10	-83.3%
DUCK	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
BEAV	0.64	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
COOT	0.54	0.10	-81.5%	0.10	-81.5%	0.10	-81.5%
PARU	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
PROT	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%

TARGET YEARS

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

FIGURE D-3 (Cont'd)

HABITAT UNITS

SPECIES	PRESENT HU	TARGET YEARS T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
MALL	80.0	349.8	337.1%	415.1	418.6%	415.1	418.6%
GOOS	78.8	328.3	316.6%	384.0	387.3%	384.0	387.3%
BITT	501.4	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
YLEG	231.9	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
MUSK	268.9	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
RAIL	357.4	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
HERO	334.8	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
DUCK							
BEAV	12.8	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	292.5	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
PARU							
PROT							

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-3 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDTIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	395.4
CANADA GOOSE	367.0
LEAST BITTERN	60.5
LESSER YELLOWLEGS	57.8
MUSKRAT	58.2
KING RAIL	59.1
GREEN-BACKED HERON	58.8
WOOD DUCK	
BEAVER	0.1
AMERICAN COOT	58.4
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-3 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

UPPER SPRING LAKE FUTURE WITH PROJECT

COMBINATION OPTION

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = UPSPLAKE	4	SPRING LAKE HREP
TARGET YR 1 = SPLUPMM	1	SPRING LAKE
TARGET YR 25 = SPLUPMM	1	SPRING LAKE
TARGET YR 50 = SPLUPMM	1	SPRING LAKE

FILE SPLUPMM CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND   TODAY'S DATE 02-13-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	540	237	237	237
BOTTOMLAND HARDWOODS-W	20			
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	560	237	237	237

FIGURE D-4

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
MALL	560.0	237.0	-57.7%	237.0	-57.7%	237.0	-57.7%
GOOS	540.0	237.0	-56.1%	237.0	-56.1%	237.0	-56.1%
BITT	540.0	237.0	-56.1%	237.0	-56.1%	237.0	-56.1%
YLEG	540.0	237.0	-56.1%	237.0	-56.1%	237.0	-56.1%
MUSK	540.0	237.0	-56.1%	237.0	-56.1%	237.0	-56.1%
RAIL	540.0	237.0	-56.1%	237.0	-56.1%	237.0	-56.1%
HERO	560.0	237.0	-57.7%	237.0	-57.7%	237.0	-57.7%
DUCK	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
BEAV	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	540.0	237.0	-56.1%	237.0	-56.1%	237.0	-56.1%
PARU	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
PROT	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%

(TARGET YEARS)

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

SPECIES	PRESENT INDEX	T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
MALL	0.14	0.27	89.3%	0.42	196.3%	0.42	196.3%
GOOS	0.15	0.27	85.0%	0.42	186.3%	0.42	186.3%
BITT	0.93	0.76	-18.5%	0.76	-18.5%	0.76	-18.5%
YLEG	0.43	0.65	50.7%	0.65	50.7%	0.65	50.7%
MUSK	0.50	0.79	58.3%	0.79	58.3%	0.79	58.3%
RAIL	0.66	0.70	5.8%	0.70	5.8%	0.70	5.8%
HERO	0.60	0.67	12.2%	0.67	12.2%	0.67	12.2%
DUCK	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
BEAV	0.64	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
COOT	0.54	0.74	36.2%	0.74	36.2%	0.74	36.2%
PARU	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
PROT	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%

(TARGET YEARS)

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

FIGURE D-4 (Cont'd)

HABITAT UNITS

SPECIES	PRESENT HU	T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
		TARGET YEARS					
MALL	80.0	64.1	-19.9%	100.4	25.4%	100.4	25.4%
GOOS	78.8	64.0	-18.8%	99.0	25.7%	99.0	25.7%
BITT	501.4	179.4	-64.2%	179.4	-64.2%	179.4	-64.2%
YLEG	231.9	153.4	-33.9%	153.4	-33.9%	153.4	-33.9%
MUSK	268.9	186.8	-30.5%	186.8	-30.5%	186.8	-30.5%
RAIL	357.4	165.9	-53.6%	165.9	-53.6%	165.9	-53.6%
HERO	334.8	158.9	-52.5%	158.9	-52.5%	158.9	-52.5%
DUCK							
BEAV	12.8	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	292.5	174.8	-40.2%	174.8	-40.2%	174.8	-40.2%
PARU							
PROT							

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-4 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDTIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	91.2
CANADA GOOSE	90.2
LEAST BITTERN	182.5
LESSER YELLOWLEGS	154.4
MUSKRAT	187.9
KING RAIL	167.9
GREEN-BACKED HERON	160.8
WOOD DUCK	
BEAVER	0.1
AMERICAN COOT	176.2
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-4 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

UPPER SPRING LAKE

FUTURE WITH PROJECT COMBINATION OPTION

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = UPSPLAKE	4	SPRING LAKE HREP
TARGET YR 1 = SPLUPMS	1	SPRING LAKE
TARGET YR 25 = SPLUPMS	1	SPRING LAKE
TARGET YR 50 = SPLUPMS	1	SPRING LAKE

FILE SPLUPMS CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND TODAY'S DATE 02-13-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	540	278	278	278
BOTTOMLAND HARDWOODS-W	20	20	20	20
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	560	298	298	298

FIGURE D-5

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
		TARGET YEARS					
MALL	560.0	278.0	-50.4%	278.0	-50.4%	278.0	-50.4%
GOOS	540.0	278.0	-48.5%	278.0	-48.5%	278.0	-48.5%
BITT	540.0	278.0	-48.5%	278.0	-48.5%	278.0	-48.5%
YLEG	540.0	278.0	-48.5%	278.0	-48.5%	278.0	-48.5%
MUSK	540.0	278.0	-48.5%	278.0	-48.5%	278.0	-48.5%
RAIL	540.0	278.0	-48.5%	278.0	-48.5%	278.0	-48.5%
HERO	560.0	278.0	-50.4%	278.0	-50.4%	278.0	-50.4%
DUCK	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
BEAV	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	540.0	278.0	-48.5%	278.0	-48.5%	278.0	-48.5%
PARU	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
PROT	20.0	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

SPECIES	PRESENT INDEX	T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
		TARGET YEARS					
MALL	0.14	0.62	337.1%	0.74	418.6%	0.74	418.6%
GOOS	0.15	0.59	301.8%	0.69	369.9%	0.69	369.9%
BITT	0.93	0.10	-89.2%	0.10	-89.2%	0.10	-89.2%
YLEG	0.43	0.10	-76.7%	0.10	-76.7%	0.10	-76.7%
MUSK	0.50	0.10	-79.9%	0.10	-79.9%	0.10	-79.9%
RAIL	0.66	0.10	-84.9%	0.10	-84.9%	0.10	-84.9%
HERO	0.60	0.10	-83.3%	0.10	-83.3%	0.10	-83.3%
DUCK	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
BEAV	0.64	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
COOT	0.54	0.10	-81.5%	0.10	-81.5%	0.10	-81.5%
PARU	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%
PROT	0.10	0.00	-100.0%	0.00	-100.0%	0.00	-100.0%

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

FIGURE D-5 (Cont'd)

HABITAT UNITS

SPECIES	PRESENT HU	T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
MALL	80.0	173.7	117.0%	206.0	157.4%	206.0	157.4%
GOOS	78.8	163.0	106.8%	190.6	141.9%	190.6	141.9%
BITT	501.4	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
YLEG	231.9	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
MUSK	268.9	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
RAIL	357.4	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
HERO	334.8	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
DUCK							
BEAV	12.8	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
COOT	292.5	0.0	-100.0%	0.0	-100.0%	0.0	-100.0%
PARU							
PROT							

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-5 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDTIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	197.1
CANADA GOOSE	183.0
LEAST BITTERN	31.8
LESSER YELLOWLEGS	29.6
MUSKRAT	29.9
KING RAIL	30.6
GREEN-BACKED HERON	30.4
WOOD DUCK	
BEAVER	0.1
AMERICAN COOT	30.1
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-5 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

HEMIMARSH WITHOUT PROJECT CONDITIONS

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = HEMILAKE	1	SPRING LAKE HREP
TARGET YR 1 = HEMIWOP	1	SPRING LAKE
TARGET YR 25 = HEMIWOP	1	SPRING LAKE
TARGET YR 50 = HEMIWOP	1	SPRING LAKE

FILE HEMIWOP CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND TODAY'S DATE 03-19-1992

THESE DATA SETS ARE FOR FUTURE WITHOUT PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	108	108	108	108
BOTTOMLAND HARDWOODS-W				
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	108	108	108	108

FIGURE D-6

ACRES OF AVAILABLE HABITAT

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	ACRES	ACRES	% CHANGE	ACRES	% CHANGE	ACRES	% CHANGE
MALL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
GOOS	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
BITT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
YLEG	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
MUSK	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
RAIL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
HERO	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
DUCK							
BEAV							
COOT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
PARU							
PROT							

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	INDEX	INDEX	% CHANGE	INDEX	% CHANGE	INDEX	% CHANGE
MALL	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
GOOS	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
BITT	0.84	0.84	0.0%	0.81	-3.4%	0.86	1.7%
YLEG	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
MUSK	0.16	0.16	0.0%	0.16	-1.9%	0.15	-7.4%
RAIL	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
HERO	0.48	0.48	0.0%	0.54	12.2%	0.51	4.9%
DUCK							
BEAV							
COOT	0.76	0.76	0.0%	0.76	0.0%	0.73	-4.9%
PARU							
PROT							

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

FIGURE D-6 (Cont'd)

HABITAT UNITS

SPECIES	PRESENT HU	T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
1ALL							
300S							
3ITT	91.0	91.0	0.0%	87.9	-3.4%	92.6	1.7%
'LEG							
4USK	17.2	17.2	0.0%	16.8	-1.9%	15.9	-7.4%
RAIL							
IERO	52.1	52.1	0.0%	58.4	12.2%	54.6	4.9%
JUCK							
3EAV							
300T	82.4	82.4	0.0%	82.4	0.0%	78.3	-4.9%
'ARU							
'ROT							

(Column group header: TARGET YEARS — T YR 1, T YR 25, T YR 50)

IABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
:F MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-6 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	
CANADA GOOSE	
LEAST BITTERN	89.9
LESSER YELLOWLEGS	
MUSKRAT	16.7
KING RAIL	
GREEN-BACKED HERON	55.8
WOOD DUCK	
BEAVER	
AMERICAN COOT	81.3
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-6 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

HEMI-MARSH FUTURE WITH PROJECT

2-YR LEVEE WITHOUT WATER CONTROL

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = HEMILAKE	1	SPRING LAKE HREP
TARGET YR 1 = HEMI2YR	1	SPRING LAKE
TARGET YR 25 = HEMI2YR	1	SPRING LAKE
TARGET YR 50 = HEMI2YR	1	SPRING LAKE

FILE HEMI2YR CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND   TODAY'S DATE 03-19-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	108	108	108	108
BOTTOMLAND HARDWOODS-W				
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	108	108	108	108

FIGURE D-7

ACRES OF AVAILABLE HABITAT

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	ACRES	ACRES	% CHANGE	ACRES	% CHANGE	ACRES	% CHANGE
MALL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
GOOS	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
BITT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
YLEG	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
MUSK	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
RAIL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
HERO	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
DUCK							
BEAV							
COOT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
PARU							
PROT							

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

FIGURE D-7 (Cont'd)

MEAN HABITAT SUITABILITY INDEX (HSI)

SPECIES	PRESENT INDEX	TARGET YEARS T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
MALL	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
GOOS	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
BITT	0.84	0.87	3.4%	0.87	3.4%	0.87	3.4%
YLEG	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
MUSK	0.16	0.35	122.2%	0.35	122.2%	0.35	122.2%
RAIL	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
HERO	0.48	0.51	4.9%	0.51	4.9%	0.51	4.9%
DUCK							
BEAV							
COOT	0.76	0.75	-1.6%	0.75	-1.6%	0.75	-1.6%
PARU							
PROT							

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

HABITAT UNITS

SPECIES	PRESENT HU	TARGET YEARS T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
MALL							
GOOS							
BITT	91.0	94.1	3.4%	94.1	3.4%	94.1	3.4%
YLEG							
MUSK	17.2	38.1	122.2%	38.1	122.2%	38.1	122.2%
RAIL							
HERO	52.1	54.6	4.9%	54.6	4.9%	54.6	4.9%
DUCK							
BEAV							
COOT	82.4	81.0	-1.6%	81.0	-1.6%	81.0	-1.6%
PARU							
PROT							

FIGURE D-7 (Cont'd)

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDTIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	
CANADA GOOSE	
LEAST BITTERN	94.1
LESSER YELLOWLEGS	
MUSKRAT	37.9
KING RAIL	
GREEN-BACKED HERON	54.6
WOOD DUCK	
BEAVER	
AMERICAN COOT	81.0
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-7 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

HEMI-MARSH FUTURE WITH PROJECT

2-YR LEVEE WITH WATER CONTROL

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = HEMILAKE	1	SPRING LAKE HREP
TARGET YR 1 = HEMI2YRC	1	SPRINGLAKE
TARGET YR 25 = HEMI2YRC	1	SPRINGLAKE
TARGET YR 50 = HEMI2YRC	1	SPRINGLAKE

FILE HEMI2YRC CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND   TODAY'S DATE 03-19-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT	TARGET YEARS		
	0	1	25	50
NONFOREST WETLAND	108	108	108	108
BOTTOMLAND HARDWOODS-W				
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	108	108	108	108

FIGURE D-8

					TARGET YEARS		
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	ACRES	ACRES	% CHANGE	ACRES	% CHANGE	ACRES	% CHANGE
MALL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
GOOS	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
BITT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
YLEG	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
MUSK	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
RAIL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
HERO	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
DUCK							
BEAV							
COOT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
PARU							
PROT							

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES
(NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

FIGURE D-8 (Cont'd)

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	INDEX	INDEX	% CHANGE	INDEX	% CHANGE	INDEX	% CHANGE
MALL	0.10	0.12	20.6%	0.26	158.8%	0.26	158.8%
GOOS	0.10	0.12	24.3%	0.26	161.4%	0.26	161.4%
BITT	0.84	0.73	-13.6%	0.66	-22.0%	0.66	-22.0%
YLEG	0.10	0.66	558.8%	0.68	582.4%	0.68	582.4%
MUSK	0.16	0.82	413.3%	0.77	386.7%	0.77	386.7%
RAIL	0.10	0.10	0.0%	0.44	342.9%	0.44	342.9%
HERO	0.48	0.73	51.2%	0.75	56.1%	0.75	56.1%
DUCK							
BEAV							
COOT	0.76	0.85	11.5%	0.81	6.6%	0.81	6.6%
PARU							
PROT							

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

HABITAT UNITS

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	HU	HU	% CHANGE	HU	% CHANGE	HU	% CHANGE
MALL		13.0	100.0%	28.0	100.0%	28.0	100.0%
GOOS		13.4	100.0%	28.2	100.0%	28.2	100.0%
BITT	91.0	78.7	-13.6%	71.0	-22.0%	71.0	-22.0%
YLEG		71.2	100.0%	73.7	100.0%	73.7	100.0%
MUSK	17.2	88.1	413.3%	83.5	386.7%	83.5	386.7%
RAIL				47.8	100.0%	47.8	100.0%
HERO	52.1	78.8	51.2%	81.3	56.1%	81.3	56.1%
DUCK							
BEAV							
COOT	82.4	91.8	11.5%	87.8	6.6%	87.8	6.6%
PARU							
PROT							

FIGURE D-8 (Cont'd)

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDTIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	24.0
CANADA GOOSE	24.4
LEAST BITTERN	73.1
LESSER YELLOWLEGS	72.4
MUSKRAT	84.0
KING RAIL	38.2
GREEN-BACKED HERON	80.4
WOOD DUCK	
BEAVER	
AMERICAN COOT	88.7
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-8 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	N	NONFOREST WETLAND
2	B	BOTTOMLAND HARDWOODS-WETLAND
3	C	CROPLAND-WETLAND
4	G	GRASSLAND-WETLAND

HEMI-MARSH FUTURE WITH PROJECT

5-YR LEVEE WITH WATER CONTROL

SPECIES ABREVIATIONS

1	MALL	MALLARD	7	HERO	GREEN-BACKED HERON
2	GOOS	CANADA GOOSE	8	DUCK	WOOD DUCK
3	BITT	LEAST BITTERN	9	BEAV	BEAVER
4	YLEG	LESSER YELLOWLEGS	10	COOT	AMERICAN COOT
5	MUSK	MUSKRAT	11	PARU	NORTHERN PARULA
6	RAIL	KING RAIL	12	PROT	PROTHONOTARY WARBLER

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = HEMILAKE	1	SPRING LAKE HREP
TARGET YR 1 = HEMI5YRC	1	SPRING LAKE
TARGET YR 25 = HEMI5YRC	1	SPRING LAKE
TARGET YR 50 = HEMI5YRC	1	SPRING LAKE

FILE HEMI5YRC CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX WETLAND TODAY'S DATE 03-19-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
NONFOREST WETLAND	108	108	108	108
BOTTOMLAND HARDWOODS-W				
CROPLAND-WETLAND				
GRASSLAND-WETLAND				
TOTAL	108	108	108	108

FIGURE D-9

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	ACRES	ACRES	% CHANGE	ACRES	% CHANGE	ACRES	% CHANGE
MALL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
GOOS	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
BITT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
YLEG	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
MUSK	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
RAIL	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
HERO	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
DUCK							
BEAV							
COOT	108.0	108.0	0.0%	108.0	0.0%	108.0	0.0%
PARU							
PROT							

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

FIGURE D-9 (Cont'd)

SPECIES	PRESENT INDEX	T YR 1 INDEX	T YR 1 % CHANGE	T YR 25 INDEX	T YR 25 % CHANGE	T YR 50 INDEX	T YR 50 % CHANGE
				TARGET YEARS			
MALL	0.10	0.13	29.4%	0.28	182.4%	0.28	182.4%
GOOS	0.10	0.13	30.7%	0.28	178.6%	0.28	178.6%
BITT	0.84	0.73	-13.6%	0.56	-33.9%	0.56	-33.9%
YLEG	0.10	0.58	476.5%	0.62	523.5%	0.62	523.5%
MUSK	0.16	0.93	485.2%	0.84	425.9%	0.81	411.1%
RAIL	0.10	0.10	0.0%	0.47	371.4%	0.51	414.3%
HERO	0.48	0.73	51.2%	0.82	70.7%	0.82	70.7%
DUCK							
BEAV							
COOT	0.76	0.95	24.6%	0.78	1.6%	0.75	-1.6%
PARU							
PROT							

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

HABITAT UNITS

SPECIES	PRESENT HU	T YR 1 HU	T YR 1 % CHANGE	T YR 25 HU	T YR 25 % CHANGE	T YR 50 HU	T YR 50 % CHANGE
				TARGET YEARS			
MALL		14.0	100.0%	30.5	100.0%	30.5	100.0%
GOOS		14.1	100.0%	30.1	100.0%	30.1	100.0%
BITT	91.0	78.7	-13.6%	60.2	-33.9%	60.2	-33.9%
YLEG		62.3	100.0%	67.3	100.0%	67.3	100.0%
MUSK	17.2	100.4	485.2%	90.2	425.9%	87.7	411.1%
RAIL				50.9	100.0%	55.5	100.0%
HERO	52.1	78.8	51.2%	88.9	70.7%	88.9	70.7%
DUCK							
BEAV							
COOT	82.4	102.6	24.6%	83.7	1.6%	81.0	-1.6%
PARU							
PROT							

HABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
IF MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

FIGURE D-9 (Cont'd)

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
MALLARD	26.2
CANADA GOOSE	25.9
LEAST BITTERN	65.1
LESSER YELLOWLEGS	65.5
MUSKRAT	91.4
KING RAIL	41.6
GREEN-BACKED HERON	86.0
WOOD DUCK	
BEAVER	
AMERICAN COOT	87.7
NORTHERN PARULA	
PROTHONOTARY WARBLER	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-9 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

HABITAT TYPE ABREVIATIONS

1	A	AQUATIC

LOWER SPRING LAKE
FUTURE WITHOUT PROJECT CONDITIONS

SPECIES ABREVIATIONS

1	CCAT	CHANNEL CATFISH	3	LGMB	LARGEMOUTH BASS
2	WALL	WALLEYE	4		

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = SLEXIST	3	LOWER LAKE
TARGET YR 1 = SLWOP	3	SPRING LAKE HREP
TARGET YR 25 = SLWOP	3	SPRING LAKE HREP
TARGET YR 50 = SLWOP	3	SPRING LAKE HREP

FILE SLWOP CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX SLFISH TODAY'S DATE 08-18-1992

THESE DATA SETS ARE FOR FUTURE WITHOUT PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
AQUATIC	2414	2414	2414	2414
TOTAL	2414	2414	2414	2414

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
CCAT	2,414.0	2,414.0	0.0%	2,414.0	0.0%	2,414.0	0.0%
WALL	2,414.0	2,414.0	0.0%	2,414.0	0.0%	2,414.0	0.0%
LGMB	2,414.0	2,414.0	0.0%	2,414.0	0.0%	2,414.0	0.0%

FIGURE D-10

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
PECIES	INDEX	INDEX	% CHANGE	INDEX	% CHANGE	INDEX	% CHANGE
CAT	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
ALL	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%
GMB	0.10	0.10	0.0%	0.10	0.0%	0.10	0.0%

IEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF
VAILABLE HABITAT (ACRES USED BY THE SPECIES).
i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

HABITAT UNITS

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
PECIES	HU	HU	% CHANGE	HU	% CHANGE	HU	% CHANGE
CAT							
ALL							
GMB							

FIGURE D-10 (Cont'd)

ABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
F MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
CHANNEL CATFISH	
WALLEYE	
LARGEMOUTH BASS	

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-10 (Cont'd)

ROCK ISLAND DISTRICT CORPS OF ENGINEERS
FISH AND WILDLIFE SERVICE ROCK ISLAND

WILDLIFE HABITAT APPRAISAL GUIDE

LOWER SPRING LAKE
FUTURE WITH PROJECT CONDITIONS
INLET STRUCTURE AND EXCAVATED CHANNELS

HABITAT TYPE ABREVIATIONS

1	A	AQUATIC

SPECIES ABREVIATIONS

1	CCAT	CHANNEL CATFISH	3	LGMB	LARGEMOUTH BASS
2	WALL	WALLEYE	4		

DATA FILE NAMES	NUMBER OF SAMPLE SITES	PROJECT NAME
PRESENT = SLEXIST	3	LOWER LAKE
TARGET YR 1 = FISHFUT	3	SPRING LAKE
TARGET YR 25 = FISHFUT	3	SPRING LAKE
TARGET YR 50 = FISHFUT	3	SPRING LAKE

FILE FISHFUT CONTAINS 3 DATA SETS

THESE DATA FILES USE MATRIX SLFISH TODAY'S DATE 08-18-1992

THESE DATA SETS ARE FOR FUTURE WITH PROJECT CONDTIONS

HABITAT TYPE ACRES

HABITAT TYPE	PRESENT 0	TARGET YEARS 1	25	50
AQUATIC	2414	2414	2414	2414
TOTAL	2414	2414	2414	2414

ACRES OF AVAILABLE HABITAT

SPECIES	PRESENT ACRES	T YR 1 ACRES	T YR 1 % CHANGE	T YR 25 ACRES	T YR 25 % CHANGE	T YR 50 ACRES	T YR 50 % CHANGE
CCAT	2,414.0	2,414.0	0.0%	2,414.0	0.0%	2,414.0	0.0%
WALL	2,414.0	2,414.0	0.0%	2,414.0	0.0%	2,414.0	0.0%
LGMB	2,414.0	2,414.0	0.0%	2,414.0	0.0%	2,414.0	0.0%

FIGURE D-11

AVAILABLE HABITAT IS THE TOTAL OF THE HABITAT TYPE ACRES USED BY THE SPECIES (NOT ALL SPECIES APPLY TO ALL HABITAT TYPES)

MEAN HABITAT SUITABILITY INDEX (HSI)

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
SPECIES	INDEX	INDEX	% CHANGE	INDEX	% CHANGE	INDEX	% CHANGE
CAT	0.10	0.45	347.2%	0.45	347.2%	0.45	347.2%
ALL	0.10	0.55	454.2%	0.55	454.2%	0.55	454.2%
GMB	0.10	0.49	390.0%	0.49	390.0%	0.49	390.0%

MEAN HSI = SUM AVERAGE HSI BY HABITAT TYPE X ACRES DIVIDED BY ACRES OF AVAILABLE HABITAT (ACRES USED BY THE SPECIES).
(i.e. MEAN HSI IS AVERAGE HSI WEIGHTED BY ACRES)

HABITAT UNITS

		TARGET YEARS					
	PRESENT	T YR 1		T YR 25		T YR 50	
PECIES	HU	HU	% CHANGE	HU	% CHANGE	HU	% CHANGE
CAT		1,079.6	100.0%	1,079.6	100.0%	1,079.6	100.0%
ALL		1,337.8	100.0%	1,337.8	100.0%	1,337.8	100.0%
GMB		1,182.9	100.0%	1,182.9	100.0%	1,182.9	100.0%

FIGURE D-11 (Cont'd)

ABITAT UNITS ARE HSI X ACRES (A MEASURE OF QUALITY X QUANTITY)
F MEAN HSI = 0.10 THEN HABITAT UNITS ARE ZERO

ANNUAL AVERAGE HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS

SPECIES	ANNUAL AVE. HABITAT UNITS
CHANNEL CATFISH	1,071.2
WALLEYE	1,326.8
LARGEMOUTH BASS	1,173.5

NOTE: THIS PROGRAM MUST BE RUN TWICE ONCE FOR FUTURE WITHOUT PROJECT AND ONCE FOR FUTURE WITH PROJECT CONDITIONS.
SUBTRACT AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITHOUT PROJECT CONDITIONS FROM AVERAGE ANNUAL HABITAT UNITS FOR FUTURE WITH PROJECT CONDITIONS TO DETERMINE THE CHANGE IN AVERAGE ANNUAL HABITAT UNITS WITH THE PROJECT.

FIGURE D-11 (Cont'd)

HYDROLOGY AND HYDRAULICS

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX E
HYDROLOGY AND HYDRAULICS

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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX E
HYDROLOGY AND HYDRAULICS

CLIMATE

The climate in northwestern Illinois is characterized by extreme temperatures and moderate precipitation. The National Weather Service operates a weather station in Mt. Carroll, Illinois, approximately 10 miles east of the project site. Temperatures range from an average monthly maximum of 86 degrees in July to an average monthly minimum of 10 degrees in January. The average daily maximum temperature is 63 degrees, and the average daily minimum temperature is 42 degrees. The average annual precipitation is 34.7 inches, and the average annual snowfall is 33.71 inches. Table E-1 below lists the average monthly precipitation and snowfall amounts at the Mt. Carroll station.

TABLE E-1

Mt. Carroll, Illinois
Average Monthly Precipitation and Snowfall

Month	Precip. (Inches)	Snowfall (Inches)	Month	Precip. (Inches)	Snowfall (Inches)
January	1.50	9.01	July	3.62	-
February	1.29	6.45	August	3.96	-
March	2.27	6.07	September	3.89	-
April	3.16	1.65	October	2.55	0.25
May	4.07	0.07	November	2.35	2.36
June	4.47	-	December	1.81	7.64

FLOOD PROFILES

Mississippi River elevation-frequency relationships are based on the 1979 publication entitled *Upper Mississippi River Water Surface Profiles, River*

Mile 0.0 to River Mile 847.5. These profiles were developed under the guidance of the Technical Flood Plain Management Task Force of the Upper Mississippi River Basin Commission. Bulletin 17B was used to establish discharge frequency relationships at gaging stations along the Mississippi River. Rating curves and extensions were used to establish elevation-frequency relationships at these gages. Profiles between gaging stations parallel observed and previously developed design profiles. The profiles were developed as a result of a concerted effort by many State and Federal agencies for the implementation of existing floodplain management programs along all reaches of the Upper Mississippi River. Flood elevations for the project are listed below in table E-2 and are shown graphically on plate E-1.

TABLE E-2

Elevation-Frequency
Mississippi River - RM 531.5 to RM 536

Frequency (yrs)	RM 531.5 Elevation	RM 536 Elevation
5	587.8	589.3
10	589.9	591.0
50	593.5	594.9
100	594.6	596.0
200	595.9	597.2
500	597.1	598.6

ELEVATION-DURATION

Elevation-duration profiles have been developed for the Mississippi River by the Hydraulics Branch of the Rock Island District. Duration percentages signify the percent of time that an elevation is equalled or exceeded. A comparison of elevations between the lower (RM 531.5) and upper (RM 536.0) boundaries of the project for different durations are shown below in table E-3. The same values are shown graphically on plate E-2.

TABLE E-3

Elevation-Duration
Mississippi River - RM 531.5 to 536

Duration - Percent of Time Equalled or Exceeded	RM 531.5 Elevation	RM 536.0 Elevation
1	588.8	590.0
2	587.1	588.3
5	585.7	586.8
10	585.0	586.0
20	584.5	585.2
30	584.0	584.6
50	583.6	584.0
70	583.3	583.5

Elevation-duration curves for the Sabula gage (RM 535.0) are shown on plates E-3 through E-6. These show the percentage of time that elevations are equalled or exceeded at the gage. Curves are shown for year-round as well as for each month.

HYDRAULIC ANALYSIS OF PROJECT

FLOOD HEIGHT IMPACTS

The effects of project construction upon flood heights were evaluated. The State of Illinois floodplain regulations require that any construction in the floodplain not cause an increase in flood elevation of more than 0.1 foot for urban areas and 0.5 foot for rural areas. This applies to a flood of any recurrence interval up to and including the 100-year flood.

This project includes no features which will cause any increase in flood elevations. Dredging, dredge placement, and dike building all will occur within the Spring Lake closed area which is encircled by a levee with a level which corresponds to a 50-year recurrence interval. Some work will take place on this levee. It will be strengthened by reshaping the slopes, but will not be raised.

LOWER UNIT

Inlet Water Control Structure

A water control structure will be installed to let water into the upper end of the Lower Lake. This will provide fresh water to the Upper Lake during periods of the year when it is necessary.

The structure was located near the upper portion of the Lower Lake in order to provide fresh water to as much of the Lower Lake as possible; the farther up in the lake that the water entered the more of the lake it would affect.

The structure was sized by determining the flow necessary to provide the amount of fresh water needed for proper fish habitat. This was determined by first estimating where the water which enters the Upper Lake through the inlet structure will flow. This was done by examining the results of the RMA-2 model as described below. The volume of water needed was calculated based on the computed area and depth. An oxygen balancing analysis was performed to estimate the flow necessary to provide this volume of water. This analysis is described in full in the water quality appendix.

The other information needed to size the structure was the amount of head available. The head on the structure is the difference in the water levels between the Mississippi River and the Lower Spring Lake sides of the structure. The greater the difference between these two water levels the more water that can be let into the Upper Lake. The head on the structure will be the same as the difference in water levels on the Mississippi River between the inlet water control structure and the breach at the downstream end of Lower Spring Lake. Therefore, actual records of Mississippi River water levels were researched to find predictions of the difference in these two water levels.

The two nearest gages to the project are Lock and Dam 13 Pool (RM 522.5) and Sabula (RM 535.0). Daily readings at these gages for the years 1965 to 1989 were used. The water surface elevation difference between these two gages for each day was used to compute a Mississippi River slope. This slope was then multiplied by the Mississippi River distance between the inlet water control structure (RM 535.0) and the breach (RM 531.9) to estimate the head which will exist on the inlet control structure.

The primary time that this water control structure will be operated is an approximate 100-day period, from December 15 to March 31. The head which exists during this time period was used to size the structure. Elevation-duration curves for the Mississippi River at the water control structure and at the breach for the 100-day period are shown on plate E-7. the difference in elevation between these two curves is the estimated head which will exist on the structure for different Mississippi River stages.

The necessary flow needed into Lower Spring Lake is 175 cubic feet per second (cfs) from the oxygen balancing analysis. A culvert rating program was used to determine the flow through the structure for various river elevations and gate settings. Table E-4 shows the relationship between river elevation and gate setting for the 100-day period. The river elevation is the Mississippi River elevation at the Sabula gage. The gate setting is the amount of gate opening. Two 5-foot by 5-foot box culverts will be used. Ten feet of gate opening is both culverts fully opened. Four feet of gate opening is both culverts opened 2 feet.

TABLE E-4

Rating Table for Water Control Structure
Operated Between December 15 to March 31

Sabula Gage	Sabula Elev.	Feet of Gate Opening > 10	Flow (cfs) 8	6	4	2
10.73	583.0	135	105	78	48	21
10.93	583.2	135	108	80	50	22
11.13	583.4	145	112	82	53	24
11.33	583.6	158	124	90	58	26
11.53	583.8	169	136	99	63	28
11.73	584.0	188	149	108	69	30
11.93	584.2	199	158	114	73	31
12.13	584.4	208	166	120	78	33
12.33	584.6	214	172	125	80	34
12.53	584.8	229	178	129	83	35
12.73	585.0	230	185	135	86	35
12.93	585.2	245	192	141	89	35
13.13	585.4	255	199	146	93	38
13.33	585.6	263	206	152	97	42
13.53	585.8	265	215	158	101	44
13.73	586.0	285	224	164	105	46

The relationship between river elevation and gate settings for a year-round operation is shown on table E-5. In other words, if the structure is being operated during the designed time of December 15 to March 31, that rating table should be used.

TABLE E-5

Rating Table for Water Control Structure Operated Year-Round

Sabula Gage	Sabula Elev.	Feet of Gate Opening > 10	Flow (cfs) 8	6	4	2
10.73	583.0	120	82	60	38	17
10.98	583.25	125	100	72	47	20
11.23	583.5	125	100	72	47	20
11.48	583.75	156	120	88	56	23
11.73	584.0	164	129	94	60	25
11.98	584.25	173	137	100	64	27
12.23	584.5	182	144	104	67	28
12.48	584.75	197	155	112	71	31
12.73	585.0	210	167	121	77	35
12.98	585.25	220	173	127	80	36
13.23	585.5	225	177	130	82	36
13.48	585.75	243	194	141	88	38
13.73	586.0	255	202	147	93	40

RMA-2 Model

As mentioned above, one feature of the project is a water control structure designed to allow water to flow into the lower unit from the Mississippi River. Where this water flows as it travels from the inlet structure to the downstream breach is important to the project. The greater the area that the flow reaches the more benefit to the fisheries aspect of the project. The affected area was quantified by developing an RMA-2 Two-Dimensional Flow Computer Model. This model predicts the magnitude and direction of flow velocities. Input to the model includes bed elevation geometry, Manning's roughness coefficients, turbulent exchange coefficients, and boundary conditions. Boundary conditions consisted of flow at the upstream boundary (the inlet water control structure) and elevation at the downstream boundary (the downstream breach). The RMA-2 model has been applied to calculate flow distribution around islands, flows in contracting and expanding reaches, flows at river junctions, and general flow patterns in rivers, reservoirs, and estuaries. This model is adaptable to the Spring Lake lower unit because a one-dimensional flow situation does not exist. Water enters the lower unit through the water control structure, spreads out over the lower unit, then contracts and flows out the breach at the downstream end of the lower unit.

The elevation at the downstream boundary of the model (the downstream breach) was determined by analyzing historical Mississippi River stage records. Typical periods of the year in which the water control structure will be operated will be from December 15 to March 31 and in late summer during low oxygen periods. The average water surface elevation at the lower breach during the winter period is 583.4. The average water surface elevation during the late summer months of August and September is 583.3. The water control structure will not be operated necessarily only in these months, but they are the most likely. The year-round average elevation is 583.6. To approximate most of the possibilities, the elevation at the downstream boundary of the model (the lower breach) which was used was 583.5.

The inflow at the upstream boundary of the model (the inlet water control structure) was determined in a trial and error fashion. Different flows were used to approximate the affected area. The affected area was then used to determine the necessary flow by the oxygen balancing analysis as described in the water quality appendix. The inflow was determined to be 175 cfs.

Output from the RMA-2 model includes the magnitude and direction of the flow velocities over the entire lower unit. Five different conditions were modeled. The conditions are:

1. No water control structure and no dredged channels

2. Water control structure with dredged channels

3. Water control structure with the selected dredge alignment

4. Water control structure with a channel dredged to the deep hole and then due east

5. Water control structure with a channel dredged to the deep hole and then southeast

Plate E-8 shows the results of the modeling for the first three conditions. Contours of velocity magnitude are shown with the velocity in units of feet per second. Each velocity is assigned specific colors. Though the velocities are very small, the model shows relatively what areas of the lower unit will have moving water and will be refreshed with the inflowing water and what areas will remain stagnant when the water control structure is in operation.

The first condition is one in which no water will be let into the lower lake. As shown on plate E-8, this results in a lower lake with all still, stagnant water. Under this scenario, there will be 2,370 acres of stagnant water, or the whole lower lake. The second condition shows what areas of the lake will have some water movement with a water control structure but with no dredged channels. For this condition, the area of stagnant water is reduced drastically to approximately 445 acres. The third condition consists of the water control structure with the selected alignment of dredged channels. Under this scenario, the area of still water is further reduced to 425 acres. The fourth and fifth conditions showed increases in the amount of stagnant water. The fourth condition had 470 acres, and the fifth condition had 455 acres.

UPPER UNIT

Operation

The upper unit will be divided into three cells by cross dikes. A channel will provide a source of water to the three cells. One 4-foot by 4-foot square box culvert will connect the channel to the lower unit. A 7,000 gpm pump also will connect the channel to the lower unit and will have the capacity to pump in both directions. Three stoplog structures, each with a width of 5 feet, will be constructed. They will connect each cell to the water supply channel.

The operating plan for the upper unit calls for different water levels in the cells for different periods of the year. In September and October, the three cells will be filled. The water level in the three cells will be maintained through March. In the period from March to September, the cells and feeder canal will be dewatered and will be kept at a low level until September, when the filling process will begin.

Filling

The filling which takes place in September and October will be accomplished using the pump. The culverts also can be used if Mississippi River elevations are high enough. The cells will be maintained at the highest level possible (maximum level is 585.0) until March. The desired filling time is 30 days. The pump was sized by calculating flow into each cell through the stoplog structures from the water supply channel using the weir equation. The flow was converted to volume and volume converted to elevation using the elevation volume relationships shown on plate E-9. This analysis showed that a 7,000-gpm pump would be adequate to fill the three cells from 583.5 to 585.0 within the required 30-day period. The filling process is shown graphically on plate E-10.

Dewatering

The dewatering process will begin in March. The cells will be at an elevation of 585.0 when the process starts and will be dewatered to an elevation of 583.5 using gravity flow through the culverts, assuming elevations in the lower unit are 583.5 or less. The stoplogs will then be shut and the feeder canal will be dewatered to elevation 579.0 using the pump. An analysis was made to determine how long it would take to dewater the cells from 585.0 to 583.5. The process should take approximately 25 days. A typical dewatering scenario is depicted on plate E-11. Again, this is assuming that the lower unit is at elevation 583.5 or lower. In a typical year, dewatering will take place beginning in March. From the duration relationships shown on plates E-3 through E-6, the lower unit will be at an elevation of 583.5 or lower approximately 40 percent of the time. Therefore, the lower unit could not always be dewatered with the culvert on demand as this depends on the elevation of the Mississippi River. However, the pumps also could be used when the Mississippi River is less than the elevation of the cross dike (elevation 590.0).

Overtopping

The occurrence of a flood event on the Mississippi River and its effect upon the upper unit also was investigated. The cross dike separating the lower unit from the upper unit will be built up to an elevation of 590 which corresponds to a 10-year flood level. When the cross dike is overtopped by a flood of this magnitude, it would be in danger of failing if some overtopping protection were not included in the design. It is desirable to have as much water ponded as possible in the upper unit when the overtopping does occur. This reduces the head acting upon the dike.

Two options were considered to pond water in the upper unit in advance of an overtopping event. One option is spillways. As water elevations rise in the lower unit, water will enter into the upper unit over the spillways in advance of the time when the entire cross dike is overtopped. Spillways will be constructed in the cross dike between cell B and the lower unit and between cell C and the lower unit. Each spillway will have a length of 100 feet and will be constructed to an elevation of 588.0. This corresponds to a 5-year flood level.

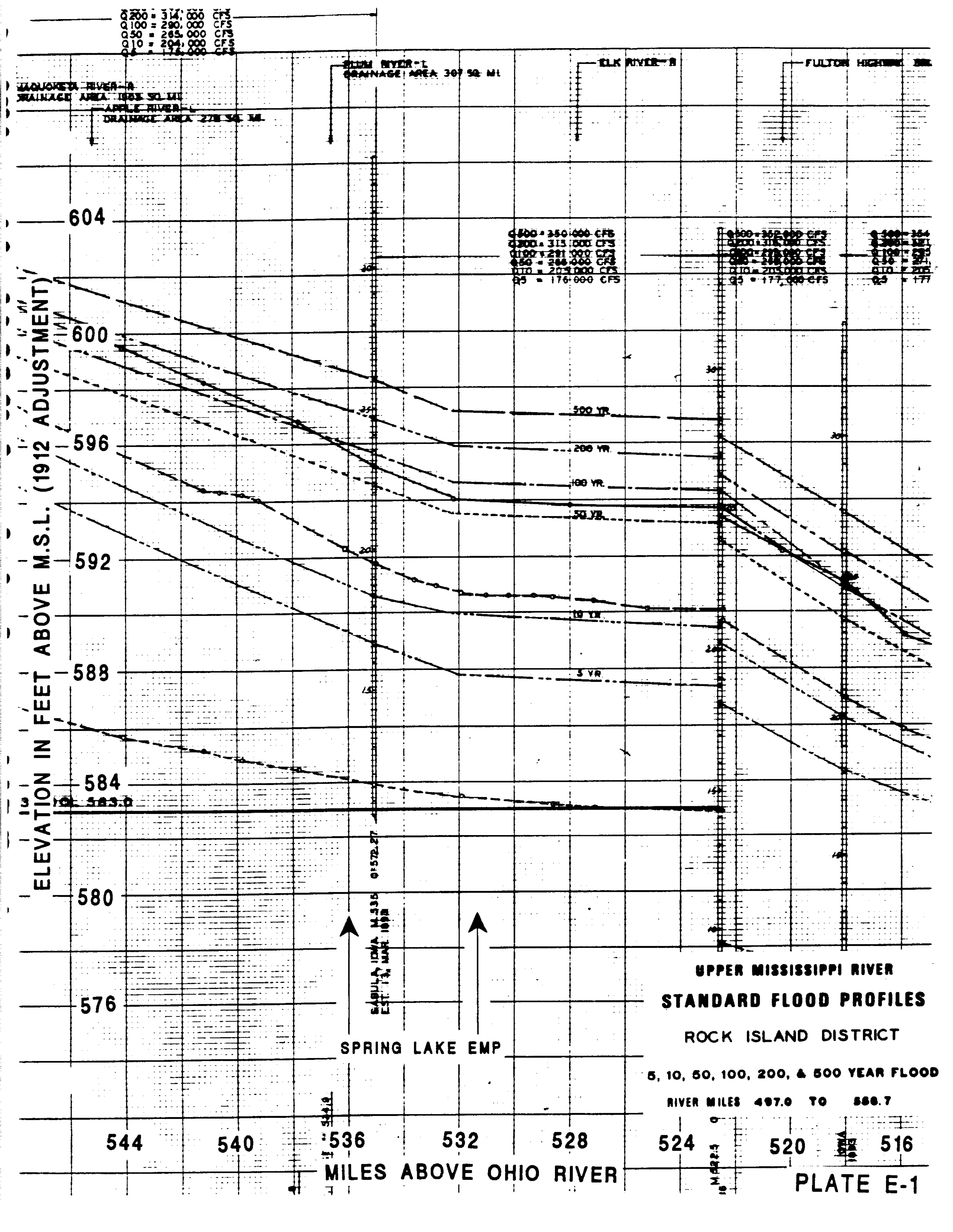
Another option is culverts. Culverts between the lower and upper units can be opened in advance of cross dike overtopping to pond water in the upper unit to reduce the head on the cross dike when it is overtopped. One culvert will be constructed to connect the lower unit and the water supply channel. It will be a 4-foot by 4-foot box culvert. This culvert will allow water to flow into the water supply channel and from there into any or all of the three cells. An existing culvert which connects the lower unit and cell C also can be opened in advance of cross dike overtopping to pond water in cell C. It is a circular culvert and has a diameter of 3 feet.

Two scenarios were considered based on possibilities of what water surface elevations could be in the upper unit when the flood occurs. Water surface elevations could be 583.5. This situation could occur in the summer. A second scenario is in the fall and winter after the cells have been pumped full. In this scenario, all cells would be at elevation 585.0.

The most critical of the above two scenarios is the first one. Elevations in the upper unit will be the lowest, and therefore the upper unit has the most volume to fill in advance of overtopping. In analyzing this scenario, certain assumptions had to be made. The rate of rise of the Mississippi River during a flood used was 1.0 foot/day. This was determined by examining stage hydrographs of past floods and is a conservative estimate. Using these assumptions, a typical overtopping event was simulated. A graphic presentation of this simulation is shown on plate E-12. Cells B and C will rise at approximately the same rate. Cell A will lag behind. The interior dikes are at an elevation of 587. When cells B and C fill to this elevation, water will begin to spill into cell A. The initial head from cells B and C to A will be approximately 2 feet, but in about 3 hours the elevations will equalize and the elevations in all three cells will be the same and will rise together. When the cross dike (elevation 590.0) overtops, the upper unit elevation will have caught up with the lower unit and no head differential will exist to endanger the cross dike.

Erosion Protection

The upper unit is designed for protection against overtopping by assuring that the unit will be filled and that a minimal amount of head will exist on the cross dike when it is overtopped. However, there will be some head differential between the lower and upper units during overtopping until the upper unit is filled and the two water levels equalize. Plate E-13 shows the head differential and velocity of the water flowing over each spillway during overtopping. The head differential is the difference between the upper and lower units water elevation. The spillway velocity was calculated using the weir equation, the head used in the weir equation being the difference between the lower unit water elevation and the spillway crest elevation. As shown on plate E-13, the maximum spillway velocity is 4.1 fps. As this could cause erosion problems, some protection against erosion should be placed on the spillways. No protection is required on the lower unit side, or riverward side, of the spillway. The river will rise slowly and no erosion-causing velocities will exist. The upper unit side of the spillway should be protected, however. Eighteen inches of riprap should be placed on the upper unit slope of the spillway for the entire length of the spillway plus 10 feet on either side of the spillway.


Q200 = 314,000 CFS
Q100 = 290,000 CFS
Q50 = 265,000 CFS
Q10 = 204,000 CFS
MAQUOKETA RIVER-R
DRAINAGE AREA 1883 SQ. MI.
APPLE RIVER-L
DRAINAGE AREA 278 SQ. MI.
PLUM RIVER-L
DRAINAGE AREA 307 SQ. MI.
ELK RIVER-R
FULTON HIGHWAY BR.
Q500 = 350,000 CFS
Q200 = 313,000 CFS
Q100 = 291,000 CFS
Q50 = 266,000 CFS
Q10 = 205,000 CFS
Q5 = 176,000 CFS
Q500 = 352,000 CFS
Q5 = 177,000 CFS
500 YR.
200 YR.
100 YR.
50 YR.
10 YR.
5 YR.
ELEVATION IN FEET ABOVE M.S.L. (1912 ADJUSTMENT)
604
600
596
592
588
584
580
576
SABULA, IOWA M.535
EST. 13, MAR. 1938
SPRING LAKE EMP
544
540
536
532
528
524
520
516
MILES ABOVE OHIO RIVER
UPPER MISSISSIPPI RIVER
STANDARD FLOOD PROFILES
ROCK ISLAND DISTRICT
5, 10, 50, 100, 200, & 500 YEAR FLOOD
PLATE E-1

MISSISSIPPI RIVER DURATION PROFILES PERCENT OF TIME ELEVATIONS ARE EQUALLED OR EXCEEDED

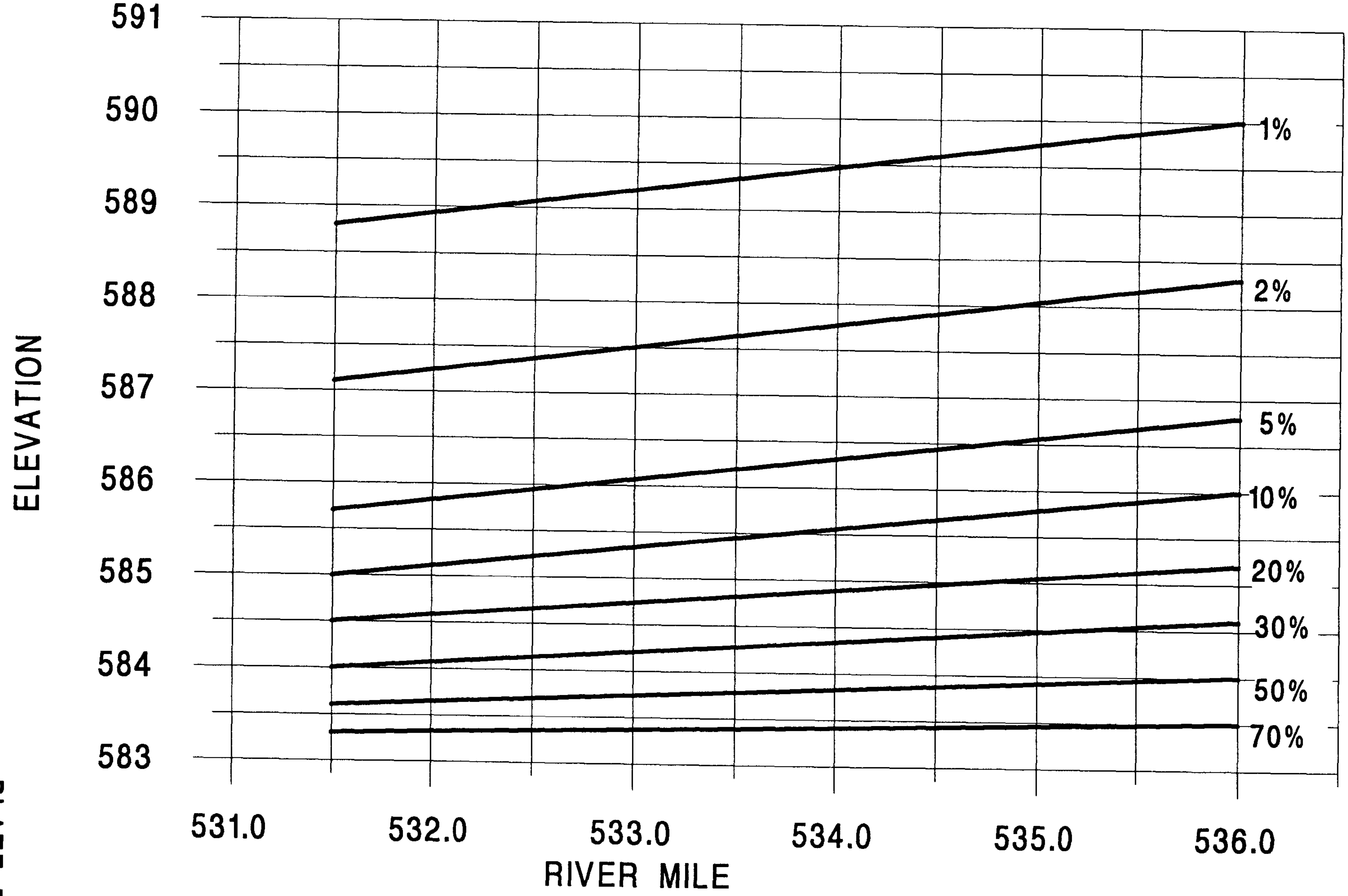


PLATE E-2

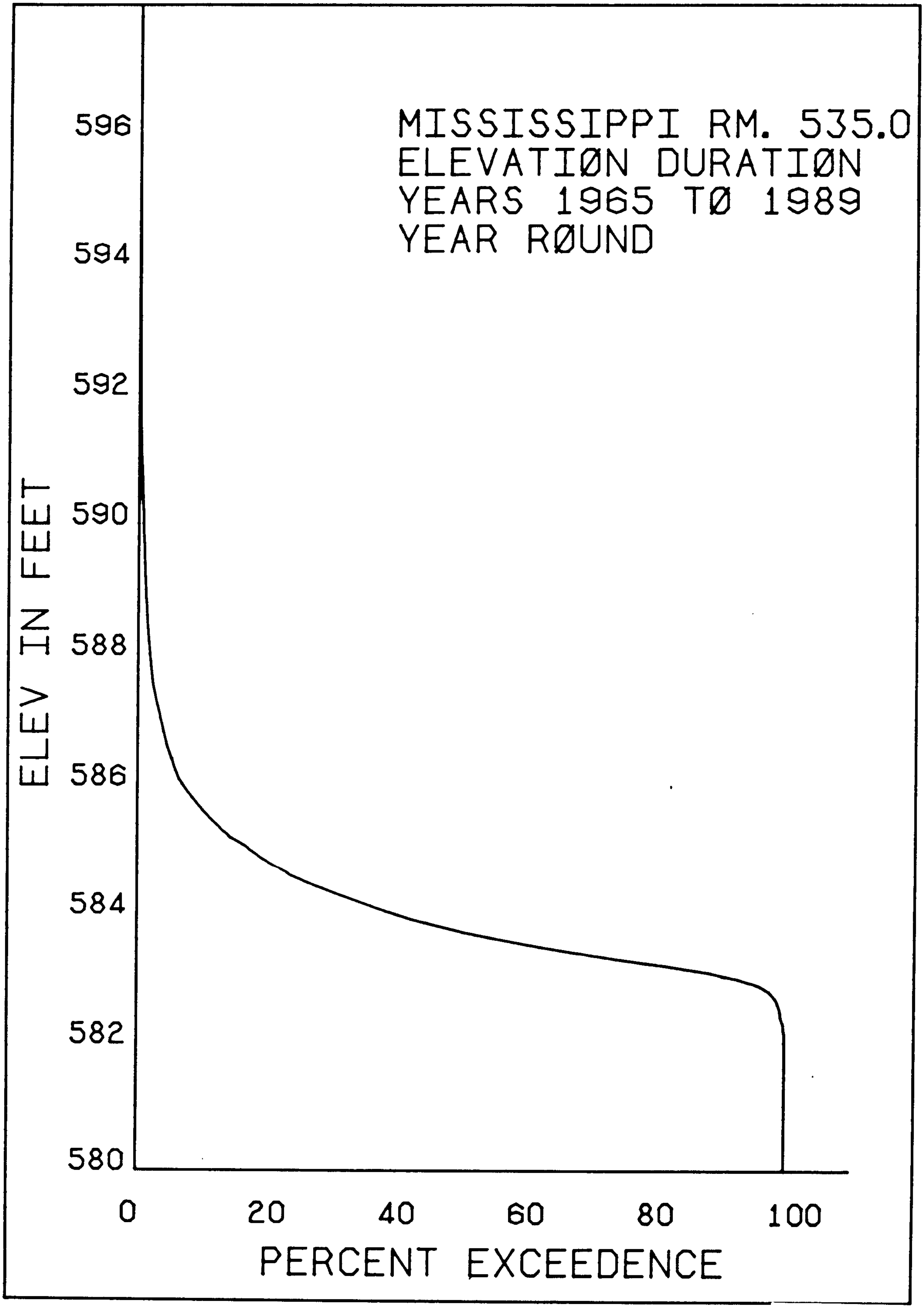
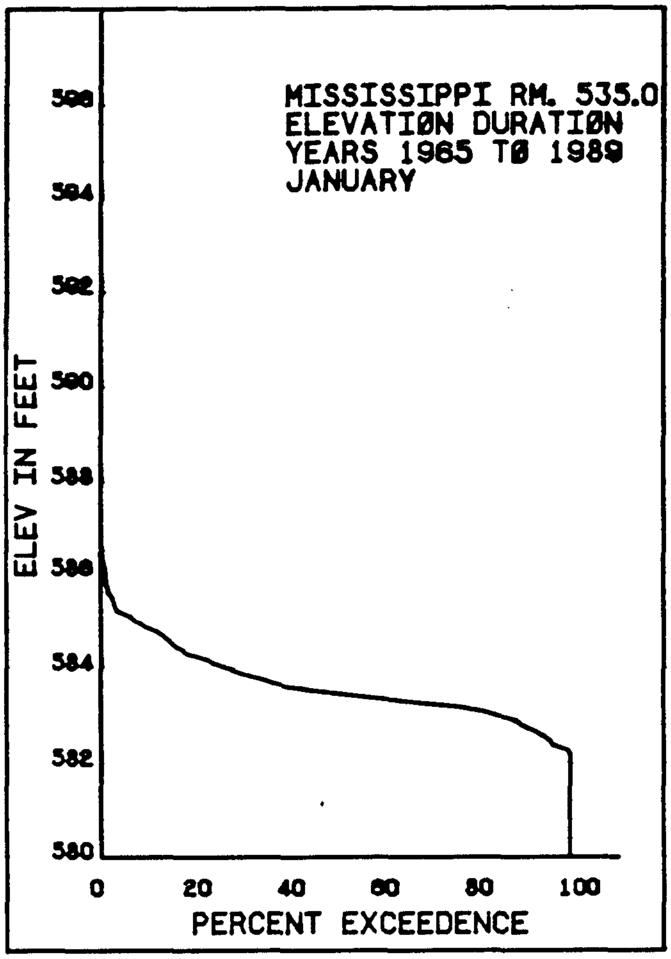
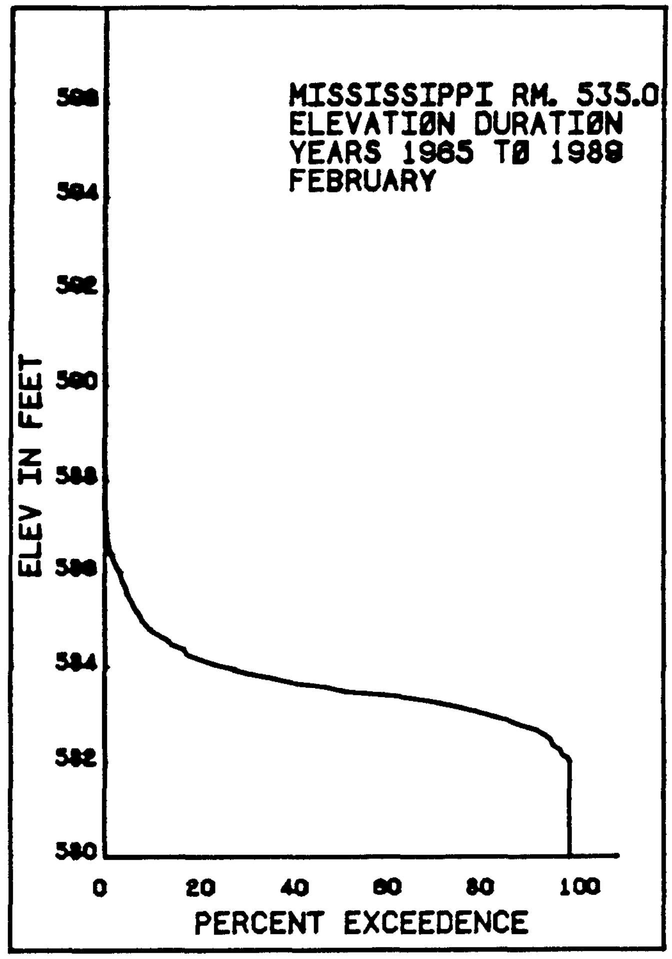
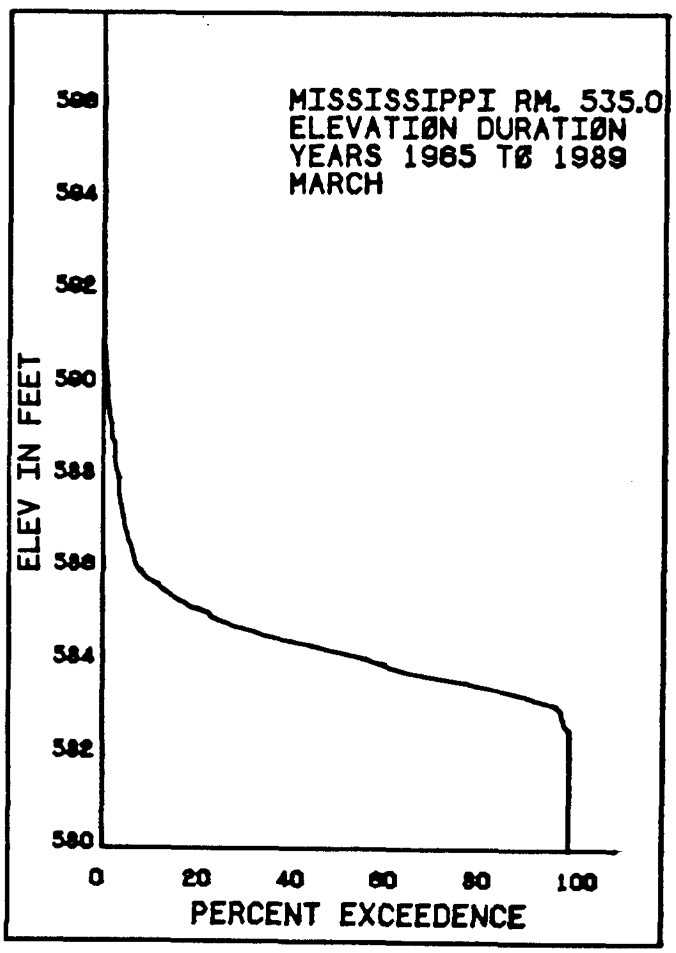

MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
YEAR RØUND
ELEV IN FEET
596
594
592
590
588
586
584
582
580
0
20
40
60
80
100
PERCENT EXCEEDENCE

PLATE E-3


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
JANUARY
ELEV IN FEET
596
594
592
590
588
586
584
582
580
0
20
40
60
80
100
PERCENT EXCEEDENCE


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
FEBRUARY
ELEV IN FEET
596
594
592
590
588
586
584
582
580
0
20
40
60
80
100
PERCENT EXCEEDENCE


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
MARCH
ELEV IN FEET
596
594
592
590
588
586
584
582
580
0
20
40
60
80
100
PERCENT EXCEEDENCE

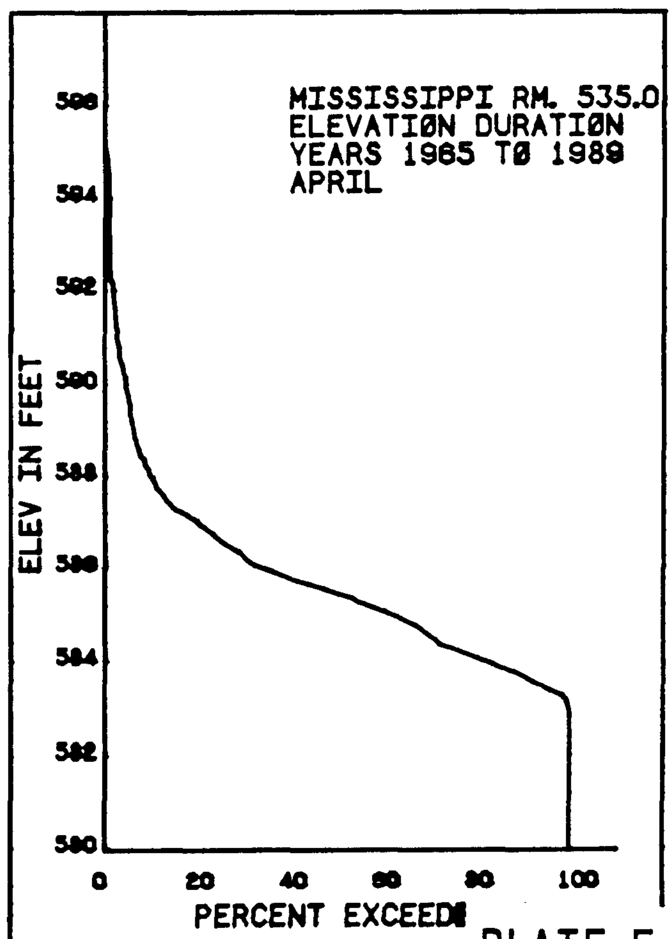
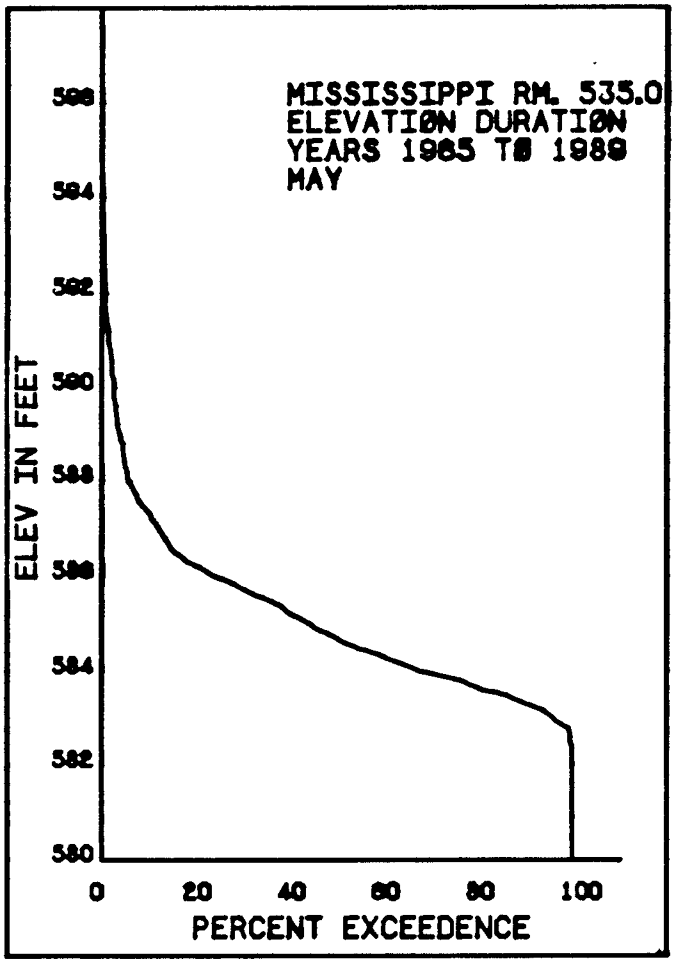
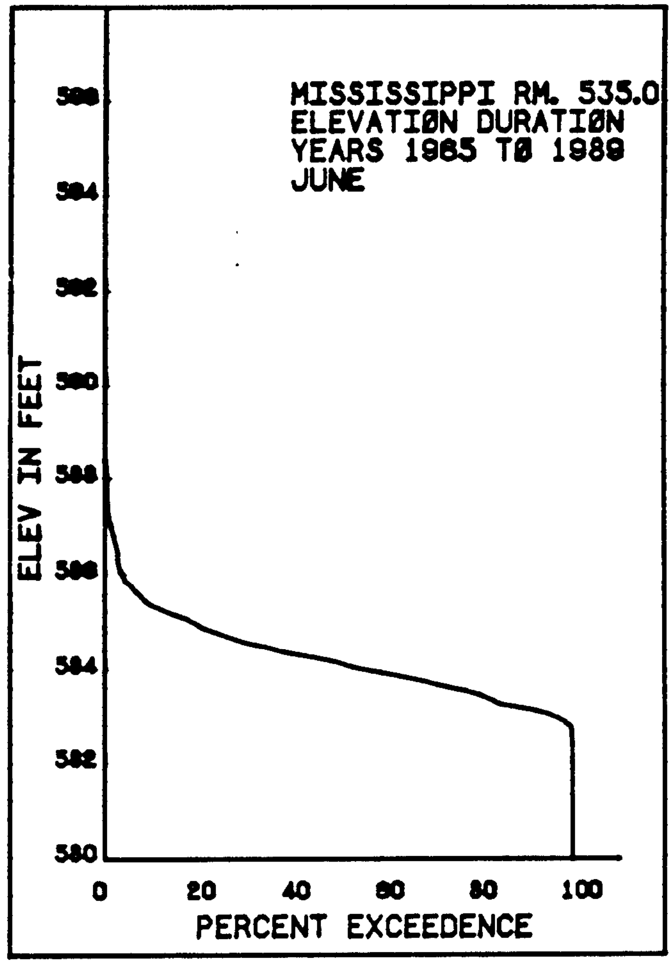

MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
APRIL
ELEV IN FEET
596
594
592
590
588
586
584
582
580
0
20
40
60
80
100
PERCENT EXCEED

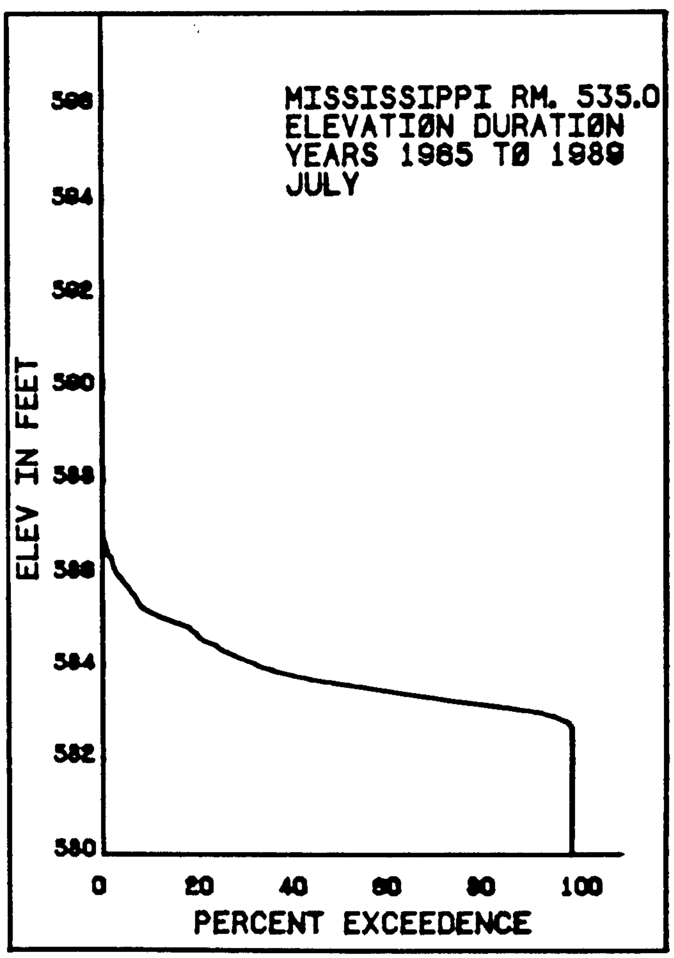
PLATE E-4



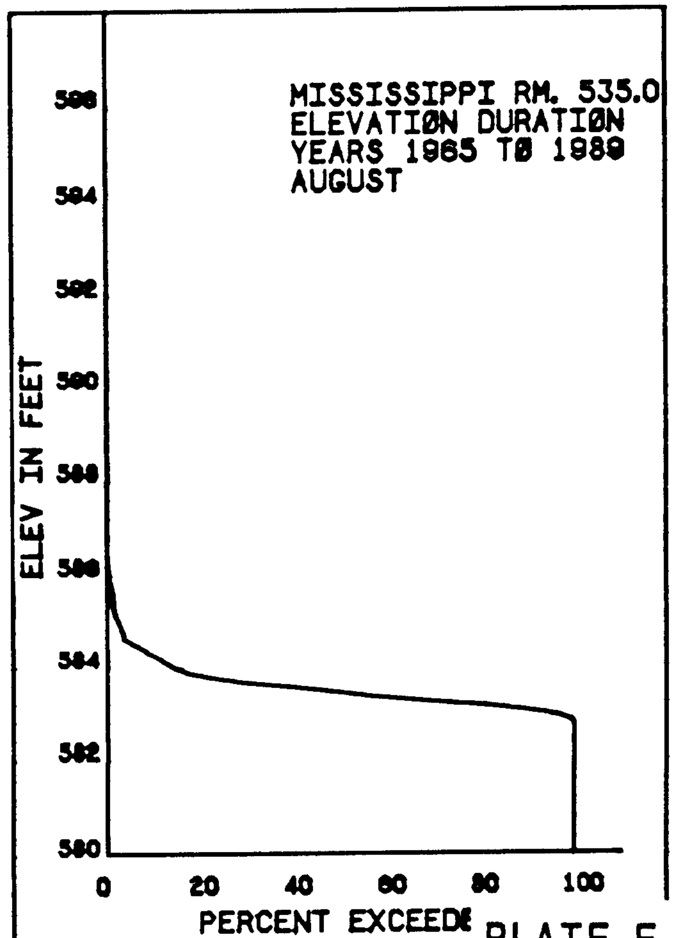
MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
MAY
ELEV IN FEET
PERCENT EXCEEDENCE



MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
JUNE
ELEV IN FEET
PERCENT EXCEEDENCE

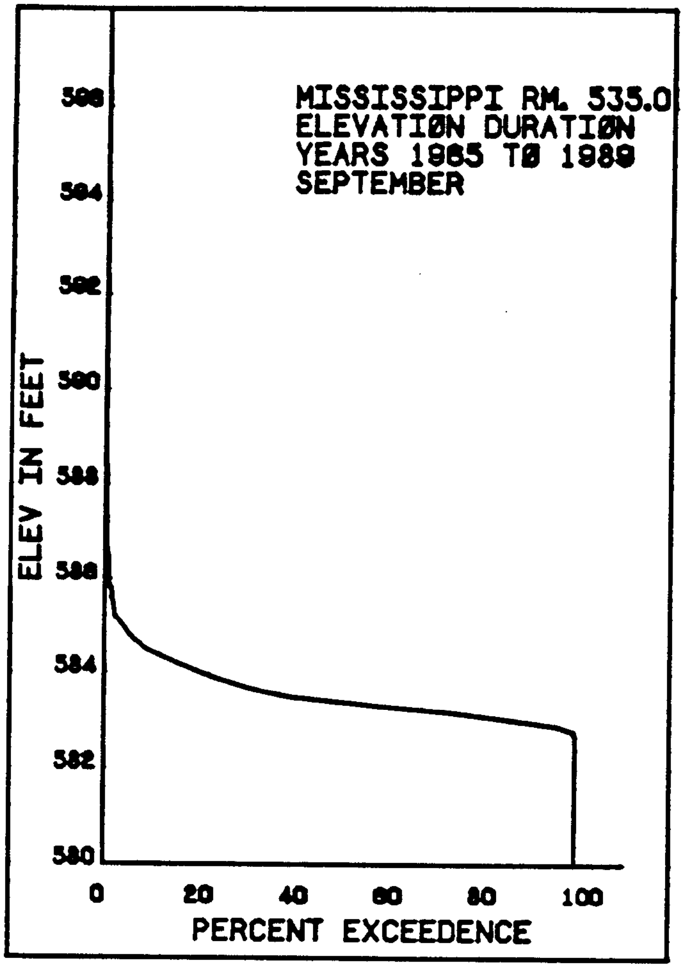


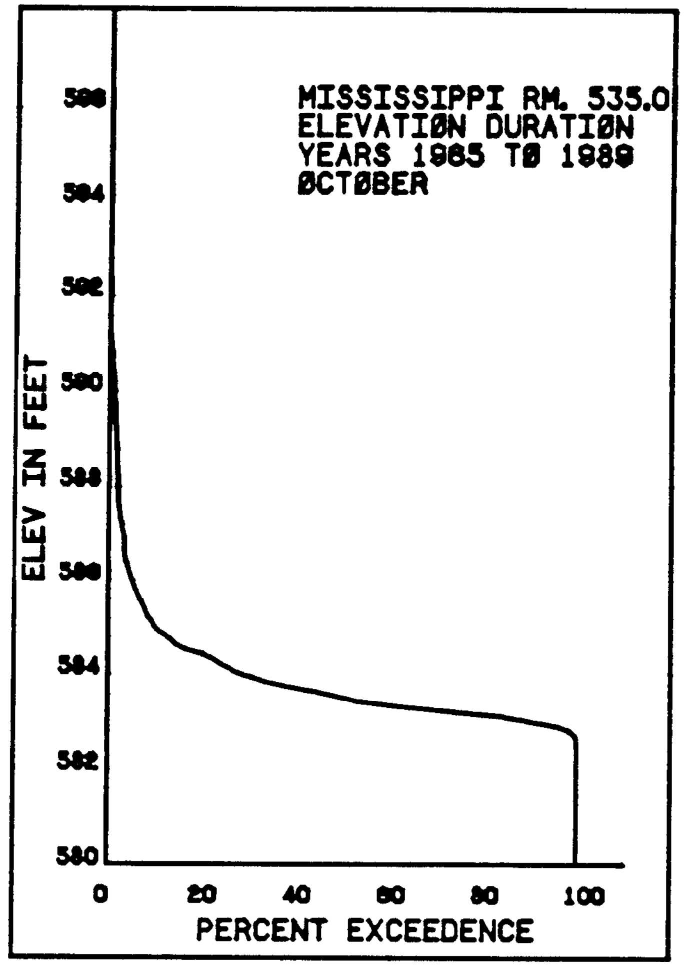
MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
JULY
ELEV IN FEET
PERCENT EXCEEDENCE

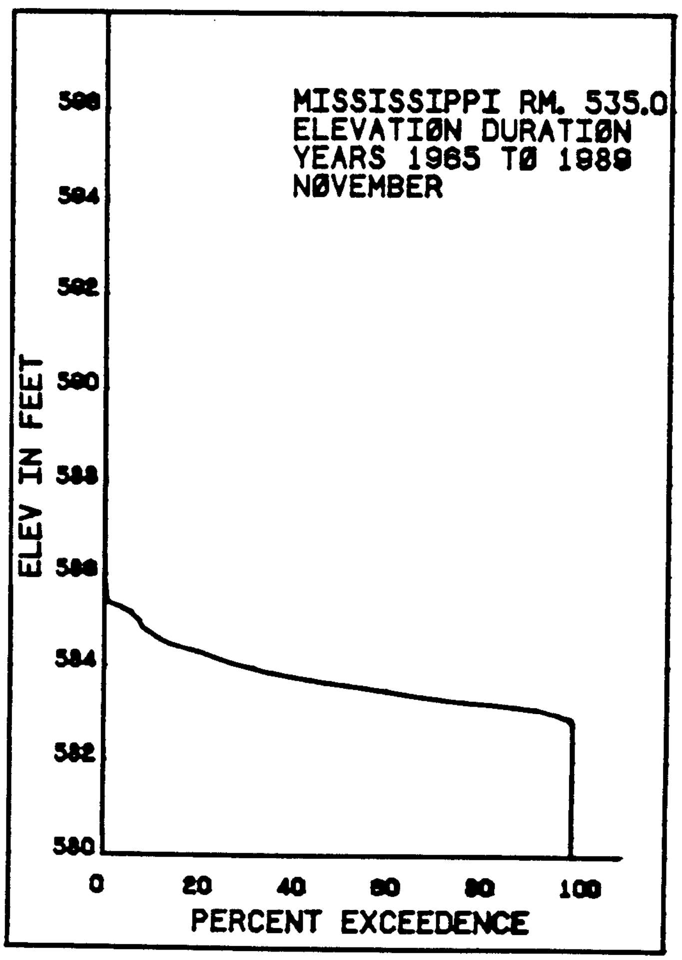


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
AUGUST
ELEV IN FEET
PERCENT EXCEEDE

PLATE E-5


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
SEPTEMBER
ELEV IN FEET
PERCENT EXCEEDENCE


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
ØCTØBER
ELEV IN FEET
PERCENT EXCEEDENCE


MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
NØVEMBER
ELEV IN FEET
PERCENT EXCEEDENCE

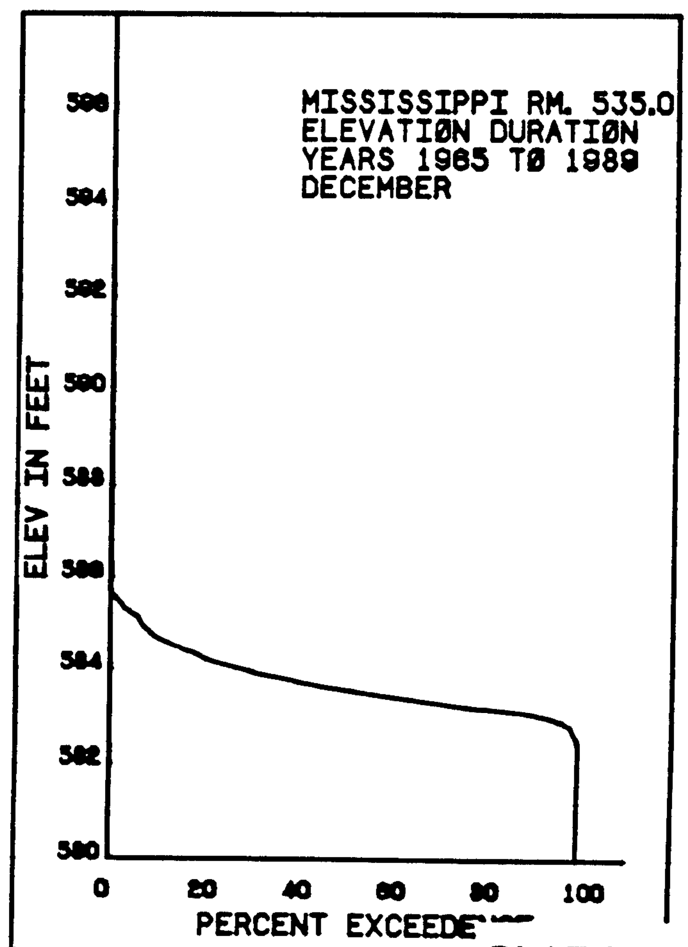

MISSISSIPPI RM. 535.0
ELEVATIØN DURATIØN
YEARS 1965 TØ 1989
DECEMBER
ELEV IN FEET

PLATE E-6

MISSISSIPPI RIVER
ELEVATION DURATION
DECEMBER 15 TO MARCH 31

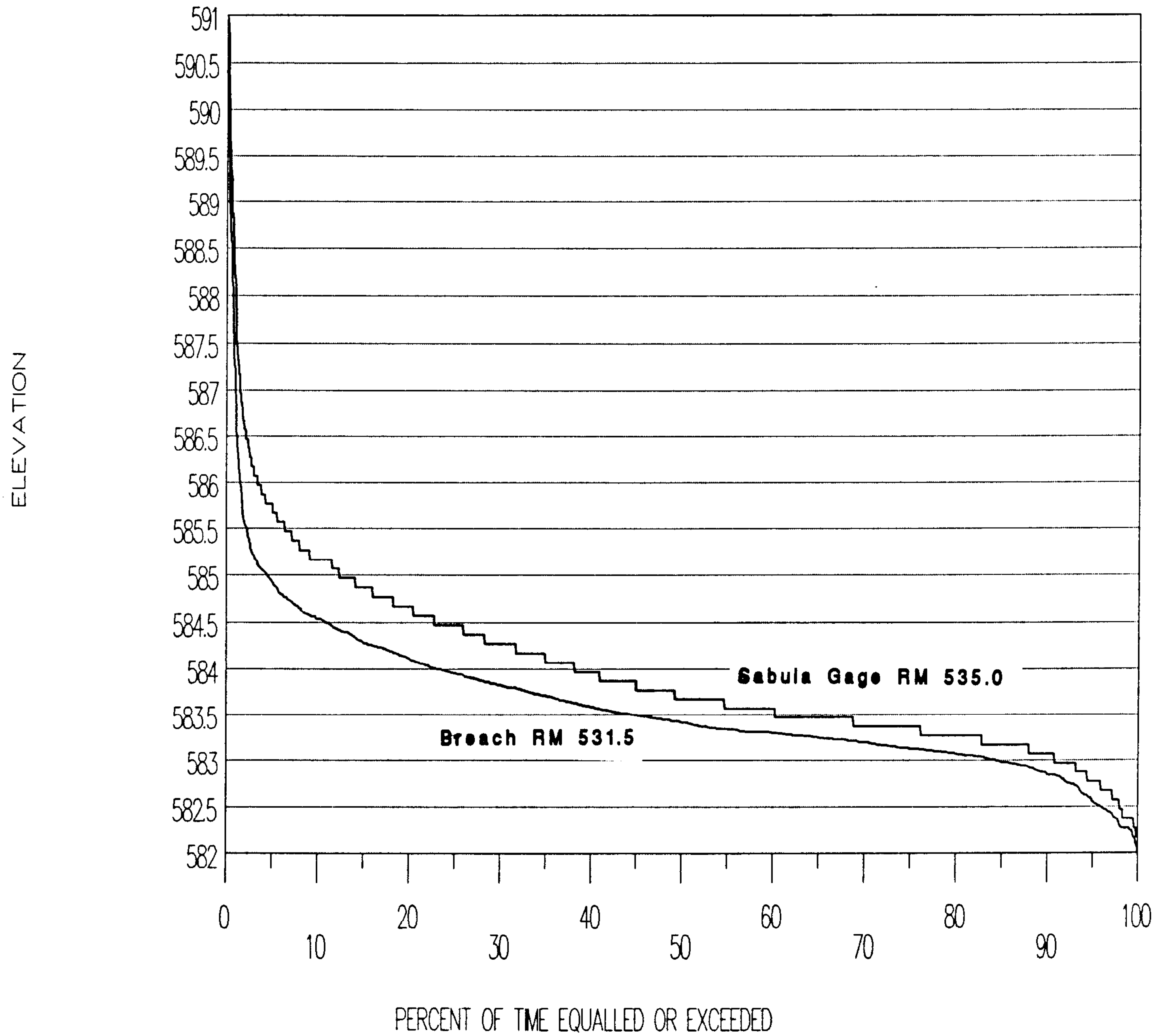


PLATE E-7

RMA-2 RESULTS

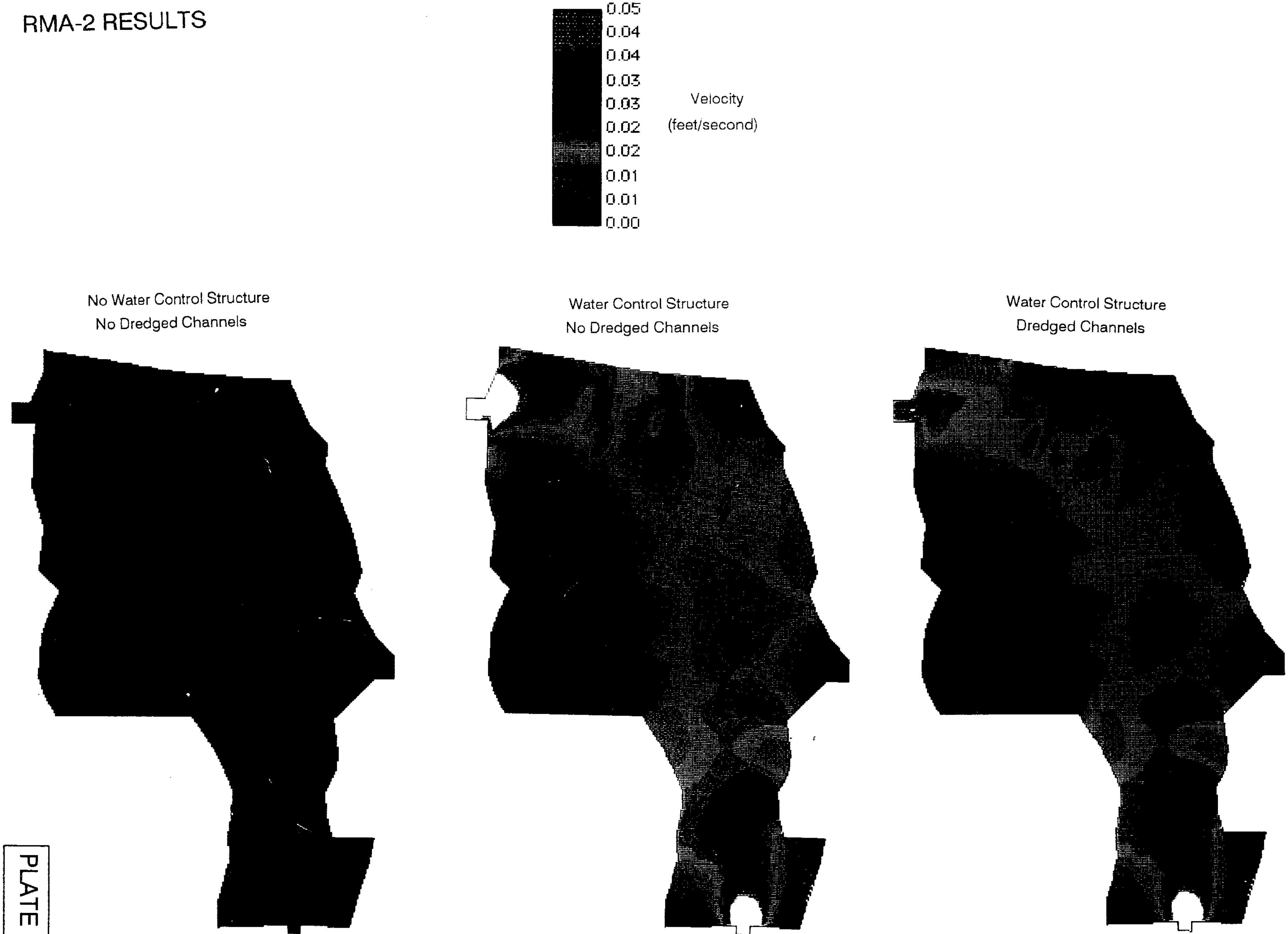


PLATE E-8

SPRING LAKE UPPER UNIT
ELEVATION - STORAGE

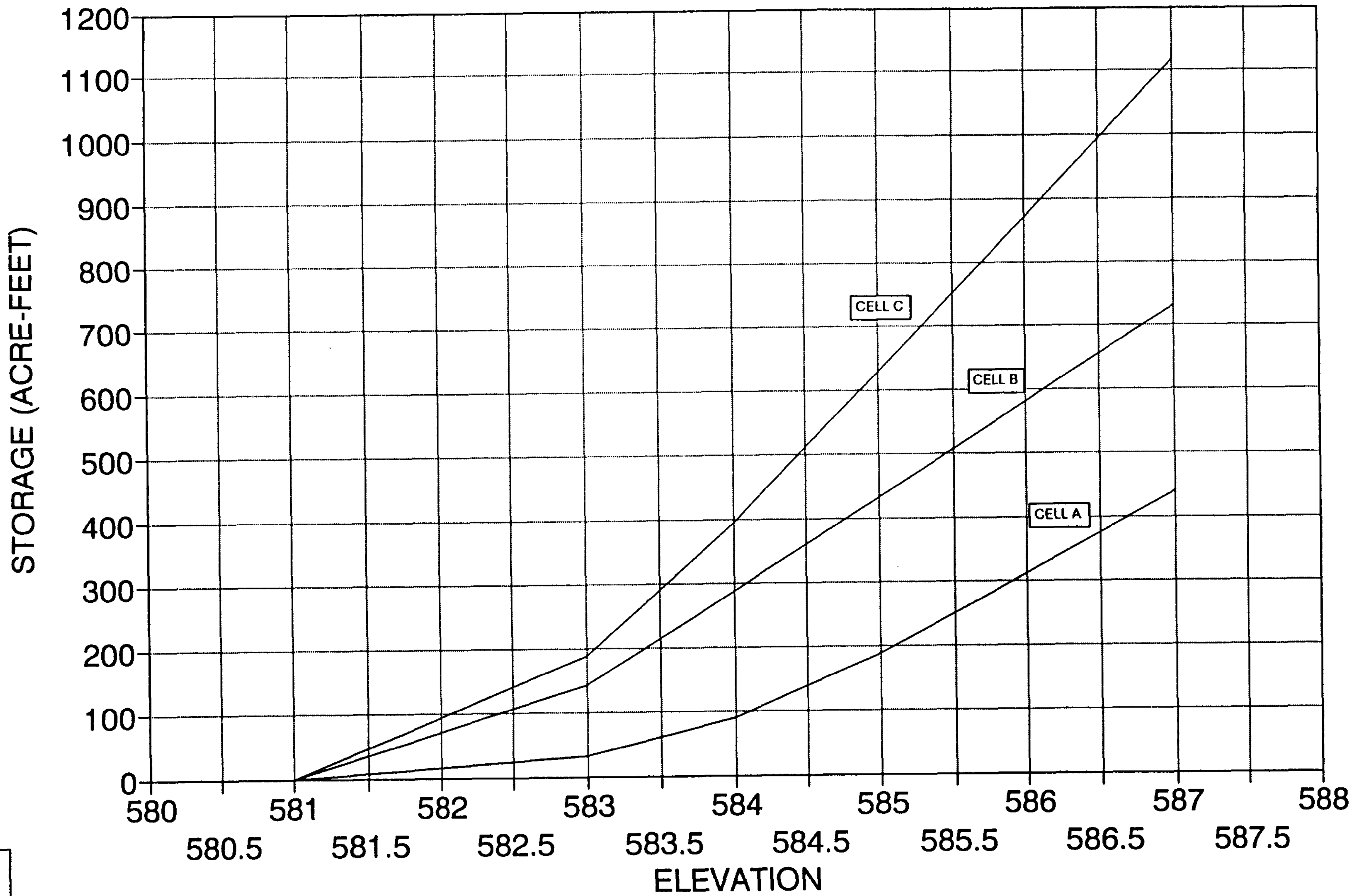


PLATE E-9

SPRING LAKE UPPER UNIT
7000 GPM, TIME TO FILL

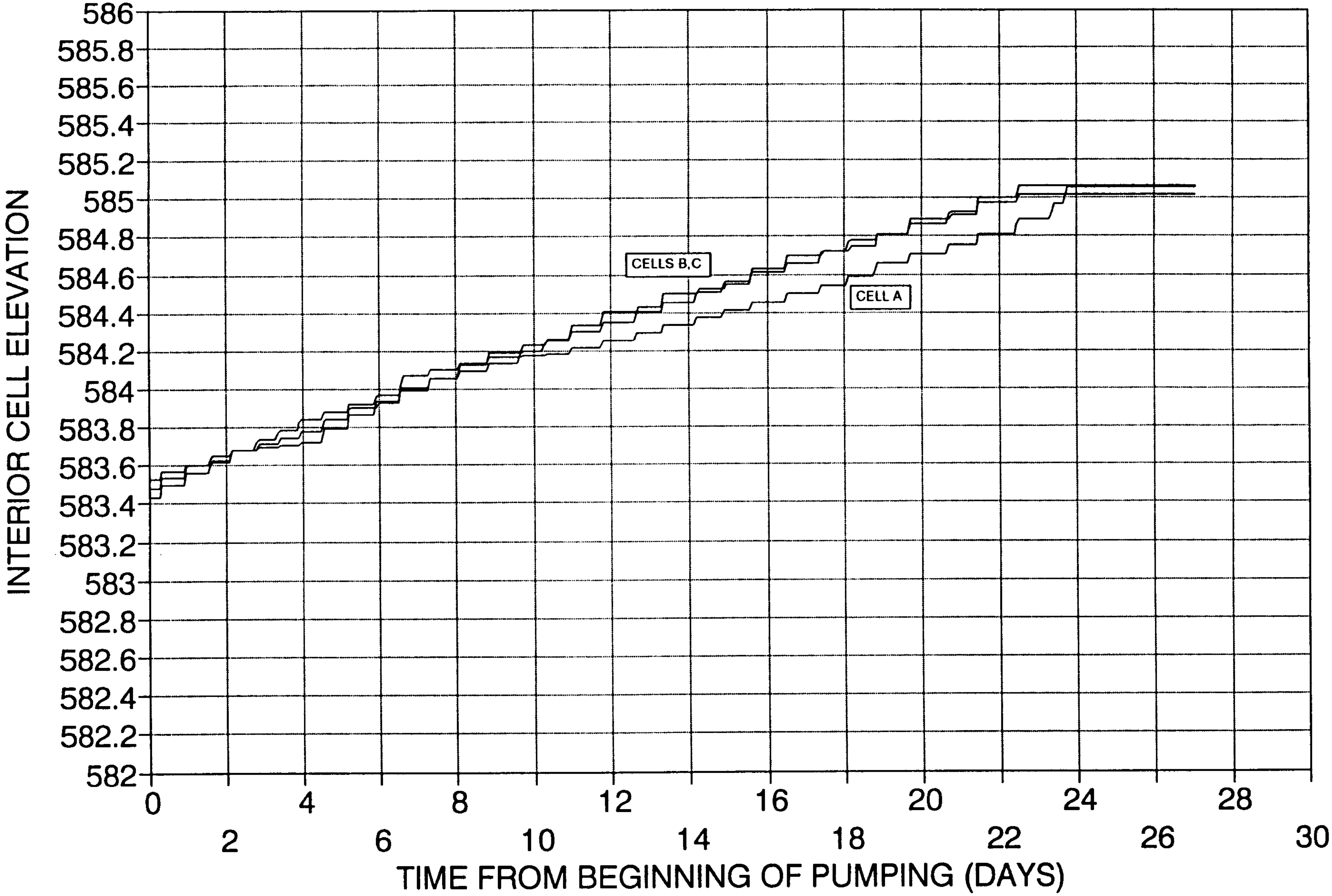


PLATE E-10

SPRING LAKE UPPER UNIT
TIME TO DEWATER WITH CULVERT

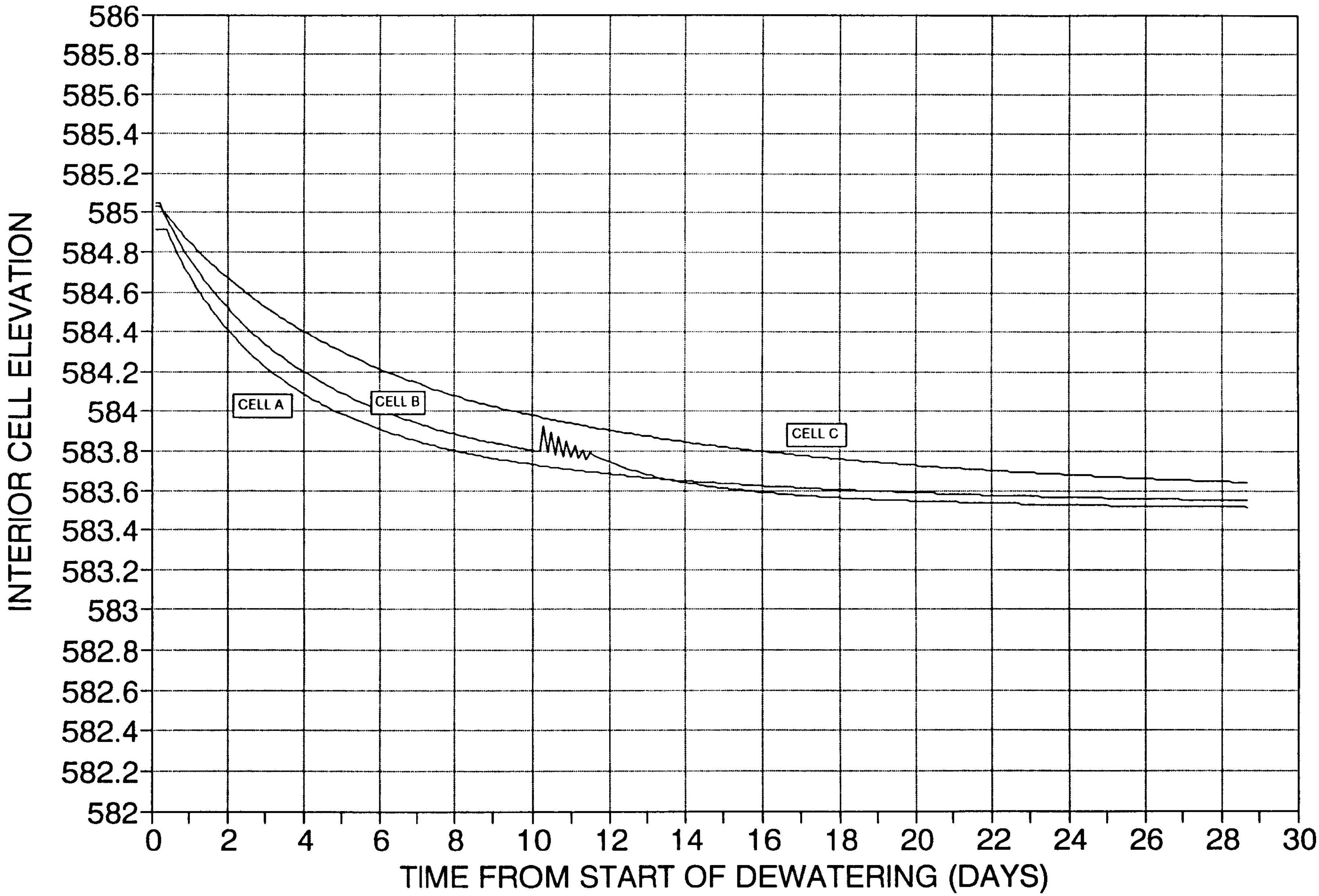


PLATE E-11

SPRING LAKE UPPER UNIT
OVERTOPPING

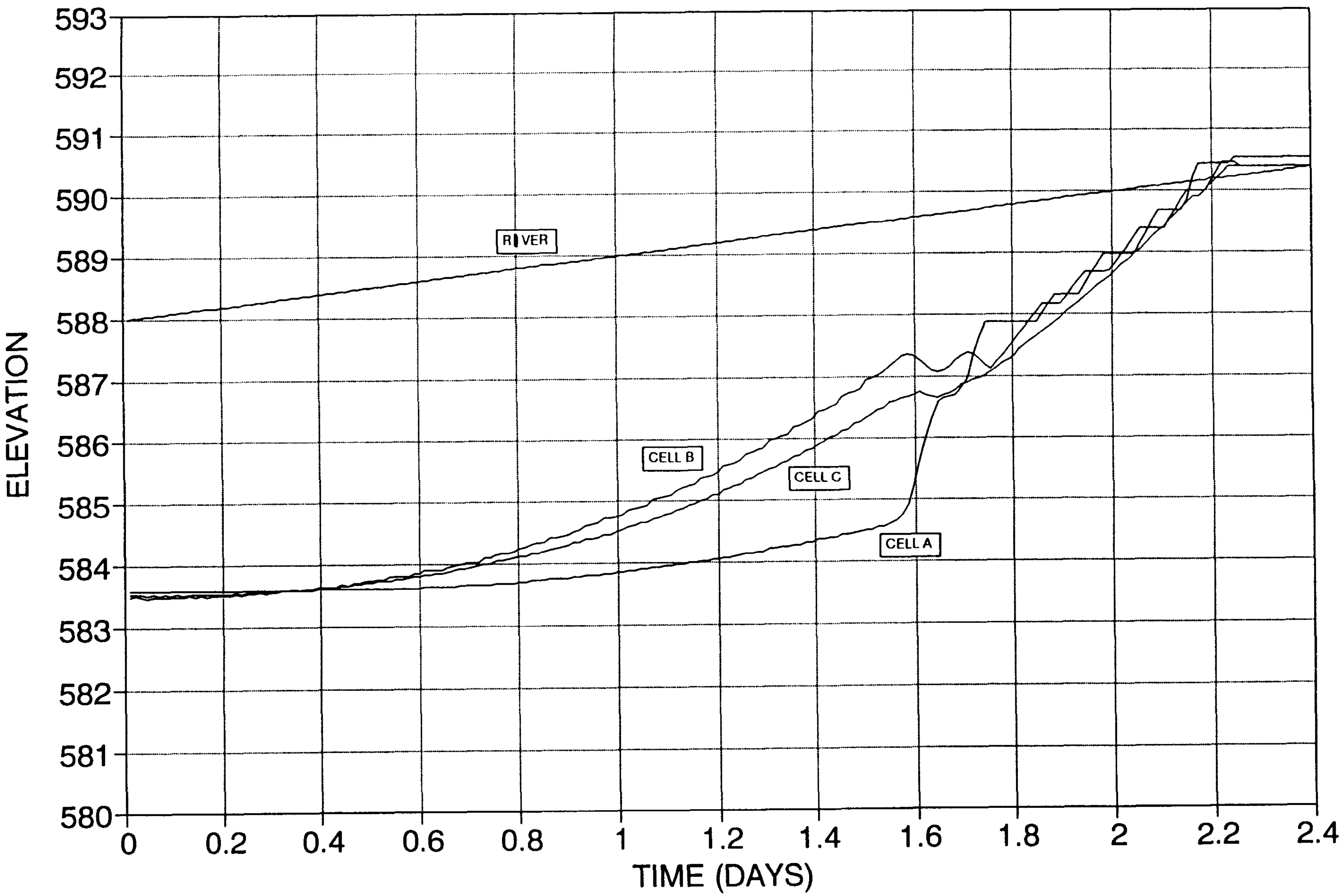
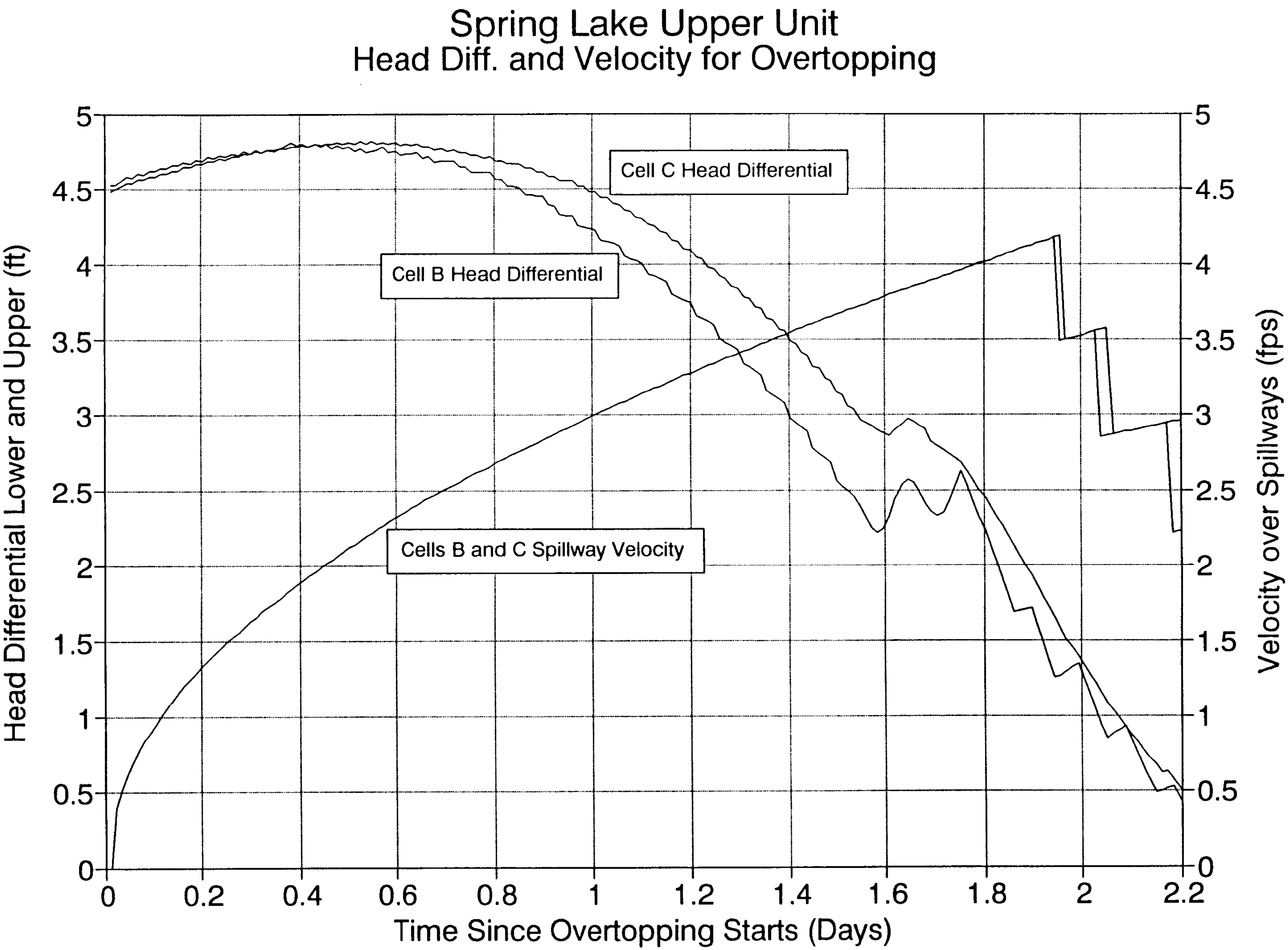


PLATE E-12



Spring Lake Upper Unit
Head Diff. and Velocity for Overtopping
Cell C Head Differential
Cell B Head Differential
Cells B and C Spillway Velocity
Head Differential Lower and Upper (ft)
Velocity over Spillways (fps)
Time Since Overtopping Starts (Days)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
0.5
1.5
2.5
3
3.5
4
4.5
5

WATER QUALITY

APPENDIX F

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX F
WATER QUALITY

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Baseline Monitoring	F-2
Dissolved Oxygen Mass Balance	F-5
Conclusions	F-20
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F-2	Ambient Water and Elutriate Results	F-4
F-3	Baseline Monitoring Results at Site 1	F-6
F-4	Mass Balance Components and Sources of Data	F-18
F-5	Dissolved Oxygen Mass Balance	F-19

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No.	Title
F-1	Spring Lake Sediment Sampling Locations
F-2	Spring Lake Baseline Monitoring Locations

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX F
WATER QUALITY

INTRODUCTION

Water quality within Spring Lake is primarily impacted by the deposition of sediment during periods when the levee system is overtopped and by the presence of emergent and submergent aquatic vascular plants. Resuspension of fine-grained sediment and the resultant turbidity, loss of water depth, and deposition of organic matter all impact negatively on water quality at various times throughout the year. In order to assess existing conditions within the lake and to evaluate the impacts of construction activities, water and sediment samples were collected at sites representative of the proposed design features.

Water quality within the majority of Spring Lake is currently adequate to support native fisheries during the summer months as wind mixing prevents episodic low dissolved oxygen (DO) situations from persisting. However, during periods of ice cover, it is possible that DO can be depleted to the point where fish kills occur. In order to improve water quality during critical periods, a supply of oxygenated river water will be provided to the lake on a continuous basis. However, to avoid excessive transport of suspended sediment to the lake, it is desirable to minimize inflow.

In order to estimate the DO requirement of a warm-water fishery during winter ice cover periods, a number of assumptions were made regarding the chemical and biological processes occurring within the lake. It was concluded that the best approach to determine the optimum inflow needed to maintain favorable water quality conditions in the lake was to perform a DO mass balance. Data from studies of water bodies having characteristics similar to those found at Spring Lake, along with the results of field testing, provided the basis for the mass balance analysis. Additionally, results of long-term water quality monitoring conducted at a completed Environmental Management Program project at Brown's Lake have been incorporated into many of the underlying assumptions of this analysis.

METHODS

EXISTING CONDITIONS

Water and sediment samples were collected by ED-HQ personnel on December 10, 1991, for the purpose of grain size and elutriate analysis. Sediment samples were taken with a 36-inch, plastic-lined, core sampler at sites SL-1, SL-2, SL-3, and SL-4, as shown on plate F-1. Duplicate grain size and elutriate samples were collected at site SL-4. To obtain a representative sample at each station, at least three subsamples were collected at a given location, placed in a container, and mixed to form a homogeneous composite sample. The composite then was placed into appropriate sample bottles and temporarily stored on ice.

Grain size analyses were performed by Corps of Engineers Geotechnical Branch personnel according to U.S. Army Corps of Engineers EM 1110-2-1906 (1986). Results are expressed as the percentage of material passing a number 230 sieve (<0.062mm), as shown in table F-1.

All samples requiring chemical analysis were shipped on ice to Applied Research and Development Laboratory, Inc., Mt. Vernon, Illinois, for analysis. The elutriate test was used to simulate lake conditions during hydraulic dredging and disposal operations and is meant to represent worst case impacts. The test consisted of combining 50 ml of a wet, well-mixed sediment sample with 200 ml of process water collected from the lake. The mixture was allowed to settle for 0.5 hour, after which the supernatant was drawn off and analyzed. Ambient water and elutriate analysis were performed according to American Public Health Association, *et al.* (1985), or U.S. Environmental Protection Agency (1979). Results of these tests are shown in table F-2. From these results, it can be seen that concentrations of most parameters were below Illinois general use water quality standards. Exceptions were noted at site SL-3, where un-ionized ammonia nitrogen equalled the standard, and at site SL-4 which exceeded the standard.

BASELINE MONITORING

Baseline water quality monitoring was initiated in June of 1987. Surface, grab samples were collected approximately every 2 weeks during the summer months and once every 2 months during the winter at various locations within Spring Lake, as shown in plate F-2. Some sampling locations changed over time due to access problems and changes in design features. Sampling at the current stations will continue through the design phase for project evaluation purposes.

Several parameters, including water temperature, Secchi disk depth, DO, pH, specific conductance, and total alkalinity were determined in the field. Additional parameters were analyzed in the laboratory. These analyses

TABLE F-1

SPRING LAKE
WATER QUALITY SAMPLE SITES
SAMPLE DATE: 10 DECEMBER 1991

GRAIN SIZE ANALYSIS OF SEDIMENT SAMPLES

SUMMARY OF TESTING

PERCENT FINER BY WEIGHT

U.S. Standard Sieve Size or Number Sample No.	SL-1	SL-2	SL-3	SL-4	(DUP) SL-4
3/8"	100.0				
# 4	99.9		100.0		
# 8	99.9	100.0	99.9		
# 16	99.9	99.9	99.9	100.0	100.0
# 30	99.8	92.8	93.3	99.9	99.7
# 50	99.3	76.1	95.6	99.8	98.9
# 70	98.8	61.3	87.1	99.6	97.9
# 100	97.3	51.6	73.8	99.1	95.9
# 200	86.7	43.0	61.8	97.9	92.5
# 230	81.2	41.5	60.7	97.1	91.6
Classification:	(a)	(b)	(a)	(c)	(c)

Notes:

1. Visual classification of soils as stated below is in accordance with "The Unified Soils Classification System (USCS)"

(a) CL Gray sandy lean clay
(b) SC Gray clayey sand
(c) 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. Sample designated (Dup) is a duplicate sample.

TABLE F-2

Ambient Water and Elutriate Results
(mg/l Unless Stated Otherwise)
December 10, 1991

Parameter	SL-4S (Ambient Water)	SL-1 (Elutriate)	SL-2 (Elutriate)	SL-3 (Elutriate)	SL-4 (Elutriate)	SL-4 (dup) (Elutriate)	IL. St. Standard
		N/A	N/A	N/A	N/A	N/A	N/A
Time	-	N/A	N/A	N/A	N/A	N/A	N/A
Water Temperature (deg C)	3.0	N/A	N/A	N/A	N/A	N/A	N/A
Ice Thickness (inches)	1-3	N/A	N/A	N/A	N/A	N/A	N/A
Water Depth (feet)	3.5	N/A	N/A	N/A	N/A	N/A	N/A
Sp. Conductance (umhos/cm)	318	N/A	N/A	N/A	N/A	N/A	N/A
Dissolved Oxygen	13.89	N/A	N/A	N/A	N/A	N/A	4.0(5.0)*
Settling Time (hours)	N/A	0.5	0.5	0.5	0.5	0.5	N/A
Arsenic	<0.0045	0.015	0.0060	0.0078	<0.0045	<0.0045	1.0
Barium	0.020	0.067	0.084	0.10	0.14	0.12	5.0
Cadmium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.05
Hexavalent Chromium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
Trivalent Chromium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
Chromium	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	<0.0070	-
Copper	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.02
Lead	<0.0020	<0.0021	0.0026	<0.0020	0.0021	0.0021	0.1
Mercury	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.0005
Nickel	<0.015	<0.015	0.032	0.041	<0.015	<0.015	1.0
Selenium	<0.0045	<0.0045	<0.0045	<0.0045	<0.0045	<0.0045	1.0
Zinc	<0.010	0.018	0.021	0.032	0.047	0.045	1.0
Ammonia Nitrogen	<0.10	0.29	0.80	2.9(0.04)	5.7(0.08)	5.7(0.08)	1.5(15)**
pH (Units)	7.4	6.7	6.6	6.8	6.8	6.8	-
BOD	5.0	<1.0	<1.0	1.1	<1.0	<1.0	-
Oil and Grease	<8.6	<3.5	<3.5	<8.6	<3.5	<3.5	-
Total Organic Carbon	27	18	17	14	15	17	-
Total Suspended Solids	<12	31	22	9.0	7.4	9.0	-
Tot Volatile Solids	140	100	100	100	150	110	-

* Illinois EPA, 1988.
** Ammonia nitrogen shall never exceed 15 mg/l. If ammonia nitrogen is less than 15 mg/l and greater than or equal to 1.5 mg/l, then un-ionized ammonia nitrogen shall not exceed 0.04 mg/l.

were performed on representative samples collected using a Kemmerer-type sampler, placed in appropriate bottles, preserved as necessary, and placed on ice. All laboratory analyses were performed according to American Public Health Association, *et al.* (1985) or U.S. Environmental Protection Agency (1979). Results of baseline monitoring are shown table F-3.

From the results of the baseline monitoring, it can be seen that DO concentrations were usually more than adequate to support most fisheries. However, during short periods, levels fell to 4 mg/l or less at the surface. Water clarity also was usually quite good but occasionally fell to 0.1 meter. Similar trends were observed for turbidity. Chlorophyll a and pH values exhibited a wide range throughout the study period, while other constituents were less variable.

DISSOLVED OXYGEN MASS BALANCE

In order to determine the optimum inflow rate which would ensure good water quality during critical periods and still limit the inflow of suspended sediment, a DO mass balance was performed. Where possible, actual field data were used as input to the model. Where field data were not available, data from the literature were used.

The first step in the analysis was to identify the most critical period of time for DO. Data collected at other midwestern lakes and reservoirs suggest that winter is the most critical period for DO depletion as ice and snow cover limits reaeration and photosynthesis. Field data verifying this assumption at Spring Lake was unavailable due to the mild winters experienced in recent years. However, every attempt will be made to gather winter DO data at the project site to confirm the above assumption.

Next, the most important sources and sinks for DO during the winter were identified. The sources include the oxygen present in the ambient water prior to the onset of ice cover and oxygen present in the river water flowing into the lake. Sinks include water column biochemical oxygen demand (BOD), fish respiration, and sediment oxygen demand (SOD). Other assumptions are as follows:

a. The pool elevation remains constant throughout the analysis period with a head differential of 0.3 foot from the water control structure to the lower breach;

b. The period of ice cover is Dec 15 - Mar 31 (100 days uninterrupted);

c. The ice and over lying snow is sufficient to prevent any net photosynthetic activity in the lake once ice forms;

d. Inflowing river water will mix with approximately 1/4 of the lake as mentioned in the hydraulic analysis (see Appendix E);

TABLE F-3. Baseline monitoring results at site W-M532.3V.

PARAMETER	DATES							
Date	61687	63087	71687	72887	81887	90287	91687	92887
Time	1000	1000	930	1005	920	1050	1000	1010
Air Temp. (Deg. C)	26.6	23.3	21.1	23.9	21.1	17.8	17.2	17.8
Water Temp. (Deg. C)	25.5	24.4	23.3	26.6	24.4	17.8	20	18.9
Depth (M)	1.22	1.22	0.46	1.13	1.22	1.16	1.13	1.28
Sp. Cond. (umhos/cm @ 25 Deg. C)	397	389	391	374	320	341	369	403
Secchi Disc Depth (M)	0.28	0.28	0.32	0.42	0.41	0.39	0.41	0.43
Dissolved Oxygen (mg/l)	4.8	5.8	7.7	5.3	6.5	8.6	7	8
pH (Units)	7.3	7.1	7	7.3	7.5	7.8	7.5	7.6
Turbidity (NTU)	-	-	-	-	-	-	-	-
Wave Heigth (IN)	-	-	-	-	-	-	-	-
Suspended Solids (mg/l)	35	49	31	24	33	30	19	34
Total Alkalinity (mg/l as CaCo3)	-	-	-	-	-	-	-	-
Chlorophyll a (ug/l)	25	18	10	20	15	10	21	22
Chlorophyll b (ug/l)	2	5	2	2	2	2	1	2
Chlorophyll c (ug/l)	4	3	2	2	2	2	1	1
Corrected Chlorophyll a (ug/l)	-	-	-	-	-	-	-	-
Pheophytin a	20	15	12	10	8	9	8	6

TABLE F-3 (continued). Baseline monitoring results at site W-M532.3V.

PARAMETER	DATES									
Date	50689	52089	60389	61789	70189	71589	72989	81289	82689	90989
Time	1415	1630	1425	1400	1340	1432	1422	1410	1335	1412
Air Temp. (Deg. C)	2	23	23	25	31	29	22	30	22	18
Water Temp. (Deg. C)	10	22	23	22	27	26	26	26	22	21
Depth (M)	0.9	0.92	1	0.69	1.02	0.67	0.97	0.69	0.92	0.82
Sp. Cond. (umhos/cm @ 25 Deg. C)	260	300	240	280	287	333	342	348	336	342
Secchi Disc Depth (M)	0.1	0.23	0.51	0.41	1.04	0.23	0.77	0.69	0.87	0.82
Dissolved Oxygen (mg/l)	12.5	13	11.3	10.6	8.2	6	4.1	6.6	4.3	7.9
pH (Units)	7.9	9.3	9.2	8.6	8.9	8.5	7.6	7.9	7.4	7.6
Turbidity (NTU)	33	42	10	22	6	27	8	3	7	3
Wave Heigth (IN)	-	-	-	-	-	-	-	-	-	-
Suspended Solids (mg/l)	220	77	17	23	1	36	23	12	18	7
Total Alkalinity (mg/l as CaCo3)	124	124	122	114	102	136	148	156	154	148
Chlorophyll a (ug/l)	154	83	14	58	3	10	16	10	15	12
Chlorophyll b (ug/l)	21	1	1	1	1	3	1	2	2	2
Chlorophyll c (ug/l)	65	12	2	5	1	1	1	3	1	1
Corrected Chlorophyll a (ug/l)	59	32	8	33	1	2	6	4	6	9
Pheophytin a	157	83	9	40	3	13	17	10	15	4

TABLE F-3 (continued). Baseline monitoring results at site W-M532.3V.

PARAMETER	DATES									
Date	92389	101489	102889	41390	50890	52590	60890	63090	72090	80490
Time	1400	1420	1430	1745	1510	1515	1455	1510	1440	1500
Air Temp. (Deg. C)	11	24	16	6	24	18	26	35	30	29
Water Temp. (Deg. C)	14	17	16	8	20	18	23	28	27	25
Depth (M)	0.76	0.76	0.75	0.7	0.8	0.9	0.77	1.23	0.77	0.92
Sp. Cond. (umhos/cm @ 25 Deg. C)	319	297	353	396	318	358	271	317	418	435
Secchi Disc Depth (M)	0.76	-	-	0.28	0.3	0.3	0.23	0.1	0.44	0.31
Dissolved Oxygen (mg/l)	6.9	9.6	10	13.6	12.5	9.5	10.8	4.4	8.3	7.2
pH (Units)	7.8	7.9	7.9	8.8	9.1	8.4	8.3	7.4	7.8	7.8
Turbidity (NTU)	5	28	16	39	60	56	54	180	14	25
Wave Heigth (IN)	-	-	-	0	6-8	6-10	1-3	0-2	0	2-4
Suspended Solids (mg/l)	1	55	23	45	84	72	47	110	17	41
Total Alkalinity (mg/l as CaCo3)	140	138	156	162	126	138	134	116	160	168
Chlorophyll a (ug/l)	6	16	36	55	84	60	6	46	20	47
Chlorophyll b (ug/l)	1	3	1	<1	<1	2	11	2	2	3
Chlorophyll c (ug/l)	1	4	5	12	17	12	10	4	3	4
Corrected Chlorophyll a (ug/l)	1	4	8	55	84	60	6	46	20	47
Pheophytin a	7	20	5	58	118	40	58	<1	8	5

TABLE F-3 (continued). Baseline monitoring results at site W-M532.6Q.

PARAMETER	DATES							
Date	81890	90190	81590	92990	51391	62591	71091	72291
Time	1315	1330	1220	1245	1009	840	1010	855
Air Temp. (Deg. C)	33	29	21	21	23	18	21	27
Water Temp. (Deg. C)	29	27	20	18	22.6	23.8	26.3	27.7
Depth (M)	3.08	3.69	3.08	3.08	3.51	1.31	1.52	0.94
Sp. Cond. (umhos/cm @ 25 Deg. C)	437	355	397	381	353	350	397	427
Secchi Disc Depth (M)	0.33	0.26	0.26	0.18	0.55	0.15	0.23	0.2
Dissolved Oxygen (mg/l)	12.8	6.1	6.5	6.7	14.59	10.65	9.39	4.06
pH (Units)	8.4	7.4	7.8	7.6	8.8	8.5	8.5	7.7
Turbidity (NTU)	26	63	30	92	11	33	21	23
Wave Heigth (IN)	1-2	1-2	1-2	0-2	0	0	1-2	0
Suspended Solids (mg/l)	35	88	76	100	12	53	39	46
Total Alkalinity (mg/l as CaCo3)	178	138	154	146	-	151	177	184
Chlorophyll a (ug/l)	68	29	66	57	-	33.9	20.4	19.7
Chlorophyll b (ug/l)	8	10	7	5	-	11.4	12.8	4.9
Chlorophyll c (ug/l)	15	9	15	10	-	0.1	0.1	4.6
Corrected Chlorophyll a (ug/l)	68	29	66	57	-	-	-	-
Pheophytin a	14	16	8	<1	-	30.8	25.8	15.8

TABLE F-3 (continued). Baseline monitoring results at site W-M532.6Q.

PARAMETER	DATES						
Date	80591	81991	82891	90991	92391	121091	13092
Time	839	1030	1035	855	1000	1000	900
Air Temp. (Deg. C)	18	20	23	23	13	6	1
Water Temp. (Deg. C)	24.2	22.4	28.6	22.3	14.1	3	2.2
Depth (M)	1.8	1.7	0.9	0.82	0.99	3.14	1.25
Sp. Cond. (umhos/cm @ 25 Deg. C)	449	402	424	431	410	301	358
Secchi Disc Depth (M)	0.2	0.21	0.23	0.27	0.38	0.82	-
Dissolved Oxygen (mg/l)	4.3	5.8	7.3	5.1	9	14.2	14.2
pH (Units)	7.6	8.2	8.2	7.5	8.4	8.1	8.1
Turbidity (NTU)	28	36	16	16	13	6	4
Wave Heigth (IN)	3-4	-	0	4-5	1-2	0	-
Suspended Solids (mg/l)	48	54	28	38	25	<6.0	-
Total Alkalinity (mg/l as CaCo3)	197	180	184	187	151	153	176
Chlorophyll a (ug/l)	55	32	26	19	17	7	-
Chlorophyll b (ug/l)	12	4	4	3	1	2	-
Chlorophyll c (ug/l)	12	2	5	1	2	4	-
Corrected Chlorophyll a (ug/l)	-	-	-	-	-	-	-
Pheophytin a	50	3	10	5	6	<1	-

TABLE F-3 (continued). Baseline monitoring results at site W-M532.7Y.

PARAMETER	DATES								
Date	62588	70288	70988	72088	73088	81388	82788	91088	92488
Time	1505	1140	1115	1120	1120	1030	1130	1035	1145
Air Temp. (Deg. C)	36	30	30	26	32	30	16	16	16
Water Temp. (Deg. C)	33	27	30	28	31	30	23	21	20
Depth (M)	0.6	1	1	0.5	0.8	0.6	0.6	0.5	0.6
Sp. Cond. (umhos/cm @ 25 Deg. C)	290	-	-	300	280	319	281	329	319
Secchi Disc Depth (M)	0.1	0.3	-	0.3	0.3	0.3	0.3	0.3	0.3
Dissolved Oxygen (mg/l)	7.2	14	7.4	7.1	5.2	5.8	5.1	7.3	6.5
pH (Units)	10.4	8.8	9.3	8.4	7.7	7.8	8.6	7.7	7.8
Turbidity (NTU)	-	44	21	-	-	20	-	-	-
Wave Heigth (IN)	-	-	-	-	-	-	-	-	-
Suspended Solids (mg/l)	8.5	-	33	42	-	33	28	26	14
Total Alkalinity (mg/l as CaCo3)	-	120	108	-	186	102	106	114	120
Chlorophyll a (ug/l)	3	-	104	-	-	-	17	-	20
Chlorophyll b (ug/l)	1	-	1	-	-	-	4	-	1
Chlorophyll c (ug/l)	1	-	14	-	-	-	1	-	2
Corrected Chlorophyll a (ug/l)	-	-	-	-	-	-	-	-	-
Pheophytin a	1	-	1	-	-	-	28	-	16

TABLE F-3 (continued). Baseline monitoring results at site W-M533.9I.

PARAMETER				
Date	81890	90190	81590	92990
Time	1345	1335	1240	1255
Air Temp. (Deg. C)	33	29	21	20
Water Temp. (Deg. C)	28	27	21	17
Depth (M)	0.31	1.23	1.13	0.51
Sp. Cond. (umhos/cm @ 25 Deg. C)	450	356	401	379
Secchi Disc Depth (M)	0.31	0.21	0.26	0.18
Dissolved Oxygen (mg/l)	13.6	5.7	6.5	6.8
pH (Units)	8.4	7.4	7.8	7.7
Turbidity (NTU)	72	67	66	79
Wave Heigth (IN)	6-8	1-2	2-4	0
Suspended Solids (mg/l)	260	86	80	80
Total Alkalinity (mg/l as CaCo3)	190	134	156	142
Chlorophyll a (ug/l)	101	9	50	41
Chlorophyll b (ug/l)	1	2	2	<1
Chlorophyll c (ug/l)	12	2	4	12
Corrected Chlorophyll a (ug/l)	-	-	-	-
Pheophytin a	12	4	3	<1

TABLE F-3 (continued). Baseline monitoring results at site W-M534.8R.

PARAMETER	DATES						
Date	81890	90190	81590	51391	62591	71091	72291
Time	1315	1330	1220	1009	840	1010	855
Air Temp. (Deg. C)	33	29	21	26	19	22	27
Water Temp. (Deg. C)	27	28	21	24.3	24.3	25.9	28
Depth (M)	4.31	3.38	3.69	1.52	1.37	1.25	1.25
Sp. Cond. (umhos/cm @ 25 Deg. C)	412	361	397	353	352	411	434
Secchi Disc Depth (M)	0.38	0.38	0.44	0.73	0.23	0.22	0.18
Dissolved Oxygen (mg/l)	11.8	9.5	9.6	14.1	11.6	10.2	3.6
pH (Units)	8.3	7.8	8.3	9	8.7	8	7.3
Turbidity (NTU)	17	21	24	6	21	26	26
Wave Heigth (IN)	6-8	1-2	2-4	0	0	1-2	6-8
Suspended Solids (mg/l)	33	29	33	6	27	46	51
Total Alkalinity (mg/l as CaCo3)	170	142	160	-	161	191	198
Chlorophyll a (ug/l)	103	32	98	-	20.3	34.1	19.3
Chlorophyll b (ug/l)	18	3	8	-	6.2	14.8	4
Chlorophyll c (ug/l)	11	5	14	-	0.5	0.1	0.7
Corrected Chlorophyll a (ug/l)	103	32	98	-	-	-	-
Pheophytin a	35	4	18	-	21.7	45.1	6.7

TABLE F-3 (continued). Baseline monitoring results at site W-M534.8R.

PARAMETER				DATES			
Date	80591	81991	82891	90991	92391	121091	13092
Time	855	1045	1105	915	1010	1300	922
Air Temp. (Deg. C)	18	20	23	23	13	6	1
Water Temp. (Deg. C)	23.6	22.7	29.4	22.1	14	3	1.8
Depth (M)	1.1	0.94	1.2	1.07	1.33	1.25	0.88
Sp. Cond. (umhos/cm @ 25 Deg. C)	438	397	417	448	411	318	324
Secchi Disc Depth (M)	0.18	0.17	0.27	0.15	0.35	0.79	-
Dissolved Oxygen (mg/l)	4.8	6.5	7.3	5.6	8	13.9	8.1
pH (Units)	7.8	8.2	8.3	8	8.3	8.1	7.3
Turbidity (NTU)	34	11	23	39	17	7	6
Wave Heigth (IN)	4-5	9	0	3-4	4-5	6	-
Suspended Solids (mg/l)	53	89	31	97	29	6	-
Total Alkalinity (mg/l as CaCo3)	192	190	191	205	170	157	165
Chlorophyll a (ug/l)	67	39	23	52	20	4	-
Chlorophyll b (ug/l)	9	7	3	5	1	<1	-
Chlorophyll c (ug/l)	7	5	3	4	2	<1	-
Corrected Chlorophyll a (ug/l)	-	-	-	-	-	-	-
Pheophytin a	45	13	32	17	7	<1	-

TABLE F-3 (Continued). Baseline monitoring results at site W-M534.9N.

PARAMETER	DATES							
Date	61687	63087	71687	72887	81887	90287	91687	92887
Time	1100	900	1030	1005	1015	950	915	910
Air Temp. (Deg. C)	28.3	21.1	22.2	25	21.1	16.7	17.2	16.7
Water Temp. (Deg. C)	24.4	22.2	21.1	26.6	25.5	17.8	20	20
Depth (M)	4.27	4.79	4.48	4.48	4.76	4.42	4.76	4.79
Sp. Cond. (umhos/cm @ 25 Deg. C)	402	392	394	383	342	327	351	373
Secchi Disc Depth (M)	0.33	0.41	0.42	0.48	0.41	0.36	0.43	0.44
Dissolved Oxygen (mg/l)	4.8	7.74	7.54	4.02	6.88	8.16	5.7	9.58
pH (Units)	7.2	7.5	7.5	7.5	7.7	8	7.6	8
Turbidity (NTU)	-	-	-	-	-	-	-	-
Wave Heigth (IN)	-	-	-	-	-	-	-	-
Suspended Solids (mg/l)	29	23	32	14	38	44	31	27
Total Alkalinity (mg/l as CaCo3)	-	-	-	-	-	-	-	-
Chlorophyll a (ug/l)	52	21	23	24	38	39	22	36
Chlorophyll b (ug/l)	2	4	3	2	2	2	2	3
Chlorophyll c (ug/l)	9	2	2	3	5	3	1	1
Corrected Chlorophyll a (ug/l)	-	-	-	-	-	-	-	-
Pheophytin a	29	16	8	12	16	25	18	14

TABLE F-3 (Continued). Baseline monitoring results at site W-M536.1Q.

PARAMETER	DATES									
Date	41390	50890	52590	60890	63090	72090	80490	81890	90190	91590
Time	1530	1400	1400	1345	1355	1335	1345	1210	1225	1105
Air Temp. (Deg. C)	6	23	18	26	38	26	30	31	29	22
Water Temp. (Deg. C)	8	18	16	19	23	24	24	24	25	22
Depth (M)	1.2	1.8	2.1	1.85	3.08	1.69	2.15	1.54	2.15	1.64
Sp. Cond. (umhos/cm @ 25 Deg. C)	389	362	353	329	228	530	458	555	394	437
Secchi Disc Depth (M)	0.38	0.38	0.3	0.23	0.03	0.31	0.18	0.28	0.21	0.21
Dissolved Oxygen (mg/l)	15	11.9	9.7	9	4.2	6.7	8	7.7	5.2	6.7
pH (Units)	8.8	8.6	8.1	8	7.2	7.8	7.9	7.7	7.5	7.9
Turbidity (NTU)	32	36	37	65	1300	43	80	42	71	63
Wave Heigth (IN)	0	6-8	6-10	1-3	0-2	0	2-4	2-3	<1	<1
Suspended Solids (mg/l)	48	60	64	95	1200	63	140	68	110	100
Total Alkalinity (mg/l as CaCo3)	152	140	130	144	90	210	184	168	152	172
Chlorophyll a (ug/l)	18	36	46	26	21	23	100	45	33	47
Chlorophyll b (ug/l)	<1	<1	6	1	14	2	2	4	9	4
Chlorophyll c (ug/l)	20	11	12	8	2	3	9	6	7	10
Corrected Chlorophyll a (ug/l)	55	84	60	6	46	20	47	45	33	47
Pheophytin a	192	93	43	47	23	11	5	2	16	9

TABLE F-3 (continued). Baseline monitoring results at site W-M536.1Q.

PARAMETER	DATES								
Date	92990	51391	62591	71091	72291	80591	82891	90991	92391
Time	1530	1400	1400	1345	1355	1335	1345	1210	1225
Air Temp. (Deg. C)	17	28	21	23	28	18	23	24	14
Water Temp. (Deg. C)	17	18	24.2	26.7	27.7	24.5	27	23	14.9
Depth (M)	1.59	2.29	2.29	1.95	1.84	1.66	1.55	1.43	2.23
Sp. Cond. (umhos/cm @ 25 Deg. C)	380	331	439	464	446	424	452	469	465
Secchi Disc Depth (M)	0.23	0.34	0.12	0.24	0.21	0.15	0.26	0.17	0.15
Dissolved Oxygen (mg/l)	8.2	10.7	5.2	7.7	6.2	6.8	6.7	7.3	8
pH (Units)	7.8	8	7.7	8.2	8.2	8.2	8.1	8.3	8.1
Turbidity (NTU)	59	28	44	30	32	36	25	33	33
Wave Heigth (IN)	0-1	0	0	0	0	0	0	2-3	0
Suspended Solids (mg/l)	92	78	129	77	105	77	50	92	24
Total Alkalinity (mg/l as CaCo3)	146	-	156	167	161	162	178	185	145
Chlorophyll a (ug/l)	40	-	2.8	10.4	20	42	15	66	23
Chlorophyll b (ug/l)	1	-	2.6	6.2	1.6	4.6	2.6	6.2	0.2
Chlorophyll c (ug/l)	<1	-	0.1	0.1	2.3	5.8	1.2	8.6	4
Corrected Chlorophyll a (ug/l)	40	-	-	-	-	-	-	-	-
Pheophytin a	10	-	5.4	4.9	14.2	28.7	15	12.8	6.1

e. The major sink in the analysis, SOD, was based on samples collected at Brown's Lake which is also located in Pool 13 and has sediment characteristics similar to Spring Lake. It is assumed that the upper 1 inch of sediment will exert this demand and that the unit weight of the sediment is 68 pounds per cubic foot, yielding an SOD value of 4 g/m2/day.

The above assumptions are felt to be conservative, yet realistic, based on worst case observations of Midwestern lakes and lessons learned in a similar analysis at Brown's Lake.

Table F-4 lists the components of the mass balance as well as the source of the values used. Table F-5 shows the calculations and equations used to determine the optimum inflow needed to balance DO sources and sinks.

TABLE F-4

Mass Balance Components and Sources of Data

DO Sources	Values Used	Source of Data
Mississippi River inflow	80% of saturation	Estimated
Initial DO content of lake	80% of saturation	Estimated
DO Sinks		
SOD	4.0 g/sq m/day @20 C	Measured*
BOD	2.5 mg/l @20 C	Measured*
Fish respiration	0.0119 ml/g-hr	Leidy, 1977
Standing crop of fish	56 g/sq m	Leidy, 1977

* Values were estimated from data collected at Brown's Lake which is similar to the project site. Verification data is being gathered, and, should significant differences be observed, appropriate changes will be reflected in future reports.

TABLE F-5

DISSOLVED OXYGEN MASS BALANCE

Equations

Sinks: Total S.O.D Depletion = S.O.D. * Area * Time

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where:

S.O.D. = 4.0 g /sq m-day @ 20 deg C = 1.42 g/sq m-day @ 4 deg C
based on temp corr. = 1.067**(t-20)

Area = 720 ac.

Time = 100 days

Total B.O.D Depletion = B.O.D. * Flow * Time
(based on iterative calculation procedure)

where:

B.O.D.= 2.5 mg/l @ 20 deg C = 0.886 mg/l @ 4 deg C
based on temp corr. = 1.067**(t-20)

Flow = 175 cfs (calculated value)

Fish Respiration = Fish Standing Crop * Area * Respiration Rate

where:

Fish Standing Crop = 500 lbs/acre

Fish Respiration Rate = 0.0119 ml/g-hr

Fish Active / Standard = 1.7
Metabolism Rate

Sources: Ambient D.O. in Lake = Volume * D.O.

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where:

Lake Volume = 2330 acre-ft

D.O. = 10 mg/l

D.O. in Inflowing River Water = Flow * D.O. * Time
(based on iterative calculation procedure)

Results of Mass Balance

Total S.O.D. Depletion (g Oxy)	Total B.O.D. Depletion (g Oxy)	Fish Respiration (g Oxy)	Total D.O. Sink (g Oxy)	Ambient D.O. in Lake (g Oxy)	Inflow D.O. Mass (g Oxy)	Total D.O. Source (g Oxy)
4.14E+08	3.74E+07	4.06E+04	4.51E+08	2.87E+07	4.23E+08	4.51E+08

CONCLUSIONS

Based on the field observations, literature values, and conservation assumptions of this analysis, it is estimated that throughout the winter an inflow of approximately 175 cubic feet per second of river water will be required to ensure an adequate supply of DO to the areas of the lake which will be impacted by the inflowing water. It should be realized that this value is approximate and will vary from year to year and possibly from season to season with more or less flow required during the summer months.

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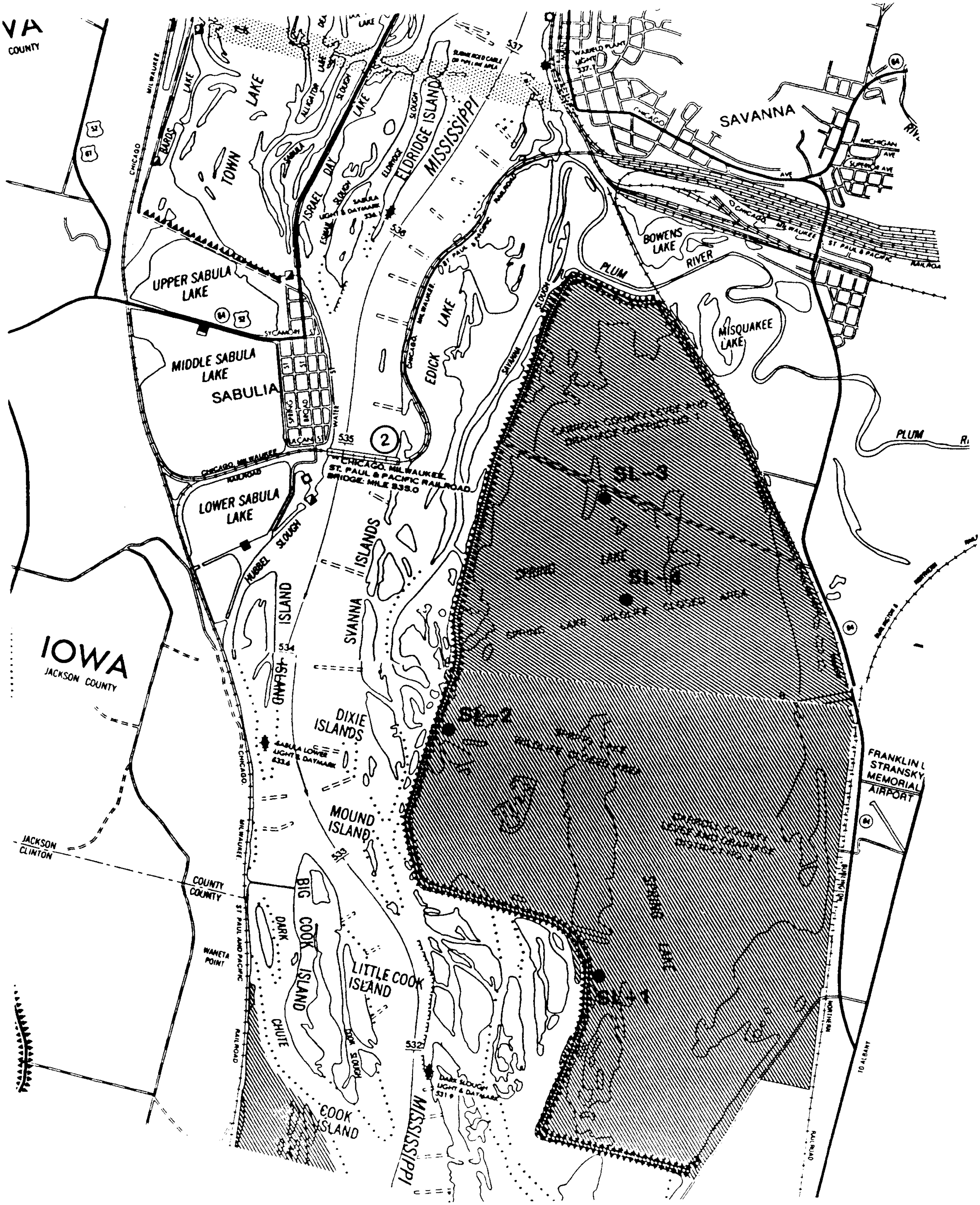
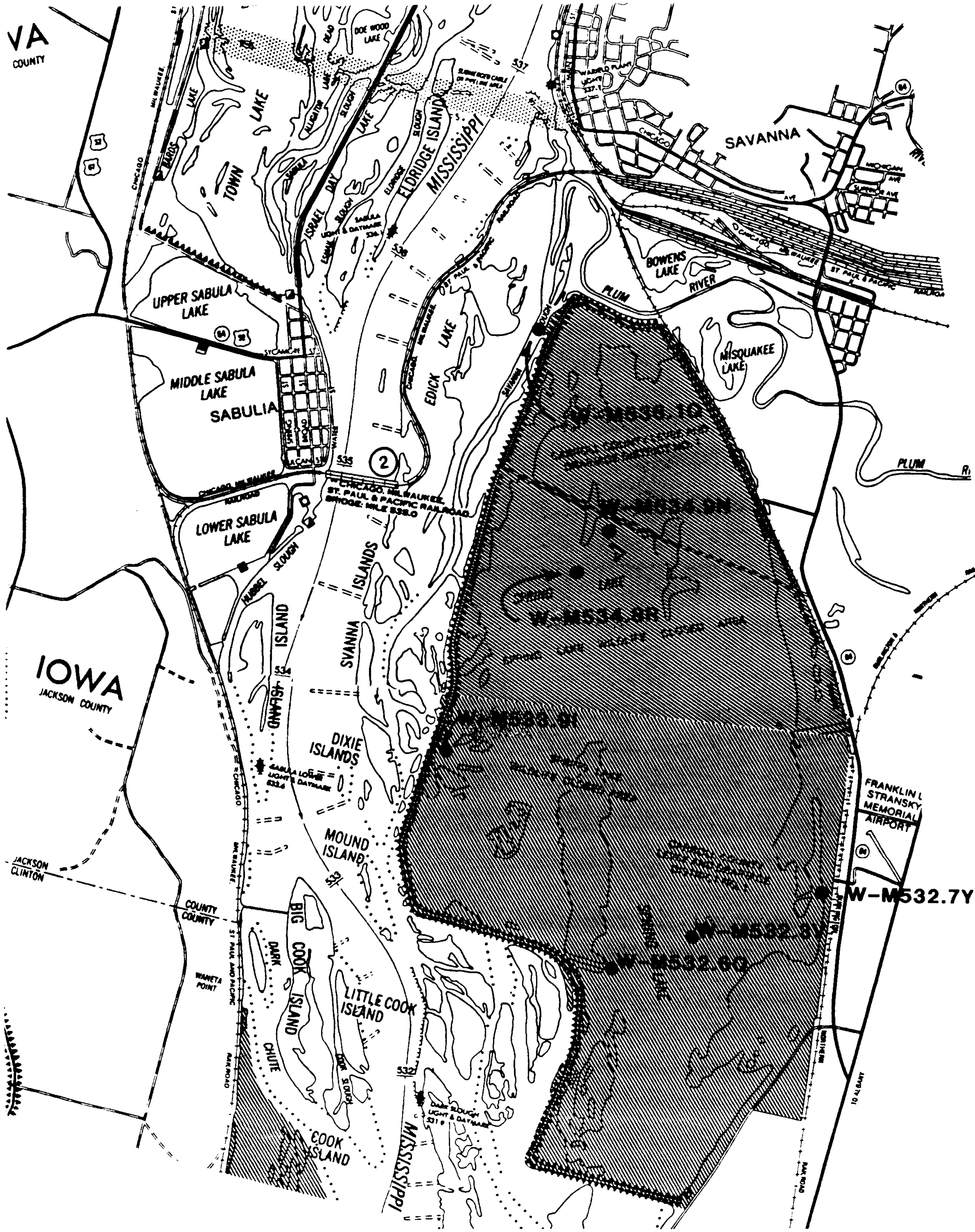


SPRING LAKE SEDIMENT SAMPLING LOCATIONS

PLATE F–1



SPRING LAKE BASELINE MONITORING LOCATIONS

PLATE F-2

GEOTECHNICAL CONSIDERATIONS

APPENDIX G

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX G
GEOTECHNICAL CONSIDERATIONS

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UPPER MISSISSIPPI RIVER SYSTEM
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SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX G
GEOTECHNICAL CONSIDERATIONS

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 Illinois Geological Survey reports, bulletins, circulars, and a review of the Carroll County Soil Survey. The geotechnical information has been obtained from soil borings that were obtained by the Rock Island District Geotechnical Branch who performed laboratory analysis and interpreted the results.

The project site is separated into two distinct areas. The northern area is proposed to have the levee rehabilitated and be apportioned into three cells divided by low-head (2-year) levees with independent water level control. The levee separating the northern and southern units will be rehabilitated to a 5-year event. The southern unit is proposed to have the perimeter levee rehabilitated to protect against a 50-year event. This unit is open to the river on the lower end. The perimeter levee is designed to prevent flow with its sediment load from flowing into the upstream end. A water control structure will be located on the upstream end to provide oxygenated flow to improve water quality when needed. A hemi-marsh is proposed to be constructed in the southern unit with water to be supplied by a well.

LOCATION

The Spring Lake Environmental Management Project is located in northwestern Carroll County, Illinois, between Mississippi River Miles (RM) 532 and 536. The 3,000-acre site, which comprises Spring Lake, is just north of Savanna, Illinois, in Pool 13 and was created in 1938 by the construction of Lock and Dam 13 at Fulton, Illinois (RM 522). The project site lies entirely in the Upper Mississippi River National Fish and Wildlife Refuge.

PHYSIOGRAPHY

The project area is situated within the Dissected Till Plaines Section of the Central Lowland Province and is located in the Mississippi River Valley. The shallow backwaters, bottomland, and islands are subjected to permanent high water tables and annual flooding.

GEOLOGY

The region around the project area is situated near the bluffs of the Mississippi Valley at the western edge of the Rock River Hill Country, a region of highly undulating glaciated uplands. This area was covered by the Illinoian glacier during the Pleistocene Epoch. The bedrock consists of about 2,300 feet of Paleozoic limestone, dolomite, sandstone, and shale ranging in age from late Cambrian to middle Silarian. These marine sedimentary rocks were laid down layer by layer in the ancient seas that covered this area from time to time. These layers are sometimes separated by thin (1- to 3-inch) layers of bentonite clay. The Plumb River Fault Zone lies to the north, as does the southern edge of the "Driftless Area" (a large part of northwestern Illinois and southwestern Wisconsin that apparently was missed by the Pleistocene glaciers).

The Mississippi River initially was 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 became increasingly coarse-grained with depth, which in some areas exceeds 100 feet in depth. Upstream of the Rock River these deposits consist primarily of igneous and metamorphic material, which originated in the Canadian Shield area to the north. These valley train deposits are assigned to the Mackinaw Member of the Henry Formation. Post-glacial reworking of the upper portion of these deposits plus additional upland erosion have left the modern valley filled with relatively fine-grained gravels, sands and silts, 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. Thickness of the unit varies, but the present Mississippi River is believed to erode as much as 50 feet in the active channels during flood stages. At least as early as 1892 and prior to the completion of Lock and Dam 13 during the 1930's, the area of Spring Lake appears to have been agricultural "bottomland" developed on a low alluvial terrace and protected by a levee and drainage system. Since the completion of Lock and Dam 13, it has essentially been a backwater lake deposition area for silts and clays, with some inflow during high water events.

SUBSURFACE EXPLORATION

An extensive subsurface exploration program was planned to identify, classify, and determine the engineering characteristics of the soils at the project site. Due to an extremely mild winter in December 1991 through February 1992 and thin (unsafe) ice conditions, many planned offshore borings were not completed. These borings will be completed as soon as conditions permit safe exploration and prior to completion of plans and specifications. The explorations that were completed are described in the following paragraphs.

Off-shore borings SL-90-1 through SL-90-4 were completed in January 1990 for evaluation as construction materials and dredging characteristics. These borings consisted almost entirely of material which classified as a SC to SP, clayey sand to poorly graded sand.

Off-shore borings SL-90-5 through SL-90-10 were performed in February 1990 for evaluation for dredging characteristics. These borings had a 1- to 2-inch soft organic layer on top. Below the soft layer was 10 feet of very stiff clay underlain by sand. The clay was classified as CL to CH, and the sand was classified as SC to SP. The liquid limits varied from 40 to 60, with the plastic limits averaging 18. The natural average water content was about 35 percent. Boring SL-90-9 consisted of 11 feet of very soft clay with water contents up to 80 percent.

Borings SL-92-1 through SL-92-3 were completed in February 1992. Boring SL-92-1 was performed to evaluate the possibility of using a well to provide water for the hemi-marsh. This boring had a top layer of clay 6 feet thick with 85 feet of poorly graded sand (SP) below. The top 40 feet of sand has an average D_{10} of 0.25 mm. The bottom 45 feet also was classified SP with an average D_{10} of 0.18 mm.

Boring SL-92-2 was completed to evaluate the condition of the existing levee as well as foundation conditions for a pump station. This boring consisted of 12 feet of sandy clay and lean to fat clay. From 12 feet to 51 feet, the material was classified as SP medium to fine sand. Boring SL-92-3 was performed to evaluate the existing perimeter levee and foundation evaluation for a stoplog structure. This boring displayed 30 feet of clay, which was classified from sandy lean clay to fat clay. There is a very soft lean clay at a depth of 25 feet. Below the clay is medium to fine sand.

Locations of borings and boring logs are shown on plates 7 through 9 of the Definite Project Report.

PROPOSED EMBANKMENTS

The proposed project includes rehabilitating the perimeter levee. The 7.1 miles of levee will be rehabilitated to protect against a 50-year flood event, thus preventing sedimentation. The river side of the levee will be left in place and undisturbed. The river side has a good growth of trees, which provide protection from erosion. To ensure a safe levee and yet retain the trees, a templet was developed and placed on each cross section. The templet was used to be certain of an adequate section. The material left in place on the river side is considered "sacrificial" because it can be lost without endangering the levee. A typical section is shown on plate G-1. The lake side will be rehabilitated with 1:V to 4:H side slopes. All borrow will be adjacent to the levee and come from the confines of the project area. The borrow material will be placed uncompacted.

The 1.4-mile cross dike is proposed to be rehabilitated to a 5-year levee. The borrow material will come from adjacent borrow and be placed uncompacted. All of the construction will take place on the interior side of the levee to prevent disturbing the existing protection, i.e., riprap and tree growth.

The Upper Lake is proposed to be apportioned into three cells that have been divided by elevation changes. The levees will be low-head levees constructed with uncompacted fill. A series of stoplog structures will be incorporated to provide independent water control in each unit.

A low levee (3 to 5 feet in height) is proposed to be constructed to create a hemi-marsh in the lower lake. A hemi-marsh is a combination of open water and marsh land. Construction materials will come from adjacent borrow and will be placed uncompacted.

Before material can be placed for levee reconstruction or new construction, the site must be prepared. All vegetating and other deteriorated materials must be stripped to a depth of 6 inches. All tap roots, lateral roots, and trees within the work area will be removed to a depth of 3 feet. A minimum 20-foot zone between the toe of the levee and the borrow excavation will remain in place and undisturbed.

FOUNDATIONS

Borings SL-92-2 and SL-92-3 were drilled through the cross dike and perimeter levee, respectively. Boring SL-92-2 was drilled to evaluate the site for a pump station. This boring revealed that the cross dike is composed of 8 feet of sandy lean clay and medium to fine sand underlain by 4 feet of fat clay (CH). The top 8 feet is the existing levee material. Below this was a fine to medium sand to a depth of 50 feet. Split spoon blow counts in the sand varied from 1 to 14 with an average of 2 to 4 to a depth of 30 feet. From 30 to 50 feet, the average blow count was 8 to 10.

Blow counts from 0 to 5 indicate a very loose sand with friction angles of 26 to 30 degrees. Blow counts from 5 to 10 indicate a loose sand with friction angles from 28 to 35 degrees.

Boring SL-92-3 was drilled through the perimeter levee to evaluate the material for slope stability and foundation conditions. From ground level to 30 feet is clay underlain by 20 feet of sand. The top 10 feet of clay is the original construction material of the levee. This material was classified as a lean clay with a natural moisture content of 25 percent which indicates a strength of 550 psi. The clay below the levee material generally had low blow counts with an average between 1 and 3, which indicates soft materials. The clay is estimated to have a strength of 500 psi average with one soft layer at a depth of 24 feet with a strength of approximately 220 psi. The sand is a medium to fine sand. From 30 to 45 feet, the blow counts were low with the average of 5. The bottom 5 feet had blow counts from 7 to 13 which indicates a medium dense sand.

Although boring SL-92-3 has a soft layer, this layer is deep enough that it should not cause any foundation problems for a stoplog structure. The material excavated will weigh more than the structure itself. Boring SL-92-2 appears to be competent material. Any unsuitable material that may be encountered during excavation for the structures will be removed and will be replaced with appropriate fill.

Borings for the proposed stoplog structures in the northern unit have not been completed because of an unusually warm 1991-1992 winter (thin ice). These borings will be completed as soon as possible and before plans and specifications are completed.

SLOPE STABILITY

The stability of the slope was analyzed by the modified Swedish method for circular Arc Slope Stability Analysis according to EM 1110-2-1902 "Engineering Design Stability of Earth and Rockfill Dams," dated April 1, 1970. Conservative shear strengths were assumed for the most severe configuration of the foundation and embankment.

The perimeter levee near station 96+50 was found to be the most critical for slope stability analysis for the end of construction condition. Successive trials of various circular sliding surfaces and circle-plane-circle failure surfaces were analyzed, and a determination of the critical failure surface having the lowest factor of safety was made. The summary of the slope stability studies is shown on plates G-2 and G-3. The computed minimum factor of safety of 1.50 computed for a circular failure surface exceeds the 1.3 minimum required by EM 1110-2-1913, "Design and Construction of Levees," dated March 31, 1978. The circle-plane-circle analysis proved to be most critical with a factor of safety of 1.3 which just meets the 1.3 required. Therefore, no slope stability problems are expected.

The slope stability analysis was checked using UTEXAS2. The computed minimum factor of safety for a circular failure surface is 1.56 and the minimum factor of safety for the circle-plane-circle analysis is 1.3. This correlates favorably with the results obtained using CENCR-ED-G's slope stability analysis and plot program.

The dredge cuts also were considered for slope stability. The dredge cuts will have 1:V on 2:H side slopes. The maximum cut depth will be approximately 6 feet. The offshore borings completed generally show a stiff medium to fat clay. It is possible that some minor local slumping may occur. However, considering the depth of cut and the material being excavated, slope stability problems are not expected.

SEEPAGE

The perimeter levee is open to the river at the lower end; therefore, there should be no difference in head, and seepage will not be a problem.

A study of the soil strata was conducted and revealed a 10-foot-thick clay layer over a pervious sand layer. The depth of adjacent borrow will be limited to reduce the chance of opening up any seepage paths.

The southern moist soil unit has been in operation for many years with differential hydraulic heads as high as 5 feet with no apparent seepage problems. The adjacent borrow depth will be limited to avoid opening up the pervious sand layer. Proposed operating plans will limit maximum head to 6.5 feet before reaching the spillway elevation. For these reasons, no seepage problems are anticipated.

WATER SUPPLY WELL

Utilization of a water supply well with requirements of 500 to 1,000 gpm for operation of the hemi-marsh was investigated. The investigation began by gathering information from the Illinois State Water Survey. They provided information on irrigation wells in the area. In summary, there are wells in the area that pump from 500 gpm to an excess of 1,200 gpm at depths of 70 to 100 feet.

Boring SL-92-1 was completed in February 1992 to analyze the site for a well. The boring log displays a 6-foot top layer of clayey sand. From 6 to 46 feet is a medium to fine sand with gravel. The average D_{10} is 0.25 mm. From 46 feet to 91 feet (bottom of boring) is also a medium to fine sand with gravel with an average D_{10} of 0.17 mm.

Using the information assembled, an analysis was completed. It is assumed that this is a confined aquifer with a depth of 91 feet to bedrock. Using an average D_{10} of 0.2, the permeability is 1000×10^{-4} cm/sec. It is assumed that the well will be fully penetrating to a depth of 91 feet with a 1-foot diameter casing. Using the above assumptions, with a flow of 500 gpm the drawdown will be 4.5 feet; with a flow of 1,000 gpm the drawdown will be 9.5 feet. This correlates with information from irrigation wells in the area.

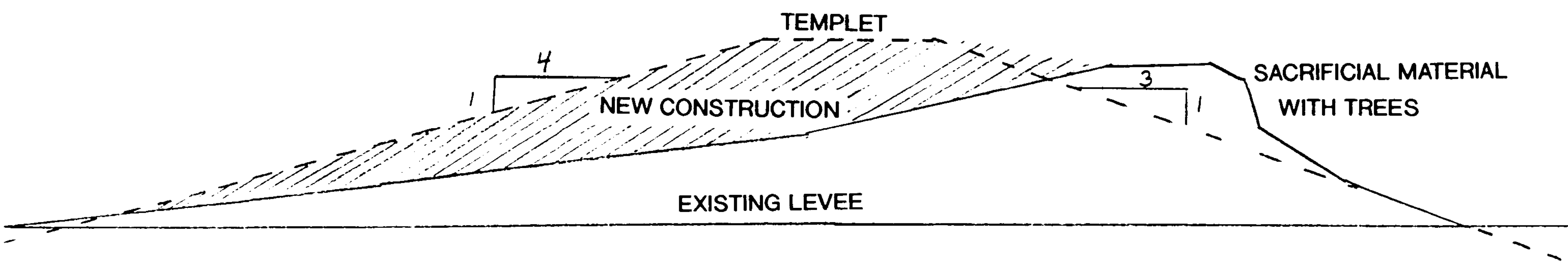
Plates G-4 through G-7 show the calculations to determine the drawdown at 500 and 1,000 gpm flow rates. Plate G-6 shows graphs of drawdown versus well flow. Plate G-7 shows a graph of D_{10} versus permeability.

A well should be able to provide all the water necessary to operate the hemi-marsh.

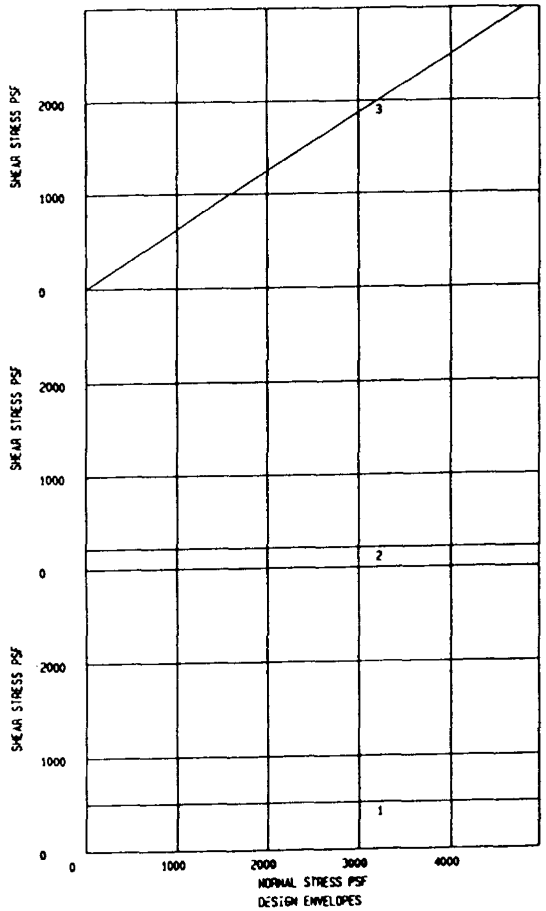
SETTLEMENT

The perimeter levee and cross dike were constructed over 50 years ago so settlement has already taken place. The cross section of the perimeter levee is proposed to be constructed to stable slopes; it is not being raised. The cross dike is being raised a maximum of 2 feet; therefore, settlement will not be a problem.

The moist soil units are being divided by low head levees as is the hemi-marsh with a maximum height of 4 to 5 feet. No settlement problems are anticipated; however, a 15 percent overbuild will be included in the specifications.



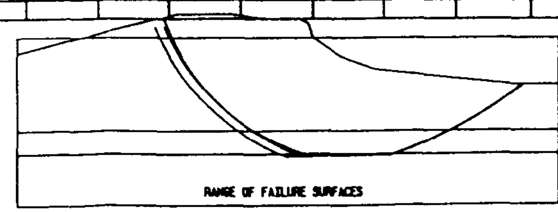
TYPICAL SECTION



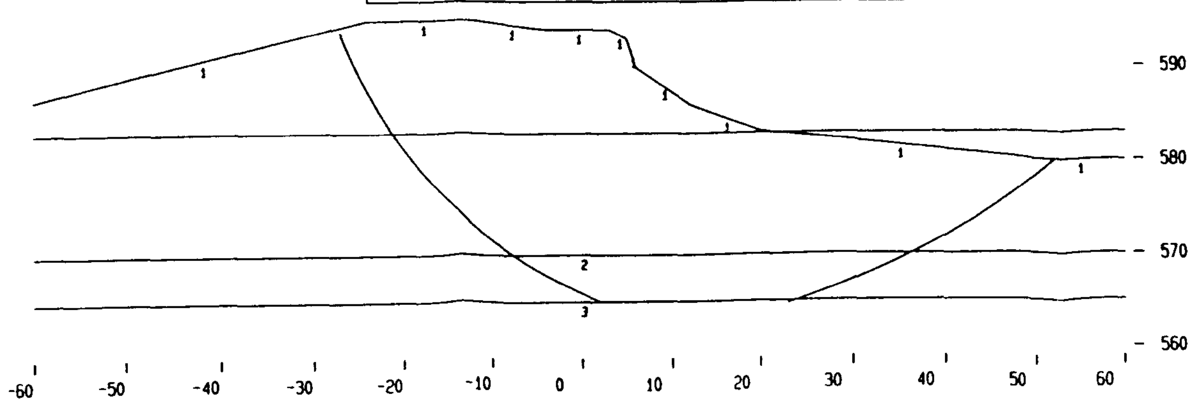
MATERIAL		SOIL WT. LBS./CUFT		SHEAR STRENGTH Q		R		S		(R+S)/2	
		MOIST	SAT.	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF
MEDIUM CLAY	1	120.00	125.00	.00	500.00						
SOFT LEAN CLAY	2	115.00	120.00	.00	220.00						
SAND	3	110.00	115.00	32.00	.00						

CIRCLE-PLANE-CIRCLE FAILURE SURFACE

ACTIVE CIRCLE CENTER OF CIRCLE DISTANCE FROM ℄	ELEV	RADIUS	NEUTRAL BLOCK INTERSECTION OF ACTIVE CIRCLE NEUTRAL BLOCK DISTANCE FROM ℄	ELEV	INTERSECTION OF PASSIVE CIRCLE NEUTRAL BLOCK DISTANCE FROM ℄	ELEV	PASSIVE CIRCLE CENTER OF CIRCLE DISTANCE FROM ℄	ELEV	RADIUS	FACTOR OF SAFETY Q Ψ =.00	
19.90	612.20	50.40	2.30	565.00	23.80	565.00	-2.30	640.60	87.60	1.29	
17.90	612.20	49.10	4.30	565.00	23.80	565.00	-2.30	640.60	87.60	1.45	
17.90	612.20	51.00	.50	564.30	23.80	564.80	-2.30	640.60	87.80	1.93	

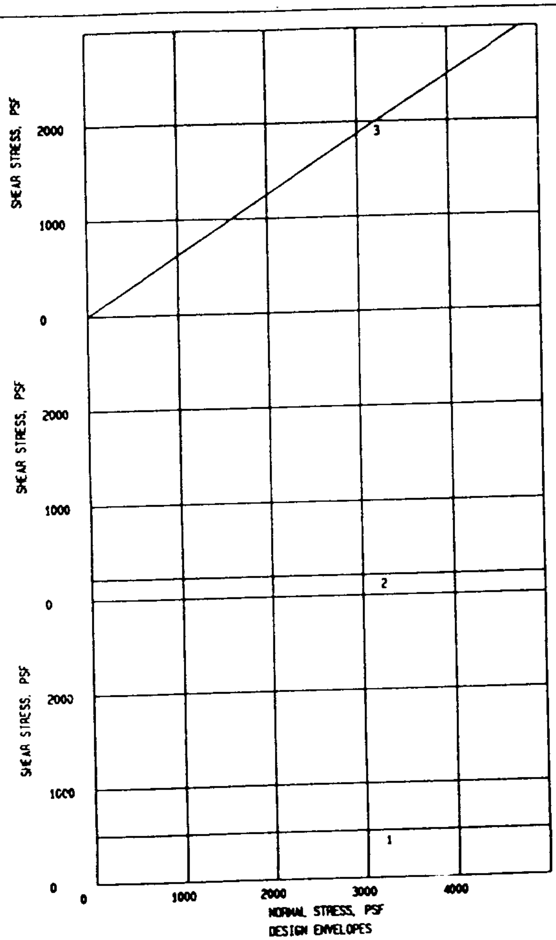


NOTES
(1) ANALYSES WERE RUN ACCORDING TO COE-EM 1110-2-1902 DATED APR 1970
(2) THE SIDE EARTH FORCE DIRECTION WAS TAKEN AS THE AVERAGE OF THE EMBANKMENT SLOPES IMMEDIATELY ADJACENT TO THE SLICE INTERFACE
(3) PSI=SIESMIC COEFFICIENT USED IN ANALYSES



SPRING LAKE EMP
STATION 96+50
END OF CONSTRUCTION
FEBRUARY 1992
GENE RAND

Plate G-2



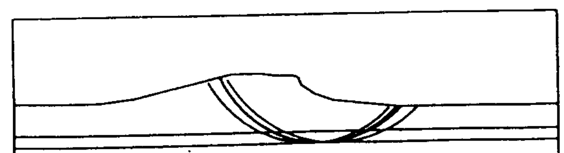
MATERIAL		SOIL WT. LBS./CUFT		SHEAR STRENGTH							
				Q		R		S		(R+S)/2	
		MOIST	SAT.	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF	PHI DEGREES	COHESION PSF
MEDIUM CLAY	1	120.00	125.00	.00	500.00						
SOFT CLAY	2	115.00	120.00	.00	220.00						
SAND	3	110.00	115.00	32.00	.00						

CIRCLE FAILURE SURFACE
USE CORPS OF ENGINEERS METHODS

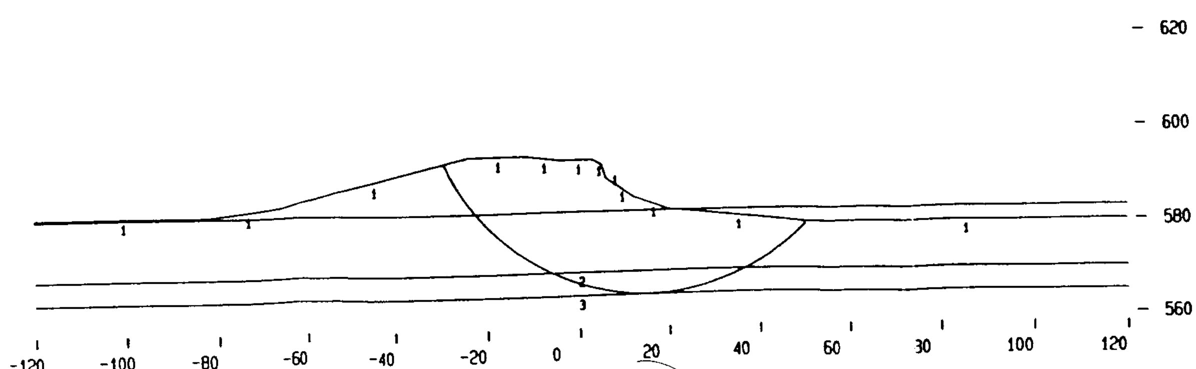
TANGENT TO ELEV 565.00
TRIAL ARCS

RADIUS OF CIRCLE	CENTER OF CIRCLE		F.S.	
	DISTANCE FROM ℄	ELEV	Q	
			ψ= .00	
49.00	15.40	614.10	1.50	
47.00	14.00	612.00	1.52	
53.90	21.00	619.00	1.52	
49.00	9.90	614.00	1.57	

NOTES
(1) ANALYSES WERE RUN ACCORDING TO EM 1110-2-1902 DATED APRIL 1970
(2) *SI=SIESMIC COEFFICIENT USED IN THE ANALYSES



RANGE OF TRIAL FAILURE SURFACES



SPRING LAKE EMP
STATION 96+50
END OF CONSTRUCTION
FEBRUARY 1992
GENE RAND

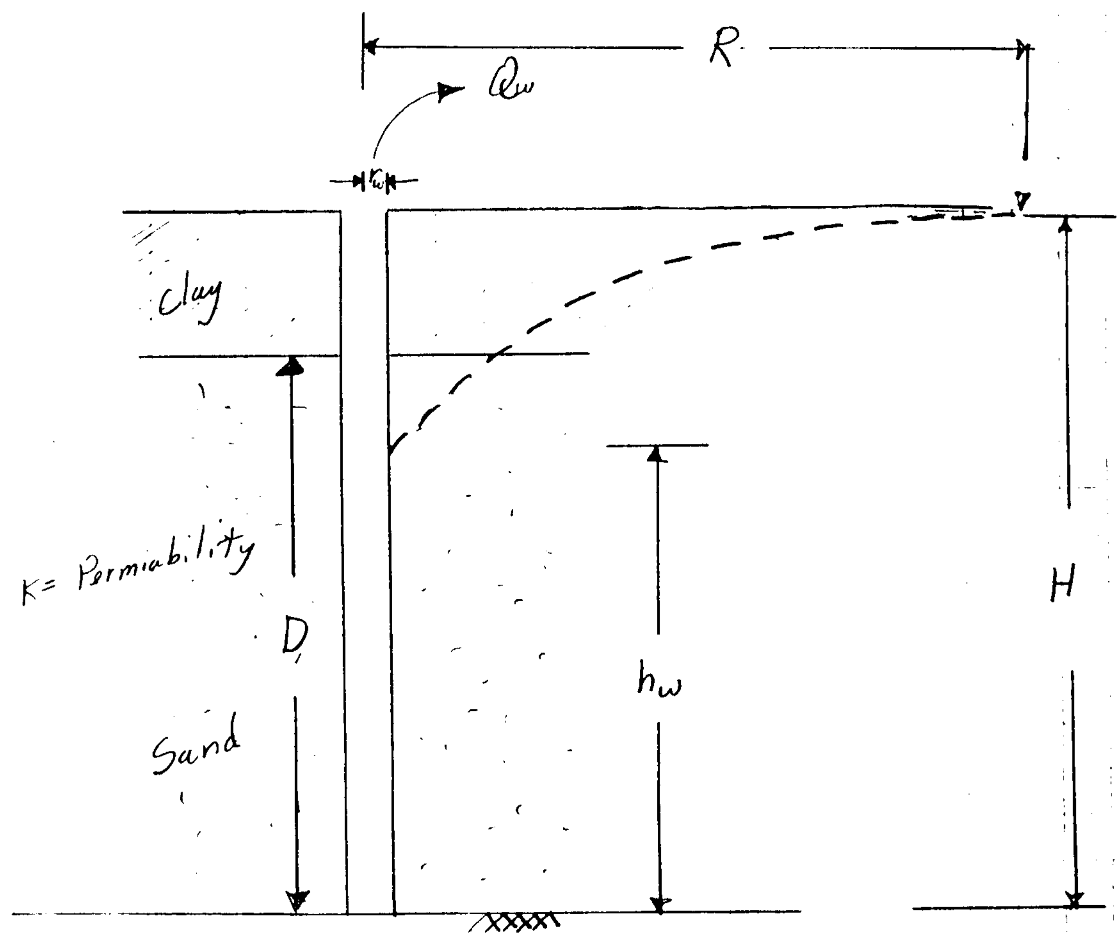
Plate G-3

Subject: Spring Lake Water Well	Date: 5 March 1992
Computed by: Gene Rand · Checked by: SAZ	Sheet 1 of 4

Assumptions

1. Confined Aquifer
2. Depth to Bedrock - 91 feet - depth of boring
3. Permeability ($D_{10} \cong .20$) = 1000×10^{-4} cm/sec
4. 12 inch diameter well
5. Q needed 500 to 1000 gpm

$$Q_w = \frac{2\pi k D(H-h_w)}{\ln(R/r_w)} \quad \text{and} \quad R = C(H-h_w)\sqrt{\frac{k}{1\times10^{-4}}}$$



* Eqns are from TM 5-818-5 "Dewatering and Groundwater Control for Deep Excavations", Dated April 1971

NCR Form 381b
1 Aug 80

Plate G-4

Subject		Date
Spring Lake		5 March 1992
Computed by Gene Kal	Checked by SAT	Sheet 2 of 4

Definitions

Q_w = flow out of well
K = Permiability
D = Thickness of aquifer
H = Depth from static water level to Bedrock
h_w = Depth from pumping water level to bedrock
R = Radius of influence
r_w = Radius of well
C = C is a constant - for this type of well C = 3

Rearanging the eqns gives

$$Q_w = \frac{2\pi K D (H - h_w)}{\ln\left(\frac{C(H-h_w)\sqrt{\frac{K}{1\times10^{-4}}}}{r_w}\right)}$$

$$Q_w = \frac{2\pi\left(1000\times10^{-4}\frac{cm}{sec}\right)\left(\frac{60\,sec}{1\,min}\right)\left(\frac{1\,in}{2.54\,cm}\right)\left(\frac{1\,ft}{12\,in}\right)(85\,ft)\left[H-h_w\ ft\right]\left(\frac{7.48\,gal}{1\,ft^3}\right)}{\ln\left(\frac{3(H-h_w)\sqrt{\frac{1000\times10^{-4}}{1\times10^{-4}}}}{.5}\right)}$$

$$Q_w = \frac{785(H-h_w)}{\ln\left[190\,(H-h_w)\right]}$$

NCR Form 1 Aug 80 381b

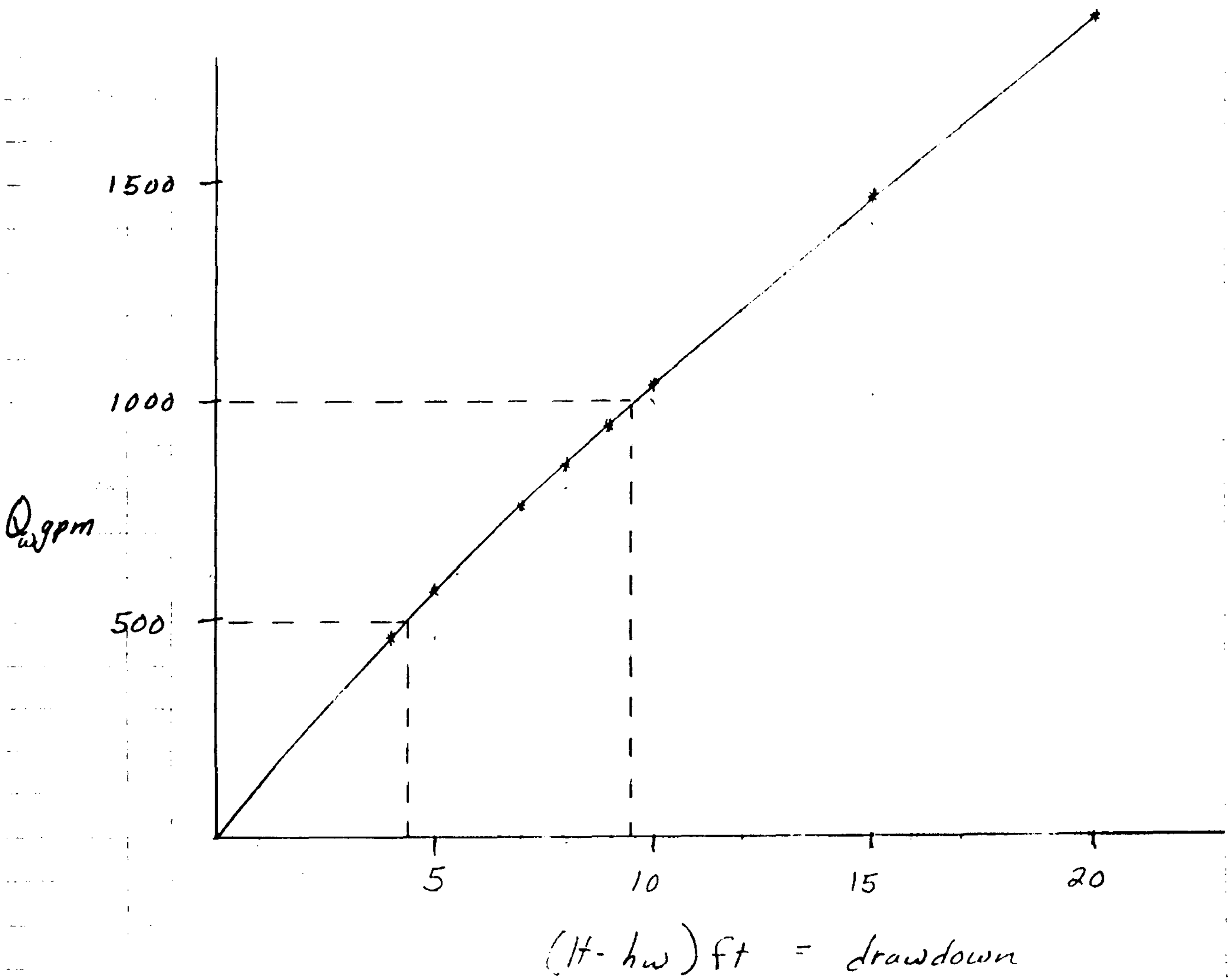
Subject Spring Lake

Computed by Gene Kay

Checked by SAL

Date 5 March 1992

Sheet 3 of 4



NCR Form 381b
1 Aug 80

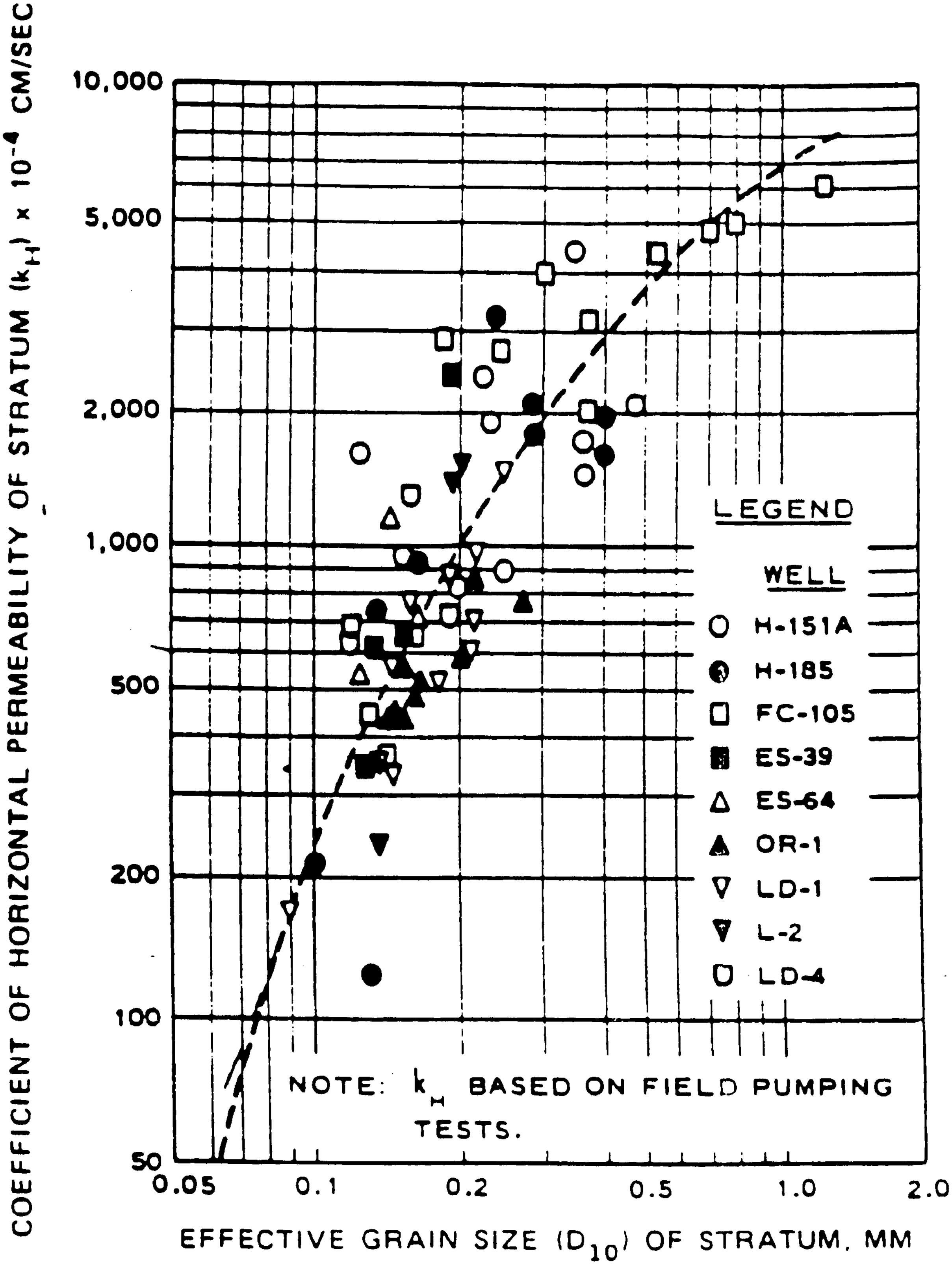


Figure 3-4. D_{10} versus in situ coefficient of horizontal permeability—Mississippi River valley and Arkansas River valley.

MECHANICAL/ELECTRICAL CONSIDERATIONS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX H
MECHANICAL/ELECTRICAL CONSIDERATIONS

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H-11	Submergence Requirements
H-12	NPSH Curves
H-13 - H-16	Electrical Energy Costs for Pumping

UPPER MISSISSIPPI RIVER SYSTEM
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SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX H
MECHANICAL/ELECTRICAL CONSIDERATIONS

PURPOSE AND SCOPE

The purpose of this appendix is to present preliminary design for the pumping station at Spring Lake Refuge. Pump manufacturers' engineering information for standard catalog units were used to develop the design presented in this appendix. Pump sizing and layout are based on the efficient operation of the station and ease of normal maintenance.

GENERAL

One pumping station containing two submersible propeller-type pumps is proposed for Spring Lake Refuge. The pumping station will serve a dual function: discharging interior drainage from the protected refuge for drawdown scenarios; and discharging river water into the protected refuge during the waterfowl migration seasons for the purpose of creating maintained pools of water.

The pumping station will be located on the cross dike which separates Upper and Lower Spring Lake. The pumping station will be constructed integral with the levee river toe section.

The pumps are sized to complete the refuge drawdown within a 2-week period from an initial elevation of 583.5. Two identical 7,000-gpm pumps will utilize manual and automatic controls for setting and maintaining water elevation within the refuge. The power and control panels will be housed on an elevated platform. The panels will be protected from condensation damage with heating elements.

Pump and motor removal can be accomplished through secured sealed manhole accesses exterior of the pump station structure. Hand-cleaned trash racks are provided at both intake and discharge ends for maximum protection of the pump impellers against debris. Mechanical and electrical design of the station is based on the Hydraulic Institute Standards, 13th Edition, 1975, and on applicable sections of EM 1110-2-3102, 03, and 05.

STATION FEATURES

The station is fed by a new 48-inch reinforced concrete pipe from the Lower Lake (Mississippi River) passing through the levee section and by a pump forebay section from the Upper Lake. A sump divider wall separates the two sumps up to elevation 588.0. A sluice gate in the divider wall permits gravity flow between the Upper and Lower Lakes. Stoplog slots will be provided at each end to facilitate sump dewatering for maintenance purposes. Gate closure of the gravity outlet occurs for water management operation, at which time the required pump is energized manually, with further control being automatic through the float system. One 24-inch, ±7,000 gpm submersible pump of axial or mixed flow type will be utilized for pumping from the Upper Lake. An identical submersible pump will be utilized for pumping from the Lower Lake. The discharge of both pumps will be piped over the sump divider wall into a basin that directs flow by gravity out to the Lower or Upper Lake. Access to the sump area will be by ladder through a removable manhole lid. System head computations and curves and an example pump selection are shown on plates H-1 through H-12. The pump station estimated operating energy cost of $1,402 per year is computed on plates H-13 through H-16.

CONTROL SEQUENCE

The sluice gate of the pump station should be operated in an open position except during periods of refuge (Upper Lake) management by U.S. Fish and Wildlife Service personnel. During desired drawdown periods, the sluice gate should be closed and the pump station activated for drawdown purposes. The pump station must be manually activated, but will automatically turn off at low water level of 579.0. The float control will automatically turn the pump on at elevation 579.5 to maintain the 579.0 drawdown elevation.

When it is desired to pump from the Lower Lake into the Upper Lake, the station must be manually activated and will continue pumping automatically until elevation 585.0 (adjustable to elevation 587.0) is reached, or the pump is manually shut down.

Each pump will be provided with a low sump water level cutout float to protect each pump. The cutout floats elevation will be set in accordance with the actual pump supplier's recommendations.

ELECTRICAL

The pump station will require electrical service to operate two submersible pumps, and a small motor to raise and lower the sluice gate. The closest high voltage system available is located approximately 3,000 feet east of the pump station site. The 13.8 KV, 3-phase line will be tapped and brought to the pump site through underground line where it will be transformed down to 480 volts, 3-phase at a pole approximately 20 feet from the site. The power and control panels will be enclosed, and located on top of the station. Local ownership of the power service will begin on the low voltage side of the transformer near the pump station. The Government, through its contractor, will pay for connection charges and Interstate Power will own and maintain the high voltage service.

A well pump with a 5 hp motor will be provided to raise the water level in the hemi-marsh during low river periods. The well station will require electrical service to operate the submersible pump. The closest high voltage system available is located approximately 2,000 feet northeast of the well station site. The 13.8 KV, 3-phase line will be transformed down to 480 volts, 3-phase at a pole approximately 20 feet from the site. The power and control panels will be enclosed and located on a wooden platform adjacent to the well. Local ownership of the power service will begin on the low voltage side of the transformer near the pump station. The Government, through its contractor, will pay for connection charges and Interstate Power will own and maintain the high voltage service. The well pump estimated operating energy cost of $153 per year is computed on plates H-13 through H-16.

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SPRING LAKE REFUGE		MAR 92
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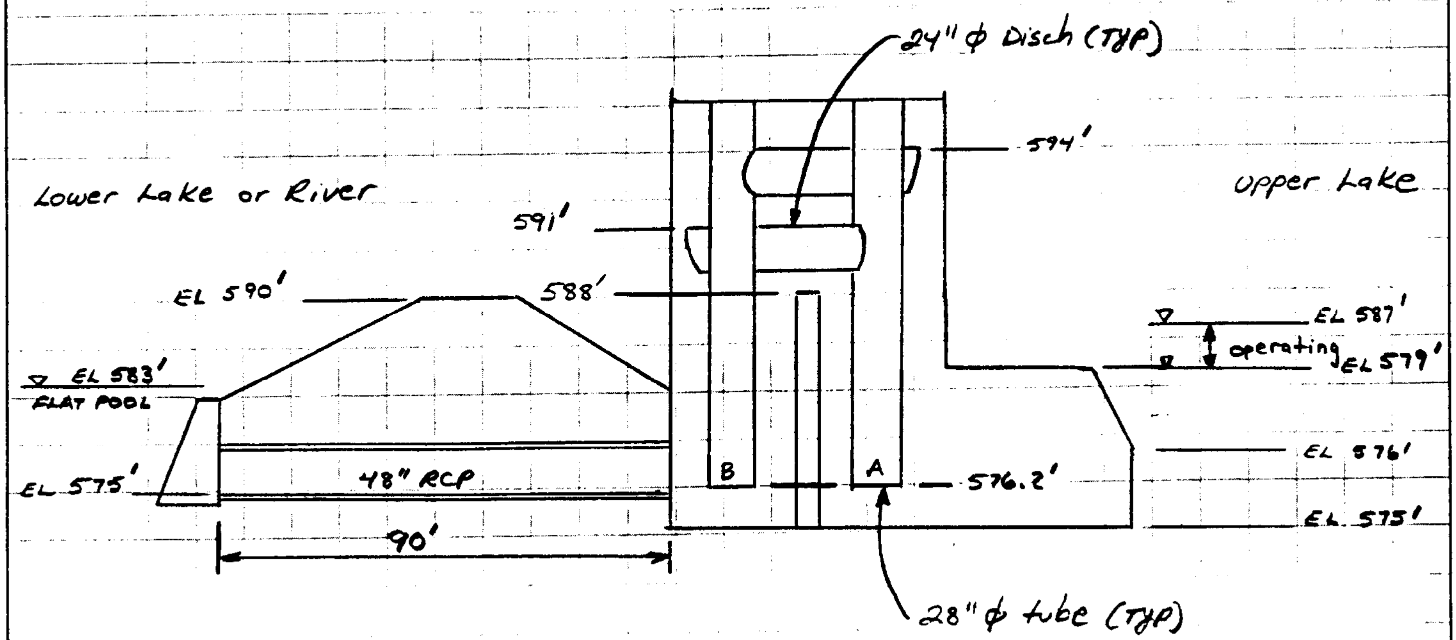

General Design Considerations

1. Pumping requirement: 7000 GPM (dewatering of upper lake) min for 15 days or less of pumping. Therefore design condition is 7000 GPM @ shutoff EL of 579'.

2. Total head requirements @ design point (CASE 1) PUMP A
   - a. static head
   - b. elbow loss
   - c. pipe friction loss
   - d. Trashrack loss
   - e. velocity head

   Total head requirements @ max head point (CASE 2) PUMP B
   - a. static head
   - b. elbow loss
   - c. pipe friction loss
   - d. Trash rack loss
   - e. RCP friction loss
   - f. velocity head

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CASE 1

a. static head = TOP of disch tube EL − shutoff EL.

= 591′ − 579′

static head = **12′**

b. Elbow loss = Reference #1 "New Concepts in the design
(E_2 elbow) p. 83 of propeller pumping stations"
by Vincenzo Bixio

$7000 \text{ GPM} \times 0.0631 \frac{l/s}{\text{GPM}} = 442\ l/s$

From fig 8.4 read head loss ≈ 0.8 meters

$0.8 \text{ meters} \times \frac{1 \text{ FT}}{0.305 \text{ meters}} = \mathbf{2.62'}$

c. Pipe Friction loss = Reference #2 " Hydraulics and useful
p. 35 information"
by Chicago Pump

Schedule 40 steel pipe, 7000 GPM, 24″ϕ

$\frac{\text{friction loss}}{100 \text{ FT}} = 0.343'$

pipe length ≈ 25′

∴ Pipe Friction loss = **0.086′**

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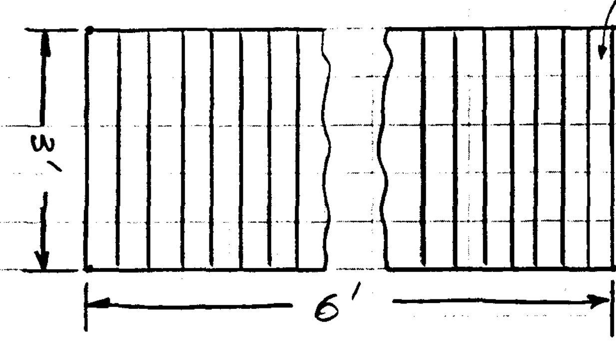
d. Trashrack loss

Trashrack overall dimensions will be approximated as ±3' High x ±6' wide w/ 3"/8 bars spaced 3" on centers.



$V_1 = \frac{7000\ \text{Gall}}{\text{min}} \times \frac{1}{60} \times \frac{1}{7.48} \times \frac{1}{18}$

$V_1 = 0.87\ \text{ft/s}$

Free area $= n \times 2\,5/8" \times 3' = 24 \times 2\,5/8" \times 3' \times \frac{1'}{12"} = 15.75\ \text{FT}^2$

Velocity thru rack $= \frac{7000\ \text{Gall}}{\text{min}} \times \frac{1\ \text{min}}{60\ \text{sec}} \times \frac{1\ \text{FT}^3}{7.48\ \text{Gall}} \times \frac{1}{15.75\ \text{FT}^2}$

$V_o = 1\ \text{ft/s}$

Reference #1 p. 71 :

$\frac{\Delta h}{V_1^2/2g} = \beta_1 K_1 \sin\phi$

$\Delta h = \frac{V_1^2}{2g} \beta_1 K_1 \sin\phi$

$= \frac{(0.87)^2}{2(32.2)} 2.34(0.1) \sin 75°$

$\Delta h = 0.003'$

Trashrack loss = **0.003'**

Assume: $a_o = 2\,5/8"$

$S_1 = 3"$

$a_o/S_1 = 0.875$

NO = 1 bar

$\beta_1 = 2.34$

$K_1 = 0.10$

$\phi = 75°$

$Re = \frac{V_o a_o}{\nu_{60°F}} = 1.79 \times 10^4$

Since > 10^4 ok to use

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e. velocity head $= \frac{V^2}{2g}$

28" ϕ tube $\Rightarrow$ 27" ϕ ID = 2.25' ϕ ID

$V = Q/A$

$V = \frac{7000 \text{ Gall}}{\text{min}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1 \text{ FT}^3}{7.48 \text{ Gall}} \times \frac{1}{\frac{\pi}{4}(2.25 \text{ FT})^2} = 3.92 \text{ ft/s}$

velocity head $= \frac{(3.92)^2}{2(32.2)} = \underline{\underline{0.24'}}$

f. TOTAL Head = static head + Elbow loss + Pipe Friction Loss + Trashrack loss + velocity head

TOTAL HEAD = 12' + 2.62' + 0.086' + 0.003' + 0.24'

TOTAL HEAD = 14.95'

∴ **CASE 1 design point: 7000 GPM @ 15'**

NOTE: FOR higher upper lake levels, ie when pump first starts, Flow will be greater due to less static head

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CASE 2

a. Due to the slight decrease in static head (1 ft) and slight increase in friction loss due to the 48"φ RCP (to be calculated) which will essentially offset each other, 7000 GPM will also be assumed for pump B

∴ static head = 11'
elbow loss = pump A loss = 2.62'
pipe friction = pump A loss = 0.086'
Trash rack loss ≈ pump A loss ≈ 0.003' (negligible)
velocity head = pump A loss = 0.24'

RCP friction loss:
48"φ RCP flowing flowing full w/ entry and exit loss

$$V = Q/A = \frac{7000\ \text{Gal}}{\text{min}} \times \frac{1\ \text{min}}{60\ \text{sec}} \times \frac{1\ FT^3}{7.48\ \text{Gal}} \times \frac{1}{\frac{\pi}{4}(4\ FT)^2} = 1.24\ FT/S$$

For Concrete : Reference #2 p. 38 ⟹ $\varepsilon/D = 0.00025$

$$Re = \frac{VD}{\nu_{60°F}} = \frac{1.24\ FT/S\,(4\ FT)}{1.217 \times 10^{-5}\ FT^2/S} = 4.1 \times 10^5$$

Reference #2 p. 39 Moody's Diagram $f = 0.0165$

$$h_{fr} = f\frac{L}{D}\frac{V^2}{2g} = \frac{0.0165\,(90)(1.24)^2}{4\,(2)(32.2)} = 0.009'$$

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Reference # 2 p. 23 ⇒ $K_{ent} = 0.5$

$K_{exit} = 1.0$

$$h_{ent} = K_{ent} V^2/2g = \frac{0.5(1.24)^2}{2(32.2)} = 0.012'$$

$$h_{exit} = K_{exit} V^2/2g = \frac{1(1.24)^2}{2(32.2)} = 0.024'$$

RCP friction loss = $h_{fr} + h_{ent} + h_{exit}$ = 0.009' + 0.012' + 0.024'

RCP friction loss = 0.045'

b. TOTAL head = static head + elbow loss + Pipe Friction Loss + Trash rack loss + velocity head + RCP friction loss

TOTAL Head = 11' + 2.62' + 0.086' + 0.003' + 0.24' + 0.045'

TOTAL HEAD = 14'

CASE 2 design point: 7000 GPM @ 14'

∴ CASE #1, more restrictive and should be used to define upper portion of pump curve and serve as guarantee point

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PLATE H6

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3. Define approx minimum head operating point. By inspection, this point occurs on pump A when upper lake is @ EL 581' and pump first comes on.

∴ Static head will be <u>4'</u>

The remaining head loss will be determined by increased flow rate. Losses will consist of elbow loss, pipe friction loss, Trashrack Loss, and velocity head loss. At 7000 GPM these sum to 3'. Assume ≈ 9000 GPM

$$\therefore \quad \frac{h_2}{h_1} = \left(\frac{Q_2}{Q_1}\right)^2$$

$$\frac{h_2}{3} = \left(\frac{9000}{7000}\right)^2$$

$$h_2 = 5'$$

∴ Low static head point
9000 GPM @ 9'

4. Motor Size
Largest Motor will be required @ highest head point

$$HP = \frac{GPM \times TDH}{3956 \times \eta_p} = \frac{7000\,(15)}{3956 \times 0.77} = 34.5\,Hp \text{ or } 25\,KW$$

(Minimum Motor Size)

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5. Pump Selection

FLYGT 7050 CURVE 63-700BY

21° Blade Angle 33KW motor RPM = 700

7000 GPM @ 15' η = 78%

9000 GPM @ 9' η = 78%

6. Check Specific Speed @ BEP 5700 GPM @ 10.5'

$$N_s = \frac{N Q^{1/2}}{H^{3/4}} \quad \text{RPM, FT, GPM}$$

$$= \frac{700 (5700)^{1/2}}{(10.5)^{3/4}}$$

N_s = 9060 ok for propeller pump

7. Check submergence

min submergence occurs @ pump shutoff point 579'

submergence = 579' − 576.2

Submergence = 2.8'

– per manufacturer's data submergence should be 20" or 1.7'

∴ ok on submergence

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8. check NPSH
per manufacturer:
NPSH REQ 7000 GPM @ 15' (442 l/s @ 4.6 m)
is ≈ 6.5 meters or 21.3 FT based on inlet flange height.

$$NPSH\ Avail = H + \frac{P_a}{\gamma} - \frac{P_v}{\gamma}$$

$$= 2.8' + \frac{14.7(144)}{62.11} - \frac{0.6982(144)}{62.11}$$

NPSH Avail = 35.3 FT

∴ ok on submergence

P_a = Atmospheric Pressure (PSIA)
P_v = H_2O vapor pressure @ 90°F
γ = specific wt H_2O @ 90°F
H = 2.8' from part 7

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FLYGT

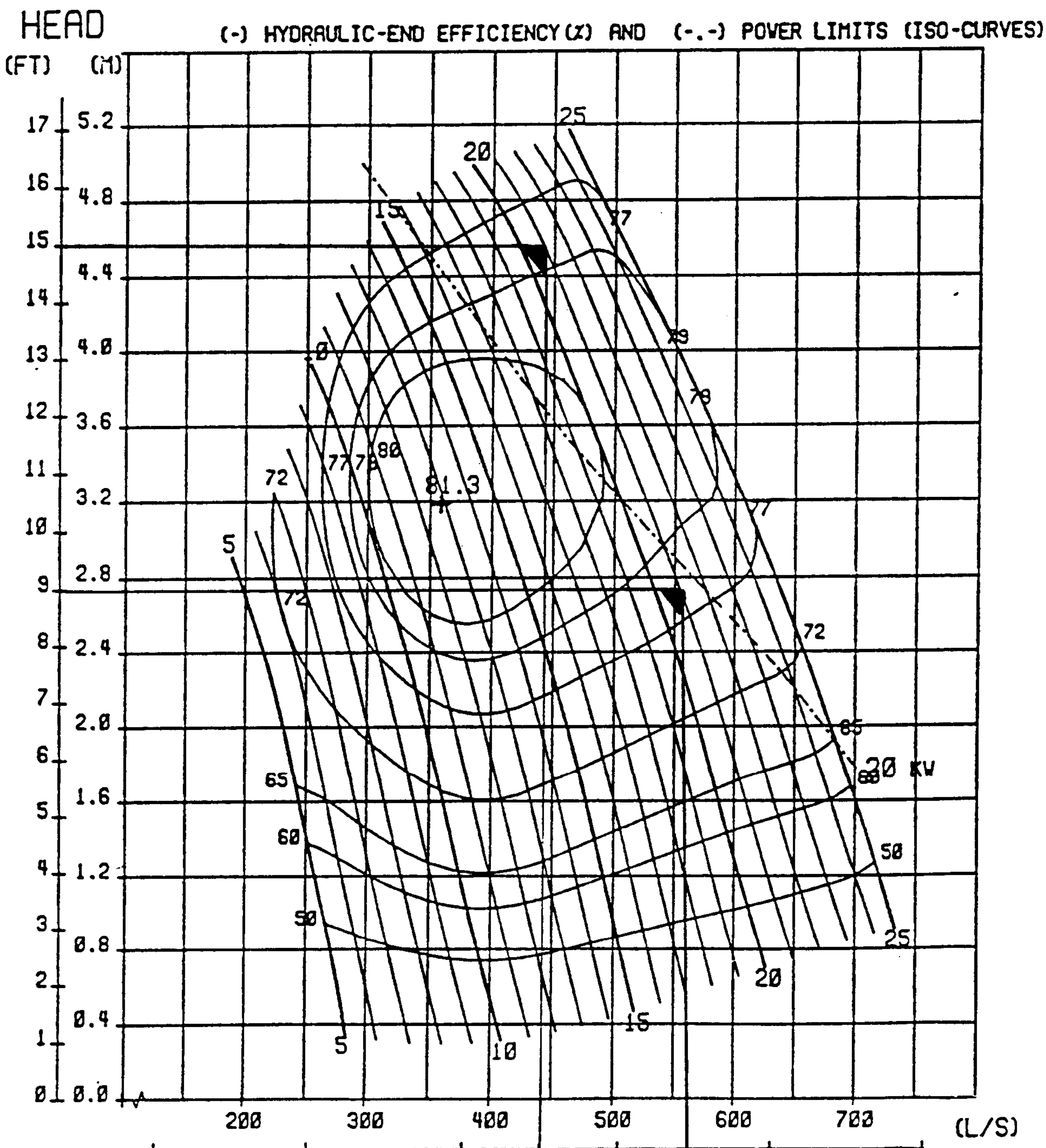
PERFORMANCE CURVE

PROD.	CURVE NO
7050	63-700B4

DATE	ISSUE	FREQ	NOMINAL HYDRAULIC-END SPEED
1984-06-05	3	60 HZ	700 RPM

IMPELLER/HUB DIAMETER	TYPE OF BLADES	NO. OF BLADES	AVAILABLE BLADE ANGLES
460/260 MM	B	4	EVERY DEG. FROM 5 TO 25 DEG

MOTOR	POLES	SHAFT POWER	GEARTYPE	GEAR RATIO	GEAR EFFICIENCY (1/1-3/4 LOAD)	RATED SPEED
~~35-24-1~~	~~10~~	~~20.0 KW~~				700 RPM
→ 35-28-1	10	33				700
~~40-30-1~~	~~10~~	~~45~~				695



NOTE:
CURVES ARE BASED ON NOMINAL CONSTANT HYDRAULIC-END SPEED AND SHOW PERFORMANCE WITH CLEAR WATER.
ALL HYDRAULIC LOSSES UP TO 500 MM. ABOVE THE PUMP/MOTOR TOP ARE INCLUDED

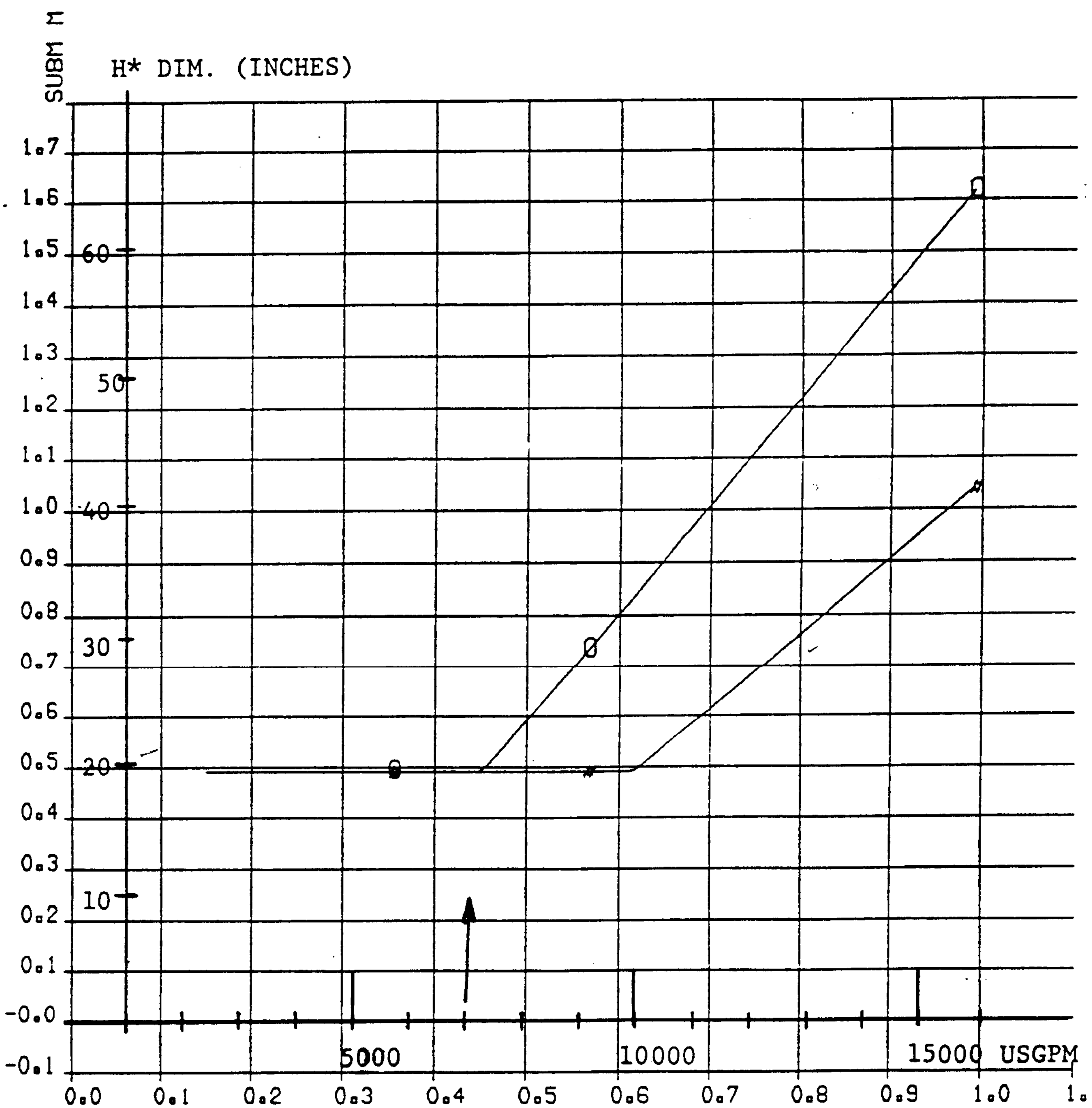
FLYGT

SYSTEM AND APPLICATION ENGINEERING

DIAGRAM: SUBMERGENCE REQUIREMENTS FOR PL 7045/50 | ISSUE: 2 | DATE: 84-05-23

REQUIRED SUBMERGENCE FOR SUMP DESIGN ACCORDING TO FLYGT TYPE "A","B".

REQUIRED SUBMERGENCE TO PREVENT VORTEXING WHICH WOULD AFFECT THE PERFORMANCE OF THE PUMP. IN SOME INSTANCES ADDITIONAL SUBMERGENCE MAY BE REQUIRED BECAUSE OF NPSH REQUIREMENTS.



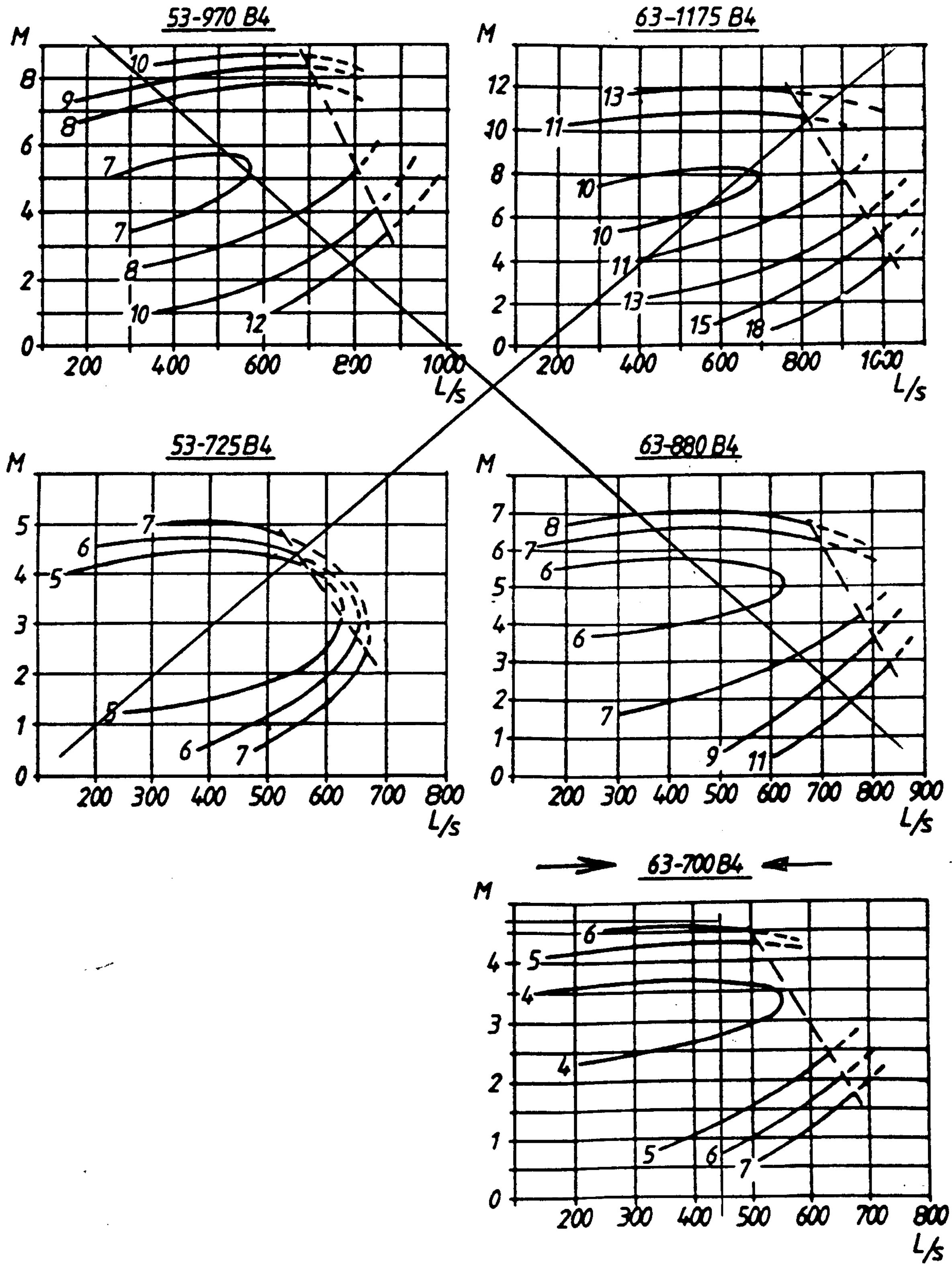
O:CONTINOUS OPERATION

#:MAX 500 OPERATING HOURS/YEAR

PLATE H-11

FLYGT	DATE 831006 ISSUE 2	NPSH CURVES	7050

NPSH$_{RE}$ VALUES IN M H_2O



THE NPSH VALUES ARE RELATED TO THE INLET FLANGE.
ALL NPSH LIMIT CURVES ARE VALID FOR OPERATION WITHOUT LOSS IN PERFORMANCE AND NO REDUCTION ON LIFE TIME.

PLATE H-12

Subject SPRING LAKE REFUGE		Date MAR 92
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ELECTRICAL ENERGY COSTS FOR PUMPING (For Selected Pump)

A. Assume an average operating point for pump A (pump which pumps out of upper lake) to be ≈ 7900 GPM @ 12' TDH ; $\eta_p = 81\%$
(Average value assume because of upper lake elevation changes)

Assume an operating point for pump B (pump which pumps into the upper lake) to be ≈ 7200 GPM @ 14' TDH; $\eta_p = 80$

Assume motor efficiencies of 97%

B. Pumping Time
* pump A & B Time and well pump data by others *
Pump A – 15 days / year and 1 hour / Month maintenance
Pump B – 26 days / year and 1 hour / Month maintenance
Well pump – 30 days / year and 1 hour / Month maintenance. Well pump Included for completeness.

C. ELECTRICAL SERVICE (BASED on Monthly Rate, Interstate power Company Data)

1. Basic service : \$ 4.76 / month

2. KWHR charge : SUMMER (June, July, Aug, Sept)
   First 1000 KWHR @ 6.835¢/KWHR
   Excess KWHR @ 5.939¢/KWHR

   Non Summer (All other months)
   First 1000 KWHR @ 5.939¢/KWHR
   Excess KWHR @ 4.987¢ KWHR

Subject		Date
SPRING LAKE REFUGE		MAR 92
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3. NET minimum monthly Bill : FOR 3 ϕ service : 1\$/Horsepower for 1st 5 Horsepower and \$0.50/Horsepower for additional

D. Costs / year

1. PUMP A (45 HP motor)
   15 days summer operation (refuge draw down in Sept)
   3 hours summer operation (maintenance)
   8 hours non-summer operation (maintenance)

$$\text{Line KW} = \text{Line HP} \times 0.746$$
$$= \frac{\text{GPM TDH}}{3956\ \eta_p \eta_m} \times 0.746$$
$$= \frac{7900(12)}{3956\,(0.81)(0.97)} \times 0.746$$
$$\text{Line KW} = 22.8\ \text{KW}$$

- Summer KWHR $= 22.8\ \text{KW} \times 15\ \text{days} \times \frac{24\ \text{hr}}{1\ \text{day}} + 22.8\ \text{KW} \times 3\ \text{hrs}$

  $= 8277$ KWHR

- NON-Summer KWHR $= 22.8\ \text{KW} \times 8\ \text{hrs} = 183$ KWHR

- Charge/year = SERVICE + KWHR + NET MIN monthly
  12(\$4.76) + \$ 512 + [5(\$1) + 40(\$0.50)]

charge/year = \$ 595/year

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PLATE H-14

Subject: SPRING LAKE REFUGE		Date: MAR 92
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2. **Pump B** (45 HP Motor)

26 days NON-Summer operation (refuge fill in Oct)
3 hours summer operation (maintenance)
8 hours non summer operation (maintenance)

$$\text{Line KW} = \text{Line Hp} \times 0.746$$

$$\frac{\text{GPM TDH}}{3956\ \eta_p \eta_m} \times 0.746$$

$$= \frac{7200\,(14)}{3956\,(0.80)(0.97)} \times 0.746$$

Line KW = 24.5 KW

- summer KWHR = 24.5 KW × 3 HRS = 73.5 KWHR

- NON SUMMER KWHR = $24.5\text{KW} \times 26\text{ days} \times \frac{24\text{ hrs}}{1\text{ day}} + 24.5\text{KW} \times 8\text{ hrs}$

  = 15484 KWHR

- charge/year = SERVICE + KWHR + NET min monthly

  0 + $782 [(5($1) + 40($0.50)]

charge/year = $807/year

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PLATE H-15

Subject: SPRING LAKE REFUGE		Date: MAR 92
Computed by: KWC	Checked by: XFF	Sheet 16 of 16

3. **Well pump** (5 Hp) 1000 GPM 10 FT TDH

30 days summer operation (Sept)
3 hours summer operation (maintenance)
8 hours non-summer operation (maintenance)

Assume: $\eta_p = 60\%$
$\eta_m = 97\%$

$$\text{Line KW} = \text{Line Hp} \times 0.746$$
$$= \frac{\text{GPM TDH}}{3956\ \eta_p \eta_m} \times 0.746$$
$$= \frac{1000(10)}{3956(0.6)(0.97)} \times 0.746$$

Line KW = 3.2 KW

- Summer KWHR = $3.2\text{ kw} \times 30\text{ days} \times \frac{24\text{ hours}}{1\text{ day}} + 3.2\text{kw}(3\text{ hrs})$
  = 2314 Kw-hr
- Non Summer KWHR = 3.2 kw x 8 hrs) = 26 Kwhr
- charge/year = Service + KWHR + NET min monthly
  0 + $148 5($1)

charge/year = $153/year

4. TOTAL COST of operation (Annual)

pump station	=	$1402/year
well pump	=	$153/year

STRUCTURAL ANALYSIS

APPENDIX I

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX I
STRUCTURAL ANALYSIS

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Stoplog Structures	I-2
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UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
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SPRING LAKE REHABILITATION AND ENHANCEMENT

POOL 13, MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX I
STRUCTURAL ANALYSIS

PURPOSE

This appendix is intended to describe the preliminary design of the structural items in this project.

REFERENCES

1. EM 1110-2-2906, Design of Pile Foundations, January 15, 1991.

2. EM 1110-2-2502, Retaining and Flood Walls, September 29, 1989.

3. EM 1110-2-2902, Conduits, Culverts, and Pipes, March 3, 1969.

4. ETL 1110-2-312, Strength Design for Reinforced Concrete Hydraulic Structures, March 10, 1988.

5. ACI 318-89, Building Code Requirements for Reinforced Concrete.

BACKGROUND

Three types of structures were designed for this project: a pump station, a water control structure, and several stoplog structures.

PUMP STATION

One pump station was designed for this project. It is located at the downstream toe of the levee which separates the lower lake and the ditch between areas "B" and "C." Two pumps will be housed in this structure which will allow pumping from the lower lake to the upper lakes and from the upper lakes to the lower lake. The horizontal loads on the pump station due to soil backfill were computed using Reference 2. The pile foundation was designed using Reference 1 and the computer program CPGA (X0080). The analysis of this structure starts on page I-3.

WATER CONTROL STRUCTURE

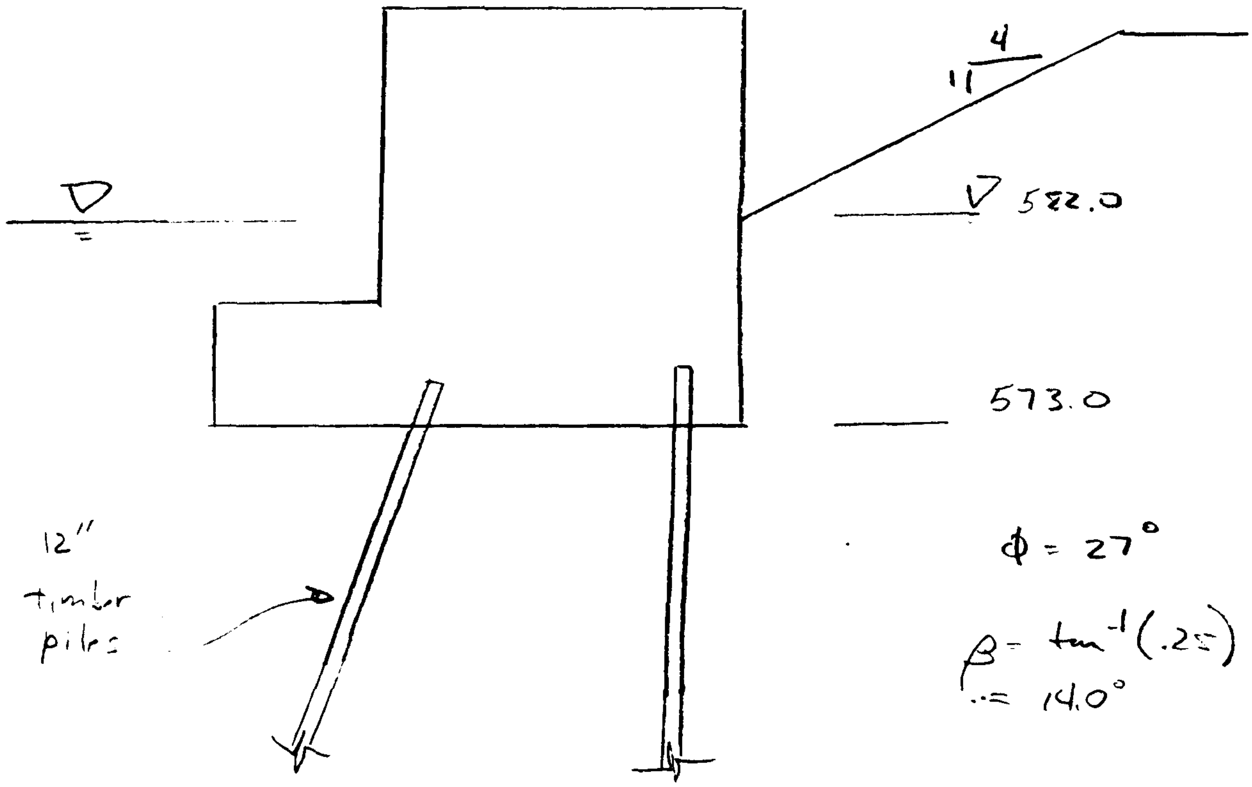
One water control structure was designed for this project. It is located at the downstream toe of the levee which separates the Mississippi River and the lower lake. The loads on the water control structure culvert were determined using Reference 3. The pile foundation was analyzed using Reference 1. The concrete sections were designed using References 4 and 5 and with the computer program CFRAME (X0030). The analysis of this structure starts on page I-20.

STOPLOG STRUCTURES

Four stoplog structures exist in this project. Their height from top of slab to top of wall varies from 5 feet to 7 feet. The analysis only considers the 7-foot-high structure and uses the same concrete sections for the 5-foot-high structure, making it conservative. The lateral loads on the structure were computed using Reference 2, and the concrete sections were designed using References 4 and 5. The foundation will be preloaded to eliminate any settlements of the structure. The analysis of this structure starts on page I-41.

Subject SPRING LAKE EMP - Pump Station	Date Feb. 92
Computed by TJW / Checked by MW	Sheet I 3 of

Pump STATION



Subject SPRING LAKE - Pump Station	Date Feb 92
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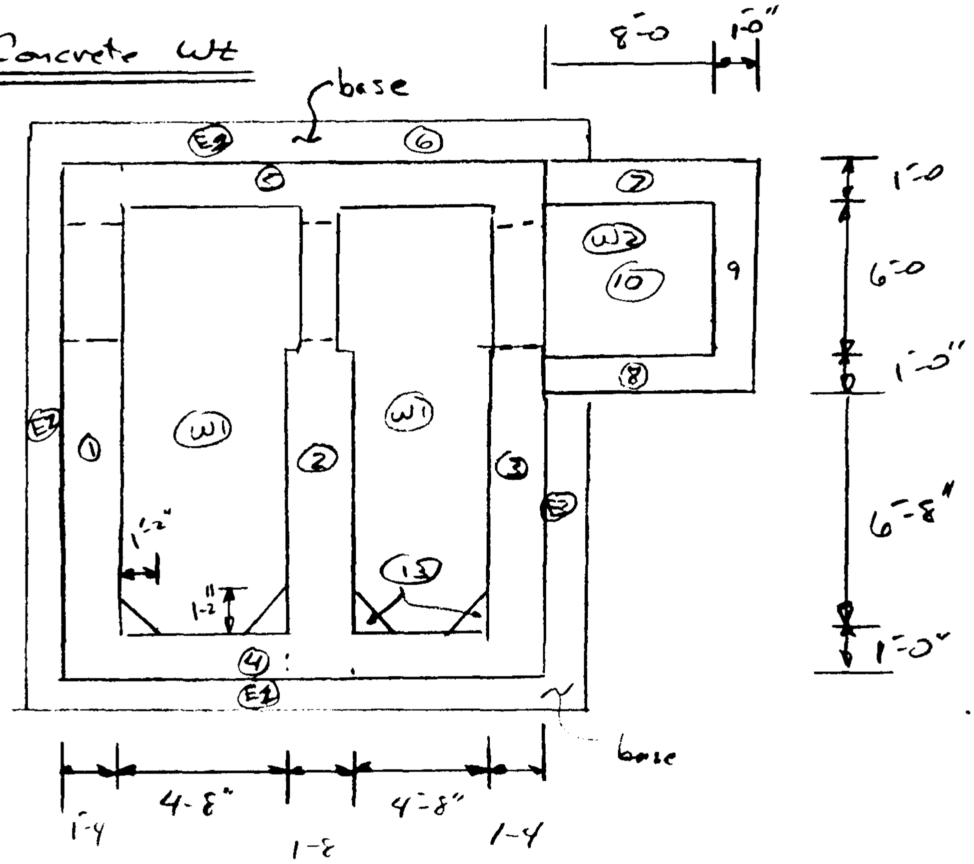
Pump STA

STABILITY ANALYSIS

Concrete Wt



Subject SPRING LAKE - Pump Station	Date Feb 92
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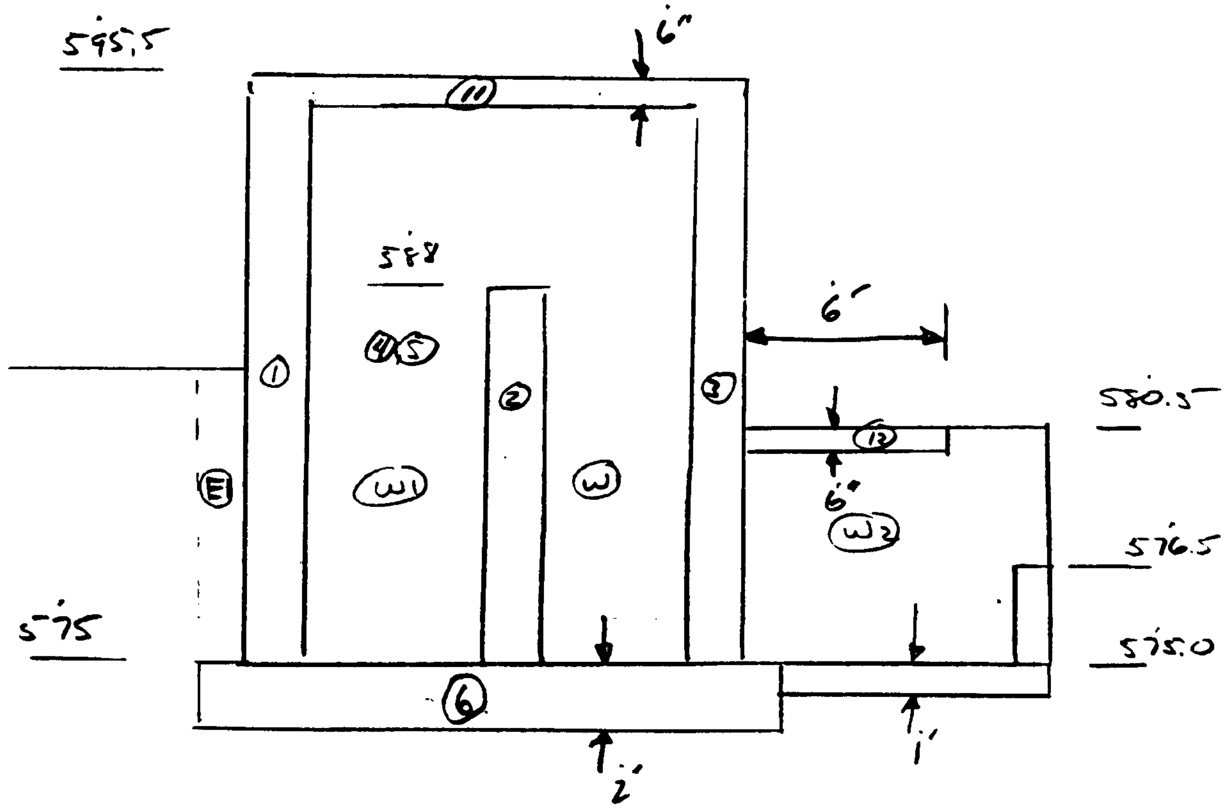

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Subject: Spring Lake EMP – Pump Station		Date: 24 feb 92
Computed by: TJW	Checked by: [illegible]	Sheet: I 6

SPRING LAKE EMP PUMPSTATION

Stability Analysis

Concrete Weight

ITEM		FORCE	ARM	MOMENT
1	15.667*1.333*(95.5-75)*0.15	64.22	1.583	101.68
2	13.667*1.6667*(88-75)*0.15	44.42	7.833	347.95
3	15.667*1.333*(95.5-75)*0.15	64.22	13.167	845.55
4	1*(95.5-75)*11*0.15	33.82	7.833	264.95
5	1*(95.5-75)*11*0.15	33.82	7.833	264.95
6	0.15*2*17.667*15.667	83.04	7.834	650.47
7	9*5.5*1*0.15	7.43	19.167	142.31
8	9*5.5*1*0.15	7.43	19.167	142.31
9	1.5*1*6*0.15	1.35	23.167	31.28
10	8*6*1*0.15	7.20	19.667	141.60
11	11*0.5*13.667*0.15	11.28	7.833	88.32
12	6*6*0.5*0.15	2.70	18.167	49.05
13	13*0.5*(14/12)^2*0.15	1.33	7.833	10.40
		=======		=======
		362.24		3080.82

Water acting down

W1	2*(7*4.667*13.667*0.0625)	55.81	7.8333	437.18
W2	8*6*7*0.0625	21.00	19.667	413.01
		=======		=======
		76.81090		850.1905

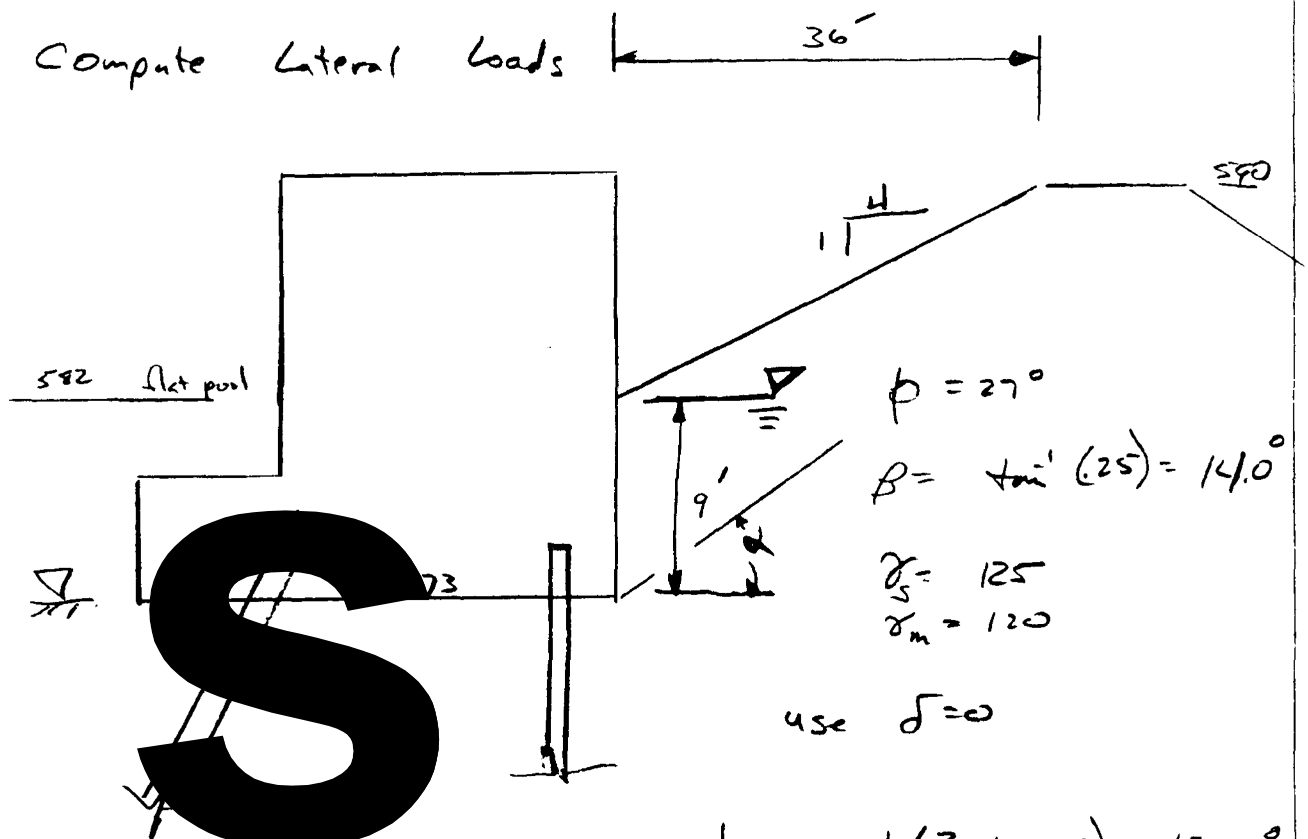
Soil acting down

E1	7*1*(2*15.6667)*0.125	27.42	7.833	214.76
E2	7*1*15.667*0.125	13.71	0.500	6.85
E3	7*1*7.667*0.125	6.71	15.170	101.77
		=======		=======
		47.83		323.39

gravity loads vertical force	486.89
gravity loads moments	4254.40

Subject SPRING LAKE EMP - Pump Sta		Date Feb 92
Computed by TJW	Checked by MW	Sheet I7 of

Compute Lateral Loads



$\phi = 27°$

$\beta = \tan^{-1}(.25) = 14.0°$

$\gamma_s = 125$

$\gamma_m = 120$

use $\delta = 0$

$\phi_d = \tan^{-1}\left(\frac{2}{3}\tan 27\right) = 18.76°$

$$K^* = \frac{1 - \tan\phi_d \cot\alpha}{1 + \tan\phi_d \tan\alpha + \tan\delta(\tan\alpha - \tan\phi_d)}$$

$$\alpha_{crit} = \tan^{-1}\left(\frac{C_1 + \sqrt{C_1 + 4C_2}}{2}\right)$$

Since $V = 0$, $\delta = 0$ & $C_d = 0$

$C_1 = 2\tan\phi_d(\tan\phi_d)/A = 2\tan^2\phi_d/A$

$= 0.231/A$

* REF 2

NCR Form 3006
1 Aug 8?

Subject Spring Lake EMP	Date Feb 92
Computed by TJW Checked by MW	Sheet I8 of

$$C_2 \quad \left[\tan\phi_d\left[1 - \tan\phi_d(\tan\beta)\right] - \tan\beta\right] / A$$

$A = \tan\phi_d + 0 - 0 - 0 + 0$

$= 0.3396$

$C_1 = .231/.3396 = 0.680$

$$C_2 = \left[\tan(18.76)\left[1 - \tan(18.76)(\tan(14.0))\right] - \tan 14.0\right] / .3396$$

$C_2 = 0.1813$

$$\alpha_{crit} = \tan^{-1}\left(\frac{0.680 + \sqrt{.680 + 4(.1813)}}{2}\right) = 43.0^\circ$$

$$K = \frac{1 - \tan(18.76) * \cot 43}{1 + \tan(18.76) * \tan 43 + 0} = 0.483$$

$$K_b = K\left[1 + \left(\frac{\tan\alpha}{\tan\alpha - \tan\beta} - 1\right)\frac{\gamma}{\gamma_b}\right]$$

Subject SPRING LAKE EMP		Date Feb 92
Computed by TJW	Checked by MW	Sheet I9 of

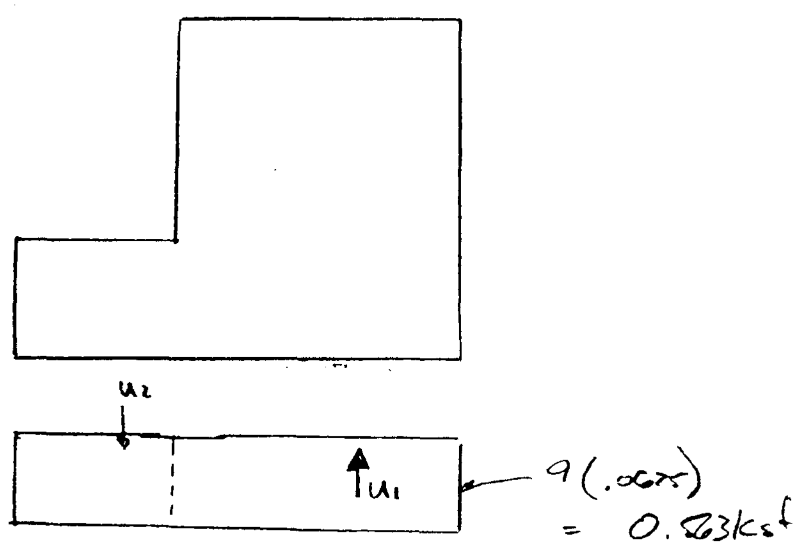
$$k_b = 0.483\left[1+\left(\frac{\tan 43}{\tan 43 - \tan 14} - 1\right)\frac{125}{62.5}\right]$$

$$= 0.836$$

Lateral Force $= 0.836\left(\frac{1}{2}\right)(9)^2(.0625)(15.667') = 33.2^k$

Moment about Toe $= 33.2\left(\frac{9}{3}\right) = 99.6$ k-ft

__uplift__



NCR Form 1 Atlas 2515

Subject SPRING LAKE EMP		Date Feb 92
Computed by TJW	Checked by MW	Sheet I10 of

			Arm	
u_1	$= -(17.667)(23.667)(.563) =$	-235^k	$\frac{23.667}{2}$	$-2786^{k\text{-}ft}$
u_2	$= \frac{1}{2}(8)(8)(.563) =$	18.0^k	$\left(15.667+\frac{8}{2}\right)$	$+354^{k\text{-}f}$
		-217		$-2432^{k\text{-}f}$

Σ Forces ↓ $= 486.9 - 217 = 270$

ΣF ← 33.2

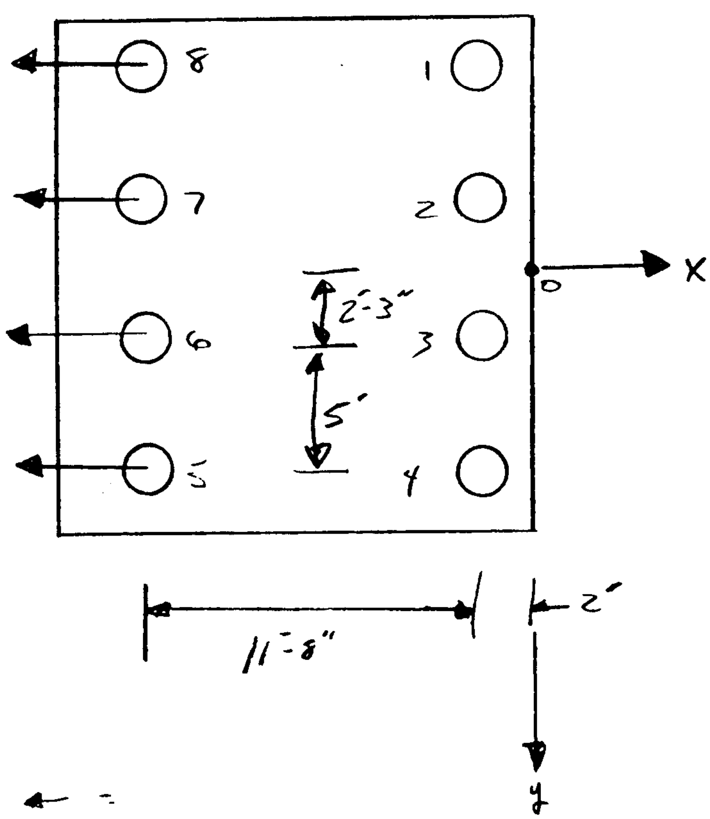
ΣM ↻ $= 4254 - 2432 + 100 = 1922$ k-f

$\bar{x} = 1922/270 = 7.12$

NCR Form 281b
1 Aug 80

Subject SPRING LAKE EMP · Pump Station		Date Feb 92
Computed by TJW	Checked by MW	Sheet I 11 of

CPGA Input



piles 5-8 battered
1/3
angle 180

F ← =

F ↓ =

M_A ↻ =

Subject SPRING LAKE EMP - Pump Station		Date Feb 92
Computed by TJW	Checked by MW	Sheet I 12 of

End bearing* driven to medium dense sand

Assume 12" timber piles

$D_c = 15B = 15'$

$q = \sigma_v' N_q$

$\sigma_v' = \gamma' D_c$ for $D > D_c$

$\sigma_v = (.0625)(15) = 0.938$ ksf

use $\phi = 35°$

$N_q = 40$ (fig 4-4 EM 1110-2-2906)

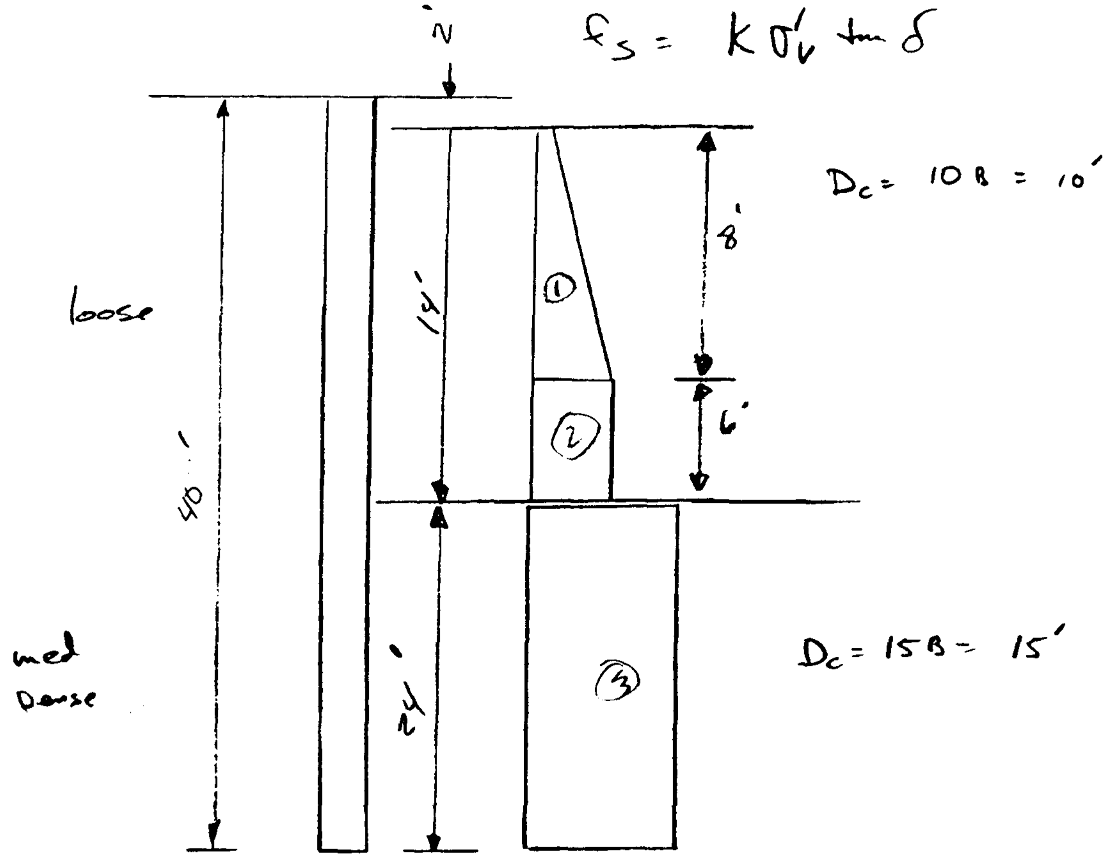
$Q_T = 0.938(40)\left(\frac{\pi}{4}(1)^2\right) = 29.5^K$

* REF 2

Subject SPRING LAKE - Pump Station		Date Feb 92
Computed by TJW	Checked by	Sheet I-13 of

skin friction *

$f_s = K \sigma_v' \tan \delta$



use $\delta = 0.8\phi = .8(30) = 24°$
$K = 2.0$

Area ① - Top $\sigma_{v_1}' = 2'(.0625) = 0.125$
bottom $\sigma_{v_1}' = 10(.0625) = 0.625$
σ_{v_1}' avg $= 0.375$ ksf

$f_s = 2(0.375)(\tan 24) = 0.334$ ksf

$Q_{s1} = \pi(1')(8')(.334) = 8.3^K$

*REF 1

Subject SPRING LAKE EMP - Pump Station	Date Feb 92
Computed by TJW Checked by MK	Sheet I-14 of

Area ②

$$Q_{s2} = \pi(1')(6')(2.0)(.625)\tan 24 = 10.5^K$$

Area ③

$$\sigma_v' = 15'(.0625) = 0.938$$

$$Q_{s3} = \pi(1)(24')(2.0)(.938)(\tan(.8 \times 35))$$

$$= 75.2^K$$

$$Q_s = 8.3 + 10.5 + 75.2 = 94$$

$$Q_u = 29.5^K + 94.0 = 123.5$$

$$Q_{allow} = \frac{123.5}{3} = 41.1^K$$

Subject SPRING LAKE EMP - Pump Station		Date Feb 92
Computed by TJW	Checked by MW	Sheet of

<u>Allowable Compressive Load</u>

F_a = 825 psi (southern pine)*

$P = 825 \frac{\pi}{4}(12)^2 = 93,305^{\#}$

use $P = \underline{\underline{93^k}}$

<u>Allowable Bending Moment</u>

$F_B = 1650 \text{ psi} = \frac{M}{S}$

$S = \frac{\pi d^3}{32} = \frac{\pi (12)^3}{32} = 169.6 \text{ in}^3$

$M = (169.6 \text{ in}^3)\, 1650 \frac{lb}{in^2} = 279,916 \text{ \#-in}$

* REF 1

```
*******************************
* CORPS PROGRAM  #  X0080     *   CPGA - CASE PILE GROUP ANALYSIS PROGRAM
* VERSION NUMBER # 89/08/11 *  RUN DATE 92/03/12  RUN TIME  8.48.19
*******************************


SPRING LAKE EMP PUMPSTATION


THERE ARE    8 PILES AND
             1 LOAD CASES IN THIS RUN.

ALL PILE COORDINATES ARE CONTAINED WITHIN A BOX
                                   X          Y          Z
                                 -----      -----      -----
WITH DIAGONAL COORDINATES = (    -12.67 ,    -7.25 ,      .00 )
                            (     -2.00 ,     7.25 ,      .00 )


*******************************************************************************

         PILE PROPERTIES AS INPUT


      E            I1           I2           A            C33           B66
     KSI          IN**4        IN**4        IN**2
  .15000E+04   .10180E+04   .10180E+04   .11310E+03   .10000E+01   .00000E+00

THESE PILE PROPERTIES APPLY TO THE FOLLOWING PILES -

    ALL


*******************************************************************************

         SOIL DESCRIPTIONS AS INPUT


   NH      ESOIL      LENGTH        L             LU
```

K/IN**3		FT	FT
.53600E-02	T	.40000E+02	.00000E+00

THIS SOIL DESCRIPTION APPLIES TO THE FOLLOWING PILES -

ALL

****

PILE GEOMETRY AS INPUT AND/OR GENERATED

NUM	X FT	Y FT	Z FT	BATTER	ANGLE	LENGTH FT	FIXITY
1	-2.00	7.25	.00	V	.00	40.00	P
2	-2.00	2.25	.00	V	.00	40.00	P
3	-2.00	-2.25	.00	V	.00	40.00	P
4	-2.00	-7.25	.00	V	.00	40.00	P
5	-12.67	7.25	.00	4.00	180.00	41.23	P
6	-12.67	2.25	.00	4.00	180.00	41.23	P
7	-12.67	-2.25	.00	4.00	180.00	41.23	P
8	-12.67	-7.25	.00	4.00	180.00	41.23	P

						324.92	

****

APPLIED LOADS

LOAD CASE	PX K	PY K	PZ K	MX FT-K	MY FT-K	MZ FT-K
1	-33.2	.0	270.0	.0	1922.0	.0

****

ORIGINAL PILE GROUP STIFFNESS MATRIX

.12189E+03	.69440E-05	-.31772E+03	-.90949E-12	-.48306E+05	-.10558E-02
.69440E-05	.42459E+02	-.27776E-04	.00000E+00	-.42231E-02	-.37372E+04
-.31772E+03	-.27776E-04	.27059E+04	.36380E-11	.23038E+06	.42231E-02
-.90949E-12	.00000E+00	.00000E+00	.11227E+08	.00000E+00	.13182E+07
-.48306E+05	-.42231E-02	.23038E+06	.00000E+00	.30683E+08	.64207E+00
-.10558E-02	-.37372E+04	.42231E-02	.13182E+07	.64207E+00	.10087E+07

LOAD CASE 1. NUMBER OF FAILURES = 0. NUMBER OF PILES IN TENSION = 0.

****

PILE CAP DISPLACEMENTS

LOAD CASE	DX IN	DY IN	DZ IN	RX RAD	RY RAD	RZ RAD
1	-.3088E-01	.3573E-07	.1006E+00	.3992E-10	-.5247E-04	-.3400E-09

****

PILE FORCES IN LOCAL GEOMETRY

M1 & M2 NOT AT PILE HEAD FOR PINNED PILES
* INDICATES PILE FAILURE
# INDICATES CBF BASED ON MOMENTS DUE TO
(F3*EMIN) FOR CONCRETE PILES
B INDICATES BUCKLING CONTROLS

NO PILES OVERSTRESSED

****

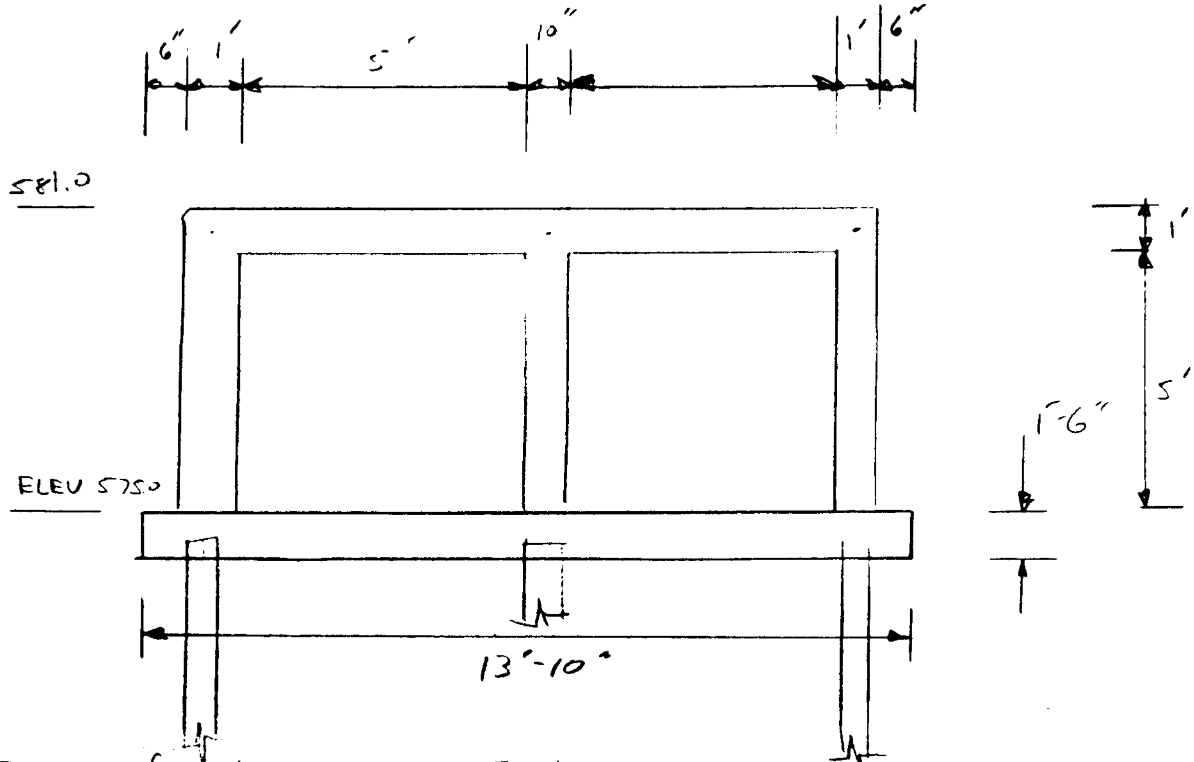
PILE FORCES IN GLOBAL GEOMETRY

LOAD CASE - 1

PILE	PX K	PY K	PZ K	MX IN-K	MY IN-K	MZ IN-K
1	-.2	.0	35.1	.0	.0	.0
2	-.2	.0	35.1	.0	.0	.0
3	-.2	.0	35.1	.0	.0	.0
4	-.2	.0	35.1	.0	.0	.0
5	-8.1	.0	32.4	.0	.0	.0
6	-8.1	.0	32.4	.0	.0	.0
7	-8.1	.0	32.4	.0	.0	.0
8	-8.1	.0	32.4	.0	.0	.0

Subject SPRING LAKE EMP - Water Control Struct	Date March 93
Computed by TJW / Checked by MW	Sheet I20 of

WATER CONTROL STRUCTURE



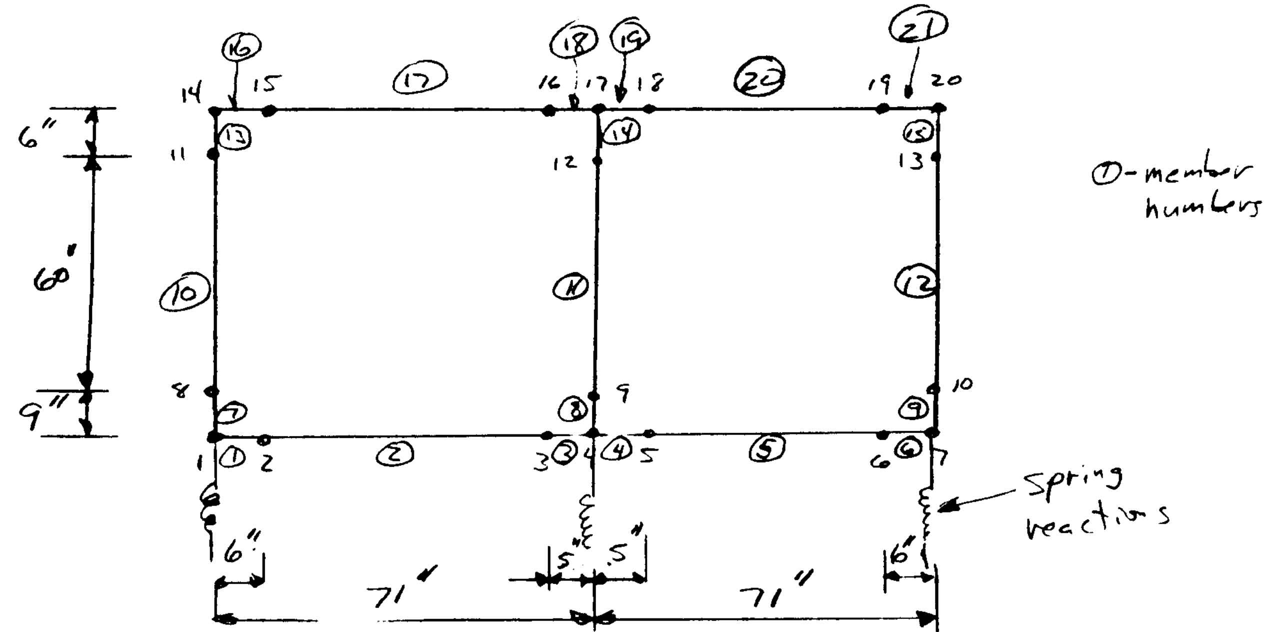
Top of Levee = 594.5

The following pages describe the CFRAME Model that was used. The piles were modeled using spring constants whose stiffness = EA/L

$$= \frac{1500 \text{ ksi} \left(\frac{\pi}{4}\right)(12)^2}{40\ (12)} = 353 \text{ k/in}$$

Subject SPRING LAKE EMP - WATER CONTROL Str.	Date Mar 92
Computed by TJW / Checked by MN	Sheet I21 of

Node Layout and MEMBER INC.

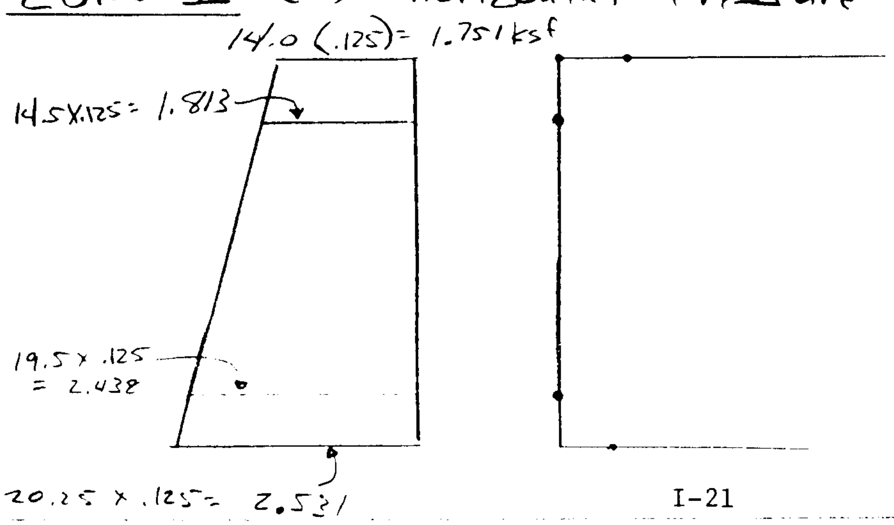


LOAD I (L1)

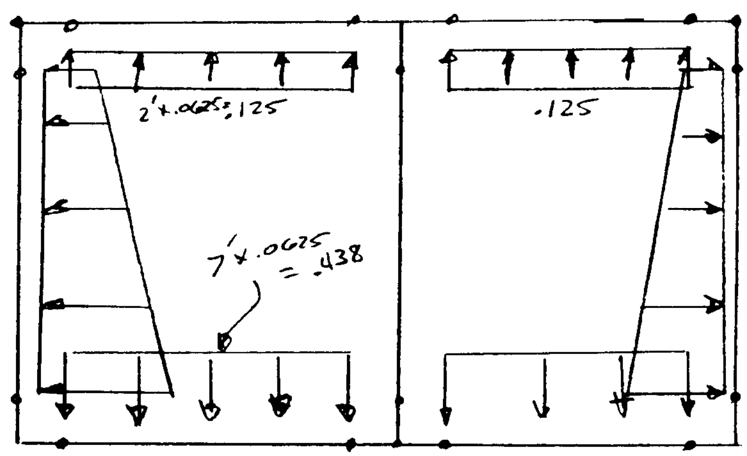
Soil on top of culvert & Top slab wt

= 13.5' (0.125 ksf) + 1'(.150) = 1.838 ksf

LOAD II (L2) Horizontal Pressure



LOAD III (L3) UPLIFT + Water inside



$(582.0 - 473.5)(.0625) - 1.5(.15) = 0.306$

(uplift - slab wt)

LOAD CASE IV = (1) L1 + 1(L2) + 1(L3)
LOAD CASE V = 1.5(L1) + .5(L2) + 1(L3)
} Load on Piles *

LOAD CASE VI = 1.9(L1) + 1.9(L2) + 1.9(L3)
LOAD CASE VII = 1.9(1.5*L1) + 1.9(.5*L2) + 1.9(L3)
} Factor Moments & Shear for Strn Design

* REF #3
Load Cases for Foundation Embankment

```
1*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
 PROGRAM CFRAME V02.05 24JUL84
 *-*-*-*-*-*-*-*-*-*-*-*-*-*-*
```

RUN DATE = 92/ 3/16
RUN TIME = 10.38.52

SPRING LAKE EMP   WATER CONTROL STRUCTURE

1 *** JOINT DATA ***

			------------------FIXITY------------------					
JOINT	X	Y	X	Y	R	KX	KY	KR
	--- IN ---					---KIP / IN---		IN-KIP/RAD
1	-71.00	.00					.353E+03	
2	-65.00	.00						
3	-5.00	.00						
4	.00	.00	*				.353E+03	
5	5.00	.00						
6	65.00	.00						
7	71.00	.00					.353E+03	
8	-71.00	9.00						
9	.00	9.00						
10	71.00	9.00						
11	-71.00	69.00						
12	.00	69.00						
13	71.00	69.00						
14	-71.00	75.00						
15	-65.00	75.00						
16	-5.00	75.00						
17	.00	75.00						
18	5.00	75.00						
19	65.00	75.00						
20	71.00	75.00						

1 *** MEMBER DATA ***

MEMBER	END A	END B	LENGTH IN	I IN**4	A IN**2	AS IN**2	E KSI	G KSI
1	1	2	6.00	.5832E+04	.2160E+03	.2160E+03	.3000E+04	.1304E+04
2	2	3	60.00	.5832E+04	.2160E+03	.2160E+03	.3000E+04	.1304E+04
3	3	4	5.00	.5832E+04	.2160E+03	.2160E+03	.3000E+04	.1304E+04
4	4	5	5.00	.5832E+04	.2160E+03	.2160E+03	.3000E+04	.1304E+04
5	5	6	60.00	.5832E+04	.2160E+03	.2160E+03	.3000E+04	.1304E+04
6	6	7	6.00	.5832E+04	.2160E+03	.2160E+03	.3000E+04	.1304E+04
7	1	8	9.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
8	4	9	9.00	.1000E+04	.1200E+03	.1200E+03	.3000E+04	.1304E+04
9	7	10	9.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
10	8	11	60.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
11	9	12	60.00	.1000E+04	.1200E+03	.1200E+03	.3000E+04	.1304E+04
12	10	13	60.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
13	11	14	6.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
14	12	17	6.00	.1000E+04	.1200E+03	.1200E+03	.3000E+04	.1304E+04
15	13	20	6.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
16	14	15	6.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
17	15	16	60.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
18	16	17	5.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
19	17	18	5.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
20	18	19	60.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04
21	19	20	6.00	.1728E+04	.1440E+03	.1440E+03	.3000E+04	.1304E+04

1 *** LOAD CASE 1 TOP SOIL

MEMBER	DIRECTION	PROJECTED LOAD KIP / IN
16	Y	-.1530E+00
17	Y	-.1530E+00
18	Y	-.1530E+00
19	Y	-.1530E+00
20	Y	-.1530E+00
21	Y	-.1530E+00

1 *** LOAD CASE 2 SIDE SOIL

MEMBER	LA IN	PA KIP / IN	LB IN	PB KIP / IN	ANGLE DEG
7	.00	.2110E+00	9.00	.2030E+00	.00
9	.00	-.2110E+00	9.00	-.2030E+00	.00
10	.00	.2030E+00	60.00	.1510E+00	.00
12	.00	-.2030E+00	60.00	-.1510E+00	.00
13	.00	.1510E+00	6.00	.1460E+00	.00
15	.00	-.1510E+00	6.00	-.1460E+00	.00

1 *** LOAD CASE 3 WATER INSIDE AND UPLIFT

MEMBER	DIRECTION	PROJECTED LOAD KIP / IN
1	Y	.2550E-01
2	Y	.2550E-01
3	Y	.2550E-01
4	Y	.2550E-01
5	Y	.2550E-01
6	Y	.2550E-01

MEMBER	LA IN	PA KIP / IN	LB IN	PB KIP / IN	ANGLE DEG
2	.00	.3650E-01	60.00	.3650E-01	.00
5	.00	.3650E-01	60.00	.3650E-01	.00
10	.00	-.3650E-01	60.00	-.1040E-01	.00
12	.00	.3650E-01	60.00	.1040E-01	.00
17	.00	-.1040E-01	60.00	-.1040E-01	.00
20	.00	-.1040E-01	60.00	-.1040E-01	.00

1 *** LOAD CASE COMBINATIONS ***

LOAD CASE	LOAD CASE FACTORS 1	2	3
4	1.00	1.00	1.00
5	1.50	.50	1.00
6	1.90	1.90	1.90
7	2.85	.95	1.90

1 LOAD CASE 4

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.6022E-03	-.1807E-01	-.1621E-03
2	.5513E-03	-.1902E-01	-.1507E-03
3	.4241E-04	-.2400E-01	-.1135E-04
4	.0000E+00	-.2402E-01	.0000E+00
5	-.4241E-04	-.2400E-01	.1135E-04
6	-.5513E-03	-.1902E-01	.1507E-03
7	-.6022E-03	-.1807E-01	.1621E-03
8	.2415E-02	-.1820E-01	-.1803E-03
9	.0000E+00	-.2423E-01	.0000E+00
10	-.2415E-02	-.1820E-01	.1803E-03
11	.1437E-02	-.1905E-01	.7017E-04
12	.0000E+00	-.2561E-01	.0000E+00
13	-.1437E-02	-.1905E-01	-.7017E-04
14	.1064E-02	-.1913E-01	-.1681E-04
15	.9737E-03	-.1970E-01	-.1051E-03
16	.7490E-04	-.2589E-01	.1377E-04
17	.0000E+00	-.2574E-01	.0000E+00
18	-.7490E-04	-.2589E-01	-.1377E-04
19	-.9737E-03	-.1970E-01	.1051E-03
20	-.1064E-02	-.1913E-01	.1681E-04

STRUCTURE REACTIONS

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT IN-KIP
1	.0000E+00	.6379E+01	.0000E+00
4	.0000E+00	.8480E+01	.0000E+00
7	.0000E+00	.6379E+01	.0000E+00
TOTAL	.0000E+00	.2124E+02	

1 LOAD CASE 5

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.1339E-03	-.2786E-01	-.1285E-03
2	.1226E-03	-.2869E-01	-.1346E-03
3	.0000E+00	-.3513E-01	-.2144E-04
4	.0000E+00	-.3521E-01	.0000E+00
5	.0000E+00	-.3513E-01	.2144E-04
6	-.1226E-03	-.2869E-01	.1346E-03
7	-.1339E-03	-.2786E-01	.1285E-03
8	.1125E-02	-.2804E-01	-.8175E-04
9	.0000E+00	-.3558E-01	.0000E+00
10	-.1125E-02	-.2804E-01	.8175E-04
11	-.1940E-04	-.2918E-01	-.8998E-04
12	.0000E+00	-.3805E-01	.0000E+00
13	.1940E-04	-.2918E-01	.8998E-04
14	.6670E-03	-.2930E-01	-.1841E-03
15	.6106E-03	-.3091E-01	-.2648E-03
16	.4697E-04	-.3861E-01	.4516E-04
17	.0000E+00	-.3830E-01	.0000E+00
18	-.4697E-04	-.3861E-01	-.4516E-04
19	-.6106E-03	-.3091E-01	.2648E-03
20	-.6670E-03	-.2930E-01	.1841E-03

STRUCTURE REACTIONS

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT IN-KIP
1	.0000E+00	.9836E+01	.0000E+00
4	.0000E+00	.1243E+02	.0000E+00
7	.0000E+00	.9836E+01	.0000E+00
TOTAL	.0000E+00	.3210E+02	

1 LOAD CASE 6

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.1144E-02	-.3433E-01	-.3080E-03
2	.1047E-02	-.3613E-01	-.2863E-03
3	.8057E-04	-.4559E-01	-.2157E-04
4	.0000E+00	-.4564E-01	.0000E+00
5	-.8057E-04	-.4559E-01	.2157E-04
6	-.1047E-02	-.3613E-01	.2863E-03
7	-.1144E-02	-.3433E-01	.3080E-03
8	.4588E-02	-.3457E-01	-.3425E-03
9	.0000E+00	-.4603E-01	.0000E+00
10	-.4588E-02	-.3457E-01	.3425E-03
11	.2731E-02	-.3619E-01	.1333E-03
12	.0000E+00	-.4865E-01	.0000E+00
13	-.2731E-02	-.3619E-01	-.1333E-03
14	.2021E-02	-.3635E-01	-.3194E-04
15	.1850E-02	-.3742E-01	-.1997E-03
16	.1423E-03	-.4918E-01	.2615E-04
17	.0000E+00	-.4891E-01	.0000E+00
18	-.1423E-03	-.4918E-01	-.2615E-04
19	-.1850E-02	-.3742E-01	.1997E-03
20	-.2021E-02	-.3635E-01	.3194E-04

STRUCTURE REACTIONS

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT IN-KIP
1	.0000E+00	.1212E+02	.0000E+00
4	.0000E+00	.1611E+02	.0000E+00
7	.0000E+00	.1212E+02	.0000E+00
TOTAL	.0000E+00	.4035E+02	

1 LOAD CASE 7

I-30

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.2544E-03	-.5294E-01	-.2441E-03
2	.2329E-03	-.5451E-01	-.2557E-03
3	.1791E-04	-.6675E-01	-.4073E-04
4	.0000E+00	-.6689E-01	.0000E+00
5	-.1791E-04	-.6675E-01	.4073E-04
6	-.2329E-03	-.5451E-01	.2557E-03
7	-.2544E-03	-.5294E-01	.2441E-03
8	.2137E-02	-.5327E-01	-.1553E-03
9	.0000E+00	-.6760E-01	.0000E+00
10	-.2137E-02	-.5327E-01	.1553E-03
11	-.3687E-04	-.5544E-01	-.1710E-03
12	.0000E+00	-.7230E-01	.0000E+00
13	.3687E-04	-.5544E-01	.1710E-03
14	.1267E-02	-.5566E-01	-.3498E-03
15	.1160E-02	-.5873E-01	-.5031E-03
[illegible]	.8924E-04	-.7336E-01	.8580E-04
[illegible]	.0000E+00	-.7277E-01	.0000E+00

18	-.8924E-04	-.7336E-01	-.8580E-04
19	-.1160E-02	-.5873E-01	.5031E-03
20	-.1267E-02	-.5566E-01	.3498E-03

STRUCTURE REACTIONS

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT IN-KIP
1	.0000E+00	.1869E+02	.0000E+00
4	.0000E+00	.2361E+02	.0000E+00
7	.0000E+00	.1869E+02	.0000E+00
TOTAL	.0000E+00	.6099E+02	

1 MEMBER END FORCES

MEMBER	LOAD CASE	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
1	4	1	-.5496E+01	.2728E+00	.3236E+02	.3446E+02	6.00
		2	-.5496E+01	-.4258E+00	.3446E+02	.3236E+02	.00
	5	1	-.1222E+01	.1593E+01	-.2281E+02	-.1279E+02	6.00
		2	-.1222E+01	-.1746E+01	-.1279E+02	-.2281E+02	.00
	6	1	-.1044E+02	.5183E+00	.6149E+02	.6547E+02	6.00
		2	-.1044E+02	-.8090E+00	.6547E+02	.6149E+02	.00
	7	1	-.2322E+01	.3027E+01	-.4335E+02	-.2431E+02	6.00
		2	-.2322E+01	-.3318E+01	-.2431E+02	-.4335E+02	.00
2	4	2	-.5496E+01	.4258E+00	.3446E+02	.4270E+02	38.40
		3	-.5496E+01	.2342E+00	.4021E+02	.3446E+02	.00
	5	2	-.1222E+01	.1746E+01	-.1279E+02	.7219E+02	60.00
		3	-.1222E+01	-.1086E+01	.7219E+02	-.1279E+02	.00
	6	2	-.1044E+02	.8090E+00	.6547E+02	.8113E+02	38.40
		3	-.1044E+02	.4450E+00	.7639E+02	.6547E+02	.00
	7	2	-.2322E+01	.3318E+01	-.2431E+02	.1372E+03	60.00
		3	-.2322E+01	-.2064E+01	.1372E+03	-.2431E+02	.00

3	4	3	-.5496E+01	-.2342E+00	.4021E+02	.4021E+02	.00
		4	-.5496E+01	.1067E+00	.3935E+02	.3935E+02	5.00
	5	3	-.1222E+01	.1086E+01	.7219E+02	.7794E+02	5.00
		4	-.1222E+01	-.1214E+01	.7794E+02	.7219E+02	.00
	6	3	-.1044E+02	-.4450E+00	.7639E+02	.7639E+02	.00
		4	-.1044E+02	.2027E+00	.7477E+02	.7477E+02	5.00
	7	3	-.2322E+01	.2064E+01	.1372E+03	.1481E+03	5.00
		4	-.2322E+01	-.2306E+01	.1481E+03	.1372E+03	.00
4	4	4	-.5496E+01	.1067E+00	.3935E+02	.4021E+02	5.00
		5	-.5496E+01	-.2342E+00	.4021E+02	.3935E+02	.00
	5	4	-.1222E+01	-.1214E+01	.7794E+02	.7794E+02	.00
		5	-.1222E+01	.1086E+01	.7219E+02	.7219E+02	5.00
	6	4	-.1044E+02	.2027E+00	.7477E+02	.7639E+02	5.00
		5	-.1044E+02	-.4450E+00	.7639E+02	.7477E+02	.00
	7	4	-.2322E+01	-.2306E+01	.1481E+03	.1481E+03	.00
		5	-.2322E+01	.2064E+01	.1372E+03	.1372E+03	5.00
5	4	5	-.5496E+01	.2342E+00	.4021E+02	.4270E+02	21.60
		6	-.5496E+01	.4258E+00	.3446E+02	.3446E+02	60.00
	5	5	-.1222E+01	-.1086E+01	.7219E+02	.7219E+02	.00
		6	-.1222E+01	.1746E+01	-.1279E+02	-.1279E+02	60.00
	6	5	-.1044E+02	.4450E+00	.7639E+02	.8113E+02	21.60
		6	-.1044E+02	.8090E+00	.6547E+02	.6547E+02	60.00
	7	5	-.2322E+01	-.2064E+01	.1372E+03	.1372E+03	.00
		6	-.2322E+01	.3318E+01	-.2431E+02	-.2431E+02	60.00
6	4	6	-.5496E+01	-.4258E+00	.3446E+02	.3446E+02	.00
		7	-.5496E+01	.2728E+00	.3236E+02	.3236E+02	6.00
	5	6	-.1222E+01	-.1746E+01	-.1279E+02	-.1279E+02	.00
		7	-.1222E+01	.1593E+01	-.2281E+02	-.2281E+02	6.00
	6	6	-.1044E+02	-.8090E+00	.6547E+02	.6547E+02	.00
		7	-.1044E+02	.5183E+00	.6149E+02	.6149E+02	6.00
	7	6	-.2322E+01	-.3318E+01	-.2431E+02	-.2431E+02	.00
		7	-.2322E+01	.3027E+01	-.4335E+02	-.4335E+02	6.00

7	4	1	-.6106E+01	.5496E+01	-.3236E+02	.8664E+01	9.00
		8	-.6106E+01	-.3633E+01	.8664E+01	-.3236E+02	.00
	5	1	-.8243E+01	.1222E+01	.2281E+02	.2959E+02	9.00
		8	-.8243E+01	-.2904E+00	.2959E+02	.2281E+02	.00
	6	1	-.1160E+02	.1044E+02	-.6149E+02	.1646E+02	9.00
		8	-.1160E+02	-.6903E+01	.1646E+02	-.6149E+02	.00
	7	1	-.1566E+02	.2322E+01	.4335E+02	.5623E+02	9.00
		8	-.1566E+02	-.5518E+00	.5623E+02	.4335E+02	.00
8	4	4	-.8266E+01	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.8266E+01	.0000E+00	.0000E+00	.0000E+00	.00
	5	4	-.1486E+02	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.1486E+02	.0000E+00	.0000E+00	.0000E+00	.00
	6	4	-.1571E+02	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.1571E+02	.0000E+00	.0000E+00	.0000E+00	.00
	7	4	-.2823E+02	.0000E+00	.0000E+00	.0000E+00	.00
		9	-.2823E+02	.0000E+00	.0000E+00	.0000E+00	.00
9	4	7	-.6106E+01	-.5496E+01	.3236E+02	.3236E+02	.00
		10	-.6106E+01	.3633E+01	-.8664E+01	-.8664E+01	9.00
	5	7	-.8243E+01	-.1222E+01	-.2281E+02	-.2281E+02	.00
		10	-.8243E+01	.2904E+00	-.2959E+02	-.2959E+02	9.00
	6	7	-.1160E+02	-.1044E+02	.6149E+02	.6149E+02	.00
		10	-.1160E+02	.6903E+01	-.1646E+02	-.1646E+02	9.00
	7	7	-.1566E+02	-.2322E+01	-.4335E+02	-.4335E+02	.00
		10	-.1566E+02	.5518E+00	-.5623E+02	-.5623E+02	9.00
10	4	8	-.6106E+01	.3633E+01	.8664E+01	.4907E+02	22.80
		11	-.6106E+01	.5580E+01	-.5752E+02	-.5752E+02	60.00
	5	8	-.8243E+01	.2904E+00	.2959E+02	.3024E+02	4.80
		11	-.8243E+01	.3613E+01	-.7004E+02	-.7004E+02	60.00
	6	8	-.1160E+02	.6903E+01	.1646E+02	.9324E+02	22.80
		11	-.1160E+02	.1060E+02	-.1093E+03	-.1093E+03	60.00
	7	8	-.1566E+02	.5518E+00	.5623E+02	.5745E+02	4.80
		11	-.1566E+02	.6864E+01	-.1331E+03	-.1331E+03	60.00

11	4	9	-.8266E+01	.0000E+00	.0000E+00	.0000E+00	.00
		12	-.8266E+01	.0000E+00	.0000E+00	.0000E+00	.00
	5	9	-.1486E+02	.0000E+00	.0000E+00	.0000E+00	.00
		12	-.1486E+02	.0000E+00	.0000E+00	.0000E+00	.00
	6	9	-.1571E+02	.0000E+00	.0000E+00	.0000E+00	.00
		12	-.1571E+02	.0000E+00	.0000E+00	.0000E+00	.00
	7	9	-.2823E+02	.0000E+00	.0000E+00	.0000E+00	.00
		12	-.2823E+02	.0000E+00	.0000E+00	.0000E+00	.00
12	4	10	-.6106E+01	-.3633E+01	-.8664E+01	.5752E+02	60.00
		13	-.6106E+01	-.5580E+01	.5752E+02	-.4907E+02	22.80
	5	10	-.8243E+01	-.2904E+00	-.2959E+02	.7004E+02	60.00
		13	-.8243E+01	-.3613E+01	.7004E+02	-.3024E+02	4.80
	6	10	-.1160E+02	-.6903E+01	-.1646E+02	.1093E+03	60.00
		13	-.1160E+02	-.1060E+02	.1093E+03	-.9324E+02	22.80
	7	10	-.1566E+02	-.5518E+00	-.5623E+02	.1331E+03	60.00
		13	-.1566E+02	-.6864E+01	.1331E+03	-.5745E+02	4.80
13	4	11	-.6106E+01	-.5580E+01	-.5752E+02	-.5752E+02	.00
		14	-.6106E+01	.6471E+01	-.9369E+02	-.9369E+02	6.00
	5	11	-.8243E+01	-.3613E+01	-.7004E+02	-.7004E+02	.00
		14	-.8243E+01	.4058E+01	-.9306E+02	-.9306E+02	6.00
	6	11	-.1160E+02	-.1060E+02	-.1093E+03	-.1093E+03	.00
		14	-.1160E+02	.1229E+02	-.1780E+03	-.1780E+03	6.00
	7	11	-.1566E+02	-.6864E+01	-.1331E+03	-.1331E+03	.00
		14	-.1566E+02	.7710E+01	-.1768E+03	-.1768E+03	6.00
14	4	12	-.8266E+01	.0000E+00	.0000E+00	.0000E+00	.00
		17	-.8266E+01	.0000E+00	.0000E+00	.0000E+00	.00
	5	12	-.1486E+02	.0000E+00	.0000E+00	.0000E+00	.00
		17	-.1486E+02	.0000E+00	.0000E+00	.0000E+00	.00
	6	12	-.1571E+02	.0000E+00	.0000E+00	.0000E+00	.00
		17	-.1571E+02	.0000E+00	.0000E+00	.0000E+00	.00
	7	12	-.2823E+02	.0000E+00	.0000E+00	.0000E+00	.00
		17	-.2823E+02	.0000E+00	.0000E+00	.0000E+00	.00

15	4	13	-.6106E+01	.5580E+01	.5752E+02	.9369E+02	6.00
		20	-.6106E+01	-.6471E+01	.9369E+02	.5752E+02	.00
	5	13	-.8243E+01	.3613E+01	.7004E+02	.9306E+02	6.00
		20	-.8243E+01	-.4058E+01	.9306E+02	.7004E+02	.00
	6	13	-.1160E+02	.1060E+02	.1093E+03	.1780E+03	6.00
		20	-.1160E+02	-.1229E+02	.1780E+03	.1093E+03	.00
	7	13	-.1566E+02	.6864E+01	.1331E+03	.1768E+03	6.00
		20	-.1566E+02	-.7710E+01	.1768E+03	.1331E+03	.00
16	4	14	-.6471E+01	.6106E+01	-.9369E+02	-.5980E+02	6.00
		15	-.6471E+01	-.5188E+01	-.5980E+02	-.9369E+02	.00
	5	14	-.4058E+01	.8243E+01	-.9306E+02	-.4774E+02	6.00
		15	-.4058E+01	-.6866E+01	-.4774E+02	-.9306E+02	.00
	6	14	-.1229E+02	.1160E+02	-.1780E+03	-.1136E+03	6.00
		15	-.1229E+02	-.9857E+01	-.1136E+03	-.1780E+03	.00
	7	14	-.7710E+01	.1566E+02	-.1768E+03	-.9070E+02	6.00
		15	-.7710E+01	-.1305E+02	-.9070E+02	-.1768E+03	.00
17	4	15	-.6471E+01	.5188E+01	-.5980E+02	.3455E+02	36.00
		16	-.6471E+01	.3368E+01	-.5214E+01	-.5980E+02	.00
	5	15	-.4058E+01	.6866E+01	-.4774E+02	.5984E+02	31.20
		16	-.4058E+01	.6280E+01	-.3016E+02	-.4774E+02	.00
	6	15	-.1229E+02	.9857E+01	-.1136E+03	.6565E+02	36.00
		16	-.1229E+02	.6399E+01	-.9907E+01	-.1136E+03	.00
	7	15	-.7710E+01	.1305E+02	-.9070E+02	.1137E+03	31.20
		16	-.7710E+01	.1193E+02	-.5731E+02	-.9070E+02	.00
18	4	16	-.6471E+01	-.3368E+01	-.5214E+01	-.5214E+01	.00
		17	-.6471E+01	.4133E+01	-.2397E+02	-.2397E+02	5.00
	5	16	-.4058E+01	-.6280E+01	-.3016E+02	-.3016E+02	.00
		17	-.4058E+01	.7428E+01	-.6443E+02	-.6443E+02	5.00
	6	16	-.1229E+02	-.6399E+01	-.9907E+01	-.9907E+01	.00
		17	-.1229E+02	.7853E+01	-.4554E+02	-.4554E+02	5.00
	7	16	-.7710E+01	-.1193E+02	-.5731E+02	-.5731E+02	.00
		17	-.7710E+01	.1411E+02	-.1224E+03	-.1224E+03	5.00

19	4	17	-.6471E+01	.4133E+01	-.2397E+02	-.5214E+01	5.00
		18	-.6471E+01	-.3368E+01	-.5214E+01	-.2397E+02	.00
	5	17	-.4058E+01	.7428E+01	-.6443E+02	-.3016E+02	5.00
		18	-.4058E+01	-.6280E+01	-.3016E+02	-.6443E+02	.00
	6	17	-.1229E+02	.7853E+01	-.4554E+02	-.9907E+01	5.00
		18	-.1229E+02	-.6399E+01	-.9907E+01	-.4554E+02	.00
	7	17	-.7710E+01	.1411E+02	-.1224E+03	-.5731E+02	5.00
		18	-.7710E+01	-.1193E+02	-.5731E+02	-.1224E+03	.00
20	4	18	-.6471E+01	.3368E+01	-.5214E+01	.3455E+02	24.00
		19	-.6471E+01	.5188E+01	-.5980E+02	-.5980E+02	60.00
	5	18	-.4058E+01	.6280E+01	-.3016E+02	.5984E+02	28.80
		19	-.4058E+01	.6866E+01	-.4774E+02	-.4774E+02	60.00
	6	18	-.1229E+02	.6399E+01	-.9907E+01	.6565E+02	24.00
		19	-.1229E+02	.9857E+01	-.1136E+03	-.1136E+03	60.00
	7	18	-.7710E+01	.1193E+02	-.5731E+02	.1137E+03	28.80
		19	-.7710E+01	.1305E+02	-.9070E+02	-.9070E+02	60.00
21	4	19	-.6471E+01	-.5188E+01	-.5980E+02	-.5980E+02	.00
		20	-.6471E+01	.6106E+01	-.9369E+02	-.9369E+02	6.00
	5	19	-.4058E+01	-.6866E+01	-.4774E+02	-.4774E+02	.00
		20	-.4058E+01	.8243E+01	-.9306E+02	-.9306E+02	6.00
	6	19	-.1229E+02	-.9857E+01	-.1136E+03	-.1136E+03	.00
		20	-.1229E+02	.1160E+02	-.1780E+03	-.1780E+03	6.00
	7	19	-.7710E+01	-.1305E+02	-.9070E+02	-.9070E+02	.00
		20	-.7710E+01	.1566E+02	-.1768E+03	-.1768E+03	6.00

Subject SPRING LAKE EMP - WATER CONTROL STR	Date Mar 92
Computed by TJW / Checked by MW	Sheet I37 of

Pile Design

from CFRAME OUTPUT

$Q_{max} = 12.4^k/ft$

TRY 4' spacing

$Q = 4'(12.4^k/ft) = 49.6^k$

use $Q = 50^k$

$FS = 3 \Rightarrow Q_{ult} = 150^k$

End Bearing

Determine Length of pile needed

use 12" timber piles

Drive to medium dense sand

$D_c = 15B = 15'$

$q = \sigma_v' = \gamma' D_c$ for $D > D_c$

$\sigma_v' = 0.0625(15) = 0.938$ ksf

use $\phi = 35°$ $\Rightarrow N_q = 70$

$Q_T = A_t * q = \frac{\pi}{4}(1)^2(.938)(70) = 51.5$ Kip

Subject SPRING LAKE EMP - WATER Control Structure		Date Mar 92
Computed by TJW	Checked by MH	Sheet I 38 of

SKIN FRICTION

$Q_S = Q_u - Q_T = 150 - 51.5 = 98.5^K$

Neglect Soil from 563 to 575 (very weak)

$Q_s = A_s f_s$

$f_s = K \sigma_v' \tan \delta$

$\delta = .8\phi = 30°$

$K = 2 \qquad \sigma_v' = 0.938$

$f_s = 2(.938)(\tan 30) = 1.08$ ksf

$A_s = \pi(1)D$

$98.5 = 1.08(\pi D) \Rightarrow D = 28.9'$

use $D = 30'$

Total Depth = 40'

STRUCTURAL DESIGN OF MEMBERS

Member 2 & 5

$M_u^+ = 137$ k-in

$d = 12''$ $b = 12''$ $f'_c = 4000$

$$\frac{M_N}{f'_c b d^2} = \frac{137}{.9(4000)(12)(12)^2} = 0.000022$$

use temp steel $\rho = 0.001$

$A_s = 12(18)(.001) = 0.216$ in²/ft

use #4 @ 12 E.F.

$V_u = 3.1$ kip - Ok by inspection

Members 10 + 12

$M_u = 133.4$ k-in

$$\frac{M_N}{f'_c b d^2} = \frac{133}{.9(4000)(12)(9)^2} = 0.00004$$

use $\rho = 0.001$

$A_s = 12(12)(.001) = 0.21$ in²

Subject SPRING LAKE EMP - Water Control Structure		Date 9 APR 93
Computed by MW	Checked by	Sheet I 39A of

STRUCTURAL DESIGN OF MEMBERS

Member 2 & 5

$M_u^+ = 137$ k-in

$d = 12''$ $b = 12''$ $f'_c = 4000$

$$\frac{M_N}{f'_c bd^2} = \frac{137}{0.9(4)(12)(12)^2} = 0.022$$

$\omega = 0.023$

$$\rho = 0.023\left(\frac{4}{48}\right) = 0.0019$$

$A_s = 1.33(0.0019)(12)(9) = 0.27$

USE # 5 @ 12 ($A_s = 0.31$ □''/ft)

$V_u = 3.31$ kip - OK by inspection

MEMBER 10 & 12

$M_u = 133.$ k-in

$$\frac{M_N}{f'_c bd^2} = \frac{133}{0.9(4)(12)(9)^2} = 0.0380$$

$\omega = 0.0389$

$$\rho = 0.0389\left(\frac{4}{48}\right) = 0.00324$$

$A_s = 1.333(.00324)(12)(9) = 0.47$

USE # 5 @ 8 ($A_s = 0.47$ □''/ft)

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Members 17 & 20

$M_u = 114$ k-in < 133 (member 10)

$$\frac{M_N}{f'_c\, b d^2} = \frac{114}{0.9(4)(12)(9)^2} = 0.0325$$

$$\omega = 0.0332$$

$$\rho = 0.332\left(\frac{4}{48}\right) = 0.0027$$

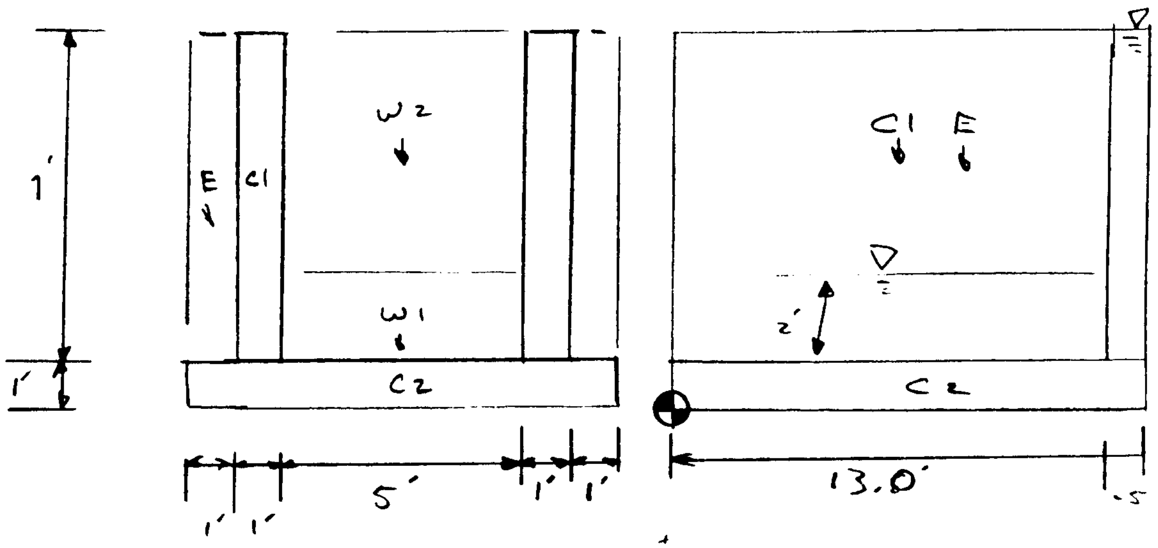
$$A_s = 1.33(.0027)(12)(9)$$
$$= 0.39$$

USE #5@9 ($A_s = 0.41$ "/ft)

Subject: STOPLOG STRUCTURE	Date: Feb 92
Computed by: TJW — Checked by: MW	Sheet: I 41 of

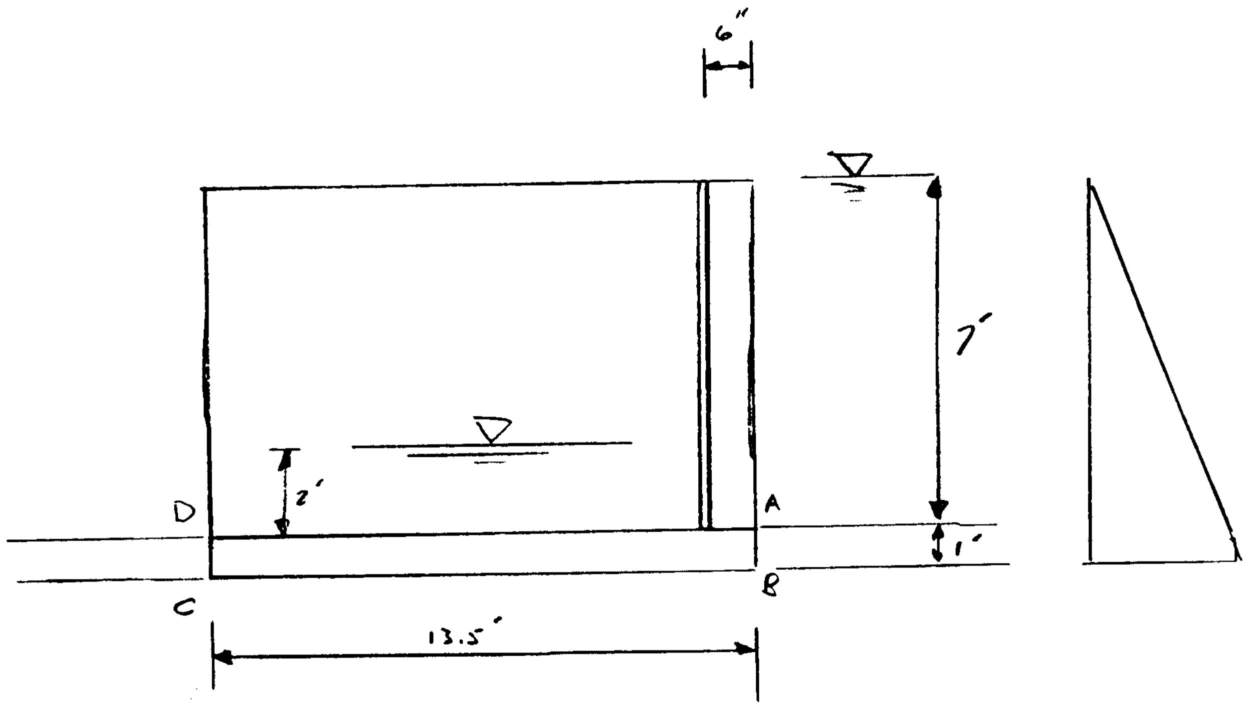
Overturning Analysis

Gravity Loads:



Load	Force ↓	Arm	Moment
C1 = (2) 1'(13.5) 7' (150)	28,350	6.75	191,363
C2 = 1'(13.5) 9' (150)	18,225	6.75	123,019
E = 2(1')(13.5)(7)(125)	23,625	6.75	159,469
W_1 = 5'(2')(13')(62.5)	8,125	6.5	52,813
W_2 = 5'(½')(7') 62.5	1,094	13.25	14,492
	79,419		541,146

Subject: SPRING LAKE - Stop log Struct.		Date: Feb 92
Computed by: TJW	Checked by: MW	Sheet: I42 of



Flow Path = 2(1') + 13.5 = 15.5"

ΔH = 5'

Gradient = 5/15.5 = 0.3226

Pressure @ A = 7(62.5) = 437.5

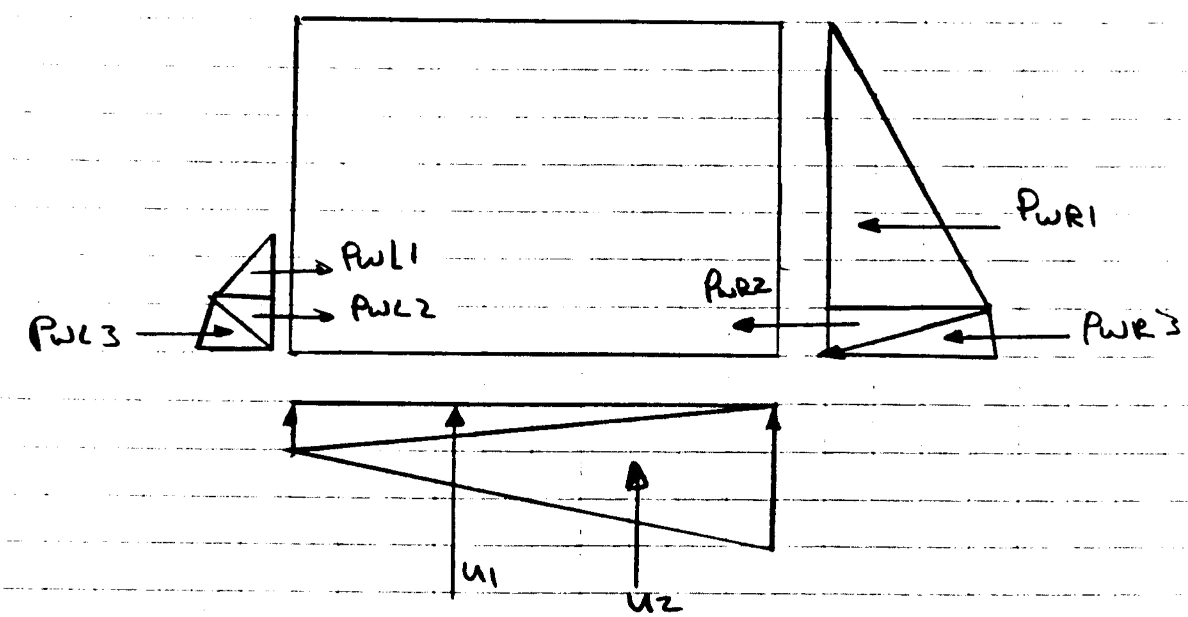
@ B = 437.5 + (1 - .3226)(62.5)(1) = 479.84 psf

@ C = 479.84 - .3226 (13.5) 62.5 = 207.64 psf

@ D = 207.64 - (1 + .3226)(1)(62.5) = 125.0 psf

Subject SPRING LAKE EMP - STOPLOG STRUCT.		Date Feb 92
Computed by TJW	Checked by MW	Sheet I 43 of

UPLIFT + Horizontal Loads



UPLIFT		Force ↓	Arm	Moment ↷
U1	$= \frac{1}{2}(13.5)(9)(207.64)$ =	-12,614	4.5	-56,764
U2	$= \frac{1}{2}(13.5)(9)(479.84)$ =	-29,150	9	-262,353
		-41,764		-319,117

Horizontal		Force →	Arm	Moment
PwR1	$= -\frac{1}{2}(437.5)(7)(9)$ =	-13,781	3.333	-45,938
PwR2	$= -\frac{1}{2}(1)(9)(437.5)$ =	-1,969	.667	-1,313
PwR3	$= -\frac{1}{2}(1)(9)(479.84)$ =	-2,159	.333	-720
PwL1	$= \frac{1}{2}(2)(9)(1250)$ =	+1125	1.667	+1,875
PwL2	$= \frac{1}{2}(1)(9)(1250)$ =	+563	.667	+375
PwL3	$= \frac{1}{2}(1)(9)(207.65)$ =	+934	.333	+3
		-15,287		-45410

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Subject SPRING LAKE EMP - STOP LOG STRUCT.		Date Feb 92
Computed by TJW	Checked by MW	Sheet I 44 of

SUMMATION OF FORCES

$\Sigma F \downarrow = 79{,}419 - 41764 = {}^{+}37{,}655^{\#}$

$\Sigma F \rightarrow = -15{,}287^{\#}$

$\Sigma M = 541{,}146 - 319{,}117 - 45{,}410 = {}^{+}176619$

$\bar{X} = 176619 / 37{,}655 = 4.69'$

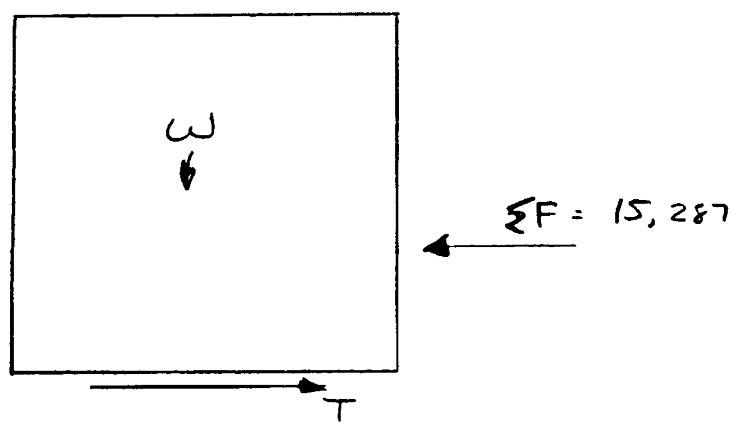
$e = 13.5/2 - 4.69 = 2.06'$

$B/6 = 13.5/6 = 2.25$

OK Resultant within the middle 1/3

100% of base is in compression

Sliding Analysis



use SMF = 2/3

FS = T/ΣF ←

Consider 2 CASES

(I) $\phi = 0$, c = 400 psf (short term)

(II) $\phi = 27°$ c = 0 (Long term)

USE SINGLE WEDGE

Subject SPRING LAKE EMP. STOPLOG Struct.		Date Feb 92
Computed by TJW	Checked by MW	Sheet I 46 of

CASE I

$C = 400$ psf

$C_d = \frac{2}{3}(400) = 267$ psf

$T = 267(9)(13.5) = 32441$

$FS = 32441/15287 = 2.12$

OK > 1.5

CASE II

$\phi = 27°$ $\qquad \phi_d = \tan^{-1}(\frac{2}{3} \tan 27) = 18.77°$

Include friction along sides in the levee.

$T_{base} = 37665 \tan 18.77 = 12797$ #

$T_{slides} = [k_o\, 2(\frac{1}{2})\, \gamma_{sub}\, H^2] \tan \phi_d \times L$

for k_o use ϕ not ϕ_d

$k_o = 1 - \sin 27 = 0.546$

$T_{slides} = 0.546(2)(\frac{1}{2})(125 - 62.5)(8)^2 \tan 18.77 \times 13.5$

$= 10020$ #

Subject SPRING LAKE EMP - STOPLOG Struct.		Date Feb 92
Computed by TJW	Checked by MW	Sheet I47 of

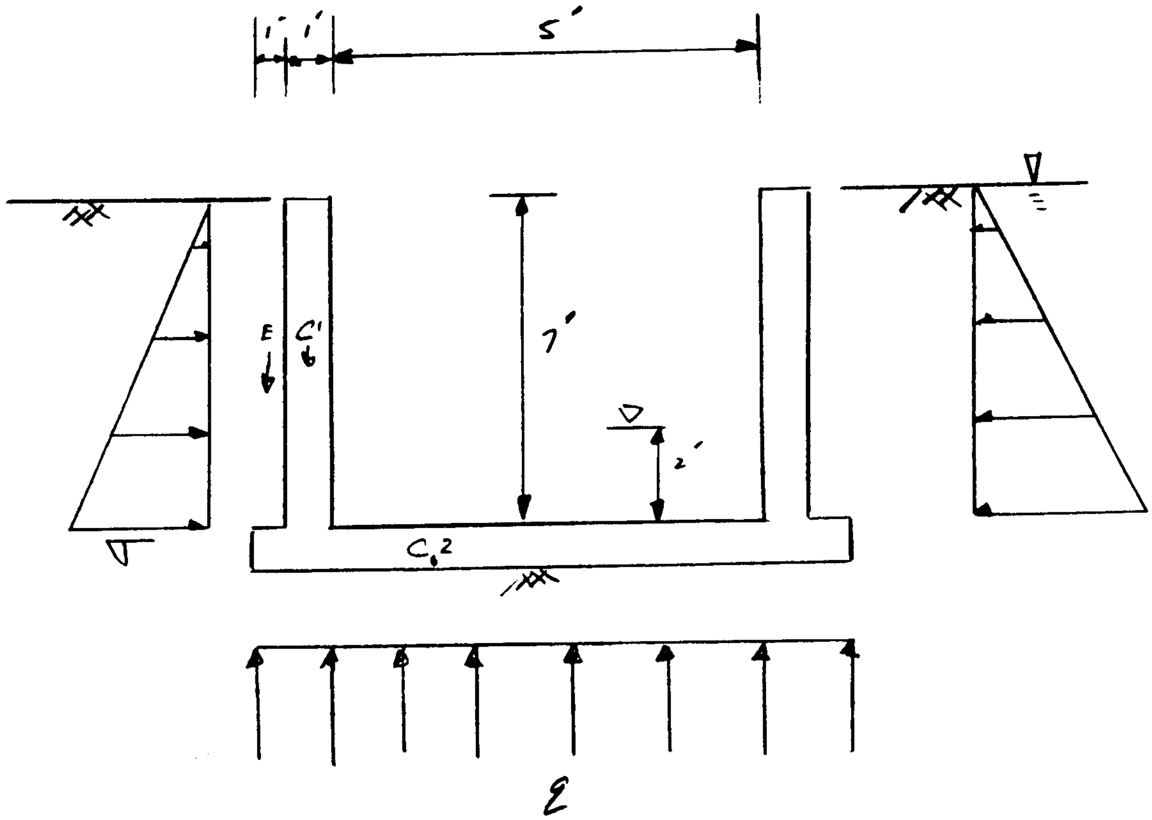
$$T_{TOTAL} = 12797 + 10020 = 22817^{\#}$$

$$FS = 22817/15287 = \underline{\underline{1.49}} > 1.33$$

OK

Subject SPRING LAKE EMP – STOPLOG STRUCT		Date Feb 92
Computed by TJW	Checked by MW	Sheet I 48 of

MEMBER DESIGN



DESIGN STEM

Use AT REST Pressures

$k_o = 1 - \sin \phi_d = 1 - \sin 18.77° = 0.66$

$\sigma = 7'[(62.5) + .66(125 - 62.5)] = 726 \ \#/ft^2$

$M_u = 1.9(726)\frac{1}{2}(7)^2/3 = 11265 \ \#\text{-}ft$

$\frac{M_N}{f'_c b d^2} = \frac{11265}{.9(4000)(1)(9)^2} = 0.0391$

$\omega = 0.0395$

$\rho = \omega \, f'_c / f_y = 0.0395 \; 4/48000$

$= 0.00329$

$\rho_{min} = 200/48000 = 0.00416$

$\rho < \rho_{min} \qquad 1.333\,(0.00329) = 0.00439$

use $\rho_{min} \qquad A_s = 0.00416\,(12)(9)$
$= 0.449$

use #6 @ 12

$\underline{A_s = 0.44}$

Check Shear

$V_{max} = 726 \text{ \#/ft} \cdot \frac{1}{2}(7) = 2541 \text{ \#/ft}$

$V_u = 1.9\,(2541) = 4828$

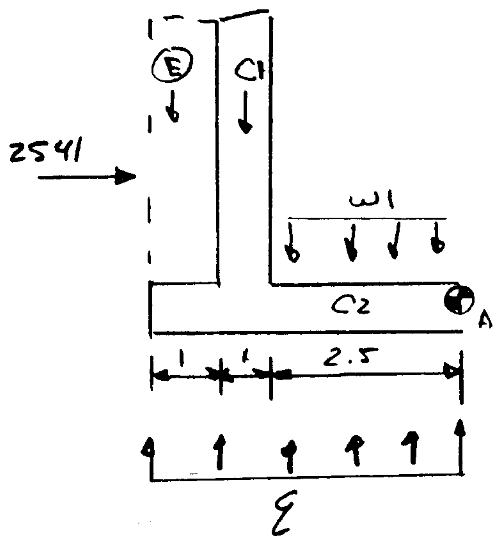
$\phi V_c = .85\,(2)\sqrt{4000}\,(12)(9) = 11612 \text{ \#/ft}$

ok $\frac{\phi V_c}{2} > V_u$

Subject SPRING LAKE EMP - STOPLOG STRUCT.		Date Feb 92
Computed by TJW	Checked by MW	Sheet I50 of

BASE DESIGN

$q = \Sigma F\downarrow / A = 37655^{\#} / (13.5)(9) = 310 \text{ psf}$



$M_A = 2541(2.833) + 4.5(310)\frac{4.5}{2}$

$- 1(7)(125)(4) - (1)(7)(150)(3)$

$- 4.5(1)(150)(\frac{4.5}{2}) - 2(62.5)(2.5)^2/2$

$= 1779 \text{ \#-f/f}$

$M_u = 3380 \text{ \#-f}$

$\frac{M_u}{f'_c b d^2} = \frac{3380}{.9(4000)1(8)^2} = 0.0147$

$\omega = 0.0148$

$\rho = 0.0148 \; 4/48 = 0.001233$

$\rho < \rho_{min}$

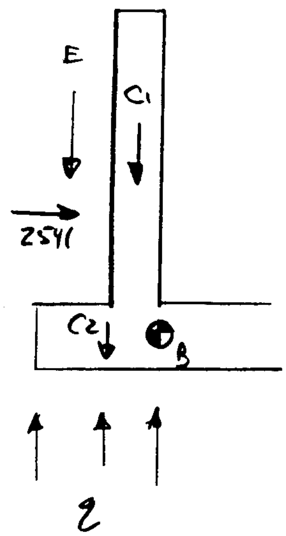
$A_s = 1.333(0.001233)(12)8 = 0.158$

use #4 @ 12 $\quad A_s = 0.20$

use top & bottom

Subject SPRING LAKE EMP - STOPLOG STR.		Date Feb 92
Computed by TJW	Checked by MW	Sheet I51 of

Moment @ B



$$M_B = 2541(2.833) + 310(2)^2/2$$
$$- 7(125)(1)(1.5) - 7(150)(1)(.5)$$
$$- (150)(1)(2)(1)$$
$$= 5682$$

$$\frac{M_N}{f'_c b d^2} = \frac{(1.9)\,5682}{.9(4000)(1)(8)^2} = 0.0469$$

$\omega = 0.0482$

$\rho = 0.0482 \; 4/48 = 0.00390 \quad < \rho_{min}$

use ρ_{min}

$A_s = 0.004167(12)(8) = 0.40$

use # 6 @ 12

bottom only

Check Shear

$V_{max} = 7(1)(125+150) + 2(150)(1) = 2225$

$V_u = 1.9(2225) = 4228$

$\frac{1}{2}\phi V_c = \frac{1}{2}(2)\sqrt{4000}\; 12(8)(.85) = 5161 \quad$ OK $> V_u$

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COST ESTIMATE

APPENDIX

J

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-12F)

SPRING LAKE REHABILITATION AND ENHANCEMENT

MISSISSIPPI RIVER MILES 532 THROUGH 536
CARROLL COUNTY, ILLINOIS

APPENDIX J
COST ESTIMATE

GENERAL

This appendix contains the detailed cost estimate prepared for the Spring Lake Rehabilitation and Enhancement Project at Mississippi River Miles 532-536, 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 Gold, v. 5.20), incorporating local wage and equipment rates, was utilized to assemble and calculate project element costs. Costs, including appropriate contingencies, are presented in accordance with EC 1110-2-536, Civil Works Project Cost Estimating - Code of Accounts.

PRICE LEVEL

Project element costs are based on October 1992 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 Memorandum, dated 7 Feb 92, Subject: Factors for Updating Study/Project Cost Estimates for the FY 1994 Budget Submission.

CONTINGENCY DISCUSSION

After review of project documents and discussion with personnel involved in the project, cost contingencies were assigned which reflect the uncertainty associated with each cost item. Per EC 1110-2-263, these contingencies are based on qualified cost engineering judgement 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 06, Fish and Wildlife Facilities.

The quantities for this work were developed by the Design and Cost Engineering Branches.

06.-.-.- Upper Lake Perimeter Levee Repair; Cross Dike Repair; and Lower Lake Perimeter Levee Repair. These project features require similar construction methods and are grouped together for purposes of this discussion. The work involves upgrading the existing levees by increasing the height, increasing the crown width, and providing proper side slopes. After clearing and grubbing operations, a dragline will excavate adjacent borrow and place it on the levee for shaping. No compaction is required other than that obtained by tracked equipment working the area. The Lower Lake Perimeter Levee Repair work is more remote than the Upper Lake Repair work and consequently some of the unit prices are higher. The even higher unit prices for embankment fill, placement, and shaping work at the Cross Dike Repair reflects the high ratio of shaping existing levee material to new fill that is required. Mobilization and demobilization cost for the project construction is shown with the Cross Dike Repair since it is anticipated that this will be one of the first work items in the construction sequence. An overall contingency of about 15 to 20 percent is considered adequate for this work.

06.-.-.- Upper Lake Interior Levee Construction. This work will be done by a dragline/clamshell working from small, portable pontoon work barges. Costs for mobilization and demobilization of the portable work barges to the project site and for their disassembly/assembly are included. An overall contingency of about 25 percent is adequate for this work to account for the remote job location.

06.-.-.- Inlet/Water Control Structure. Access for constructing this structure is along the existing cross dike which is to be upgraded. A 30 percent contingency is assigned to the timber piling to account for uncertainties in final design quantities. The dewatering cost includes a temporary sheetpile cofferdam around the structure. Recent quotes were used for the slide gate material cost. An overall contingency of about 15 percent is considered satisfactory for this structure because of available cost information for a similar structure constructed as part of the Brown's Lake EMP project by the Rock Island District in 1988.

06.-.-.- Stop Log Structures (Cell A, Cell B, Cell C, and Hemi Marsh). These structures are identical in design except for Cell A which is slightly smaller. Dewatering costs for these structures are assigned a 30 percent contingency to account for uncertainties in construction duration. It is anticipated that the contractor will have the option to use the new pump station to control the water level in the upper lake area during construction, and sheetpile cofferdams will not be needed for these structures. Temporary earthen cofferdams and small pumps will be used at the stop log structure sites for dewatering. All of the structures are located in remote areas and construction productivities account for this. Recent quotes were used for the material cost of the heavy duty grating. An overall contingency of about 24 percent is used for these structures.

06.-.-.- Pump Station. This structure is located in a remote area. Access during construction will be along the cross dike which will be upgraded during project construction. The contractor's staging area for the project will probably be about three-quarters of a mile from the pump station site. Staging area at the pump station site will be very limited, and these factors were considered in assigning productivities for the work items. Also, a separate cost for material handling to the site is included with the pump station cost. Historical data was used in pricing the pumps and slide gate. Timber piling is given a 30 percent contingency to account for final design quantity unknowns. Dewatering cost includes a temporary sheetpile cofferdam around the structure. An overall contingency of about 18 percent is considered satisfactory for the pump station construction.

06.-.-.- New Well. A preliminary price quote was used for the cost of the 1,000 gpm submersible pump which is included in the well cost. Cost for the electrical power to the well was coordinated with the local utility, Interstate Power Company. A 35 percent contingency is assigned this work to account for possible final design changes in the proposed 125-foot deep well.

06.-.-.- Overflow Areas. The designated overflow areas will be reinforced with riprap. A supplier's quote was used for the delivered material price of the riprap. A 20 percent contingency is used to account for minor changes in quantity.

The project's overall construction cost contingency is 20.2 percent.

b. 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 prepare construction plans and specifications. This cost also includes engineering support during construction and preparation of as-built drawings and operation/maintenance manuals. The design effort for the construction was analyzed to determine the man-year effort required. This estimate is based upon monies expended to date, discussions between the project engineer and project manager, and historical data and experience gained on other projects of similar nature.

c. Feature 31, Construction Management.

Construction management includes the following items: review of project reports, plans and specifications, and conferences of construction staff to become familiar with design requirements; biddability, contractibility, and operability reviews; preaward activities to acquaint prospective bidders with the nature of 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 the construction phase to determine suitability and compliance with plans and specifications; negotiation with the contractor on all contract modifications, including preparation of all contract documents required therefor; 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 costs may be incurred at the job site, an area office, or at the District Office. For the construction of the Spring Lake Rehabilitation and Enhancement EMP Project, the estimated cost of construction management is $416,000 for a construction contract with a 3-year duration and an estimated value of $4.0 million.

DISTRIBUTION LIST

APPENDIX

K

SPRING LAKE DISTRIBUTION LIST PROJECT 861

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SUPERINTENDENT IL DEPT OF AGR - JR LIVESTOCK BLDG SPRINGFIELD, IL 62706	DIVN OF NATURAL RESOURCES ILLINOIS STATE FAIRGROUNDS		1			
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* I - Draft Coordination Documents
II - Public Review Documents
III - Administration Approval Documents
IV - Construction Plans and Specifications
V - Operations and Maintenance Instructions

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GEOLOGICAL SURVEY BUREAU IOWA DEPT OF NATURAL RESOURCES IOWA CITY IA 52240	ENERGY AND GEOLOGICAL RESOURCES DIVN 123 NORTH CAPITOL STREET		1			
DR ALLAN HIRSCH - DIRECTOR US ENVIRONMENTAL PROTECTION AGENCY WASHINGTON DC 20460	OFFICE OF FEDERAL ACTIVITIES (A-104) 401 M STREET SW		1			
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DIRECTOR OLD PO BLDG #809 WASHINGTON DC 20004	ADVISORY COUNCIL ON HISTORIC PRESERV 1100 PENNSYLVANIA AVENUE NW		1			
HONORABLE HARLAN RIGNEY P.O. BOX 691	ILLINOIS SENATOR FREEPORT, IL 61032		1			
HONORABLE RICHARD MULCAHEY P O BOX 107	ILLINOIS REPRESENTATIVE DURAND, IL 61024		1			

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MR DAVID L. GROSS ENV STUDIES & ASSESSMENT SEC CHAMPAIGN IL 61821	ILLINOIS STATE GEOLOGICAL SURVEY 615 E PEABODY DR		1			
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OFFICE OF THE GOVERNOR STATE OF ILLINOIS	ATTN: TOM BERKSHIRE SPRINGFIELD, IL 62706		1			
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HONORABLE JOHN W COX JR 218 FIRST AVENUE	REPRESENTATIVE IN CONGRESS STERLING IL 61081		1			
MR JONATHAN WHITNEY PO BOX 188	CARROLL COUNTY REVIEW THOMSON IL 61285		1			
MR DENNIS KENNEDY 3215 EXECUTIVE PARK DRIVE SPRINGFIELD IL 62794-9484	DEPT OF TRANS-DIV OF WATER RESOURCES PO BOX 19484		1			
MR SAM MOTOUFI 3215 EXECUTIVE PARK DRIVE SPRINGFIELD IL 62794-9484	DEPT OF TRANS-DIV OF WATER RESOURCES PO BOX 19484		1			

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DIRECTOR DEPT OF ENERGY - ROOM 4G064 WASHINGTON DC 20585	OFFICE OF ENVIRONMENTAL COMPLIANCE 1000 INDEPENDENCE AVE SW		1			
HONORABLE JIM EDGAR STATE CAPITOL	GOVERNOR OF ILLINOIS SPRINGFIELD IL 62706		1			
CHARLES WHITMORE SOIL CONSERVATION SERVICE CHAMPAIGN IL 61820	STATE CONSERVATIONIST 1902 FOX DRIVE		1			
MR G BRENT MANNING-DIRECTOR LINCOLN TOWER PLAZA SPRINGFIELD IL 62701-1787	ILLINOIS DEPT OF CONSERVATION 524 SOUTH 2ND STREET		1			
MR VALDAS J ADAMKUS - ADMINISTRATOR 230 S DEARBORN ST	US ENVIRONMENTAL PROTECTION AGCY CHICAGO IL 60604	1	1	1		
COMMANDER D ANDERSON SECOND COAST GUARD DISTRICT ST LOUIS MO 63101	DEPARTMENT OF TRANSPORTATION 1430 OLIVE STREET		1			

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MR NEIL FULTON IL DIVN OF WATER RESOURCES CHICAGO IL 60604	CHIEF-BUR OF RES REG 310 S MICHIGAN AVE - RM 1606		1			
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IV - Construction Plans and Specifications
V - Operations and Maintenance Instructions

		* I	II	III	IV	V
KEITH BESEKE- EMP COORDINATOR FISH & WILDLIFE REFUGE SYSTEM WINONA MN 55987	FISH AND WILDLIFE SERVICE/UPPER MISS 51 E 4TH STREET - ROOM 101	2 1/	2 1/	2 1/		
MS HOLLY STOERKER 415 HAMM BUILDING ST PAUL MN 55102	UPPER MISS RIVER BASIN ASSN 408 ST PETER STREET	1	1	1		
HONORABLE ALAN J DIXON 331 HART SENATE OFFICE BLDG	UNITED STATES SENATOR WASHINGTON DC 20510-1301		1			
MR WAYNE FISCHER 4469 48TH AVENUE COURT	US FISH & WILDLIFE SERVICE ROCK ISLAND IL 61201	1	1	1		
DISTRICT ENGINEER ATTN CELMS-PD/BEN HAWICKHORST ST LOUIS MO 63103-2833	US ARMY ENGINEER DISTRICT ST LOUIS 1222 SPRUCE STREET	1	1			
DR. KEN LUBINSKI HREP COORDINATOR 575 LESTER DRIVE	US FISH & WILDLIFE SERVICE-EMTC ONALASKA WI 54650	1	1	1		
MR DAN SALLEE LINCOLN TOWER PLAZA SPRINGFIELD IL 62706	ILLINOIS DEPT OF CONSERVATION 524 SOUTH 2ND STREET	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

1/ All copies of documents identified for receipt by USFWS personnel are provided to EMP Coordinator for internal redistribution.

SPRING LAKE DISTRIBUTION LIST PROJECT 861

03/26/92	Page 9	* I	II	III	IV	V
MR BOB SMITH-REGL ENGINEER LINCOLN TOWER PLAZA SPRINGFIELD IL 62706	ILLINOIS DEPT OF CONSERVATION 524 SOUTH 2ND STREET	1	1	1		
DISTRICT ENGINEER ATTN PLANNING DIV - CHUCK CRIST ST PAUL MN 55101-1479	US ARMY ENGINEER DISTRICT-ST PAUL 180 E KELLOGG BLVD-1421 USPO	1	1			
MR BRUCE YURDIN ENVIRONMENTAL PROTECTION AGENCY SPRINGFIELD IL 63101	ENVIRONMENTAL PROT SPCLST DWPC 2200 CHURCHILL ROAD	1	1			
MR DOUG DUFFORD DEARBORN HALL MT CARROLL IL 61053	IL DEPT OF CONSERVATION 205 EAST SEMINARY ST	1	1	1		
MR MIKE BORNSTEIN EMP COORDINATOR RR 1 - BOX 75	USFWS-MARK TWAIN NTL WILDLIFE REFUGE WAPELLO IA 52653	1	1	1		
MR MILO ANDERSON ENVIRONMENTAL REVIEW BOARD-5ME-16 CHICAGO IL 60604	US ENVIRONMENTAL PROTECTION AGENCY 230 SOUTH DEARBORN ST	1	1	1		

*
I - Draft Coordination Documents
II - Public Review Documents
III - Administration Approval Documents
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V - Operations and Maintenance Instructions

		* I	II	III	IV	V
MR LARRY WARGOWSKY UMR NATL WILDLIFE & FISH REFUGE SAVANNA IL 61074	US FISH & WILDLIFE SERVICE POST OFFICE BLDG	1	1	1		
DON PIERCE 1607 W HWY 50	GRAHAM-PIERCE O'FALLON IL 62269		1			
INTERSTATE POWER CO 201 NORTH 2ND ST	ATTN RON SEYMOUR CLINTON IA 52732		1			
MR RUSS GHENT 206 ROSE ST	LTRM BELLEVUE FIELD STATION BELLEVUE IA 52031	1	1	1		
Kevin Szcodronski Wallace State Office Building	Iowa Department of Natural Resources Des Moines, Iowa 50319-0034	1	1	1		
Chairman, UMRCC 4469 48th Avenue Court	US Fish and Wildlife Service Rock Island IL 61201	1	1	1		
Jeff Janvrin 3550 Mormon Coulee Drive	Wisconsin Dept of Natural Resources Lacrosse Wisconsin 54601	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

Distribution -- Internal

District Engineer
U.S. Army Engineer District
Rock Island
Clock Tower Building
PO Box 2004
Rock Island, IL 61204-2004

	*I	II	III	IV	V
ATTN: CENCR-DE	1	1	1		
CENCR-DP	1	1	1		
CENCR-PP-M	1	1	1		1
CENCR-ED	1	1	1		1
CENCR-ED-D	1	1	1	1	1
CENCR-ED-DN	3	3	3	3	3
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CENCR-ED-HQ	1	1	1		1
CENCR-PA	1	1	1		
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CENCR-PD-E	1	10	10	1	1
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CENCR-RE	1	1	1		
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*I - Draft Coordination Documents
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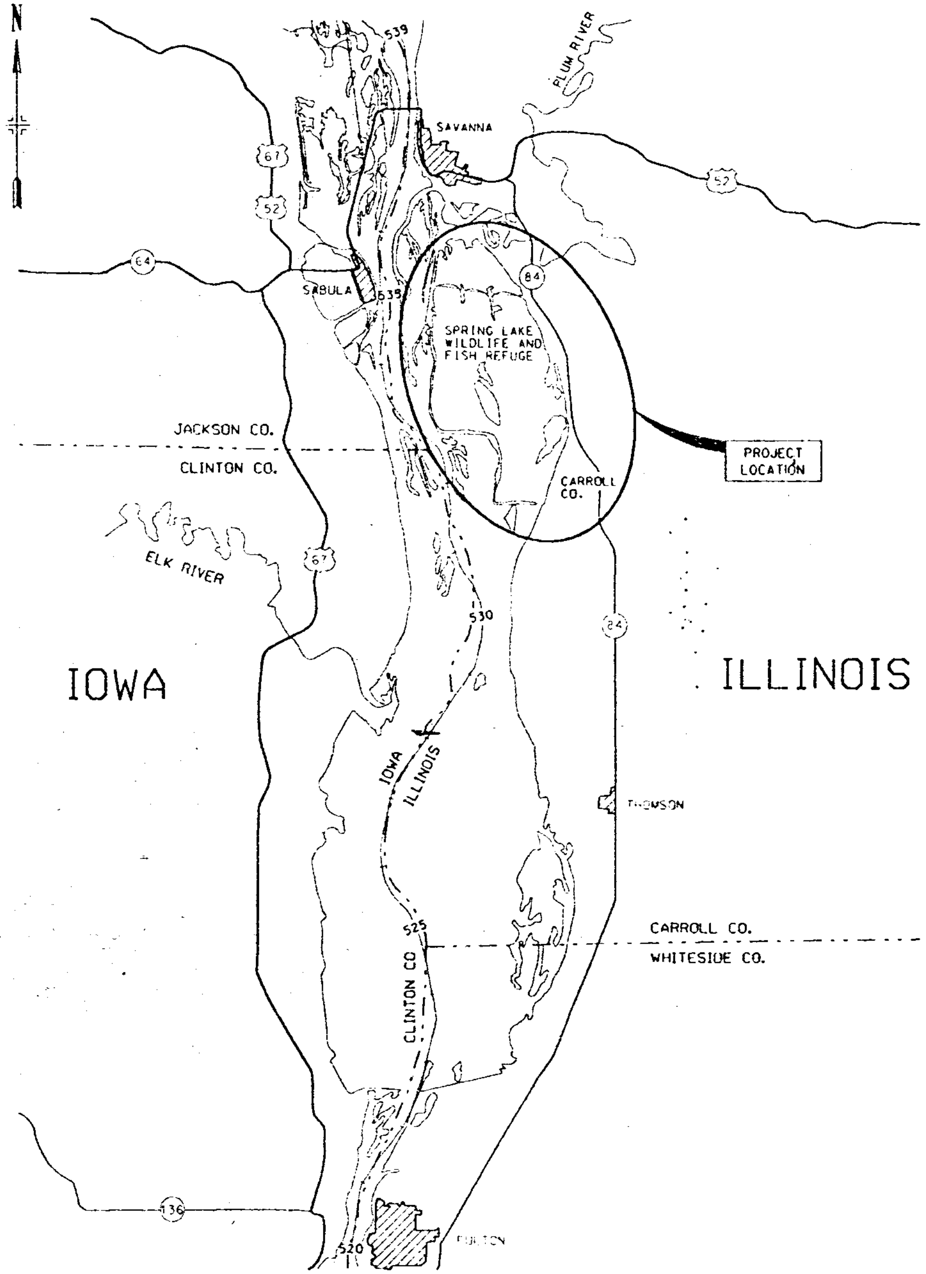
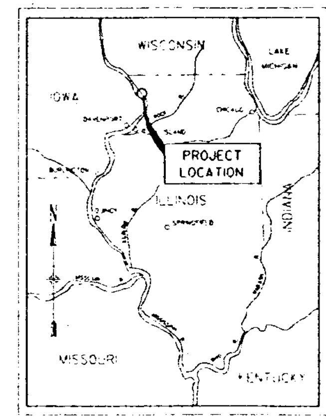


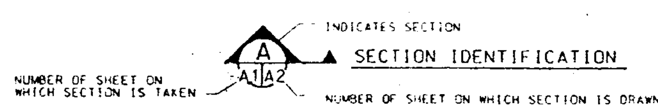
LOCATION PLAN

SHEET NO.	SHEET REF. NO.	
1	X-1	LOCATION MAP AND INDEX
2	C-1	RECOMMENDED PLAN
3	C-2	POTENTIAL FEATURES PLAN
4	C-3	HYDRAULIC DATA I
5	C-4	HYDRAULIC DATA II
6	C-5	HYDRAULIC DATA III
7	C-6	BORING LOCATIONS
8	C-7	BORING LOGS I
9	C-8	BORING LOGS II
10	C-9	SHEET KEY PLAN
11	C-10	UPPER PLAN AND PROFILE STA. 0+00U TO STA. 45+00U
12	C-11	UPPER PLAN AND PROFILE STA. 45+00U TO STA. 90+00U
13	C-12	UPPER PLAN AND PROFILE STA. 90+00U TO STA. 135+00U
14	C-13	UPPER PLAN AND PROFILE STA. 135+00U TO STA. 180+00U
15	C-14	UPPER PLAN AND PROFILE STA. 180+00U TO STA. 214+11.40U
16	C-15	LOWER PLAN AND PROFILE STA. 0+00L TO STA. 45+00L
17	C-16	LOWER PLAN AND PROFILE STA. 45+00L TO STA. 90+00L
18	C-17	LOWER PLAN AND PROFILE STA. 90+00L TO STA. 135+00L
19	C-18	LOWER PLAN AND PROFILE STA. 135+00L TO STA. 180+00L
20	C-19	LOWER PLAN AND PROFILE STA. 180+00L TO STA. 225+00L
21	C-20	LOWER PLAN AND PROFILE STA. 225+00L TO STA. 244+65L
22	C-21	TYPICAL SECTIONS I
23	C-22	TYPICAL SECTIONS II
24	C-23	TYPICAL UPPER PERIMETER LEVEE DESIGN SECTIONS
25	C-24	TYPICAL CROSS DIKE LEVEE DESIGN SECTIONS
26	C-25	TYPICAL LOWER PERIMETER LEVEE DESIGN SECTIONS I
27	C-26	TYPICAL LOWER PERIMETER LEVEE DESIGN SECTIONS II
28	C-27	HEMI MARSH AND WELL STATION PLAN
29	S-1	PUMP STATION SITE PLAN
30	S-2	PUMP STATION DETAILS
31	S-3	INLET STRUCTURE PLAN AND ELEVATION
32	S-4	STOP LOG STRUCTURES
33	E-1	ELECTRICAL ONE - LINE DIAGRAM PUMP STATION
34	E-2	ELECTRICAL ONE - LINE DIAGRAM WELL STATION
35	MP-1	MONITORING PLAN



VICINITY MAP

LEGEND



Revisions			
Symbol	Description	Date	Approved

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDICATED ON EACH INDIVIDUAL TITLE BLOCK

Prepared by: U.S. ARMY ENGINEER DISTRICT, ROCK ISLAND
Submitted by: CHIEF, DESIGN BR.
CHIEF, HYDRAULICS BR.
CHIEF, GEOTECHNICAL BR.
Recommended by: CHIEF, ENGINEERING DIV.
Approved by: COL, CORPS OF ENGINEERS Date:

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. FRAUS COL., CORPS OF ENGINEERS

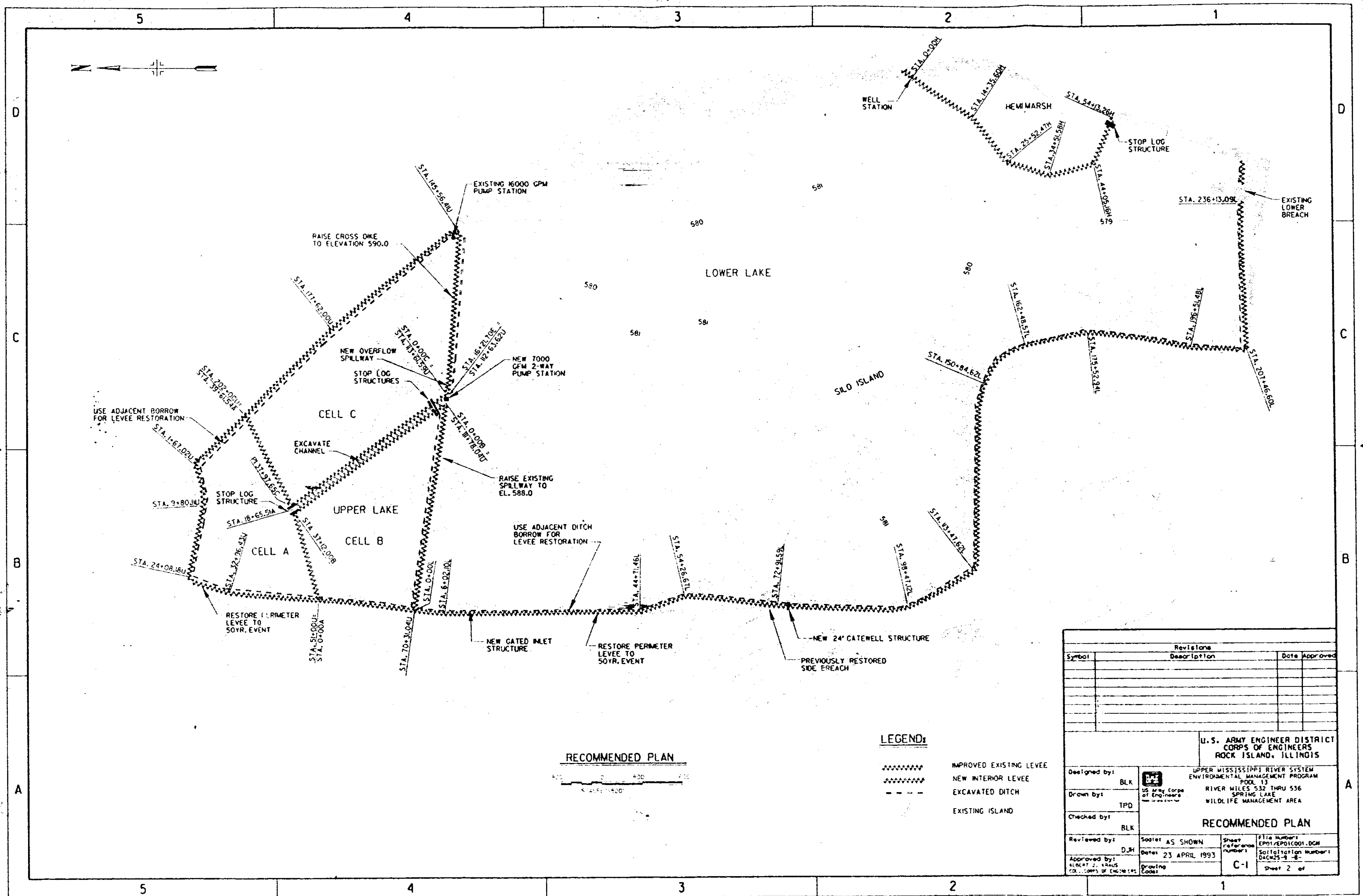
US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

LOCATION MAP AND INDEX

Scale: AS SHOWN
Date: 23 APR 1993
Drawing Code:
Sheet reference number: X-1
File Number: ep01/ep01x001.dgn
Solicitation Number: DACW25-9 -8-
Sheet 1 of

PLATE 1


LOWER LAKE
UPPER LAKE
CELL A
CELL B
CELL C
SILO ISLAND
HEMIMARSH
WELL STATION
STOP LOG STRUCTURE
EXISTING LOWER BREACH
EXISTING 16000 GPM PUMP STATION
RAISE CROSS DIKE TO ELEVATION 590.0
NEW OVERFLOW SPILLWAY
STOP LOG STRUCTURES
NEW 7000 GPM 2-WAY PUMP STATION
USE ADJACENT BORROW FOR LEVEE RESTORATION
EXCAVATE CHANNEL
RAISE EXISTING SPILLWAY TO EL. 588.0
USE ADJACENT DITCH BORROW FOR LEVEE RESTORATION
RESTORE PERIMETER LEVEE TO 50YR. EVENT
NEW GATED INLET STRUCTURE
NEW 24" GATEWELL STRUCTURE
PREVIOUSLY RESTORED SIDE BREACH
STA. 236+13.09L
STA. 24+08.18U
STA. 9+80.JIU
STA. 1+67.02U
STA. 18+65.51A
RECOMMENDED PLAN
LEGEND:
IMPROVED EXISTING LEVEE
NEW INTERIOR LEVEE
EXCAVATED DITCH
EXISTING ISLAND
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
US Army Corps of Engineers
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
RECOMMENDED PLAN
Scale: AS SHOWN
Date: 23 APRIL 1993
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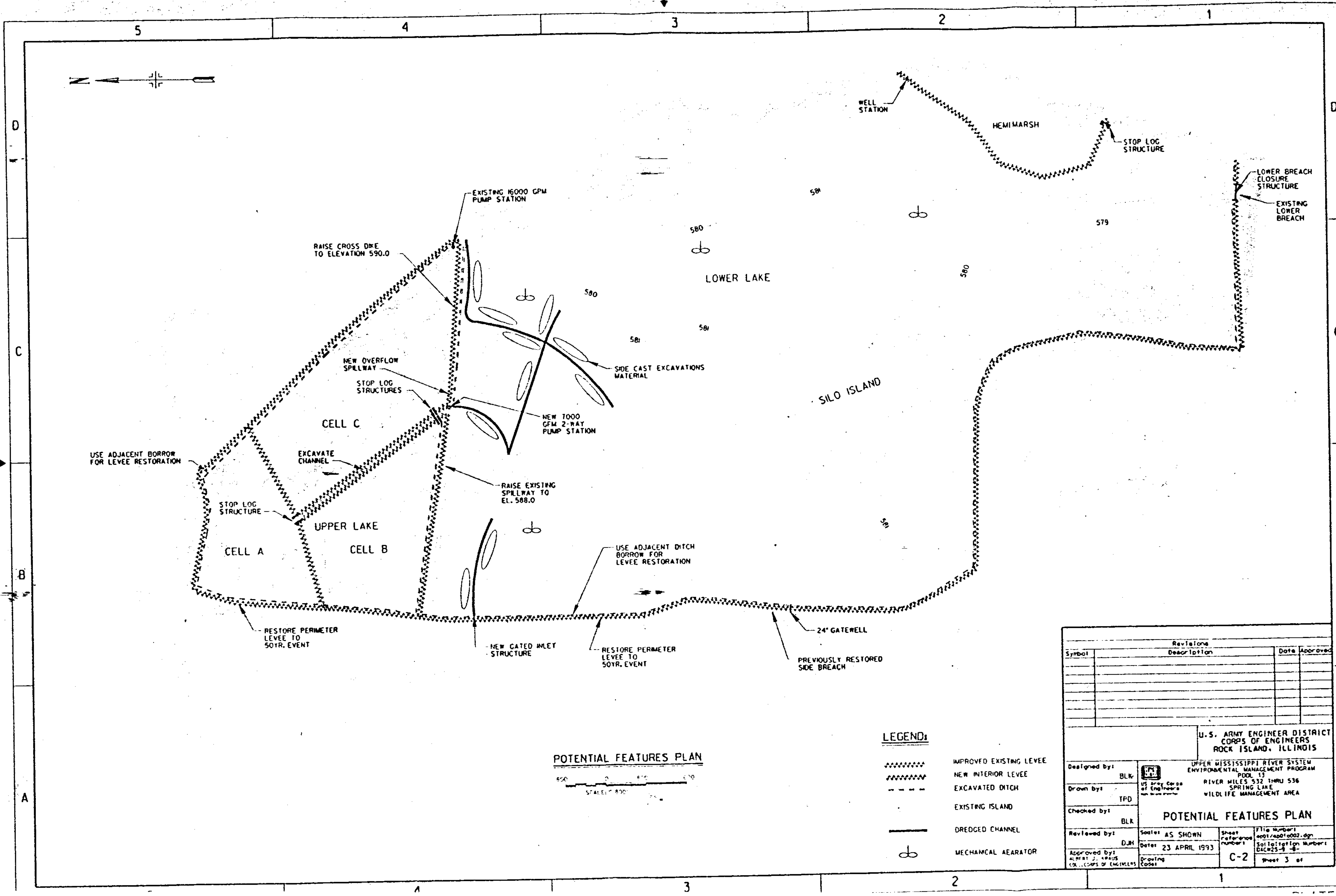
Sheet reference number: C-1
File Number: EP01/EP01C001.DGN
Solicitation Number: DACW25-9 -B-
Sheet 2 of

PLATE 2


WELL STATION
HEMIMARSH
STOP LOG STRUCTURE
LOWER BREACH CLOSURE STRUCTURE
EXISTING LOWER BREACH
EXISTING 16000 GPM PUMP STATION
RAISE CROSS DIKE TO ELEVATION 590.0
LOWER LAKE
580
581
579
SIDE CAST EXCAVATIONS MATERIAL
NEW OVERFLOW SPILLWAY
STOP LOG STRUCTURES
NEW 7000 GFM 2-WAY PUMP STATION
SILO ISLAND
CELL C
EXCAVATE CHANNEL
USE ADJACENT BORROW FOR LEVEE RESTORATION
RAISE EXISTING SPILLWAY TO EL. 588.0
STOP LOG STRUCTURE
UPPER LAKE
CELL A
CELL B
USE ADJACENT DITCH BORROW FOR LEVEE RESTORATION
RESTORE PERIMETER LEVEE TO 50YR. EVENT
NEW GATED INLET STRUCTURE
RESTORE PERIMETER LEVEE TO 50YR. EVENT
PREVIOUSLY RESTORED SIDE BREACH
24" GATEWELL
POTENTIAL FEATURES PLAN
LEGEND:
IMPROVED EXISTING LEVEE
NEW INTERIOR LEVEE
EXCAVATED DITCH
EXISTING ISLAND
DREDGED CHANNEL
MECHANICAL AEARATOR
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
POTENTIAL FEATURES PLAN
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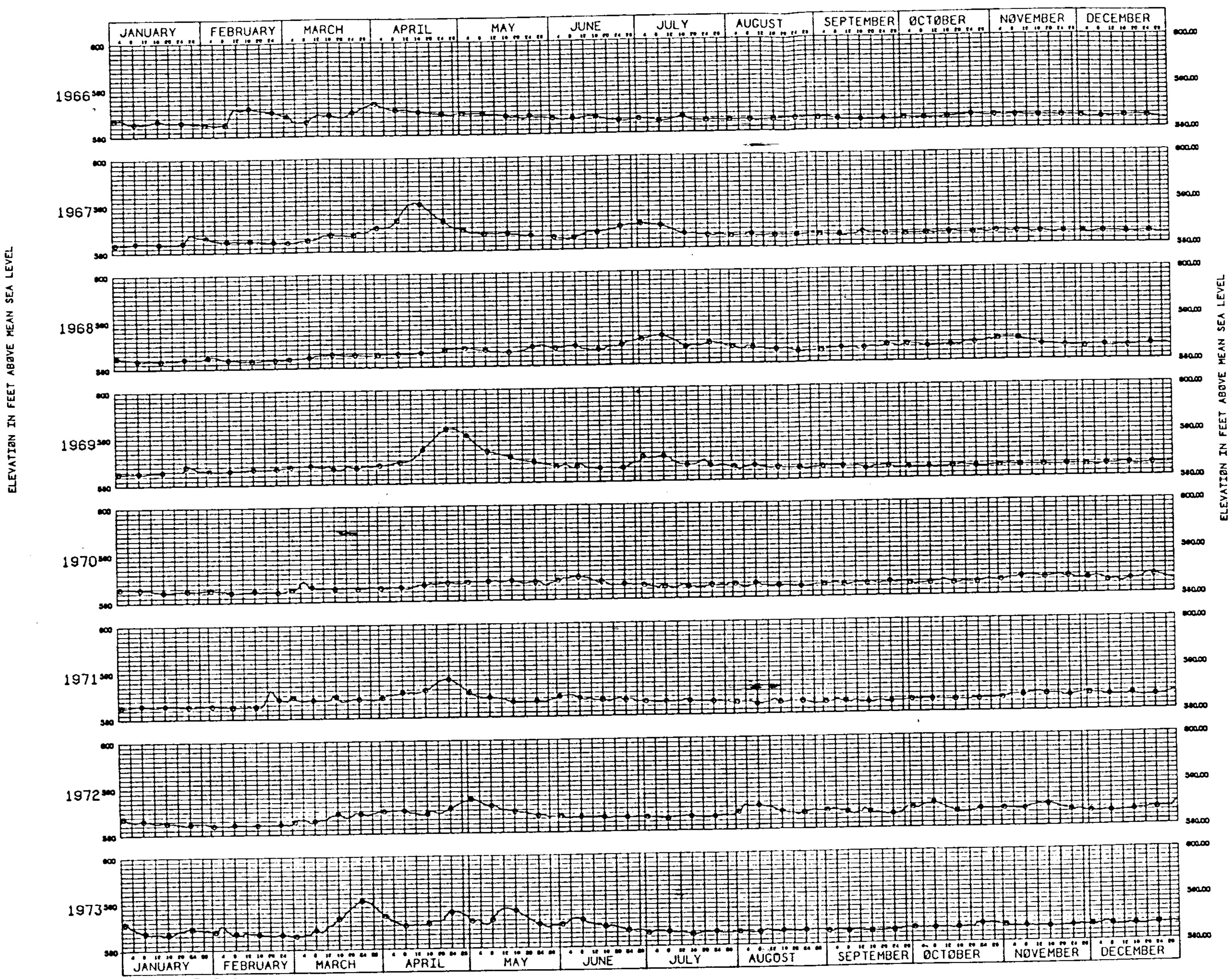
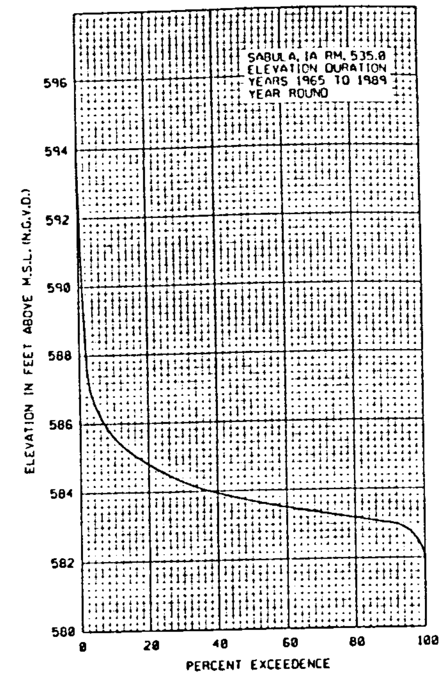
Sheet reference number: C-2
File Number: ep01/ep01c002.dgn
Sheet 3 of



MISSISSIPPI RIVER

NØTE- SPRING LAKE EMP

HYDRØGRAPH
AT SABULA, IØWA RM. 535.0



DURATION CURVE

NOTE:
FLAT POOL ELEVATION 583.0

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by:
Drawn by:
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Approved by:

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

HYDRAULIC DATA I

Scale:
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Drawing Code
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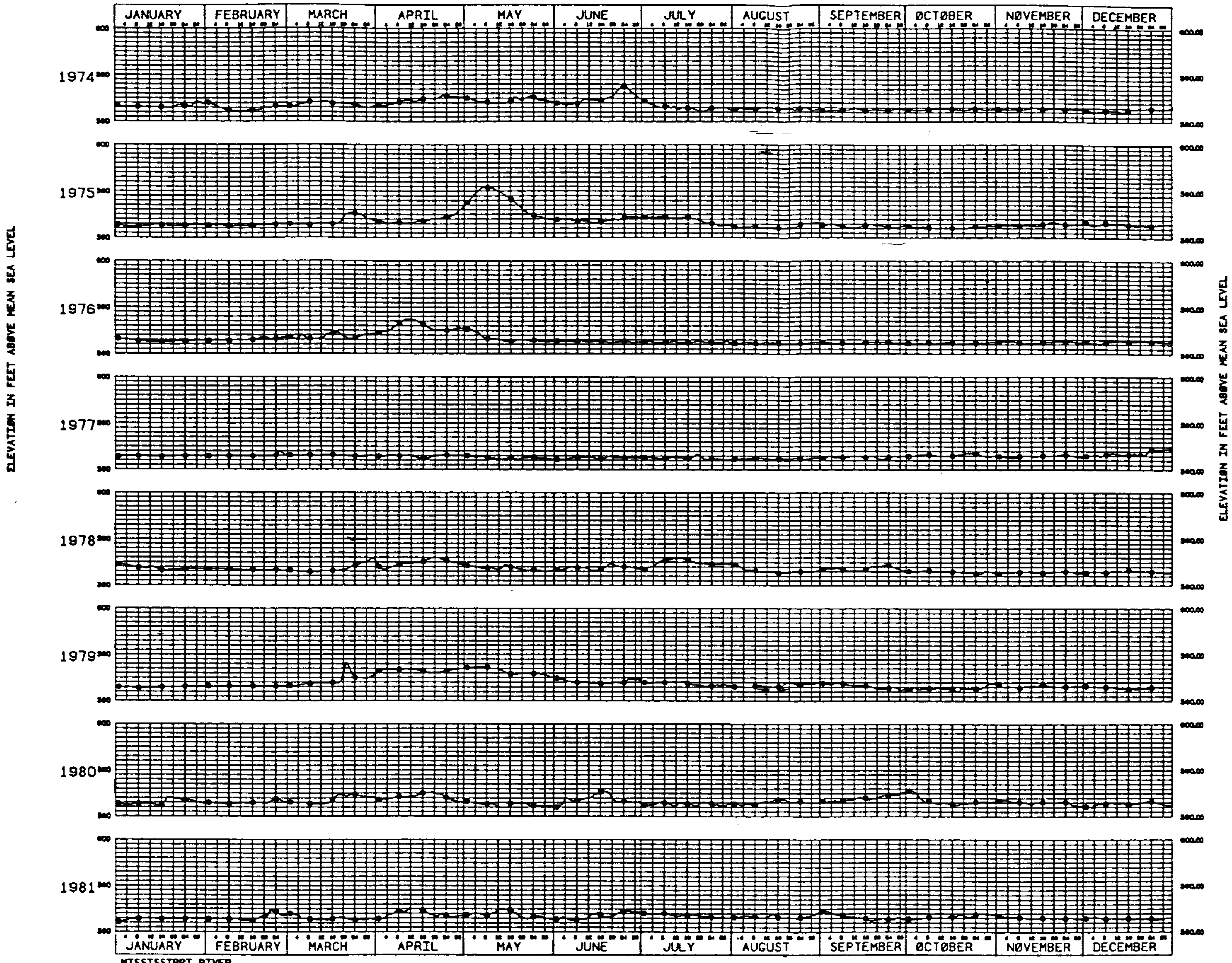
Sheet _ 4 _ of _

PLATE 4



NOTE- SPRING LAKE EMP

HYDRØGRAPH
AT SABULA. IØWA RM. 535.0

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

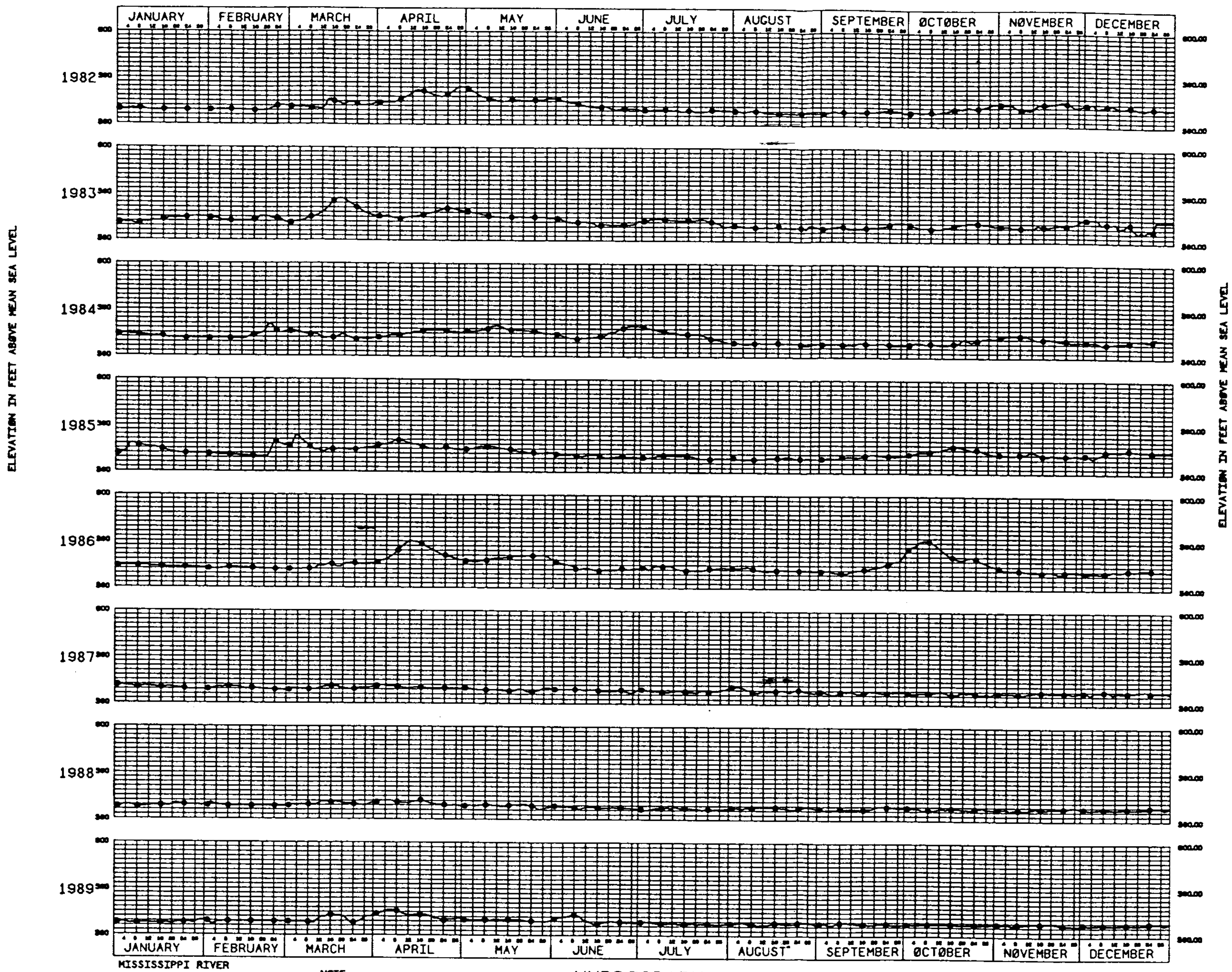
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

HYDRAULIC DATA II

Sheet reference number: C4

Sheet _ 5 _ of _

PLATE 5



NØTE- SPRING LAKE EMP

HYDRØGRAPH AT SABULA, IØWA RM. 535.0

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

HYDRAULIC DATA III

Designed by:
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Approved by:
Scale:
Date:
Drawing Code:
Sheet reference number: C5
Sheet _ 6 _ of _

PLATE 6

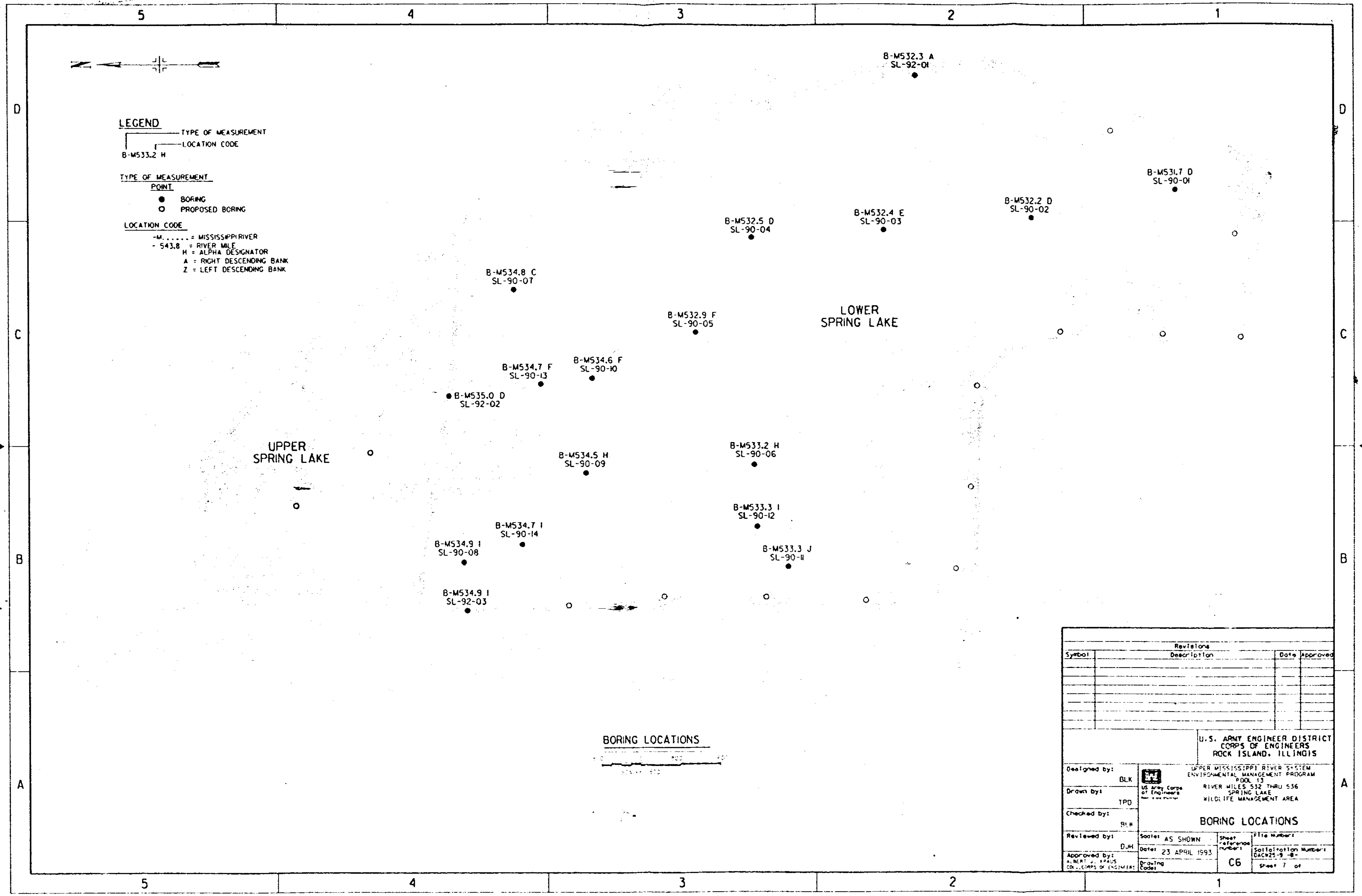
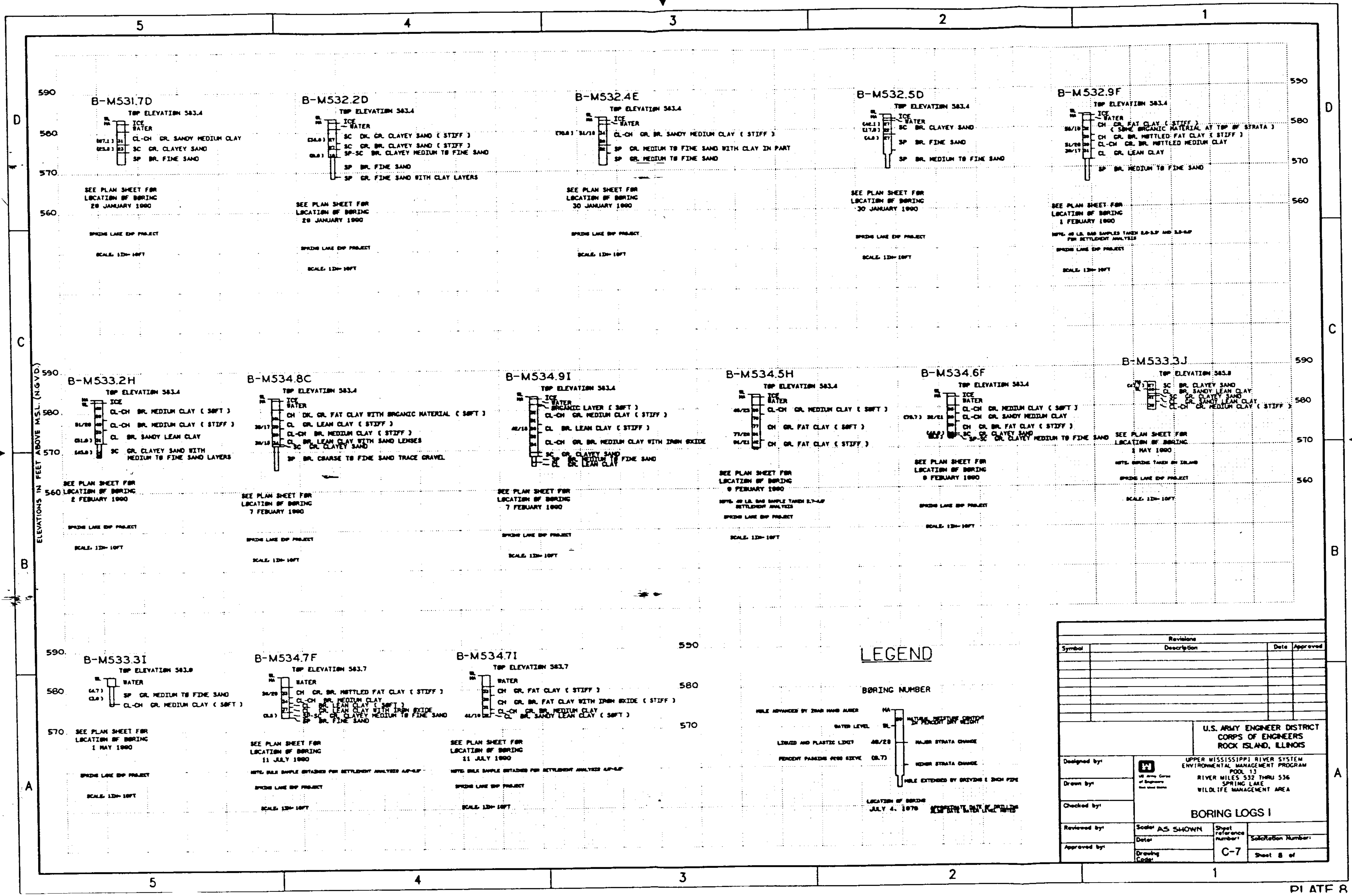
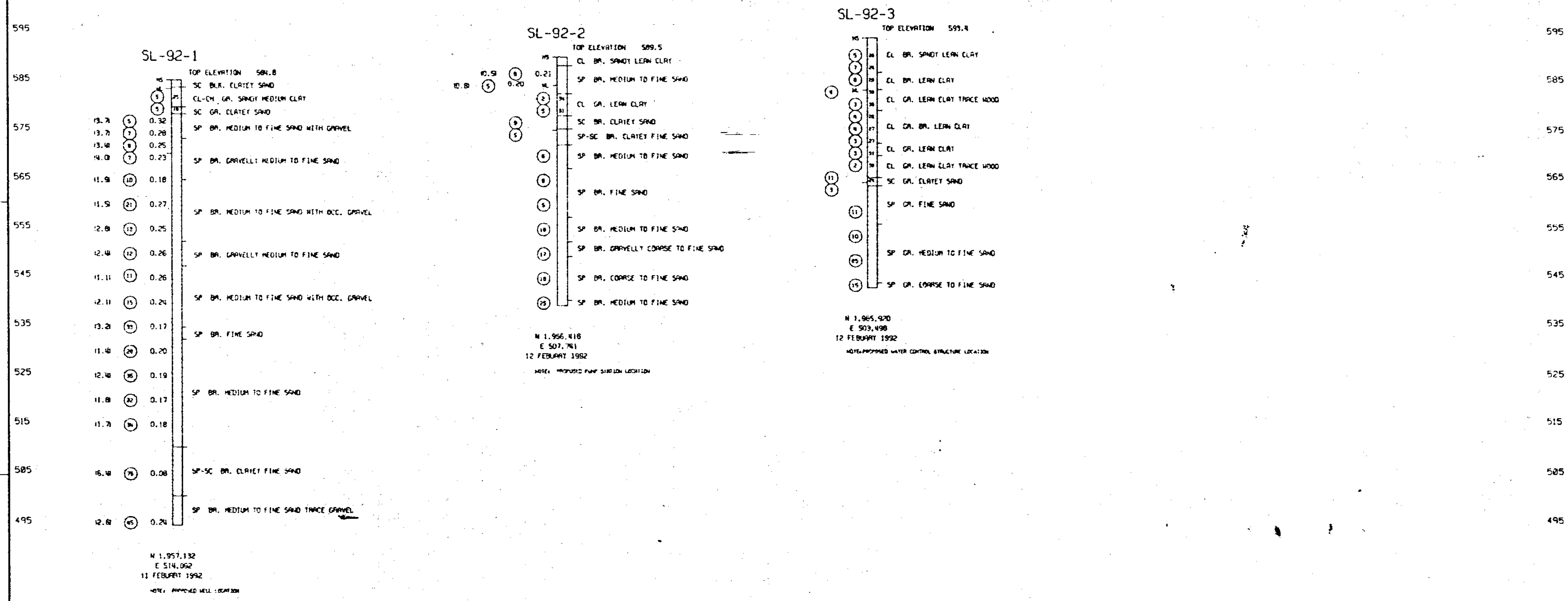

LEGEND
TYPE OF MEASUREMENT
LOCATION CODE
B-M533.2 H
TYPE OF MEASUREMENT POINT
BORING
PROPOSED BORING
LOCATION CODE
-M....... = MISSISSIPPI RIVER
- 543.8 = RIVER MILE
H = ALPHA DESIGNATOR
A = RIGHT DESCENDING BANK
Z = LEFT DESCENDING BANK
B-M532.3 A
SL-92-01
B-M531.7 D
SL-90-01
B-M532.2 D
SL-90-02
B-M532.4 E
SL-90-03
B-M532.5 D
SL-90-04
B-M534.8 C
SL-90-07
B-M532.9 F
SL-90-05
LOWER
SPRING LAKE
B-M534.7 F
SL-90-13
B-M534.6 F
SL-90-10
B-M535.0 D
SL-92-02
UPPER
SPRING LAKE
B-M534.5 H
SL-90-09
B-M533.2 H
SL-90-06
B-M533.3 I
SL-90-12
B-M534.7 I
SL-90-14
B-M534.9 I
SL-90-08
B-M533.3 J
SL-90-11
B-M534.9 I
SL-92-03
BORING LOCATIONS
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by:
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
BORING LOCATIONS
Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number:
C6
File Number:
Solicitation Number:
Sheet 7 of

PLATE 7



B-M531.7D
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 29 JANUARY 1990
B-M532.2D
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 29 JANUARY 1990
B-M532.4E
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 30 JANUARY 1990
B-M532.5D
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 30 JANUARY 1990
B-M532.9F
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 1 FEBRUARY 1990
B-M533.2H
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 2 FEBUARY 1990
B-M534.8C
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 7 FEBUARY 1990
B-M534.9I
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 7 FEBUARY 1990
B-M534.5H
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 8 FEBUARY 1990
B-M534.6F
TOP ELEVATION 583.4
SEE PLAN SHEET FOR LOCATION OF BORING 8 FEBUARY 1990
B-M533.3J
TOP ELEVATION 583.8
SEE PLAN SHEET FOR LOCATION OF BORING 1 MAY 1990
B-M533.3I
TOP ELEVATION 583.8
SEE PLAN SHEET FOR LOCATION OF BORING 1 MAY 1990
B-M534.7F
TOP ELEVATION 583.7
SEE PLAN SHEET FOR LOCATION OF BORING 11 JULY 1990
B-M534.7I
TOP ELEVATION 583.7
SEE PLAN SHEET FOR LOCATION OF BORING 11 JULY 1990
SPRING LAKE EMP PROJECT
SCALE: 1IN= 10FT
ELEVATIONS IN FEET ABOVE M.S.L. (N.G.V.D.)
LEGEND
BORING NUMBER
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
BORING LOGS I
Scale: AS SHOWN
C-7
PLATE 8



Revisions

Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

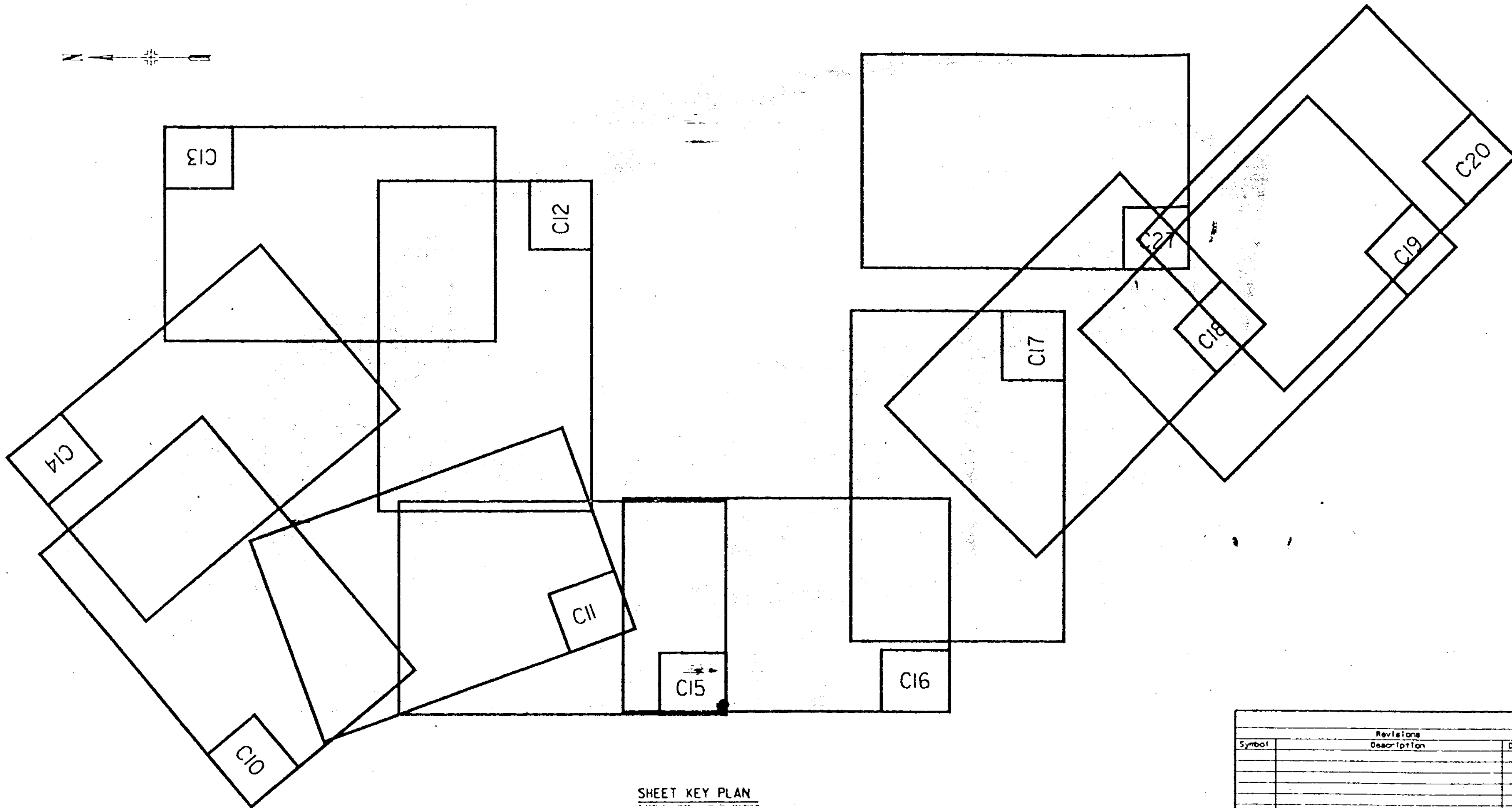
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

BORING LOGS II

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by:

Scale: 1"=10'
Date: 23 APR 1993
Drawing Code:
Sheet reference number: C-8
File Number: ep01/ep01g008.dgn
Solicitation Number: DACW25-9 -B-
Sheet 9 of

PLATE 9



SHEET KEY PLAN

Revisions			
Symbol	Description	Date	Approved

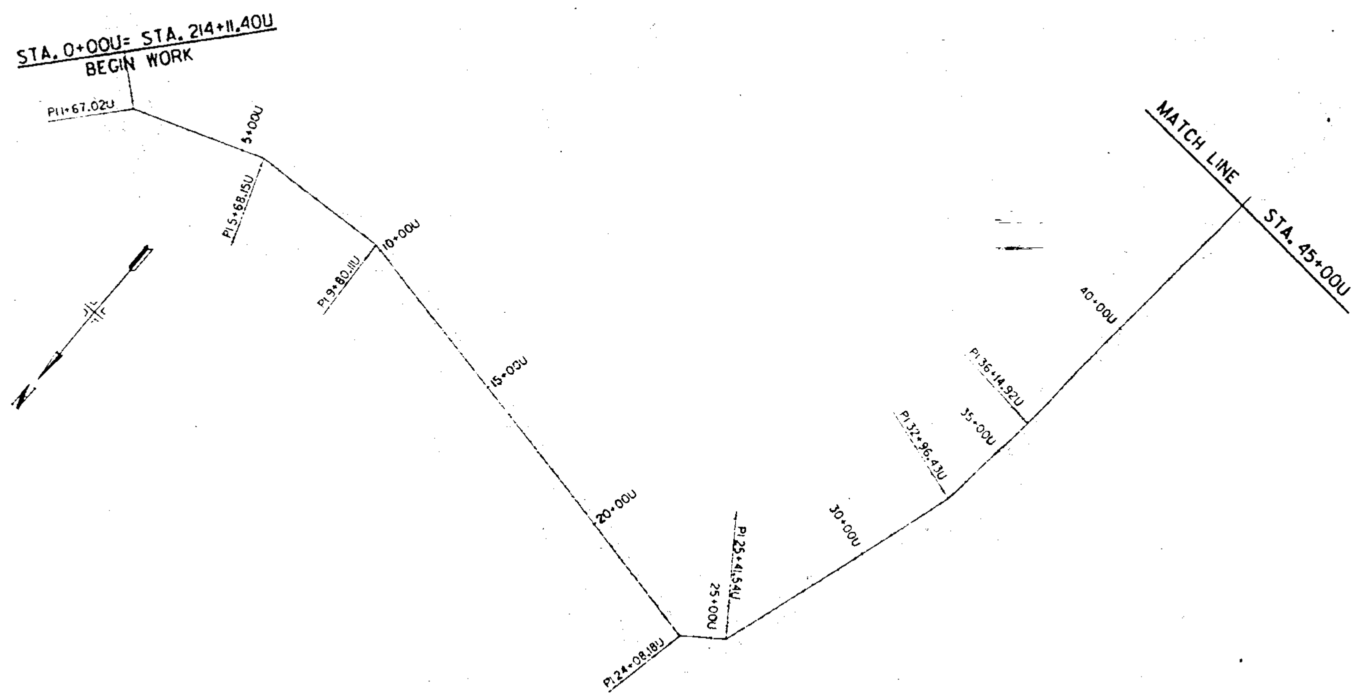
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

US Army Corps of Engineers

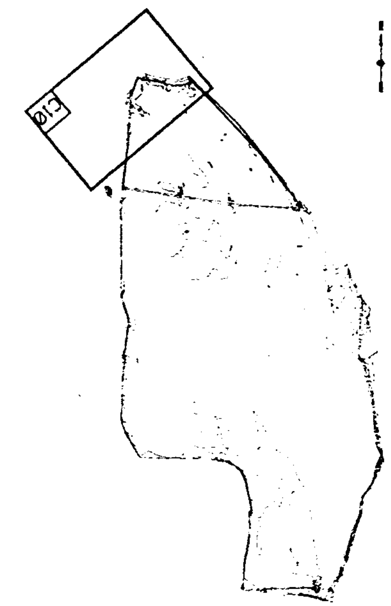
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

SHEET KEY PLAN

Designed by:	BLK
Drawn by:	TPD
Checked by:	BLK
Reviewed by:	DJH
Approved by:	ALBERT J. KRAUS, COL., CORPS OF ENGINEERS
Scale:	AS SHOWN
Date:	23 APRIL 1993
Drawing Code:	
Sheet reference number:	C-9
File Number:	ep01/ep01a009.dgn
Solicitation Number:	DACW25-9 -B-
Sheet 10 of	



PLAN



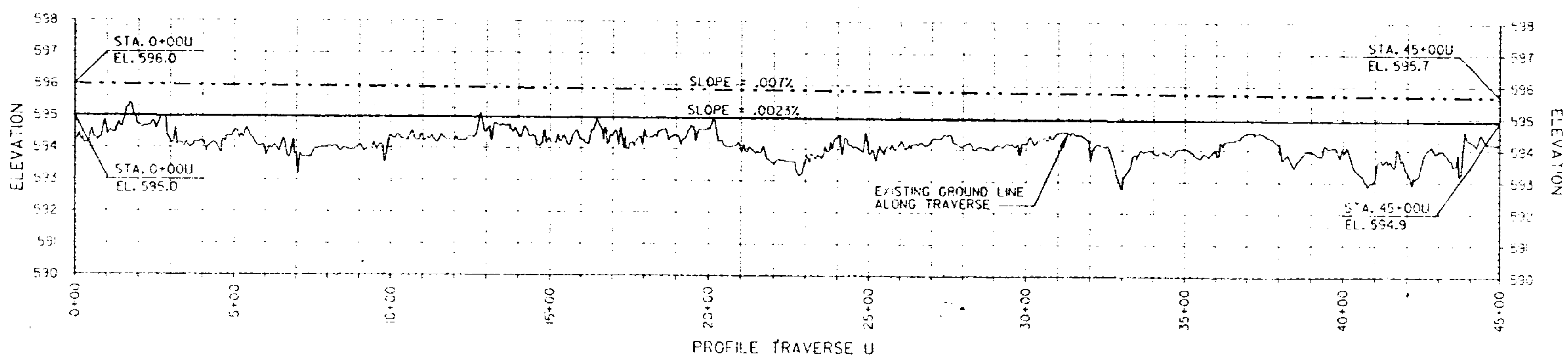
KEY PLAN

LEGEND:

———	RECOMMENDED PLAN
— · · —	100 YEAR EVENT

NOTE:

1. FLAT POOL EL. 583.0
2. FOR AREAS WITH EXISTING GROUND ELEVATIONS ABOVE PROFILE GRADE, CLEAR, GRUB, AND STRIP ONLY. NO EXCAVATION(CUT) REQUIRED.



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

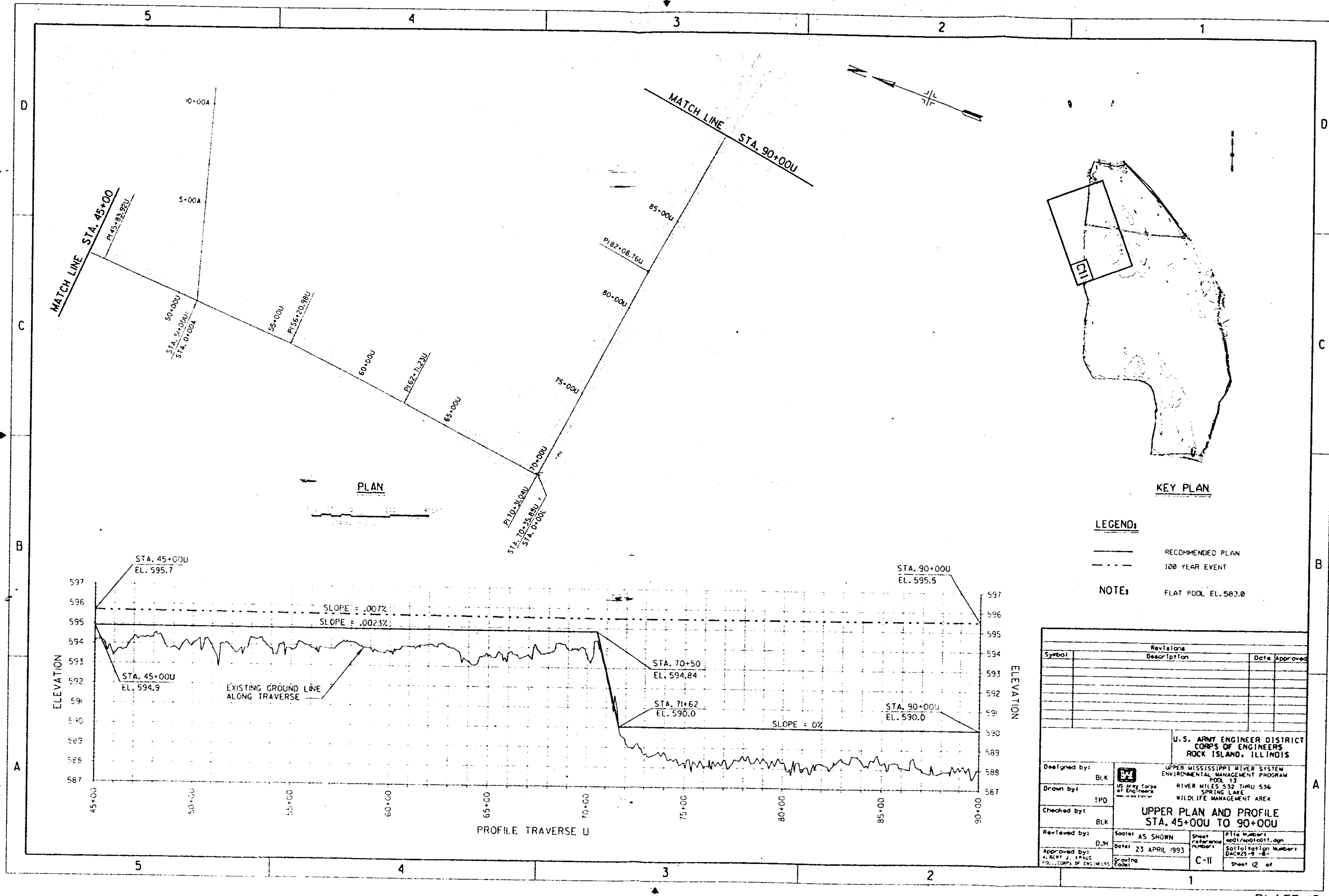
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS, COL, CORPS OF ENGINEERS

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

UPPER PLAN AND PROFILE STA. 0+00U TO STA. 45+00U

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-10
File Number: ep01/ep01o010.dgn
Solicitation Number: DACW25-9 -B-
Sheet # of



MATCH LINE STA. 45+00
PI 45+83.92U
5+00A
10+00A
50+00U
STA. 51+00U = STA. 0+00A
55+00U
PI 56+20.98U
60+00U
PI 62+71.23U
65+00U
70+00U
PI 70+31.04U
STA. 70+35.88U = STA. 0+00L
75+00U
80+00U
PI 82+08.76U
85+00U
MATCH LINE STA. 90+00U
PLAN
KEY PLAN
C11
LEGEND:
RECOMMENDED PLAN
100 YEAR EVENT
NOTE:
FLAT POOL EL. 583.0
STA. 45+00U
EL. 595.7
SLOPE = .007%
SLOPE = .0023%
STA. 45+00U
EL. 594.9
EXISTING GROUND LINE ALONG TRAVERSE
STA. 70+50
EL. 594.84
STA. 71+62
EL. 590.0
SLOPE = 0%
STA. 90+00U
EL. 595.5
STA. 90+00U
EL. 590.0
ELEVATION
PROFILE TRAVERSE U
45+00
50+00
55+00
60+00
65+00
70+00
75+00
80+00
85+00
90+00
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
UPPER PLAN AND PROFILE
STA. 45+00U TO 90+00U
Scale: AS SHOWN
Date: 23 APRIL 1993
Sheet reference number: C-11
File Number: ep01/ep01c011.dgn
Solicitation Number: DACW25-9 -B-
Sheet 12 of

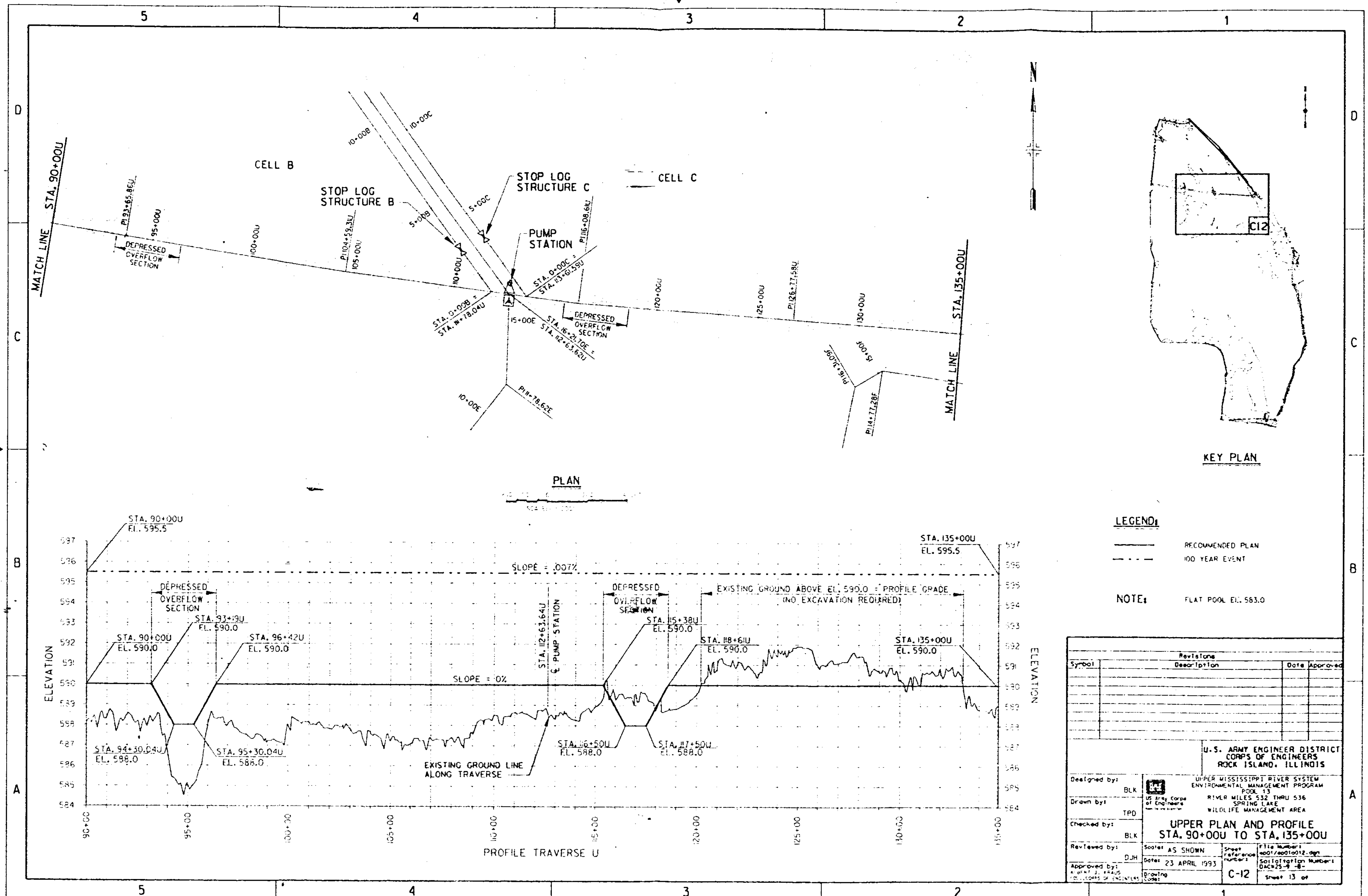
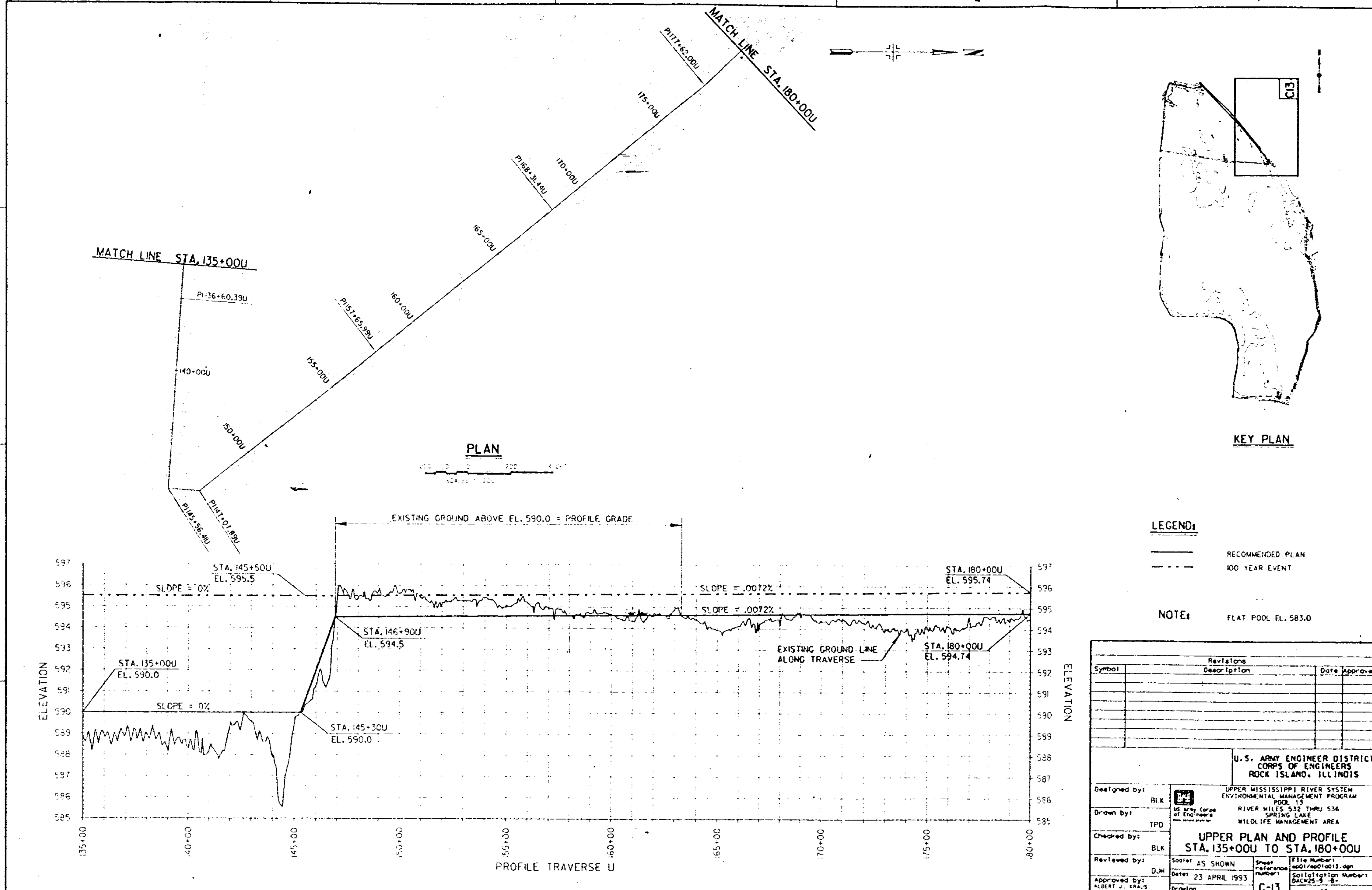

CELL B
CELL C
STOP LOG STRUCTURE B
STOP LOG STRUCTURE C
PUMP STATION
MATCH LINE STA. 90+00U
MATCH LINE STA. 135+00U
DEPRESSED OVERFLOW SECTION
DEPRESSED OVERFLOW SECTION
PLAN
KEY PLAN
C12
STA. 90+00U
EL. 595.5
STA. 135+00U
EL. 595.5
SLOPE = .007%
DEPRESSED OVERFLOW SECTION
DEPRESSED OVERFLOW SECTION
EXISTING GROUND ABOVE EL. 590.0 = PROFILE GRADE (NO EXCAVATION REQUIRED)
STA. 90+00U
EL. 590.0
STA. 93+19U
EL. 590.0
STA. 96+42U
EL. 590.0
STA. 112+63.64U
℄ PUMP STATION
STA. 115+38U
EL. 590.0
STA. 118+61U
EL. 590.0
STA. 135+00U
EL. 590.0
SLOPE = 0%
STA. 94+30.04U
EL. 588.0
STA. 95+30.04U
EL. 588.0
STA. 116+50U
EL. 588.0
STA. 117+50U
EL. 588.0
EXISTING GROUND LINE ALONG TRAVERSE
ELEVATION
PROFILE TRAVERSE U
LEGEND:
RECOMMENDED PLAN
100 YEAR EVENT
NOTE: FLAT POOL EL. 583.0
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by:
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
UPPER PLAN AND PROFILE
STA. 90+00U TO STA. 135+00U
Scale: AS SHOWN
Date: 23 APRIL 1993
C-12
Sheet 13 of

PLATE 13



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

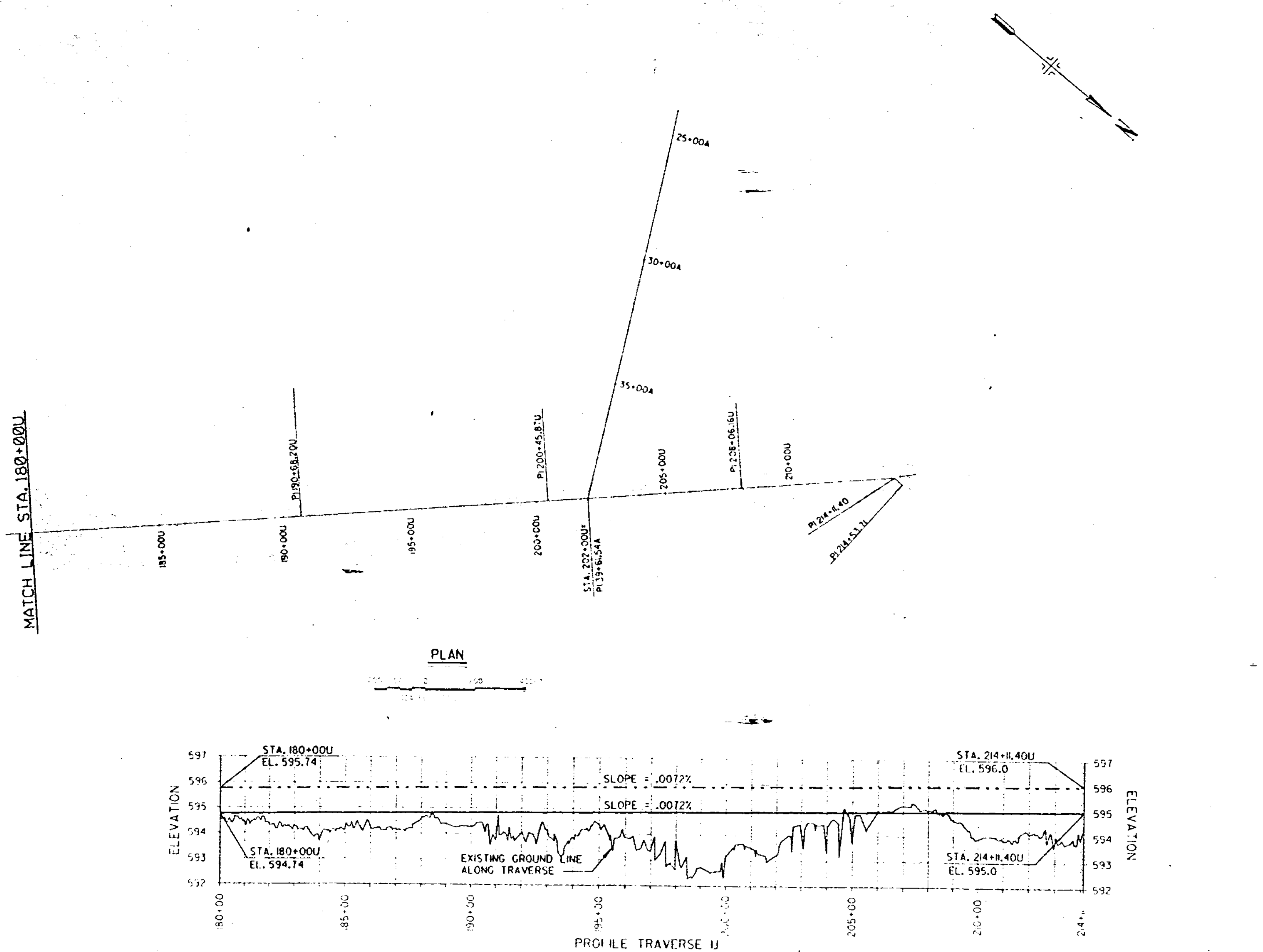
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

UPPER PLAN AND PROFILE STA. 135+00U TO STA. 180+00U

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-13
File Number: ep01/ep01c013.dgn
Solicitation Number: DACW25-9 -B-
Sheet 14 of



KEY PLAN

LEGEND:

RECOMMENDED PLAN

100 YEAR EVENT

NOTE: FLAT POOL EL 583.0

Symbol	Revisions Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: BLK
Drawn by: TPO
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS, COL., CORPS OF ENGINEERS

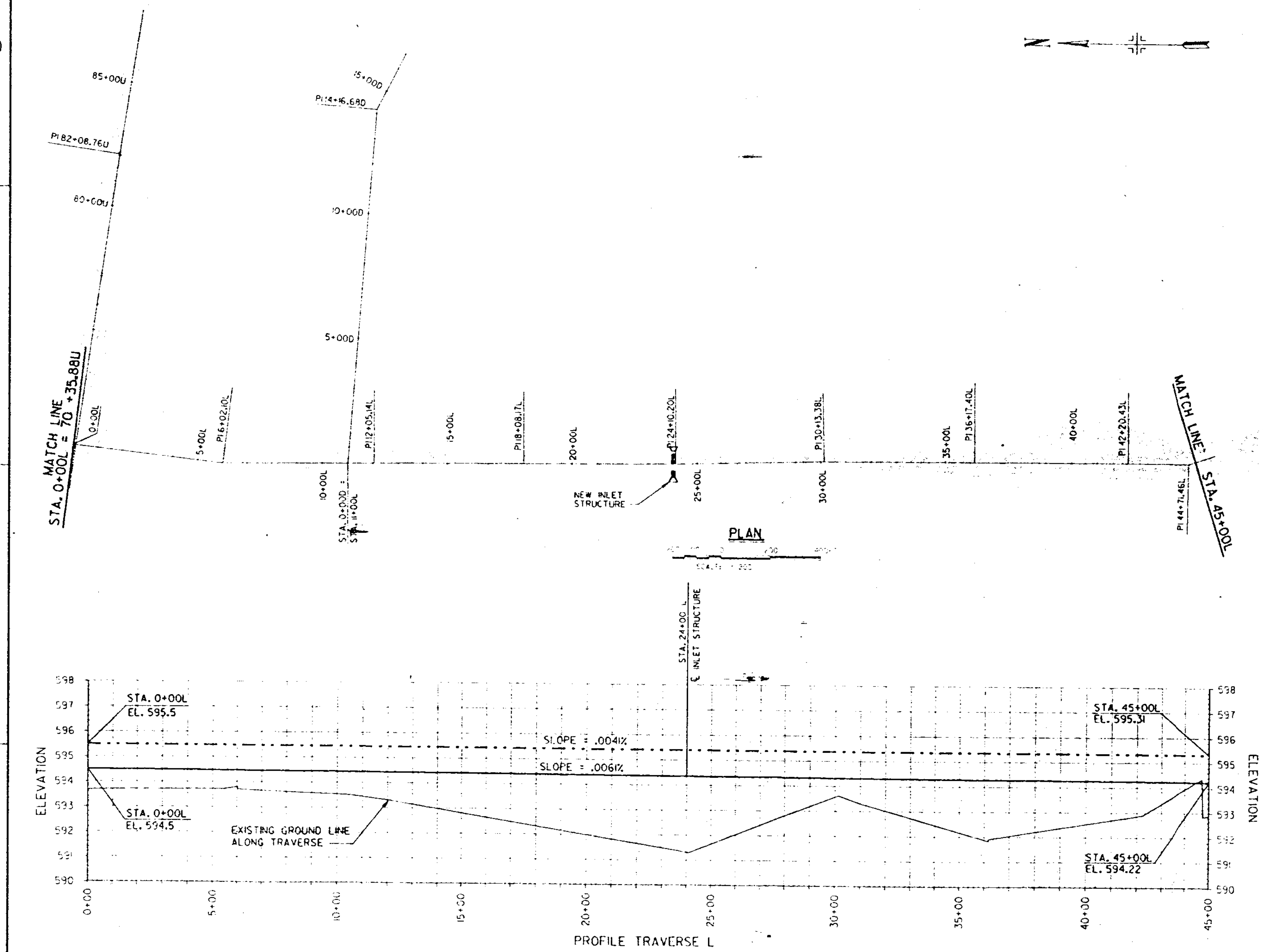
US Army Corps of Engineers

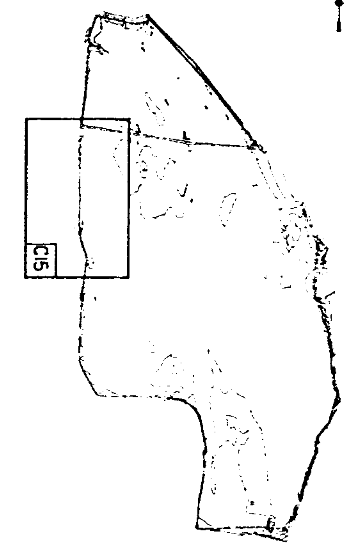
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

UPPER PLAN AND PROFILE STA. 180+00U TO STA. 214+11.40U

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Codes:
Sheet reference number: C-14
File Number: ep01/ep01c014.dgn
Solicitation Number: DACW25-9 -B-
Sheet 15 of

PLATE 15





KEY PLAN

LEGEND:

RECOMMENDED PLAN

100 YEAR EVENT

NOTE: FLAT POOL EL. 583.0

Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

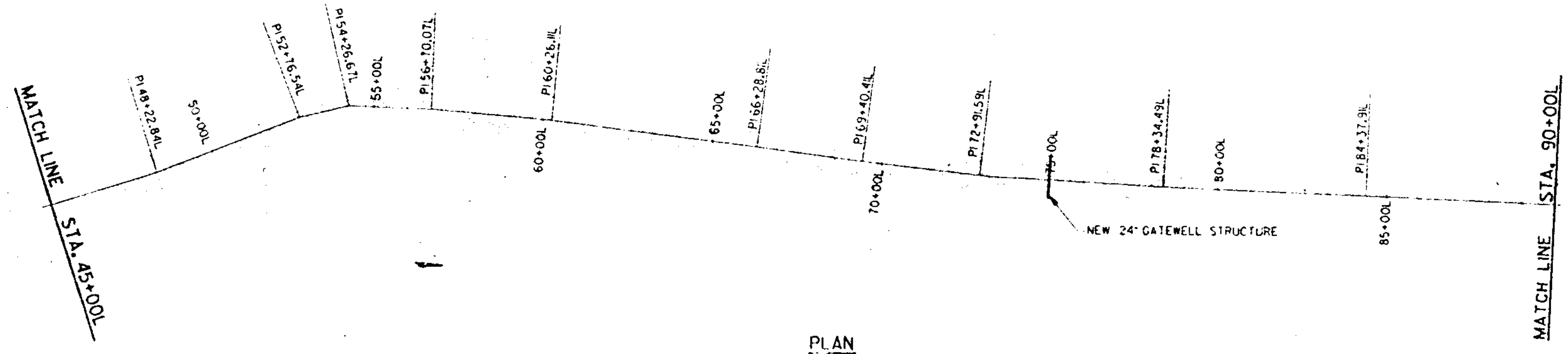
US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

LOWER PLAN AND PROFILE
STA. 0+00L TO STA. 45+00L

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS, COL., CORPS OF ENGINEERS

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-15
File Number: ep01/ep01c015.dgn
Solicitation Number: DACW25-9 -8-
Sheet 16 of



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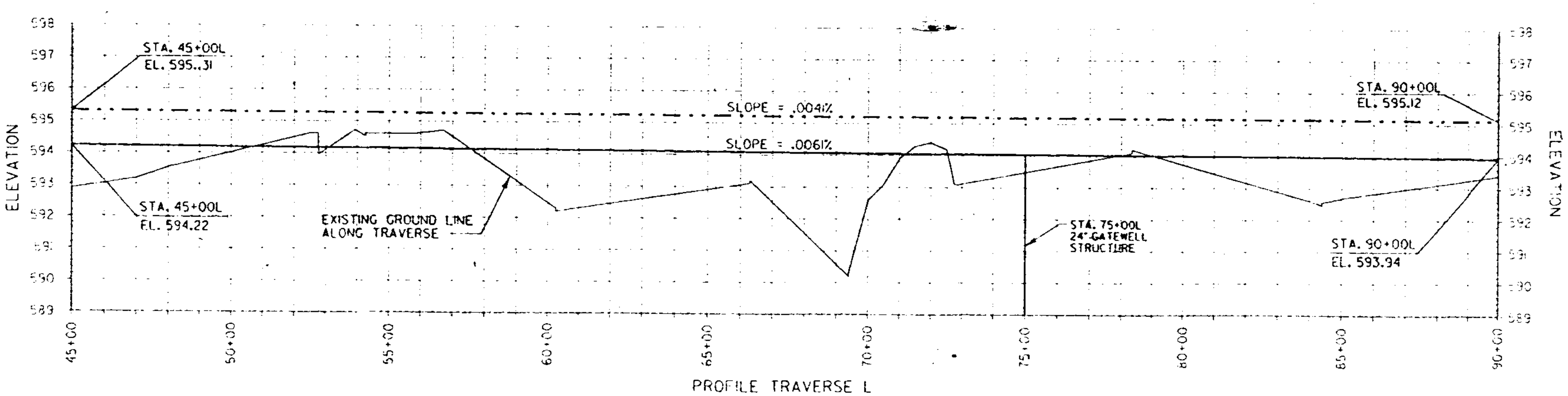

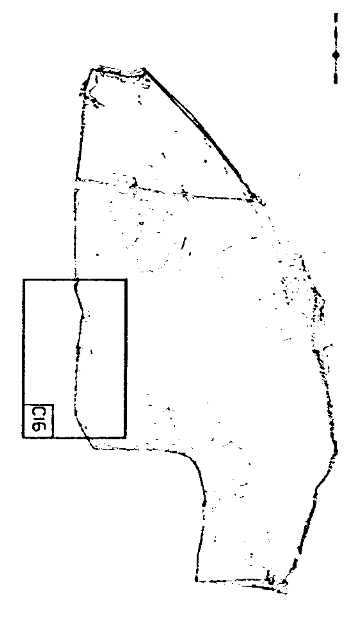

KEY PLAN

LEGEND:

- RECOMMENDED PLAN
- 100 YEAR EVENT

NOTE: FLAT POOL EL. 583.0

Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

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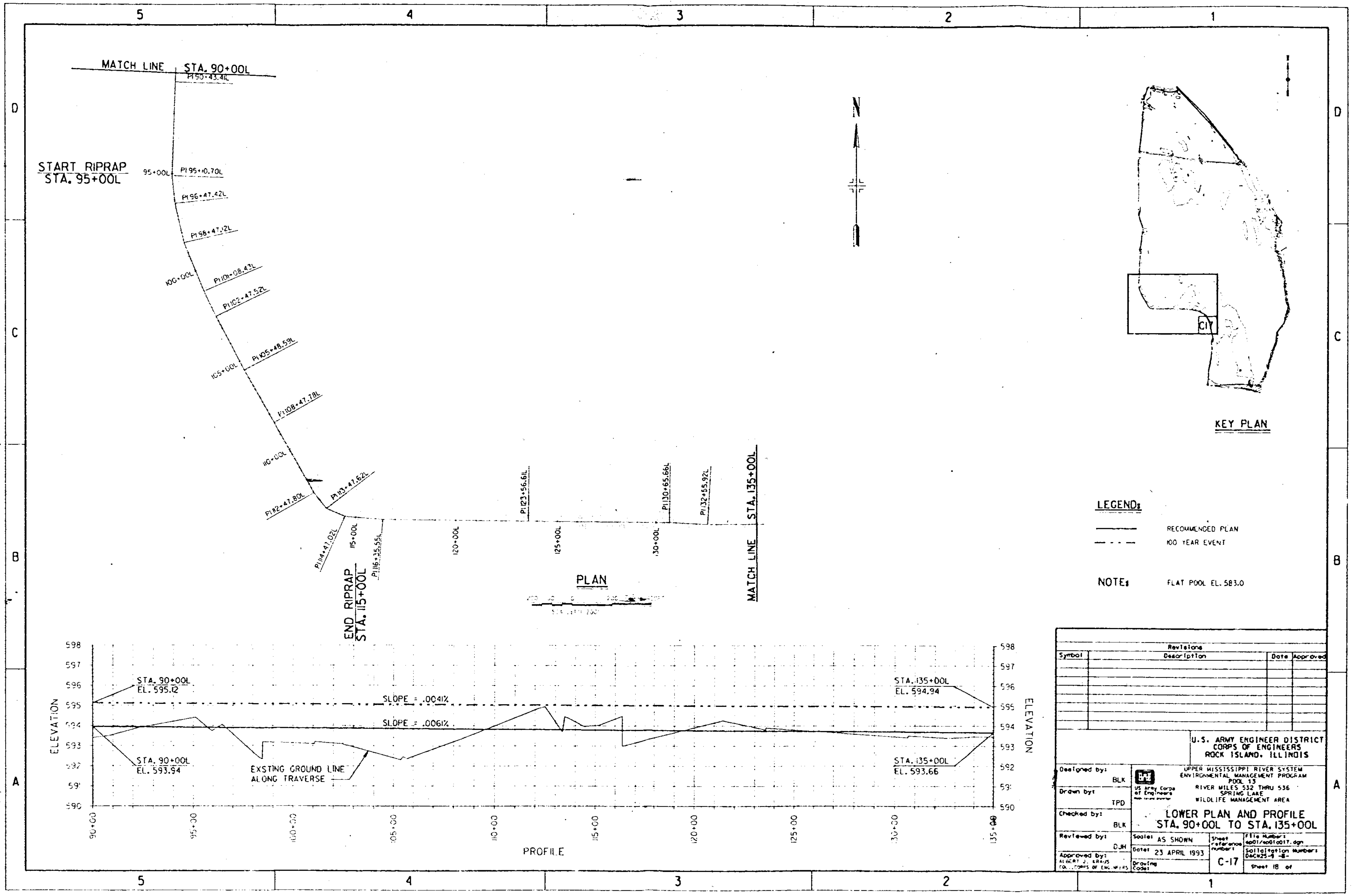
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL. CORPS OF ENGINEERS

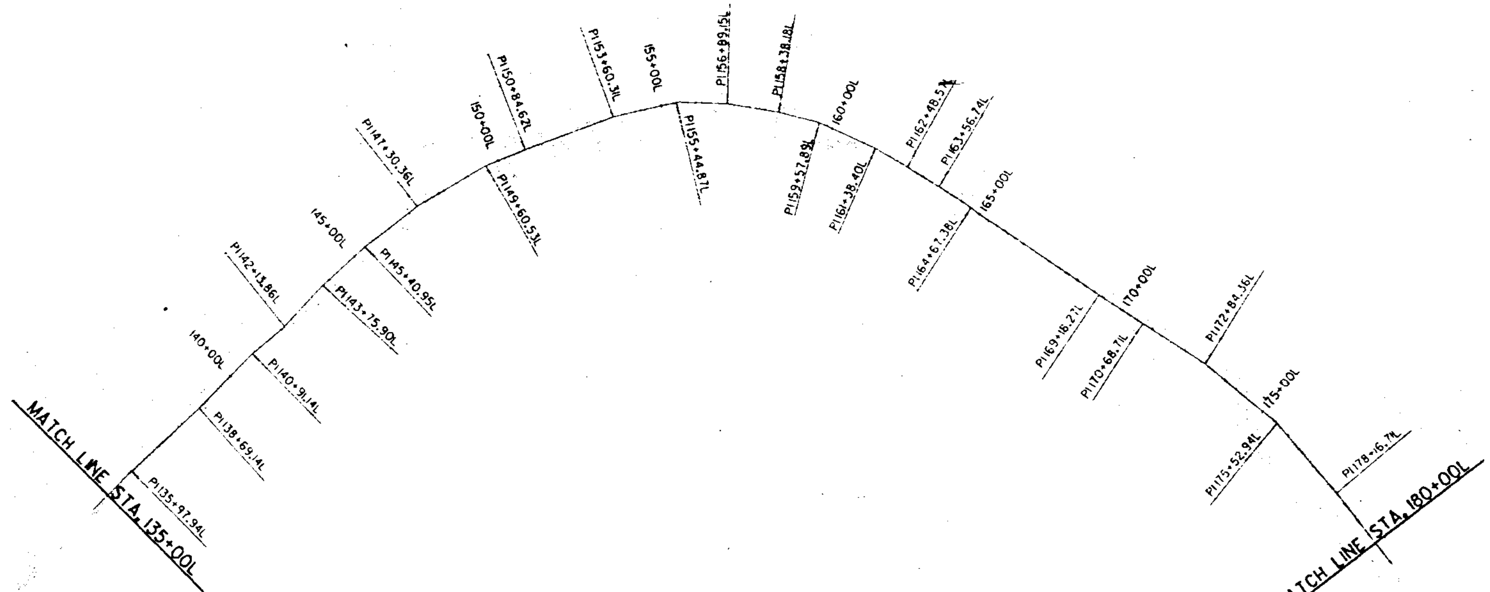
US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

LOWER PLAN AND PROFILE
STA. 45+00L TO STA. 90+00L

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-16
File Number: ep01/ep01c016.dgn
Solicitation Number: DACW25-9 -B-
Sheet 17 of


MATCH LINE STA. 90+00L
START RIPRAP
STA. 95+00L
END RIPRAP
STA. 115+00L
MATCH LINE STA. 135+00L
PLAN
KEY PLAN
LEGEND:
RECOMMENDED PLAN
100 YEAR EVENT
NOTE: FLAT POOL EL. 583.0
STA. 90+00L
EL. 595.12
STA. 90+00L
EL. 593.94
SLOPE = .0041%
SLOPE = .0061%
EXISTING GROUND LINE
ALONG TRAVERSE
STA. 135+00L
EL. 594.94
STA. 135+00L
EL. 593.66
ELEVATION
PROFILE
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
LOWER PLAN AND PROFILE
STA. 90+00L TO STA. 135+00L
Scale: AS SHOWN
Date: 23 APRIL 1993
C-17
Sheet 18 of



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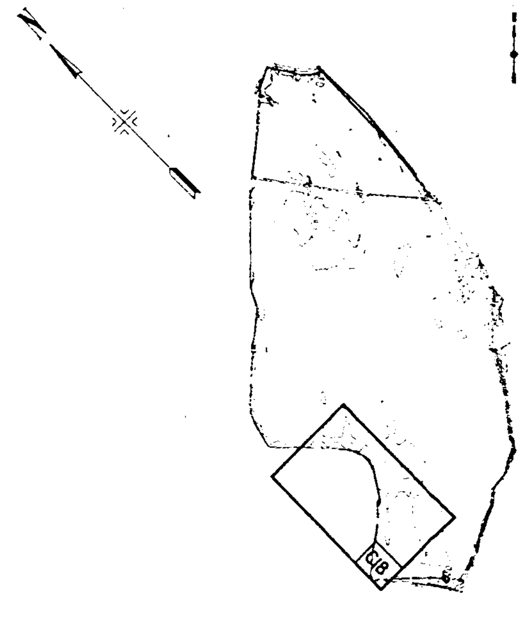
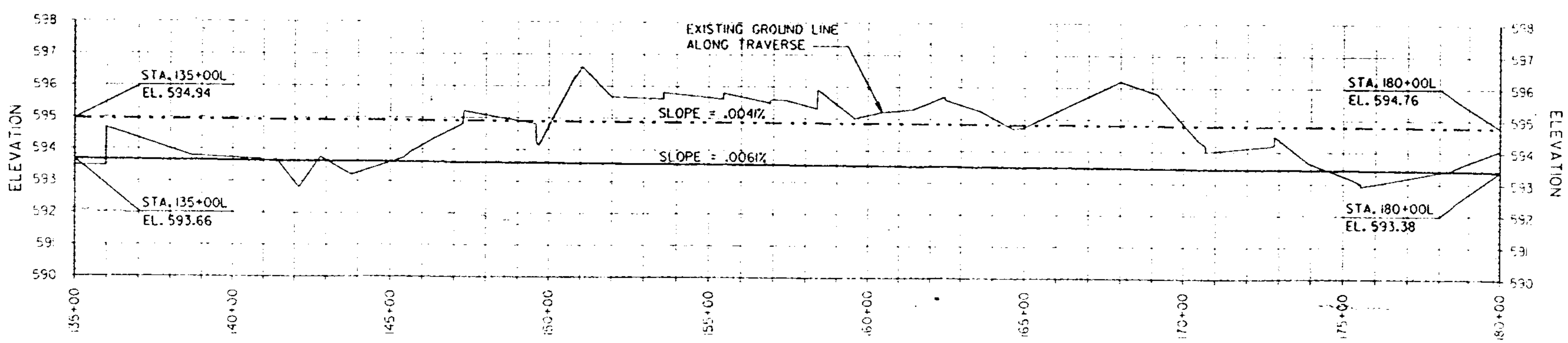


KEY PLAN

LEGEND:

RECOMMENDED PLAN
100 YEAR EVENT

NOTE: FLAT POOL EL. 583.0



PROFILE

Symbol	Revisions Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

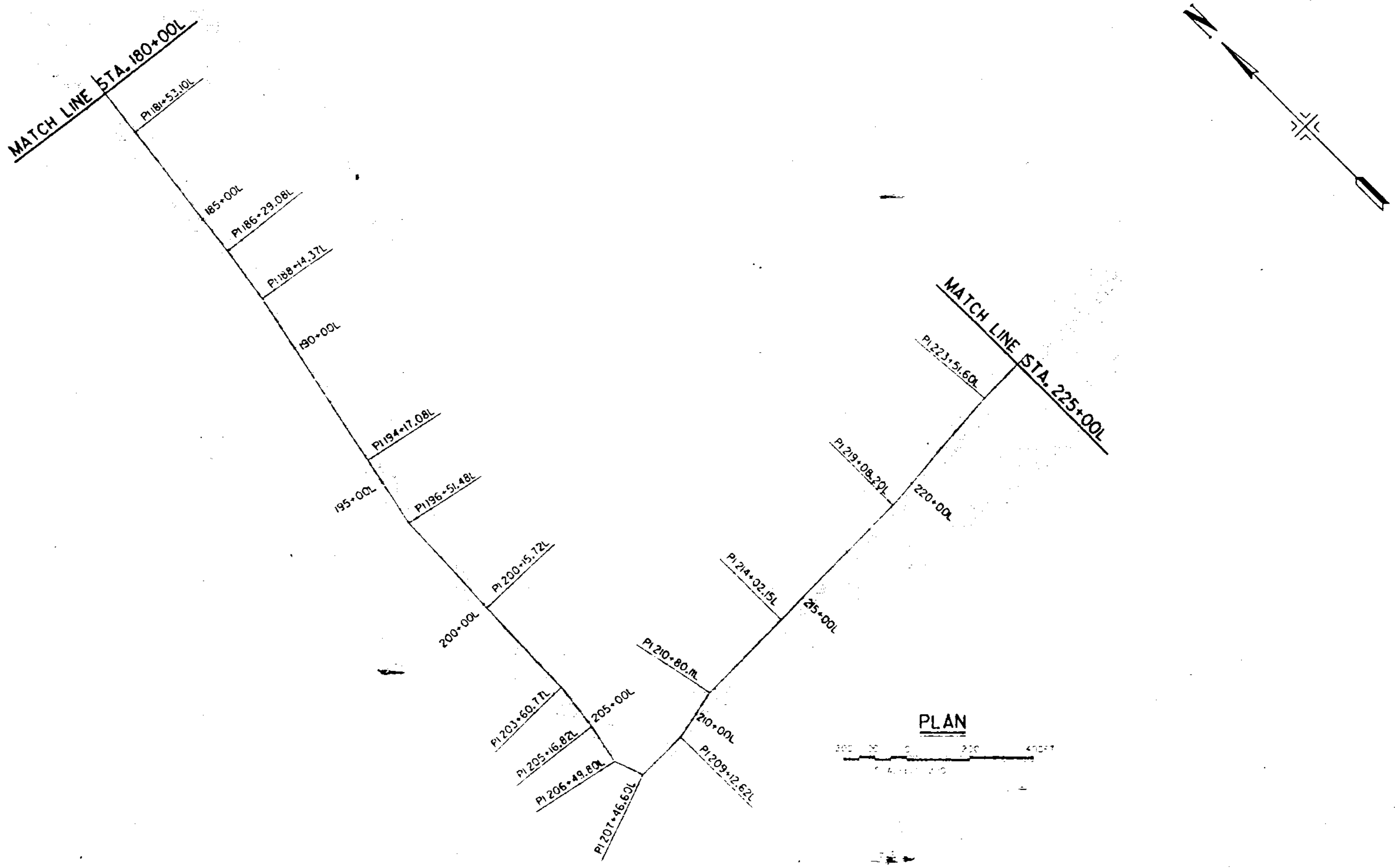
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

LOWER PLAN AND PROFILE
STA. 135+00L TO STA. 180+00L

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-18
File Number: ep01/ep01o018.dgn
Solicitation Number: DACW25-9 -B-
Sheet 19 of



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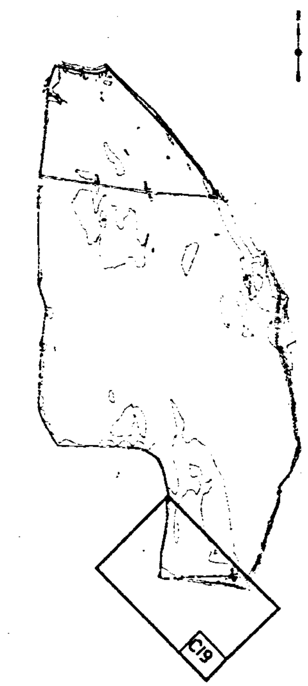
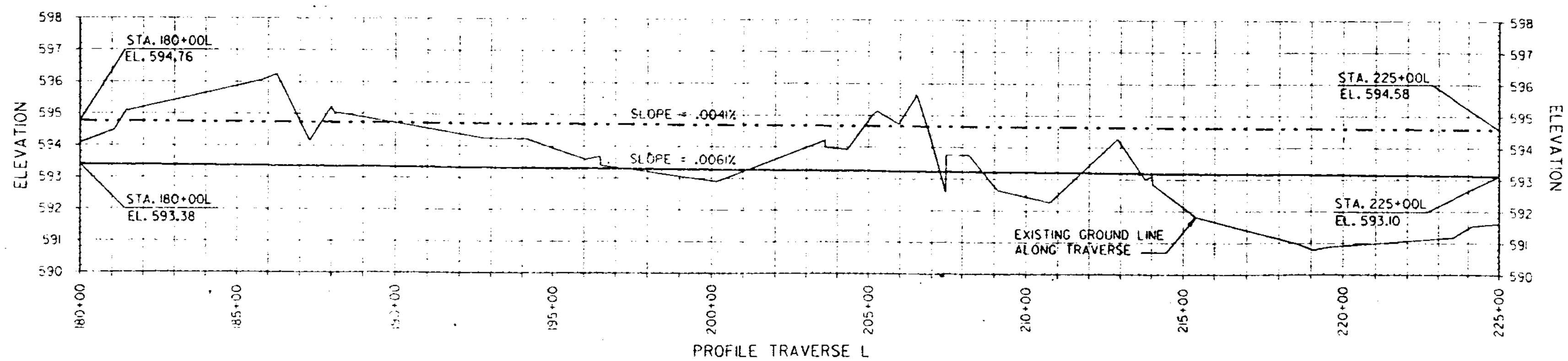


KEY PLAN

LEGEND:

RECOMMENDED PLAN
100 YEAR EVENT

NOTE: FLAT POOL EL. 583.0



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

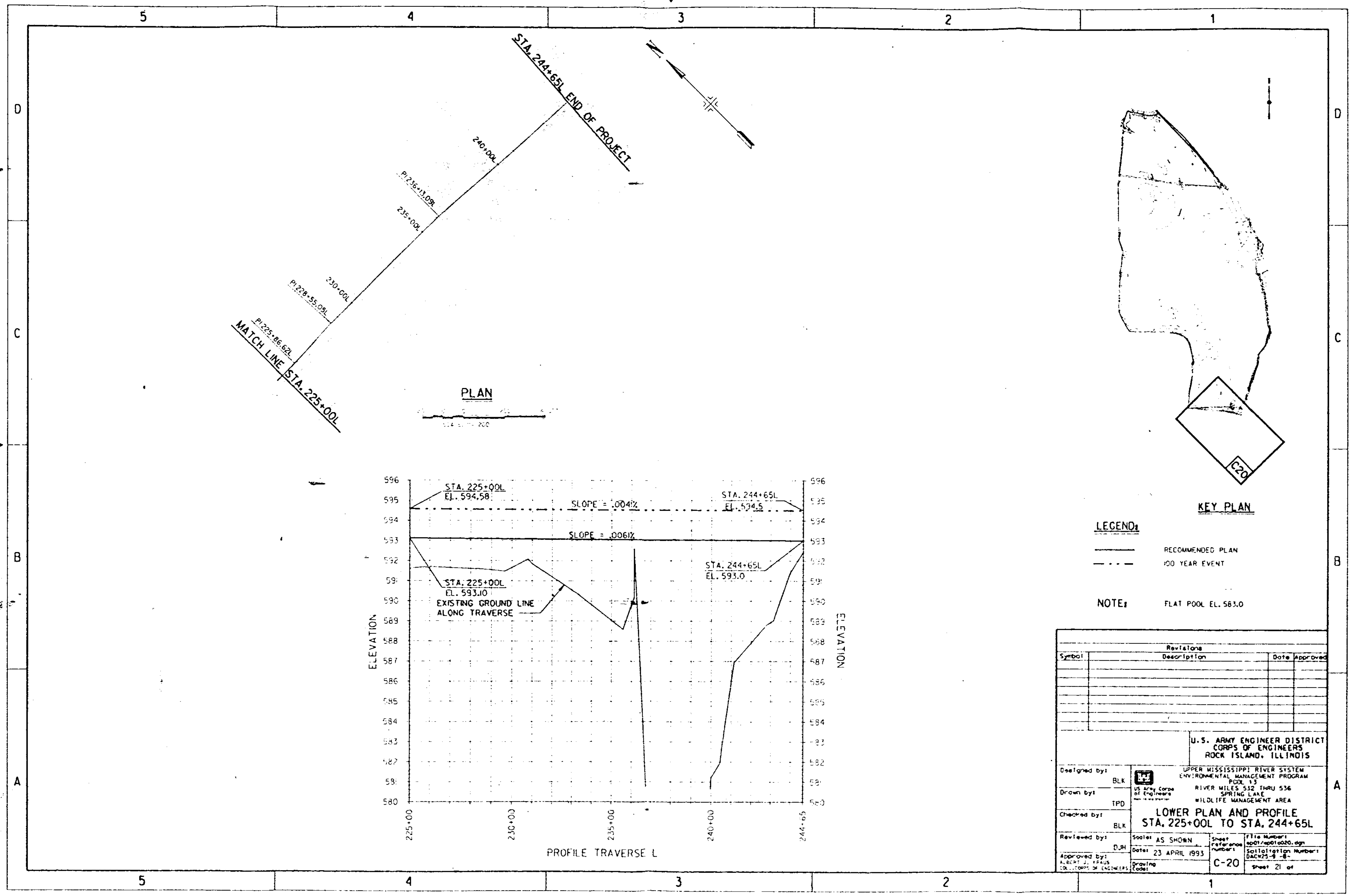
US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

LOWER PLAN AND PROFILE
STA. 180+00L TO STA. 225+00L

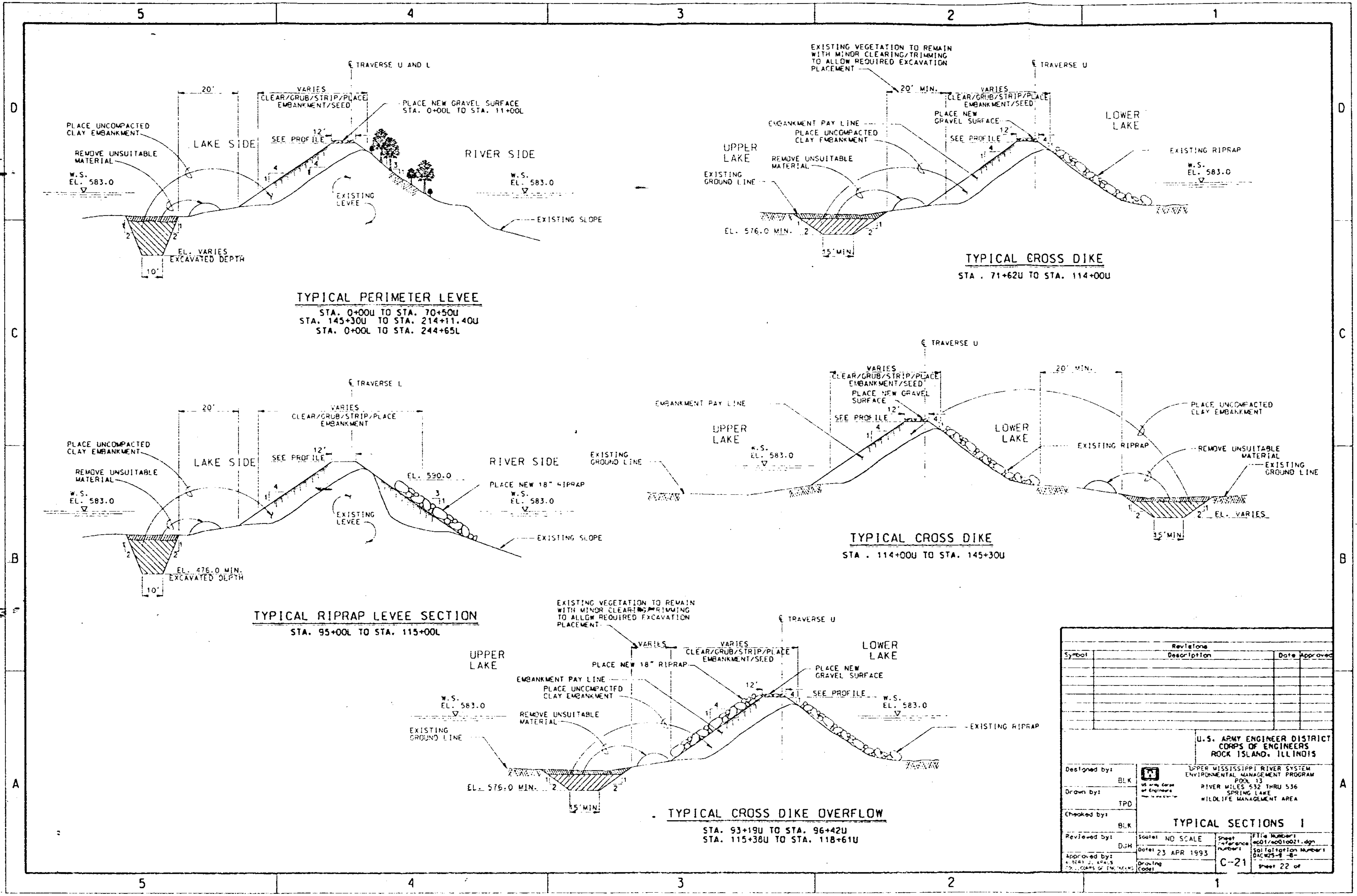
Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-19
File Number: ep01/ep01a019.dgn
Solicitation Number: DACW25-9 -8-
Sheet 20 of

PLATE 20



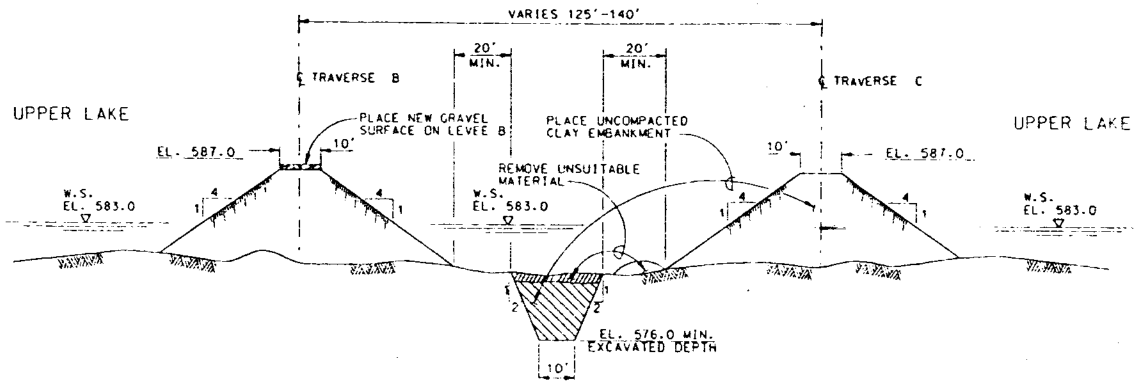
STA. 244+65L END OF PROJECT
240+00L
PI 236+13.05L
235+00L
230+00L
PI 228+55.05L
PI 225+86.62L
MATCH LINE STA. 225+00L
PLAN
STA. 225+00L
EL. 594.58
SLOPE = .004%
STA. 244+65L
EL. 594.5
SLOPE = .0061%
STA. 244+65L
EL. 593.0
STA. 225+00L
EL. 593.10
EXISTING GROUND LINE
ALONG TRAVERSE
ELEVATION
PROFILE TRAVERSE L
KEY PLAN
C20
LEGEND:
RECOMMENDED PLAN
100 YEAR EVENT
NOTE: FLAT POOL EL. 583.0
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS
COL., CORPS OF ENGINEERS
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
LOWER PLAN AND PROFILE
STA. 225+00L TO STA. 244+65L
Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-20
File Number: ep01/ep01c020.dgn
Solicitation Number: DACW25-9 -8-
Sheet 21 of

PLATE 21



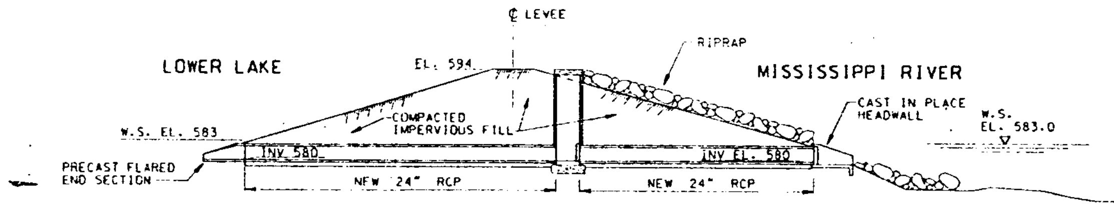
TYPICAL PERIMETER LEVEE
STA. 0+00U TO STA. 70+50U
STA. 145+30U TO STA. 214+11.40U
STA. 0+00L TO STA. 244+65L
TRAVERSE U AND L
VARIES
CLEAR/GRUB/STRIP/PLACE EMBANKMENT/SEED
PLACE NEW GRAVEL SURFACE STA. 0+00L TO STA. 11+00L
PLACE UNCOMPACTED CLAY EMBANKMENT
REMOVE UNSUITABLE MATERIAL
LAKE SIDE
RIVER SIDE
SEE PROFILE
W.S. EL. 583.0
EXISTING LEVEE
EXISTING SLOPE
EL. VARIES EXCAVATED DEPTH
TYPICAL CROSS DIKE
STA. 71+62U TO STA. 114+00U
EXISTING VEGETATION TO REMAIN WITH MINOR CLEARING/TRIMMING TO ALLOW REQUIRED EXCAVATION PLACEMENT
TRAVERSE U
20' MIN.
EMBANKMENT PAY LINE
PLACE NEW GRAVEL SURFACE
UPPER LAKE
LOWER LAKE
EXISTING RIPRAP
EXISTING GROUND LINE
EL. 576.0 MIN.
15' MIN
TYPICAL RIPRAP LEVEE SECTION
STA. 95+00L TO STA. 115+00L
TRAVERSE L
CLEAR/GRUB/STRIP/PLACE EMBANKMENT
EL. 590.0
PLACE NEW 18" RIPRAP
EL. 476.0 MIN. EXCAVATED DEPTH
TYPICAL CROSS DIKE
STA. 114+00U TO STA. 145+30U
EL. VARIES
TYPICAL CROSS DIKE OVERFLOW
STA. 93+19U TO STA. 96+42U
STA. 115+38U TO STA. 118+61U
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
Designed by: BLK
Drawn by: TPO
Checked by: BLK
Reviewed by: DJH
Approved by:
TYPICAL SECTIONS I
Scale: NO SCALE
Date: 23 APR 1993
C-21
Sheet 22 of

PLATE 22



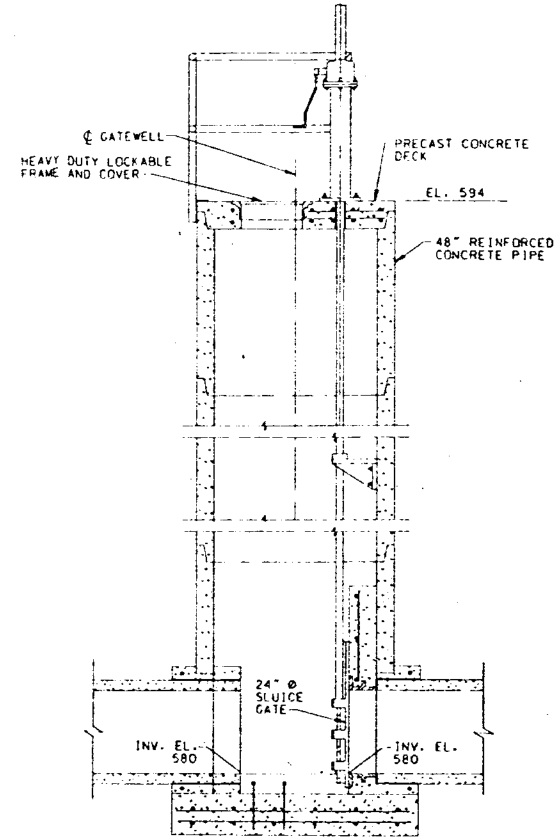
TYPICAL INTERIOR LEVEE SECTION

UPPER LEVEE
STA. 0+00B TO STA. 37+65B
STA. 0+00C TO STA. 38+37C

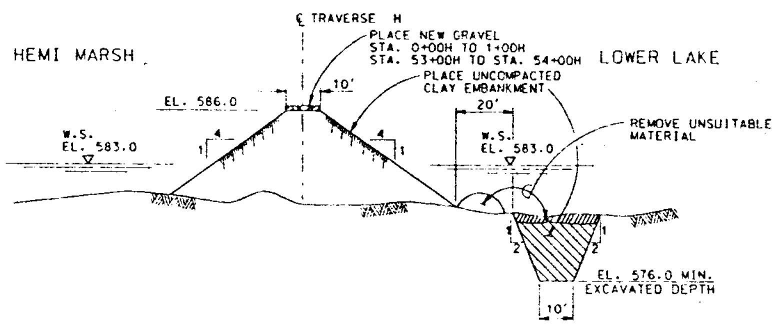


GATEWELL STRUCTURE

STA. 70+00 L

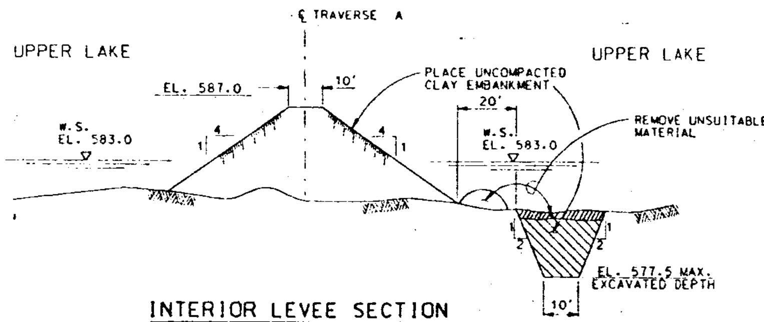


GATEWELL SECTION



TYPICAL HEMI MARSH LEVEE SECTION

LOWER LAKE
STA. 0+00H TO STA. 60+98.09H



INTERIOR LEVEE SECTION

UPPER LEVEE
STA 0+00A TO STA. 39+66.62A

Revisions			
Symbol	Description	Date	Approved

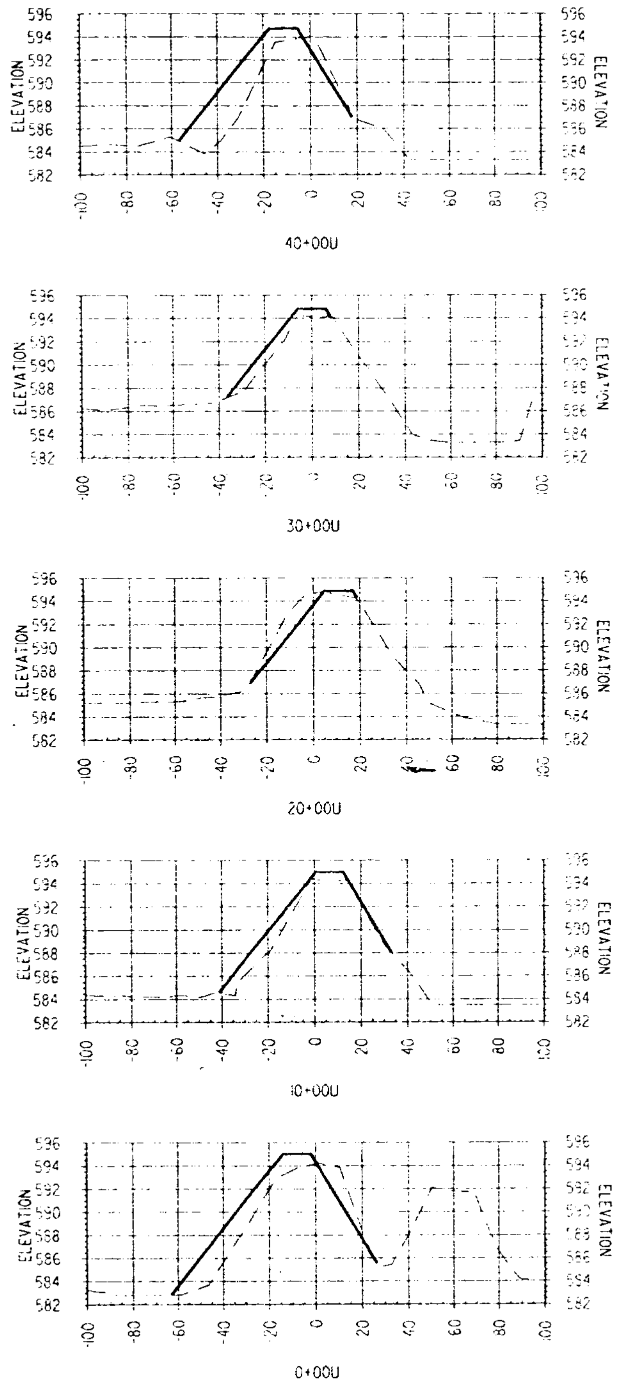
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

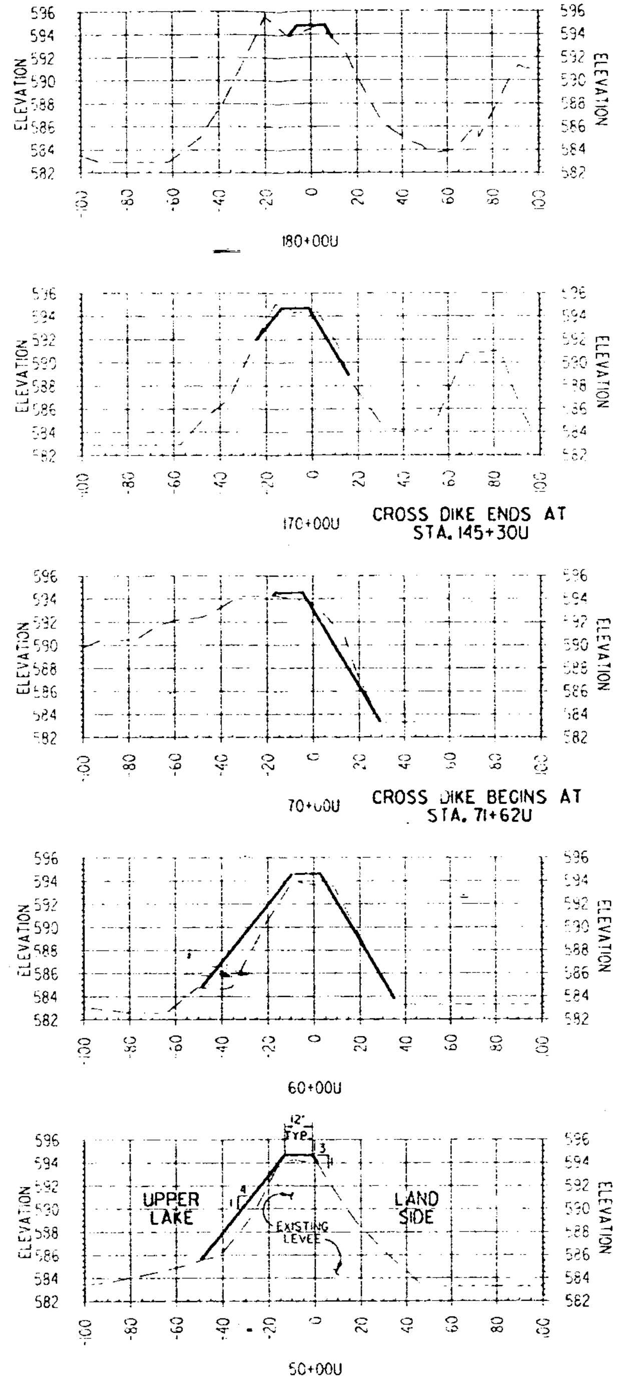
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

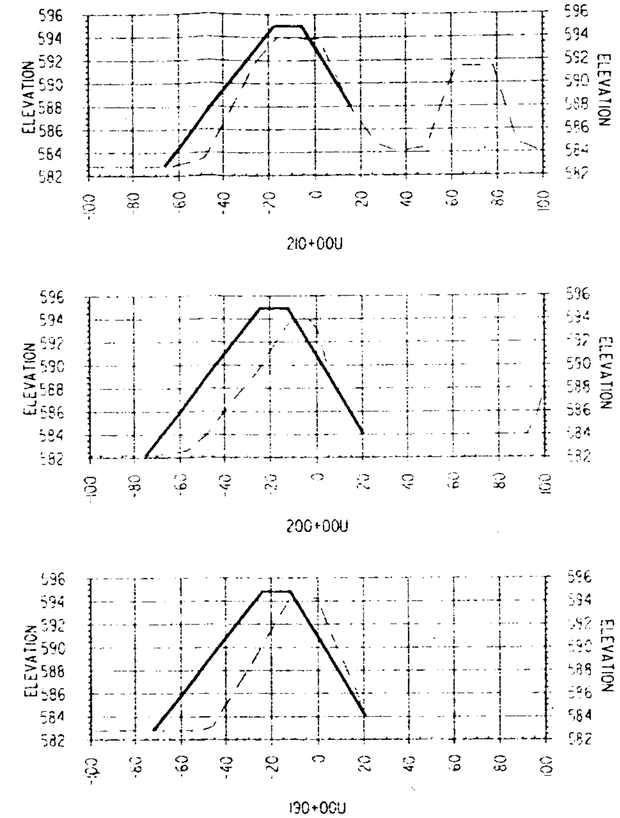
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

TYPICAL SECTIONS II

Scale: NO SCALE
Date: 23 APR 1993
Drawing Code:
Sheet reference number: C-22
File Number: ep01/ep01o022.dgn
Solicitation Number: DACW25-9 -B-
Sheet 23 of







Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS, COL, CORPS OF ENGINEERS

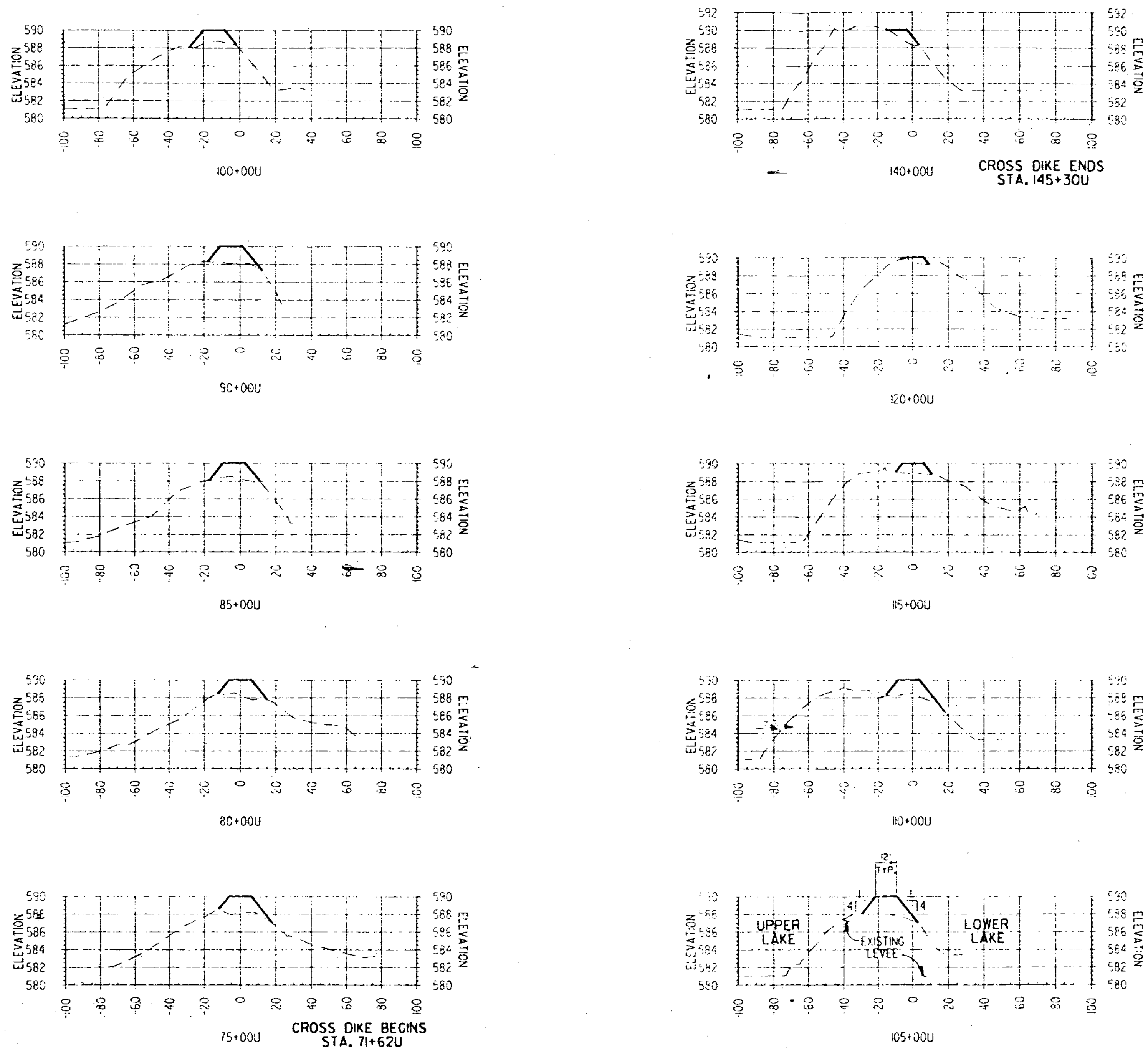
US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

TYPICAL UPPER PERIMETER LEVEE DESIGN SECTIONS

Scale: AS SHOWN
Date: 23 APRIL 1993
Sheet reference number: C-23
File Number: ep01/ep01a023.dgn
Solicitation Number: DACW25-9 -B-
Sheet 24 of

PLATE 24



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

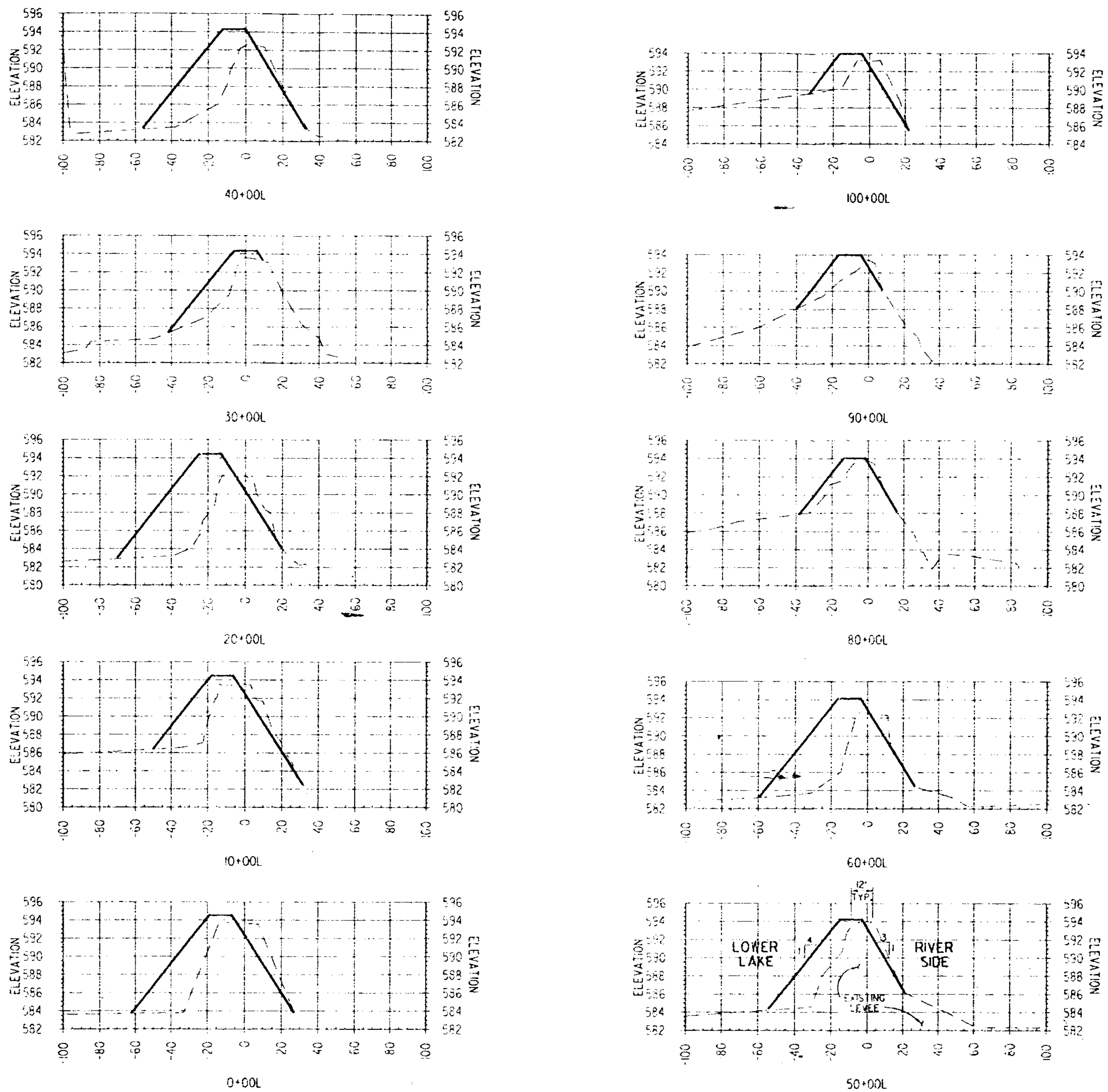
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

TYPICAL CROSS DIKE LEVEE DESIGN SECTIONS

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by:

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-24
File Number: ep01/ep01c024.dgn
Solicitation Number: DACW25-9 -B-
Sheet 25 of

PLATE 25



Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

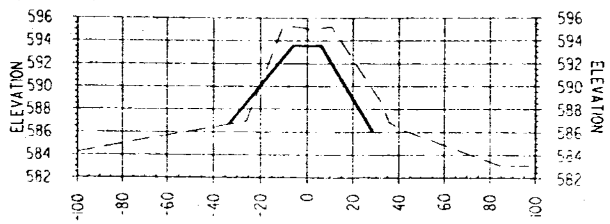
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS

US Army Corps of Engineers

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

TYPICAL LOWER PERIMETER LEVEE DESIGN SECTIONS I

Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-25
File Number: ea01/ec01a025.dgn
Solicitation Number: DACW25-9 -E-
Sheet 26 of



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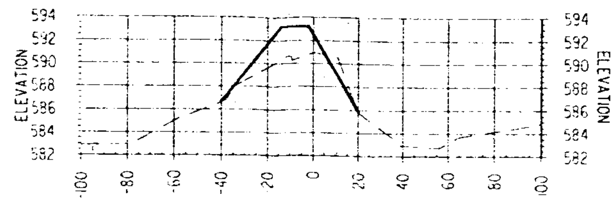

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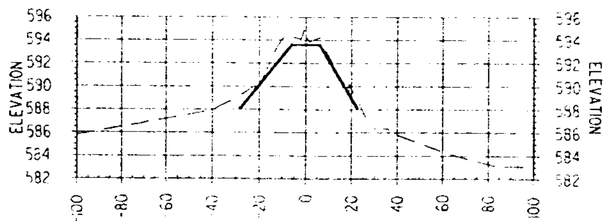
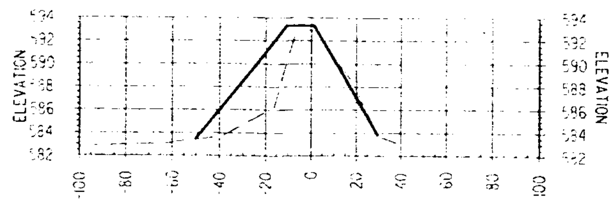


150+00L

NO WORK REQUIRED
STA. 150+00L TO STA. 160+00L



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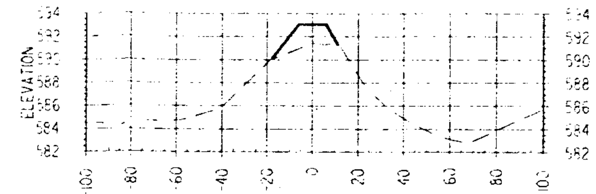

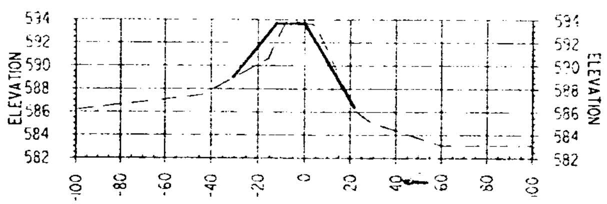

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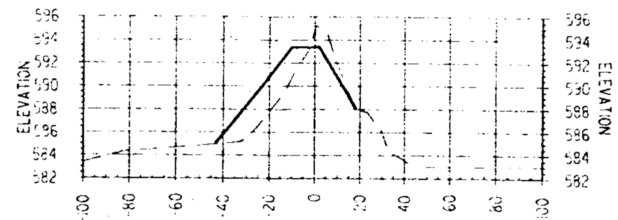

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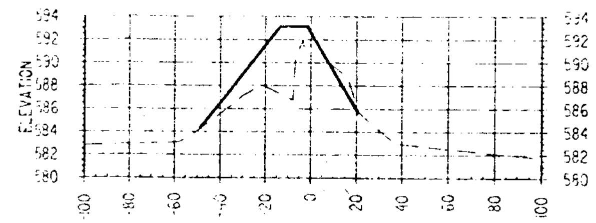

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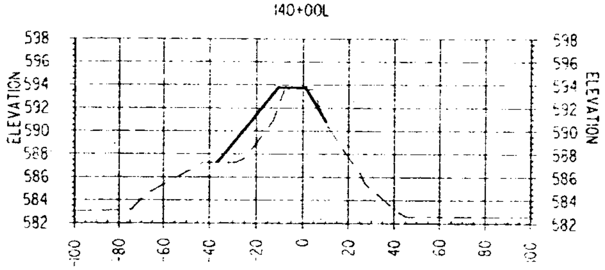

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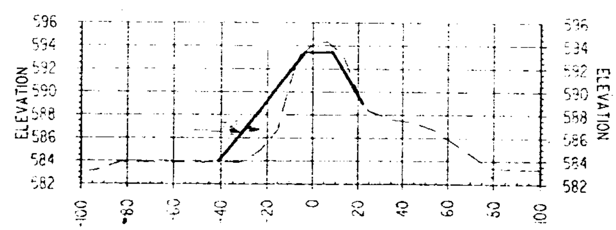
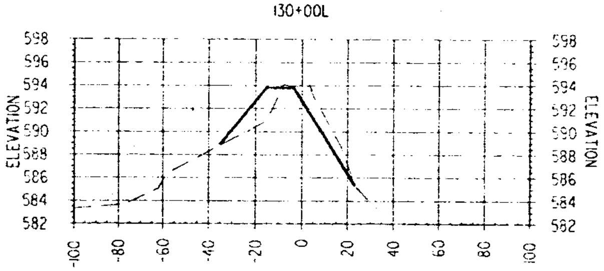


180+00L



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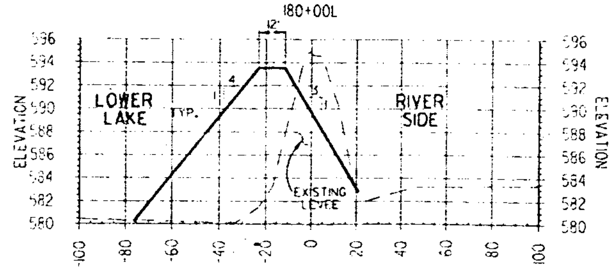


170+00L

Symbol	Revisions Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

TYPICAL LOWER PERIMETER
LEVEE DESIGN SECTIONS II

Scale: AS SHOWN
Date: 23 APRIL 1993
Sheet reference number: C-26
Sheet 27 of

PLATE 27

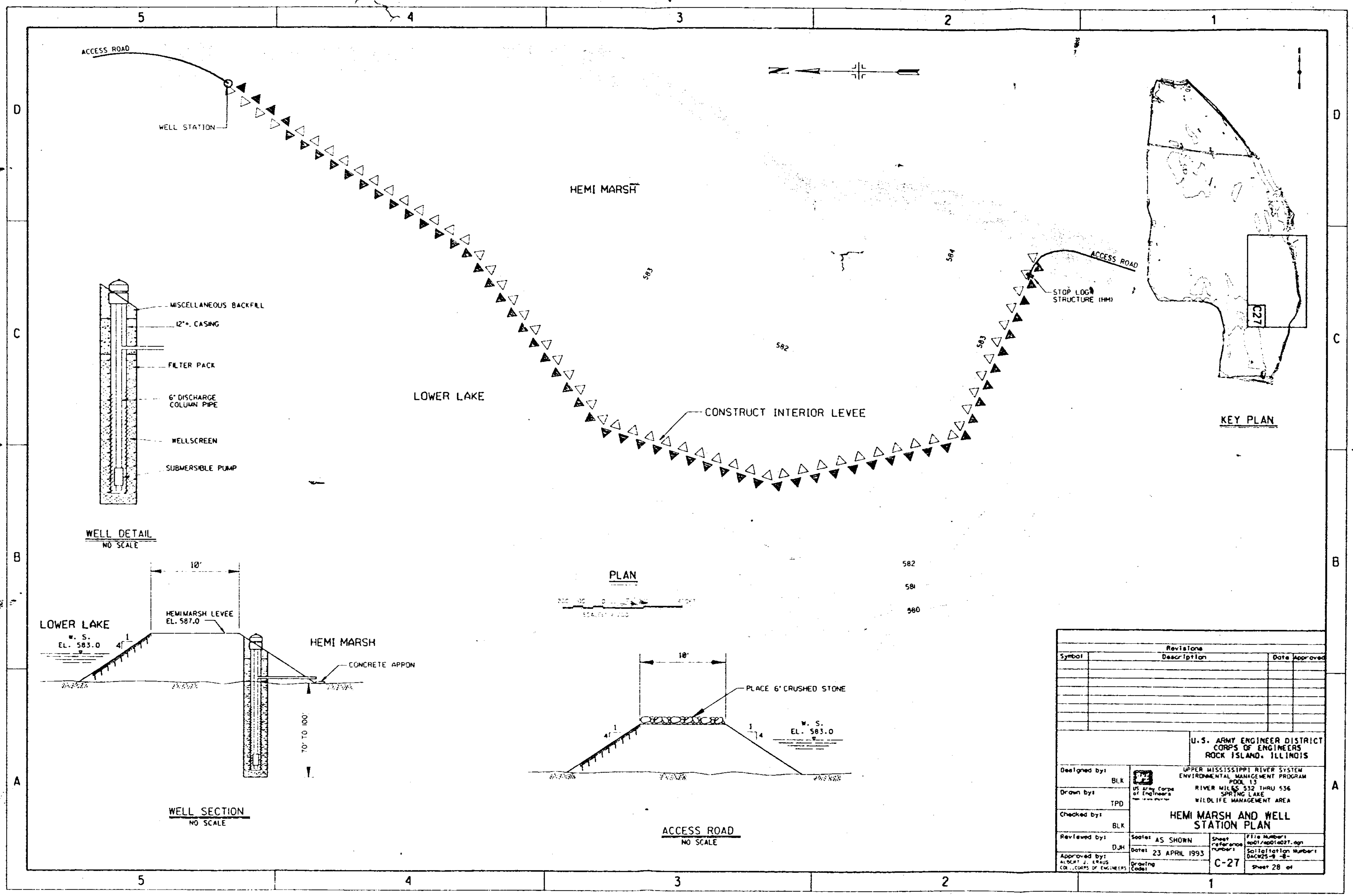
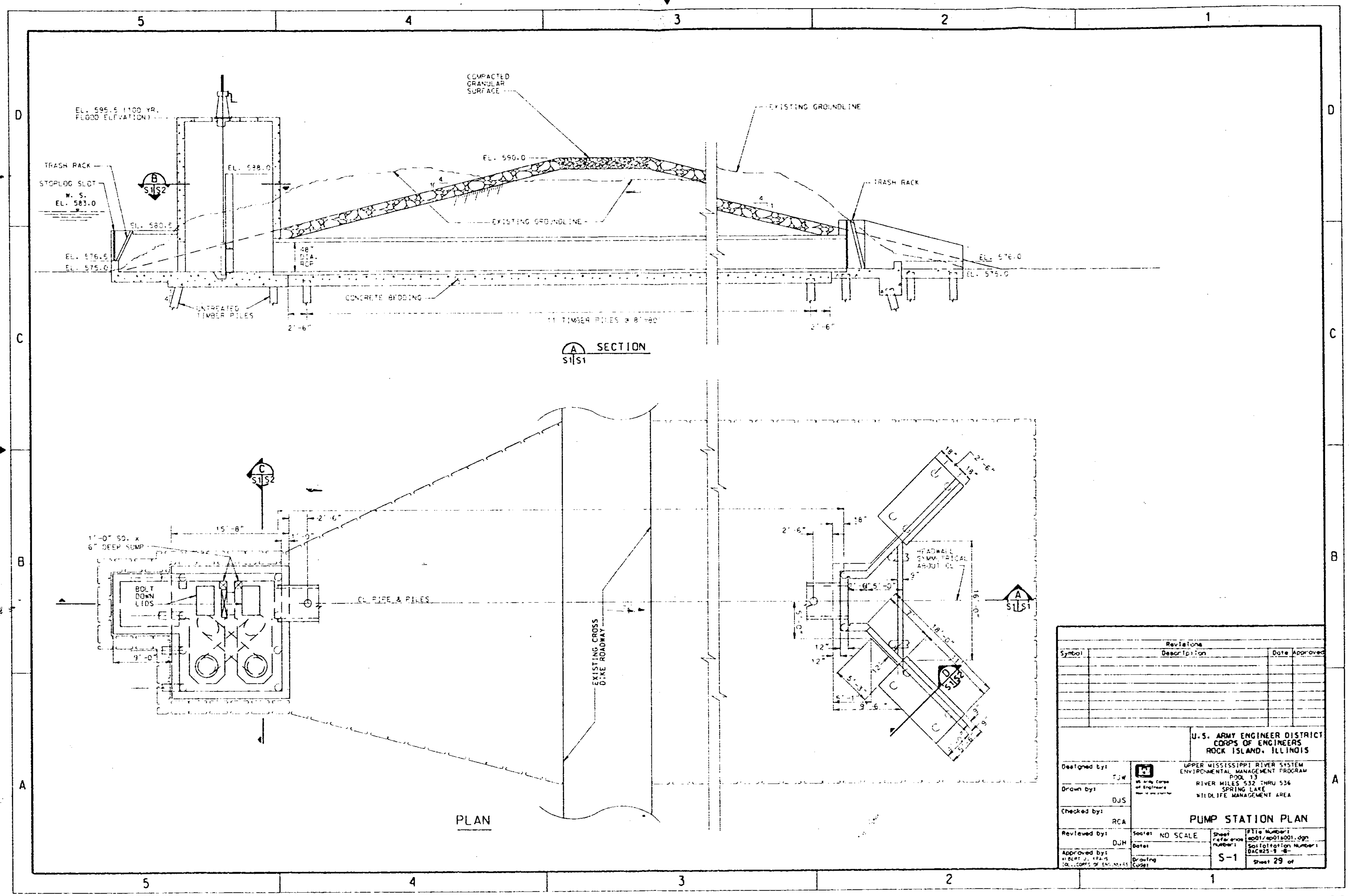
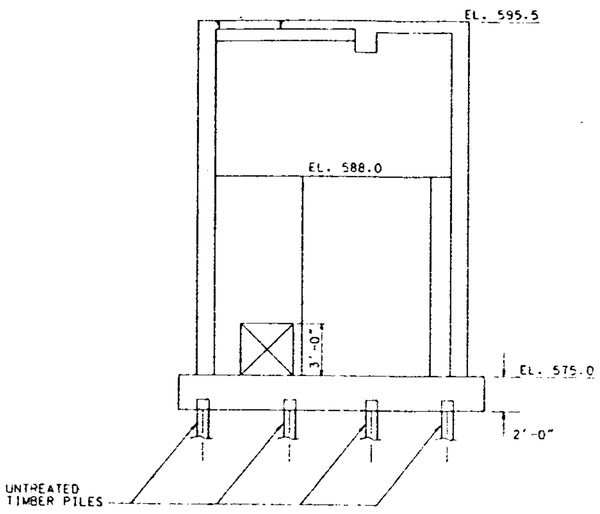

ACCESS ROAD
WELL STATION
HEMI MARSH
LOWER LAKE
CONSTRUCT INTERIOR LEVEE
STOP LOG STRUCTURE (HM)
ACCESS ROAD
583
584
582
583
KEY PLAN
C27
MISCELLANEOUS BACKFILL
12"+. CASING
FILTER PACK
6" DISCHARGE COLUMN PIPE
WELLSCREEN
SUBMERSIBLE PUMP
WELL DETAIL
NO SCALE
PLAN
582
581
580
10'
HEMIMARSH LEVEE
EL. 587.0
LOWER LAKE
W. S.
EL. 583.0
HEMI MARSH
CONCRETE APRON
70' TO 100'
WELL SECTION
NO SCALE
10'
PLACE 6" CRUSHED STONE
W. S.
EL. 583.0
ACCESS ROAD
NO SCALE
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: BLK
Drawn by: TPD
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
HEMI MARSH AND WELL
STATION PLAN
Scale: AS SHOWN
Date: 23 APRIL 1993
Drawing Code:
Sheet reference number: C-27
File Number: ep01/ep01a027.dgn
Solicitation Number: DACW25-9 -B-
Sheet 28 of

PLATE 28

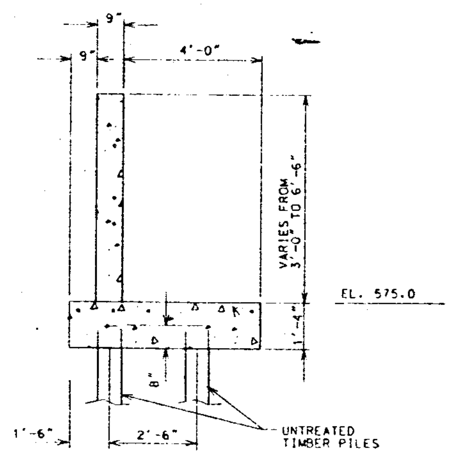


COMPACTED GRANULAR SURFACE
EXISTING GROUNDLINE
EL. 595.5 (100 YR. FLOOD ELEVATION)
TRASH RACK
STOPLOG SLOT
W. S. EL. 583.0
EL. 588.0
EL. 590.0
EL. 580.5
EL. 576.5
EL. 575.0
48" DIA. RCP
EXISTING GROUNDLINE
TRASH RACK
EL. 576.0
EL. 575.0
UNTREATED TIMBER PILES
CONCRETE BEDDING
11 TIMBER PILES @ 8'-0"
2'-6"
2'-6"
SECTION
1'-0" SQ. x 6" DEEP SUMP
15'-8"
2'-6"
BOLT DOWN LIDS
CL PIPE & PILES
9'-0"
EXISTING CROSS DIKE ROADWAY
HEADWALL SYMMETRICAL ABOUT CL
16'-0"
18'-0"
PLAN
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: TJW
Drawn by: DJS
Checked by: RCA
Reviewed by: DJH
Approved by:
US Army Corps of Engineers
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
PUMP STATION PLAN
Scale: NO SCALE
Date:
Drawing Code:
Sheet reference number: S-1
File Number: ep01/ep01s001.dgn
Solicitation Number: DACW25-9 -B-
Sheet 29 of

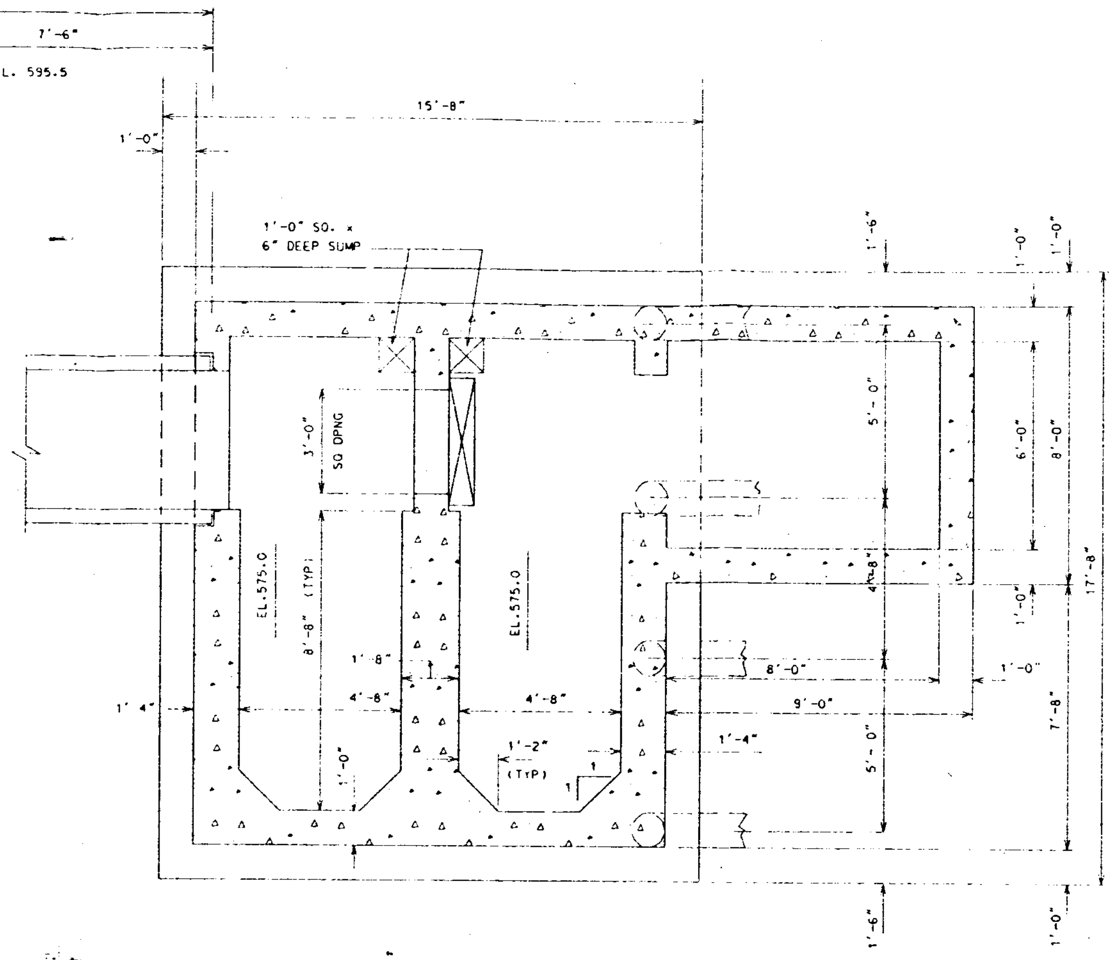
PLATE 29



SECTION C S1|S2
SCALE: 1/4" = 1'-0"



SECTION D S1|S2
SCALE: 1/2 = 1'-0"



SECTION B S1|S2
SCALE: 1/2 = 1'-0"

Symbol	Revisions Description	Date	Approved

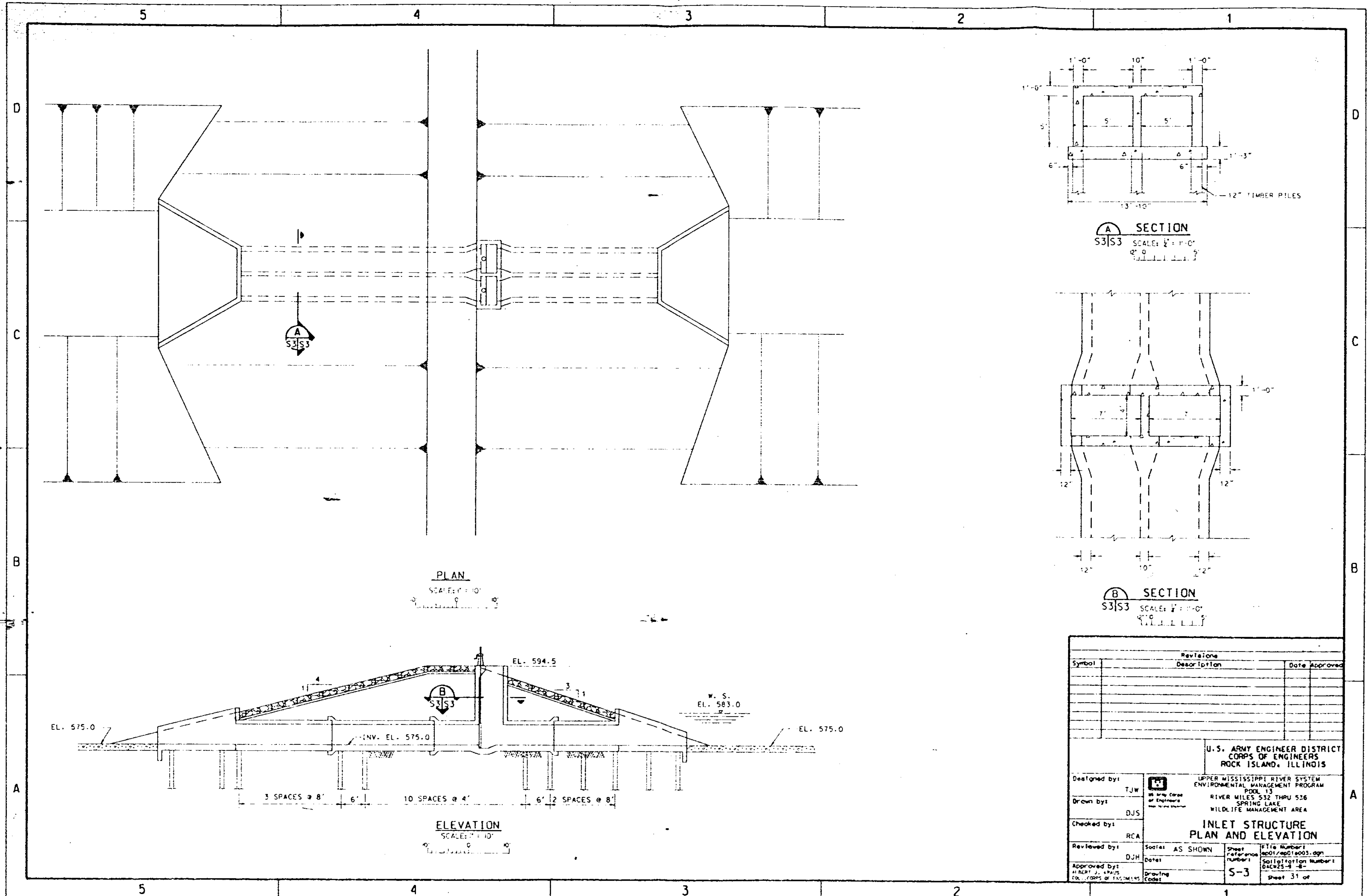
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

Designed by: TJW
Drawn by: DJS
Checked by: RCA
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL. CORPS OF ENGINEERS

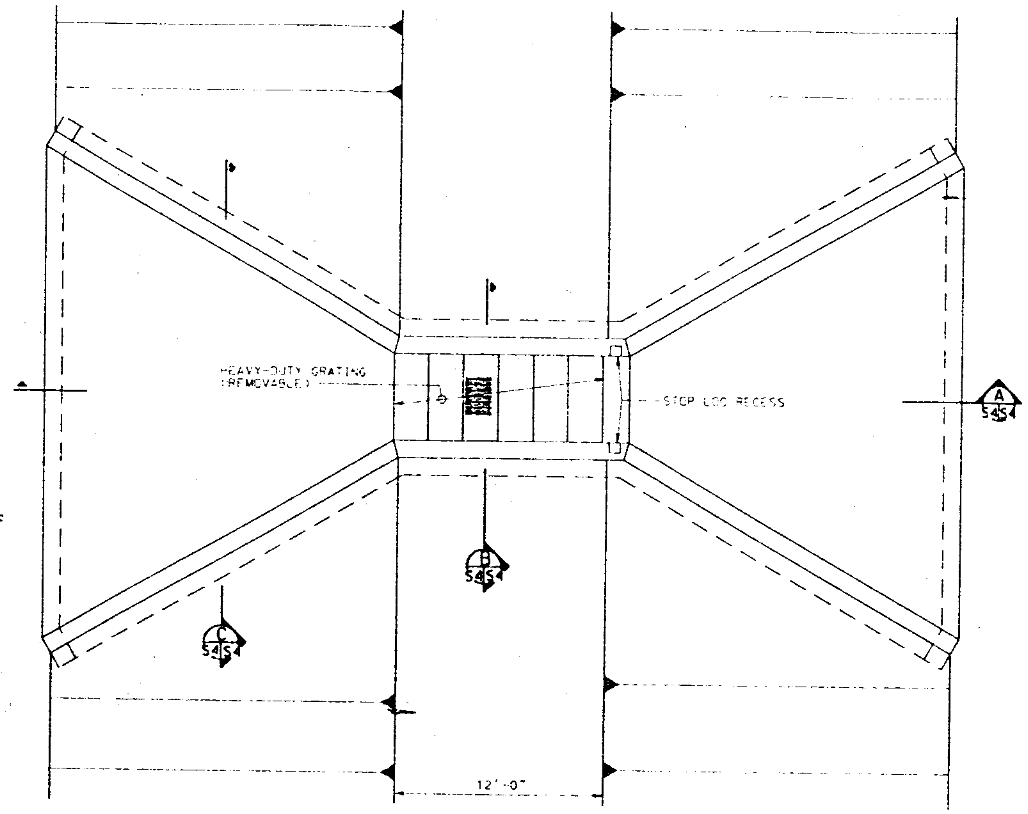
PUMP STATION DETAILS

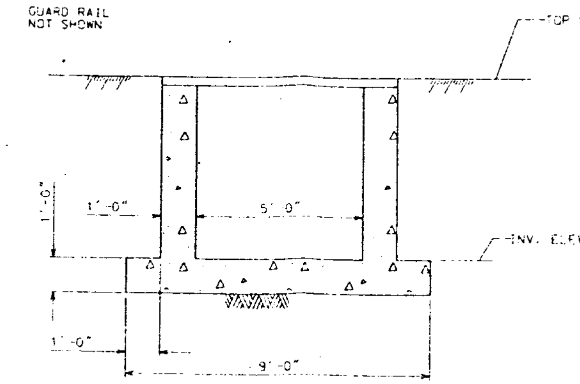
Scale: AS SHOWN
Date:
Drawing Code:
Sheet reference number: S-2
File Number: ep01/ep01e002.dgn
Solicitation Number: DACW25-9 -8-
Sheet 30 of



PLAN
ELEVATION
EL. 594.5
W. S. EL. 583.0
EL. 575.0
INV. EL. 575.0
3 SPACES @ 8'
10 SPACES @ 4'
2 SPACES @ 8'
SECTION A S3|S3
12" TIMBER PILES
SECTION B S3|S3
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
INLET STRUCTURE
PLAN AND ELEVATION
Designed by: TJW
Drawn by: DJS
Checked by: RCA
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
Scale: AS SHOWN
Date:
Drawing Code:
Sheet reference number: S-3
File Number: ep01/ep01e003.dgn
Solicitation Number: DACW25-9 -8-
Sheet 31 of

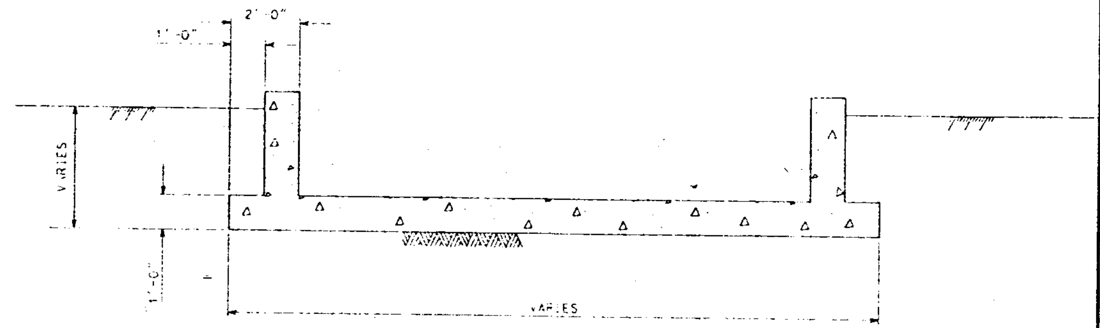
PLATE 31



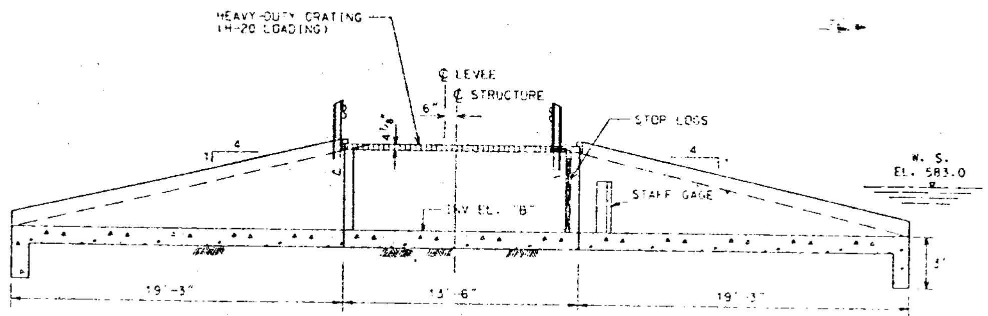


B SECTION S4|S4

SCALE: 1/2" = 1'-0"



C SECTION S4|S4



A SECTION S4|S4

SCALE: 1/4" = 1'-0"

STOP LOG STRUCTURE	LEVEE ELEVATION	INVERT ELEVATION
A	587.0	582.0
B	586.0	579.0
C	586.0	579.0
HM	588.0	581.0

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

Designed by: TJW
Drawn by: DJS
Checked by: RCA
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

STOP LOG STRUCTURES

Scale: AS SHOWN
Date:
Drawing Code:
Sheet reference number: S-4
File Number: ep01/ep01s004.dgn
Solicitation Number: DACW25-9 -B-
Sheet 32 of

PLATE 32

22-APR-1993 11:50 /usr/projects/ep01/ep01s4

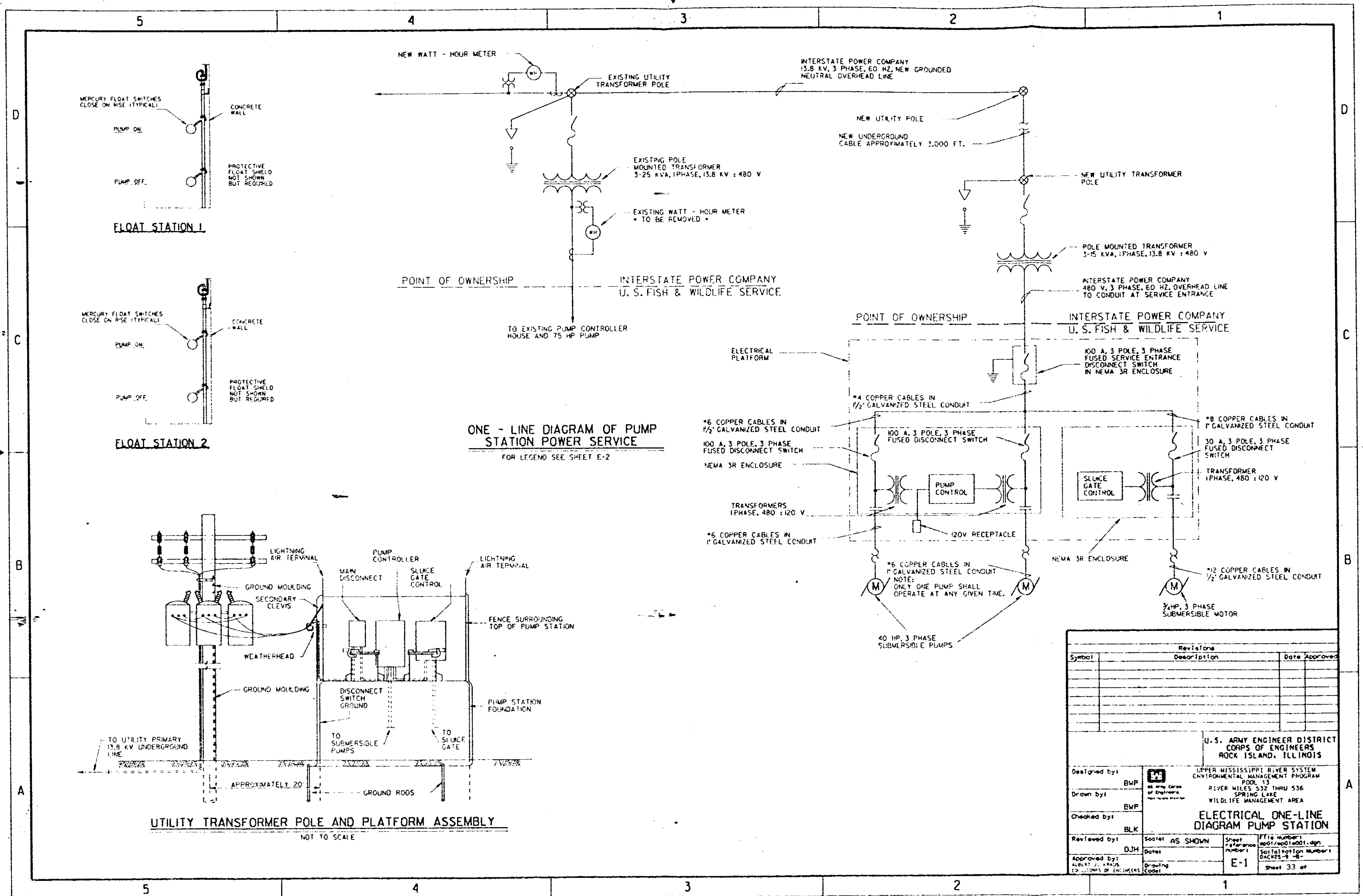
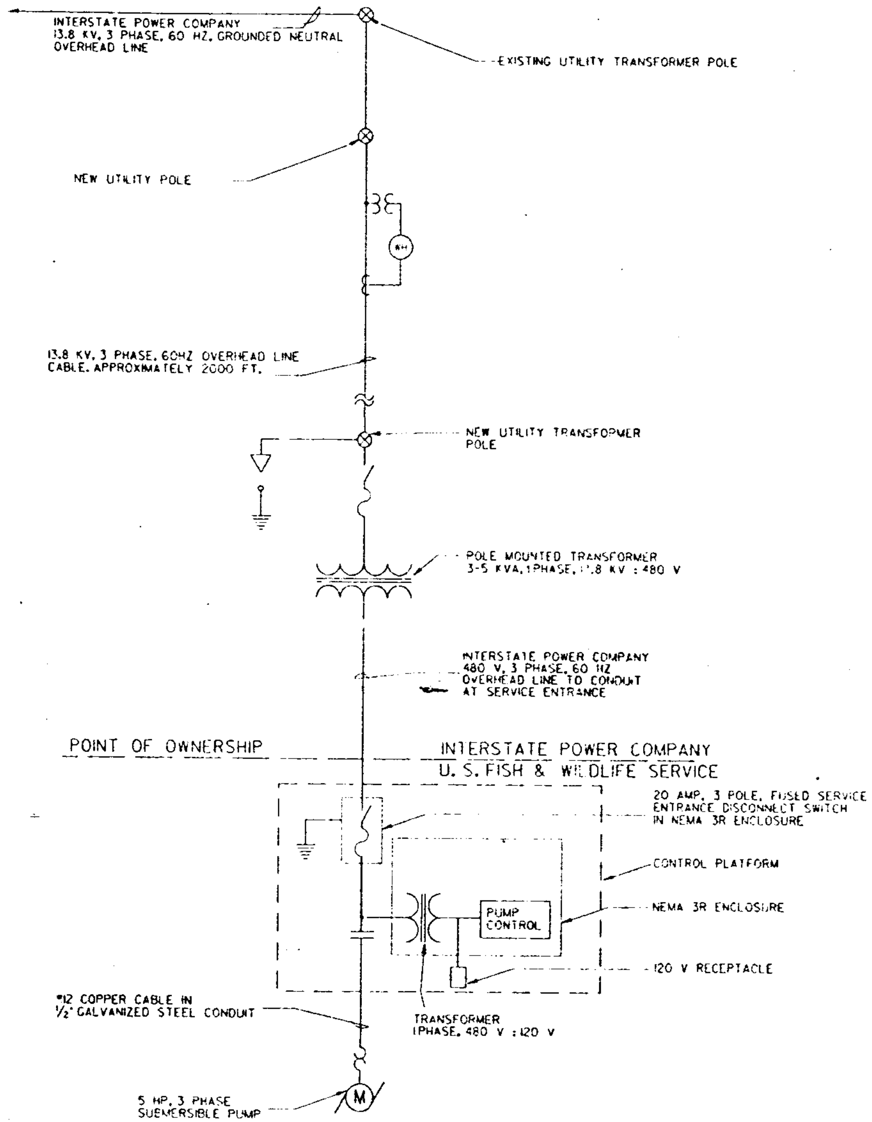
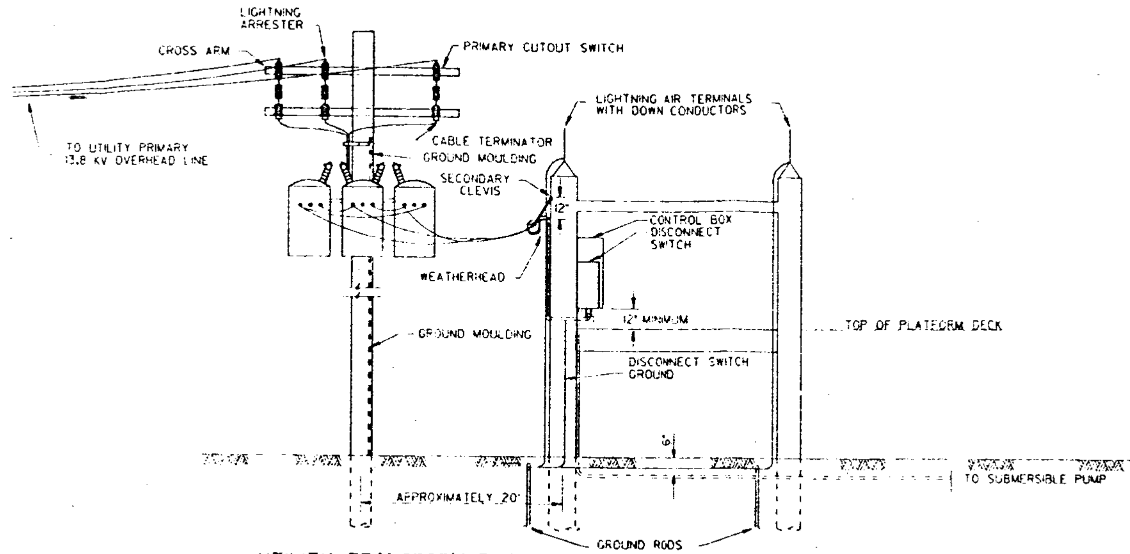

NEW WATT - HOUR METER
EXISTING UTILITY TRANSFORMER POLE
INTERSTATE POWER COMPANY 13.8 KV, 3 PHASE, 60 HZ, NEW GROUNDED NEUTRAL OVERHEAD LINE
NEW UTILITY POLE
NEW UNDERGROUND CABLE APPROXIMATELY 3,000 FT.
NEW UTILITY TRANSFORMER POLE
EXISTING POLE MOUNTED TRANSFORMER 3-25 KVA, 1PHASE, 13.8 KV : 480 V
EXISTING WATT - HOUR METER * TO BE REMOVED *
POLE MOUNTED TRANSFORMER 3-15 KVA, 1PHASE, 13.8 KV : 480 V
INTERSTATE POWER COMPANY 480 V, 3 PHASE, 60 HZ, OVERHEAD LINE TO CONDUIT AT SERVICE ENTRANCE
POINT OF OWNERSHIP
INTERSTATE POWER COMPANY
U. S. FISH & WILDLIFE SERVICE
TO EXISTING PUMP CONTROLLER HOUSE AND 75 HP PUMP
MERCURY FLOAT SWITCHES CLOSE ON RISE (TYPICAL)
CONCRETE WALL
PUMP ON
PUMP OFF
PROTECTIVE FLOAT SHIELD NOT SHOWN BUT REQUIRED
FLOAT STATION 1
FLOAT STATION 2
ONE - LINE DIAGRAM OF PUMP STATION POWER SERVICE
FOR LEGEND SEE SHEET E-2
ELECTRICAL PLATFORM
100 A, 3 POLE, 3 PHASE FUSED SERVICE ENTRANCE DISCONNECT SWITCH IN NEMA 3R ENCLOSURE
#4 COPPER CABLES IN 1½" GALVANIZED STEEL CONDUIT
#6 COPPER CABLES IN 1½" GALVANIZED STEEL CONDUIT
100 A, 3 POLE, 3 PHASE FUSED DISCONNECT SWITCH
NEMA 3R ENCLOSURE
PUMP CONTROL
SLUICE GATE CONTROL
#8 COPPER CABLES IN 1" GALVANIZED STEEL CONDUIT
30 A, 3 POLE, 3 PHASE FUSED DISCONNECT SWITCH
TRANSFORMER 1PHASE, 480 : 120 V
TRANSFORMERS 1PHASE, 480 : 120 V
#6 COPPER CABLES IN 1" GALVANIZED STEEL CONDUIT
120V RECEPTACLE
NEMA 3R ENCLOSURE
NOTE: ONLY ONE PUMP SHALL OPERATE AT ANY GIVEN TIME.
#12 COPPER CABLES IN ½" GALVANIZED STEEL CONDUIT
¾HP, 3 PHASE SUBMERSIBLE MOTOR
40 HP, 3 PHASE SUBMERSIBLE PUMPS
LIGHTNING AIR TERMINAL
PUMP CONTROLLER
MAIN DISCONNECT
SLUICE GATE CONTROL
GROUND MOULDING
SECONDARY CLEVIS
FENCE SURROUNDING TOP OF PUMP STATION
WEATHERHEAD
DISCONNECT SWITCH GROUND
PUMP STATION FOUNDATION
TO SUBMERSIBLE PUMPS
TO SLUICE GATE
TO UTILITY PRIMARY 13.8 KV UNDERGROUND LINE
APPROXIMATELY 20'
GROUND RODS
UTILITY TRANSFORMER POLE AND PLATFORM ASSEMBLY
NOT TO SCALE
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ROCK ISLAND, ILLINOIS
Designed by: BWP
Drawn by: BWP
Checked by: BLK
Reviewed by: DJH
UPPER MISSISSIPPI RIVER SYSTEM ENVIRONMENTAL MANAGEMENT PROGRAM POOL 13 RIVER MILES 532 THRU 536 SPRING LAKE WILDLIFE MANAGEMENT AREA
ELECTRICAL ONE-LINE DIAGRAM PUMP STATION
Scale: AS SHOWN
E-1
Sheet 33 of

PLATE 33



ONE - LINE DIAGRAM OF WELL STATION POWER SERVICE



UTILITY TRANSFORMER POLE AND PLATFORM ASSEMBLY

NOT TO SCALE

ELECTRICAL LEGEND

- UTILITY POLE
- WATT - HOUR METER
- GROUND CONNECTION
- TRANSFORMER
- TRANSFORMER
- FUSIBLE DISCONNECT SWITCH
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMER
- LIGHTNING ARRESTER
- THERMAL OVERLOAD
- MOTOR STARTER

Revisions			
Symbol	Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA

ELECTRICAL ONE - LINE DIAGRAM WELL STATION

Designed by: BWP
Drawn by: BWP
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS

Scale: NO SCALE
Date:
Drawing Code:
Sheet reference number: E-2
File Number: ep01/ep01e002.dgn
Solicitation Number: DACW25-9 -
Sheet 34 of

PLATE 34

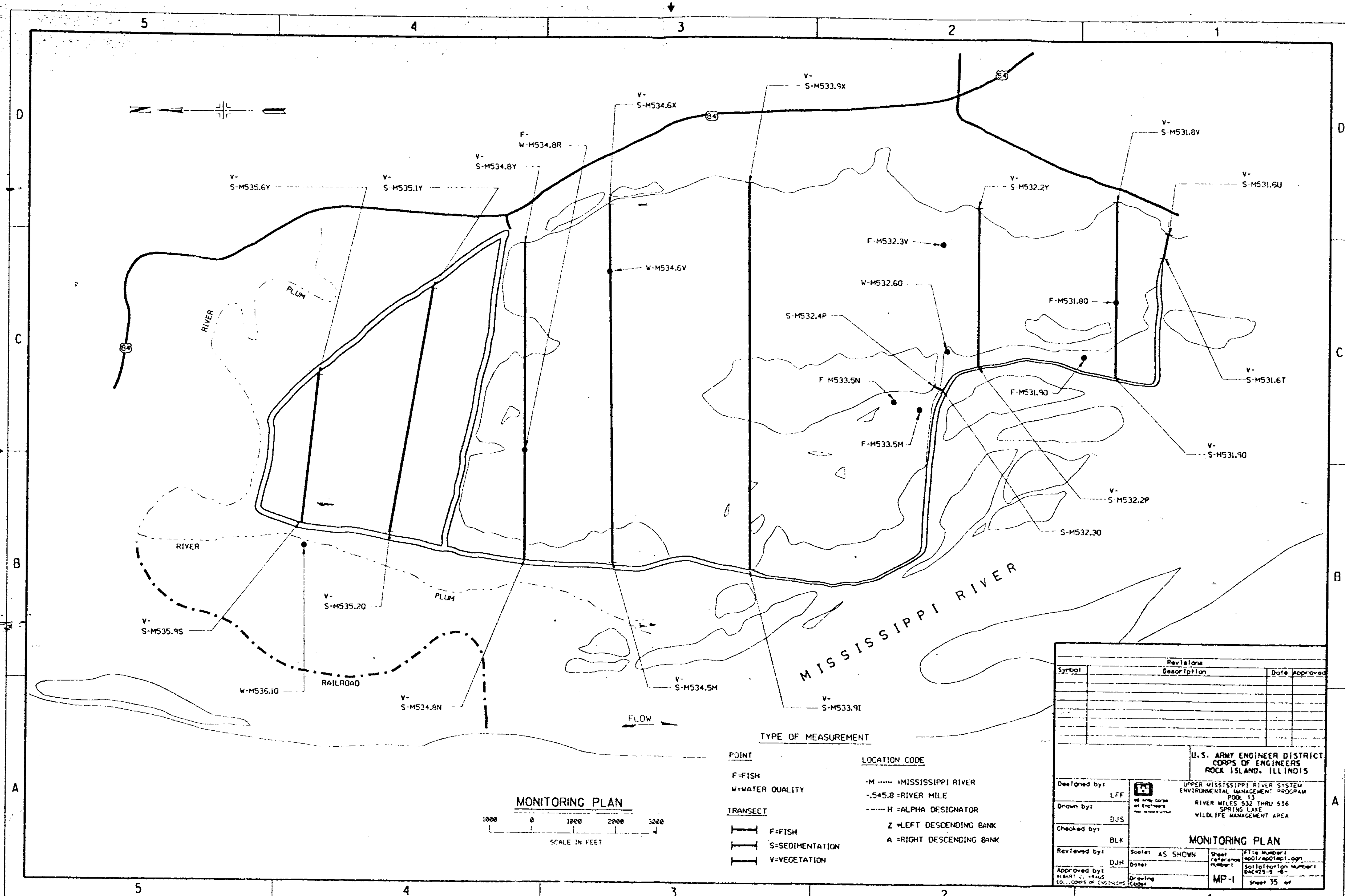

V-
S-M535.6Y
V-
S-M535.1Y
V-
S-M534.8Y
F-
W-M534.8R
V-
S-M534.6X
V-
S-M533.9X
V-
S-M532.2Y
V-
S-M531.8V
V-
S-M531.6U
F-M532.3V
W-M534.6V
W-M532.60
S-M532.4P
F-M531.80
V-
S-M531.6T
F M533.5N
F-M531.90
F-M533.5M
V-
S-M531.90
V-
S-M532.2P
S-M532.30
PLUM
RIVER
RIVER
PLUM
V-
S-M535.20
V-
S-M535.9S
MISSISSIPPI RIVER
RAILROAD
W-M536.10
V-
S-M534.8N
V-
S-M534.5M
V-
S-M533.9I
FLOW
MONITORING PLAN
1000 0 1000 2000 3000
SCALE IN FEET
TYPE OF MEASUREMENT
POINT
F=FISH
W=WATER QUALITY
TRANSECT
F=FISH
S=SEDIMENTATION
V=VEGETATION
LOCATION CODE
-M ······ =MISSISSIPPI RIVER
-.545.8 =RIVER MILE
······H =ALPHA DESIGNATOR
Z =LEFT DESCENDING BANK
A =RIGHT DESCENDING BANK
Revisions
Symbol
Description
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ROCK ISLAND, ILLINOIS
Designed by: LFF
Drawn by: DJS
Checked by: BLK
Reviewed by: DJH
Approved by: ALBERT J. KRAUS COL., CORPS OF ENGINEERS
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
POOL 13
RIVER MILES 532 THRU 536
SPRING LAKE
WILDLIFE MANAGEMENT AREA
MONITORING PLAN
Scale: AS SHOWN
Date:
Drawing Code:
Sheet reference number: MP-1
File Number: ep01/ep01mp1.dgn
Solicitation Number: DACW25-9 -B-
Sheet 35 of

PLATE 35