LEVEL II

# Dredging Requirements Work Group Appendix

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# GREAT II

Upper Mississippi River
(Guttenberg, Iowa to Saverton, Missouri)

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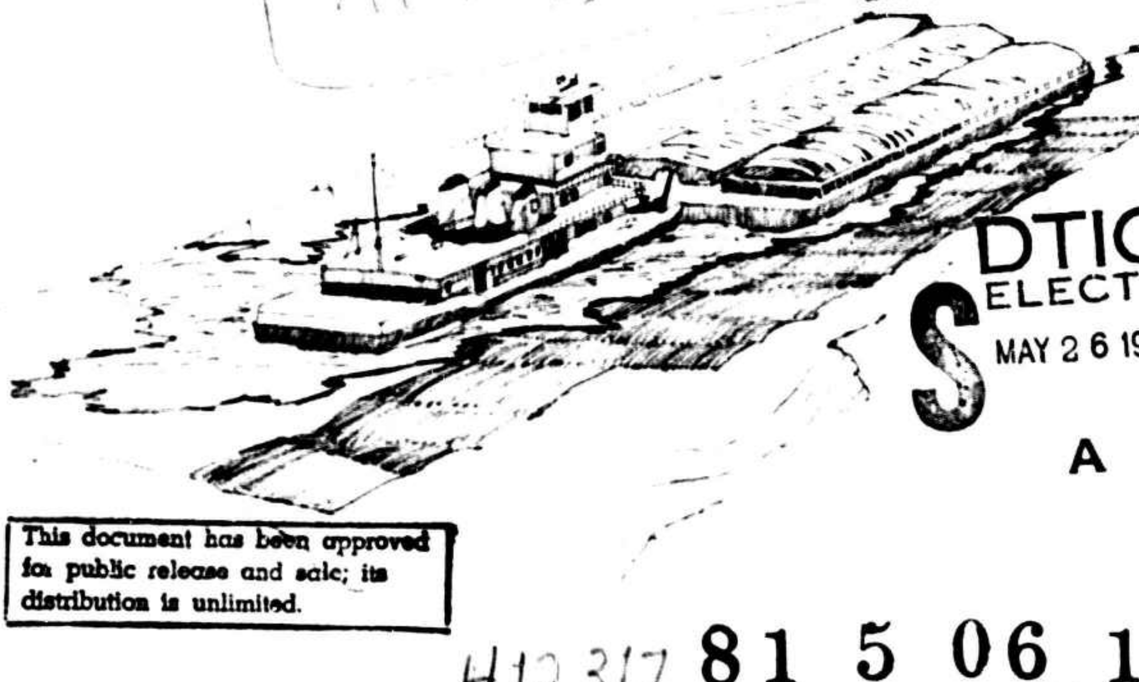

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## Great River Environmental Action Team

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

## LIST OF ILLUSTRATIONS

# I - INTRODUCTION

# I. INTRODUCTION

The Mississippi is the greatest river in North America, gathering runoff from 31 states and two Canadian provinces, draining 1.5 million square miles. It is the third largest watershed in the world, flowing 2,500 miles to the Gulf of Mexico. Millions of people live on its banks and draw life from its waters. Over five hundred kinds of animals live among the diverse plant communities that thrive in and along the river.

Man, in his progress, has put the river to many varied and sometimes conflicting uses. The pressures of man's use of the river are feared to be degrading the environmental qualities of the river. More information is needed on the complex interactions of the river's resources and these resource reactions to man's activities on the river. When this information is obtained, it can then be used to determine where problems exist and the alternatives available to man to solve these problems and coordinate river uses to minimize conflicts.

## A. Study Authorization and Development

In response to increasing public concern for the environmental quality of the river, the Great River Study was authorized by Congress in the Water Resources Development Act of 1976 (PL 94-587). This legislation authorizes the US Army Corps of Engineers "to investigate and study, in cooperation with interested states and Federal agencies, through the Upper Mississippi River Basin Commission, the development of a river system management plan."

The total study program includes three Great River Environmental Action Teams (GREAT), which have the responsibility for the river reaches from St. Paul/Minneapolis to Guttenberg, Iowa (GREAT I); Guttenberg to Saverton, Missouri (GREAT II); and Saverton to the confluence of the Ohio (GREAT III).

The study programs and recommendations of the three GREAT Teams will be brought together into a river management strategy for the entire Upper Mississippi River. The goal of the study is to present to Congress and the people a river resource management plan that is, above all, realistic - a plan that is technically and economically sound, socially and environmentally acceptable, and capable of being put into action within a reasonable period of time.

## B. Study Purpose and Scope

The purpose of the GREAT II Studies is to identify and resolve conflicts resulting from separate legislative actions of Congress which mandated that the Upper Mississippi River be managed in the national interest for commercial navigation and as a fish and wildlife refuge.

The concept of the study originated from a need to coordinate the maintenance activities of a 9-foot navigation channel by the US Army Corps of Engineers from Guttenberg, Iowa, to Saverton, Missouri, with other river uses. GREAT II was founded because of increasing concern by conservationists and the general public over the lack of information available about the impacts of US Army Corps of Engineers channel maintenance activities on many key resources of the river.

The scope of the GREAT II Study is directed toward developing a river system management plan incorporating total river resource requirements. GREAT II was organized early in fiscal year 1977 (October 1976 through September 1977) and is studying the river from Guttenberg, Iowa, to Saverton, Missouri.

C. Study Participation and Organization

The GREAT II Team is composed of representatives from the following Upper Mississippi Basin States and the Federal River Resource-oriented agencies:

State of Illinois
State of Iowa
State of Missouri
State of Wisconsin
US Department of the Interior - Fish and Wildlife Service
US Department of Agriculture - Soil Conservation Service
US Department of Defense - Department of the Army - Corps of Engineers
US Department of Transportation - US Coast Guard
US Environmental Protection Agency
Upper Mississippi River Conservation Committee (ex officio)

GREAT II is organized into 12 functional work groups and the Plan Formulation Work Group. Each work group is to accomplish the study objectives as they relate to the work group's functional area and as directed by the team. Work groups are composed of persons having expertise and interest in the work group's area of study.

This report summarizes the concerns, objectives, activities, conclusions, and recommendations of the Dredging Requirements Work Group as they relate to the GREAT II Study area.

D. Dredging Requirements Work Group Objectives

The Dredging Requirements Work Group (DRWG) has two objectives. The short-term objective is to reduce the quantity of dredged material (site specific each dredging occurrence), and still maintain a safe navigable channel. The long-term objective is to reduce quantities of dredged material by determining channel depths and widths that minimize dredging quantities, yet maintain an adequate navigation channel, and to make more efficient use of regulatory structures to prevent channel shoaling.

## E. Dredging Requirements Work Group Organization

1. Participants:

Jerry Crittenden, Chairman, US Army Engineer District, Rock Island
Robert Behrens, Wisconsin Department of Natural Resources
Robert Jack, Iowa Conservation Commission
Lonnie Jacobs, American Waterways Operators
CPT T. E. Kenny, Wisconsin Barge Lines, Inc.
Wendy Nichols, Don McGuiness and Associates
CPT Donn Williams, Williams Marine Enterprise
Richard Baker, US Army Engineer District, Rock Island
Jon Duyvejonck, US Army Engineer District, Rock Island
William Koellner, US Army Engineer District, Rock Island
Marv Martens, US Army Engineer District, Rock Island
Mark Schroeder, US Army Engineer District, Rock Island
Tim Mullen, US Army Engineer District, Rock Island

2. Meetings and Discussions

To accomplish the objective of reduced dredging, the Dredging Requirement Work Group scheduled a variety of coordination activities throughout the study period's duration. Formal work group meetings were held on a regular basis to consolidate views and direct the overall team effort. Items addressed at these meetings included the identification, review, and discussion of dredge requirement problems; developing associated recommendations and impact assessments; and the review and discussion of the Dredging Requirements Work Group Appendix.

The problem identification and recommendations of other work groups were also addressed at these monthly meetings. Coordination meetings were held as required to discuss and review input from individual group members to the Dredge Requirements Work Group Appendix. Meetings involving all or a portion of the work group were held as necessary to resolve problems encountered between regularly scheduled quarterly meetings.

# II - PROBLEM IDENTIFICATION

## II. PROBLEM IDENTIFICATION

### A. Process

Once the 12 functional work groups and their overall objectives were formulated, the work group members began to identify public concerns, use conflicts, and other problems related to their overall objective and area of study. The work group's list of problems is included at the end of this section, Attachment #1. These problems were identified by any of the following ways:

1. the problem was identified in GREAT I and was applicable to the GREAT II area

2. the work group recognized an existing problem based on existing conditions

3. the work group recognized a potential problem based on future projections of existing conditions and identified trends

4. other work groups identified problems that relate to the work group's area of study

5. the public expressed concerns and problems directly to the work group

6. the public expressed concerns and problems to a particular work group through the public participation and information work group (i.e., town meetings; houseboat trips; etc.)

These problems were then compiled into a list to be evaluated by the work group for their relevancy to the study, the urgency or certainty of the problem, and the potential for resolving the problem within the time frame of the study. Certain problems were eliminated from further study based on criteria guidelines developed by the Upper Mississippi River Basin Commission in 1974. The list of remaining problems was then prioritized by the work groups. (See Plan Formulation Work Group Appendix for the listing of these problems.)

The results of this screening process were put into tables and displayed in the Preliminary Feasibility Report.

Once the work groups had developed a set of problems and needs, they formulated a list of objectives designed to address and, at a minimum, partially resolve their problems. These objectives were then used to identify tasks and/or studies which the work group needed to accomplish in order to identify the possible alternative solutions to their respective problems. The problems, objectives, and tasks, therefore, represent the plans-of-action each work group used to derive their final conclusions and recommendations.

The conditions, both existing and future, which were used to identify a work group's problems are discussed in the following sections. The year 1979 was chosen as the base year for existing conditions, and a project life of 50 years was used to predict future conditions. Attachments 1, 2, and 3 summarize the plan-of-action for the work group.

Attachment 11

WORK GROUP Dredging Requirements

PROBLEM IDENTIFICATION

| 1. STATEMENT OF PROBLEM (LIST IN CHRONOLOGICAL ORDER) | 2. DATE IDENTIFIED | 3. AGENCY, GROUP, ETC. WHO IDENTIFIED | 4A. IS THE PROBLEM BEING ADDRESSED BY GREAT II? | 4B. IF IT IS, BY WHICH TASKS | 4C. IF IT'S NOT, WHY NOT? |
|---|---|---|---|---|---|
| 1. There is a need to determine sites that are available for the placement of dredge material. | Prior to GREAT | State and Federal Conservation Agencies | Partially | 4, 5 | Pertains also to MENWG & DMUWG |
| 2. There is a need to reduce, as much as possible, the quantity of material dredged each dredging occurance in the short term. | 1976 | GREAT I | Yes | 2, 3, 5 | In short term will also get reduction from CTWG & general channel widths & depth |
| 3. Definition of a 9-foot channel. | 1976 | GREAT I | No | - | Is being addressed by CTWG Rec. #5501 |
| 4. Determine the effect of a 9-foot channel on dredging requirements. | 1976 | GREAT I | No | - | As written, it is not a problem. |
| 5. There is a need to determine the flow vs. depth vs. dredging requirements relationships. | 1976 | GREAT I | Partially | 1 | Inadequate funding for further study |
| 6. There is a need to determine the relationship between regulation of pool levels and dredging requirements. | 1976 | GREAT I | No | - | Cannot vary pool levels due to real estate, |

Attachment #1

WORK GROUP Dredging Requirements

PROBLEM IDENTIFICATION

| 1. STATEMENT OF PROBLEM (LIST IN CHRONOLOGICAL ORDER) | 2. DATE IDENTIFIED | 3. AGENCY, GROUP, ETC. WHO IDENTIFIED | 4A. IS THE PROBLEM BEING ADDRESSED BY GREAT II? | 4B. IF IT IS, BY WHICH TASKS | 4C. IF IT'S NOT, WHY NOT? |
|---|---|---|---|---|---|
| 7. There is a need to determine the relationship between channel width requirements vs. tow size. | 1976 | GREAT I | No | - | Not a problem at this time in GREAT II area |
| 8. There is a need to determine the relationship between river traffic and dredging requirements. | 1976 | GREAT I | No | - | Not a problem at this time in GREAT II area |
| 9. The environmental and hydrological impacts of riverine disposal of dredge material are unknown. | 1976 | GREAT I | Partially | 6 | Total resolution is not possible within time frame & funding of GREAT II |
| 10. There is a need for long-term reduction of dredging requirements through evaluation of the hydraulic factors of the river as they relate to navigation and channel maintenance. | 1977 | Dredging Requirements Work Group | Partially | 1, 2, 6, 7 | Studies have been initiated for certain factors |
| 11. There exists insufficient capability to maintain all the navigation aids on the Mississippi River. | 1977 | Dredging Requirements Work Group | No | - | Does not directly relate to dredging requirements |
| 12. There is a need to determine the impacts of barge traffic on channel stability. | 1977 | Dredging Requirements Work Group | No, but some studies have been done by WES | - | Low Priority for GREAT II funding |

WORK GROUP Dredging Requirements

PROBLEM IDENTIFICATION

| 1. STATEMENT OF PROBLEM (LIST IN CHRONOLOGICAL ORDER) | 2. DATE IDENTIFIED | 3. AGENCY, GROUP, ETC. WHO IDENTIFIED | 4A. IS THE PROBLEM BEING ADDRESSED BY GREAT II? | 4B. IF IT IS, BY WHICH TASKS | 4C. IF IT'S NOT, WHY NOT? |
|---|---|---|---|---|---|
| 13. There is little time, between the identification of sites requiring dredging and when dredging is accomplished, for coordinating review and permit approval. | 1977 | Dredging Requirements Work Group | No | - | - |
| 14. What are the possible impacts of contract dredging on dredging capabilities? | 1977 | Dredging Requirements Work Group | Partially, M&ENWG also addressing | 3, 5 | Work on writing job specifications |
| 15. There is a need to determine equipment needs. | 1977 | Dredging Requirements Work Group | Yes | M&ENWG | - |
| 16. There is a need to determine the secondary movement of the material at dredged material disposal sites. | 1977 | Federal and state coordinating agencies | Yes | 3, 4, 5 | - |
| 17. What solution, if any, has come from the University of Iowa on Fox Island study in Pool 20? | August 1978 | Public | Yes | 8 | - |
| 18. A gentleman had a problem with the Corps of Engineers building a closing dam behind Fox Island. He feels that it will cut off all the flow into the backwater area, Gray Chute. Is there some other alternative for keeping the flow in the channel without depriving the backwaters? | August 1978 | Public | Partially | 1, 3 | - |

WORK GROUP Dredging Requirements

## PROBLEM IDENTIFICATION

| 1. STATEMENT OF PROBLEM (LIST IN CHRONOLOGICAL ORDER) | 2. DATE IDENTIFIED | 3. AGENCY, GROUP, ETC. WHO IDENTIFIED | 4A. IS THE PROBLEM BEING ADDRESSED BY GREAT II? | 4B. IF IT IS, BY WHICH TASKS (from Attach #3) | 4C. IF IT'S NOT, WHY NOT? |
|---|---|---|---|---|---|
| 19. Current regulatory laws may inhibit maintenance of a safe navigation channel. | August 1979 | Dredging Requirements Work Group | Yes | 3 | - |
| 20. Current conditions of the regulatory structures is unknown | August 1979 | Dredging Requirements Work Group | Yes | 1,3,7 | - |
| | | | | | |
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| | | | | | |
| | | | | | |

Attachment #2

## DREDGING REQUIREMENTS WORK GROUP

Overall Objective:

Methods means by which the volume of dredge material removed for the navigation project in the GREAT II area can be significantly reduced while still maintaining a safe navigable channel should be devised.

Sub-Objectives:

1. Reduce short-term dredging amounts, for each dredging occurrence.

2. Determine the relationships between river flows and depths, and dredging requirements.

3. Determine the relationship between tow sizes and corresponding channel width requirements.

4. Determine the environmental, hydrological, and hydraulic impacts of riverine disposal.

5. Reduce long-term dredging requirements through evaluation of riverine hydraulic factors that relate to navigation and channel maintenance.

6. Identify and analyze the impacts of contract dredging on dredging capabilities.

7. Analyze the relationship between equipment size, availability, and dredging requirements. The results of this analysis would be used to make recommendations as to the new equipment and/or the coordination of use of existing equipment necessary to reduce dredging requirements.

8. Identify dredge material placement sites where placement of the material poses few or no environmental problems and results in slower secondary movement of the dredge material back into the main channel.

9. Identify public concerns regarding regulating structure and propose alternative solutions.

10. Identify the current condition of regulating structures in the study area and determine the relationship between structure condition and corresponding dredging requirements to develop programs, based on these relationships, which reduce dredging requirements through observation and maintenance of regulating structures.

11. Identify laws which inhibit maintenance dredging for a safe, navigable channel, and recommend modification or change to these laws where appropriate.

12. Provide and disseminate information to the public, and Federal and State coordinating agencies about dredging requirements and the factors affecting these requirements.

ORK GROUP Dredging Requirements

FORMULATION OF TASKS

| DESCRIPTION OF TASK | PURPOSE OF TASK | PERSON(S) OR GROUP(S) RESPONSIBLE FOR COMPLETION OF TASK | PROBLEMS ADDRESSED BY TASK | ANTICIPATED COMPLETION DATE OF TASK |
|---|---|---|---|---|
| 1. Sediment Transport Model | 1. To predict movement of sediment in the river.<br>2. Application of baseline data to computer modes (2 stages) | University of Iowa, Institute of Hydraulic Research | 5<br>10<br>18<br>20 | April 1980 |
| 2. Review of Dredging Records | To review the dredging records at various depths and coordinate with other districts | Work Group | 2<br>10 | On-going |
| 3. Work Group meeting and discussions | To obtain and disseminate new or existing information about dredging requirements to other work groups | Work Group | 2<br>10<br>14<br>16<br>18<br>19<br>20 | On-going |
| 4. Disposal Site Selection | To select possible dredge material disposal sites and look for sites in conjunction with other work group concerns | Disposal Site Selection Task Force | 1<br>16 | On-going |
| | | | | |

| DESCRIPTION OF TASK | PURPOSE OF TASK | PERSON(S) OR GROUP(S) RESPONSIBLE FOR COMPLETION OF TASK | PROBLEMS ADDRESSED BY TASK | ANTICIPATED COMPLETION DATE OF TASK |
|---|---|---|---|---|
| 5. Input to, and from, other work groups | To provide or obtain information pertaining to dredging requirements work group problems | Work Group | 1<br>2<br>7<br>14<br>16 | On-going |
| 6. Main Channel Disposal | To develop procedure for carrying out a riverine disposal demonstration project | Work Group | 9<br>10 | Just Initiated |
| 7. Regulating Structures Assessment | To determine the relationship of the current condition of regulating structures to chronic dredging areas | Corps of Engineers | 10<br>20 | January 1981 |
| 8. Use of other studies (i.e., Sediment Transport Study) | To collect baseline data for sediment transport in relation to dredging requirements | University of Iowa | | |

B. 1979 Conditions

1. General History of the Navigation System and Dredging Quantities.

Before any navigation improvements were made, the Upper Mississippi River was an uncontrolled and treacherous river for navigation. Spring floods uprooted trees and carried them into the river, which formed "snags" that were treacherous for vessels travelling the river. Rapids were major obstacles to navigation. The Des Moines Rapids, from Keokuk to Montrose, Iowa, and the Rock Island Rapids from Rock Island, Illinois, to LeClaire, Iowa, were among the most dangerous.

Between 1820 and 1860, the river supported heavy traffic despite its shallowness and hazards. The river facilitated settlement and industrialization of the Upper Mississippi Valley. As the populations of river towns increased, dependable transportation of farm equipment, livestock, and domestic goods became imperative.

Because of the demand for safe navigable inland waterways, the Congress, in 1878, authorized a river improvement program to provide a 4-1/2 foot deep channel in the Upper Mississippi River. A canal was constructed from Keokuk to bypass the Des Moines Rapids and a channel was cut through the Rock Island Rapids. Material was dredged from the channel, and wing dams were built from the shore by the Corps of Engineers to assist scouring of the channel. The Corps also built many closing dams to shut the flow of water off to sloughs and secondary channels. All improvements were aimed at providing maximum flow in one main river channel for navigational use.

By 1900 the railroads were competing with the river transportation, eventually surpassing it in material moved because the river channel was too shallow for large towboats requiring a deeper channel. Commercial river interests petitioned Congress, and in 1907 Congress authorized deepening of the channel between St. Louis and St. Paul to six feet. This improvement was to be accomplished by building more wing dams, dredging, revetting banks, and constructing two locks at the Rock Island Rapids. This project required approximately 10 years for completion, with delays as a result of World War I. Most of the work was completed in the 1920's.

By 1930 the 6-foot channel also became obsolete, as had the 4-1/2 foot channel. This initiated the formation of the present navigation system in 1930, when Congress passed appropriate legislation in that year's "River and Harbors Act". This legislation provided for a navigation channel of at least nine feet deep and a minimum of 300 feet wide with appropriate widths in bendways by construction of a series of lock and dams to work in conjunction with the regulating structures and augmented by dredging at necessary locations.

The lock and dam system was complete by 1940 and provided the increased channel depth needed to accommodate modern barge traffic. As a result, cargo totals on the Upper Mississippi increased from 0.5 million tons in 1930 to 54 million tons in 1970. At the same time, the dams raised the water levels and created many new backwater areas that were larger and provide more stable habitat for fish and wildlife.

Dredging in the Rock Island District has steadily decreased in quantities dredged since the lock and dams were put into operation in the 1940's. The reason for this steady reduction in dredging quantities has been more a result of natural forces than man-made.

Immediately after the lock and dams were put into operation, the Mississippi River changed in its water surface profile during low flows. Before 1940 the river was a free-flowing alluvial river within the constraints of the 6-foot channel training structures. With the implacement of the lock and dams, it became a stepped gradient river. The river bottom was not characteristic to a step-type gradient and, thus, has gradually attempted to readjust its bottom profile, sediment transport characteristics, and main channel location. Huge quantities of material were dredged during this period to maintain a navigable channel. This is because the new channel did not follow the old meandering channel.

After several years of attempting to stabilize the river system from the time the dams were built, the river bottom is somewhat stabilized and does not meander as an uncontrollable river would. Consequently, dredging quantities also began to stabilize and were only a product of the hydrologic cycle. In the last 20 years, the Rock Island District dredging requirements have averaged approximately 989,260 cubic yards per year with an average of 17 sites. Since 1974, the Rock Island District has drastically reduced dredged material quantities to less than one-tenth of those in the past, and less than 100,000 cubic yards at approximately eight sites. See Table 1 for total yearly dredging statistics.

Table 1, History of Dredging Quantities

DREDGING STATISTICS, RID, LAST 20 YEARS

| YEAR | NO. SITES | LINEAL FT. DREDGED | CU. YDS. DREDGED | AVE. CU. YDS. PER SITE |
|---|---|---|---|---|
| 1959 | 13 | 39,545 | 1,348,462 | 103,728 |
| 60 | 17 | 44,930 | 1,002,574 | 58,975 |
| 61 | 15 | 30,720 | 989,832 | 65,989 |
| 62 | 18 | 48,620 | 1,469,818 | 81,656 |
| 63 | 11 | 35,646 | 998,292 | 90,754 |
| 64 | 14 | 33,012 | 868,412 | 62,030 |
| 65 | 23 | 49,726 | 1,366,963 | 59,433 |
| 66 | 21 | 66,360 | 1,554,260 | 74,012 |
| 67 | 17 | 74,545 | 1,873,597 | 110,211 |
| 68 | 16 | 38,640 | 1,025,923 | 64,120 |
| 69 | 16 | 76,570 | 1,088,967 | 68,060 |
| 70 | 17 | 34,270 | 837,635 | 49,272 |
| 71 | 19 | 48,146 | 1,168,767 | 61,514 |
| 72 | 24 | 65,440 | 1,511,279 | 62,969 |
| 73 | 26 | 78,411 | 2,055,539 | 79,059 |
| 74 | 14 | 49,155 | 958,958 | 68,497 |
| 75 | 10 | 30,740 | 586,473 | 58,647 |
| 76 | 6 | 10,796 | 206,874 | 34,479 |
| 77 | 4 | 5,650 | 71,925 | 17,981 |
| 78 | 4 | 6,225 | 68,560 | 17,140 |
| 79 | 8 | 12,480 | 222,500 | 27,813 |
| TOTAL | 313 | 879,627 | 21,275,610 | 67,063 |

The Rock Island District has been able to reduce dredging quantities through a better understanding of the river's bottom and sedimentation characteristics. The Rock Island District and other Districts' experience indicate that advance maintenance dredging practices are not very successful in curtailing the need for future dredging at a particular site in a riverine situation. Similar results were found in the St. Paul District when a sediment trap was constructed at the mouth of the Chippewa River in May 1965 in the hopes that it would catch sediment before it reached the Mississippi River main channel, thus reducing the need for dredging in the channel. In the first year, the sediment trap completely filled and the river reverted to its previous flow and sedimentation characteristics.

Most pools in the Rock Island District have a number of chronic dredging areas. The makeup of the material dredged is generally sand (over 94% quartz, 5% igneous/metamorphic rock, and 1% other). The fineness modules range from 2.1 to 2.72 with 100% passing the #4 sieve, 95% passing the #10 sieve, 40% passing the #40 sieve, and 0% passing the #100.

The annual average volumes dredged and average annual flow in the Rock Island District have been:

| | | Average Volume Dredged (cubic yards) | Average Annual Flow (cubic feet/second) |
|---|---|---|---|
| Past 39 years | - | 1,102,000 | 65,400 |
| Past 20 years | - | 989,260 | 70,200 |
| Past 10 years | - | 761,970 | 74,600 |
| Past 5 years | - | 231,270 | 65,600 |
| Past 3 years | - | 121,000 | 66,200 |

Historically, each spring, as soon as river conditions permit, bi-weekly trips are made by river channel inspectors to check the channel's condition with electronic sounding equipment. The inspectors' reports are submitted to the Rock Island District's Operations Division where they are reviewed to identify problem areas. These problem areas are then scheduled for detailed hydrographic surveys. On the basis of the detailed surveys, the Operations Division determines areas that need to be dredged. The General Engineering Section, Rock Island District, does the estimating of quantities for each dredge cut and maintains the dredging records. The Hydraulics Branch, Rock Island District, provides the fluvial hydrologist expertise to Operations Division to determine dredging depths for each site. Before the actual dredging begins, Rock Island District conducts conferences with affected and concerned Federal and state agencies to discuss the potential dredge and disposal sites. A site is then selected which is accessible with available equipment and which is usually in agreement with all concerned parties. All state and Federal Regulatory functions and laws are complied with.

Eight sites were dredged during the 1979 dredging season. Those site locations are as follows:

| Location UMR Mile No. | Site Name |
|---|---|
| 302-302.4 | Saverton |
| 313.0 | Whitney |
| 349.0 | Buzzard Island |
| 398.0 | Kemps Landing |
| 426.0 | Keithsburg Lower |
| 448.0 | Bass Island |
| 482.0 | L/D 15 Lower Approach |
| 565.0 | Gordon's Ferry |

2. Channel Widths

Authorizing legislation for the Mississippi River [illegible] Channel Project directed the Corps of Engineers to construct a project with a 9-foot channel depth below low water (flat pool) elevations with widths suitable for navigation. Current channel widths are maintained up to approximately 600 feet as determined according to Engineer Technical Letter 1110-2-225 on river bends, and a minimum of 300 feet in areas with little or no directional change. Dredging depth is currently a maximum of 11 feet, unless site specifics indicate a need to dredge deeper than 11 feet. This determination is made after a fluvial hydrologist conducts a detailed study of the site, specific problems, and possible alternatives. This year, Rock Island District dredged 4 sites to 12 feet and 4 sites to 11 feet. The navigation channel was tailored to accommodate the maximum tow size operating on the Upper Mississippi River as 107.5 feet wide by 1,200 feet long, and drafting up to 9 feet.

3. Regulatory Structures

The Rock Island District currently has over 1,150 regulating structures to maintain channel position and depth. The total length of these structures is approximately 178 miles, averaging over 800 feet in length per structure. What effects these structures have on the quantity and frequency of dredging is not fully known. However, the Rock Island District's program to catalog and evaluate existing structures, as will be discussed in a later section, is expected to provide this information for areas where dredging is a recurrent problem.

4. Dredge Schedule

The time when the required maintenance dredging can be accomplished is dependent on the hydrologic-hydraulic conditions of the river (high or low water) and dredging equipment availability. Dredging could commence as early as late spring after the usual period of high water, or at any other time of low water conditions through to late fall. Specific hydrological conditions can require emergency dredging any time except during near flood stages.

The dredging in Rock Island District has been performed in recent years by the dredge William A. Thompson, which is owned and operated by the St. Paul District. The Rock Island District does not own a dredge and is dependent on renting the St. Paul District's equipment. The Thompson is a cutter head suction dredge equipped with 1,850 feet of 20-inch floating pontoon pipeline and a 2,000 horsepower pump. The dredge is capable of pumping 2,000 cubic yards of material per hour as far as 1,650 feet from the center of the dredge cut to shore. Shore pipe can transport the dredge material up to an additional 800 feet to the disposal site. A booster pump boat, Mullen, also owned by the St. Paul District, is often used in conjunction with the Thompson to increase the transport distance up to one mile to the disposal site.

Specifications for contract dredging have been prepared and Invitation for Bid has been offered to the private sector for maintenance dredging in both St. Paul and Rock Island Districts for the 1980 dredging season. However, no bids were received from private industry, and it is anticipated that bids will be solicited again for the 1981 season.

The navigation channel dredging season in the Rock Island District usually starts in August or September, after completion of work in the St. Paul District, except for emergency dredging. The Thompson usually starts from the northern end of the Rock Island District, working down river dredging the most critical areas. Returning northward, it dredges the less critical areas, usually finishing in October. This year, because of a late high-river stage, and scheduled dredging on the Illinois waterway, the dredge Thompson was sent to the Chicago District. Therefore, dredging within the Rock Island District did not begin until late October, after the Illinois River was dredged and river stages on the Mississippi had fallen to very low levels.

The Thompson usually operates 24 hours a day, 5 days a week. During periods of high work load, the dredge is operated 7 days a week. On occasion, when needed, the dredge Kennedy or St. Genevieve from the St. Louis District is used for emergency dredging in pools of Rock Island District. The Kennedy is a "dustpan" dredge equipped with a 24-inch pipeline able to discharge 1,000 feet from the center of the dredge cut. The St. Genevieve is a cutter head hydraulic dredge with a discharge capability of up to 3,000 feet with certain materials. Neither the Kennedy or St. Genevieve has the capability for on-land disposal.

Publicly funded small-boat harbors and a few recreational access channel projects are maintained to a 5-foot project depth. In the past, these operations have been conducted by the Depoe Bay from the Chicago District. The Depoe Bay is a cutter-head dredge equipped with an 8-inch pipeline. For two years the RID maintained these harbors with the 12" dredge Dubuque, which has been transferred to the St. Paul District. More recently, however, these projects are being dredged by private contractor dredges.

All non-emergency dredging is conducted according to Federal and individual state laws which require permits for disposal of dredge material.

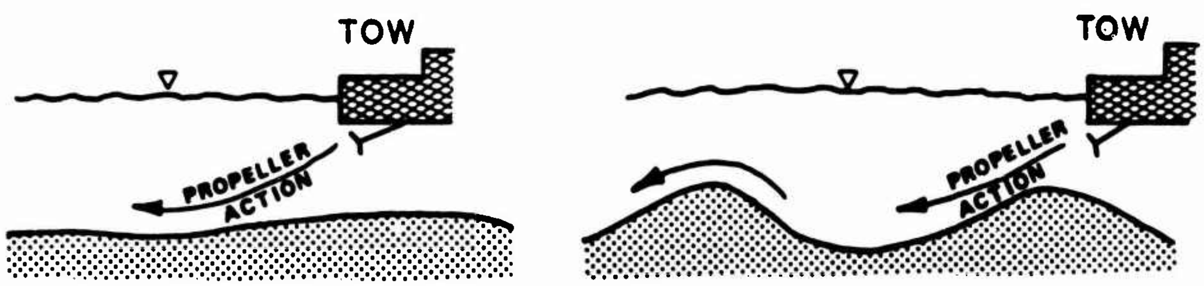
5. Problems in Maintaining a Navigation Channel

a. Natural Effects on Channel

Problems in maintaining the navigation channel, based on experience and analysis of past dredging operations, indicate that regardless of how large a channel may be dredged, the characteristics of the river will only support a channel with a specific size depending on the hydraulic conditions in the channel. For the Mississippi River within the Rock Island District, this channel width generally falls in a range between 200 and 800 feet. Excessive dredging beyond this range is usually ineffective, since these areas will refill at a rapid rate and then stabilize at the width that the channel can support. However, the narrow sections, 200-300 feet, are generally dredged slightly wider than this. This insures that the channel width will remain sufficient at least until the next dredging season. Channel maintenance is further complicated due to storm runoff and its associated sediment loads from the tributary streams. Natural channel slumping is a cause of channel narrowing in many areas of the navigation system. Maintenance dredging is eventually required to alleviate these problems when channel depths and widths decrease and become critical to the safe passage of barge traffic.

b. Barge Traffic and Navigation Aids Effects on Channel

The direct effects of barge traffic on the navigation channels and the resulting requirements for dredging have not been determined on a quantitative basis. However, it has been observed that prop agitation from tows will move the bottom sediments. The sediments may either be moved out of the channel preventing a closure, or they may be moved such that a closure may result. For example, in a section of channel that is slowly shoaling with very light sand, the propeller action of tows passing through the channel may push the shoaling sediments out of the area, thus keeping the channel open until dredging can be done. On the contrary, in a section of channel where heavy sands are shoaling, and the depth is nearing 9-feet, the propellor action may cause a rippling of the channel's bottom causing a channel closure as soon as the tow passes and the sediments settle out. See Figure 1 below for a diagram of the two possible effects of propellor action on bottom sediments.




Wash-out effect on light sand sediments

Rippling effect on heavy sand sediments

Figure 1 - Propellor Action on Bottom Sediments

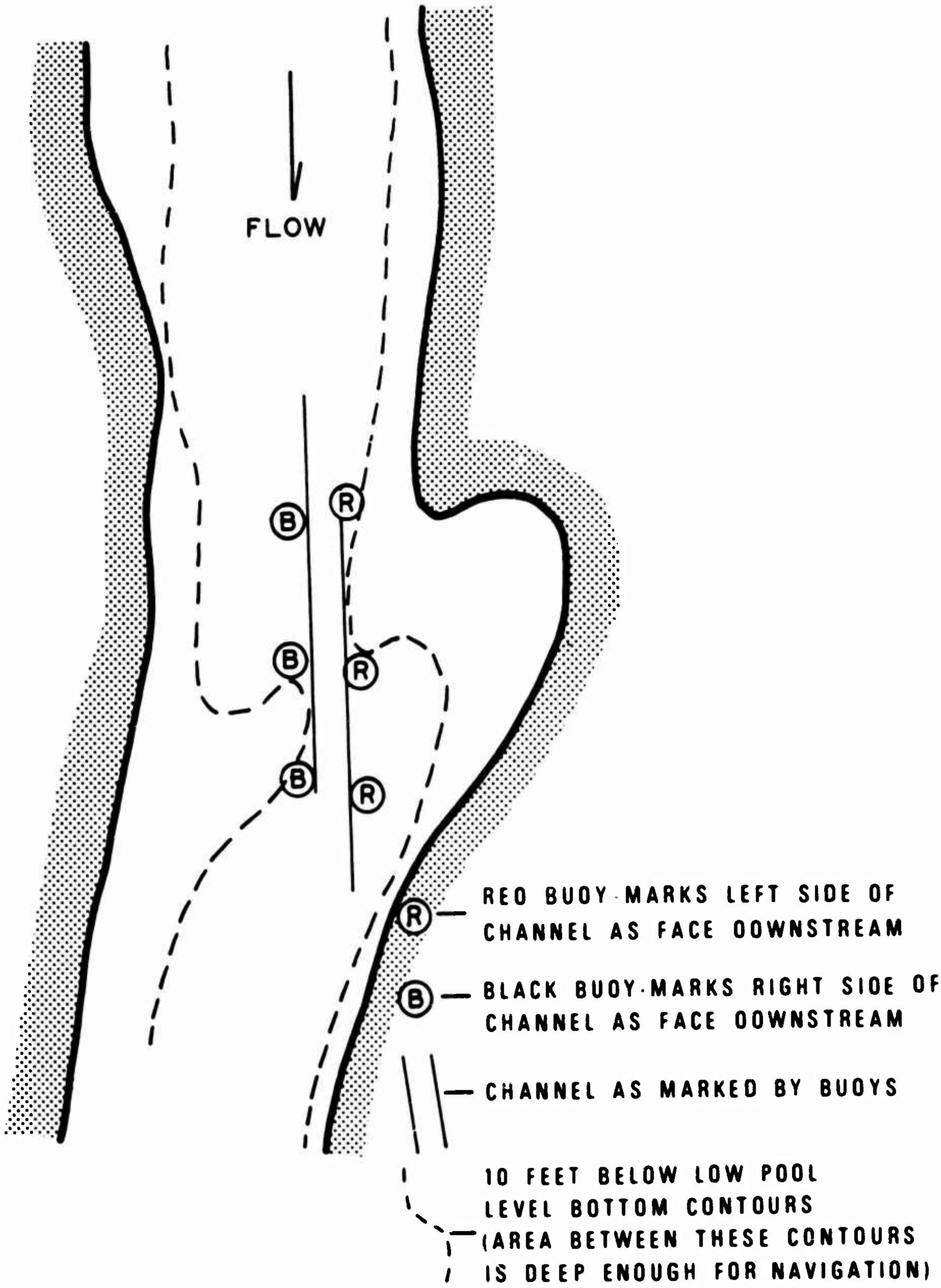
In parts of the Upper Mississippi River where sediments react as in the wash-out effect, navigation aids may be used to direct tows through shoaling-in areas when the channel is nearing closure. This results in keeping the channel open until emergency dredging can be done.

A hypothetical example of how barge traffic can keep the channel open in a known shoaling area can be seen in Figure 2. The area near the center of the drawing that is marked as "shoaling area" may be in the process of shoaling across the channel, but because the barge traffic is being directed through a narrowly marked channel at that point, the propellor agitation may keep the channel open until dredging can be done.

Because the Mississippi River channel hydraulic conditions are dynamic and result in natural shifts in channel alignment from time to time, buoys must not only be carefully positioned initially, but periodically checked and relocated as necessary. Problems with buoy locations may also result when a tow "misses" a buoy and moves it off-station, or as in springtime, ice movement will move buoys. The US Coast Guard has a difficult job of maintaining all the navigation aids in the United States. In the Upper Mississippi River, only two buoy tender vessels, USCG Sanganmon and the USCG Wayaconda, are currently assigned to perform the duty of relocating off-stationed buoys. In view of the high number of navigation aids and miles of river involved, the opportunity to check each buoy's location throughout the system is relatively low during the navigation season.

Since the Corps of Engineers conducts periodic river soundings to spot trouble areas, and has other vessels regularly travelling the Mississippi River, off station buoys are often located or the need for additional buoys is found. Because of the Corps of Engineers' presence and mission to maintain a safe navigation channel on the Mississippi, it should have a buoy tending capability similar to the Coast Guard's. The St. Louis District accomplished buoy tending operations using the M. V. Pathfinder.

## FIGURE 2 - NAVIGATION AID PLACEMENT TO MAINTAIN AN OPEN CHANNEL



6. Public Concerns

Public concerns related to current dredging operations have been expressed at public meetings held in the GREAT II study areas and in response to other public notices issued by the Rock Island District. Generally these concerns can be summarized into the following three categories:

1. Concerns expressed to determine what possible beneficial uses can be made of dredge material near areas requiring frequent dredging. The Dredge Material Usage Work Group is determining the usage of dredge material and are making recommendations in their appendix.

2. Interest expressed by environmental groups as to what would be the expected environmental trade-offs associated with continued channel maintenance and dredge material disposal in the Upper Mississippi River Basin.

3. Interest was expressed by a number of communities for use of dredge material as road fill, for winter street treatment, general construction, beaches, and parks.

C. <u>Projected Future Conditions (Without GREAT II)</u>

1. Barge Traffic

River transportation of goods is a very energy efficient method of transporting large quantities of bulk materials, such as coal, petroleum, and grain. The amount of energy required per unit of material transported is significantly lower with barges than for other methods of transportation, such as rail or truck. This is especially true on the inland water systems where there are no size limits to the number of barges that can be tied together into a "tow." It is not uncommon to see towboats pushing tows of 30 or more barges on the Lower Mississippi River. With the cost of fuels steadily increasing, the amount of energy required to move each unit of material is becoming increasingly important to shipping firms. The result is an expected increase in barge traffic throughout the United States on its inland water systems.

On the Upper Mississippi River, the size of the tows that can be assembled is largely restricted, by the size of the lock chambers that exist in the navigation project. The tow's width is limited to 110 feet since that is the width of all locks on the Upper Mississippi River. Their lengths are not as restricted, and they can be as long as the towboat operator feels he can navigate with, but since the locks are 600 or 1,200 feet long, (the only 1,200-foot lock chamber being at L/D 19 at Keokuk, Iowa), the normal maximum length is 1,200 feet. The maximum draft that the barges can load to is also restricted due to the design of the locks for 9-foot navigation project. Because of the physical restrictions placed on the size of tows that can navigate on the Upper Mississippi River due to the lock and dam system, it would be safe to say that in the future tow sizes will not change and barge drafts will not increase. Since the tows cannot get bigger, it is forecast that the number of tows traveling the river will continue to increase.

2. Future Dredging Requirements

Prediction of future dredging quantities in the Upper Mississippi River is a formidable task to undertake because we are dealing with an alluvial river with major tributary influence. In 1974, the Rock Island District had a statistical analysis performed by John S. Ramberg (1974) of the University of Iowa, concerning the predictability of dredging sites and volumes. Among the conclusions that he made in his report was, "statistical analysis discussed in this report does not lead to 'highly reliable' predictions of dredging sites." With this in mind, the following is our methodology for predicting dredging sites and quantities for the next 50 years.

The baseline data to make dredging predictions should be for the previous 40 years of the 9-foot navigation project. However, emphasis was placed on dredging done during the last 20 years, since we know that the channel has acquired some stability that it did not have immediately after the lock and dam system was put into operation. The river has gradually re-adjusted its slope and cross section to be more compatible with the lock and dam system, Simons, et. al. (1976), and has resulted in dredging volumes continuously declining, especially in the last 20 years.

The projections made in this appendix for future dredging requirements, based on the 20-year history of dredging volumes, may prove inappropriate for the future due to "State of the Art" changes in soil conservation, the practices of managing navigable rivers, and other socio-economic factors. From the baseline data used, no effort was made to predict new sites nor to predict a shift of dredging volumes to the lower pool area which may occur within 50 years (currently most of the dredging occurs in the upper and middle reaches of each pool). The predictions do not reflect changes in river control or regulating structures which could drastically reduce dredging volumes at a given location. The placement of wing and closing dams to alter the river's hydraulics and reduce dredging volumes is going to be a program for continuing study development. Future placement of such structures was not considered in these predictions.

The predictions are based on the assumptions that dredging to 11 feet would be done at almost all locations and that a slight increase in frequency of dredging at some sites may occur because of lesser depths of dredging. In actual practice, due to local hydrological conditions, dredging will be accomplished to 11, 12, and 13 foot, based on consultation between the hydrology experts and operations personnel in order to maintain a safe channel for one navigation season. Included in our predictions are the facts that some reductions in dredging quantities per event has occurred where we are currently maintaining narrower channel widths than was the historic practice. Some of the narrower channels may require increased frequency of dredging as a result.

In summation, the dredging volume projections were made on historical precedence, combined with engineering skills and personal experience of the persons making the projections. Anything more definitive at this time would require a rather expensive study. Furthermore, those results probably would not be much better than what the current "cheap and dirty" analysis made.

The projections are site specific and linear, with no greater weight given to near or long term. The following is an example of how the projections were developed:

Historic Data Base

| Location UMR Mile No. | Site Name | Time Span | Dredging Events | Total Dredged cubic yds | Cu. Yds. Per. Dredging |
|---|---|---|---|---|---|
| 447.5-448.5 | Bass Island | 1941 - 74 | 13 | 895,791 | 68,907 |

Projected Data Base

| Location UMR Mile No. | Site Name | Dredging Frequency | Cu. Yds. Per Dredging | Dredging Freq. 10 yrs. | Cu. Yds. 10 yrs. | Dredging Freq. 50 yrs. | Cu. Yds. 50 yrs. |
|---|---|---|---|---|---|---|---|
| 447.5-448.5 | Bass Island | 1 in 4 yrs. | 35,000 | 2.5 | 87,500 | 12.5 | 437.500 |

The above example has not been analyzed for accuracy; it is intended only to serve as a format example. The predictions made are listed on a pool by pool basis in Section IV of this appendix and should be reasonably accurate for the next decade. However, short-term flow conditions, such as high- and low-water levels and durations, could alter actual dredging substantially during any given season, on the high or low side. The 50-year linear projection should be close, except where changes are made to the channel's hydraulic characteristics, with regulatory structures. These may alter dredging requirements, either at specific sites, or throughout the river system.

Although these volume assumptions are based on 11-foot dredging, many sites will be dredged to 12 or 13 feet in the foreseeable future, until more data is developed that will insure the integrity of the 9-foot channel project with 11-foot dredging.

The overall dredging volume, based on a straight line 50-year projection, is approximately 300,000 cubic yards at 10 sites in an average year. This compares with a previous historical average in excess of 1,000,000 cubic yards per year. It must be noted that in both the predicted future and the historical base, there are a few "average" years.

# III - WORK GROUP ACTIVITIES AND ACCOMPLISHMENTS

## III WORK GROUP ACTIVITIES AND ACCOMPLISHMENTS

### A. Sediment Transport Model (Phase I)

The study is a Field Study of Sediment Transport Characteristics of the Mississippi River near Fox Island (RM 355-6) and Buzzard Island (RM 349-50), NAKATO, et al (1977).

It was conducted by the Iowa Institute of Hydraulic Research, University of Iowa, in mid-1976 primarily to determine the mechanisms and processes responsible for the recurrent shoaling which has been experienced in the reaches of the Mississippi River in the vicinities of Fox Island (RM 355 to 356) and Buzzard Island (RM 349 to 350), in Pool 20 between Keokuk, Iowa, and Canton, Missouri. These shoaling study areas are 9 and 15 miles respectively, downstream from Lock and Dam 19.

The chronic shoaling these reaches historically have experienced has necessitated periodic dredging by the Rock Island District of large quantities of riverbed material in order to maintain the 9-foot navigation channel. Figures 3 and 4 illustrate the chronic shoaling reaches.

Just upstream from the shoaling reaches, the river widens in the downstream direction. Therefore, a reduction in the velocity necessary to support the sediment-transportation capacity of the flow occurs and deposition results. In addition, the shoaling reaches are near the inflection points of the channel thalweg. These "cross-over" reaches are frequently sites of chronic dredging, because of the absence of strong secondary currents which are normally produced in channel bends and which significantly increase the sediment-transport capacity of the flow. Also, the location of these two shoaling sites is immediately downstream from the mouth of the Des Moines River, which delivers a large sediment load to the Mississippi. One conclusion in the study has been that the major source of the sediment for the shoaling areas is from the Des Moines River.

The field study was conducted in order to obtain detailed data on transverse and streamwise distributions of flow velocity, suspended sediment discharge, bed-load discharge, bed material properties, and flow depth. Another objective was establishment of a sediment-transport formula for the study area. The third objective was to evaluate the reliability of existing flow and sediment transport formulas in the same study area, and the last objective was to develop corrective measures which could be implemented to reduce the frequency and volume of dredging required to maintain the 9-foot navigation channel.

The following are the conclusions from the report by Iowa Institute of Hydraulic Research, University of Iowa, Iowa City, Iowa. The Researchers were Tatsuaki Nakato and John F. Kennedy.

1. The vertical distributions of velocity in the study reaches are adequately described by logarithmic relations of the Karman-Prandtl type.

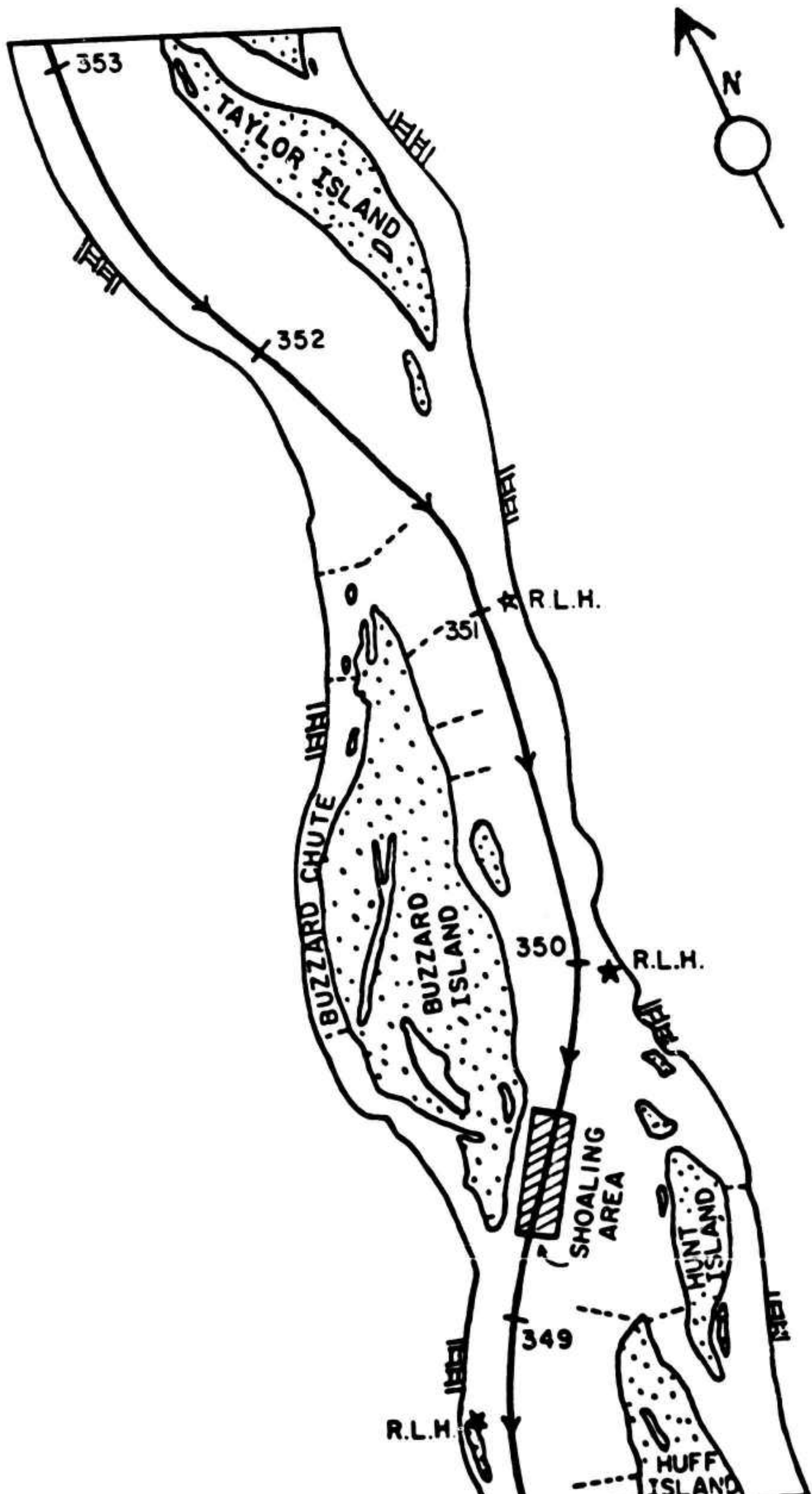



**Figure 3     Buzzard Island study reach**

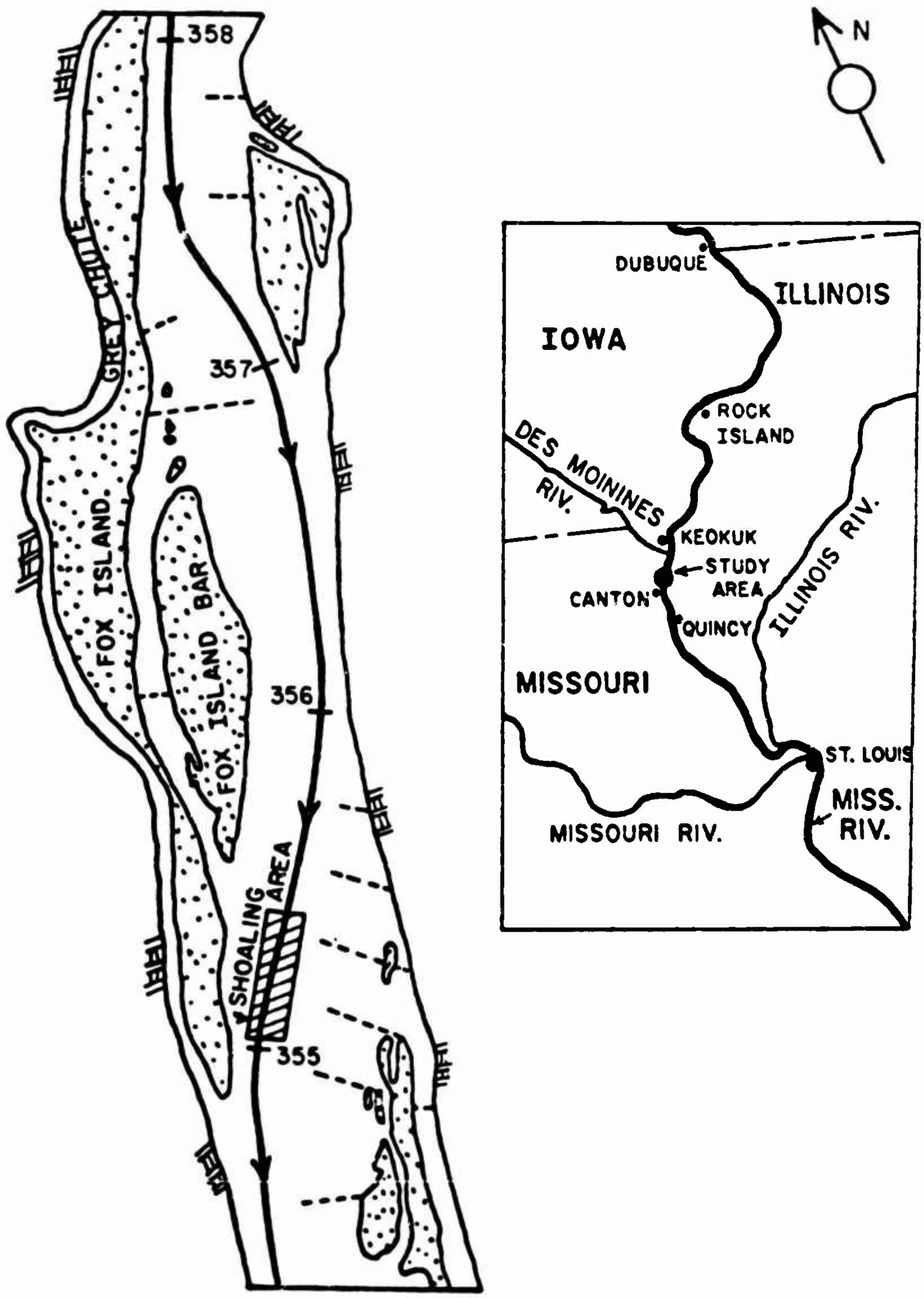



Figure 4 Fox Island study reach

2. The Des Moines River sediment concentrations are generally higher near the right bank of the Mississippi during high stages; but during low stages, the Des Moines flow becomes mixed with the Mississippi flow more rapidly.

3. The sediment causing the problem in the Fox and Buzzard Island areas originates from the Des Moines River Drainage Basin.

4. The flow of the river was found to bifurcate at Hunt and Huff Islands, see Figure 3, with an excess of 25 percent of the flow passing between these islands. It was concluded from examination of the collected field data that this bifurcation and the attendant channel velocity reduction downstream from it, is responsible for the recurrent shoaling in the Buzzard Island reach. Replacing the closure in the channel between Hufford and Hunt Islands would increase the velocity in the main channel by about 25 percent.

5. In the Fox Island reach, see Figure 4, it was found that about 10 percent of the flow passes through the secondary channel between Hackley Island and the Illinois shore. Closure of this channel would increase the sediment-transport capacity of the main channel by about 40 percent, and would significantly reduce the problem in the Fox Island reach.

This study cost $48,527.89.

B. Sediment-Transport Model Studies (Phase II)

Reduction in dredging large quantities of river material could possibly be accomplished if a predictive model was available for the calculation of sediment-transport in the Mississippi River pools in the Rock Island District. The availability of such a model may be used as a decision-making tool to plan of dredging and dredge-material placement. Such a model could assist the District in the design, construction, modification, or maintenance of channel-training devices, such as wing and closure dams. The model would also have the capability to provide information to make engineering decisions to maintain or reclaim aquatic and wildlife habitats in the river's regime.

There are a number of one-dimensional computer-based numerical models of sediment-transport in rivers available. The following models were tested by the Institute of Hydraulic Research, University of Iowa, Iowa City, Iowa.

a. HEC-6: A one-dimensional steady flow simulation model designed to analyze scour and deposition in rivers and reservoirs. The model was supplied by the Hydrologic Engineering Center at Davis, California. In this model cross-sections are each subdivided into a part which is a moveable bed, and a part which is not. The entire moveable bed portion moves vertically while the other remains fixed. The model cannot simulate the development of meanders, the lateral distribution of sediment load across a cross-section, or density and secondary currents. The model does account for sediment particle or mooring and dredging operations.

The model was utilized using monthly, weekly, and daily averaged flow quantities for a 28-month period. There was very little difference between the results using the various intervaled quantities. The costs of the weekly and daily simulations were two and eight times the monthly values, respectively. The model results compared to the 1978 field study were very good in areas where the model was constructed from 1976 cross-sections, but poor in areas where cross-sections were established from 1945 topographic maps. The models overall trends agree well with field observations made in 1976 and 1978. The model illustrated the recurrent shoaling areas at Buzzard Island (RM 349.5) and Fox Island (RM 355). The model simulated the field measurements well in determining the water surface profiles except for periods of ice cover.

b. CHAR2: A one-dimensional mathematical model was developed by Sogreah, a consulting firm in Grenoble, France. The model consists of a one-dimensional steady flow equation and a sediment continuity equation. In the model, the flow celerities are much greater than bed form movement. The flow resistance is defined by manning and is considered constant in time. The bed material is also considered homogeneous. The model only considers bedload transport. The numerical scheme utilized to solve the system of non-linear hyperbolic partial differential equations is an implicit finite-difference method with a double sweep procedure.

Monthly averaged data were utilized and the results included water surface and thalweg elevations, mean velocity, flow discharge, and sediment transport rate at each cross-section of the study reach. The resultant calculated water surface elevation which was simulated, agreed very well with the observed data. The overall prediction of the thalweg elevation seemed to be satisfactory.

c. Colorado State University, UUWSR: It is a one-dimensional uncoupled-unsteady water and sediment routing model. The model employs an implicit numerical method for water routing to solve the water continuity and momentum equations assuming a fixed bed. The sediment continuity equation for routing is then solved at the same time step. This model has been previously applied to Pools 4 and 8 in the Upper Mississippi River system. This model shows promise in its ability to predict river changes. This model provided a good stage elevation prediction.

d. Colorado State University - SUSR: A one-dimensional, steady-uncoupled sediment routing model assumes a fixed bed, then computes the backwater profile for a step discharge by solving the energy equation. The bed elevation changes are determined at the end of the time step by solving the sediment continuity equation. This model has been applied to the Yazoo River Basin and has been found to be excellent in studying long-term changes in a complex river system.

The calibration of both CSU models which simulates flow characteristics and geomorphic changes require the following: (1) the water discharge and water surface elevation at computational cross-sections; (2) the cross-sectional changes; and (3) the sediment transport rates. The model was able to use a longer time step and required less computer time and is better suited to studying long-term impacts.

The following is a summary with recommendations. The contract included testing of the HEC-6 model (Hydrologic Engineering Center, Corps of Engineers), the UUWSR and SUSR models (Colorado State University), and the CHAR2 model (Sogreah). The HEC-6 program was run at the University of Iowa, and the other three models were run by the developers using the basic initial and boundary input data model constructed by the Iowa Institute of Hydraulic Research (IIHR). Although each one-dimensional model has its own numerical model characteristics, accurate prediction of a longitudinal riverbed profile required them to have in common the following three major factors: (1) accurate initial conditions, including a cross-section profile and bed material size distributions at each computational cross-section; (2) accurate boundary conditions such as water and sediment inflows along the model boundaries, quantitative expressions of suspended and bedloads, and sediment size information of the sediment inputs, stage hydrographs at the upstream and downstream boundaries, etc.; and (3) bed roughness characteristics at each computational point, and reliable sediment transport formulas which describe the sediment transport characteristics in the study reach. It is extremely important to understand the interrelationship between these factors; an accurate estimate of sediment transport rate depends entirely on accurate estimates of riverflow characteristics which require detailed geometric information as well as bed roughness, which in turn, adjusts itself according to the sediment transport rate. The interaction between the flow and movable riverbed is a constant, dynamic activity. Therefore, the exclusion of even one item listed above can lead to serious errors in computer simulations. However, since one can hardly be provided with a complete set of input data in a practical numerical application, a lot of assumptions have often to be made to close the gap in the input information.

Unfortunately, the study reach lacked various input data in varying degrees; the most serious one being a lack of information on geometric configurations of the initial Mississippi River bed profiles, sediment inflow rates from the Des Moines River, and bed material size distributions along the river.

Simulation runs of the aforementioned models were all made for a 28-month time period between May 1976 and August 1978. The initial, longitudinal riverbed profiles for the HEC-6, UUSWR, and SUSR models were constructed mainly using COE's 1945 topographic maps, except for the cross-sections measured in 1976 by IIHR. In the CHAR2 model, more recent topographic data obtained by COE in 1974 and 1976, were incorporated for several sections. Therefore, the initial conditions for these two groups were slightly different. The predicted thalweg elevations by the four models were compared with the measured 1978 values. The degree of agreement between the computed and measured values seems to be almost in the same order. Better agreements were generally found in the areas with sufficient input data. As far as a time step for the input is concerned, monthly-averaged input data seem to be sufficient in both the HEC-6 and CHAR2 models; whereas, on the other hand, the two CSU models require a 5-day time step for a flow discharge over 100,000 c.f.s, a 10-day time step for a discharge between 50,000 c.f.s and 100,000 c.f.s, and a 30-day time step for a discharge below 50,000 c.f.s.

In order to apply these numerical models to predict and evaluate accurately the riverbed changes in the study reach, it is indispensable to establish the initial bed profiles at all computation points. This task can easily be accomplished by detailed sounding, including side channels along the reach. Concerning the sediment input information in the Des Moines River, sediment sampling should be continued at St. Francisville, Missouri, to establish a meaningful and reliable flow-sediment rating curve since the Des Moines River is believed to be the major source of sediment responsible for the recurrent shoaling. With these simple, supplementary data, the calibration of one-dimensional models will certainly become more reliable, and the long-term effect of side channel closures, for example, can be tested. Although, a two-dimensional model has been recently developed by CSU and tested for Pool 4 of the Mississippi River, the future of such models is still in the dark merely because of a lack of sufficient field data to calibrate (note here that there are not sufficient input data for even a ONE-DIMENSIONAL case) and the high cost of computation.

## C. Review of Dredging Records

Detailed dredging records have been kept since 1940 in the Rock Island District. The records are very well kept, organized, and easily accessible. The location of each dredge cut in the river, the dates and quantities removed, and spoil location, are all recorded on individual Upper Mississippi River survey sheets and navigation charts. From review of these survey sheets and charts, one can get a very good illustration of what dredging has been done in the last 40 years. Chronic areas are easily noticeable on the navigation charts that are used to keep the dredge records. They appear as an area with many overlapping dredge cuts. Figures 6 and 7 are examples of the charts used to illustrate past dredging sites and show a chronic and a spot dredge area, respectively.

In addition to the navigation charts dredge recording system, detailed graphic charts have been kept summarizing the quantities of material dredged from each UMR river mile for each year since 1945. An example of these charts' format appears below.

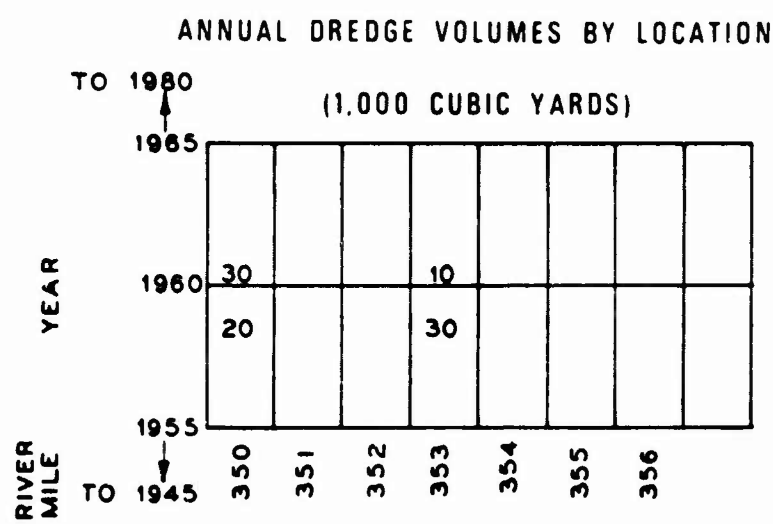



Figure 5

FIGURE 6 - EXAMPLE OF DREDGING RECORDS - CHRONIC DREDGE SITE

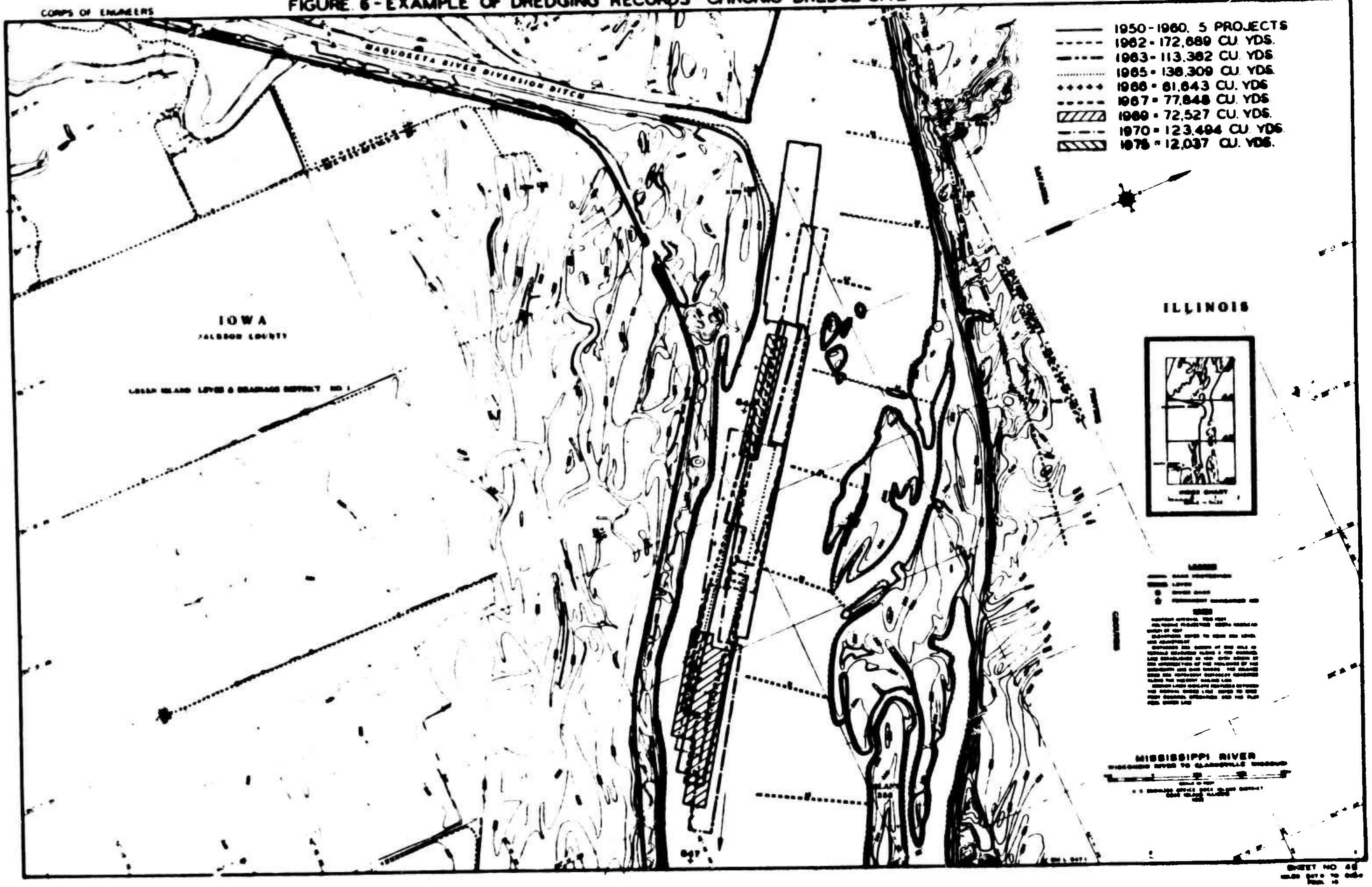
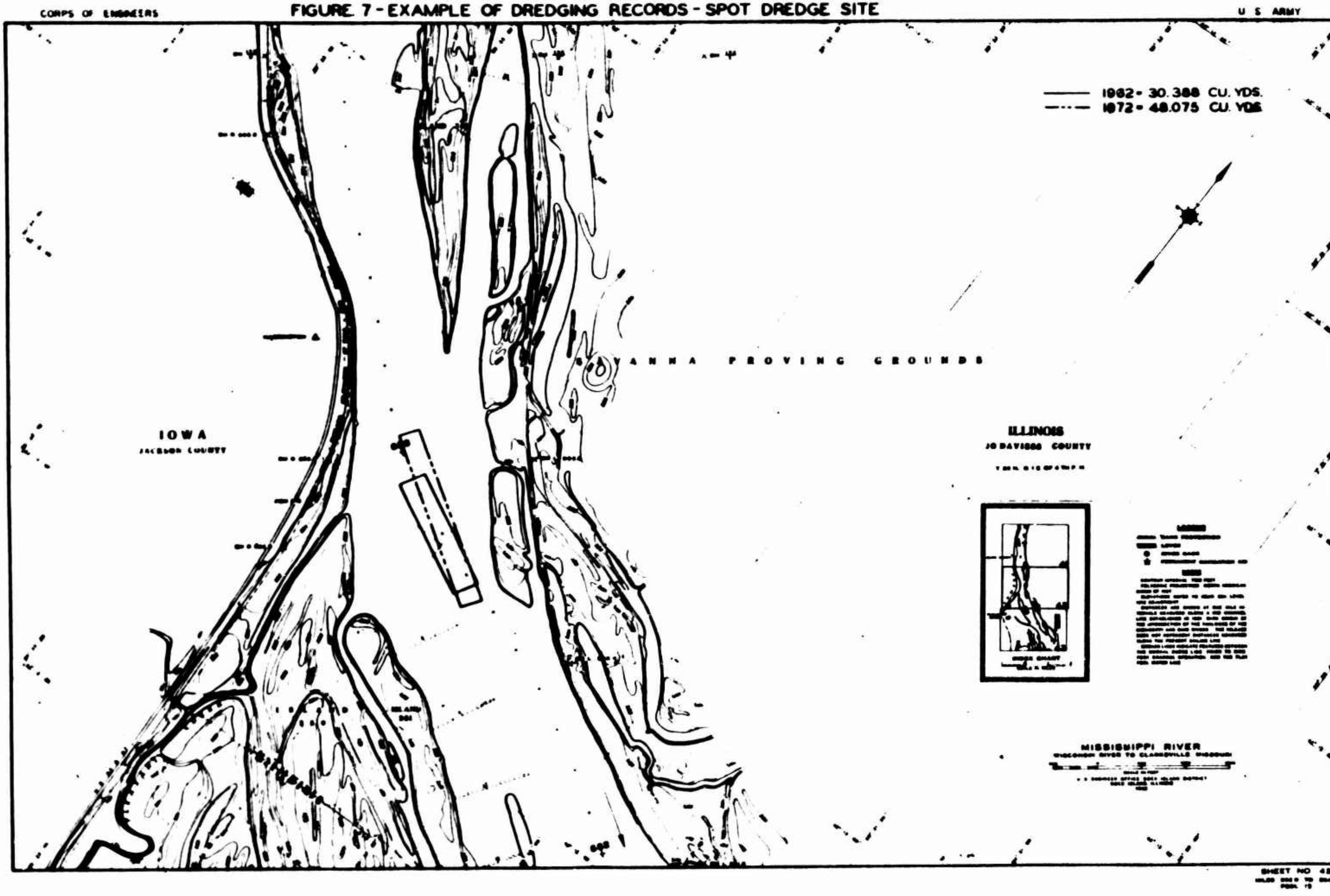


FIGURE 7 - EXAMPLE OF DREDGING RECORDS - SPOT DREDGE SITE



Note: The above is not actual data. For actual quantities dredged, by river mile and year, see the indivudual pool descriptions in a later section of this appendix.

From the hypothetical example above, it can be seen that the reach from river mile 350.6 to 351.0 is probably a chronic dredging area (more than 3 years of data would need to be examined before a conclusion could be made as done here). The chart shows that in 1958, 20,000 cubic yards were dredged, and in 1960 almost 30,000 cubic yards were dredged. At river mile 352.8 to 353.5, there was a sizable cut of 30,000 cubic yards; but from this example of only a few years, it could not be said that this is a chronic dredge area. At river mile 352.4 to 352.6, a small cut was made in 1960 of only 8,000 cubic yards which indicates that it was probably only a "touch up job."

D. Work Group Meetings and Discussions

Work group meetings, both formal and informal, were held as previously discussed to address the problems identified with navigation channel maintenance and dredging requirements. The formulation of alternatives, assessment of impacts and the recommendation of the work group concerning each problem were determined by a group consensus at these meetings.

E. Disposal Site Selection

The Disposal Site Selection Task Force is responsible for the identification of alternative dredge material disposal sites within the GREAT II study area and the recommendation as to which sites should be utilized on both a short- and long-term basis. The task force is composed of members from the various GREAT II work groups. They provide their views of site selection based on their different areas of expertise and interest.

From past experience, most pools in the Rock Island District have a number of chronic dredging areas. The approach of the disposal site selection task force is to look at each dredge cut individually and classify the potential dredge disposal sites around the cut, extending outwards. The task force generally selected sites for consideration in three categories: (1) the historic dredge disposal site, (2) the best alternative site within the flood plain, (3) the best site outside of the flood plain. Beneficial uses for the dredge material is of prime consideration when reviewing the various sites available. The relative strengths and weaknesses of each site as they relate to the National Economic Development (NED) and Environmental Quality (EQ) objectives are also identified by the task force. The selected sites for each area requiring dredging is then submitted to the Plan Formulation Work Group for further analysis and concurrence.

F. Main Channel Thalweg Disposal Proposal

To maintain the 9-foot navigation channel, the Rock Island District has to dredge and dispose of large volumes of material each year. Previous disposal practices have been along banklines, in side channels, on marshes, and on islands. The primary impacts of this disposal are possible reintroduction of the material into the river and alteration of biologically productive habitats.

A comparison of the environmental impacts of open water disposal of dredged material, with its geomorphic and hydraulic properties, has revealed areas of serious conflict. Usually, areas that meet the physical qualifications of desirable disposal sites are often rejected when the biological impacts on the area are considered.

Presently, many of the acceptable areas of disposal have been totally utilized. Further disposal of material at these sites would require extensive work be done to develop these sites, such as the construction of containing structures (i.e., levees and dikes), so that further disposal can be made possible. Also, in many areas along the main channel, the Corps cannot acquire the needed disposal sites because landowners do not want large quantities of material placed on their properties.

The concept of main channel thalweg disposal is supported from a geomorphic point of view. However, the process involves a degree of risk such as possibly affecting the integrity of the channel downstream of the disposal site. However, the risks incurred would be outweighed by the potential decreased environmental impacts at many on-land disposal locations. Further investigation to evaluate the feasibility of main channel thalwag disposal in various river environments is required. The final recommendation for main channel disposal of dredged material will provide a method which is acceptable and determine what impacts may be involved.

The field experience, geomorphic study and mathematical model analysis all indicate that main channel (thalweg) disposal of dredged material can provide a feasible solution to the disposal problem in certain cases. A demonstration project can certainly improve our understanding of the applicability of thalweg disposal.

In this study, tracer methods are proposed for tracking the movement of dredged material disposed of in the main channel. Three categories of tracer methods were evaluated: fluorescent tracers, radioactive tracers, and stable isotope tracers. After considering accuracy, safety, cost, and other related factors, it is determined that the fluorescent tracer method is the most suitable method for this demonstration project. A demonstration project is then planned based on the decision.

The design of the demonstration project considers the selection of study sites, the design of the tracer method, and the development of a data collection program. The major results are summarized below:

a. Based on the knowledge of river characteristics, a suitable thalweg disposal site should be within the practical range of dredging so that the dredged material can be transported to the disposal site without excessive effort. There should not be severe dredging requirements, backwater areas, and side channels immediately downstream of the disposal site.

b. Based on these criteria, a list of suitable and unsuitable thalweg disposal sites in Pools 11 through 22 in the Upper Mississippi River was compiled from a preliminary analysis of dredging records and river geomorphology. However, because frequent or heavily dredged areas (reaches) are the ones with historic disposal site problems, the thalweg disposal concept should be proven or disproven in marginal and unfavorable sites regarding hydraulic suitability and identification of impacts on dredging requirments downstream. Potential sites at River Mile 406, 355, and 332 (two unfavorable sites and one marginal site) were then identified.

c. The amount of fluorescent tracer particles required is about 15 tons if the quantity of dredged material is less than 350,000 cubic yards. Otherwise, the additional amount of tracer particles can be determined by using a tracer concentration of 33 ppm by volume.

d. Sand tracers can be produced by taking bed material from the study areas to be dredged and coating each grain with a thin layer of fluorescent plastic. Dye AX11 (pink), AX15 (orange), A19 (blue) manufactured by Day Glo Color Corporation, or other dyes which minimize background interference can be used to tag sand particles. It is expected that these tracer particles can retain their brilliance during the monitoring period (1 year). However, their hydraulic properties should be examined before utilization by comparing their fall velocities and sediment sizes with those of natural sediment.

e. An underwater TV monitoring system equipped with ultraviolet light can be used to photograph riverbed surface for later counting of tracer particles. Water turbidity in the Upper Mississippi River within the Rock Island District should have no significant effects on the efficiency and accuracy of the TV monitoring system at low and intermediate flows. However, effects of large turbidity at high flows require further evaluations. Some bed-material samples can be collected to determine the relation between the number of tracers counted on the riverbed surface by the TV monitoring system and tracer concentration. With this TV monitoring system, an experienced operator can better define the sampling zone and make necessary adjustments to establish a more effective sampling program.

f. The transport pipeline in a hydraulic dredge should be modified for mixing tracer particles with dredged material in the pipeline before the dredged material is transported to the disposal site. A funnel tube with adequate valve controls can be connected to the transport pipeline upstream of the pump. Tracer particles can then be fed through the funnel tube into the pipeline at an adequate rate. The turbulence generated by the pump ensures uniform mixing of the tracer particles with the dredged material. Another method for mixing tracer particles with dredged material is by dumping tracer particles evenly on the site to be dredged. Then the dredging operation will automatically do the mixing. One potential of this latter method is the possibility of nonuniform mixing.

g. The pipeline discharge point should be modified to control the dispersion of dredged material slurry on the disposal site according to a predetermined pattern. A submerged diffusion system can be utilized to control the dispersion and to minimize the turbidity generated by open water disposal. Because the bed material in the Upper Mississippi River is relatively coarse, a 90-degree elbow submerged at a depth about 3 feet below the water surface to discharge dredged material can provide a reasonable slurry pattern.

h. The fluorescent tracer particles will not cause adverse impact on the environment. The turbidity generated by dredging and open water disposal will be minor and localized. However, the open water disposal may cause impacts on the benthic organisms. Since the main channel of the Upper Mississippi River is, in general, less productive, therefore the impact on the benthic organisms should be minor. In any event, evaluation of the impact should be included in the demonstration project.

i. Data needs, equipment needs, and methods for collection and analyses of samples are described in Sections 4.3.1 and 4.3.2.

j. Data collection periods can be divided into three phases: (1) pre-disposal phase, (2) during-disposal phase, and (3) post-disposal phase. One complete data collection session should be performed for the pre-disposal phase to determine the baseline conditions. One water-quality data collection session should be performed for the during-disposal phase. One complete data collection session should be conducted for the post-disposal phase. Then five subsequent tracer data collection sessions should be performed to trace the movement of disposed material and measure hydraulic variables.

k. The cost for conducting the data collection program at three demonstration sites was roughly estimated to be $300,000. This cost estimate is very preliminary and requires refining during the actual planning of the demonstration project.

A river reach can be generally categorized as a meander, a straight, or a braided river with or without side channels, and/or backwater areas. Ideally, typical reaches of each different river pattern should be investigated in the demonstration projects to evaluate applicability of main channel disposal techniques at different river conditions and locations. However, the cost to implement this comprehensive demonstration project may be prohibitive.

Theories and knowledge of river mechanics, hydraulics, sediment transport, and biological responses can be used to analyze existing data or cursory field review to qualitatively evaluate the applicability of the main channel disposal of dredged material. To better evaluate the applicability of the main channel proposal and predict the river responses, the following alternatives are recommended for future studies:

a. Use three-dimensional physical models of selected river reaches to investigate potential problems induced by thalweg disposal and to trace the movement of disposed material. The model study would enable us to visualize filling of dredged cuts and movement of disposed material. The study results would be very useful for improving knowledge of thalweg disposal and in designing the data collection program in the field demonstration project.

b. Develop a combined one-dimensional and two-dimensional dispersion model to study the dispersion of disposed material. With the calibration of mathematical models using river contour, sediment and hydraulic data, the model can be applied to simulate the movement of disposed particles and investigate related problems. One advantage of the mathematical model is that the model can be easily modified to study different reaches of the Upper Mississippi River, and therefore is very effective in evaluating the general applicabilities of the thalweg disposal methodologies and developing criteria for its application. Also, the mathematical model can be utilized to study long-term impacts of main channel disposal of dredged material.

## G. Regulating Structures Assessment

The Corps of Engineers began building regulatory structures in 1878 when the 4-1/2-foot channel was authorized. The 4-1/2-foot channel was to be achieved by closure of chutes, bank revetment, and contraction of the channel by wing dams. In 1907, the 6-foot channel was authorized on the upper river. The depth increase over the 4-1/2-foot channel was to be accomplished by construction of rock and brush dikes, which like the earlier structures, were low structures extending laterally from the bankline into the river to constrict low-stage flows.

Under the 1930 authorization for the extension of the 9-foot channel from St. Louis to St. Paul, the approach was considerably different than the 4-1/2- and 6-foot projects. The authorization stated that a 9-foot deep, 300-foot wide navigation channel was to be achieved by construction of a system of locks and dams to completely regulate the flow, as well as supplemental dredging to maintain the channel. This required the addition of many new wing dams and the upgrading of others. However, some of the 4-1/2- and 6-foot dikes were not modified and were submerged when the 9-foot project was completed.

Considerable changes in the condition of the dikes has been observed since 1930. In many cases, the exact integrity of the structures is unknown.

In order to fill these informational gaps, Rock Island District established a committee of in-house personnel in August 1979 to assess the regulating structures along the Mississippi River. The committee is known as "Committee to Assess Regulatory Structures" (CARS).

The immediate goal of this committee is to complete a survey program to catalog and evaluate existing regulating structures within the GREAT II study area. The long-range purpose is to determine the effectiveness of the existing regulating structures and to propose possible alterations to existing structures and/or the construction of new structures. The committee plans to accomplish its objectives over a 2-year period through the following sequential work items:

* Determine critical areas of concern with relation to dredging frequency.

* Historical review of wing/closing dam work, including modifications, restoration, and new construction.

* Review of dredging frequency and historical wing/closing dam data to determine critical areas.

* Physical survey of existing structures and water velocities at sites determined critical.

* Review and catalog existing baseline conditions of typical structure hydraulics as applicable.

* Evaluate and recommend solutions at critical sites and programming of funds for work.

* Prepare standard operating procedures for a continuing survey/monitoring program of regulating structures.

* Implementation of standard operating procedure for monitoring regulating structures.

Interim information derived from the program which relates to the potential of reduced dredging in critical areas will be used by the Dredging Requirements Work Group in developing their recommendations for GREAT II.

# IV - FORMULATION OF ALTERNATIVES AND RECOMMENDATIONS

## IV FORMULATION OF ALTERNATIVES AND RECOMMENDATIONS

### A. Process

The tasks that each work group are to accomplish varied by work group, by the type of problem they were addressing, and by the existing knowledge they had about that problem. All work groups needed to collect and organize background information. This background information was used to identify further problems, to provide input and data for other work groups and as part of the narrative for their work group appendix. Where little background information existed, baseline data was collected and/or research studies conducted.

As all tasks were completed, the results were distributed to members of the pertinent work group. Conclusions were then drawn by members of the work group based on the results of their work group's tasks.

The conclusions developed by each work group led to the identification and consequent development of potential alternatives to their problems. The results of some tasks indicated that there still was not enough available information to ensure a knowledgeable assessment of the potential alternative solutions to a problem. In these cases, no alternatives could be formulated and the only recommendation which could be made was for further study of the problem. Where completion of work group tasks led to identification of potential solutions, the alternatives were displayed on Attachment 4. The alternatives varied in specificity from site specific guidelines to general policy changes, dependent upon the problem they were addressing. Alternatives displayed on Attachment 4 were assessed and an alternative selected on the basis of a judgmental impact assessment. Once an alternative was selected; the rationale for its selection and all available supporting documents, information, and studies supporting its selection were identified and displayed on Attachment 4. This information (and other) was used to compile a brief summary of the types of impacts that would result if the recommendation were implemented. Based on the impact assessment and careful evaluation of the recommendation, the work group, through various voting procedures, either approved or rejected the recommendation.

All work group approved recommendations were sent to the GREAT II impact assessment coordinator for review and advice. The coordinator would then mail this information, complete with comments, back to the approprpiate work group chairman. The work group then did a more thorough and detailed assessment of the impact potential of their recommendations. This information was recorded on Attachment 7. Each work group was responsible for obtaining or estimating the necessary information for their impact assessment through their studies, work group meetings, discussions with other work groups, discussions with other agencies having expertise in that particular field, discussions with economists, and discussions with the impact assessment coordinator. When Attachment 7 was completed to the work group's satisfaction, sufficient copies of Attachment 4 and 7 were brought to the next Plan Formulation Work Group meeting. The impact assessment was reviewed by all members present; and additions, changes, or suggestions were made to the impact assessment. Each work group chairman made the appropriate revisions and brought a final version of the impact assessment to the next Plan Formulation Work Group meeting for final review.

At this time, these recommendations were dropped from further active consideration, until all recommendations were submitted by all of the work groups. When all of the recommendations had been submitted to the Plan Formulation Work Group, the development of integrated and final plans began.

The recommendations brought to the Plan Formulation Work Group varies in specificity and implementability and were grouped into the following general categories:

1. Implementable actions with existing authority
2. Implementable actions requiring legislation
3. Implementable studies within existing authority
4. Implementable studies requiring legislation
5. Feasibility studies, etc.
6. Policy changes

Within each of the six groups above, the recommendations varied from general recommendations applying to the river as a whole to those recommendations site specific in nature. Three categories of specificity used to help organize the recommendations into action plans are listed below:

1. General - apply to entire GREAT II reach or entire Upper Mississippi River Basin
2. Pool - apply to a specific pool or group of pools
3. Site - apply to a specific site(s) within a pool

The following recommendations represent those of the Work Group after they were modified by the Plan Formulation Work Group in the plan development process, with the exception of recommendation #4002. The work group felt the Corps of Engineers should have the capability to realign buoys.

## B. General Alternatives

The following are eight sections, each addressing a specific problem identified as needing to be addressed by the Dredging Requirements Work Group. Each Section is further subdivided into 3 sections: (1) display of resulting recommendation developed by the DRWG; (2) Attachment #4 displaying the problem(s) addressed (see Section II, "Problem Identification", subsection A, "Process" for the procedure used to develop the problem statements), subobjective addressed, task(s) used to address the problem(s), alternatives considered as solutions to the problem, alternative selected, rational for the alternative's selection and the elimination of others, and the preliminary impacts that may be expected if the alternative were implemented; and (3) Attachment #7 displaying the detailed environmental impacts that may be expected if the DRWG Recommendation are accepted and implemented.

# IMPACT ASSESSMENT SUMMARY

Dredging Requirements WORK GROUP

RECOMMENDATION NUMBER

| IMPACTS | 4001 | 4002 | 4003 | 4005 | 4006 | 4007 | 4009 | 4011 | 4012 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Noise | | | | | | | | | |
| 2. Displacement of People | | | | | | | | | |
| 3. Aesthetic Values | X | | / | X | | | / | | |
| 4. Community Cohesion | | | | | | | | | |
| 5. (Desired) Community Growth | | | | | | | | | |
| 6. Tax Revenues (COST) | X | X | X | X | X | X | X | | |
| 7. Property Values | | | | | | | | | |
| 8. Public Facilities | | | | | | | | | |
| 9. Public Services | / | X | / | | | | | X | |
| 10. (Desired) Regional Growth | | | | | | | | | |
| 11. Employment/Labor Force | | | | | | = | | | |
| 12. Business/Industrial Activity | = | = | | | | X | = | | |
| 13. Displacement of Farms | | | | | | | | | |
| 14. Man-Made Resources | X | X | / | | X | | X | | / |
| 15. Natural Resources | X | X | / | X | X | | X | | / |
| 16. Air Quality | | | | | | | | | |
| 17. Water Quality/Quantity | = | = | | X | X | | X | | / |

KEY

- X — Significant Direct Impact
- / — No direct Impact, Indirect Impacts May Need Further Assessment
- = — Negligible Direct Impact
- (blank) — No Direct Impact

NOTE: Significant Direct Impacts and Indirect Impacts which may need further assessment are shown and measured on Attachment 7.

RECOMMENDATION #4001

Dredge Material should be disposed of by the Corps by utilizing existing and new disposal sites following guidelines established by GREAT II.

Attachment #4
Dredging Requirements Work Group

DISPLAY OF RECOMMENDATION &
PRELIMINARY IMPACT ASSESSMENT

Recommendation Number 4001

Pool Number General

River Mile District-Wide

Date Approved by Work Group 30 November 1979

1. General problem addressed (write out & use number from Att. #1):

1. There is a need to determine sites that are available for placement of dredge material.
16. Dredged material disposal sites and secondary movement of the material.

2. Sub-problem addressed (write out - use only when necessary):

3. Sub-objective addressed (taken from Att. #2 - write out):

8. To identify dredge material placement sites where placement of the material poses few or no environmental problems and results in slower secondary movement of the dredge material back into the main channel.

4. Tasks accomplished to address problem (taken from Att. #3 - write out):

4. Disposal site selection.

5. Input to other work groups.

5. Listing of alternatives to problem:

a. Utilize existing disposal sites as necessary.

b. Let out contract to identify new disposal sites.

c. Utilize existing GREAT II recommended sites and follow guidelines established by GREAT II to locate new sites.
d. Remove material from flood plain.

e.

f.

g.

6. Selected alternative C (write in the letter).

7. Rationale for selection of alternative:

- Many old sites are still suitable for disposal.
- New sites, closer to dredge activity, may be identified.
- Open channel disposal would reduce need to pipe material and would reduce effects on the terrestrial environment.

8. References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):

- Work group discussions.
- Dredge material uses work group.

9. Rationale for elimination of other alternatives:

- Most other methods are not economical.

10. Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)

- Sites close to dredge site would reduce costs of dredging.
- Beaches may be created along river banks.
- Use of material may help reduce construction costs for local governments for construction, fill material, winter road use.
- Small companies may be formed to process, sell, and distribute material for its commercial value.
- Reduced energy consumption when disposal site is not far from dredge site.
- On-bank disposal upsets terrestrial habitat located there.
- In-channel disposal may increase sedimentation of other stretches of the river and its backwaters.

11. Reason for work group rejection of recommendation:

RECOMMENDATION # 4001
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 1. Aesthetics (Direct Impact) | Visual | Piles of dredge material are unsightly | Piles of dredge material are unsightly | With reduced quantities to dispose of, disposal sites not as large; Future sites selection may be where not within easy view. | Less unsightly dredge spoils piles |
| 9. Public Services (Direct Impact) | $1.00/cu.yd. | Local govt's may use mat'l for winter road treatment, road fill mat'l, in concrete. Sites need to be accessible. | Local govt's may use mat'l for winter road treatment, road fill mat'l, in concrete. Sites need to be accessible. | Mat'l may be placed where inaccessible to reduce visual, environmental impacts. Less material may be available if reduce quantities dredged. Assume 50,000 cy. | $50,000 |
| 14. Man-made resources (Direct impact) | Acres | Dredge mat'l used for river beaches where possible. | Dredge mat'l used for river beaches where possible. | Dredge mat'l used for river beaches where possible. | Unknown |
| 15. Natural resources (Direct Impact) | Biological productivity | Dredged mat'l contains no readily available nutrients. Sites are lifeless until nutrients become available. | Dredged mat'l contains no readily available nutrients. Sites are lifeless until nutrients become available. | Impacts of riverine disposal are unknown. Terrestrial sites will be more carefully chosen. | Unknown at present time. |
| | Gallons fuel | Disposal sites all are on-land. May need pumping. Up to 1 mile, elevation change uphill. 6,000 gallon. | Disposal sites all are on-land. May need pumping. Up to 1 mile elevation change uphill. 6,000 gallon. | Riverine disposal would require less pumping, distance & elevation, less fuel consumed. 10,000 gallon. | 4,000 gallon |

RECOMMENDATION # 4001
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM (Cont'd)

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| | Fish & Wildlife Habitat-Acres | Dredged mat'l disposal has impacted approximately 1,800 acres between 1950 & 1975. | Additional 4,500 acres impacted assuming historic practices & a linear relationship. | Sites chosen to reduce habitat impacts & increased beneficial use. | Reduction of disposal impacts on habitat. |

No, or Negligible, impacts on Impact Nos. 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 16, 17.

RECOMMENDATION #4002

To reduce the quantities of material dredged each dredging occurrence in the short term, detailed hydrographic surveys of each prospective dredge site needs to be done to find the location, depth, and width of the best channel for that stretch of the river to minimize the amount of dredging required. (Navigation buoys should be realigned as necessary by the Coast Guard and they should be supported by the Corps of Engineers Personnel and equipment to assure a safe and navigable channel.) Buoys should be realigned to where the channel might stabilize as determined by the Corps of Engineers.

June 26, 1979

Attachment #4
Dredging Requirements Work Group

# DISPLAY OF RECOMMENDATION & PRELIMINARY IMPACT ASSESSMENT

**Recommendation Number** 4002

**Pool Number** General

**River Mile** Distrist-Wide

**Date Approved by Work Group** 30 November 1979

**1. General problem addressed (write out & use number from Att. #1):**

2. There is a need to reduce, as much as possible, the quantity of material dredged each dredging occurance, short term

**2. Sub-problem addressed (write out - use only when necessary):**

**3. Sub-objective addressed (taken from Att. #2 - write out):**

1. To reduce short-term dredging amounts, for each dredging occurrance.

**4. Tasks accomplished to address problem (taken from Att. #3 - write out):**

2. Review of Dredging Records
3. Work Group meetings and discussions
5. Input to other Work Groups

**5. Listing of alternatives to problem:**

a. Dredge when and where felt necessary, including advance dredging.

b. Layout detailed hydrographic surveys at each prospective dredge site to find location, depth, and width of best channel to minimize dredging required. Also, realign buoys as necessary to maintain safe and open channel, with Coast Guard supported by Corps of Engineers personnel and equipment.

c. Utilize over depth dredging.

d. Work with Commercial Transportation Work Group to find best channel widths and depths for least amount of dredging.

e. Continue current practice of Corps of Engineers of assisting Coast Guard in realigning navigation buoys.

**6. Selected alternative** B **(write in the letter)**

**7. Rationale for selection of alternative:**

Hydrograph surveys are done for chronic trouble spots as needed.

**8. References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):**

- Work Group dicussions
- W.E.S. studies

**9. Rationale for elimination of other alternatives:**

For "e" - Corps does not have equipment or authority to move buoys.
For "a" & "c" - Corps has found that advance and over-dredging don't reduce need to dredge the following year.
- Over-dredging increases volume of material that needs to be disposed of.

**10. Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)**

- Less dredged material for use for beaches, commercial uses.
- Life of disposal sites increases.
- Less environmental impacts at disposal site with less material to dispose of.
- Impact on navigation safety - when use minimum channel widths and depths.
- Cost of dredging is higher on a per cubic yard basis.

**11. Reason for work group rejection of recommendation:**

RECOMMENDATION # 4002
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Cost (direct Impact) | $ /cubic yard | Most efficient operation of dredge cutterhead is when making full 18" cut or more. Any less is less than peak efficiency. | Same as present but with some reduction in dredging quantities. | Cuts of dredge will be shallower, less than 18". Cost per cubic yard dredged will increase. | Increase |
| 7. Public services (Local scale) (Direct Impact) | $ 1.00/cu. yd. | Some local communities use dredge mat'l for road fill, winter road treatment, and in concrete. Mat'l is free to community. | Same as without. Assume 50,000 cu. yd. Also, with riverine disposal, none available to community for use. | Less mat'l to dispose of, communities that used to use mat'l may need to purchase sand - Less funds for other services. | $50,000 |
| 14. Man-made resources. (Direct Impact) | Cubic yards | Where feasible, dredge mat'l used for river beach formation. | Same as present. | Dredging quantities reduced, less mat'l available for use as beach fill. | Decrease |
| 15. Natural resources. (Direct Impact) | Biological productivity | Impacts result from dredge mat'l disposal. | Same as without but with more reduction in quantities dredged, less environmental impacts. | Less material to dispose of, less environmental impacts. | Less environmental impacts. |
| | Gallons fuel | Fuel used to dredge, pump mat'l to disposal site, and to move mat'l within disposal site. 6,000 gallon. | Less mat'l dredged, less to move around in disposal site, less fuel consumed. | Even less mat'l to dispose of, site closer to dredge site chosen, less mat'l to move, more fuel saved. - 10,000 gallon. | 4,000 gallon |

No, or negligible, impacts on Impact Nos. 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 16, and 17.

RECOMMENDATION #4003

Calibrate the existing two-dimensional sediment transport model to assess the regulatory structures' effectiveness and further needs near chronic dredge areas and use model to determine the optimum channel size for a given stretch of the river knowing the flow and depth conditions that exist there.

Attachment #4
Dredging Requirements Work Group

DISPLAY OF RECOMMENDATION &
PRELIMINARY IMPACT ASSESSMENT

Recommendation Number 4003

Pool Number General

River Mile District-Wide

Date Approved by Work Group 30 November 1979

1. General problem addressed (write out & use number from Att. #1):

5. Flow vs. depth vs. dredging relationships.

2. Sub-problem addressed (write out - use only when necessary):

Adequacy of regulatory structures in river.

3. Sub-objective addressed (taken from Att. #2 - write out):

2. To determine the relationships between river flows and depths and dredging requirements.

4. Tasks accomplished to address problem (taken from Att. #3 - write out):

1. Sediment Transport Model.

5. Listing of alternatives to problem:

a. Do nothing - continue to dredge as before.

b. Use physical models - problem areas or District-wide.

c. Use one-dimensional sediment transport models to assess regulatory structures near chronic dredging areas.

d. Refine existing two-dimensional sediment transport model to assess regulatory structure's effectiveness and needs near chronic dredge areas.

e. Determine optimum channel size for given chronic dredge areas knowing flows & depth conditions that exist there.

f. Construct reservoirs on tributary streams to reduce Mississippi River flow & sediment loads.

g. Increase number of wing and closing dams to direct all low water flow into channel.

h. Use a combination of alternatives d & e to assess and correct chronic dredging areas site by site for entire GREAT II study area.

6. Selected alternative h (write in the letter).

7. Rationale for selection of alternative:

- This is the most cost-effective in terms of scientific methods to reduce dredging frequencies and quantities.

8. References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):

- University of Iowa research
- WES studies
- Colorado State studies
- Work done on other rivers (Case studies)

9. Rationale for elimination of other alternatives:

- Too costly to do district-wide models.
- Do not want to convert river into a canal.
- Models alone won't give all needed answers.
- Too costly and controversial to build reservoirs just to reduce dredging on Mississippi River.

10. Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)

- Potential for over construction of regulatory structures.
- Costs of prolonged model development and field testing is very high.
- Dredging costs reduced (or increased with decreased efficiency of dredge operation)
- Less dredge material to dispose of, less disposal site environmental impact.
- Side channel and back water sloughs may be affected by new or upgraded regulatory structures.
- Navigation channel safe for navigation, less closures occur.

11. Reason for work group rejection of recommendation:

RECOMMENDATION # 4003
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Study costs (Direct impact) | $ | Corps of Engineers, hydraulic Engineers, use best available technology and methods to determine how to build or rebuild regulatory structures. | Same as #3, with some chronic areas studied and attempts made to reduce dredging by use of regulatory structures. | Same as #3 with more research done to develop better ways to reduce dredging by use of regulating structures. | 100,000 |
| Indirect impacts on:<br>3. Aesthetics<br>9. Public services<br>14. Man-made resources<br>15. Natural resources | See Impact assessment Forms (Attachment #7) done for Recommendations #4001 and #4002 for the Indirect Impacts that might expect from a reduction in dredging as a result of these studies. | | | | |

No, or negligible, impacts on Impact Nos. 1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 16, 17.

RECOMMENDATION #4005

Conduct main channel disposal experiment as described in the Scope-of-Work for Main Channel Disposal developed for GREAT II to determine the environmental and hydrological impacts of riverine disposal.

June 26, 1979

Attachment #4
Dredging Requirements Work Group

# DISPLAY OF RECOMMENDATION & PRELIMINARY IMPACT ASSESSMENT

Recommendation Number 4005

Pool Number General

River Mile District-Wide

Date Approved by Work Group 30 November 1979

1. General problem addressed (write out & use number from Att. #1):
   9. The environmental and hydrological impacts of riverine disposal of dredge material are unknown.

2. Sub-problem addressed (write out - use only when necessary):

3. Sub-objective addressed (taken from Att. #2 - write out):
   4. To determine the environmental, hydrological, and hydraulic impacts of riverine disposal.

4. Tasks accomplished to address problem (taken from Att. #3 - write out):
   6. Main Channel Disposal

5. Listing of alternatives to problem:

   a. Use present methods for studying the impacts of riverine disposal.

   b. Utilize riverine disposal as needed without regards to study.

   c. Carry out riverine disposal experiment as described in Main Channel Disposal - Scope of Work contract

   d.

   e.

   f.

   g.

6. Selected alternative C (write in the letter)

7. **Rationale for selection of alternative:**

Only alternative that will provide data on the acceptability of riverine disposal.

8. **References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):**

- Colorado State University studies
- Literature search to find other work that was done on riverine disposal practices

9. **Rationale for elimination of other alternatives:**

The effects of riverine disposal on channel maintenance requirements is not known

10. **Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)**

Experiment costs
Environmental impacts of experiment on aquatic life
- Possibility that material may shoal in other parts of channel after riverine disposal, thus impact navigation safety
- Water quality - siltation, chemicals in sediment released
- Increased sedimentation of side channels, sloughs
- Alteration of river hydraulics
- Energy conservation when don't have to pump dredge material long distances to disposal sites
- Less equipment and disposal coordination for riverine disposal practices, compared to piping or barging material to terrestrial sites

11. **Reason for work group rejection of recommendation:**

RECOMMENDATION # 4005
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Cost (Direct Impact) | $ | No research being conducted studying effects of in-channel disposal. | No research being conducted studying effects of in-channel disposal. | Research done to study environmental and hydrological effects of in-channel disposal of dredge material. $300,000 | $300,000 |
| (All impacts as a result of the experiment will be very site specific to area of experiment.) | | | | | |
| 15. Natural Resources (Direct Impact) | Biological Productivity | Do not do in-channel disposal of material. | Do not do in-channel disposal of material. | Aquatic organisms in area of disposal may be affected. | Unknown. |
| | Fishery Habitat Acres | Unknown impact. | No change. | Identify impacts on main & side channels; wing dams; benthos; & spawning & and resting habitat. | Impacts of main channel disposal can be measured. |
| 17. Water Quality (Direct Impacts) | Suspended Solids | Do not do in-channel disposal of material | Do not do in-channel disposal of material. | Suspended solids may increase in area that dispose of material. Period of suspension dependent on particle size. | Increased suspended solids in dredged area. |
| | Hydraulics | Do not do in-channel disposal of material. | Do not do in-channel disposal of material. | In-channel disposal may cause shoaling in backwaters, sloughs, cause change in water flow characteristics. | Could be increased backwater shoaling. |

ATTACHMENT NO. 7

RECOMMENDATION # 4005
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM (Cont'd)

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 3. Aesthetics (Direct Impacts) | Visual Quality | Do not do In-channel disposal of material. | Do not do In-channel disposal of material. | In-channel disposal eliminates on-land disposal sites, cannot see disposed of material. | Increased visual quality on land. |

No, or negligible, Impacts on Impact Nos. 1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16

RECOMMENDATION #4006

Corps of Engineers, Rock Island District, Committee for the Assessment of Regulatory Structures (CARS), should be adopted as a permanent means to evaluate regulatory structures and physical and mathematical models should be utilized to determine the need for regulatory structures in chronic dredge areas, with the goal of long-term reduction of dredging requirements through evaluation of river hydraulics.

June 26, 1979 **Attachment #4**

Dredging Requirements **Work Group**

**DISPLAY OF RECOMMENDATION &**
**PRELIMINARY IMPACT ASSESSMENT**

**Recommendation Number** 4006

**Pool Number** General

**River Mile** District-Wide

**Date Approved by Work Group** 30 November 1979

1. **General problem addressed (write out & use number from Att. #1):**
   10. There is a need for long-term reduction of dredging requirements through evaluation of the hydraulic factors of the river as they relate to navigation and channel maintenance.

2. **Sub-problem addressed (write out - use only when necessary):**
   20. Current conditions of regulatory structure is unknown.

3. **Sub-objective addressed (taken from Att. #2 - write out):**
   5. To reduce the long-term dredging requirements through evaluation of riverine hydraulic factors that relate to navagation and channel maintenance.

4. **Tasks accomplished to address problem (taken from Att. #3 - write out):**
   1. Sediment Transport Model Study
   2. Review of Dredging Records
   6. Main Channel Disposal Project
   7. Regulating structure assessment by Corps of Engineers study

5. **Listing of alternatives to problem:**

   a. Do nothing - condition of most regulating structures remains unknown.

   b. Let contracts to private firms to evaluate the hydraulic function and to survey the condition of the regulating structures.

   c. Rely on Corps of Engineers to continue on-going program of surveying and evaluating structures. CARS - "Committee to Assess Regulating Structures".

   d. Corps of Engineers conducts structure evaluation and contracts out field survey of structures.

   e. Continue in-house small boat soundings to survey existing structures as part of on-going District operation and maintenance program.

   f. Utilize physical and/or mathematical models to determine the need for regulating structures in chronic dredging areas.

   g.

6. **Selected alternative** C & F **(write in the letter)**

7. **Rationale for selection of alternative:**

- Corps of Engineers program is underway (CARS)
- A long-range program is needed to minimize dredging requirements
- Corps of Engineers program (CARS) would be most cost-effective

8. **References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):**

- Dredge records
- Historical data on structures
- Various studies on river hydraulics

9. **Rationale for elimination of other alternatives:**

a. Does nothing to solve problem
b. Cost is excessive
c. Does not meet long-range needs

10. **Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)**

- Cost of program annually
- Reduction of dredging results in; less disposal sites required, lower costs, less energy consumed, less equipment needs, less material for beneficial uses
- Cost of maintaining structures in need of repair
- Impact on aquatic environment due to increased repairing and moving of regulating structures
- Cost of additional structures that are determined to be needed
- Change in distribution of river transported sediments as a result of structure repair or additional structures
- Navigation safety may be affected due to repaired or additional structures

11. **Reason for work group rejection of recommendation:**

RECOMMENDATION # 4006
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Costs (Direct impact) | $ | Corps of Engineers conducting survey of all regulatory structures in Rock Island District (CARS) $100,000/year | Complete study, apply current technology to evaluate structure effects on dredging requirements - $500,000/year | Better methodology to evaluate effects of regulatory structures on chronic dredging areas. $2,500,000/year. | $2,000,000/yr. |
| All other impacts that would be as a result of the field study designed to evaluate the effectiveness of the hydraulic models developed. Impacts that may occur as a result of the field test would be: | | | | | |
| 14. Man-made resources - regulation structures (Direct Impact). | Tons of rock | Regulating structures are rebuilt as found necessary. Use old methods of evaluating effects of structure on sediment transport in area. 5,000 tons at $20/ton. | Regulating structures are rebuilt as found necessary. Use old methods of evaluating effects of structure on sediment transport in area. 30,000 tons at $16/ton. | Will build or rebuild regulatory structures based on findings of new models to predict changes in river hydraulics. 180,000 tons at $14/ton. | 150,000 tons |
| 15. Natural resources (Direct Impact) | Biological productivity | Impacts of regulatory structures on aquatic organisms not fully understood. | Impacts of regulatory structures on aquatic organisms not fully understood. | Better understanding of impacts of regulating structures on aquatic environment will result. | Less environmental impacts |
| 17. Water quantity (Direct Impact) | CFS | Water flows where easiest movement occurs. | Water flows where easiest movement occurs. | Water flows where easiest movement occurs, but with new or rebuilt regulating structures, the distribution of water within reaches of river will change. | Unknown at present |

No, or negligible, impacts on Impact Nos. 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 16.

RECOMMENDATION #4007

Corps of Engineers should determine the optimum location to maintain dredge equipment for emergency and spot dredging and attempt to contract out the average annual amount of dredging to the private sector (i.e., chronic areas, boat harbors).

June 26, 1979

Attachment #4
Dredging Requirements Work Group

# DISPLAY OF RECOMMENDATION & PRELIMINARY IMPACT ASSESSMENT

**Recommendation Number** 4007

**Pool Number** General

**River Mile** District-Wide

**Date Approved by Work Group** 30 November 1979

1. **General problem addressed (write out & use number from Att. #1):**

   14. What are the possible impacts of contract dredging on dredging capabilities?

2. **Sub-problem addressed (write out - use only when necessary):**

   Time and equipment constraints associated with contract dredging

3. **Sub-objective addressed (taken from Att. #2 - write out):**

   6. To identify and analyze the impacts of contract dredging on dredging capabilities.

4. **Tasks accomplished to address problem (taken from Att. #3 - write out):**

   3. Work group meetings and discussions
   5. Input to, and from, other work groups

5. **Listing of alternatives to problem:**

   a. Rely on Corps of Engineers to do all dredging with Government-owned equipment.

   b. Rely on private sector to do all dredging.

   c. Corps of Engineers should determine optimum location to maintain dredge equipment but contract out average annual amount of dredging. (i.e., chronic areas, harbors)

   d.

   e.

   f.

   g.

6. **Selected alternative** C **(write in the letter)**

**7. Rationale for selection of alternative:**
Present Corps of Engineers policy is to increase the amound of dredging by private sector, but must retain emergency dredging capability if private sector is unable to respond in needed time frame.

**8. References used to select alternative (use tasks, support documents and/or discussions, atudies, articles, etc.):**

- Corps of Engineers policy
- Work Group discussion

**9. Rationale for elimination of other alternatives:**

- Existing legislation that Corps of Engineers cannot do all dredging
- Contractors want guaranteed quantities before contract agreed upon
- Time and equipment constraints for emergency dredging by private sector

**10. Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)**

- Cost to Corps of Engineers to purchase, maintain, and operate equipment
- Private dredge companies will form and/or grow to meet Corps of Engineers' requirement for contract dredging
- Private sector dredging operations may not be as safety-minded to maintain a safe navigation channel

**11. Reason for work group rejection of recommendation:**

RECOMMENDATION # 4007
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Costs (Direct Impact) | $ and manpower | Rock Island District rents dredges owned and operated by St. Paul and St. Louis Districts as necessary. Boat harbors contracted to private sector. | Rock Island District rents dredges owned and operated by St. Paul and St. Louis Districts as necessary. Boat harbors contracted to private sector. | More contract dredging will reduce need for Corps of Engineers to own and operate dredges. Fewer Corps of Engineers employees. | Fewer Corps of Engineers employees. More contracting. |
| 12. Business activity (Direct Impact) | $ | Are only a few privately operated dredges operated on Upper Miss. River. | Won't be large increase in number of private dredging companies. | With possible increase in contracting out of dredging, private firms, will expand to meet increased demand. | Increase in private sector. |
| 6. Costs (Direct Impact) | $ | Rock Island District does not own dredge. | Rock Island District does not own dredge. | Increased cost to Rock Island District to purchase, then own and operate its own dredge for emergency dredging only. | Increase costs. |

No, or negligible, impacts to Impact Nos. 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 16, and 17.

RECOMMENDATION #4011

The States of Minnesota, Wisconsin, Iowa, Illinois, and Missouri, should develop and implement a compact based of the GREAT II report, to guide consistent regulatory laws relating to dredging, dredge material disposal, definition of emergency dredging, permitting requirements, and time frame for permit actions.

DISPLAY OF RECOMMENDATION &
PRELIMINARY IMPACT ASSESSMENT

Recommendation Number 4011

Pool Number General

River Mile District-Wide

Date Approved by Work Group 30 November 1979

1. General problem addressed (write out & use number from Att. #1):

19. Current regulatory laws may inhibit maintenance of a safe navigation channel.

2. Sub-problem addressed (write out - use only when necessary):

3. Sub-objective addressed (taken from Att. #2 - write out):

11. To identify laws that inhibit maintenance dredging for a safe navigation channel and recommend modification of these laws where appropriate.

4. Tasks accomplished to address problem (taken from Att. #3 - write out):

3. Work Group meetings and discussions.

5. Listing of alternatives to problem:

a. No action - comply with laws as they currently apply.

b. Corps of Engineers sets up committee to review all laws pertaining to dredging and make recommendations.

c. Suspend all laws inhibiting dredging operations.

d. Corps of Engineers and state and Federal EPA's form joint committee to evaluate dredging regulations and recommend needed changes to law to accomodate a more efficient channel maintenance program.

e. States of Iowa, Illinois, Minnesota, Missouri, and Wisconsin should develop and implement a compact, based on the GREAT II report, to guide consistent regulatory laws relating to dredging, dredged material disposal, definition of emergency dredging, permitting requirements and time frame for permit actions.

6. Selected alternative e (write in the letter).

7. Rationale for selection of alternative:

Corps of Engineers expertise in dredging, state and Federal EPA expertise in environmental management, and state water regulation and conservation departments could provide the most balanced and acceptable changes to the regulatory laws for a safe and environmentally sound navigation channel maintenance program. States of Iowa and Missouri allow on land disposal, State of Illinois allows open water disposal, State of Wisconsin wants material removed from flood plain. Time frame for 404T compliance must be shortened so emergency closures do not occur.

8. References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):

- General discussions of work groups.
- Corps of Engineers experts

9. Rationale for elimination of other alternatives:

a. No change from current problem.
b. Recommendations from a single governmental agency not acceptable in law making process.
c. Unrealistic implementation alternative.

10. Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)

- Safer navigational channel.
- Fewer emergency closures, therefore a more reliable channel. Transportation dependability would increase.

11. Reason for work group rejection of recommendation:

RECOMMENDATION # 4011
LOCATION (RIVER MILE) General
POOL District-Wide

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| Institutions | Number of Institutions Involved | State and Federal regulations exist that may effect the Corps of Engineers' ability to maintain a safe and navigable channel. | State and Federal regulations exist that may effect the Corps of Engineers' ability to maintain a safe and navigable channel. | Interagency action would result, possibly resulting in selected state and Federal regulations being changed to favor maintnenance of a safe and navigable channel. | Corps of Engineers able to maintain a safe and navigable channel. |

All other impacts would be secondary to the changes in legislation that may occur.

## RECOMMENDATION 4012

Dredging and dredge material disposal is a continuous channel maintenance operation. There are thirty potential "recurrent" dredging sites from Mississippi River mile 300.0 to mile 614.0 under the Rock Island District's channel maintenance responsibility. An area of "recurrent" dredging is one that has been dredged at least three times in the last fifteen years, including at least once in the last five years.

During the 1979 dredging season, the Rock Island District dredged nine sites. Six of these sites are "recurrent" sites and are sites Saverton Bluff 302, Whitney Island 313, Buzzard Island 349, Kemps Island 398, Keithsburg 426, and Bass Island 448.

These sites are part of the Dredge Requirements Work Group recommended regulatory structures studies. The improvement of the regulatory structures will improve the adequacy of the river to keep sediments in the main channel and minimize or eliminate dredging in these reaches of the river.

DRWG recommends that the Corps initiate the recommended regulatory structures studies as part of the CARS program as their number one priority.

# DISPLAY OF RECOMMENDATION & PRELIMINARY IMPACT ASSESSMENT

Recommendation Number 4012

Pool Number 11, 12, 13, 14, 16, 17, 18, 19, 20, 21 & 22

River Mile Various

Date Approved by Work Group 30 November 1979

1. General problem addressed (write out & use number from Att. #1):

   There is a need for long-term reduction of dredging requirements through evaluation of the hydraulic factors of the river as they relate to navigation and channel maintenance.

2. Sub-problem addressed (write out - use only when necessary):

3. Sub-objective addressed (taken from Att. #2 - write out):

4. Tasks accomplished to address problem (taken from Att. #3 - write out):

   Regulating structures assessment

5. Listing of alternatives to problem:

   a. The Corps should initiate the attached recommended regulating structures studies.

   b. Do nothing.

   c.

   d.

   e.

   f.

   g.

6. Selected alternative A (write in the letter)

**7. Rationale for selection of alternative:**

a. Recommendation of Corps fluvial hydrologists.

b. Recommendation by contractor of Fox Island and Buzzard Island study.

c. Regulating structures study being conducted by State of Iowa.

**8. References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):**

a. Study conducted in April 1977.

b. Study conducted in July 1979.

c. Study presently being conducted by State of Iowa.

**9. Rationale for elimination of other alternatives:**

Does not accomplish task.

**10. Preliminary impact assessment of selected alternative. (List below <u>all</u> general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)**

1. The backwater areas would have slower moving water with the potential of less depth.

2. The main channel velocities will become faster.

3. Potential for impact on fish feeding and nursing areas.

**11. Reason for work group rejection of recommendation:**

## DREDGING REQUIREMENTS WORK GROUP

The following regulatory structures studies should be conducted by the Corps' "CARS" Committee.

Pool #11:

a. Closure of Ackerman's Cut, located at mile 613.8, except to small boat traffic, should be accomplished.

b. Closing Dam No. 2 and Wing Dam No. 12 near river mile 599.3 should be examined for their adequacy to keep sediments moving in the main channel.

Pool #12: Study of closing dam at upstream end of Deadman's Slough, located at mile 569.1, for adequacy to keep sediments moving in the main channel.

Pool #13:

a. Study of wing dams in the Sand Prairie reach above the mouth of the Maquoketa River, located at mile 549.8 to 550.8, for adequacy and design elevation to keep sediments moving in the main channel.

b. Monitor the restored wing dams, located at mile 546.0 to 548.8, for the next five years to determine that wing dams remain adequate to move sediment, especially in years when ice jams occur.

c. Monitor river channel from mile 544.0 to 545.0 to determine if additional sediments are being deposited in this reach. If additional sediments are being deposited, Wing Dams 14, 15, 17, and 18 should be studied for adequacy to keep sediments moving in the main channel.

d. Monitor wing dams and bank revetment from mile 540.5 to 541.0 to determine if further deterioration has taken place.

e. Closing Dam No. 15 at river mile 532.9 should be examined for adequacy to maintain flows in the main channel.

f. Wing Dams 19, 20, 21, and 22 located on left bank at river miles 531 to 532 should be examined for adequacy to maintain flows in the main channel.

Pool #14:

a. A model study should be made of the reach of the river from river mile 512.8 to 517.5 to determine what action should be taken to keep the sediments moving in the main channel and Beaver Slough channel.

b. Wing Dams 25, 26, and 27 and Closing Dam No. 17 located at river miles 503.3 to 505.9 should be examined for adequacy to maintain flow in the main channel.

Pool #16:

a. A flow study should be made of the reach of the rivers from river mile 472.0 to 473.2 to determine the method to keep the sediments moving in the main channel at Buffalo, Iowa.

b. Regulating structures located at river mile 461 to 462 should be examined for their adequacy to keep sediments moving in the main channel.

Pool #17: Regulating structures located at river miles 447.5 to 448.5 should be examined for their adequacy to keep sediments moving in the main channel.

Pool #18:

a. Monitor river channel near Wing Dam No. 16 located at river mile 433.7 near the Iowa River to determine if additional sediments ae being deposited in this reach.

b. Regulating structures located at river miles 431 to 432 should be examined for adequacy to keep sediments moving in the main channel.

c. Regulating structures located at river miles 425.5 to 426.5 should be examined for adequacy to keep sediments moving in the main channel.

d. Examination of Wing Dams 16, 2, 3, 6, 7, 33, and 35 located at river mile 424.2 to 424.7 for adequacy to keep sediments moving in the main channel.

e. Regulating structures located at river mile 418.5 to 420.5 should be examined for adequacy to keep sediments moving in the main channel.

Pool #19:

a. Regulating structures located at river miles 404.3 to 408.4 should be examined for adequacy to keep sediments moving in the main channel.

b. Regulating structures located at river miles 398.2 to 399.2 should be examined for adequacy to keep sediments moving in the main channel.

c. The placement of a regulating structure at river mile 399 should be studied to determine if it would improve the flow in the main channel.

Pool #20: The recommendations of the University of Iowa, Institute of Hydraulic Research report on Fox Island Reach, river mile 355 to 356 and Buzzard Island Reach, river mile 349 to 350, should be implemented.

Pool #21:

a. Wing Dams No. 12 and 14 on the right bank and No. 29, 15, 16, and 13 on the left bank and Closing Dam No. 5 between river miles 335.9 to 337.3 should be examined to determine their adequacy to keep sediments moving in the main channel.

b. Regulating structures located at river miles 331 to 333.2 should be examined to determine their adequacy to keep sediments moving in the main channel.

Pool #22:

a. Regulating structures located at river miles 323.5 to 324.7 should be examined for adequacy to keep sediments moving in the main channel.

b. Wing dams located at river miles 319.5 to 321.0 should be examined for adequacy to keep sediments moving in the main channel.

c. Closing structures located above Beebe Island river mile 317 should be examined for adequacy to keep sediments moving in the main channel.

d. The placement of a closing dam at the upstream end of Armstrong Island river mile 313.7, and Wing Dam No. 17 at river mile 304.1 should be examined for adequacy to keep sediments moving in the main channel.

e. Wing Dam No. 12 at river mile 305.4 should be examined for adequacy to keep sediments moving in the main channel.

f. Closing Dam No. 2 at river mile 302.7 should be reconstructed to the original elevation and the wing dams located at river mile 302.0 to 303.5 should be examined for adequacy to keep sediments moving in the main channel.

RECOMMENDATION # 4012
LOCATION (RIVER MILE) Various
POOL 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, & 22

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Cost | $ | Cost of dredging $300 k/year<br>Cost of reg. struct. repairs $300 k/year | Cost of dredging $200 k/year<br>Cost of repairs $500 k/year | Cost of dredging $100 k/year<br>Cost of repairs $2,500 k/year | -100 k/year<br>+2,000 k/year |
| 15. Man-Made Resources | Feet of reg. structures | Regulating structures have deteriorated since their original const. | Repairs made but not on a scheduled basis. | All regulating structures repaired & maintained. | Unknown. |
| 16. Natural Resources | Biological Productivity | Biological resources in back waters receiving water in these areas. | Some areas would be changed. | In all restored areas biological resources would be changed. | Unknown. |
| | Fish & Wildlife Habitat. Acres & Quality. | Loss of habitat at recurrent sites from increased dredging. | Reduction in some dredging volumes & disposal as budget allows. | Reduction in impact of disposal. Additional impacts from construction & a potential for, decreased flows in backwaters. | Protection of habitat at disposal sites at expense of unknown losses at construction site & adjacent backwaters. |
| 17. Water Quality | c.f.s. | Water flowing slower than needed to keep sediments moving. | Some areas would be changed. | All areas that can be improved would be. | Unknown. |
| 18. Aesthetic Quality | Visual | Fresh water flowing naturally in back water area. | Some areas would be changed. | Minimum amount of fresh water in back water areas. Area can become stagnant during low flows. | Unknown. |

No, or negligible, impacts to Impact Nos. 1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, & 14

C. Pool Descriptions

Following are twelve sections, each addressing a specific pool in the Rock Island District.

Each pool section addresses; (1) Extent and frequency of dredging since 1945; (2) Areas of recurrent or recent dredging; (3) Hydraulic conditions causing the problems in chronic dredging areas; (4) Projected dredge sites for the next 50 years; (5) Projected dredge quantities for the next 50 years based on past dredging quantities; (6) Display of pool specific recommendation, Preliminary Impact Assessment, and detailed impact assessment (Attachments #4 & #7); (7) Location of projected dredge sites for next 50 years.

Regulatory Structures - Wing dams were constructed prior to the nine-foot channel project to produce a faster current in the navigation channel, with the intent of reducing the need for dredging. Repairs and adjustments have been made to many of the wing dams since their placement. Continued adjustments of height and length are made to the wing dams to improve the channel's hydraulic conditions to reduce dredging.

Some closing dams with flow passes have been placed in and across sloughs, slowing the current entering sloughs and forcing water into the main channel during low water periods. The banks along the channel have been protected where necessary to prevent erosion and maintain channel integrity. There are cases of bank erosion occurring due to the lack of bank protection, but have not been protected in the past because they are not necessary to the navigation channel.

Following each specific pool section, "Dredging Site" maps are included. The locations of wing dams, closing dams, and bank protection works are shown on each map. Also shown on each map are the projected dredge cut sites. Historic dredge cut sites are not shown separately on these maps and are parts of the dredge sites shown.

Areas of Recurrent and Recent Dredging - An area of "recurrent" dredging is one that has been dredged at least three times in the last 15 years, including at least once in the last 5 years. Areas that do not meet this criterion, but have been dredged twice in the last five years, were considered possible recurrent area.. and were classified as "recent".

## POOL 11

Extent and Frequency of Dredging - Channel maintenance dredging has been done primarily in the upper portion of the Pool 11. The total amount of material dredged since 1945 has totaled 2.72 million cubic yards from 12 locations. Chart 11A, Plate 1, "Extent and Frequency of Dredging" illustrates the quantities of material dredged in thousand cubic yards by mile location and the year dredged. The annual summary of volumes dredged is extended to the right of the chart and the number of dredge cuts that have occurred by mile of river channel is extended directly below. For the locations of past and expected future dredging sites, see the attached "Dredging and Disposal Sites" charts for Pool 11. In Pool 11, approximately 17 percent of the 32.1 river miles has been dredged since 1945.

Areas of Recurrent and Recent Dredging - In Pool 11, only the area from UMR mile 609.5 to 610.2 has been identified as recurrent in the past.

Hydraulics

The dredging in Pool 11 originates from two sources. The dredging problem between MR Mile 613.8 to 607.5 is from fluvial sediments being deposited from either material being transported downstream from Pool 10 or from the Turkey River.

The area mostly influenced by the Turkey River is from UMR Mile 609.3 to 607.5. The sediment that is carried into the Mississsippi River by one of three Turkey River channels is being carried at a higher velocity because its slope is more steep than the Mississippi River's. The velocity of the Turkey River is slowed as it encounters the large pool of slower moving water and the sediment that was being carried is released and shoaling begins.

The problem between 613.8 to 609.3 results from the bifurcation of flows at MR Mile 613.8. At least 25 percent of the flow is directed down Cassville Slough via Ackerman's Cut. This reduction in flow reduces the velocity, suspends the sediment, and deposits it downstream, primarily in the cross-over portions of the channel.

Studies by Nakato and Kennedy have found that the bed-load discharge varies by the fourth power of velocity, and the suspended-sediment load varies by the square of velocity. This problem occurs throughout the RID and deposition occurs.

Closure of Ackerman's Cut would roughly double the bed-load transport capacity through the navigation channel.

The area near Hurricane Island, Mississippi River Mile 598.6 to 599.1, should be investigated because of the deposition of material in this reach, primarily since the late 1960's. Deposition in this reach is unusual because of the width of the river and the velocities which carry the material through this reach. Field surveys have indicated that

Closing Dam No. 2 has been degraded up to 50 feet, therefore allowing large volumes of flow to pass down this chute. It also appears that Wing Dam No. 12, R. M. 599.3, has been partially degraded, reducing its effectiveness. The flows are bifurcated at RM 599.2 and the material is deposited in the main channel due to velocity reduction. It is recommended that these two structures be examined for their adequacy.

Future Dredging - In Pool 11, even though only one site has been identified as "recurrent" in the past, five will probably need regular maintenance dredging in the next 50 years based on expected river conditions, and dredging requirements and practices. These sites and their expected quantities and frequencies of dredging are shown below: (assuming dredge depth of 11 feet)

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 612.3-613.0 | 1) Goetz Island | 1 in 5 | 25,000 | 2.0 | 50,000 | 10.0 | 250,000 |
| 610.0-614.0 | 2) St. Louis Woodyard | 1 in 5 | 25,000 | 2.0 | 50,000 | 10.0 | 250,000 |
| 609.0-610.0 | 2) Turkey River | 1 in 5 | 25,000 | 2.0 | 50,000 | 10.0 | 250,000 |
| 598.0-599.0 | 3) Hurrican Island | 1 in 6 | 15,000 | 1.7 | 25,500 | 8.5 | 127,500 |
| 595.5-596.5 | 4) Finley's Landing | 1 in 6 | 35,000 | 1.7 | 59,500 | 8.5 | 297,500 |

1) At Goetz Island, the frequency of dredging for the next 50 years is expected to decrease as compared to the historic 40 year average for the site.

2) At the St. Louis Woodyard and Turkey River Dredge Sites, the frequency of dredging for the next 50 years is expected to decrease as a result of recent regulatory structure restoration work done in the areas.

3) At Hurricane Island, the frequency of dredging for the next 50 years is expected to increase as compared to the historic 40 year average for the site.

4) At Findley's Landing, the frequency of dredging is expected to increase in the next 50 years even though a narrower channel will be maintained.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged in Pool 11, is shown in Chart 11b, Plate 2, "Projected Dredging". The total amount of material to be dredged from Pool 11 in the next 50 years is expected to be approximately 1.175 million cubic yards. This quantity is slightly more than the average that has been dredged during the last 20 years in Pool 11.

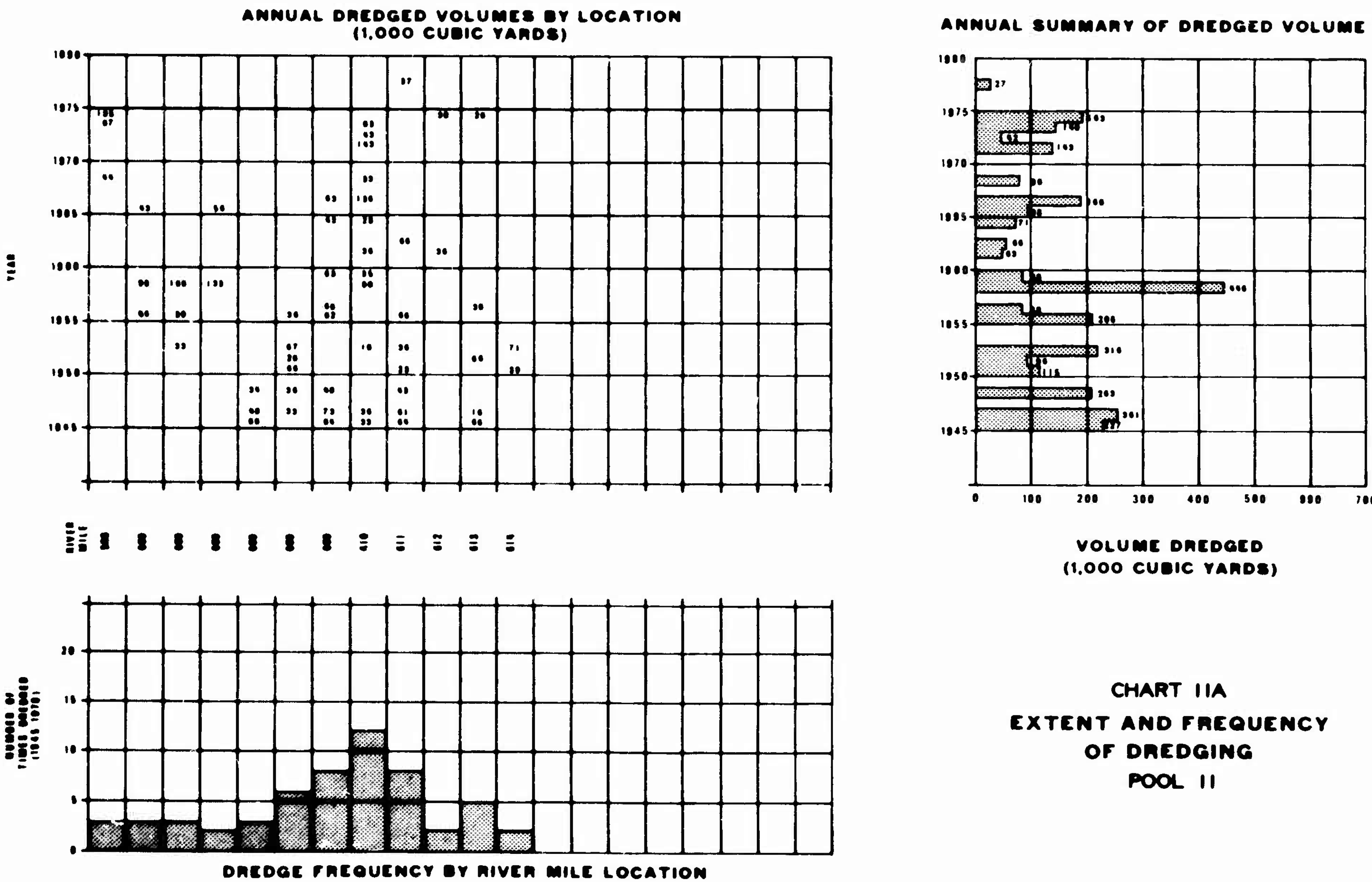



CHART 11A
EXTENT AND FREQUENCY
OF DREDGING
POOL 11

PLATE 1

## CHART IIB – PROJECTED DREDGING, POOL II

CHANNEL DREDGING PROJECTION

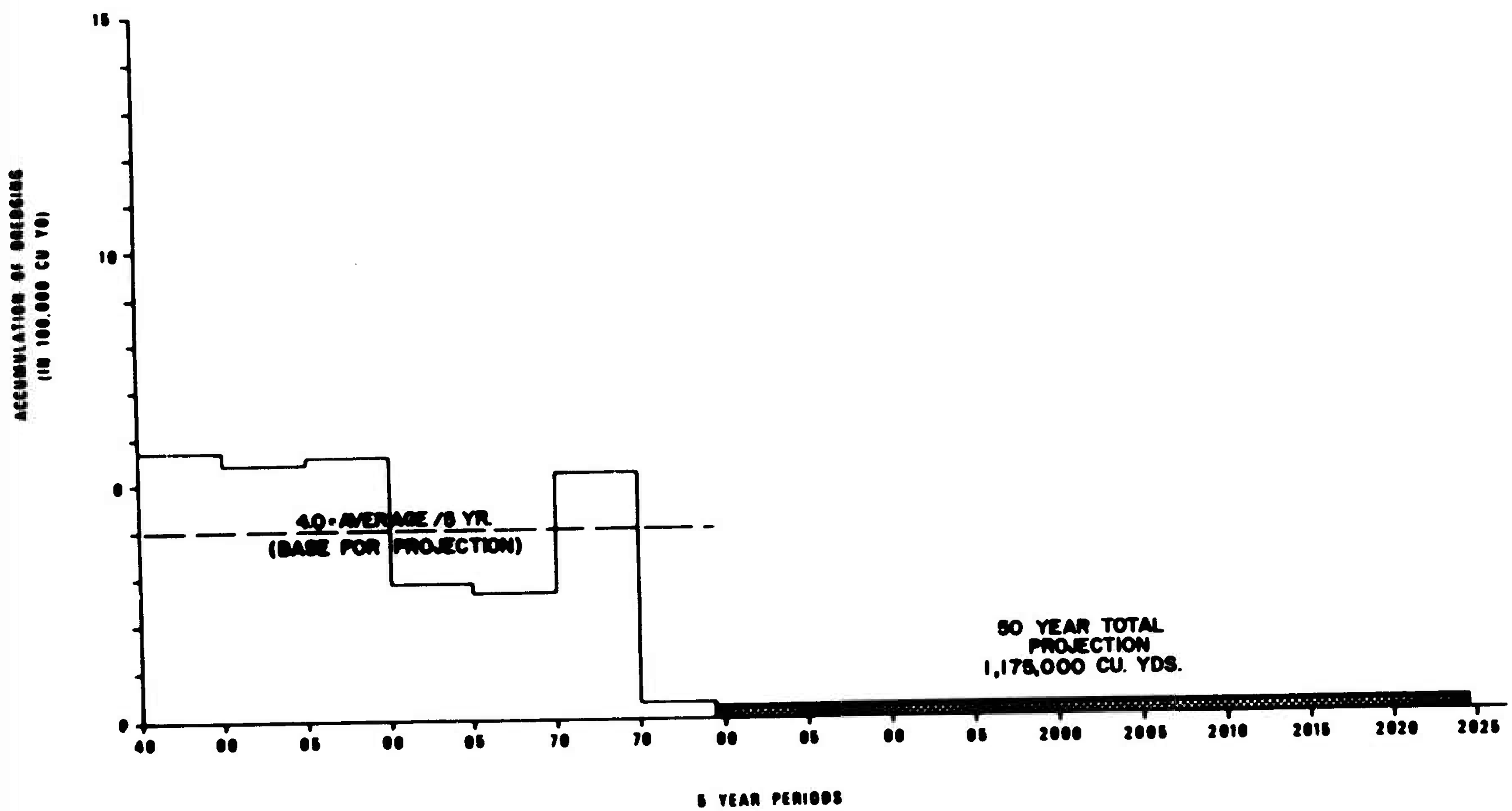
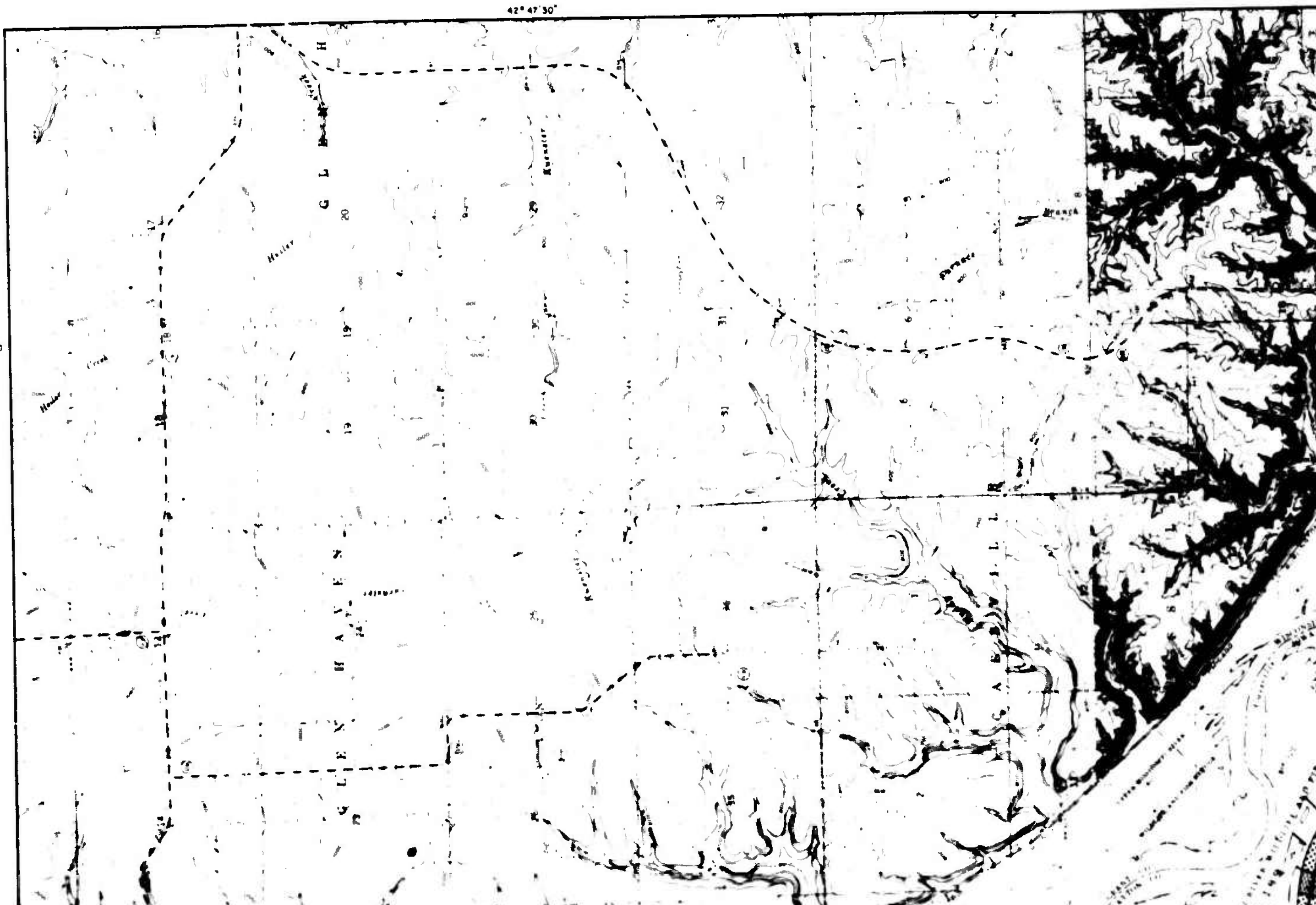



PLATE 2

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
(POOL 11 — LOCK AND DAM 10 TO MILE 605)



UPPER MISSISSIPPI RIVER
ENVIRONMENTAL ATLAS
(POOL 11 — MODULE 1)


LEGEND

**UPPER MISSISSIPPI RIVER**

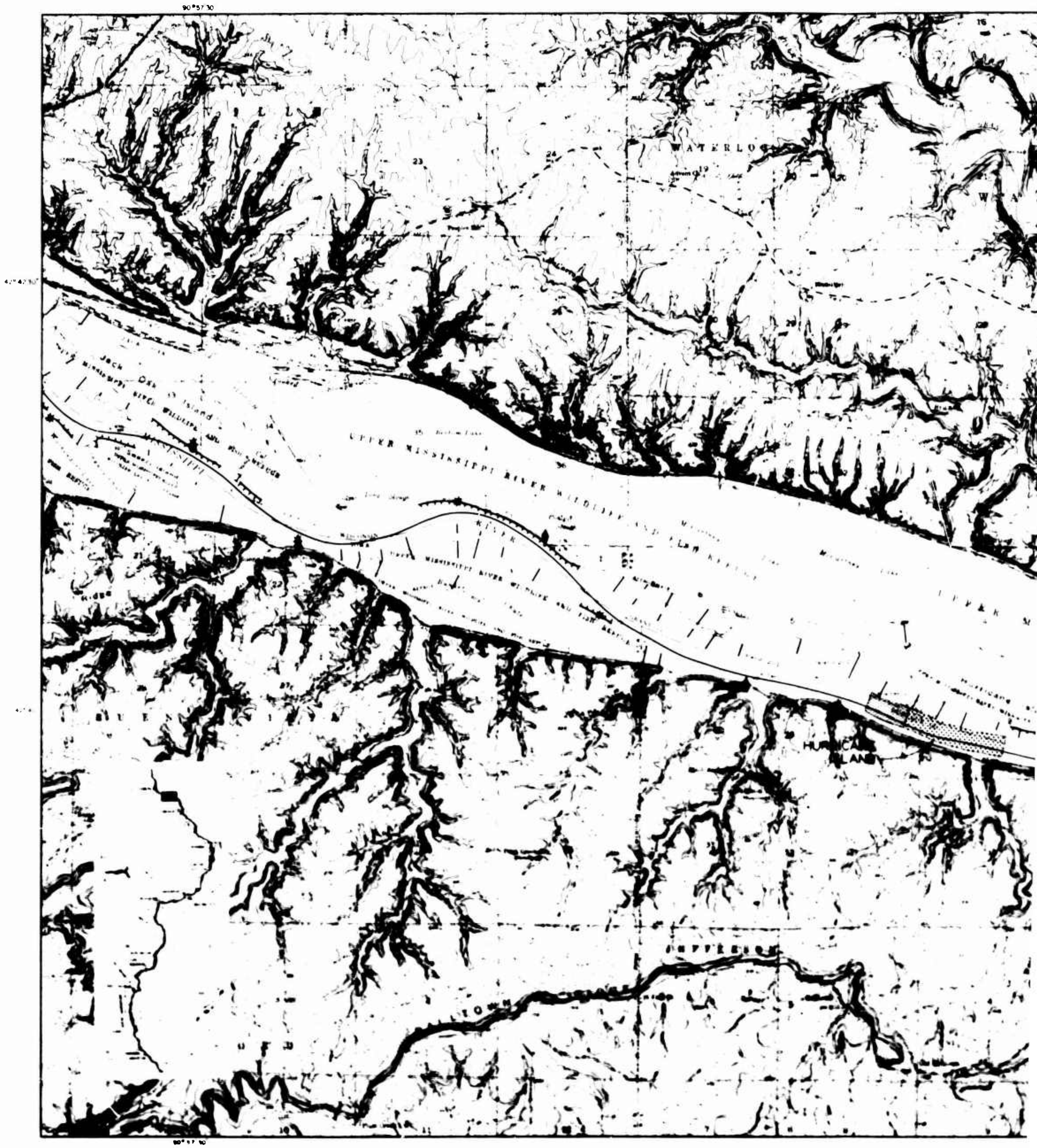
(POOL 11 — LOCK AND DAM 10 TO MILE 605)

(MODULE 1) NAVIGATION STRUCTURES

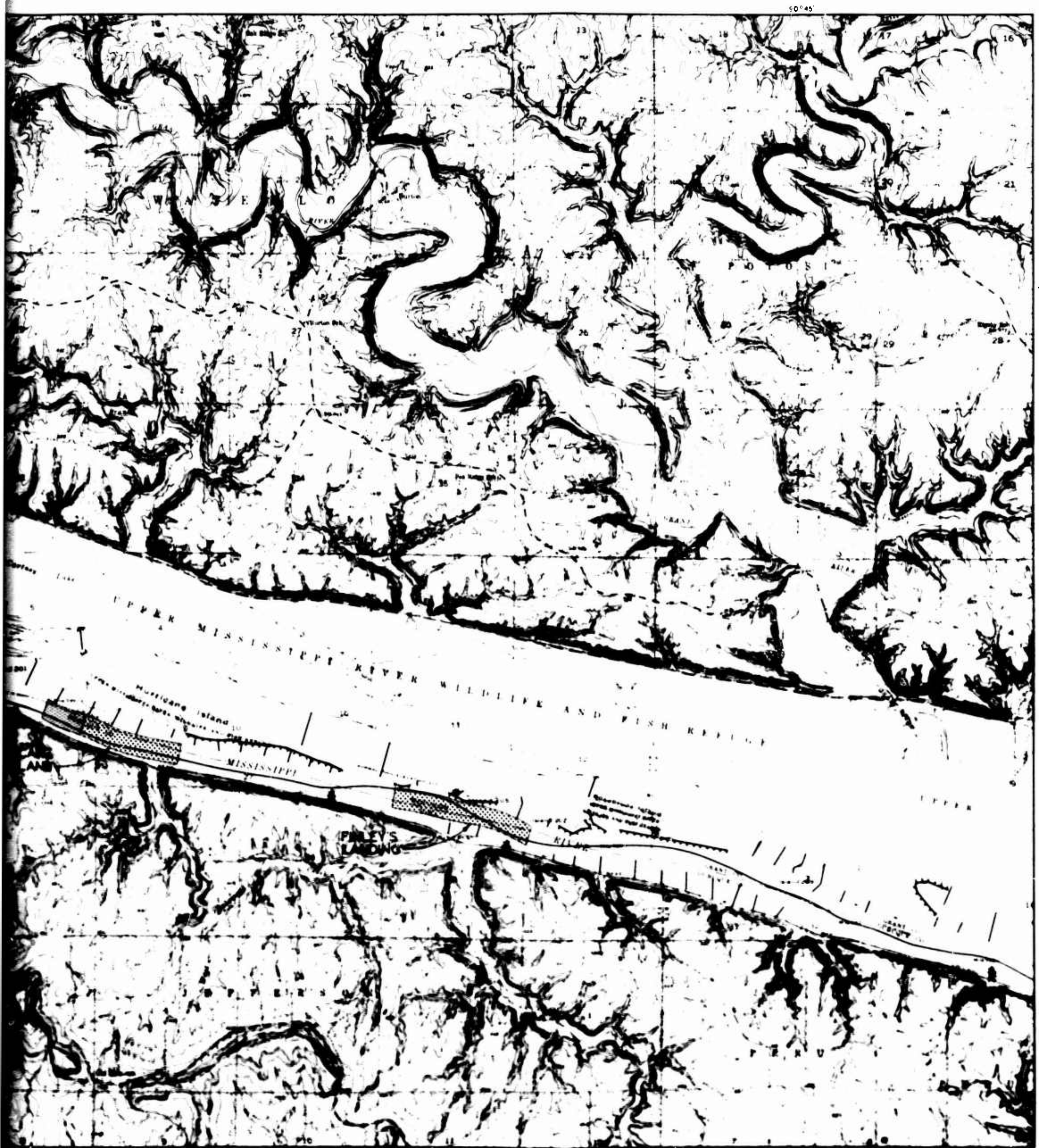
**PLATE 3**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

(POOL 11 — MILE 605 TO MILE 592)



## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 11 — MODULE 2)




**LEGEND**

WING DAM
BANK PROTECTION

**UPPER MISSISSIPPI RIVER**
(POOL 11 — MILE 605 TO MILE 592)
(MODULE 2) NAVIGATION STRUCTURES

**PLATE 4**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 11 — MILE 592 TO LOCK AND DAM 11)**

# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

**(POOL 11 — MODULE 3)**


LEGEND

**UPPER MISSISSIPPI RIVER**

(POOL 11 — MILE 592 TO LOCK AND DAM 11)

(MODULE 3) NAVIGATION STRUCTURES

**PLATE 5**

## POOL 12

Extent and Frequency of Dredging - Channel maintenance dredging has totaled 530,000 cubic yards from seven locations since 1945. Chart 12A, Plate 6, illustrates the quantities dredged in thousand cubic yards by mile location and year dredged. The annual summary of volumes dredged is extended to the right of the chart and the number of cuts that have occurred by mile of river channel is extended directly below. For the locations of past and projected future dredging sites, see the attached "Dredging Sites" charts for Pool 12. In Pool 12, approximately 14 percent of the 23.6 river miles have been dredged since 1945.

There are no regularly maintained 5 foot depth small boat harbors in Pool 12.

Areas of Recurrent and Recent Dredging - In Pool 12, of the seven areas that have been dredged in the past, none meet the criterion of recurrent or recent dredge sites, therefore, all were classified as nonrecurrent.

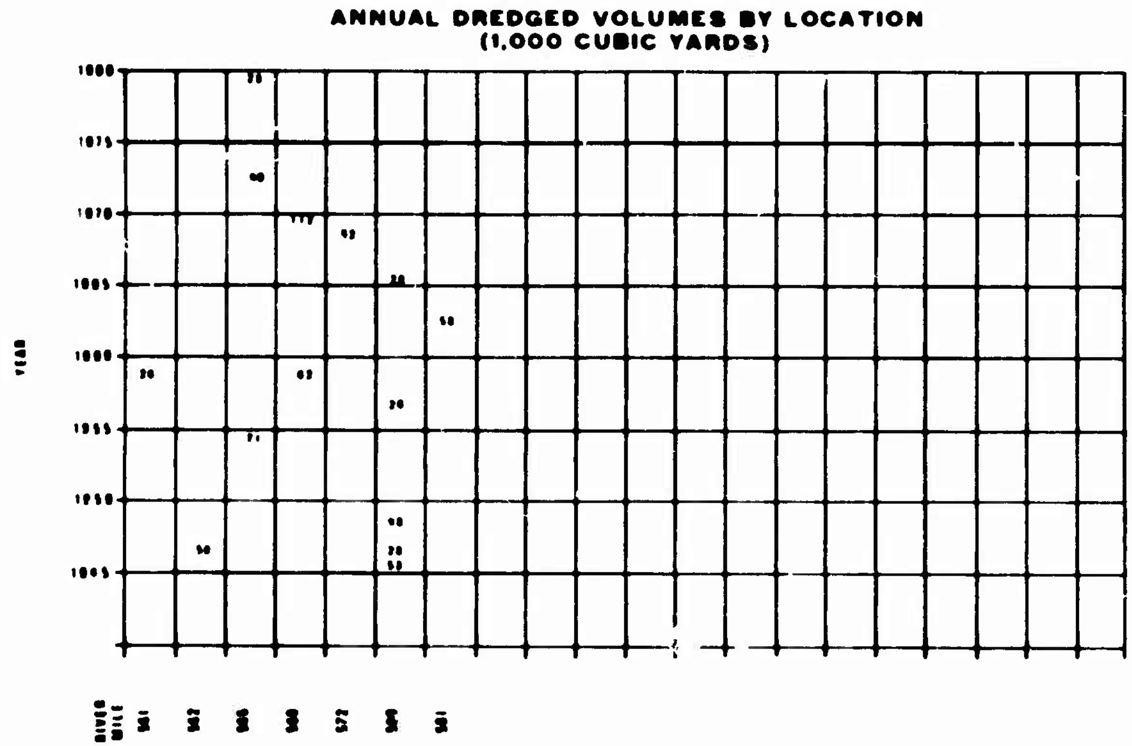
Hydraulics

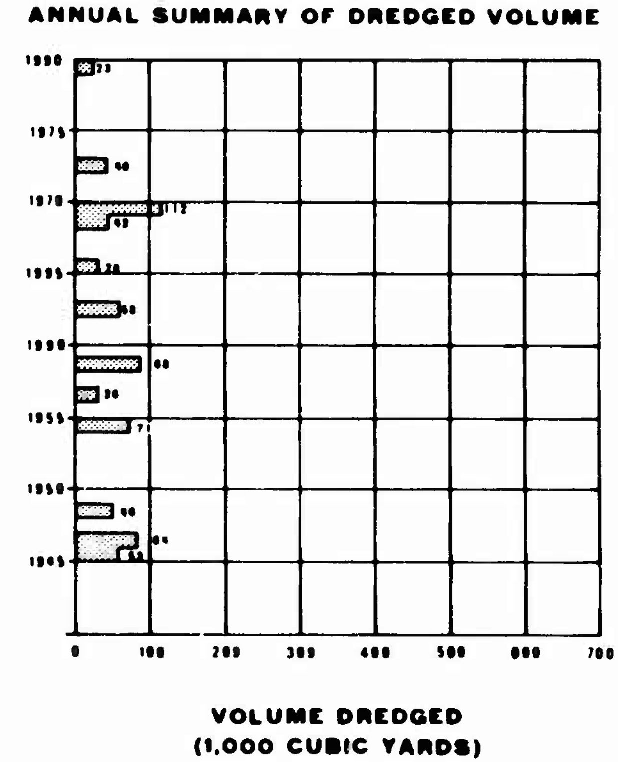
The only location in Pool 12 which has the potential for recurrent dredging is at Gordon's Ferry, river mile 565 to 566. Gordon's Ferry has been of particular interest during the last few years, since after each spring recession the channel appears to close off from the left bank to the right bank. Buoys have needed to be reset in this area so that navigational traffic can move through the area without grounding. At river mile 569.6, the Mississippi River bifurcates into a side channel called Deadman's Slough. In the upper reach of this pool, at river mile 569.2, flows are controlled from going into this side channel by Closing Dam No. 1. Water re-enters the main channel from this back channel at approximately river mile 565.7. The original Mississippi River channel passed between Island 235 and Island 238. However, the channel was realigned to traverse along the right bank of the Mississippi River adjacent to the bluff line. The combination of flow through Deadman's Slough plus the flow that passes between Islands 235 and 238 and re-enters the main stem at river mile 565.7, has aided in the reduction of velocity in the main channel in the area called Gordon's Ferry. Water depths in the channel behind Islands 235 and 238 are generally greater than in the navigation channel. Deposition has occurred through this reach shortly after high water periods. Emergency dredging has not been required in this area since a total closeoff has not been observed to date. Towboat operators are warned that as soon as the channel gets to a marginal level to go slow through the area. The slow movement of traffic through this reach tends to reopen the main channel, preventing a closeoff. It is recommended that the closing dam at the upstream end of Deadman's Slough be examined for its adequacy, and measures taken to reduce flows behind Islands 235 and 238 in order to effect better sediment transport through the navigation channel.

Future Dredging - In Pool 12, even though there are no sites that have historically been chronic dredging sites, one has been identified as probably needing regular maintenance dredging in the next 50 years. This site and its expected quantities and frequencies of dredging are shown below and is based on the assumption of an 11 foot dredge depth. This prediction is based on expected river conditions, and dredging requirements and practices.

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 565-566 | Cordon's Ferry | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of the past quantities dredged, is shown in Chart 12B, Plate 7, "Projected Dredging". The total amount of material to be dredged in the next 50 years, in Pool 12, is expected to be only .125 million cubic yards.



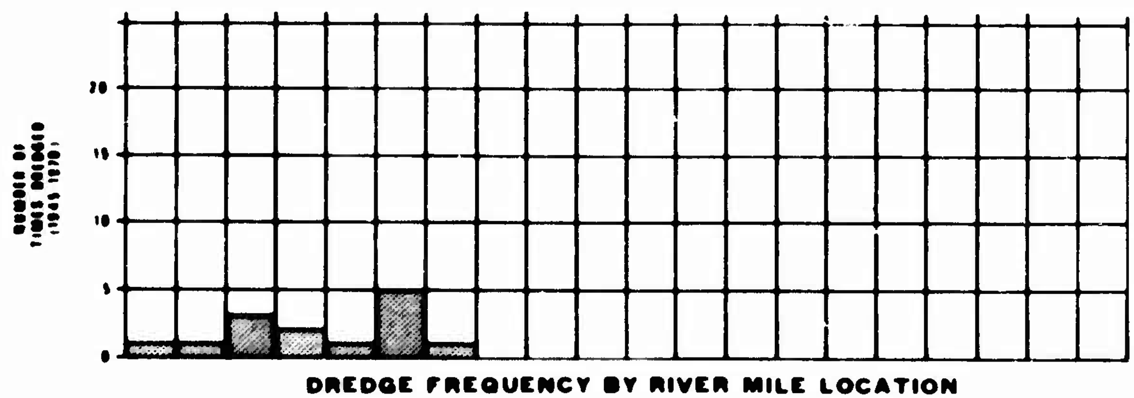
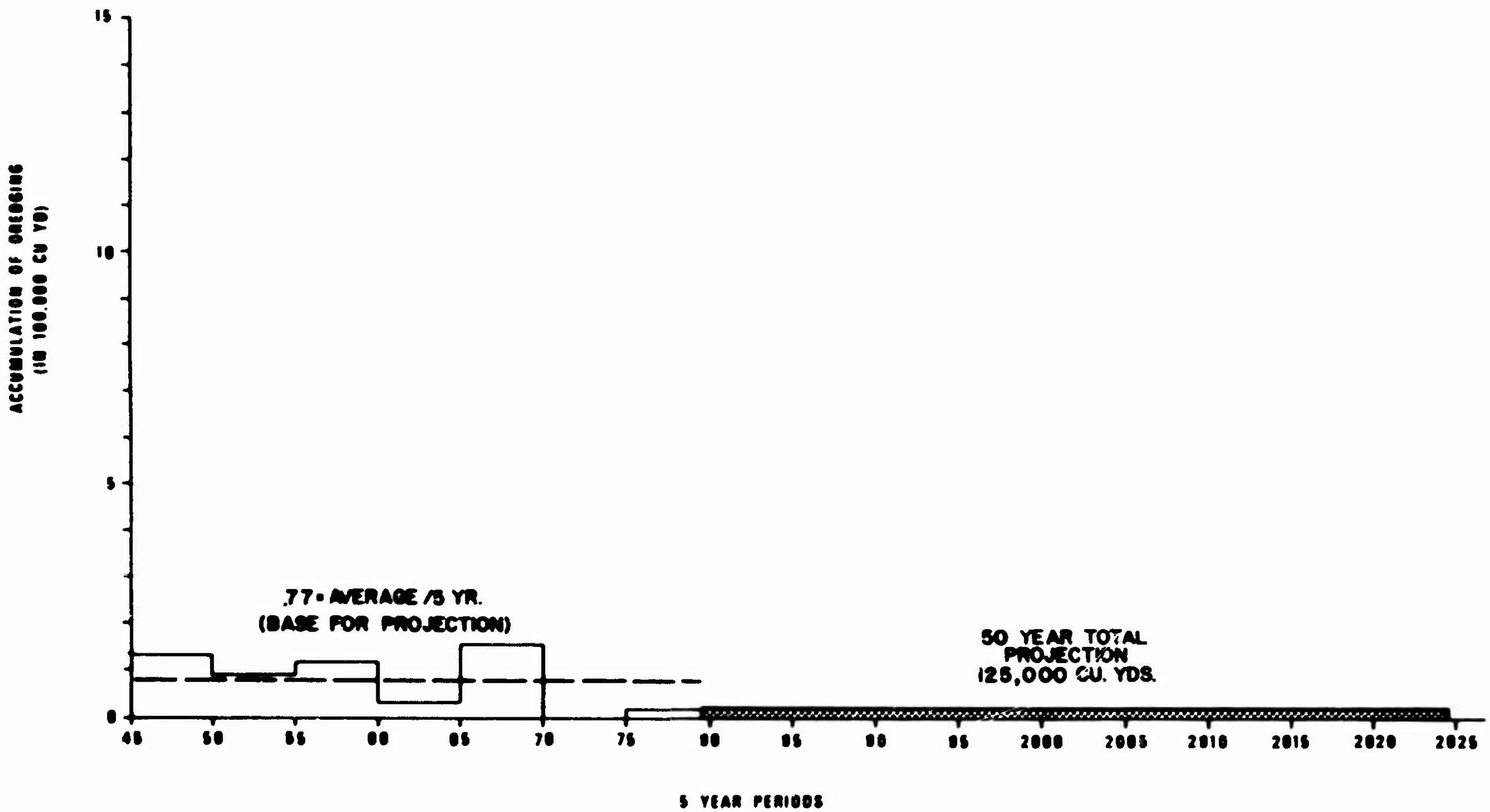




CHART 12A
EXTENT AND FREQUENCY
OF DREDGING
POOL 12

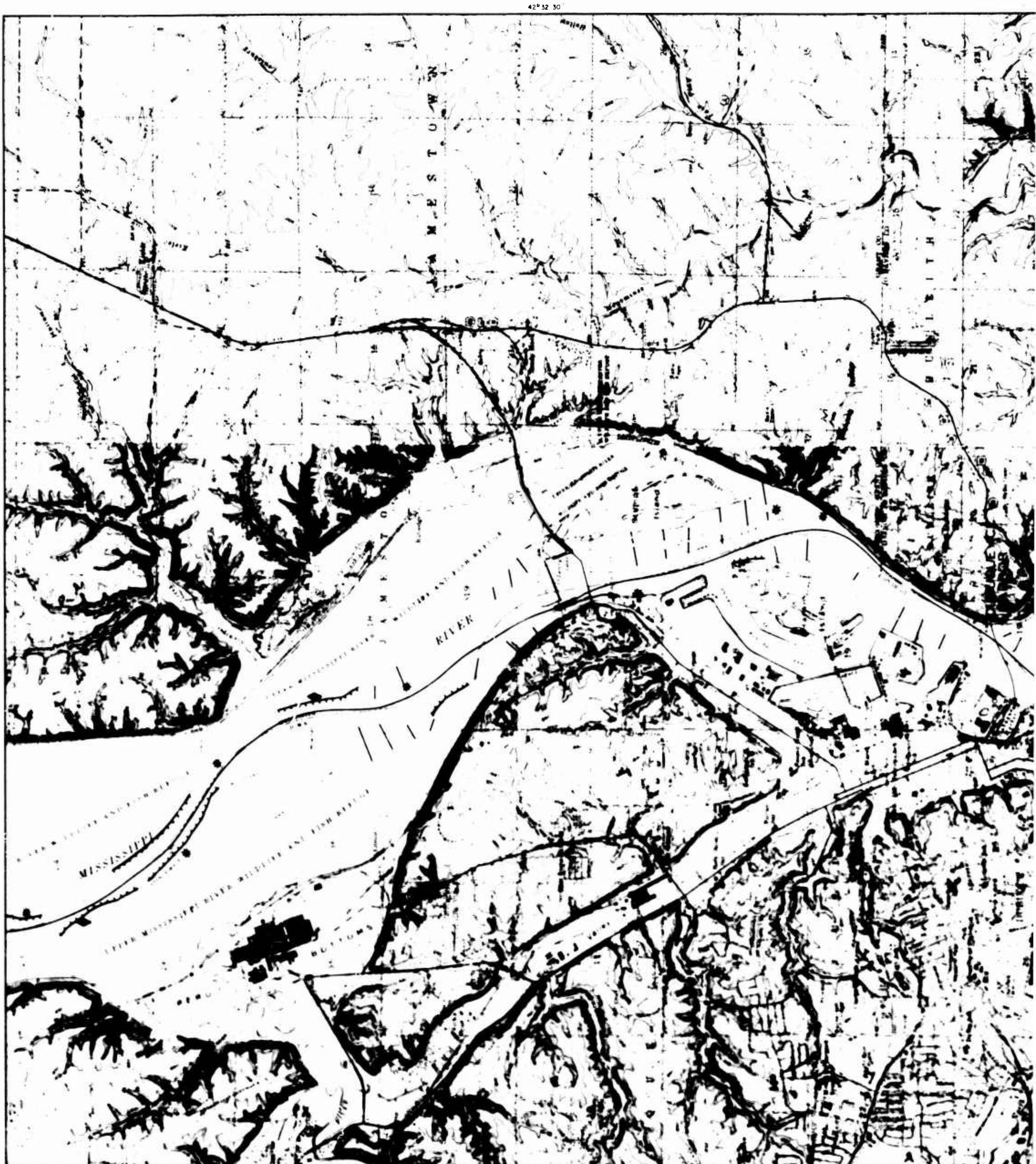
## CHART 12B — PROJECTED DREDGING POOL 12

CHANNEL DREDGING PROJECTION



# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 12 — LOCK AND DAM 11 TO MILE 574)**

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## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 12 — MODULE 1)

LEGEND

**UPPER MISSISSIPPI RIVER**

(POOL 12 — LOCK AND DAM 11 TO MILE 576)

(MODULE 1) NAVIGATION STRUCTURES

**PLATE 8**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 12 — MILE 574 TO MILE 567)**


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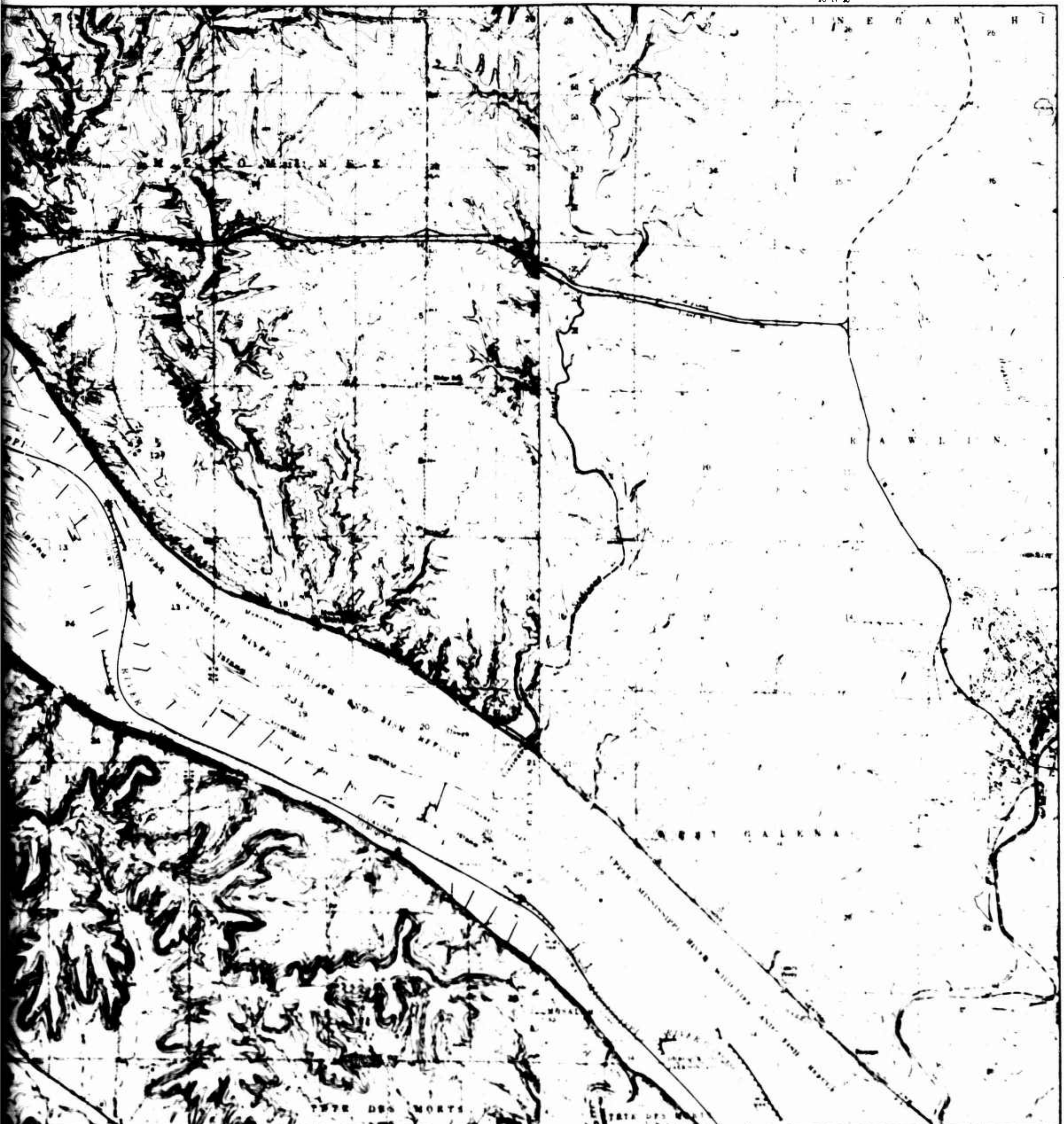
## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 12 — MODULE 2)




LEGEND

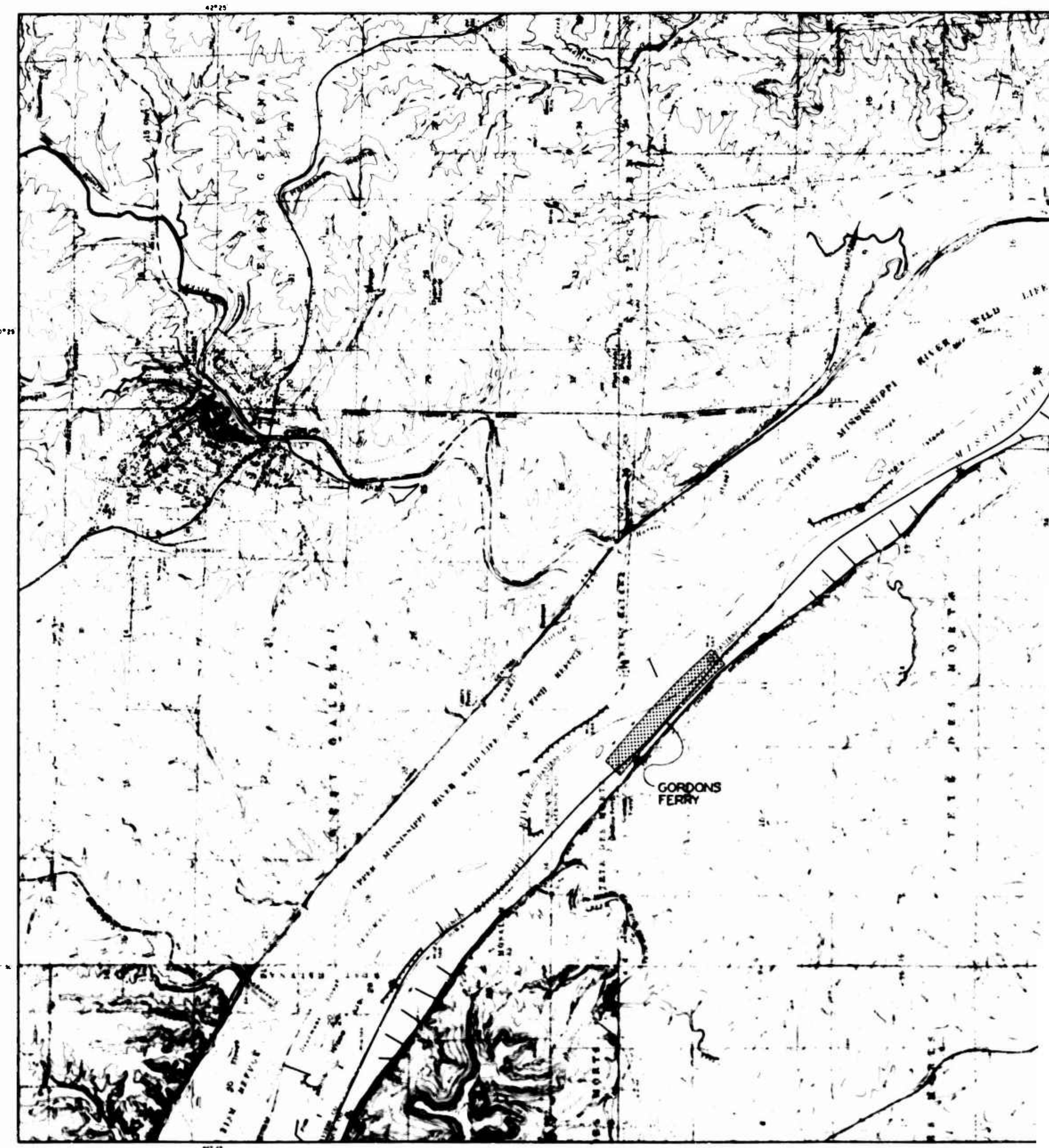
- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- MAIN CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- RECURRENT DREDGING SITES

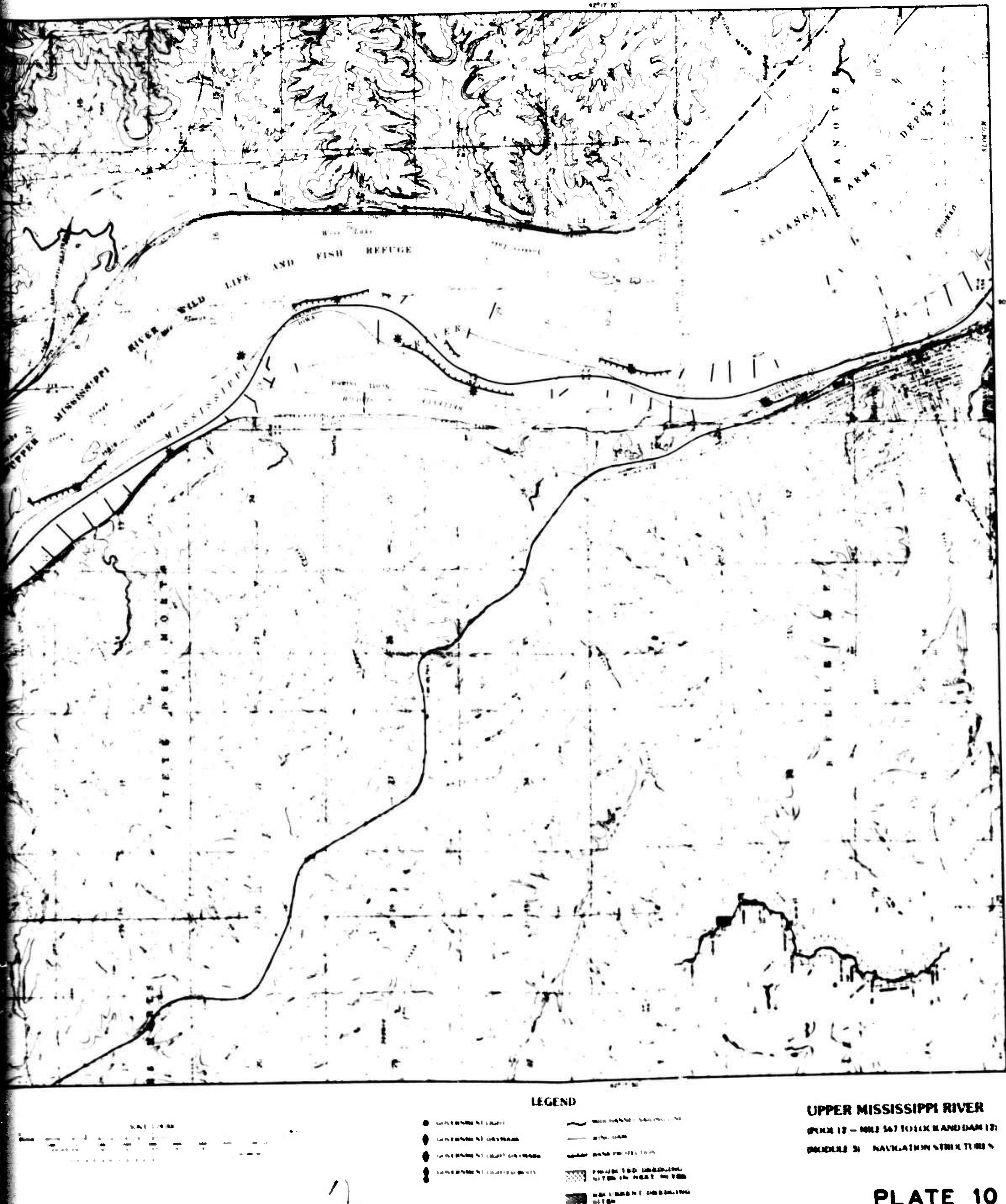
**UPPER MISSISSIPPI RIVER**
(POOL 12 — MILE 574 TO MILE 567)
(MODULE 2) NAVIGATION STRUCTURES

**PLATE 9**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 12 — MILE 567 TO LOCK AND DAM 12)**






**UPPER MISSISSIPPI RIVER**

(POOL 12 — MILE 567 TO LOCK AND DAM 12)

(MODULE 3) NAVIGATION STRUCTURES

**PLATE 10**

## POOL 13

Extent and Frequency of Dredging - Channel maintenance dredging in Pool 13 has totaled 3.09 million cubic yards from 11 locations since 1945. Chart 13A, Plate 11, illustrates the quantities dredged in thousand cubic yards by mile location and year dredged. The annual summary of volumes dredged is extended to the right of the chart and the number of cuts that have occurred by mile of river channel is extended directly below. For the locations of past and expected future dredging sites, see the attached "Dredging and Disposal Sites" charts for Pool 13. Approximately 28 percent of the 32.4 river miles of channel in Pool 13 has been dredged since 1945.

The Savanna Bay small-boat access at UMR mile 539.5 is maintained to a five-foot depth for pleasure craft use. Since its construction in 1966, dredging quantities have been:

| Year | Cubic Yards |
|---|---|
| 1968 | 13,806 |
| 1970 | 23,041 |
| 1972 | 6,315 |
| 1973 | 10,375 |

Areas of Recurrent and Recent Dredging - In Pool 13, of the eleven areas dredged in the past, seven are classified as non-recurrent and the following are classified as recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recent | Sand Prarie | 549.9 - 550.8 |
| Recurrent | Maquoketa River | 546.0 - 548.8 |
| Recent | Sabula Lower | 532.5 - 533.7 |
| Recent | Dark Slough | 530.9 - 531.2 |
| Recurrent | Savanna Bay Access | 539.5 |

### Hydraulics

Pool 13 has 3,100 square miles of local drainage area which flows directly into its pool. Much of this area constitutes bluff drainage from streams whose levels rise and fall rapidly at approximately the same rate. These flood-swollen streams carry large quantities of suspended and bedload sediment to the Mississippi River. Consequently, Pool 13 has received more than the average amount of dredging. There are approximately 10 locations in Pool 13 which have been identified as potential dredging areas. The three major tributaries which enter Pool 13 are the Maquoketa River from the right bank, and the Apple River and the Plum River from the left bank. The first area of dredging which is considered to be a problem area is an area called Pleasant Creek at river mile 552.5 to 553.0. This area of deposition occurs in an area where there is a crossover from the right bank to the left bank in the main channel. It is also influenced by backwater during high periods of flow from the Maquoketa River. The Maquoketa River, during flood times, provides a backwater condition as far upstream as Lock and Dam No. 12. During the winter, snowmelt in the Maquoketa River basin causes flooding not only in the Maquoketa River, but also in the Mississippi River. The Maquoketa River often loses its ice cover into the main channel of the Mississippi River and deposits it downstream from the mouth between river miles 545.5 and 548.5. This constricts the entire river and forces water into the back channel area. Increased flow in the back channel area resuspends sediment that has been deposited there during previous high water periods and moves it back into the main channel period. During periods of flooding, when the Maquoketa River causes a backwater condition upstream to Lock and Dam No. 12, the reduction of velocities in the Pleasant Creek area provides for potential sedimentation and shoaling.

Sand Prairie, between river mile 549.8 and 550.8 in Pool No. 13, has been a major problem, particularly during the last decade. This area, like Pleasant Creek, is just upstream from the mouth of the Maquoketa River and is subject to backwater conditions from high flows on the Maquoketa. In addition to the problem of slowed velocity from backwater conditions during flood, the entire Sand Prairie reach is affected by deposition on the inside of the bend accreting from the west bank to the east bank. It is recommended that the wing dams above the mouth of the Maquoketa River in the Sand Prairie reach be re-examined for their adequacy and design elevation, such that suspended material will remain suspended and move on downstream and not deposited, causing a need for dredging.

The next area downstream is called the Maquoketa River. It is divided into two areas, Maquoketa River between river mile 547.5 and 548.8, and Maquoketa River Lower between river mile 546.0 and 547.5. During every period of high water since 1945, dredging has been required downstream of the Maquoketa River. Ice jams in this area have caused increased velocities along the left bank with the result being the reduction in the original grade of the wing dams between river mile 548.8 and 546.0. Recent surveys conducted by the GREAT II Fish and Wildlife Work Group, in conjunction with the Corps of Engineers, surveyed profiles of these wing dams. It was found that existing structures were lower in elevation than they were originally designed and built. Recently restored regulatory works in this area should improve movement of sediment through the reach. It is recommended that a monitoring system be set up to determine the effectiveness of restoration and adequacy of those wing dams during the next five years. This is particularly important since an ice jam has been observed in this reach for several years.

River mile 544.0 to 545, entitled Island 257 Lower, is the next downstream area of recurrent dredging. This area has received less dredging than the Maquoketa River area. However, with the restoration of the wing dams upstream from the Maquoketa River reach, potential deposition in this area has increased. Since the material will be moving downstream from the Maquoketa River reach, and the velocities may not be sufficient to carry them on downstream, the potential of deposition in this reach will increase. If deposition occurs more frequently during the next five years, examination of Wing Dams 15, 17, 18, and 14, on the left bank should be made.

Santa Fe Island Upper (or Lanesville Lower) is the next area downsteam at river mile 540.5 to 541. Surveys of wing dams during the last three years along the right bank have indicated that they were not at the design level. Consequently, the towhead across from Santa Fe Island has been subjected to higher velocities. The revetment along the main channel was washed away and the island has deteriorated in size. Recent plans by the Army Corps of Engineers to restore Wing Dams 6 and 7, as well as replacing revetment on this island, will help to keep the main channel from shifting to the right bank. If this work is not accomplished, there will be a channel alignment problem. Continued accretion along the left bank is anticipated since it is on the inside of a bend.

Deposition in the reach between river mile 532.5 and 536.5, just downstream from the mouth of the Plum River, is a problem because of the limited availability of suitable dredged material disposal sites. In this reach, most dredging has occurred between river mile 532.5 and 533.5. Through this area, the channel is in the form of an "S" with two cross-overs, thus providing the opportunity for reduced velocities deposition. It is recommended that the wing dams in this area be surveyed to determine if they are at the designed grade, and if restoration or improvement would improve the movement of the material through this reach.

The next area downstream that required dredging is an area called Dark Slough. It is located at river mile 531 to 532. This is in a crossover area just downstream of the Dark Slough confluence with the main channel. The combination of flow re-entering the main channel (slowing the velocities down, and allowing for deposition), and reduced crossover secondary velocities has the potential for reducing of the total channel velocity which causes deposition and potential dredging. It is recommended that wing dams 19, 20, 21, and 22, on the left bank should be examined for adequacy to determine if any change needs to be made to keep the sediment moving through the reach.

Future Dredging - In Pool 13, eleven sites have been identified as probably needing routine maintenance dredging in the next 50 years, based on expected river conditions, dredging requirements, and practices. These sites, and their expected quantities and frequencies of dredging are shown below: (assuming an 11 foot dredge depth)

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 552.5-553.0 | Pleasant Creek | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |
| 549.8-550.8 | Sand Prairie | 1 in 5 | 20,000 | 2.0 | 40,000 | 10.0 | 200,000 |
| 547.5-548.8 | 1) Maquoketa River | 1 in 5 | 35,000 | 2.0 | 70,000 | 10.0 | 350,000 |
| 546.0-547.5 | Maquoketa River Lwr | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |
| 544.0-545.0 | 2) Island 257 Lower | 1 in 10 | 30,000 | 1.0 | 30,000 | 5.0 | 150,000 |
| 540.5-541.0 | 2) Lainsville Lower | 1.5 in 10 | 35,000 | 1.5 | 52,500 | 7.5 | 262,500 |
| 538.8-539.8 | Savanna Bay Light | 2 in 10 | 25,000 | 2.0 | 50,000 | 10.0 | 250,000 |
| 532.5-533.5 | 3) Sabula Lower | 2 in 10 | 25,000 | 2.0 | 50,000 | 10.0 | 250,000 |
| 531.0-532.0 | 2) Dark Slough | 1 in 10 | 20,000 | 1.0 | 20,000 | 5.0 | 100,000 |
| 525.0-525.5 | 4) Pomme de Terre | 1 in 10 | 35,000 | 1.0 | 35,000 | 5.0 | 175,000 |
| 539.5 | Savanna Bay Access | 1 in 4 | 2,500 | 2.5 | 6,250 | 12.5 | 31,250 |

1) At the Maquoketa River site, the future dredging frequency is expected to be less than the historic 40-year average. This will be a result of the recent regulatory works restoration done in that area of the river.

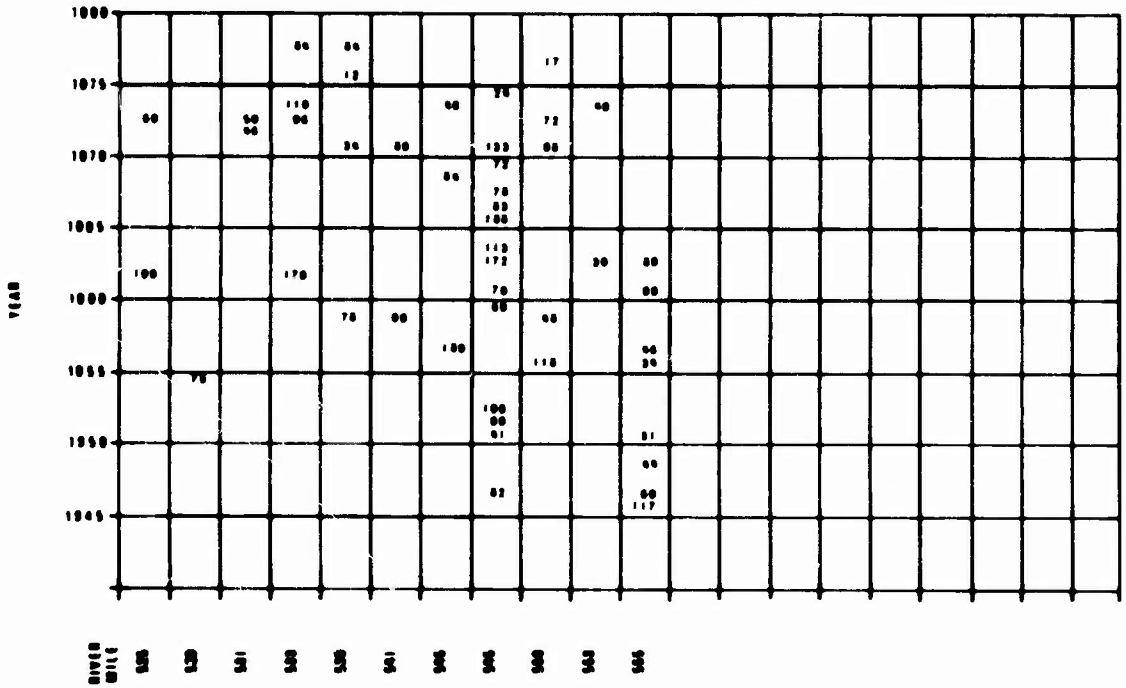
2) At the Island 257 Lower, Lainsville Lower, and Dark Slough dredge sites, the dredging frequency in the future is expected to increase as compared to the historic 40-year average.

3) At Sabula Lower dredge site, the dredging frequency in the future is expected to increase as compared to the historic 40-year average. This increase is expected even though the channel will be maintained at a narrower width than in the past.

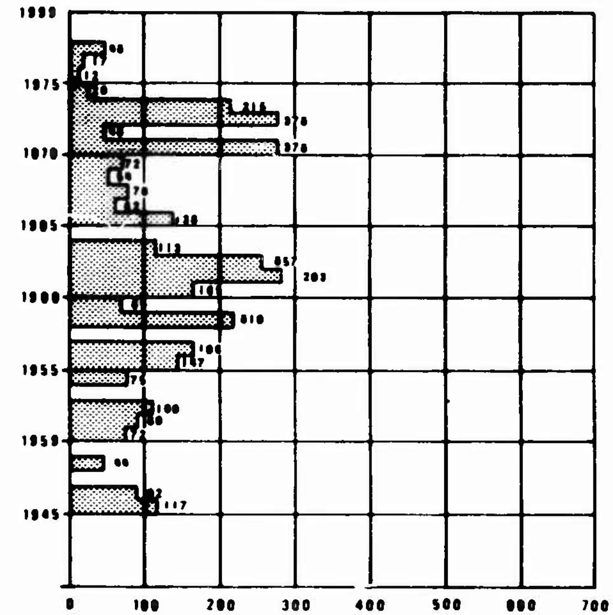
4) At Pomme de Terre, the channel will be maintained at a narrower width than in the past.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of the past quantities dredged is shown in Chart 13B, Plate 12, "Projected Dredging". The total amount of material to be dredged in the next 50 years, in Pool 13, is expected to be approximately 2.019 million cubic yards. This amount is about average for the last 20 years.

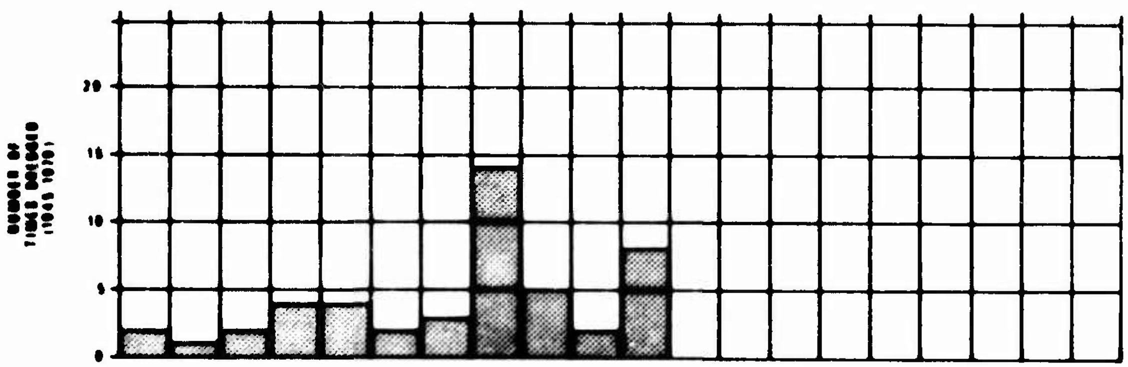
ANNUAL DREDGED VOLUMES BY LOCATION
(1,000 CUBIC YARDS)




ANNUAL SUMMARY OF DREDGED VOLUME




VOLUME DREDGED
(1,000 CUBIC YARDS)




DREDGE FREQUENCY BY RIVER MILE LOCATION

CHART 13A
EXTENT AND FREQUENCY
OF DREDGING
POOL 13

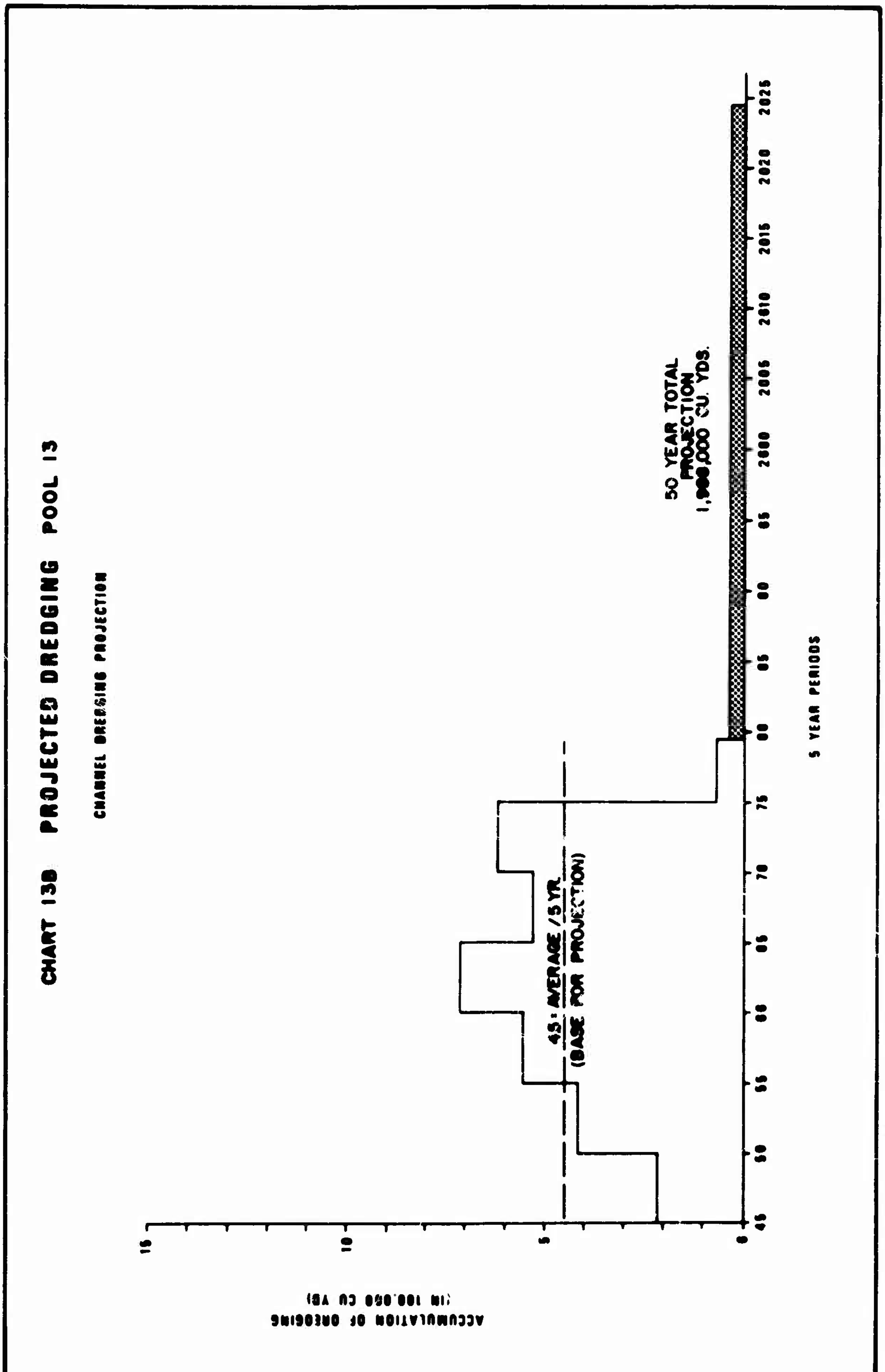
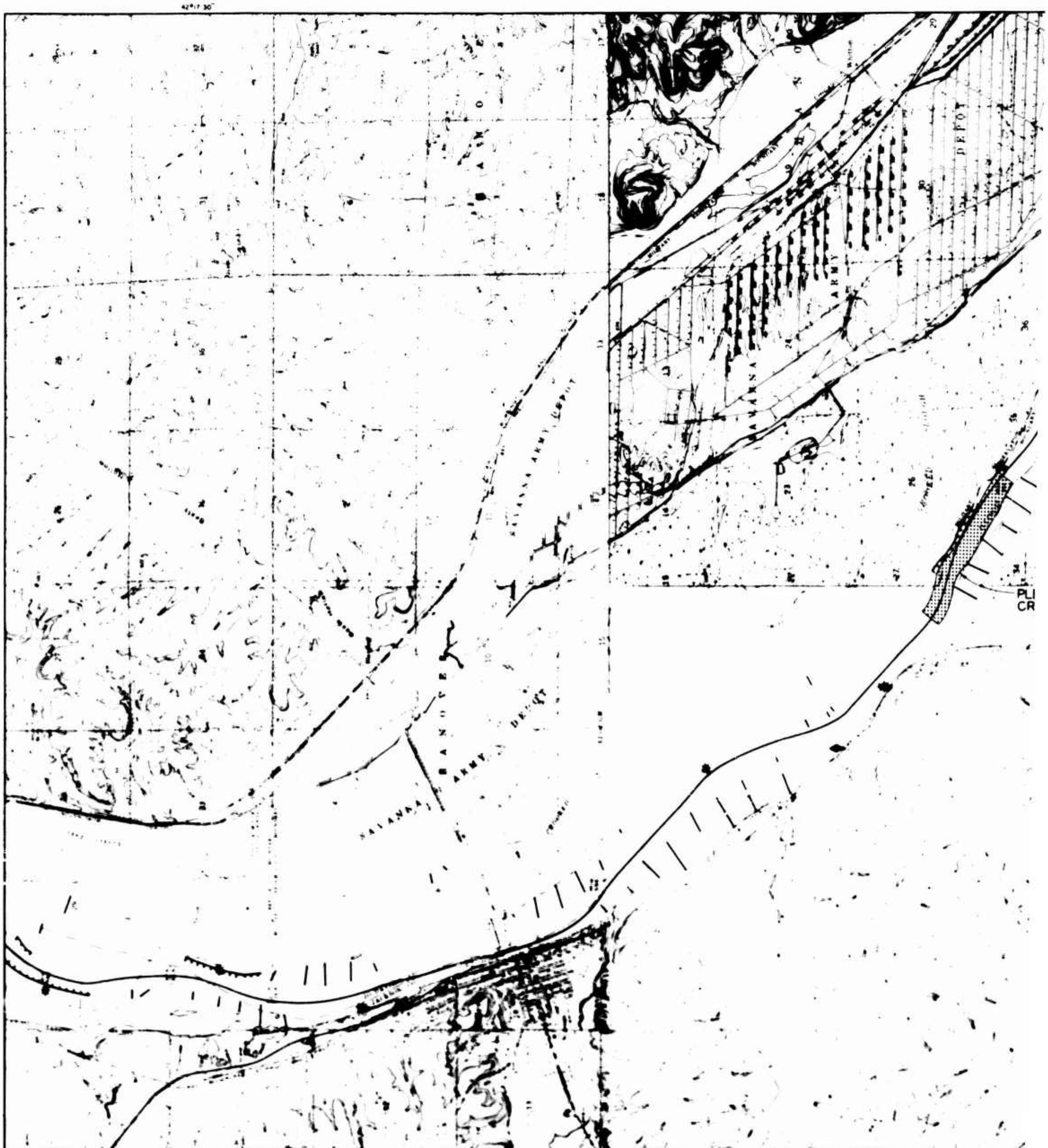


CHART 13B PROJECTED DREDGING POOL 13
CHANNEL DREDGING PROJECTION
ACCUMULATION OF DREDGING (IN 100,000 CU YD)
15
10
5
0
4.5' AVERAGE / 5 YR.
(BASE FOR PROJECTION)
50 YEAR TOTAL
PROJECTION
45
50
55
60
65
70
75
80
85
90
95
2000
2005
2010
2015
2020
2025
5 YEAR PERIODS

## GREAT RIVER ENVIRONMENTAL ACTION TEAM
## UPPER MISSISSIPPI RIVER (GREAT II)

(POOL 13 — LOCK AND DAM 12 TO MILE 549)



UPPER MISSISSIPPI RIVER
ENVIRONMENTAL ATLAS
(POOL 13 — MODULE 1)

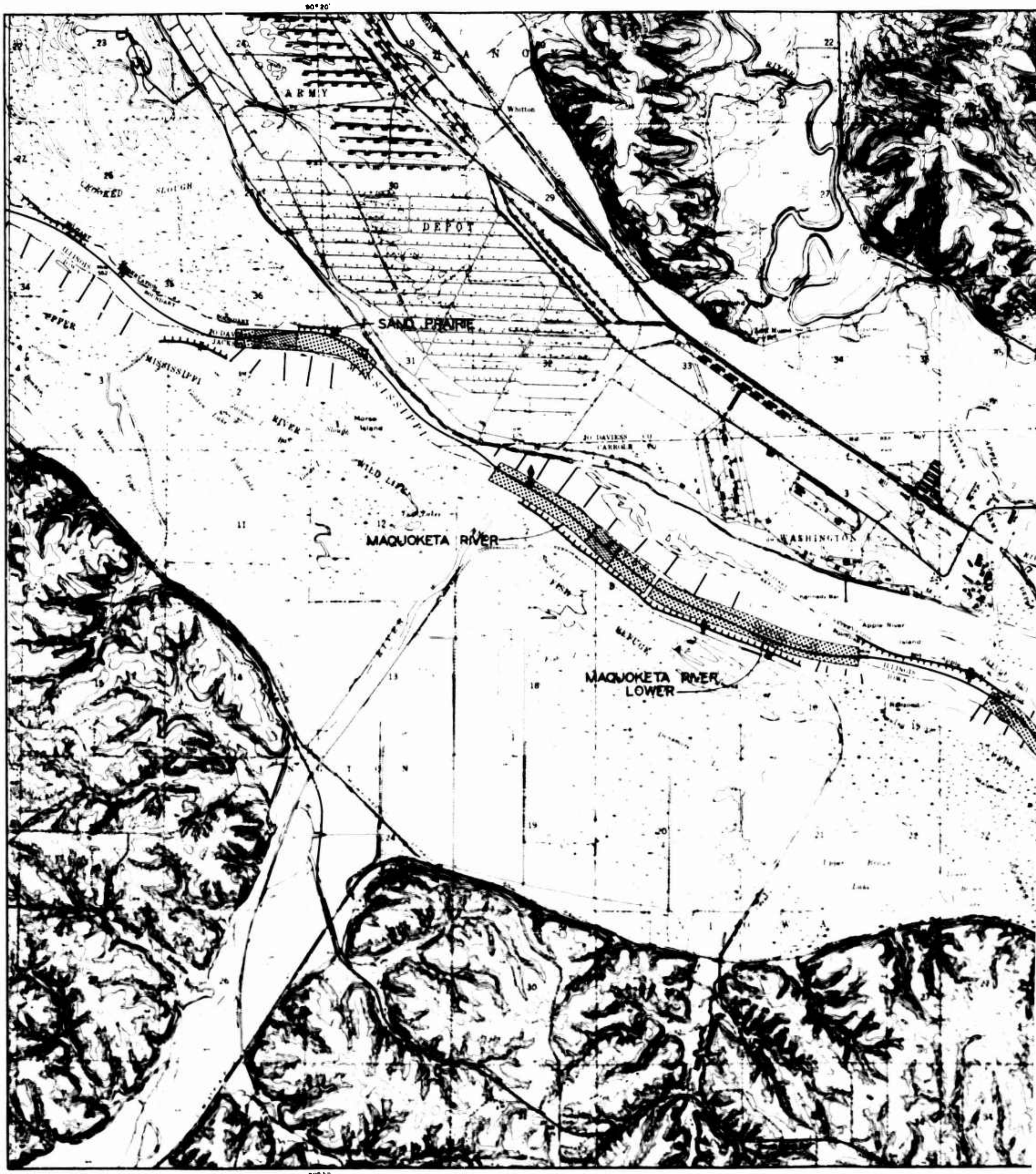

LEGEND

UPPER MISSISSIPPI RIVER

PLATE 13

## GREAT RIVER ENVIRONMENTAL ACTION TEAM
## UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 13 — MILE 549 TO MILE 541)**

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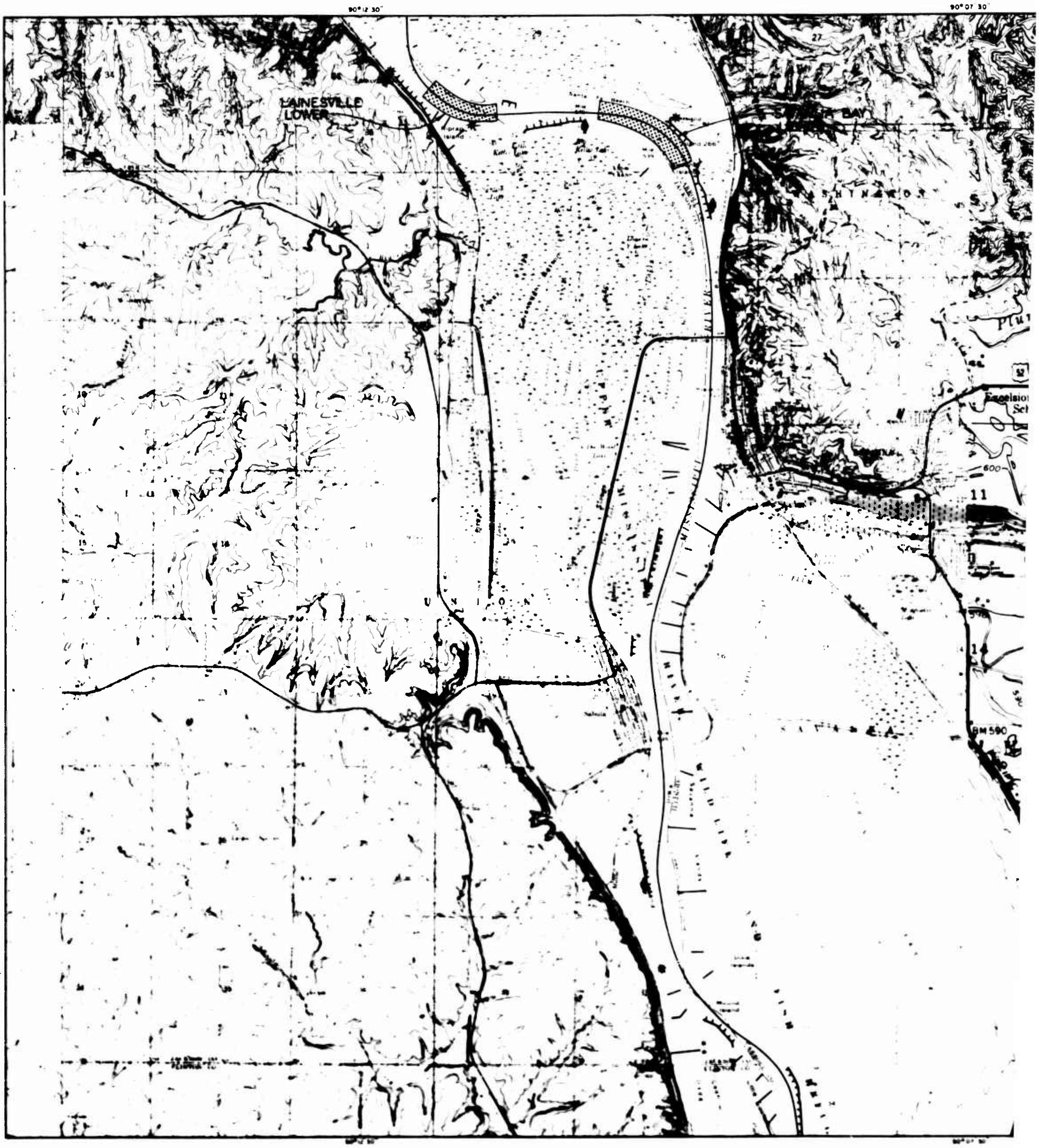
# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 13 — MODULE 2)


**UPPER MISSISSIPPI RIVER**

PLATE 14

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 13 — MILE 541 TO MILE 533)**




LEGEND

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHTED BUOY
- WING DAM
- BANK PROTECTION

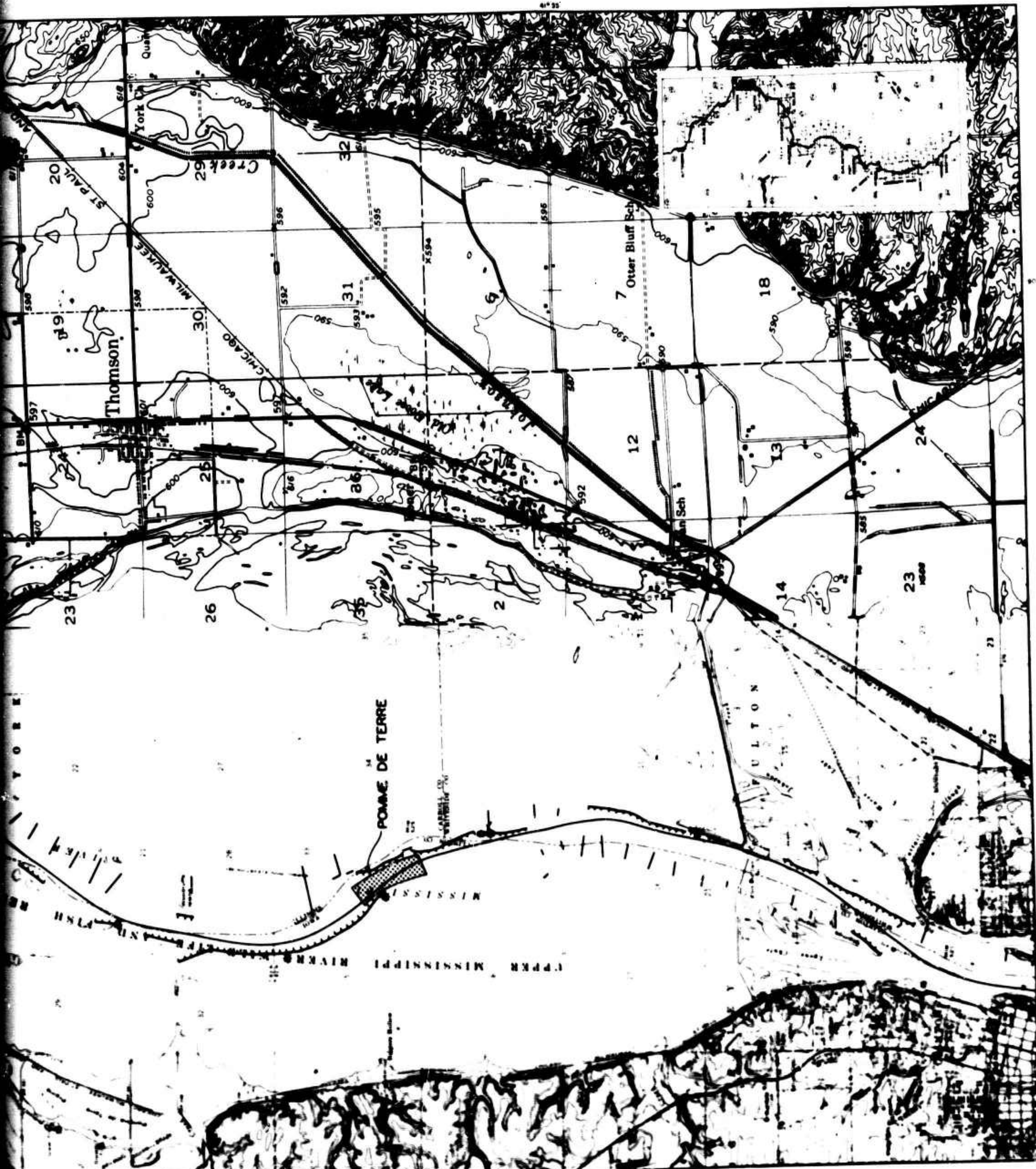
**UPPER MISSISSIPPI RIVER**
(POOL 13 — MILE 541 TO MILE 533)
(MODULE 3) NAVIGATION STRUCTURES

PLATE 15

## GREAT RIVER ENVIRONMENTAL ACTION TEAM
## UPPER MISSISSIPPI RIVER (GREAT II)
(POOL 13 — MILE 533 TO LOCK AND DAM 13)

# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 13 — MODULE 4)




LEGEND

**UPPER MISSISSIPPI RIVER**

(POOL 13 — MILE 533 TO LOCK AND DAM 13)

(MODULE 4) NAVIGATION STRUCTURES

**PLATE 16**

## POOL 14

Extent and Frequency of Dredging - Channel maintenance dredging in Pool 14 has totaled 2.64 million cubic yards from ten locations since 1945. Maintenance dredging of the Beaver Slough secondary nine-foot channel at Clinton, Iowa, has totaled 240,000 cubic yards from three locations. Chart 14A, Plate 17, illustrates the quantities dredged in thousand cubic yards by mile location and year dredged. The annual summary of volumes dredged is extended to the right of the chart and the number of cuts that have occurred by mile of river channel is extended directly below. For the locations of past and expected future dredging operations, see the attached "Dredging and Disposal Sites" charts for Pool 14. Approximately 18 percent of the 29.2 river miles of channel in Pool 14 has been dredged since 1945.

The LeClaire Canal is maintained to a five-foot depth for pleasure craft. The amounts dredged since 1965 have been:

| Year | Cubic Yards |
|---|---|
| 1969 | 11,590 |
| 1970 | 10,687 |
| 1971 | 18,413 |
| 1973 | 5,691 |

Areas of Recurrent and Recent Dredging - In Pool 14, of the ten sites that have been dredged in the past, eight are classified as nonrecurrent, and the following are classified as recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recurrent | Steamboat Slough | 503.3 - 504.0 |
| Recurrent | Above L/D 14 | 493.8 - 494.8 |
| Recurrent | Beaver Slough | 517.2 - 517.4 |
| Recurrent | LeClaire Canal | 494.5 |

Hydraulics

The first location at the upstream portion of Pool 14 is called Joyce Island, river mile 518.5 to 519.5. This area was frequently dredged during the early 1950's, but has had considerable less dredging in the 60's and the 70's. Past dredging has occurred where a crossover from left to right bank occurs in the channel. Due to the loss of secondary velocities, the sediment deposits in the main channel end require dredging. At this time, examination of the regulatory structures in the area does not appear to be necessary since depths greater than 9 feet have been observed throughout this reach.

The next area downstream is called Beaver Island. The main channel dredging has been from approximately river mile 515.7 to 517.8. The side channel called Beaver Slough, which is an industrial channel, has been dredged primarily throughout the entire reach, approximately from river mile 512.8 to 517.5. At river mile 517.5, the Mississippi River bifurcates and the flow is split. While the majority of it stays in the main channel of the Mississippi, Wing Dam No. 17 directs the flow down Beaver Slough. This loss in flow and the subsequent loss in velocities have created the need for dredging both the slough and the main channel. The source of material to be dredged in this area is primarily from suspended and bedload material during floods. The material in the main channel accretes slowly from the right bank to the left bank, until the channel is nearly closed off and dredging is required. Because of the slow velocities in Beaver Slough and the lack of navigational traffic in the area, accretion of sediments in the bottom of Beaver Slough causes shoaling with subsequent dredging. This area should be examined by a model study to determine what action should be taken to keep the material moving, not only in the main channel, but in Beaver Slough.

The next area, which is adjacent to Beaver Island, is called Albany. It is located from river mile 513 to 514. Basically, it is a continuation of the Beaver Island sedimentation problem and its sources and results are the same as the Beaver Island problem.

At river mile 505.9, the Mississippi River bifurcates into the main channel and Cordova Slough at the upstream end of Island 299. At the lower end of Island 300 is the confluence of Cordova Slough and the main channel of the Mississippi River. This is located at river mile 503.3. The amount of water which is traveling down Cordova Slough is sufficient enough to cause a backwater condition in the main channel during periods of high flow. Therefore, the velocities are reduced in the reach and sedimentation occurs. The area where the sedimentation has been observed in the past is also a crossover area in the main channel, and the secondary velocity that is required to keep the sediment suspended has been lost or reduced.

Wing Dams 25, 26, and 27, which are located at the upstream end of Island 299 on the right bank of the Mississippi River, and Closing Dam No. 17, which is located in Cordova Slough at river mile 505.1, are recommended to be examined for adequacy of channeling the flow of the Mississippi River in the main channel rather than in Cordova Slough. This area does not fill in rapidly. However, when dredging is required, quantities between 75,000 and 150,000 yards are normally pumped and placed on Island 300 and on the left bank in an accretion area below Wing Dam No. 19. This area is referred to as Steamboat Slough and has not required dredging due to constant commercial sand and gravel mining operations adjacent to the channel.

The last area in Pool 14 is called "Above Lock and Dam 14", (river mile 493.5 to 494.8). Lock and Dam 14 is located at river mile 493.3. Deposition has occurred in this area sporadically during the last 35 years, with the majority of the deposition occurring since 1963. Sedimentation in this reach has been slow and has occurred from the left bank to the right bank. After dredging has occurred, it takes approximately five years for this area to fill back in before dredging is necessary again. Because this is directly above a dam, water is considerably slower in the lock approach area. This portion of the pool is under a pool condition rather than an open river condition. Therefore, the velocities are considerably less in this reach. Sediment inflows from the Wapsipinicon River, upstream at river mile 506.7, usually travel along the right bank of the Mississippi River until they get downstream and are fully mixed in the cross-section of the river. The old LeClaire Canal Trailer Dam begins at river mile 496.5 and a portion of the flow travels along the right bank of the river down the LeClaire Canal. Sedimentation in the canal has occurred periodically and requires dredging.

Future Dredging - In Pool 14, ten sites have been identified as probably needing maintenance dredging in the next 50 years, based on expected river conditions, dredging requirements and practices. These sites and their expected frequencies and quantities of dredging are shown below: (assuming a dredge depth of 11 feet)

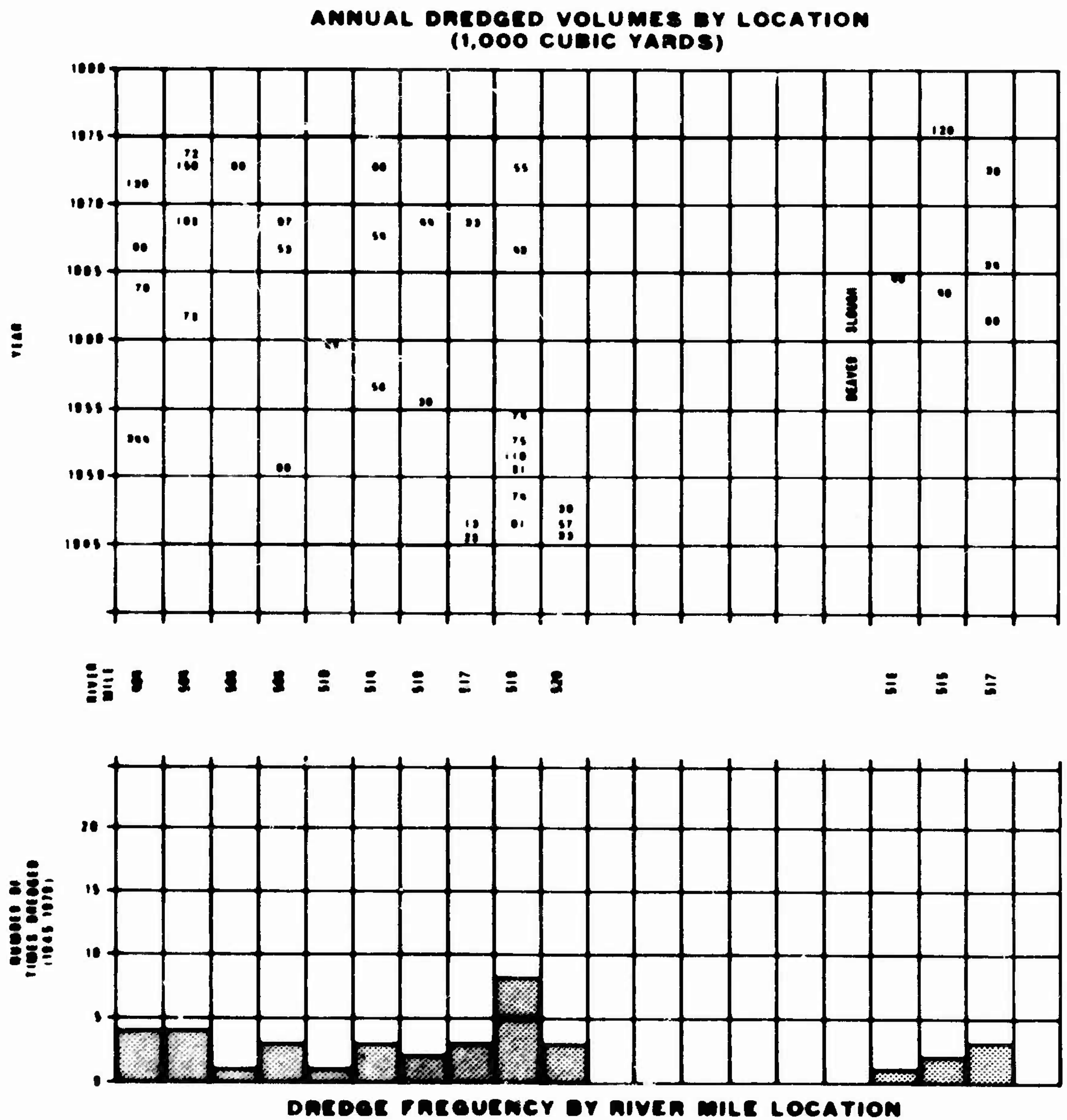
| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 518.5-519.5 | Joyce Island | 1 in 20 | 20,000 | 0.5 | 10,000 | 2.5 | 50,000 |
| 517.0-517.8 | Below Clinton RR Bridge | 1 in 20 | 10,000 | 0.5 | 5,000 | 2.5 | 25,000 |
| 513.5-517.5 | 1) Beaver Slough Industrial Channel | 1 in 4 | 30,000 | 2.5 | 75,000 | 12.5 | 375,000 |
| 516.0-517.0 | 2) Beaver Island | 1 in 10 | 30,000 | 2.5 | 30,000 | 5.0 | 150,000 |
| 513.0-514.0 | 2) Albany | 1 in 5 | 30,000 | 2.0 | 60,000 | 10.0 | 300,000 |
| 508.5-509.0 | 2) Adams Island Upper | 1 in 10 | 10,000 | 1.0 | 10,000 | 5.0 | 50,000 |
| 505.5-506.0 | Island 299 | 1 in 20 | 15,000 | 0.5 | 7,500 | 2.5 | 37,500 |
| 503.2-504.0 | 3) Steamboat Slough | 1 in 8 | 35,000 | 1.25 | 43,750 | 6.25 | 218,750 |
| 493.5-491.8 | Above L/D #14 | 1 in 10 | 40,000 | 1.0 | 40,000 | 5.0 | 200,000 |
| 494.5 | LeClaire Canal | 1 in 5 | 2,500 | 2.0 | 5,000 | 10.0 | 25,000 |

1) For Beaver Slough, channel changes that are to be made in conjunction with the Clinton Flood Control Project may affect the predictions shown here. These changes could possibly increase the frequency of dredging needed as compared to the historical 40-year average.

2) At the Beaver Island, Albany, and Adam's Island Upper Island 297 sites, the channel will be maintained at a narrower width than historically maintained.

3) At Steamboat Slough, above L/D #14, commercial sand and gravel dredging is being, or planned to be, done either adjacent to and/or in the channel and will offset (decrease) historic dredging requirements.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged, is shown in Chart 14B, Plate 18, "Projected Dredging". The total amount of material to be dredged in the next 50 years is expected to be approximately 1.628 million cubic yards. This amount is slightly less than the quantities dredged in the past 15 years.



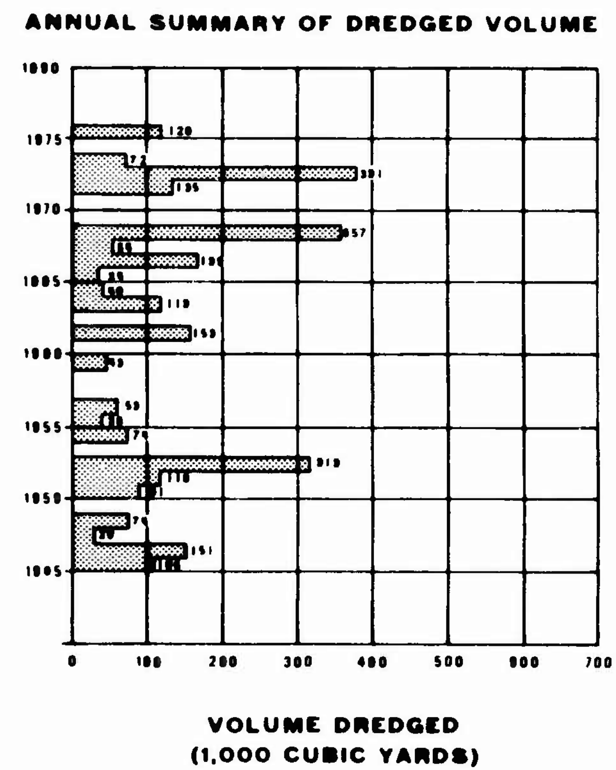
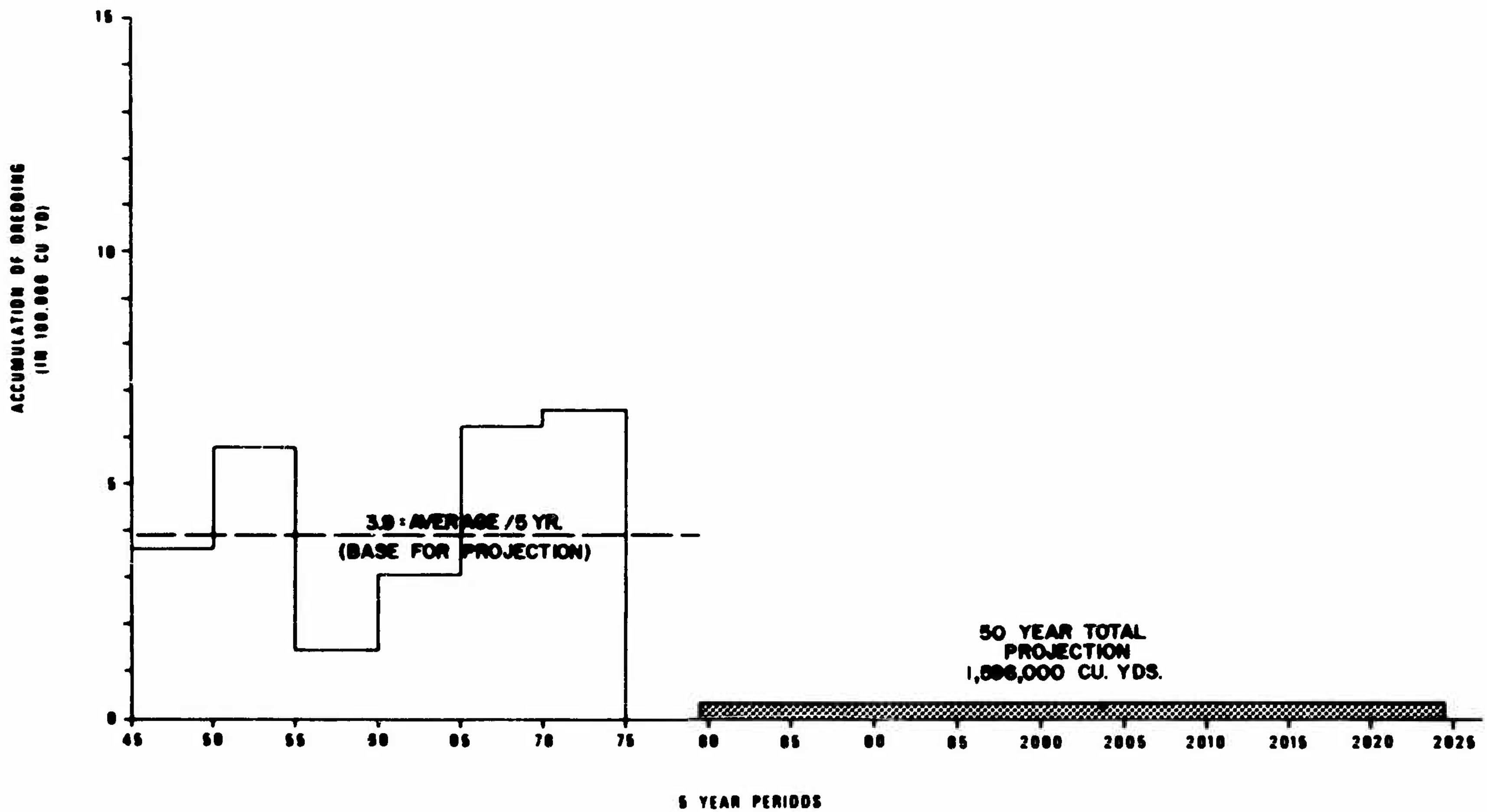



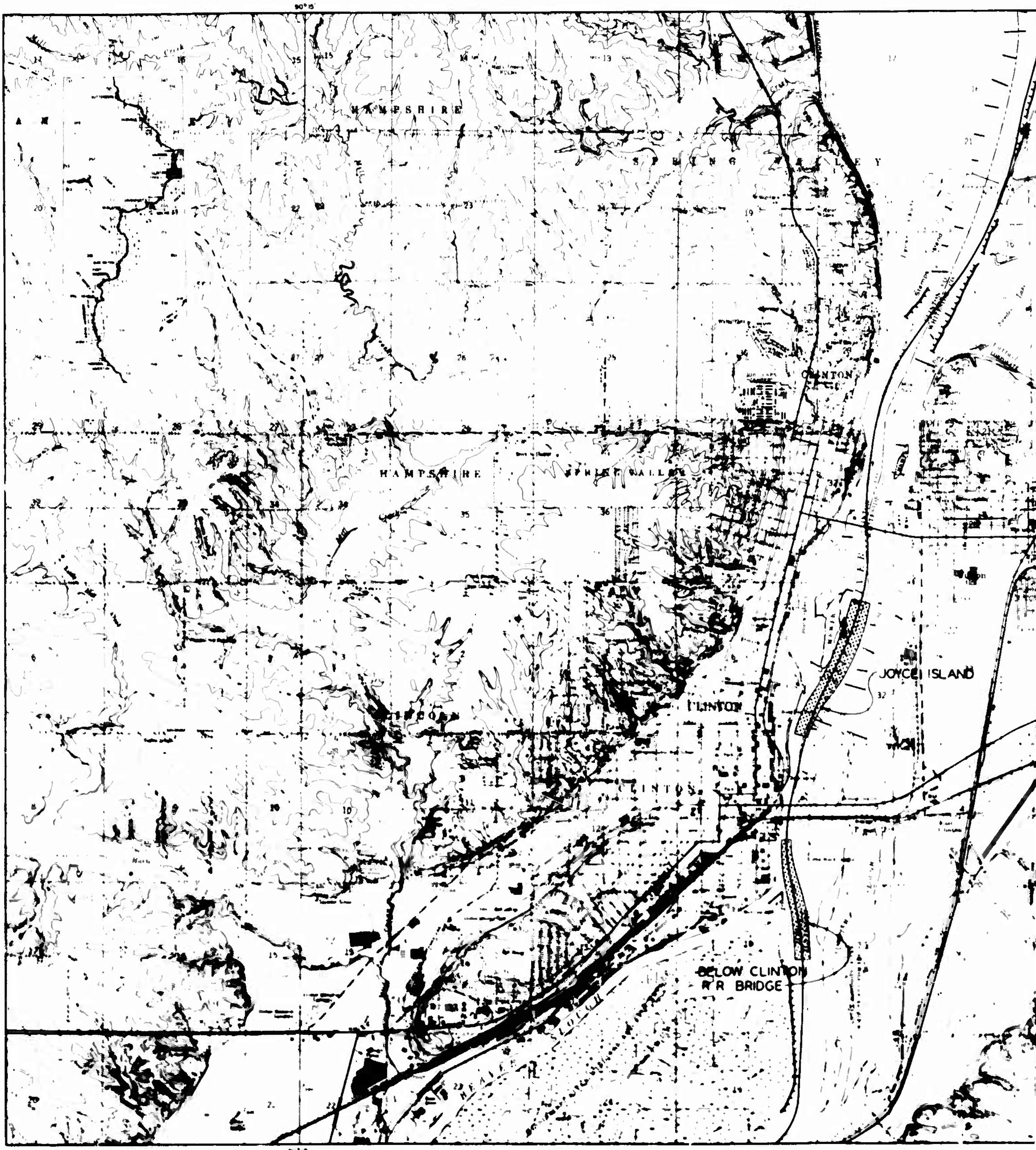

CHART 14 A
EXTENT AND FREQUENCY
OF DREDGING
POOL 14

## CHART 14B – PROJECTED DREDGING POOL 14

CHANNEL DREDGING PROJECTION

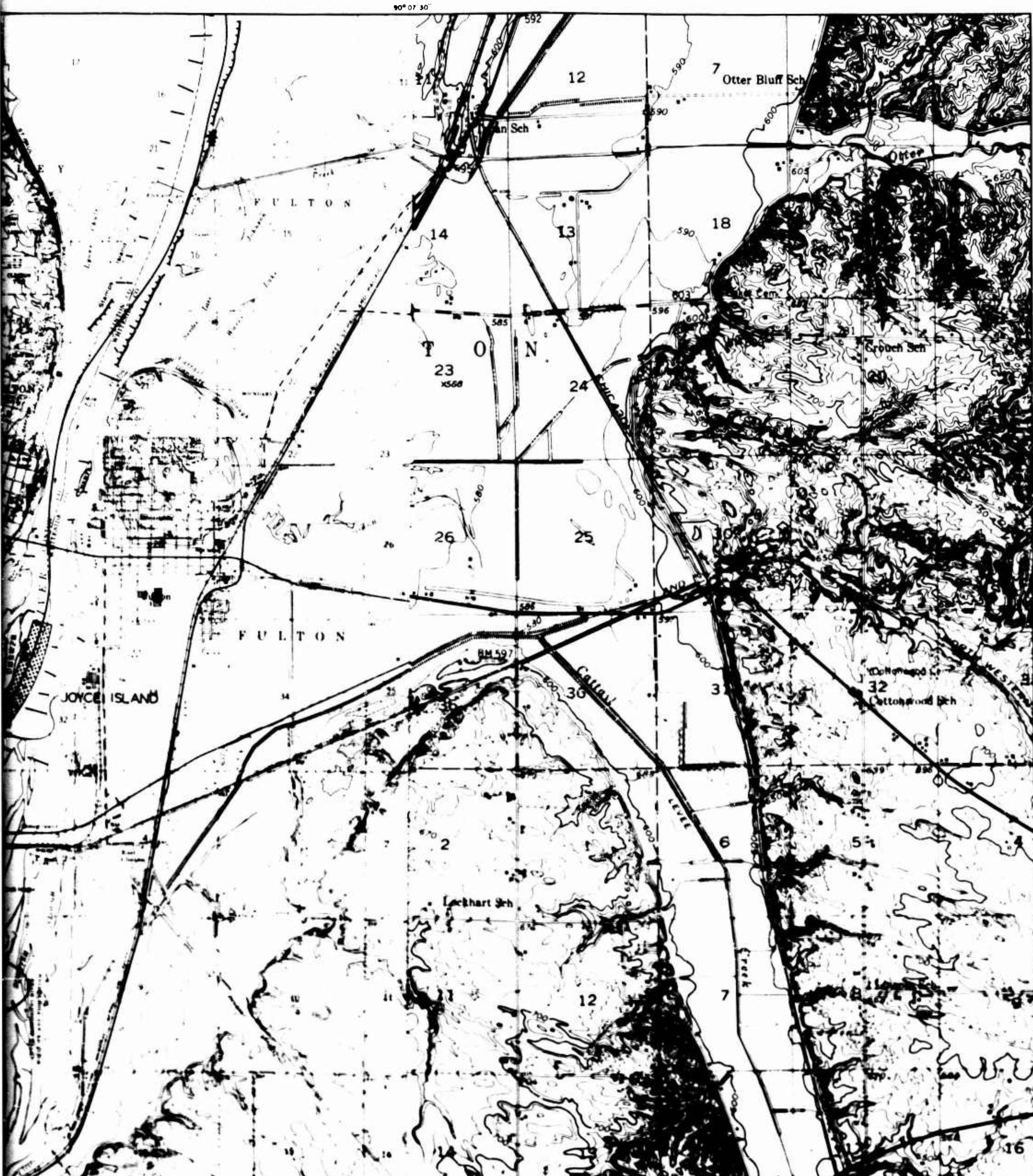


# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 14 — LOCK AND DAM 13 TO MILE 516)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 14 — MODULE 1)




LEGEND

UPPER MISSISSIPPI RIVER

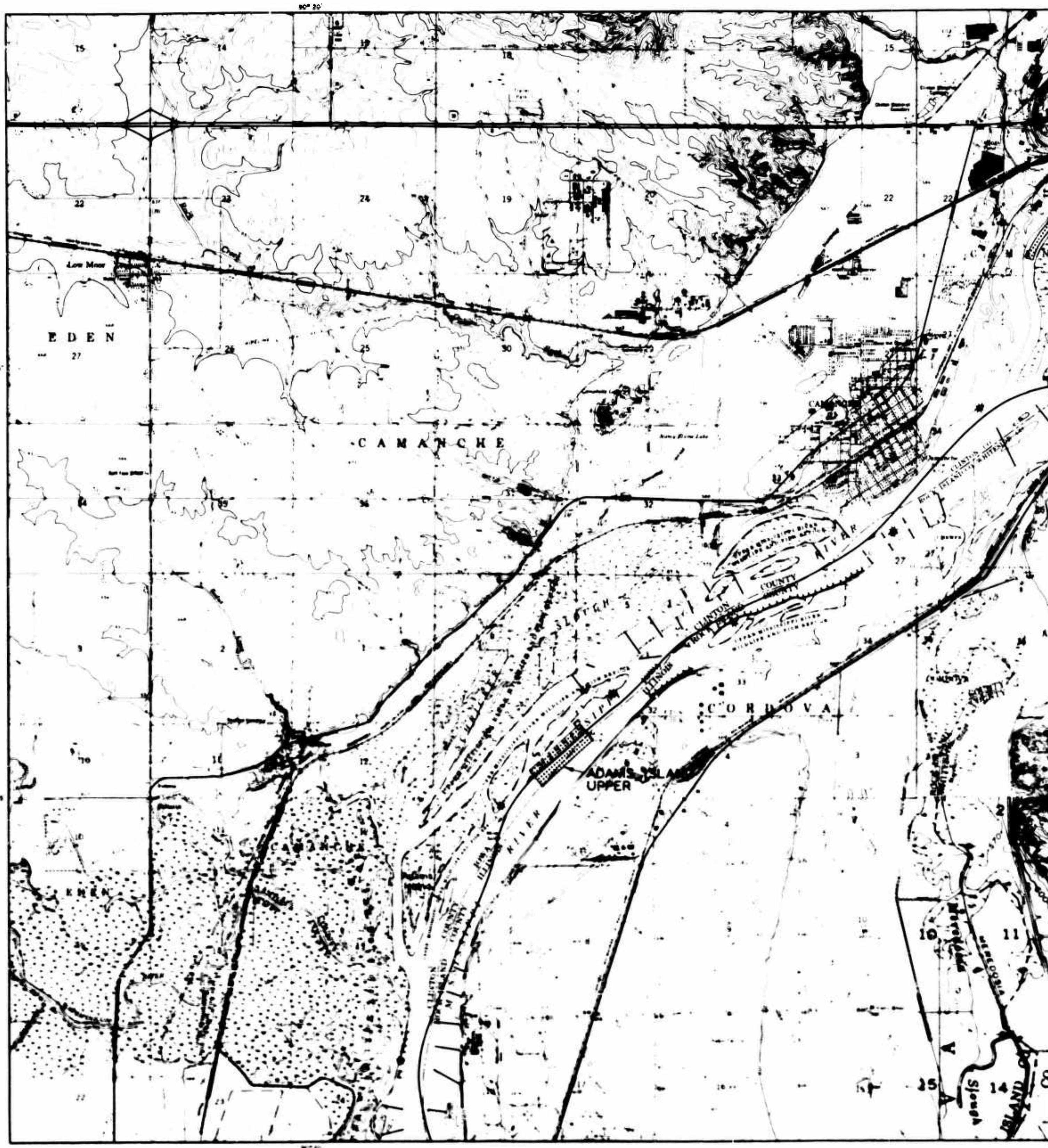
(POOL 14 — LOCK AND DAM 13 TO MILE 516)

(MODULE 1) NAVIGATION STRUCTURES

**PLATE 19**

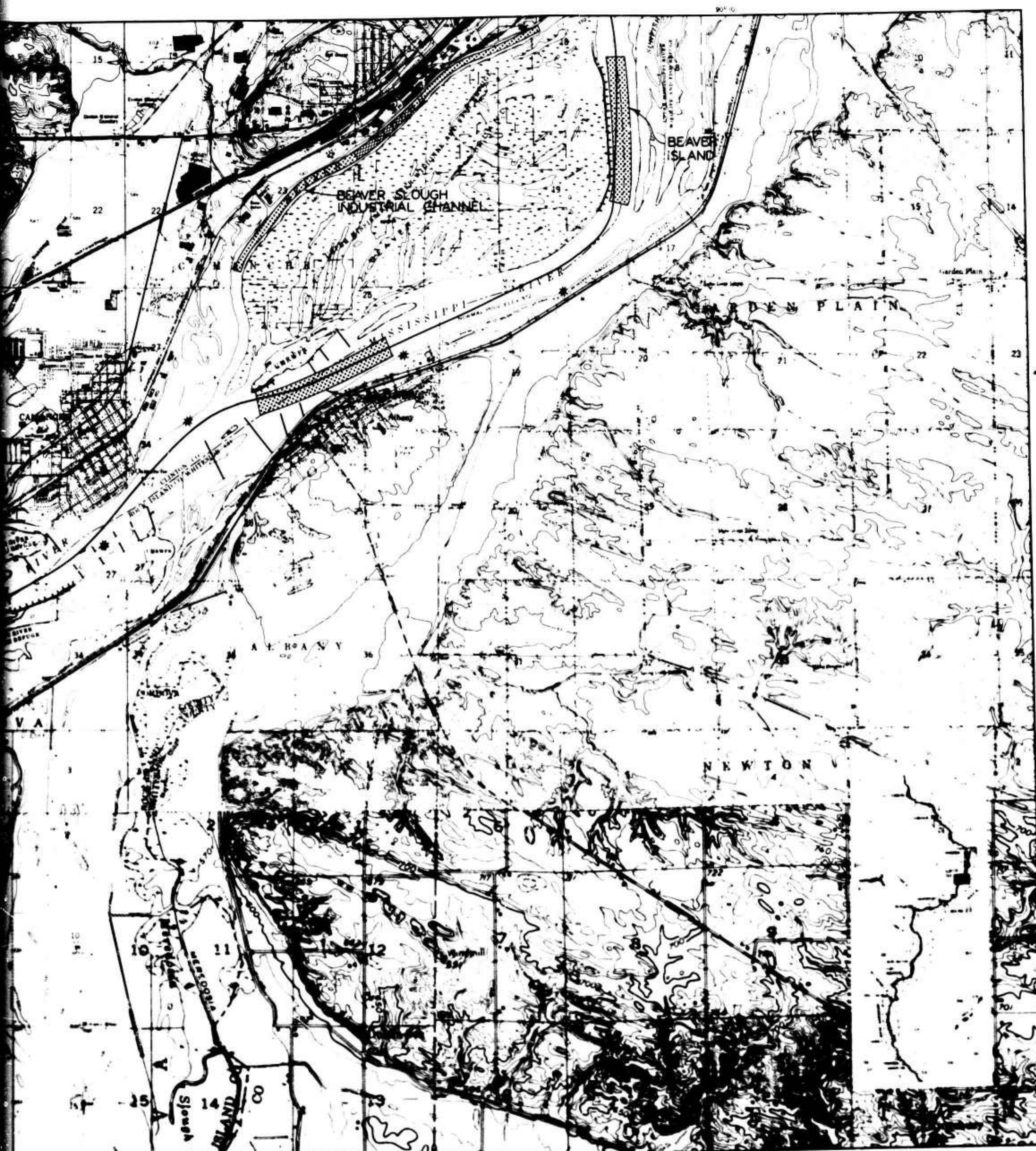
# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 14 — MILE 516 TO MILE 507)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 14 — MODULE 2)




LEGEND

UPPER MISSISSIPPI RIVER

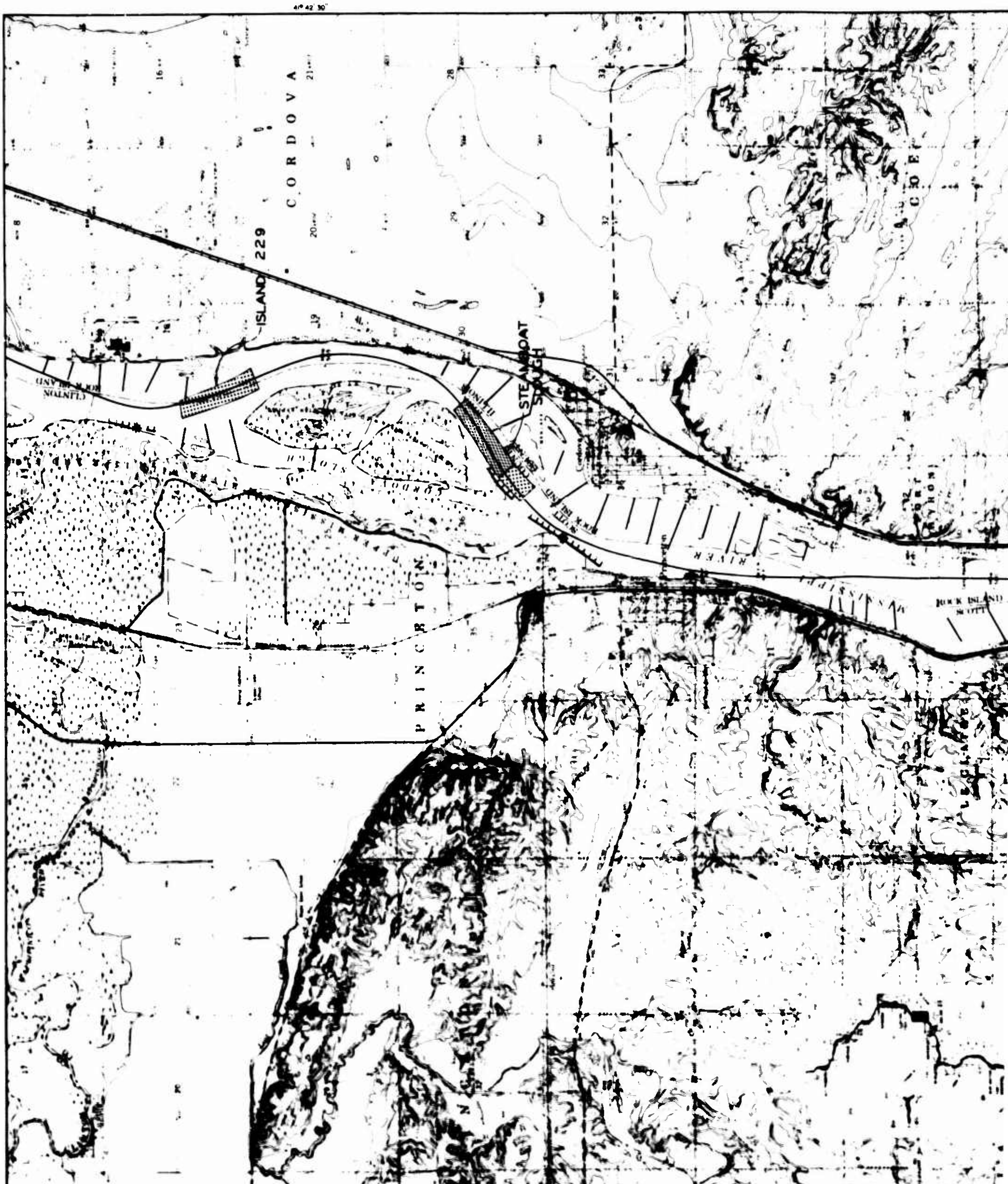
(POOL 14 — MILE 516 TO MILE 507)

(MODULE 2) NAVIGATION STRUCTURES

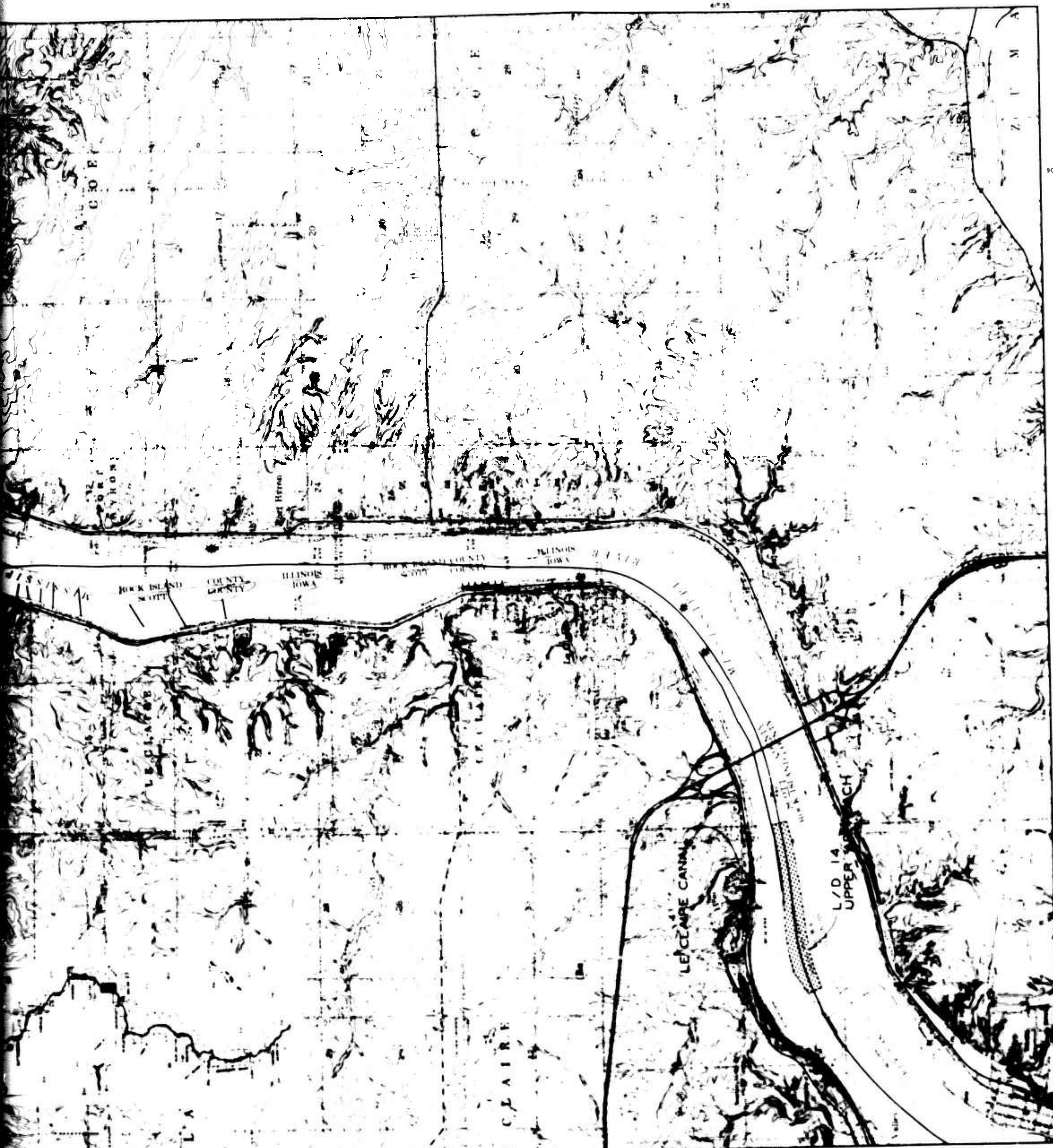
PLATE 20

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 14 — MILE 507 TO LOCK AND DAM 14)**



## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 14 — MODULE 3)




LEGEND

**UPPER MISSISSIPPI RIVER**

(POOL 14 — MILE 507 TO LOCK AND DAM 14)

(MODULE 3) NAVIGATION STRUCTURES

**PLATE 21**

## POOL 15

Extent and Frequency of Dredging - Channel maintenance dredging, largely in the upper portion of the pool, has totaled 220,000 cubic yards from four locations since 1945. Chart 15A, Plate 22, illustrates the quantities dredged in thousand cubic yards by mile location and year dredged. The annual summary of volumes dredged is extended to the right of the chart and the number of cuts that have occurred by mile of river channel is extended directly below. For the locations of past and expected future dredging operations, see the attached "Dredging and Disposal Sites" charts for Pool 15. Approximately 18 percent of the 10.2 miles of channel in Pool 15 has been dredged since 1945.

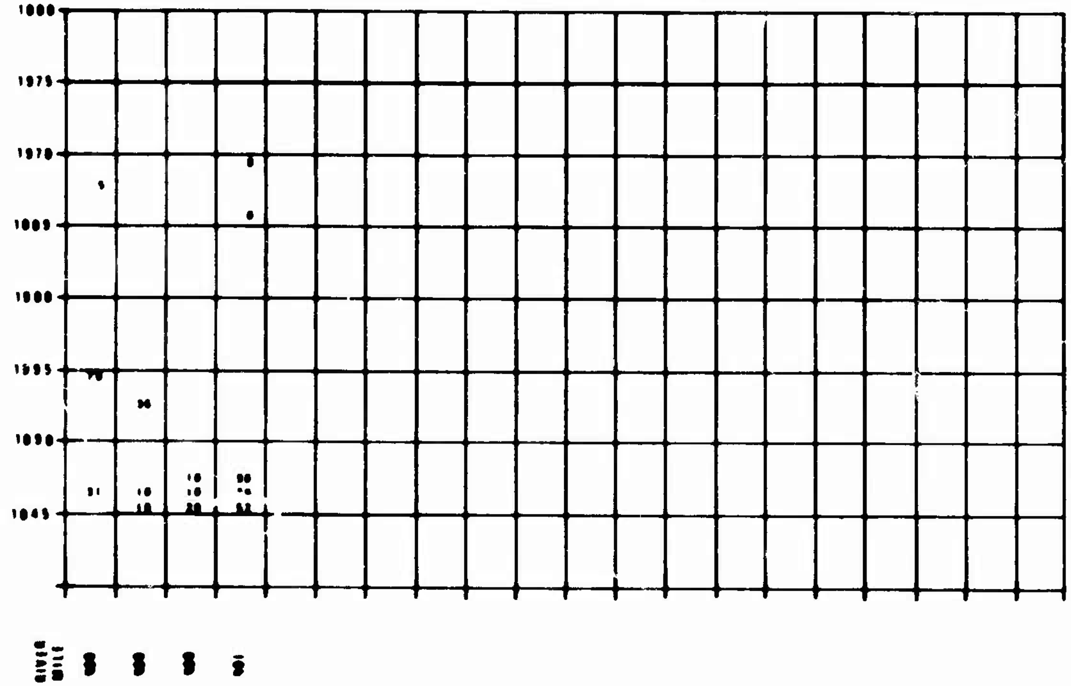
The Moline small-boat harbor at UMR mile 488 and the Lindsay Park boat harbor at UMR mile 484 have not been dredged since the lock and dam went into operation.

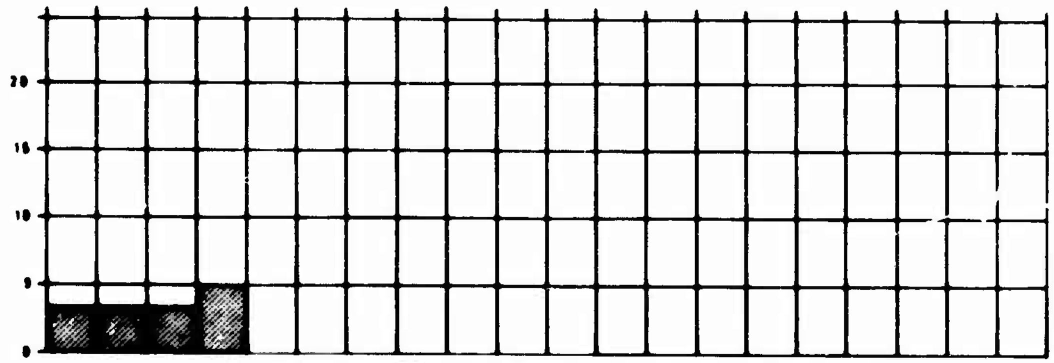
Areas of Recurrent and Recent Dredging - In Pool 15, four areas have been dredged in the past. None of the sites meet the criterion for recent or recurrent dredging areas; all four are, therefore, classified as nonrecurrent.

Future Dredging - In Pool 15, four sites have been identified as probably needing dredging in the next 50 years, based on expected river conditions, dredging requirements and practices. These sites and their expected quantities and frequencies of dredging are shown below. (Assuming dredge depth of 11 feet.) Notice that the predictions for expected frequency and quantities are for long periods of time between dredging and small quantities each occurrance, respectively.

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 490.8-491.8 | Campbell's Is Upper | 1 in 12 | 10,000 | 0.8 | 8,000 | 4.0 | 40,000 |
| 489.2-489.8 | Winnebago Island | 1 in 12 | 10,000 | 0.8 | 8,000 | 4.0 | 40,000 |
| 488.0 | Moline Boat Harbor | 1 in 5 | 1,000 | 2.0 | 2,000 | 10.0 | 10,000 |
| 484.1 | Lindsay Boat Harbor | 1 in 30 | 2,000 | 0.33 | 660 | 1.67 | 3,300 |

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged, is shown in Chart 15B, Plate 23, "Projected Dredging". The total amount of material to be dredged in the next 50 years in Pool 15, is expected to be approximately .103 million cubic yards. This amount is about average as compared to the last 15 years. Notice that the quantities, past and projected, are very small compared to the other pools in the GREAT II study area.



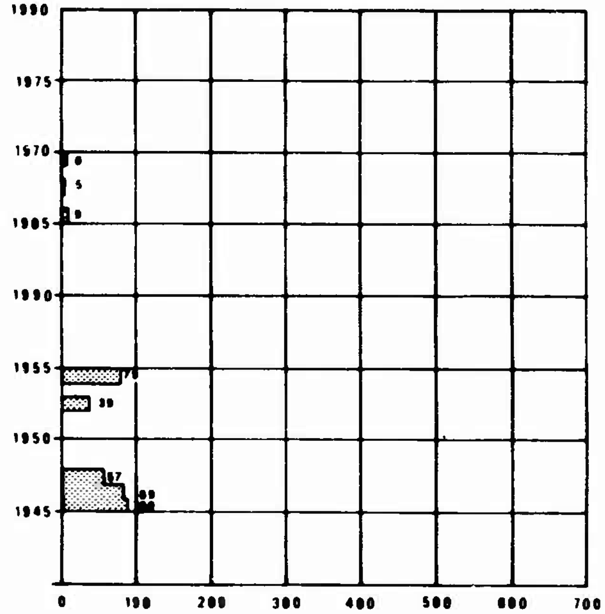
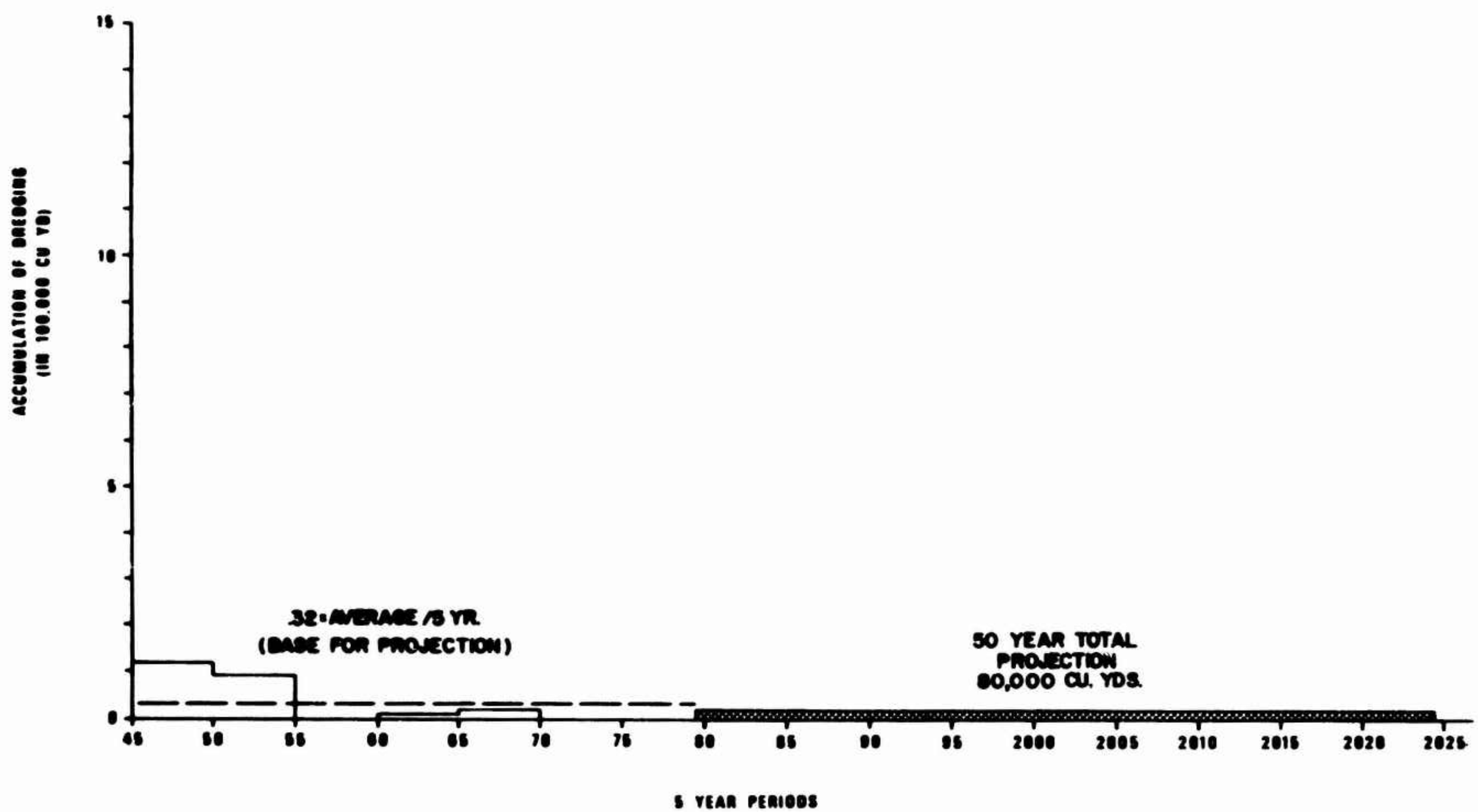




CHART 15A
EXTENT AND FREQUENCY
OF DREDGING
POOL 15

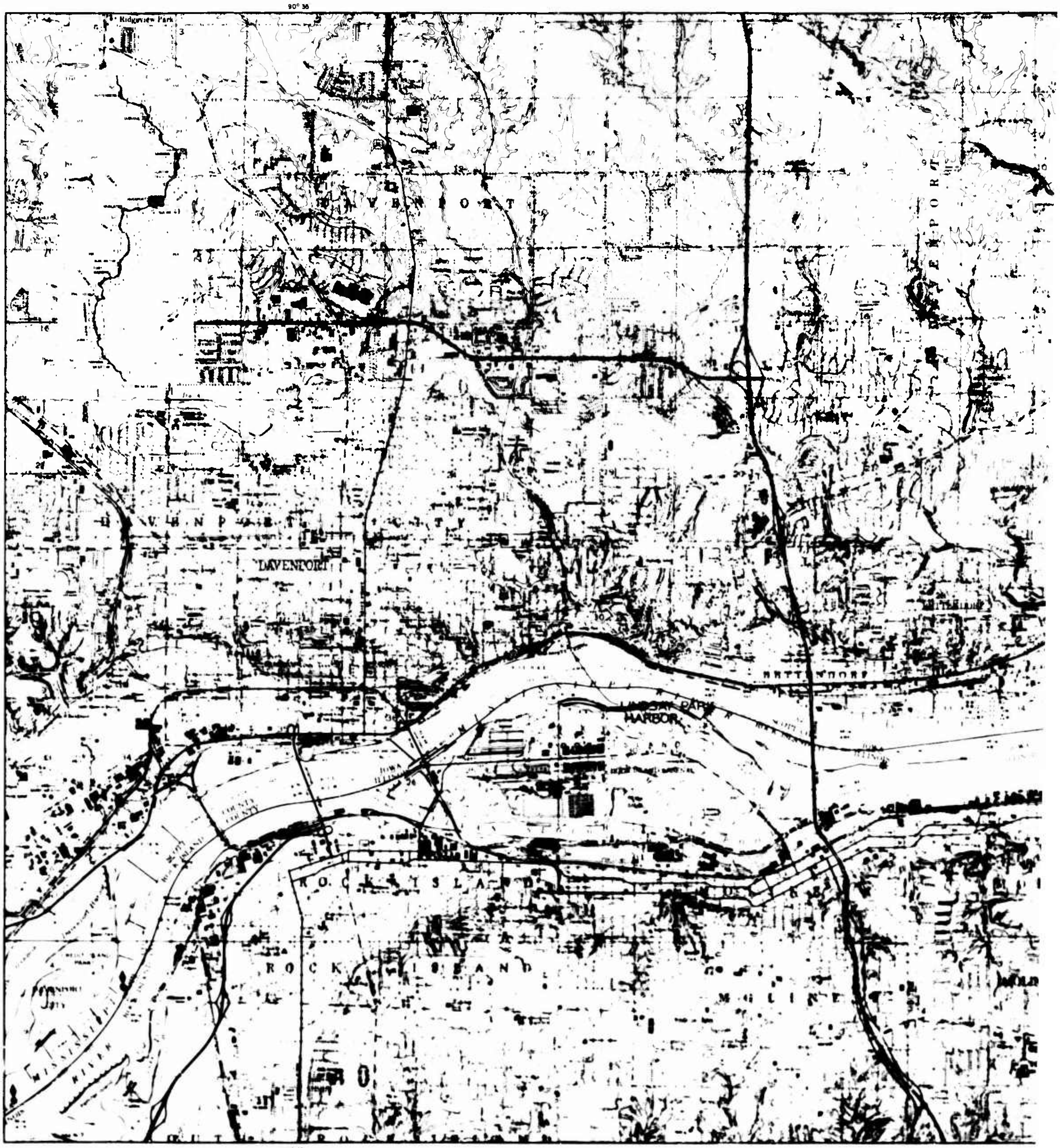
## CHART 15B– PROJECTED DREDGING POOL 15

CHANNEL DREDGING PROJECTION

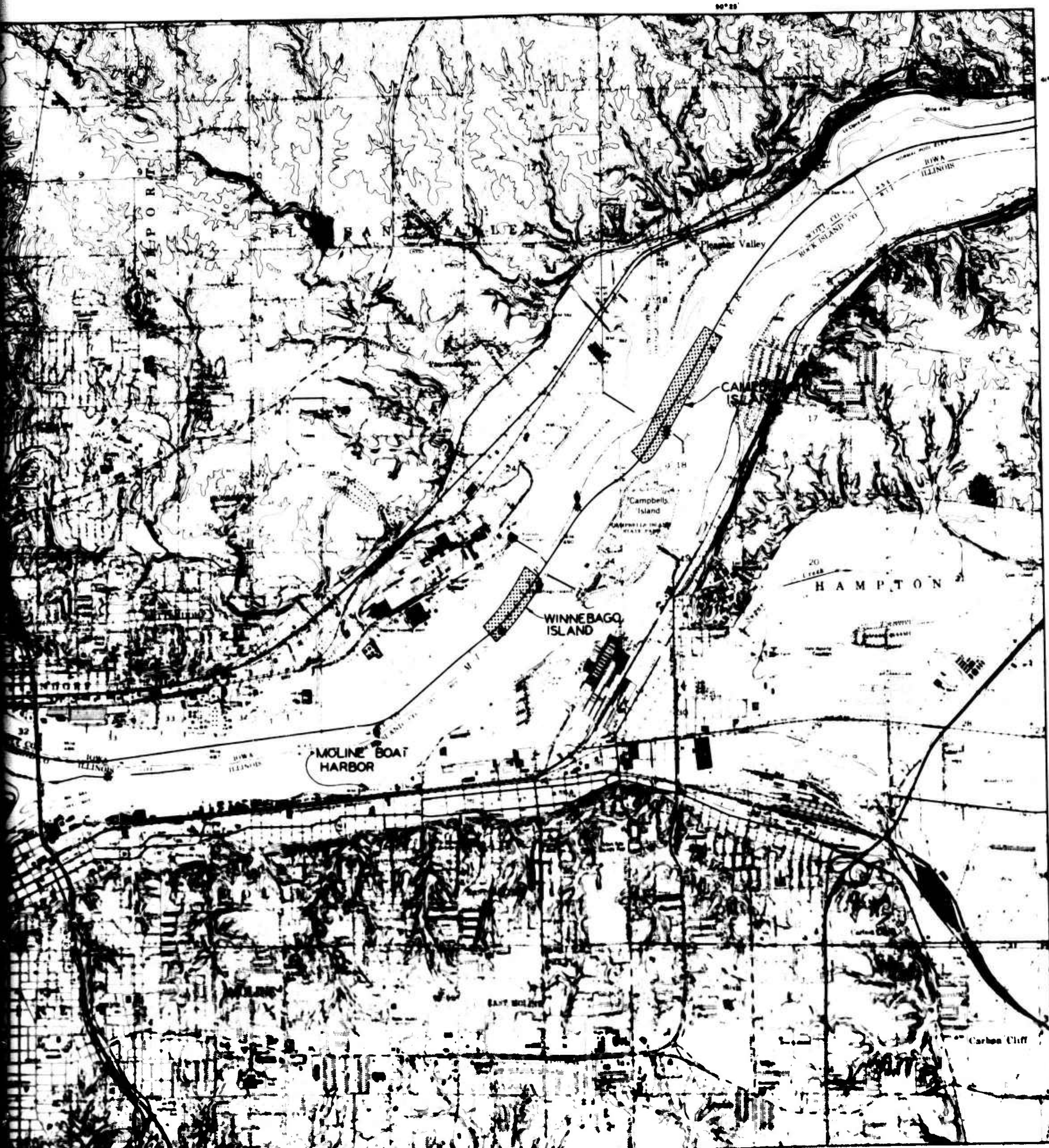


# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

(POOL 15 — LOCK AND DAM 14 TO LOCK AND DAM 15)



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 15 — MODULE 1)




LEGEND

**UPPER MISSISSIPPI RIVER**
(POOL 15 — LOCK AND DAM 14 TO LOCK AND DAM 15)
(MODULE 1) NAVIGATION STRUCTURES

PLATE 24

## POOL 16

Extent and Frequency of Dredging - Channel maintenance dredging has totalled 950,000 cubic yards from seven locations since 1945. Chart 16A, Plate 25, illustrates the quantities dredged in thousand cubic yards by mile location and year dredged. The annual summary of dredge volumes is extended to the right of the chart and the number of dredges per mile is extended directly below. For the locations of past dredging operations, see the attached "Dredging and Disposal Sites" charts for Pool 16. Approximately 18 percent of the 25.7 river miles of channel in Pool 16 has been dredged since 1945.

The small boat harbors at Rock Island, mile 479.8, and at Andalusia, mile 473.0, are maintained to a five-foot depth. The amount dredged in these harbors since 1965 has been:

| | Cubic Yards | |
|---|---|---|
| Year | Rock Island | Andalusia |
| 1966 | 10,371 | --- |
| 1967 | --- | 8,975 |
| 1968 | 10,887 | --- |
| 1969 | --- | --- |
| 1970 | 12,698 | 8,937 |
| 1971 | --- | 6,679 |
| 1972 | --- | 8,370 |
| 1973 | 7,443 | 2,469 |

Areas of Recurrent and Recent Dredging - In Pool 16, of the seven channel areas dredged in the past, five are considered nonrecurrent and the following are classified as either recurrent or recent.

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recent | Below Centennial Bridge | 481.8 - 482.8 |
| Recent | Hershey Chute Upper | 461.0 - 461.5 |
| Recurrent | Rock Island SB Harbor | 479.8 |
| Recurrent | Andalusia SB Harbor | 473.0 |

Hydraulics - The area downstream of Lock and Dam 15 between river mile 482.9 and 481.2, has been a major dredging problem, primarily since 1960. During almost every wet year on the Mississippi River or the Rock River, some amount of material has to be dredged from the channel and placed along the left bank of the river or in the diked disposal area at the tip of Arsenal Island. When high flows exist on the Rock River they cause a backwater condition on the Mississippi River, slowing velocities in the reach so that deposition can occur. A portion of the flow in the Mississippi River bifurcates upstream above Arsenal Island, and its confluence is at river mile 482.4 where Sylvan Slough re-enters the Mississippi River. Sylvan Slough is controlled by two run-of-the-river hydropower dams, Rock Island Arsenal Power Dam, and Iowa-Illinois Gas and Electric Power Dam. The majority of this reach of the river is founded on a rock foundation, and dredging is very difficult throughout it. With the Rock River entering at river mile 479.1 and causing a backwater condition upstream, a dredging problem will always exist in this reach.

At Buffalo, Iowa, dredging has been required between river mile 472.0 and 473.2. This is a relatively straight stretch of the river. However, considerable flow passes on the left bank of the river along the Andalusia Slough. Access to Andalusia, Illinois, is maintained via an access between Island 319 and Andalusia Island at river mile 473.8. Water can re-enter the main channel from Andalusia Slough at this location. The combination of water entering the Mississippi River from this bank channel and the potential of the wing dams along the left and the right banks of the channel not being of the adequate grade, provides for potential shoaling in this reach. It is recommended that a flow study and a wing dam analysis be made in this reach to determine a method to reduce the dredging along the Buffalo, Iowa, area.

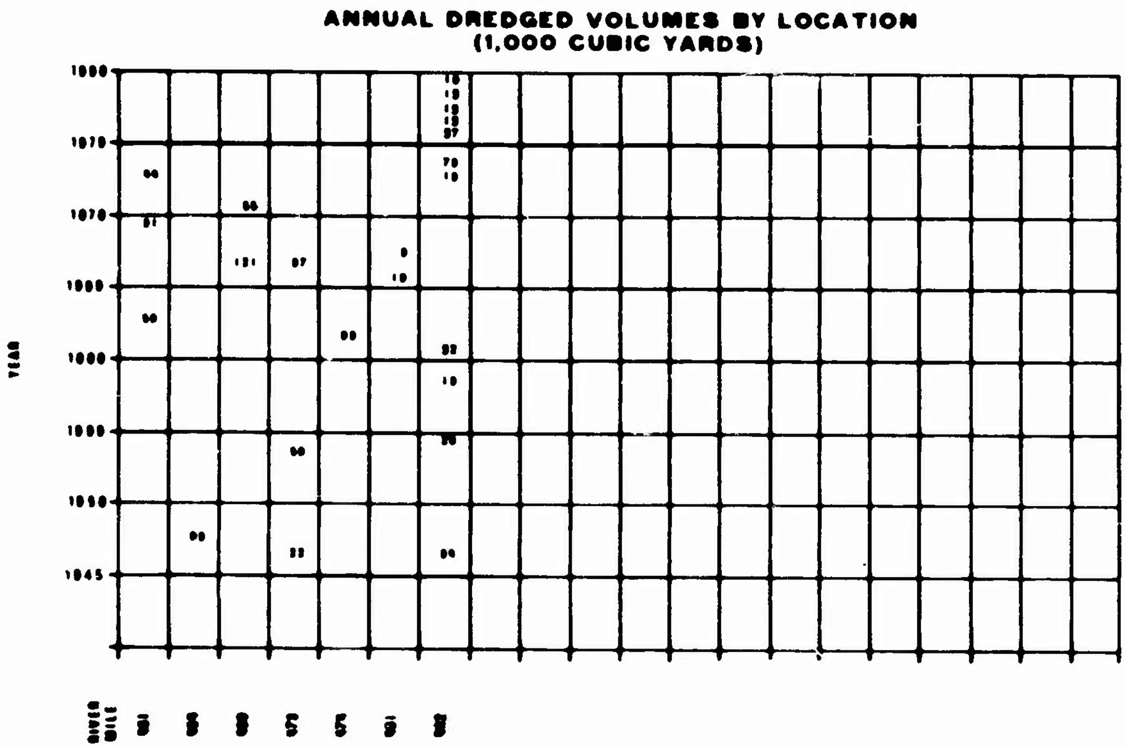
Hershey's Chute Upper, located at river mile 461 to 462, is the last location in Pool 16. A complex series of backchannels between the Illinois and the Iowa shore allow considerable flow in the reach between river mile 461 and 462. At river mile 462 a portion of the water travels down the Iowa side in Wyoming Slough and at river mile 461.4 a portion of the main channel flow travels down Drury Slough. If Wing Dams No. 12 and 11, which reduce the amount of flow going down Wyoming Slough, are not at the design grade, deposition will occur in the main channel because of a lack of velocities. Wing Dam No. 2 at the head of Drury Slough allows water to travel down that reach, reducing the amount of flow in the main channel. Wing Dams 19 and 23, along the right bank of the main channel, could possibly be degraded to the point that deposition occurs because of the low velocities carrying sediments through the reach. Deposition usually occurs in an area where the channel is making a bend and deposition on the inside of the bend tends to slowly close off the channel from the right bank to the left bank. It is recommended that the closing dams and the wing dams in this area be examined for their adequacy.

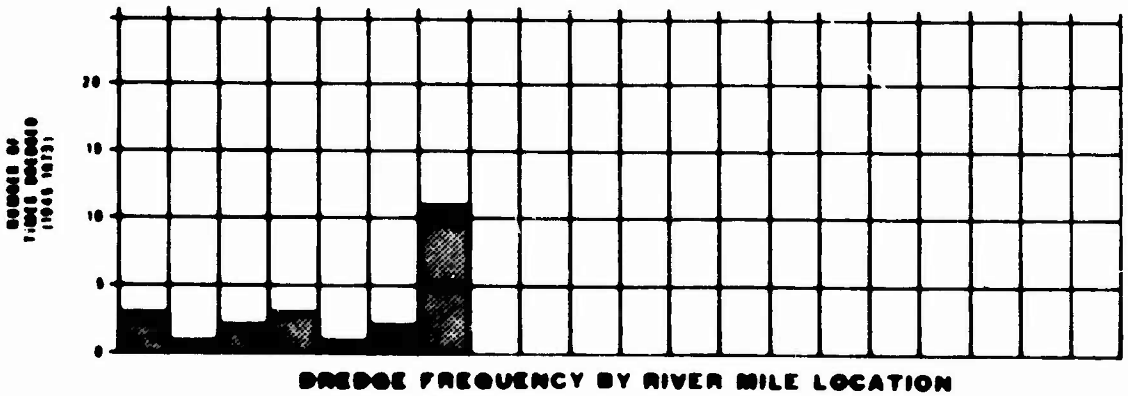
Future Dredging - In Pool 16, six sites have been further identified as "chronic" dredging sites for the next 50 years, based on expected river conditions, dredging requirements and practices. These sites and their expected quantities and frequencies of dredging are shown below: (assuming an 11 foot dredge depth)

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 482.3-482.8 | L/D 15 Lower Approach | 1 in 5 | 20,000 | 2.0 | 40,000 | 10.0 | 200,000 |
| 481.3-482.0 | Below Centennial Br | 1 in 4 | 20,000 | 2.5 | 50,000 | 12.5 | 250,000 |
| 472.0-473.2 | Buffalo | 1 in 8 | 25,000 | 1.25 | 31,250 | 6.33 | 156,250 |
| 469.2-471.2 | Montpelier | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |
| 461.0-462.0 | Hershey Chute Upper | 1 in 6 | 30,000 | 1.7 | 51,000 | 8.5 | 255,000 |
| 479.8 | Sunset Marina | 1 in 4 | 10,000 | 2.5 | 25,000 | 12.5 | 125,000 |
| 473.0 | Andalusia Harbor | 1 in 3 | 3,000 | 3.3 | 9,900 | 6.5 | 49,500 |

At the Montpelier and Hershey Chute upper sites, the dredging frequency in the future is expected to increase as compared to the historic 40-year average for dredging at these sites.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged, is shown in Chart 16B, Plate 26, "Projected Dredging". The total amount of material to be dredged in the next 50 years from Pool 16 is expected to be approximately 1.036 million cubic yards. This amount is slightly less than the quantities that have been dredged from Pool 16 in the last 20 years.



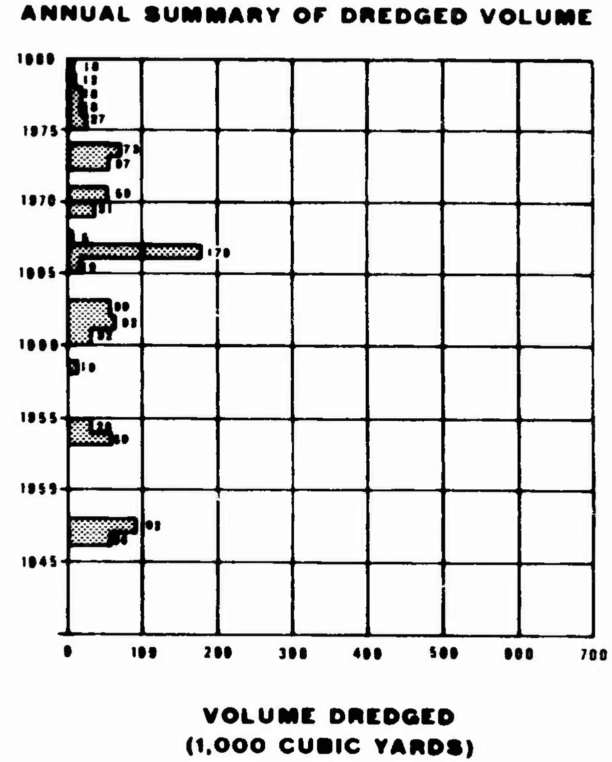
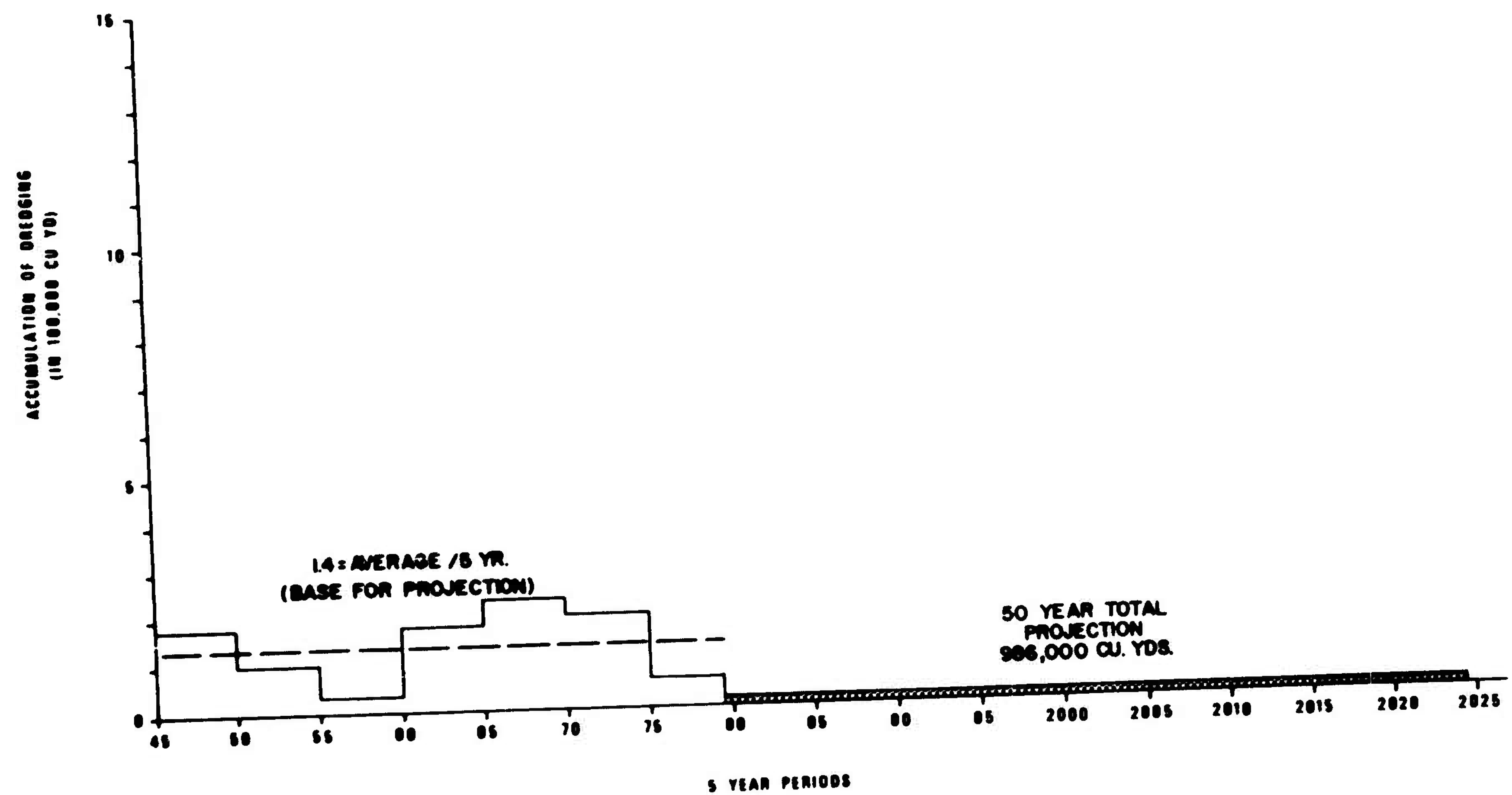




CHART 16A
EXTENT AND FREQUENCY
OF DREDGING
POOL 16

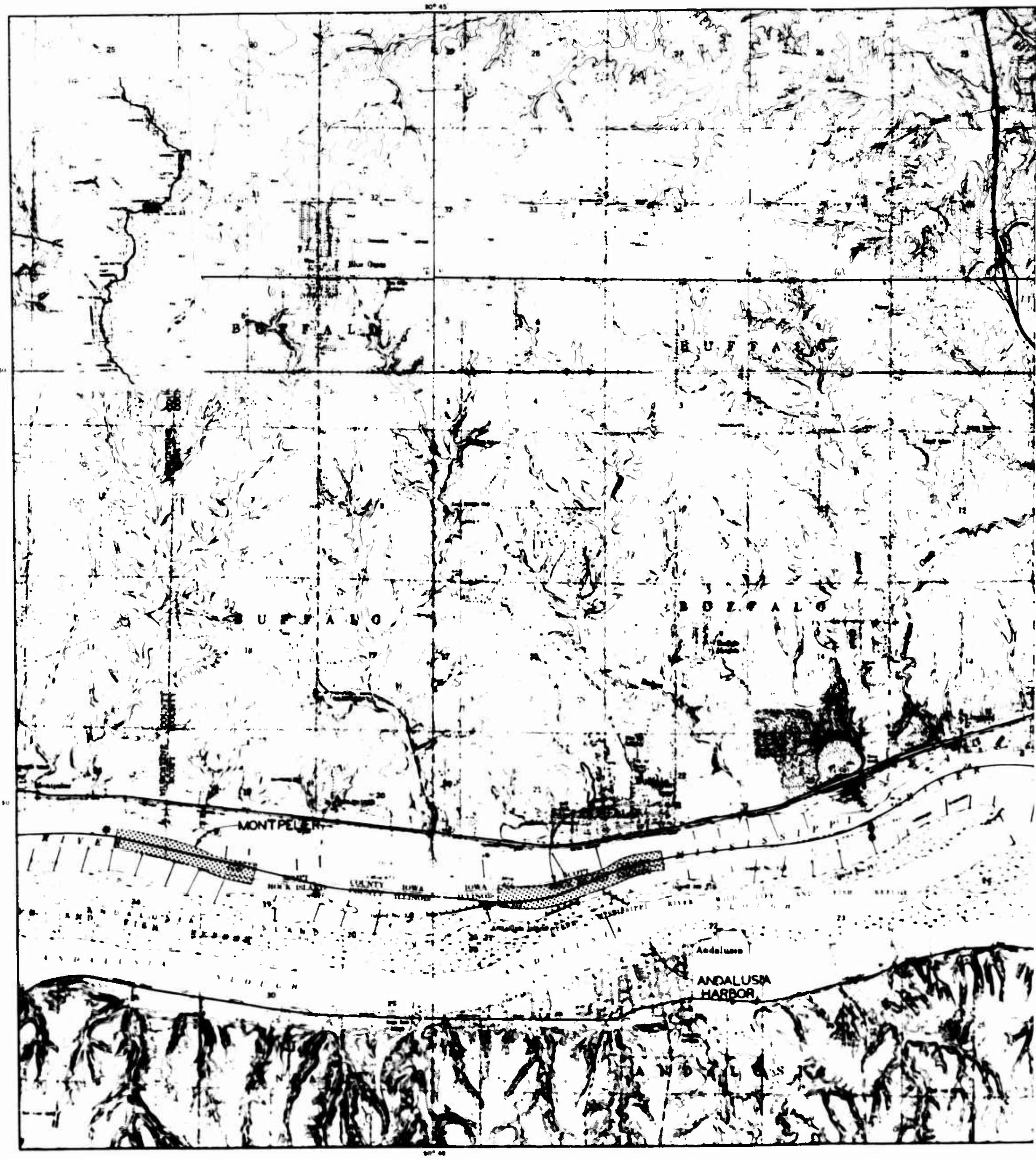
## CHART 16B – PROJECTED DREDGING POOL 16

CHANNEL DREDGING PROJECTION

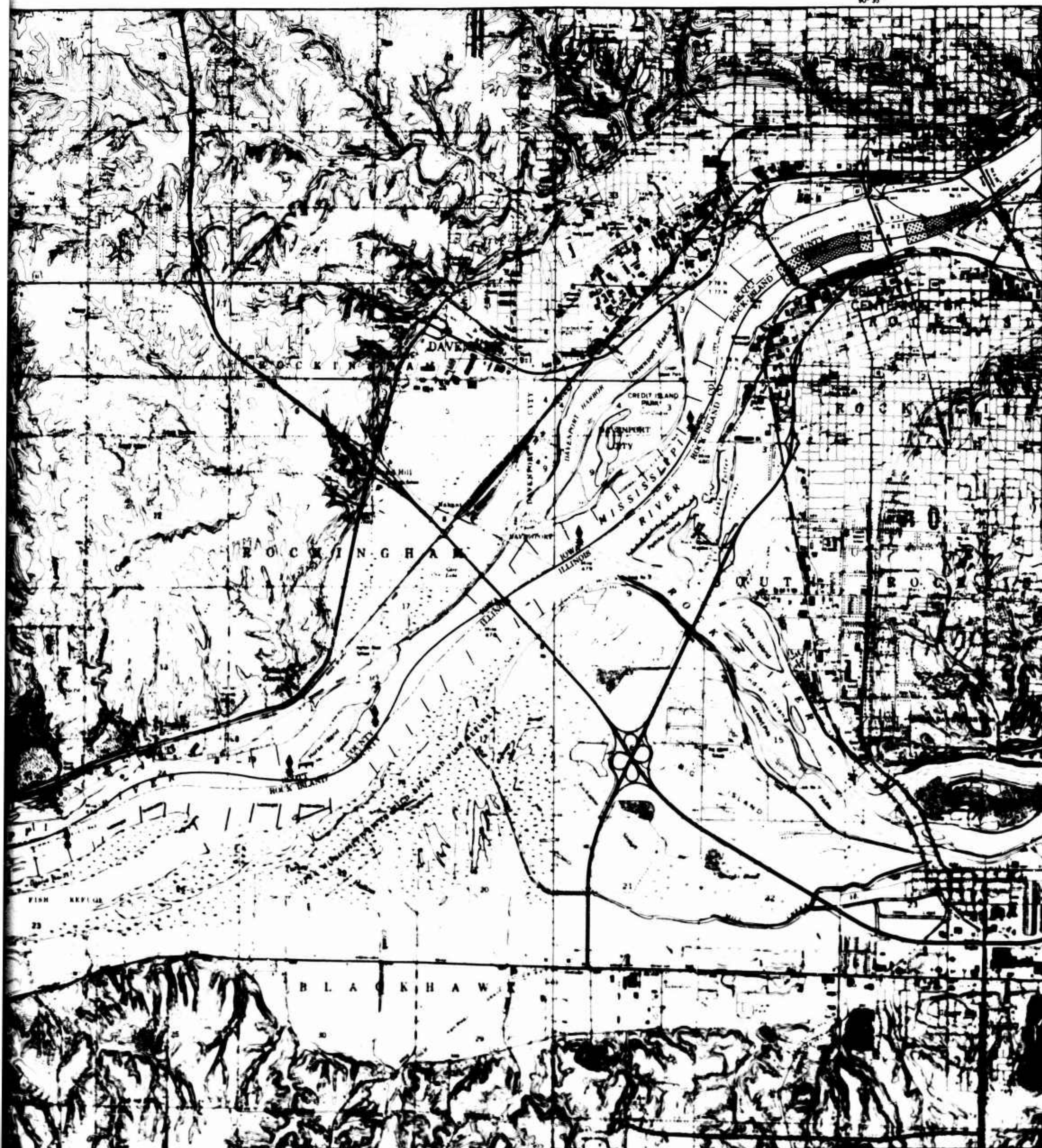


# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

(POOL 16 — LOCK AND DAM 15 TO MILE 469)



## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 16 — MODULE 1)



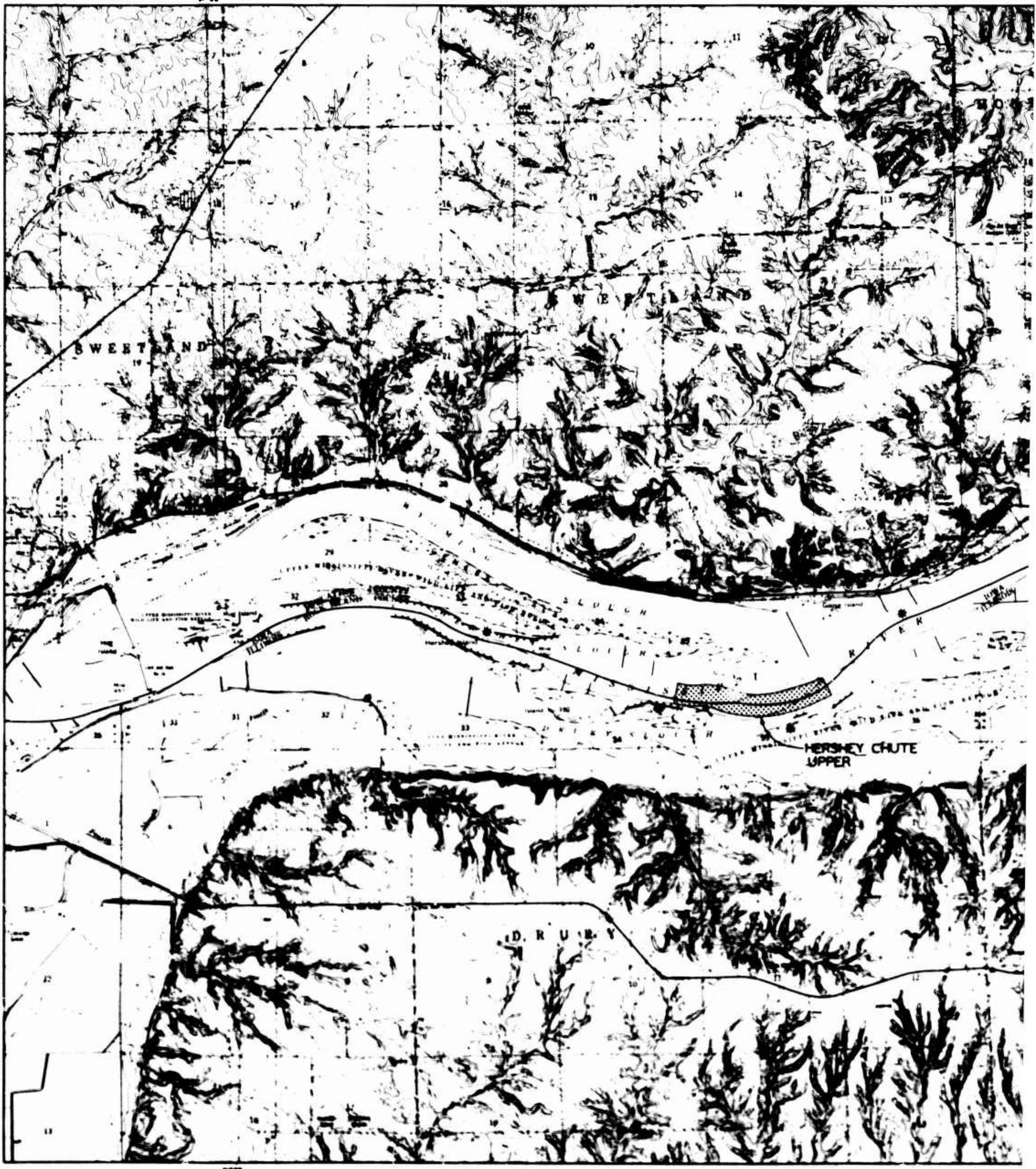

LEGEND

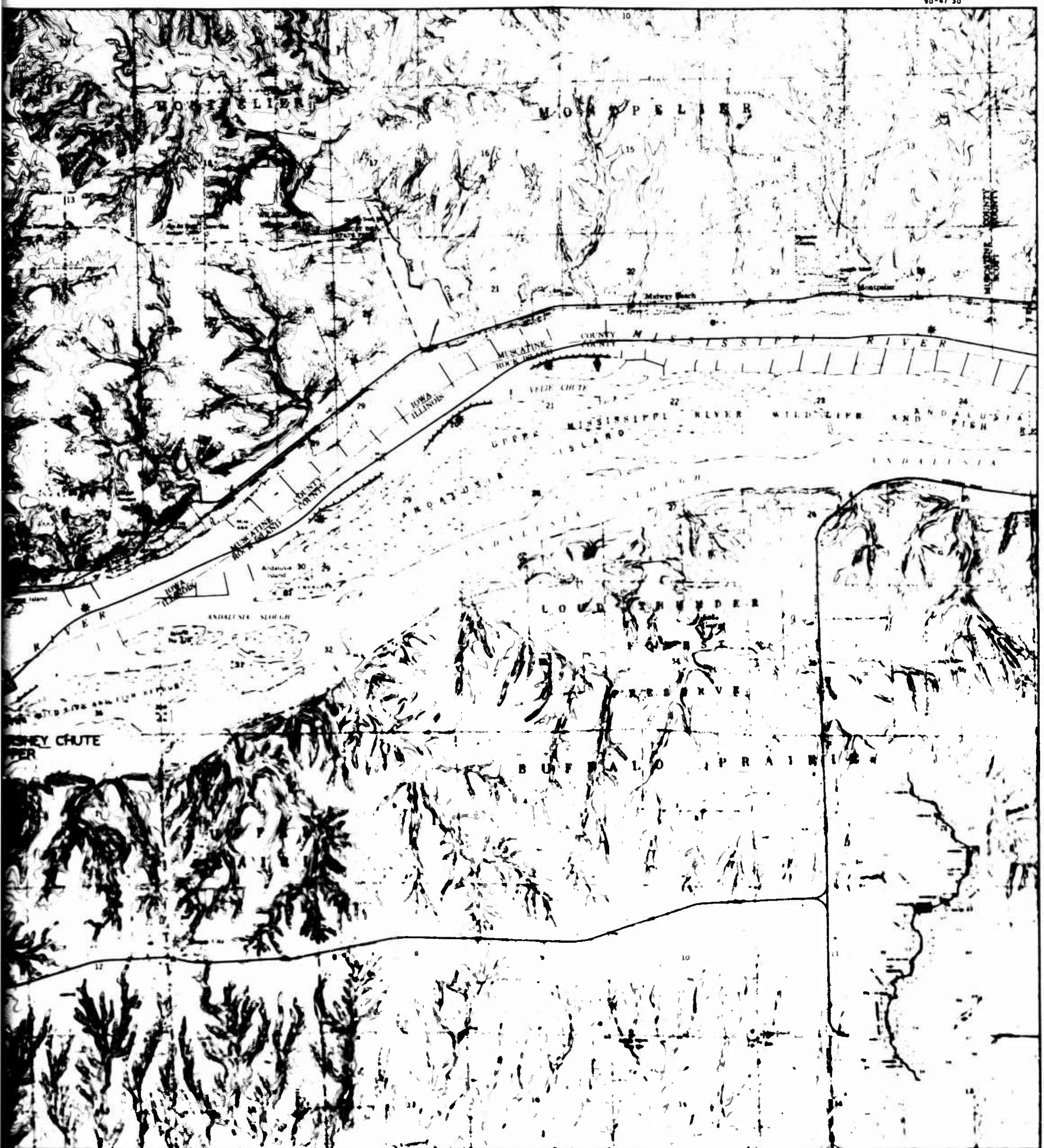
- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- MIDCHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 50 YRS
- RECURRENT DREDGING SITES

**UPPER MISSISSIPPI RIVER**
(POOL 16 — LOCK AND DAM 15 TO MILE 469)
(MODULE 1) NAVIGATION STRUCTURES

**PLATE 27**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
### (POOL 16 — MILE 469 TO LOCK AND DAM 16)






LEGEND

UPPER MISSISSIPPI RIVER
(POOL 16 — MILE 469 TO LOCK AND DAM 16)
(MODULE 2) NAVIGATION STRUCTURES

PLATE 28

Extent and Frequency of Dredging - Channel maintenance dredging, largely in the upper portion of the pool, has totaled 1.34 million cubic yards from three locations since 1945. Chart 17A, Plate 29, illustrates the quantities dredged in thousand cubic yards, by mile location and year dredged. The annual summary of dredge volume is extended to the right of the chart and the number of cuts per mile is extended directly below. For the locations of past dredging operations, see the attached "Dredging and Disposal Sites" charts for Pool 17. Approximately nine percent of the 20.1 river miles of channel in Pool 17 has been dredged since 1945.

The small-boat harbor at Muscatine, at UMR mile 455.5, is maintained to a five-foot depth. The amount of material dredged since 1965 has been:

| Year | Cubic Yards |
|---|---|
| 1966 | 2,365 |
| 1970 | 8,844 |
| 1973 | 5,873 |

Areas of Recurrent and Recent Dredging - In Pool 17, of the three channel areas dredged in the past, one is classified as nonrecurrent and the following are classified as recurrent or recent.

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recurrent | Muscatine Island | 453.5 - 454.6 |
| Recurrent | Bass Island | 447.8 - 448.1 |
| Recurrent | Muscatine SB Harbor | 455.5 |

The three chronic locations in Pool 17 are located in the upper portions of the pool.

Hydraulics - The Muscatine Boat Harbor requires periodic dredging primarily because of entrance siltation and lack of depth near the slips closest to the entrance. The normal flow vectors are parallel to the Iowa shore line and the entrance to the Boat Harbor is on the downstream side and perpendicular to the normal flow vectors.

As the flood water, laden with sediment, passes the entrance, a portion of the flow enters the harbor. This quieter water allows the sediment to drop in the entrance and inside the harbor.

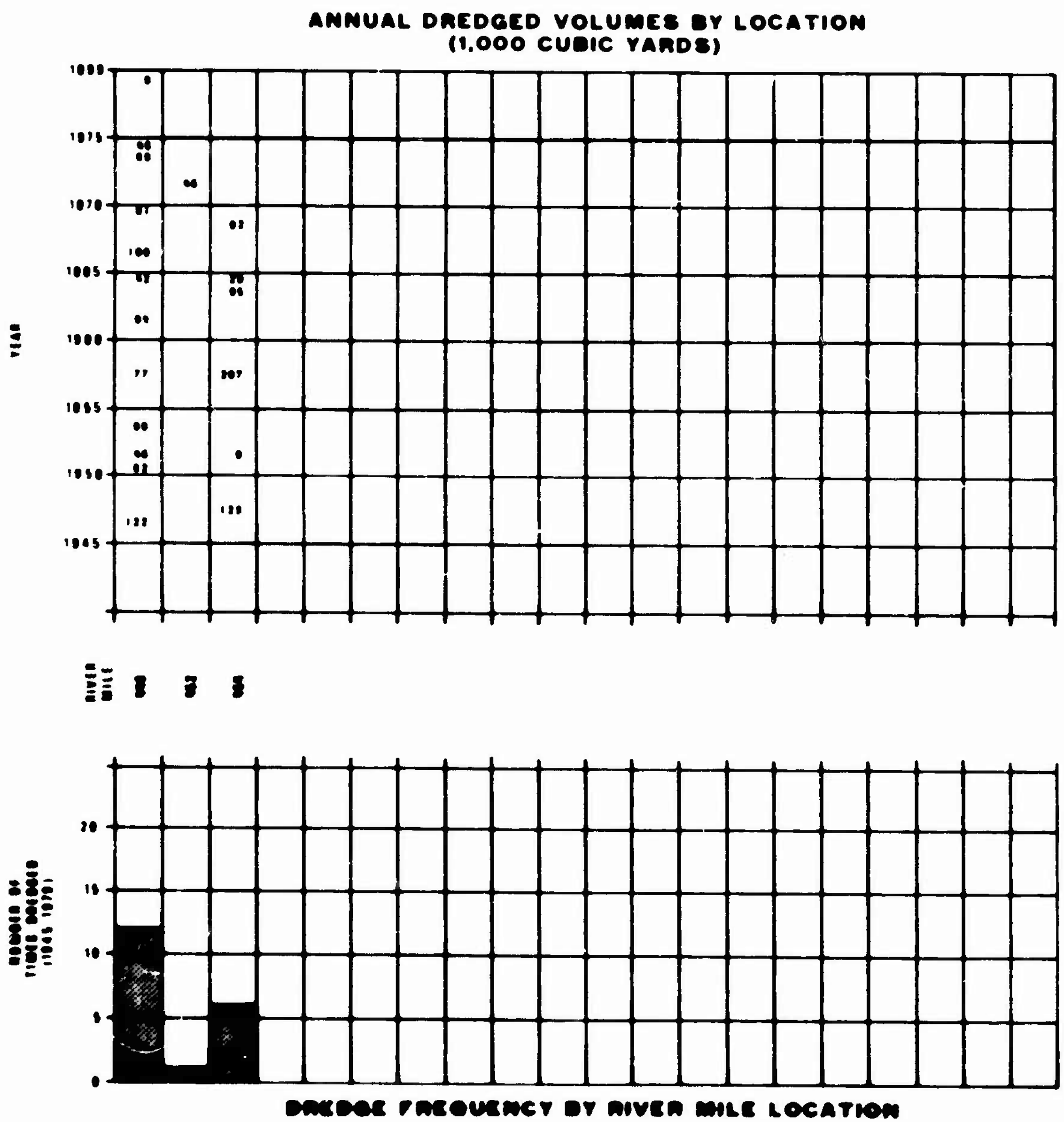
The Muscatine Island area, UMR 453.2 to 454.5, is on the bend of the river and the sediment is deposited on the inside of the bend. The material builds up on previously shoaled material adjacent to Island 335. There is ample depth observed adjacent to the Iowa shore. An occasional ice jam downstream from UMR mile 453 forces the water to flow behind Island 335 and move the earlier deposited material into the main channel.

The area near Bass Island is a chronic dredging site. The location of this dredging is mostly due to deposits in the "crossover" area. The secondary velocities necessary to carry the bed-load sediment are insufficient and the material settles in the main channel. It is recommended that an examination of the regulating structures in this area be made.

Future Dredging - In Pool 17, four sites have been further identified as "chronic" dredging sites for the next 50 years, based on expected river conditions, dredging requirements and practices. These sites and their expected quantities and frequencies of dredging are shown below: (assuming an 11 foot dredge depth)

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 453.2-454.5 | Muscatine Island | 1 in 12 | 45,000 | 0.8 | 36,000 | 4.16 | 180,000 |
| 451.5-452.0 | Blanchard Island | 1 in 20 | 20,000 | 0.5 | 10,000 | 2.5 | 50,000 |
| 447.5-448.5 | Bass Island | 1 in 4 | 30,300 | 2.5 | 75,000 | 12.5 | 375,000 |
| 455.5 | Muscatine Harbor | 1 in 4 | 5,000 | 2.5 | 7,500 | 12.5 | 37,500 |

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged, is shown in Chart 17B, Plate 30, "Projected Dredging". The total amount of material to be dredged in the next 50 yars from Pool 17 is expected to be approximately .643 million cubic yards. This amount is about average compared to the quantities dredged for the past 20 years.



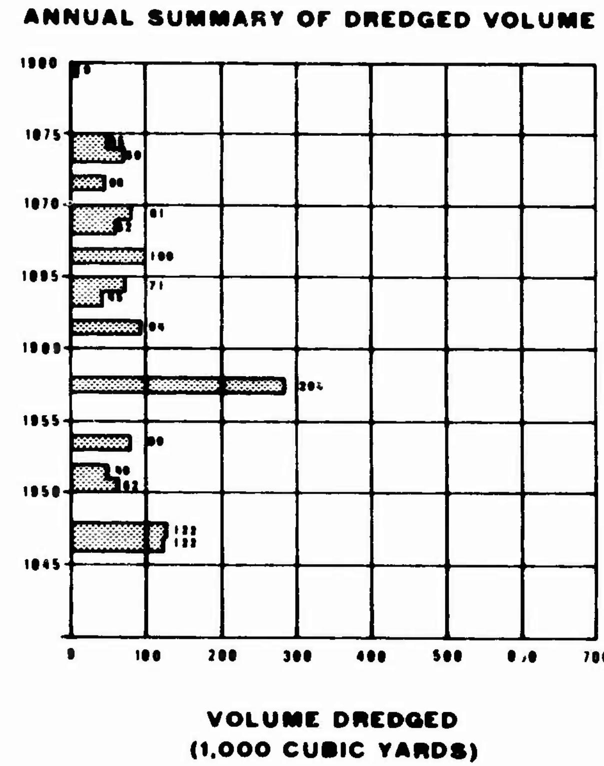
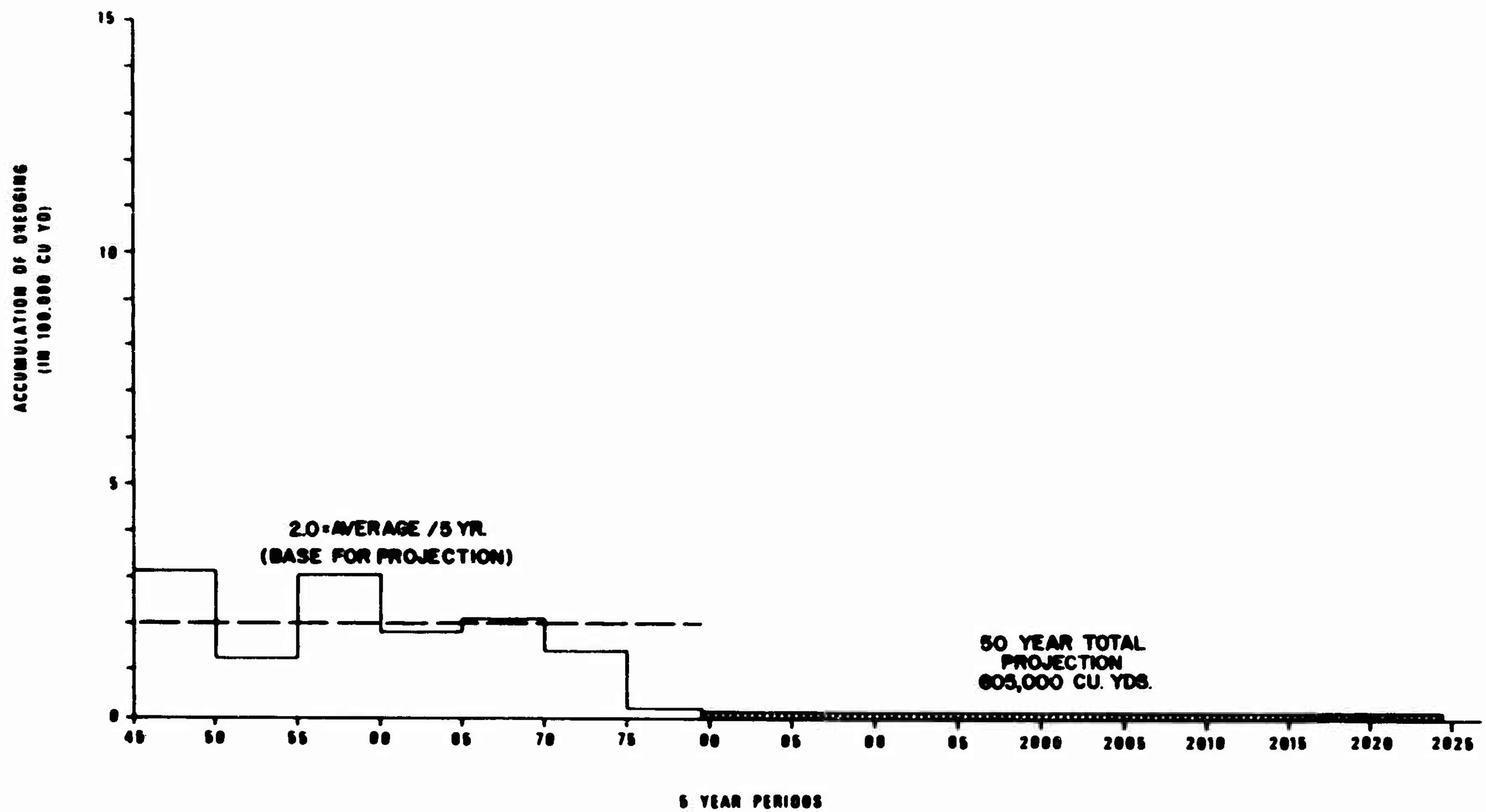



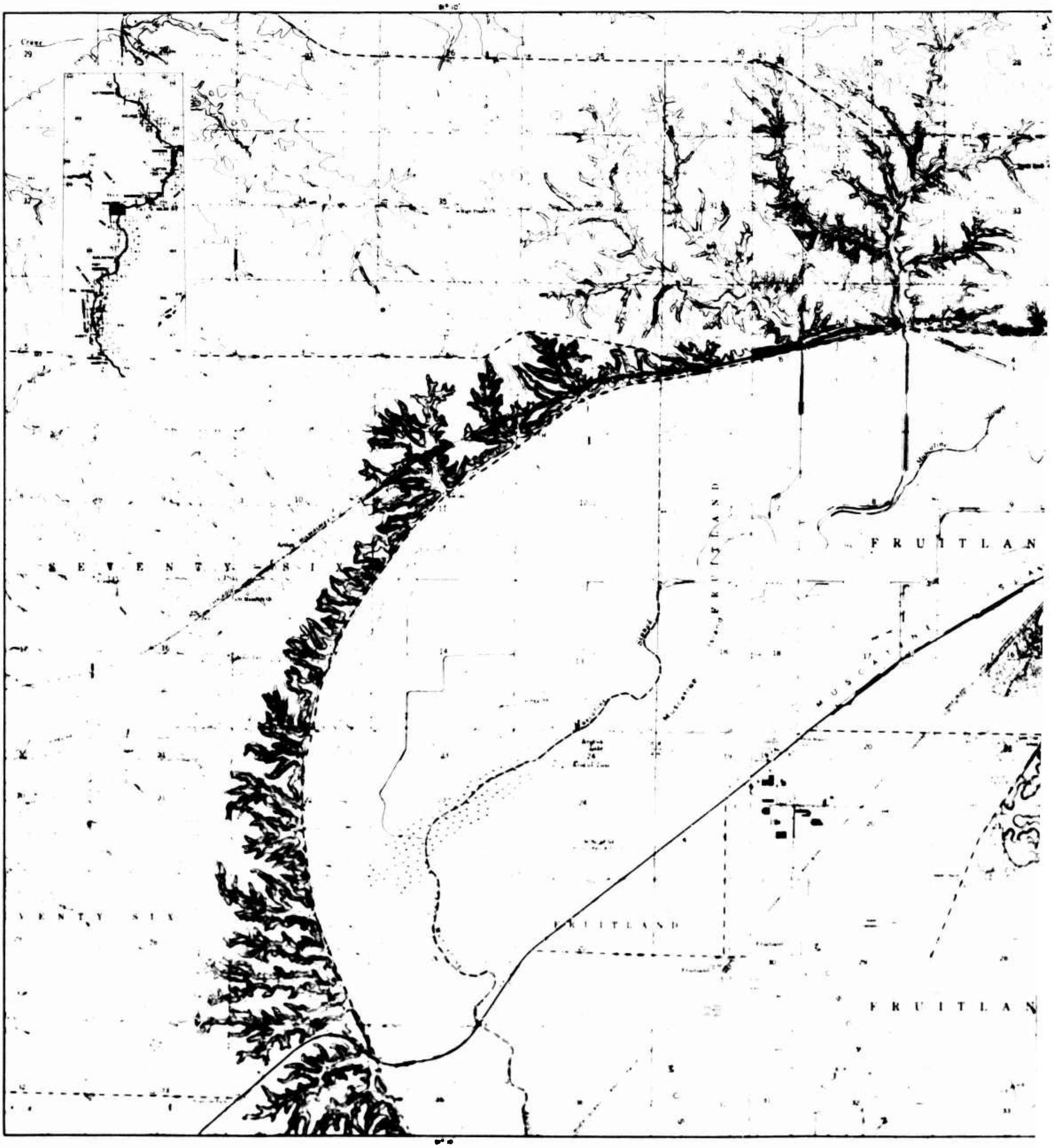

CHART 17A
EXTENT AND FREQUENCY
OF DREDGING
POOL 17

## CHART 17B – PROJECTED DREDGING POOL 17

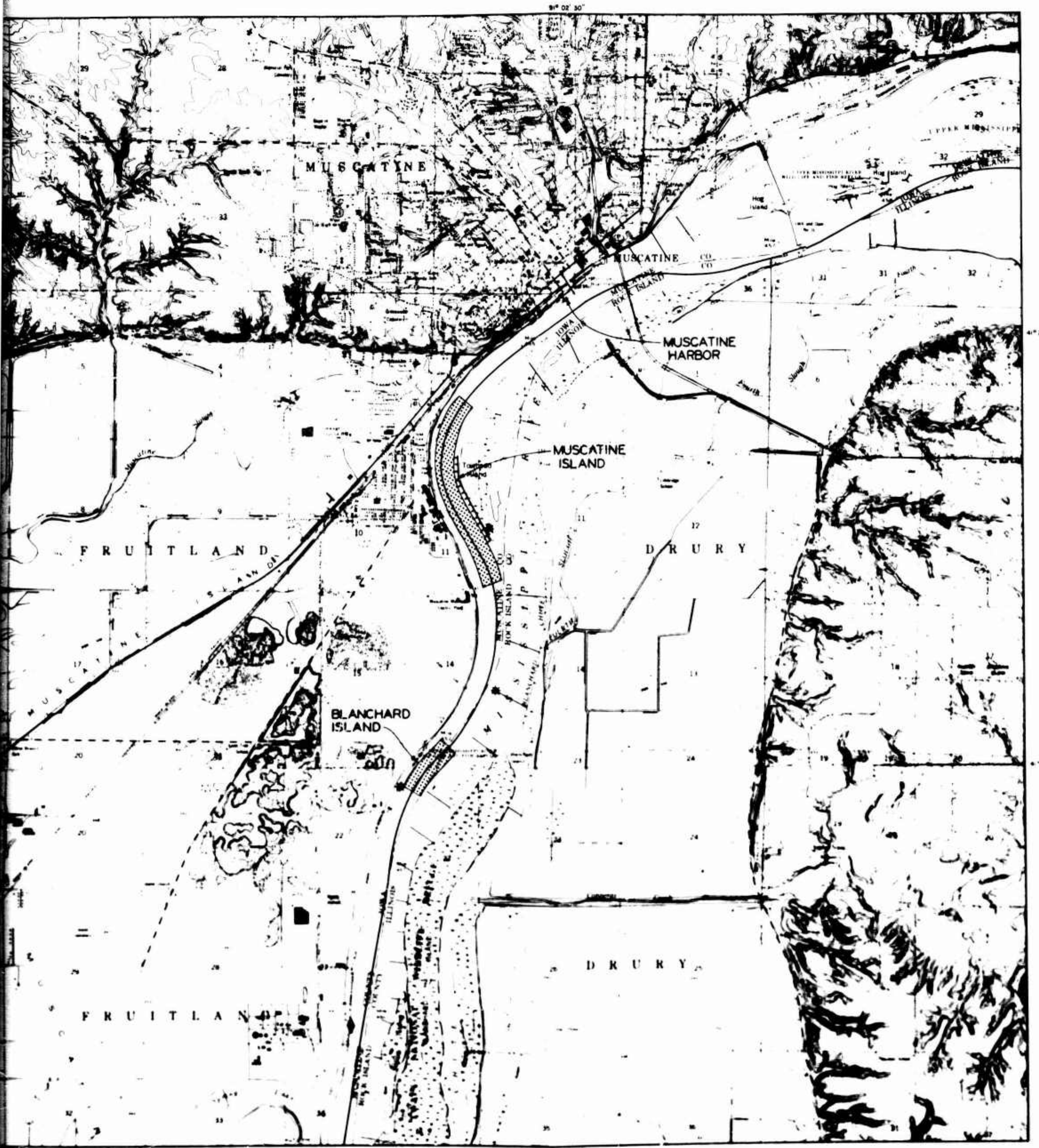
CHANNEL DREDGING PROJECTION



## GREAT RIVER ENVIRONMENTAL ACTION TEAM
## UPPER MISSISSIPPI RIVER (GREAT II)
(POOL 17 — LOCK AND DAM 16 TO MILE 450)



## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 17 — MODULE 1)




LEGEND

**UPPER MISSISSIPPI RIVER**

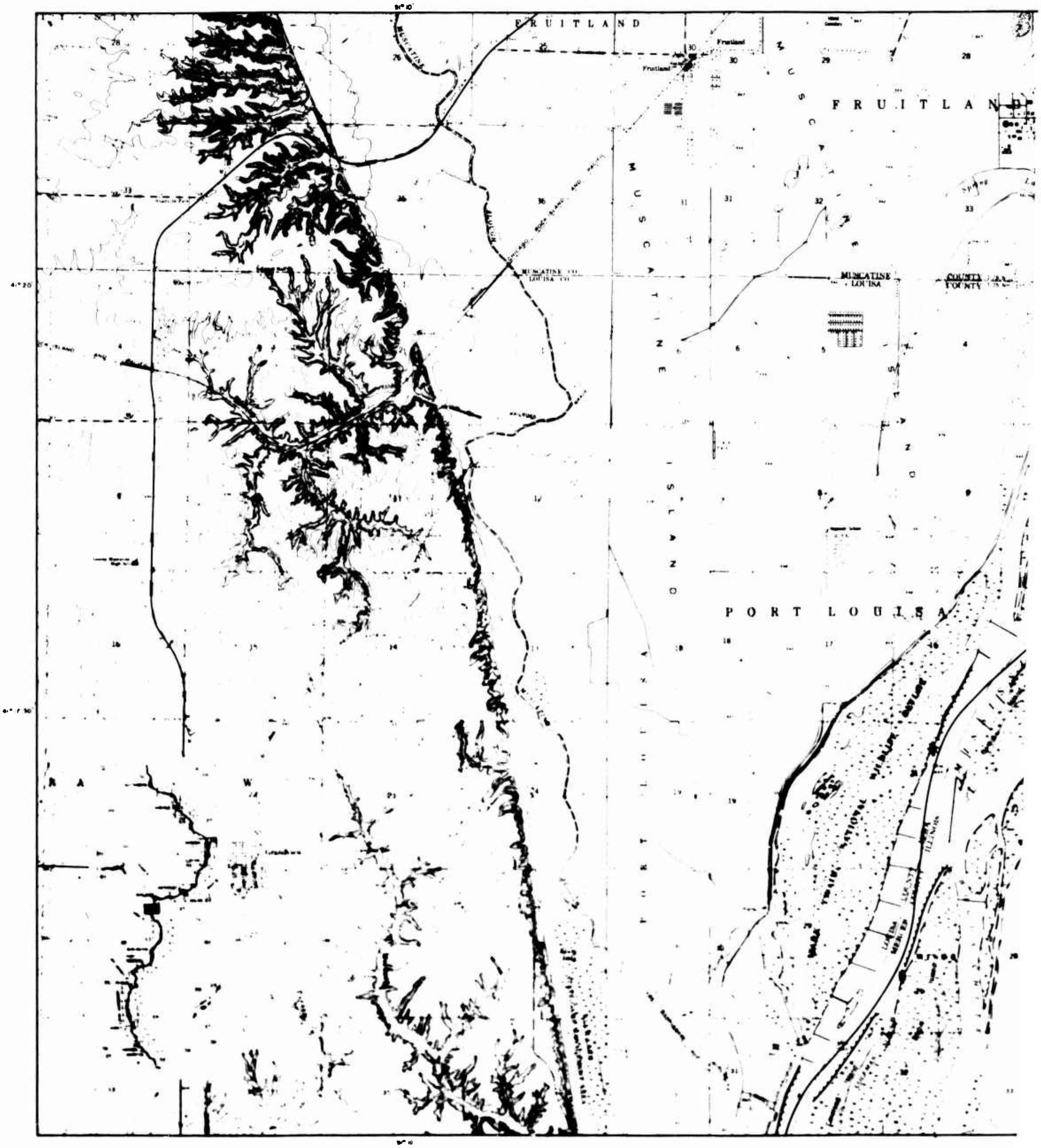
(POOL 17 — LOCK AND DAM 16 TO MILE 450)

(MODULE 1) NAVIGATION STRUCTURES

**PLATE 31**

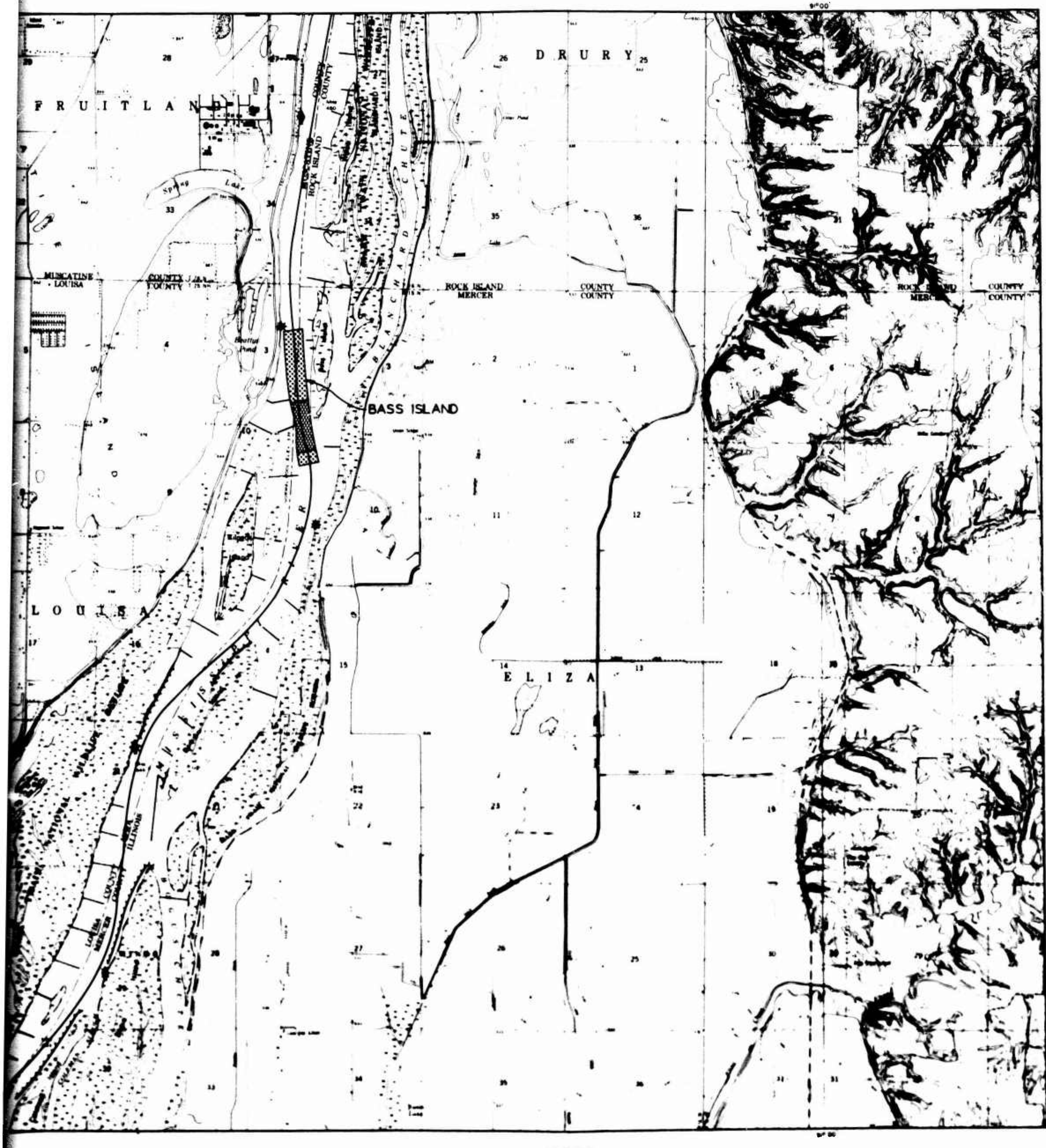
# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 17 — MILE 450 TO MILE 443)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 17 — MODULE 2)




LEGEND

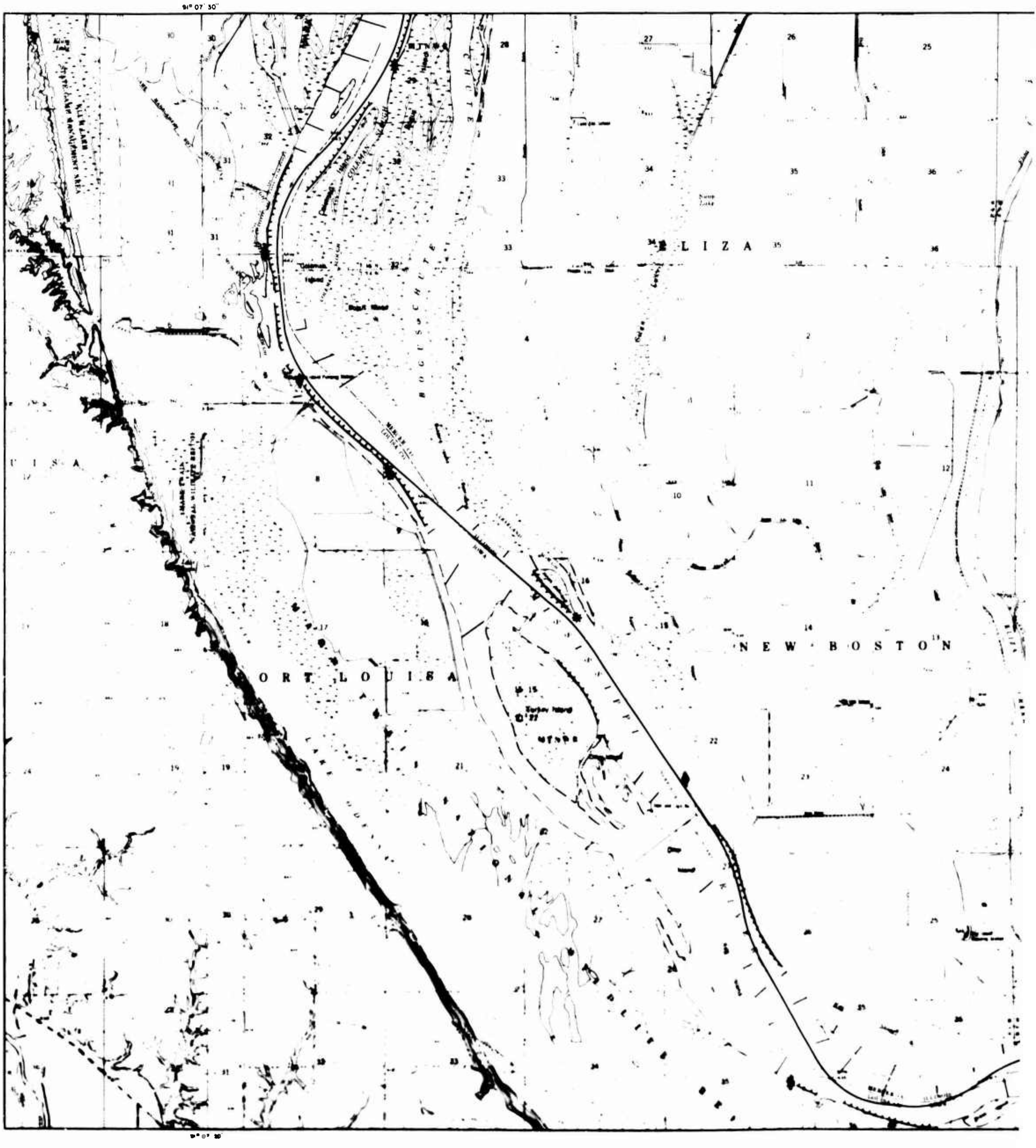
**UPPER MISSISSIPPI RIVER**

**(POOL 17 – MILE 450 TO MILE 443)**

**(MODULE 2) NAVIGATION STRUCTURES**

**PLATE 32**

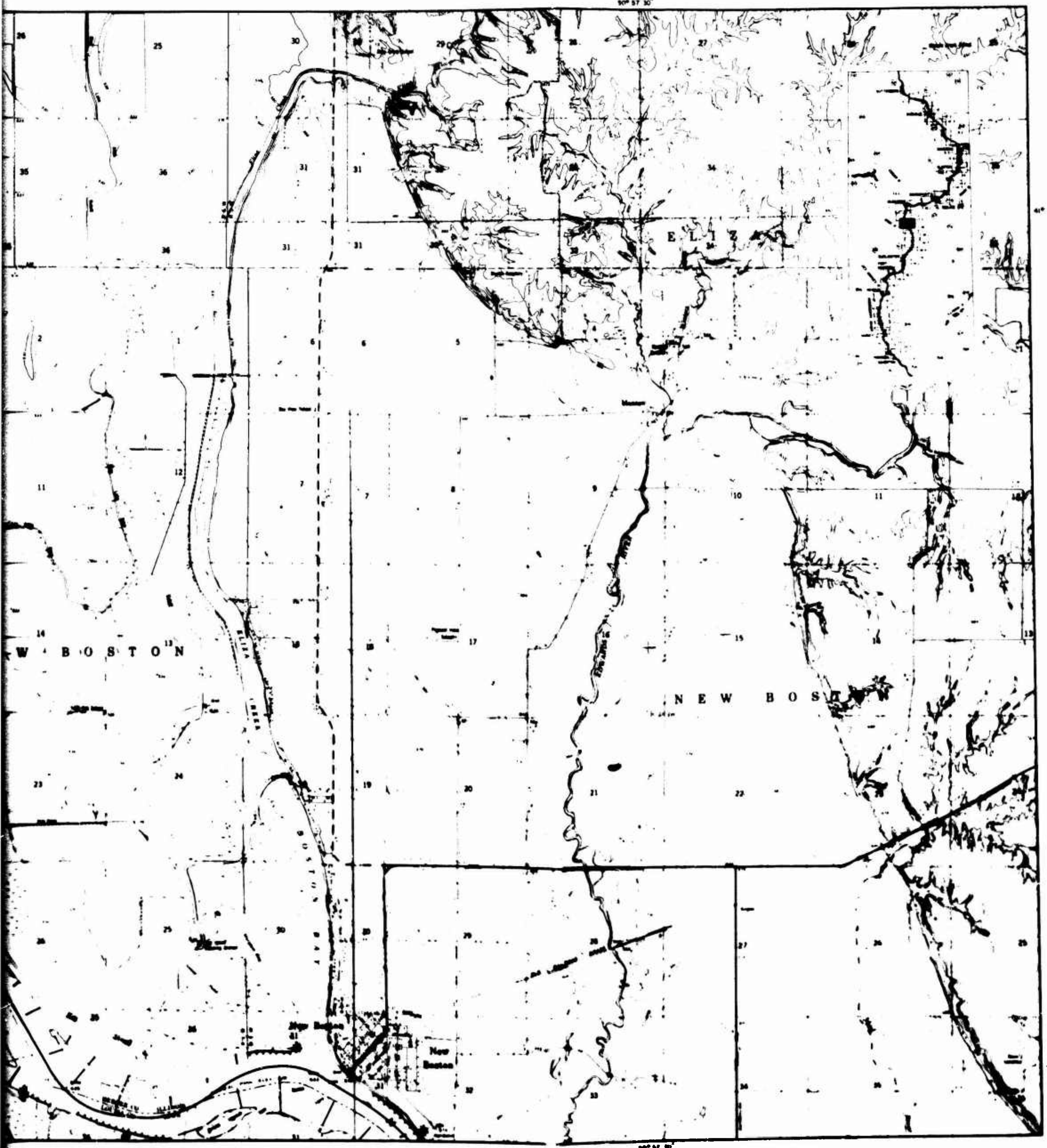
# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
### (POOL 17 — MILE 443 TO LOCK AND DAM 17)




Prepared by Environmental Systems Research Institute Aerial Information Systems for the Great River Environmental Action Team

# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 17 — MODULE 3)




**LEGEND**

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT-DAYMARK
- GOVERNMENT LIGHTED BUOY
- MIDCHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

**UPPER MISSISSIPPI RIVER**

(POOL 17 — MILE 443 TO LOCK AND DAM 17)

(MODULE 3) NAVIGATION STRUCTURES

**PLATE 33**

## POOL 18

Extent and Frequency of Dredging - Channel maintenance dredging, largely in the upper portion of the pool, has totaled 4.14 million cubic yards from 14 locations since 1945. Chart 18A, Plate 34, illustrates the quantities, in thousand cubic yards, dredged by each river mile location and year. The annual summary of dredged volume is extended to the right and the number of dredges at each river mile is extended below. See the attached "Dredging and Disposal Site" charts for the locations of past dredging operations. Approximately 29 percent of the 26.6 river miles of channel has been dredged since 1945.

There are no small-boat harbors that are dredged in Pool 18.

Areas of Recurrent and Recent Dredging - In Pool 18, of the 14 sites dredged in the past, eight were classified as nonrecurrent and the following are classified as recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recurrent | New Boston Upper | 433.5 - 433.8 |
| Recurrent | Edwards River | 431.1 - 432.0 |
| Recurrent | Keithsburg | 426.9 - 427.5 |
| Recurrent | Keithsburg Lower | 425.9 - 426.6 |
| Recurrent | Huron Island | 424.2 - 424.7 |
| Recent | L/18 Upper Approach | 411.1 - 411.3 |

Hydraulics - There are six sites in Pool 18 which have been major dredging sites. Pool 18 has one major tributary and two minor tributaries entering its pools. The Iowa River has a drainage area of 12,640 square miles at the confluence with the Mississippi River. Edwards River and Pope Creek have small drainage areas which enter Pool 18. The Iowa River enters at Upper Mississippi River mile 433.3, Pope Creek at 427.9, and Edwards River at 431.3. Pool 18 has the second largest drainage area in the Rock Island District with 14,000 square miles.

One of the most frequently dredged locations in the pool has been between UMR 433 and 434. This is located at the mouth of the Iowa River. This site is also at a "crossover" in the channel, so the velocities are decreased. The degradation of Wing Dam #16 from erosion and ice effects also allowed the velocities to be reduced.

The Iowa River, as one of the higher sediment carriers, loses its velocity as it enters the Mississippi River, and the combination of the other two contributing reasons provides a situation for bottom aggradation. The reconstruction of Wing Dam No. 16 is helping to keep the sediment moving downstream.

The area called Edwards River, UMR 431-432, has been dredged numerous times, some of which were small volumes. The location of the Edwards River with regard to the recurrent dredge site provides a source of additional bedload material as well as from the Iowa River. Shoaling tends to build from the right bank until the channel has been narrowed to require dredging. Examination of the regulating structures in this reach is recommended as a possibility to increase the velocity. Point Bar shoaling also occurs at the apex of the crossover on the left bank and is usually so rocky only derick boat work will clear the material.

The location of Keithsburg Lower, UMR 425.5-426.5, has two sources of sediment aggradation. One is that this is a crossover and the secondary velocities are not sufficient to keep the sediment suspended. The depths of the side channels; Hu-on Slough and Blackhawk Chute are nearly as deep as the Main Channel and a considerable amount of water passes down these back channels. This area is usually dredged whenever any highwater occurs on the Mississippi River. The high flow of water in the back channels provides the sediments an opportunity to be deposited in the slower moving water. This area is also the confluence of the Mississippi and the two chutes. An examination of the closing dams on these two bank channels as well as the integrity of the mainstem wing dams is recommended.

Dredging has been recurrent between 424.2 to 424.7. This area is called Huron Island. This area is immediately downstream from Keithsburg Lower and the majority of the dredging is in the area of the crossover. The channel becomes more narrow through this area and is subject to ice jamming. An examination of Wing Dams 16, 2, 3, 6, 7, 33, and 35, is recommended.

The area from 418.5, (Benton Island), upstream to (Campbells Island), 420.5, has been dredged several times, but not as consistently as Keithsburg Lower. A series of side channels and crossovers in this reach contribute to much of the problem of sediment deposition. This is a narrow reach of channel and the velocities should be substantial to carry the sediment load in through the reach. The regulatory structures in this reach should be examined for adequacy.

Future Dredging - In Pool 18, six sites have been further identified as "chronic" dredging sites for the next 50 years based on expected river conditions, dredging requirements and practices. These sites, their expected quantities, and frequencies of dredging are shown below:

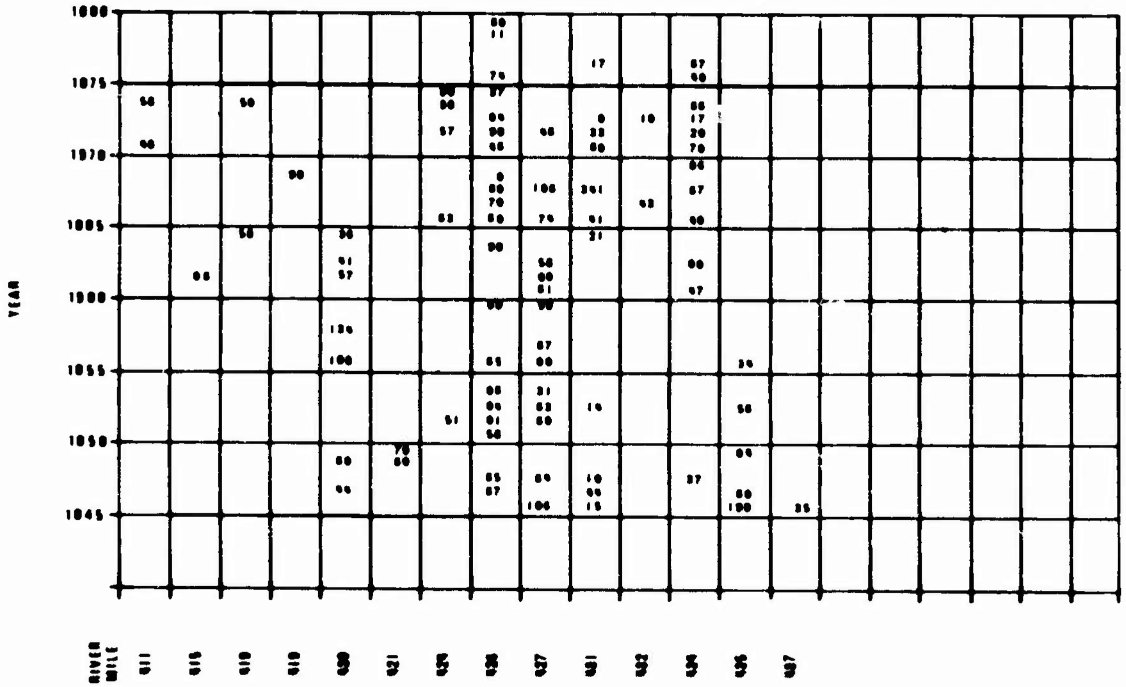
| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 433.0-434.0 | 11 New Boston Upper | 1 in 4 | 20,000 | 2.5 | 50,000 | 12.5 | 250,000 |
| 431.0-432.0 | Edwards River | 1 in 3 | 10,000 | 3.3 | 33,000 | 16.5 | 165,000 |
| 425.5-426.5 | 21 Keithsburg Lower | 1 in 2 | 30,000 | 5.0 | 150,000 | 25.0 | 750,000 |
| 424.2-424.5 | Huron Island | 1 in 5 | 20,000 | 2.0 | 40,000 | 10.0 | 200,000 |
| 418.5-420.0 | Benton Island | 1 in 5 | 30,000 | 2.0 | 60,000 | 10.0 | 300,000 |
| 411.0-412.0 | L/18 Upper Approach | 1 in 8 | 25,000 | 1.25 | 31,250 | 6.33 | 156,250 |

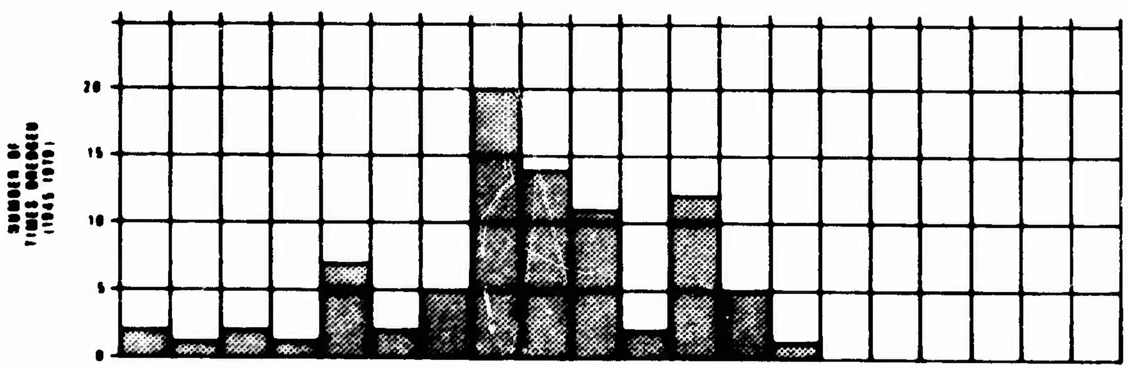
1) At the New Boston Upper site, the proposed restoration of a destroyed wing dam may reduce future dredging requirements below predicted quantities and frequencies.

2) At the Keithsburg Lower site, the frequency of dredging in the future is expected to be less than the historical 40-year average. Also, the channel will be maintained at a narrower width than in the past.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged, is shown in Chart 18B, Plate 35, "Projected Dredging". The total amount of material expected to be dredged in Pool 18 in the next 50 years is 1.566 million cubic yards. This amount is about the same amount as averaged for the last 20 years in this pool.

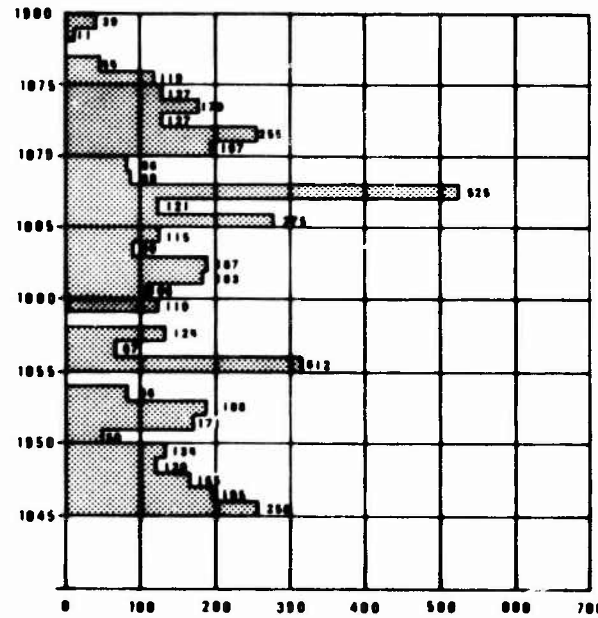
ANNUAL DREDGED VOLUMES BY LOCATION
(1,000 CUBIC YARDS)





DREDGE FREQUENCY BY RIVER MILE LOCATION

ANNUAL SUMMARY OF DREDGED VOLUME

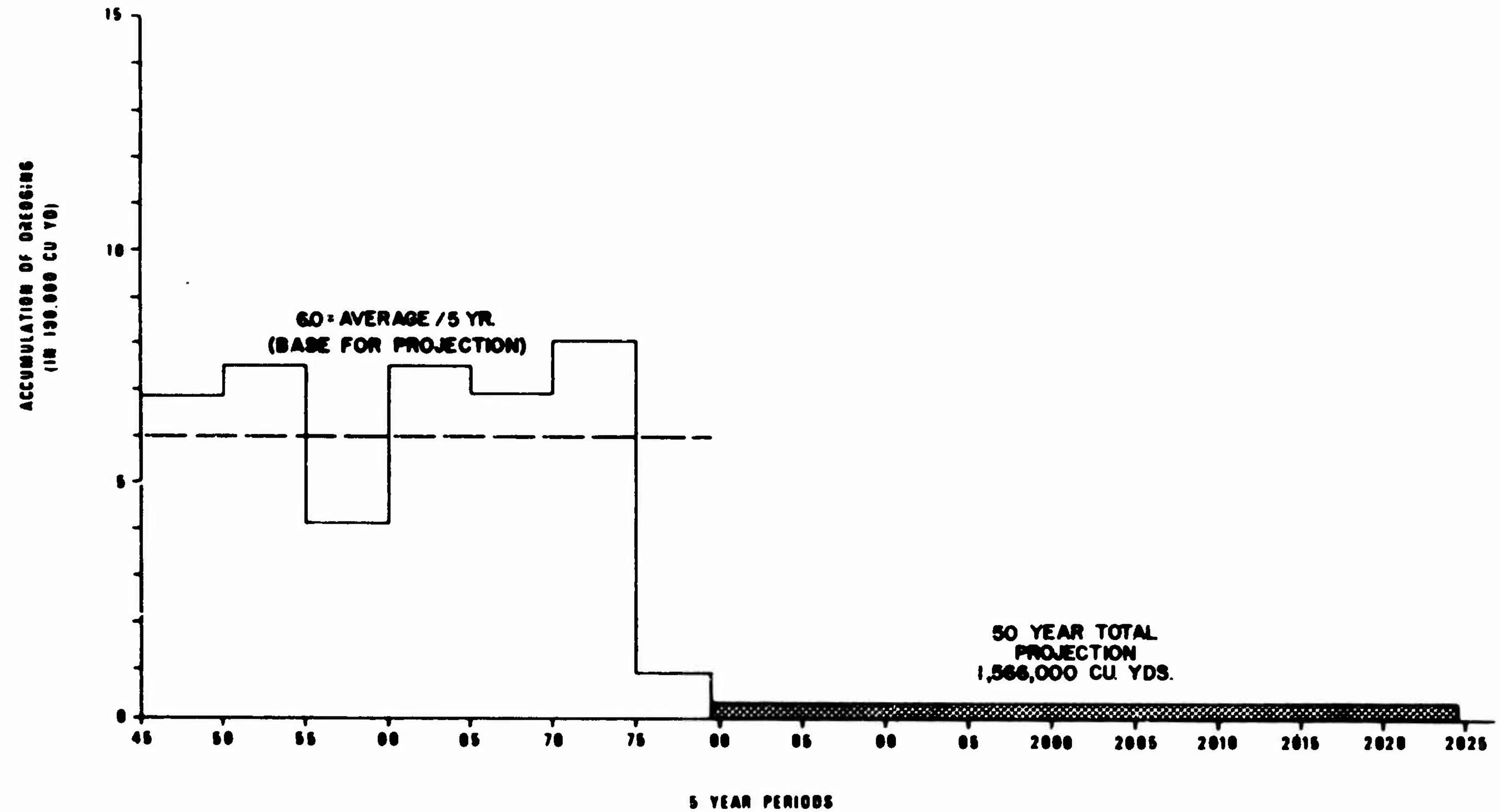


VOLUME DREDGED
(1,000 CUBIC YARDS)

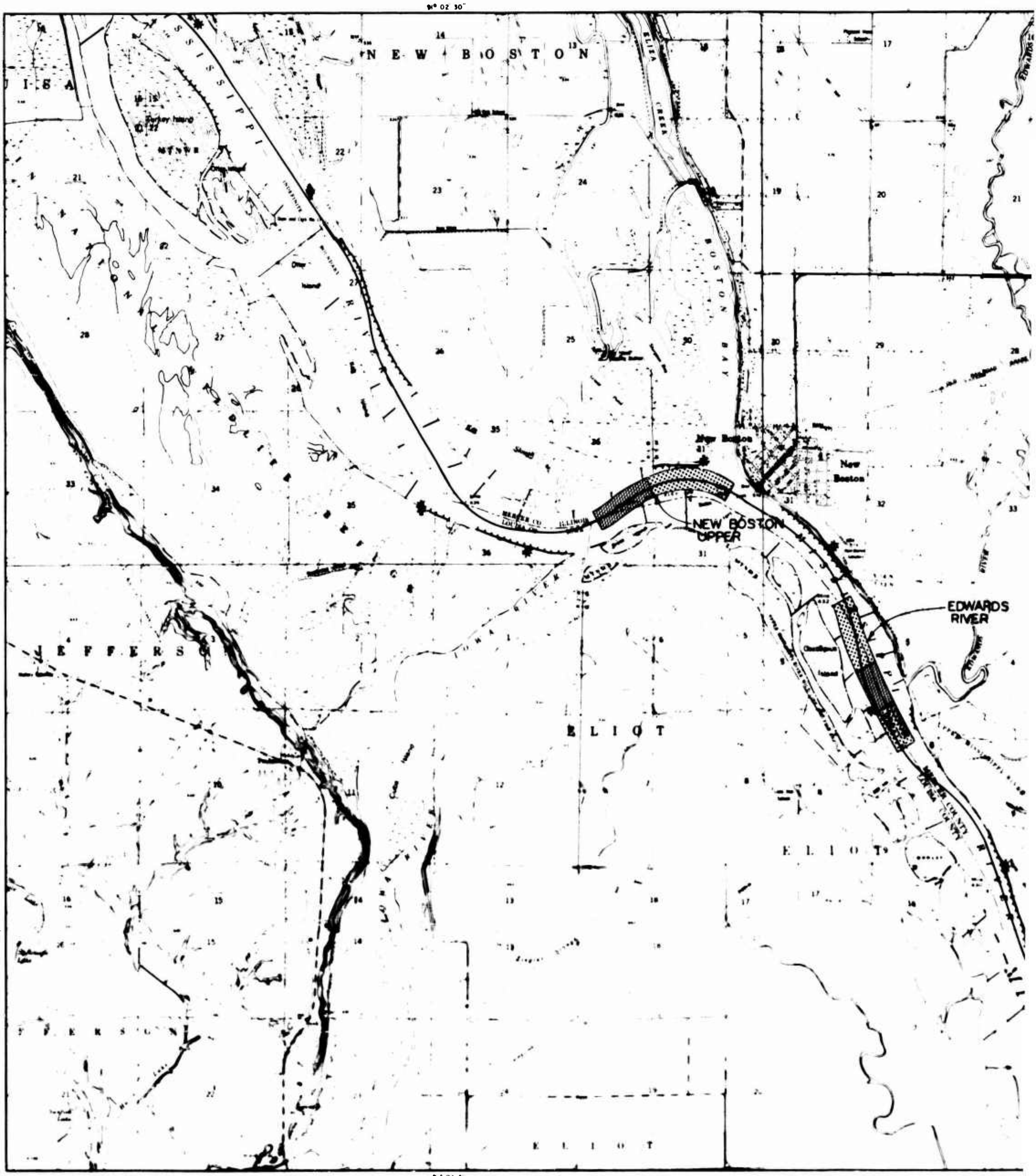
CHART 18A
EXTENT AND FREQUENCY
OF DREDGING
POOL 18

## CHART 18B — PROJECTED DREDGING POOL 18

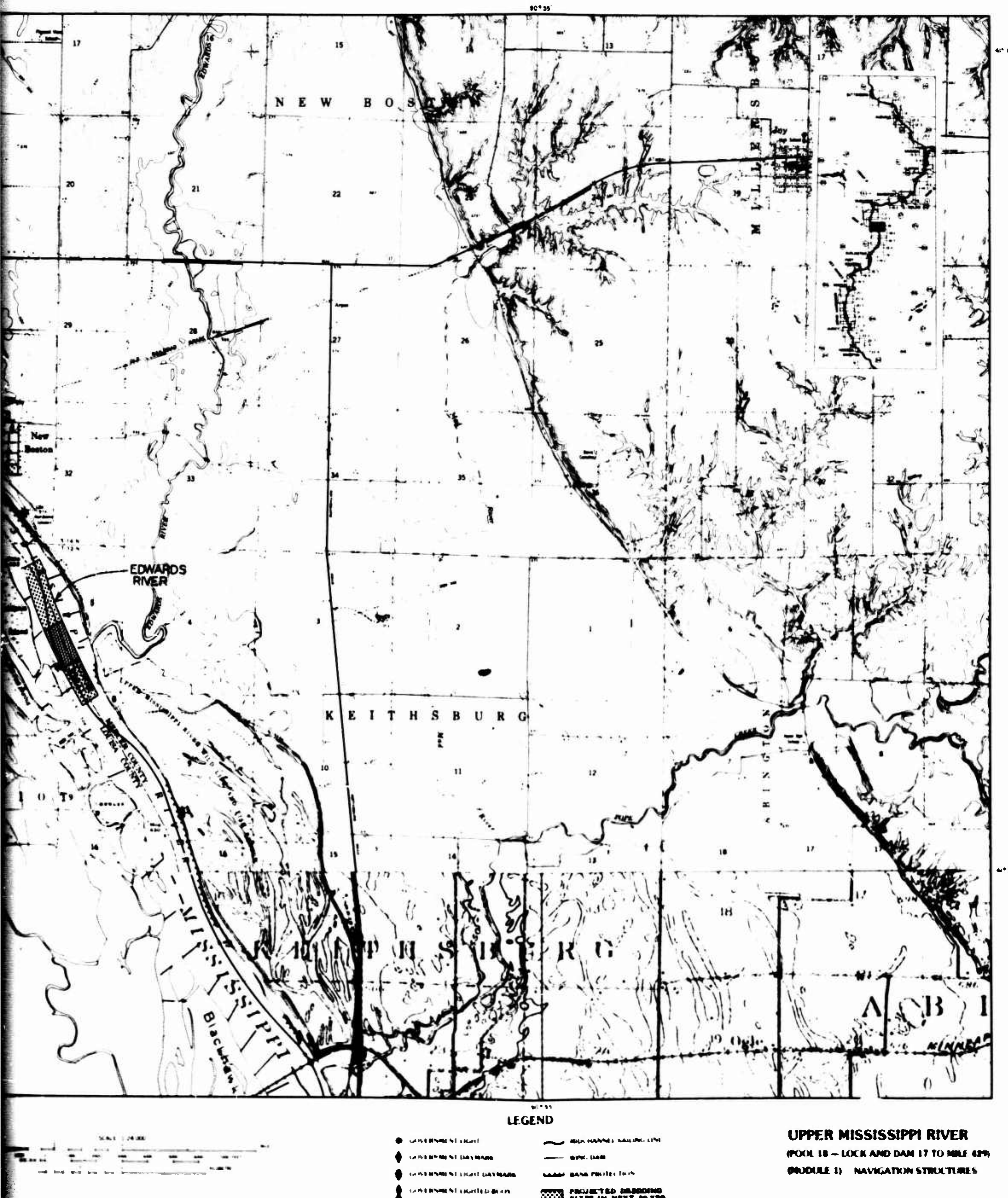
CHANNEL DREDGING PROJECTION



# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 18 — LOCK AND DAM 17 TO MILE 429)**



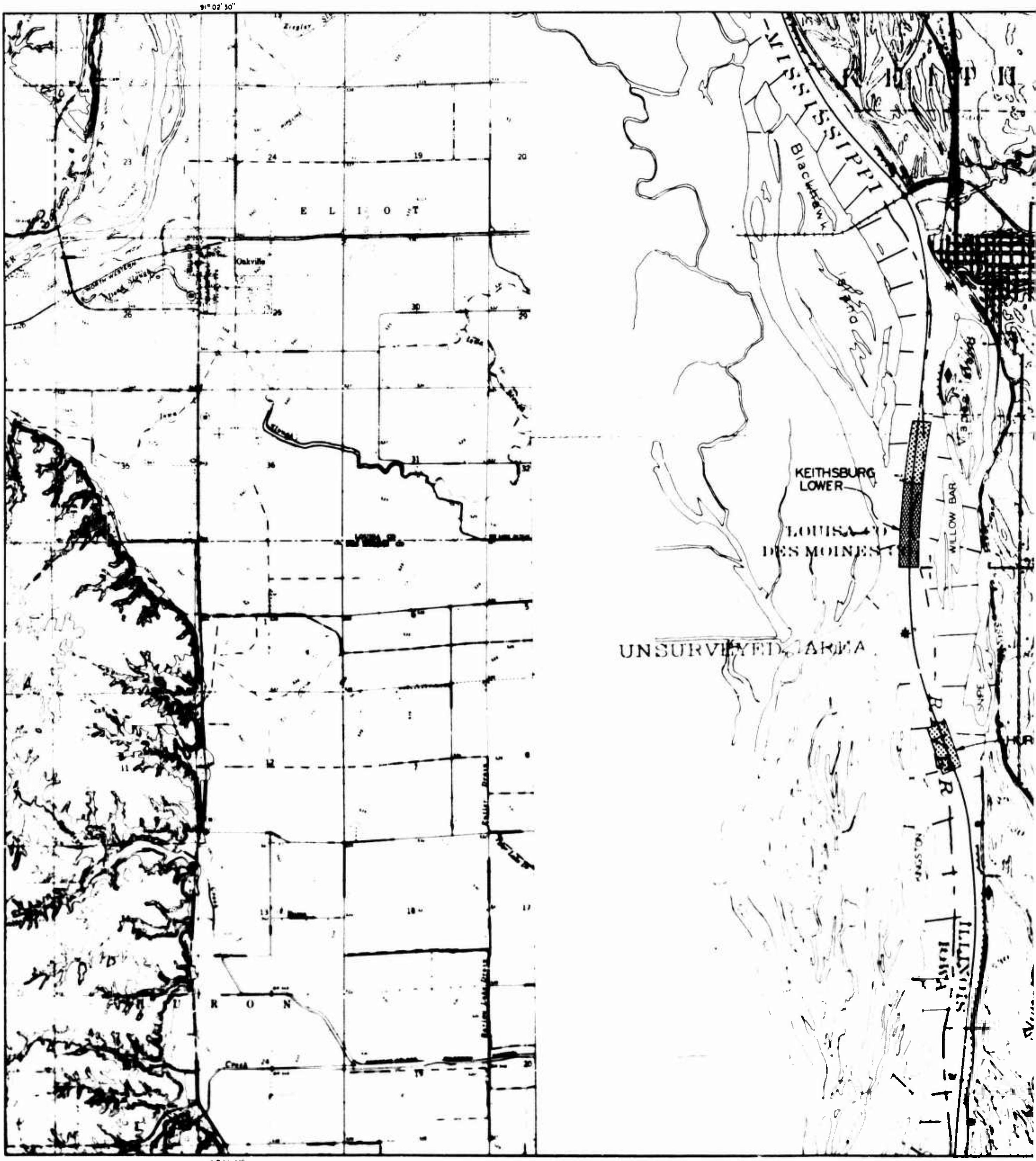
UPPER MISSISSIPPI RIVER
ENVIRONMENTAL ATLAS
(POOL 18 — MODULE 1)




UPPER MISSISSIPPI RIVER
(POOL 18 — LOCK AND DAM 17 TO MILE 429)
(MODULE 1) NAVIGATION STRUCTURES

PLATE 36

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 18 — MILE 429 TO MILE 422)**




**LEGEND**

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- MIDCHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

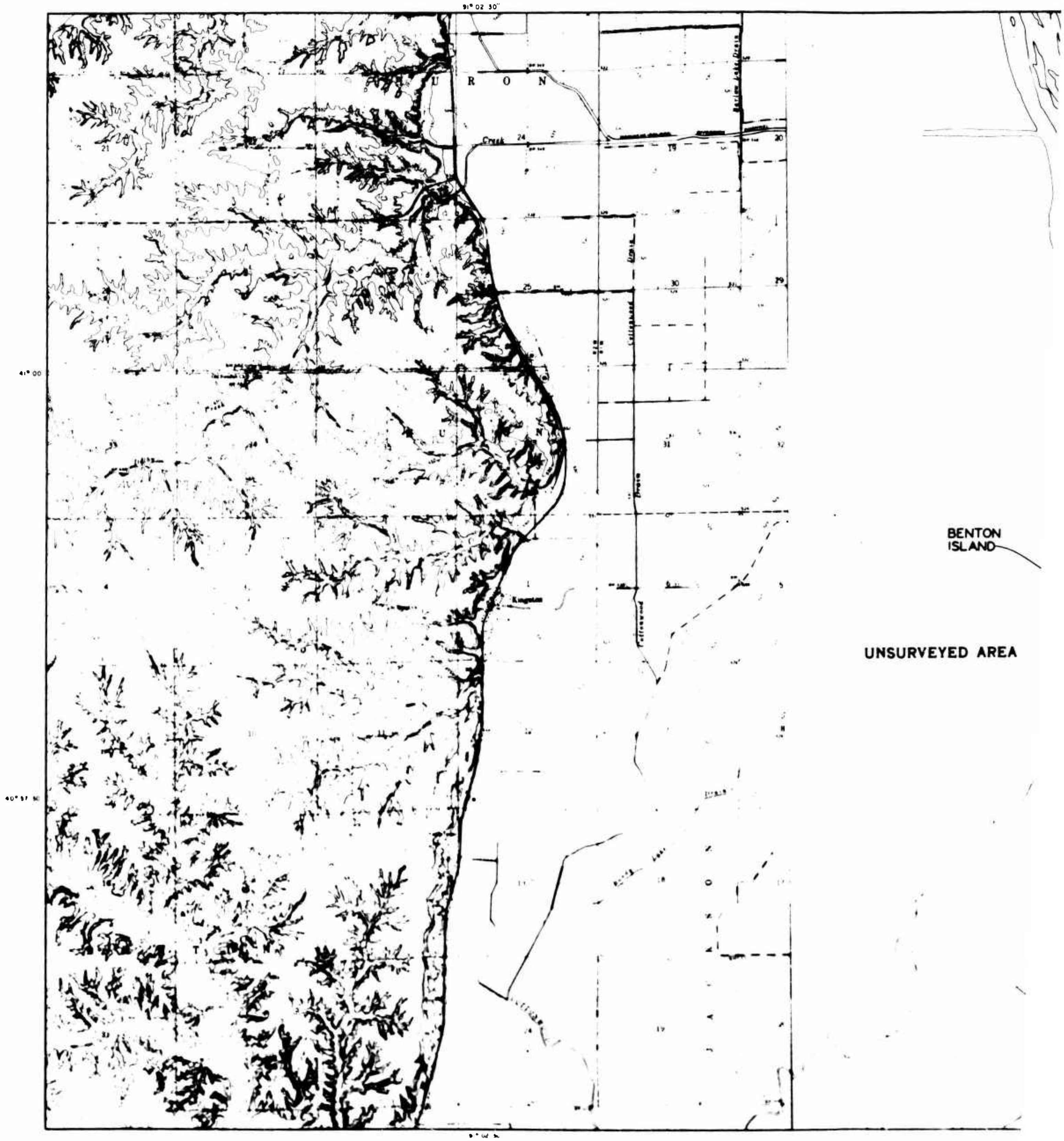
**UPPER MISSISSIPPI RIVER**

(POOL 18 — MILE 429 TO MILE 422)

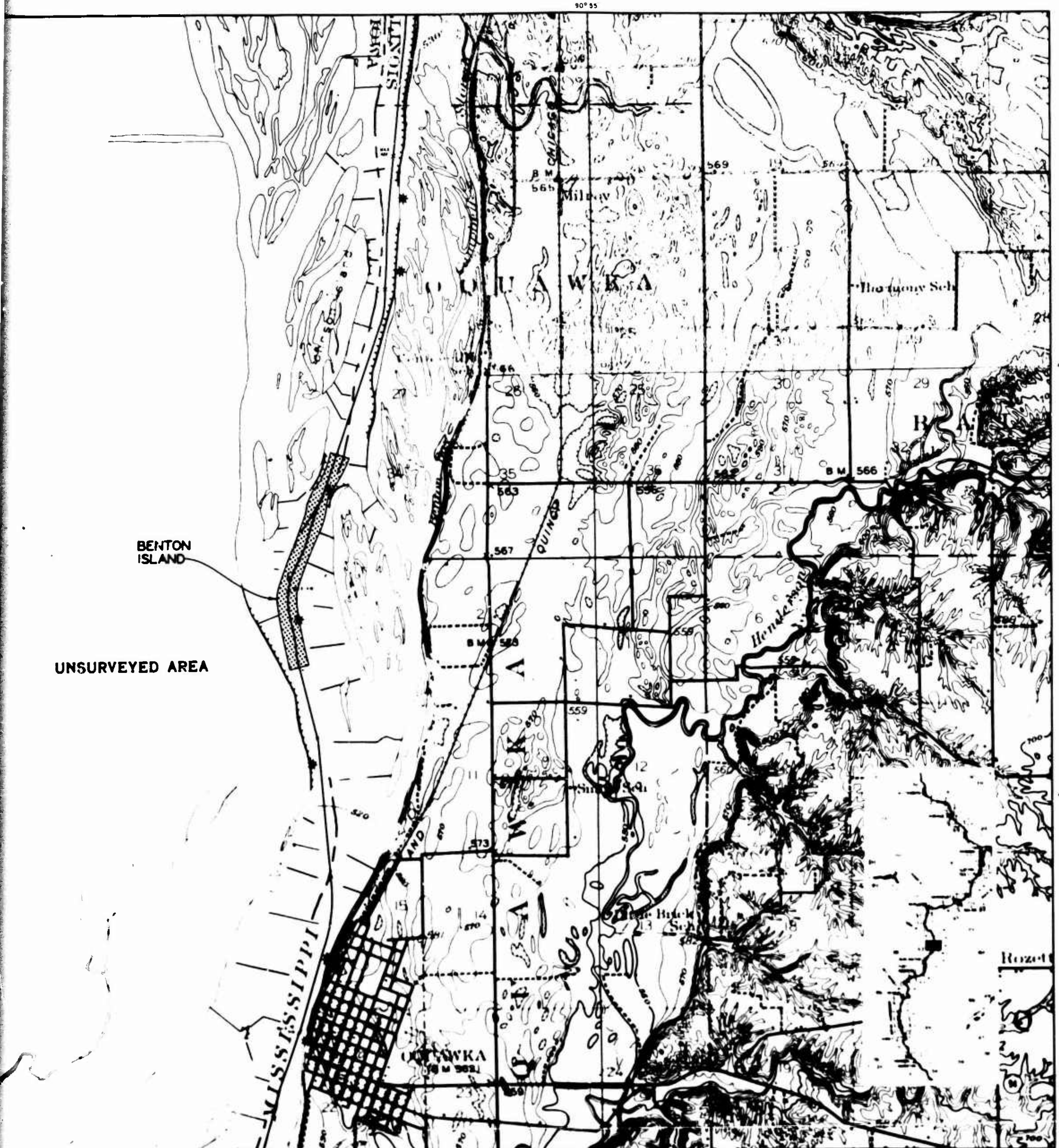
(MODULE 2) NAVIGATION STRUCTURES

**PLATE 37**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
(POOL 18 — MILE 422 TO MILE 416)



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 18 — MODULE 3)




LEGEND

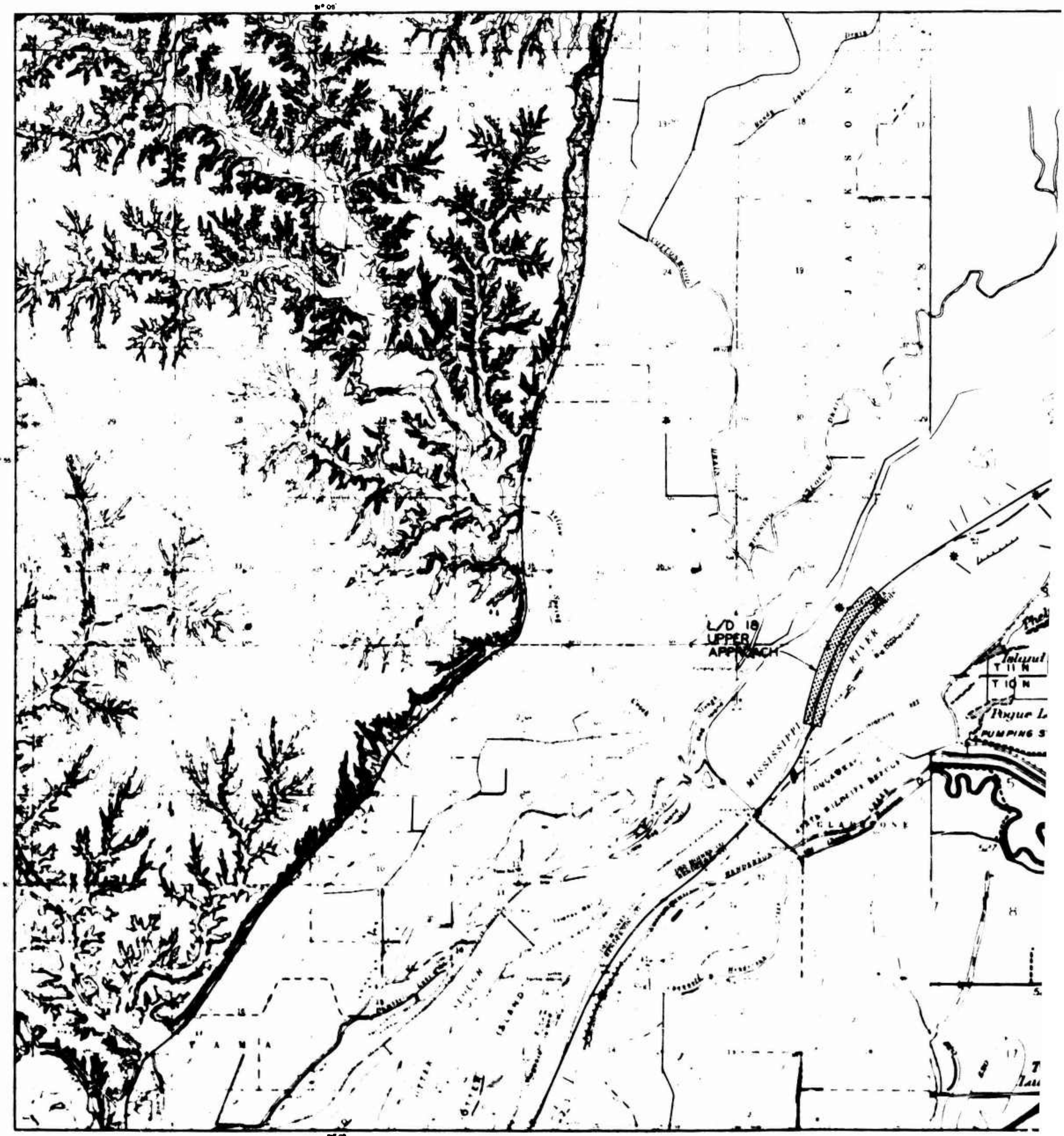
WING DAM
BANK PROTECTION
PROJECTED DREDGING SITES IN NEXT 10 YRS
RECURRENT DREDGING SITES

UPPER MISSISSIPPI RIVER
(POOL 18 — MILE 412 TO MILE 416)
(MODULE 3) NAVIGATION STRUCTURES

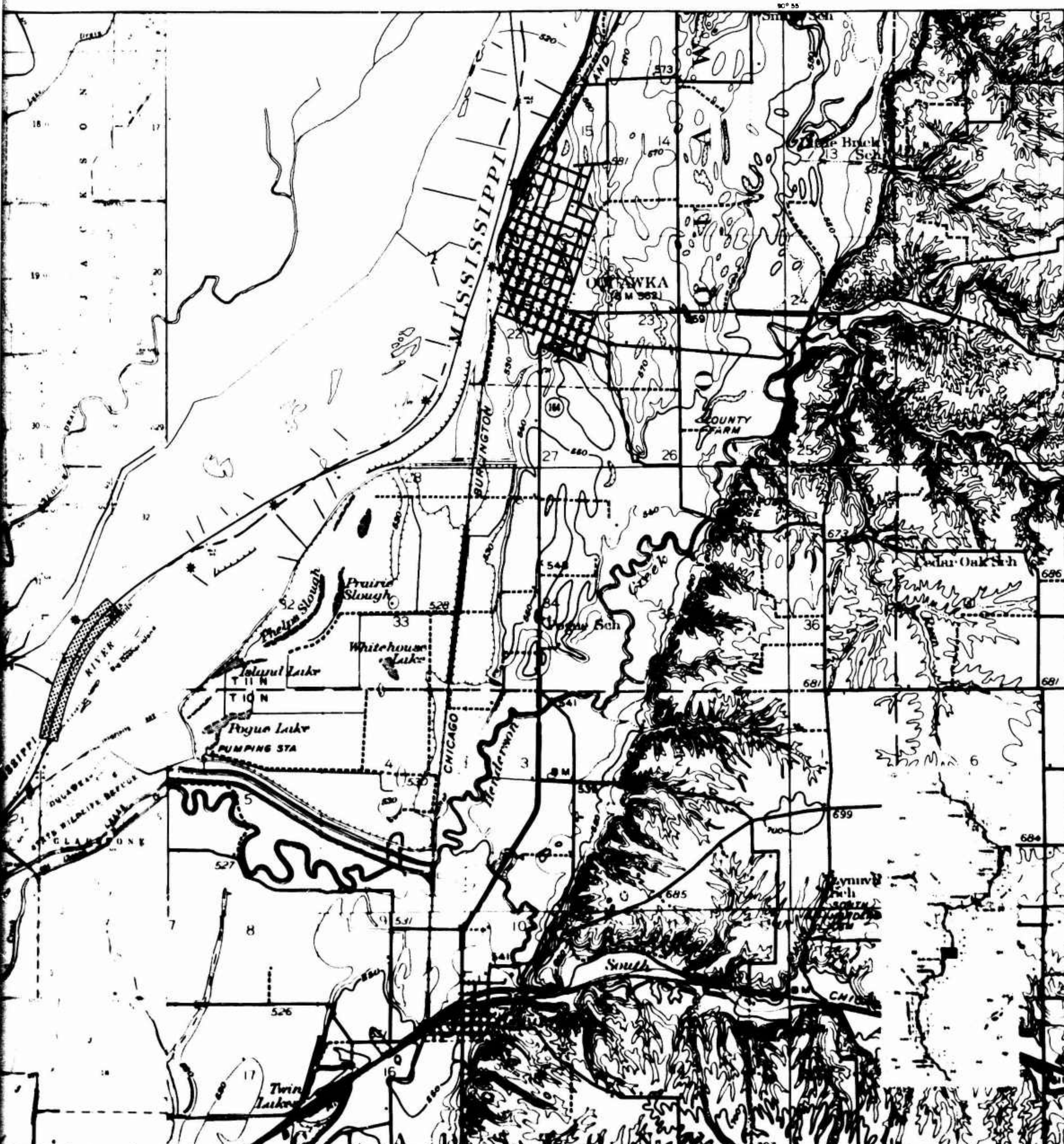
PLATE 38

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 18 — MILE 416 TO LOCK AND DAM 18)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 18 — MODULE 4)




LEGEND

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- MAIN CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

**UPPER MISSISSIPPI RIVER**

(POOL 18 — MILE 416 TO LOCK AND DAM 18)

(MODULE 4) NAVIGATION STRUCTURES

**PLATE 39**

## POOL 19

Extent and Frequency of Dredging - Channel maintenance dredging, largely in the upper portion of the pool, has totaled 4.31 million cubic yards at 12 locations since 1945. Chart 19A, Plate 40, illustrates the quantities, in thousand cubic yards, by mile location and year dredged. The annual summary of dredge volume is extended to the right of the chart and the number of dredges per mile is extended below. For locations of past dredging operations, see the attached "Dredging and Disposal Site" charts for Pool 19. Approximately 16 percent of the 46.3 river miles of channel has been dredged since 1945.

The Fort Madison small-boat harbor at mile 383.6 is maintained to a five-foot depth. From 1965, the dredging quantities have been:

| Year | Cubic Yards |
|---|---|
| 1965 | 9,072 |
| 1968 | 7,174 |
| 1970 | 6,650 |
| 1971 | 5,615 |

Areas of Recurrent and Recent Dredging - An area of "recurrent" dredging is one that has been dredged at least three times in the last 15 years, including at least once in the last 5 years. Areas that do not meet this criterion, but have been dredged twice in the last 5 years, were considered possible recurrent areas and classified as "recent". In Pool 19, of the 12 sites that have been dredged in the past, nine are classified as nonrecurrent and the following are classified as recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recurrent | Rush Island | 405.7 - 407.0 |
| Recent | Burlington Hwy Bridge | 404.2 - 404.5 |
| Recent | Kemps Landing | 398.4 - 398.5 |
| Recurrent | Fort Madison SB Harbor | 383.6 |

Hydraulics - The area from mile 404.3 to 408.4 is a chronic area for dredging. This area could be referred to as Rush Island and Rush Island Lower. Every year that high water has occurred, dredging has been performed in this area. A very large slough called Otter Slough transports a large volume of river water and sediment. The main channel loses its velocity to carry both suspended and bedload material. After the channel bifurcates at mile 409.4, material begins to build in the area of the first crossover at river mile 408.0. The majority of the dredging at river mile 408.0 was conducted between 1950 and 1963. Since 1963, dredging has been located downstream below river mile 406.6. Otter Slough joins the Mississippi River main channel at river mile 406.5. Depending on the magnitude of the flow in Otter Slough, the velocities are decreased in the main channel of the Mississippi River at the point where the two join. This is primarily due to backwater effect and lack of regulating structures to increase the velocity below 406.5.

At mile 407.4, Otter Slough trifurcates into two additional channels called O'Connell Slough and Rush Chute. The flows in O'Connell Slough are controlled by Closing Dam 27 and Rush Chute by Closing Dam 4. Depending upon the flows in those channels, Otter Slough can lose its ability to carry water and sediment back to the Mississippi. The dredging at river mile 405.0 to 406.0 is caused by a combination of the crossover in the main channel and the confluence of Rush Chute with the main channel of the Mississippi River. If Closing Dam No. 4 is not performing its function, a great deal of sediment can be carried down Rush Chute. After the large flood in 1973, the channel became quite narrow just below the confluence of Otter Slough and the main Mississippi. An examination of the flow regime at river mile 409.5, where the Mississippi bifurcates into Otter Slough, is recommended. A determination of the amount of sediment that is being transported behind Otter Island, and eventually into Rush Chute and O'Connell Slough, is needed to determine what regulatory works are necessary to solve the dredging problem in the Rush Island, Lower Rush Island area. Recent surveys have shown water in excess of 9 to 10 foot in O'Connell Slough where O'Connell Slough and the Mississippi join. This is in the area where the submerged Wing Dam No. 19 parallels the channel from river mile 404.4 to 404.9. It is recommended that this entire area be studied by a model study to determine a solution for the movement of sediment through this reach.

The area from river mile 399.9 to 400.6 is called Burlington Bluff. This area has had considerable dredging since the great flood of 1965. The channel is quite narrow between river mile 401.1 and 401.9. Historically, the channel has moved from the area near Craigel Island westerly to along the bluff. Previous disposal sites have been along Craigel Island and in an area upstream between river mile 400.0 and 400.4. The area along Craigel Island is on the inside of a bend and sediments have been accreting along this area for the past two decades. During periods of high sediment flow, sediment continues to shoal in a westerly direction from Craigel Island until the channel is so narrow that dredging is required to maintain channel alignment and width. It is recommended that the use of regulating works in this area be examined. There is a general lack of regulatory works in this area compared to similar river reaches.

The area from river mile 398.2 to 399.2 is called Kemps Landing. Kemps Landing has been dredged every year after a major flood. Those years are 1951, 1965, 1971, 1973, 1974, and now 1979. The velocities in the area where the major deposition occurs are reduced because the channel widens just upstream of the deposition area. Major quantities have not been dredged from this area in comparison to quantities dredged from other areas on the Upper Mississippi. The accretion in this area is considerably slower than those in other locations and the dredging is a product of the channel being reduced by sediment accretion from east to west. The potential of placing a regulating structure in the area of about river mile 399 has potential of keeping the material moving through this reach rather than being deposited. The possibility of a new wing dam should be examined in this area.

The area from river mile 394.2 to 394.8 is called Shokokon. Deposition in this area is primarily from two sources; a crossover between river mile 395 and 394 and the river expanding from a narrow channel at river mile 395.3 to a wide channel. The lack of velocities below river mile 395.3 sufficient to carry the sediment from the Skunk River at river mile 395.9, provides for deposition in this area. One of the major problems in Pool 19 comes from the suspended sediment and bedload which is carried from the Skunk River into the Mississippi River and its eventual deposition in Pool 19. Attempting to build regulating structures to carry the sediment through Pool 19 is a major undertaking, since Pool 19 begins to widen downstream of Fort Madison and the velocities required to carry sediments would be reduced.

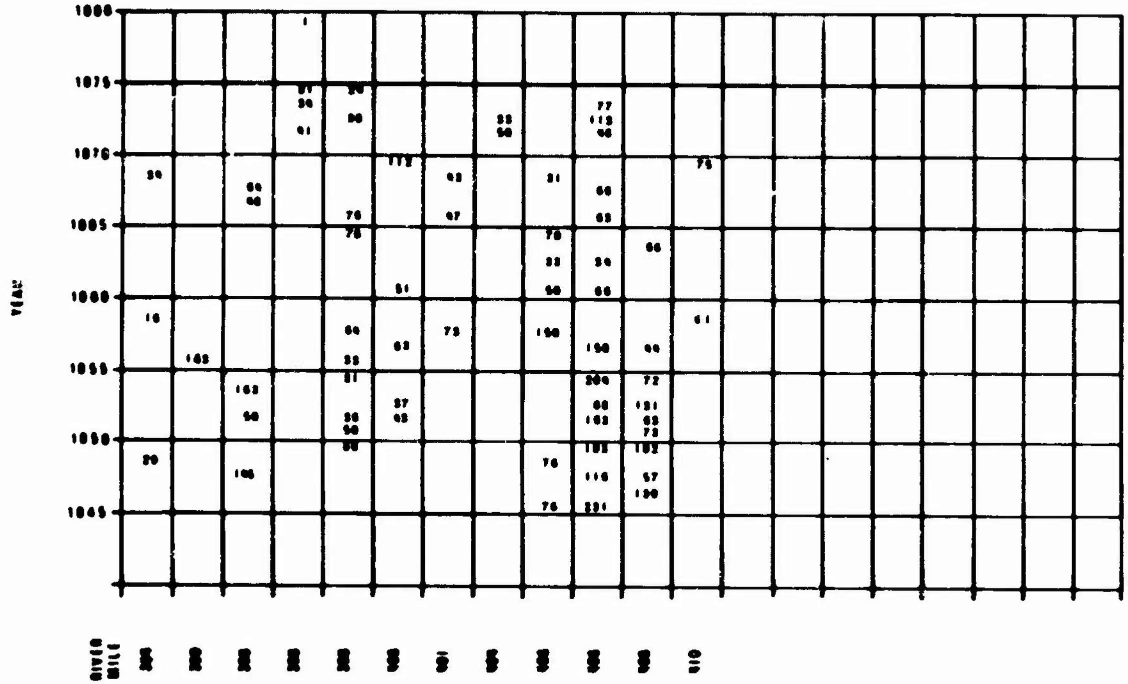
Future Dredging - In Pool 19, ten sites have been further identified as "chronic" dredging sites for the next 50 years based on expected river conditions, dredging requirements and practices. These sites, their expected quantities and frequencies of dredging, are shown below:

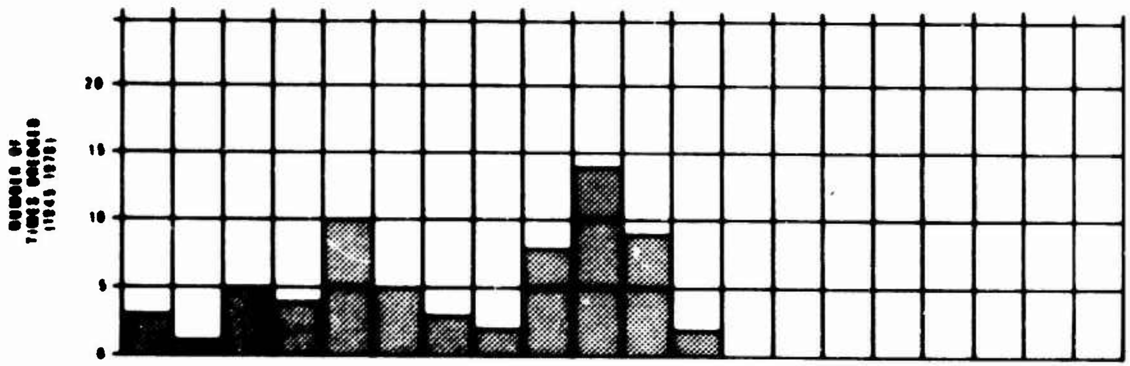
| Location UMR Mile No. | | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|---|
| 410.3 | | Yellow Springs Diversion Channel | 1 in 20 | 10,000 | 0.5 | 5,000 | 2.5 | 25,000 |
| 407-408 | 1) | Drew Chute | 1 in 20 | 30,000 | 0.5 | 15,000 | 12.5 | 75,000 |
| 406-407 | 1) | Rush Island | 1 in 4 | 35,000 | 2.5 | 87,500 | 12.5 | 437,500 |
| 405.0-406.0 | | Rush Island Lower | 1 in 4 | 30,000 | 2.5 | 75,000 | 12.5 | 325,000 |
| 404.2-404.5 | | Burlington Hwy Bridge | 1 in 12 | 20,000 | 0.6 | 16,000 | 4.16 | 80,000 |
| 399.6-400.6 | | Burlington Bluff | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |
| 399.2-399.6 | | Craigel Island | 1 in 10 | 25,000 | 1.0 | 20,000 | 5.0 | 125,000 |
| 398.2-399.2 | | Kemps Landing | 1 in 10 | 20,000 | 1.0 | 20,000 | 5.0 | 100,000 |
| 394.2-394.8 | | Shokokon | 1 in 10 | 40,000 | 1.0 | 40,000 | 5.0 | 200,000 |
| 383.6 | | Ft. Madison Harbor | 1 in 3 | 5,000 | 3.3 | 16,500 | 6.5 | 82,500 |

1) At the Drew Chute and Rush Island sites, the frequency of dredging is expected to decrease compared to the historical 40-year average and the channel will be maintained at a narrower width.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of past quantities dredged, is shown in Chart 19B, Plate 41, "Projected Dredging". The total amount of material to be dredged in Pool 19 in the next 50 years is expected to be approximately 1.6 million cubic yards. This amount is more than the average for the last 20 years in this pool.

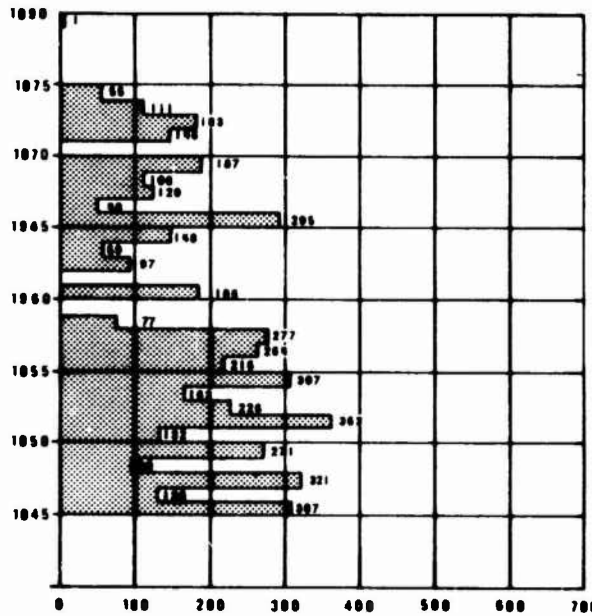
ANNUAL DREDGED VOLUMES BY LOCATION
(1,000 CUBIC YARDS)





DREDGE FREQUENCY BY RIVER MILE LOCATION

ANNUAL SUMMARY OF DREDGED VOLUME

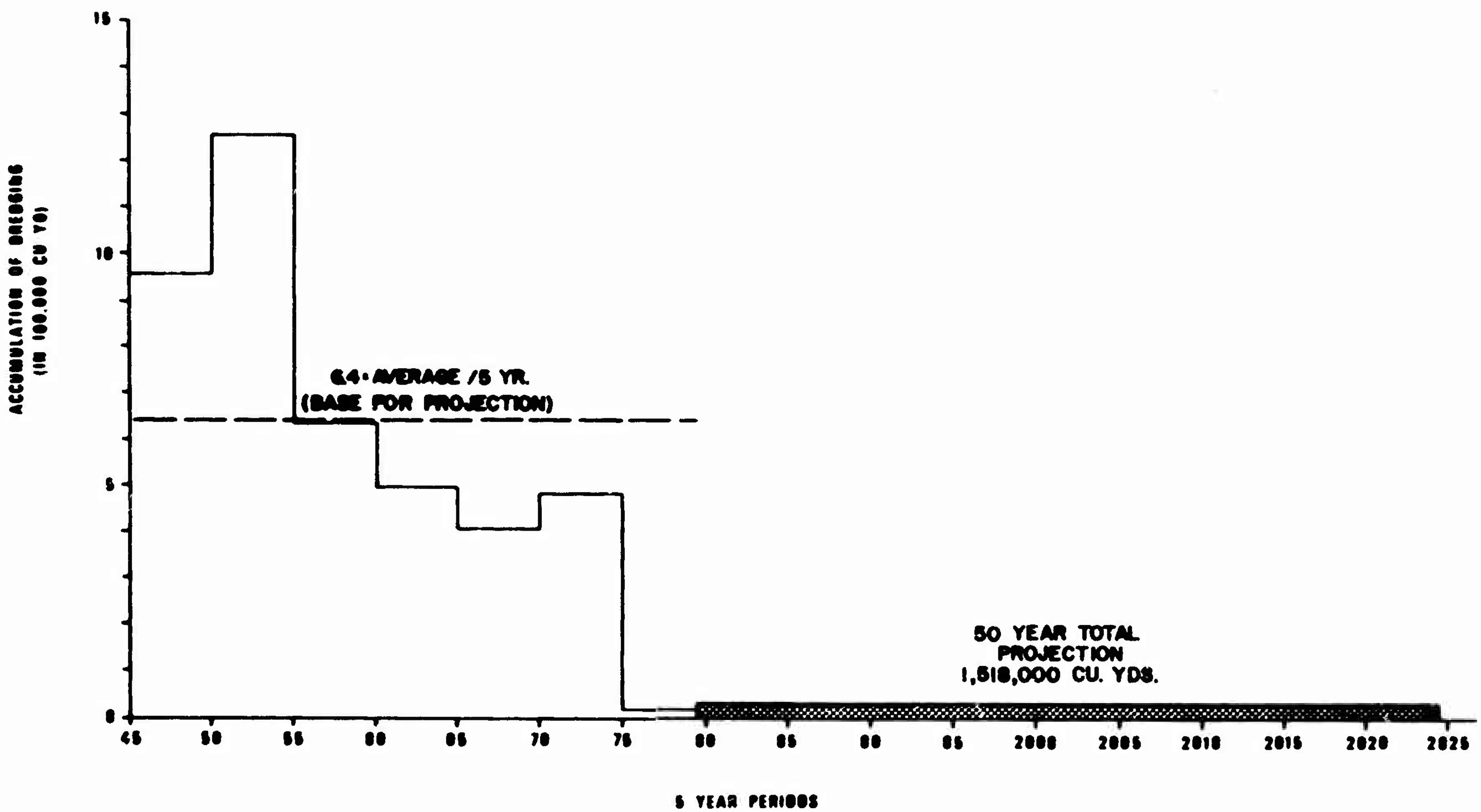


VOLUME DREDGED
(1,000 CUBIC YARDS)

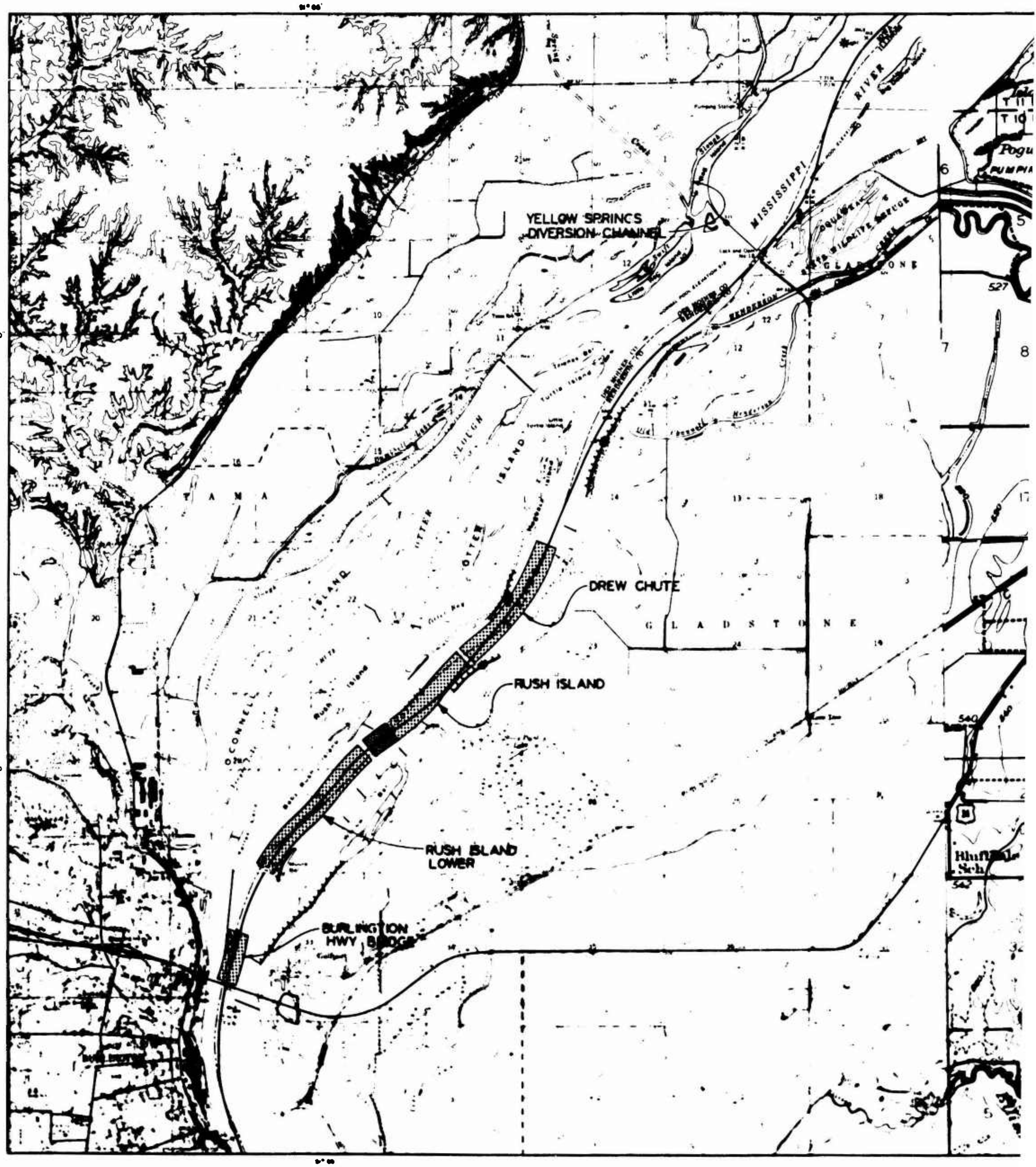
CHART 19A
EXTENT AND FREQUENCY
OF DREDGING
POOL 19

CHART 19B — PROJECTED DREDGING POOL 19

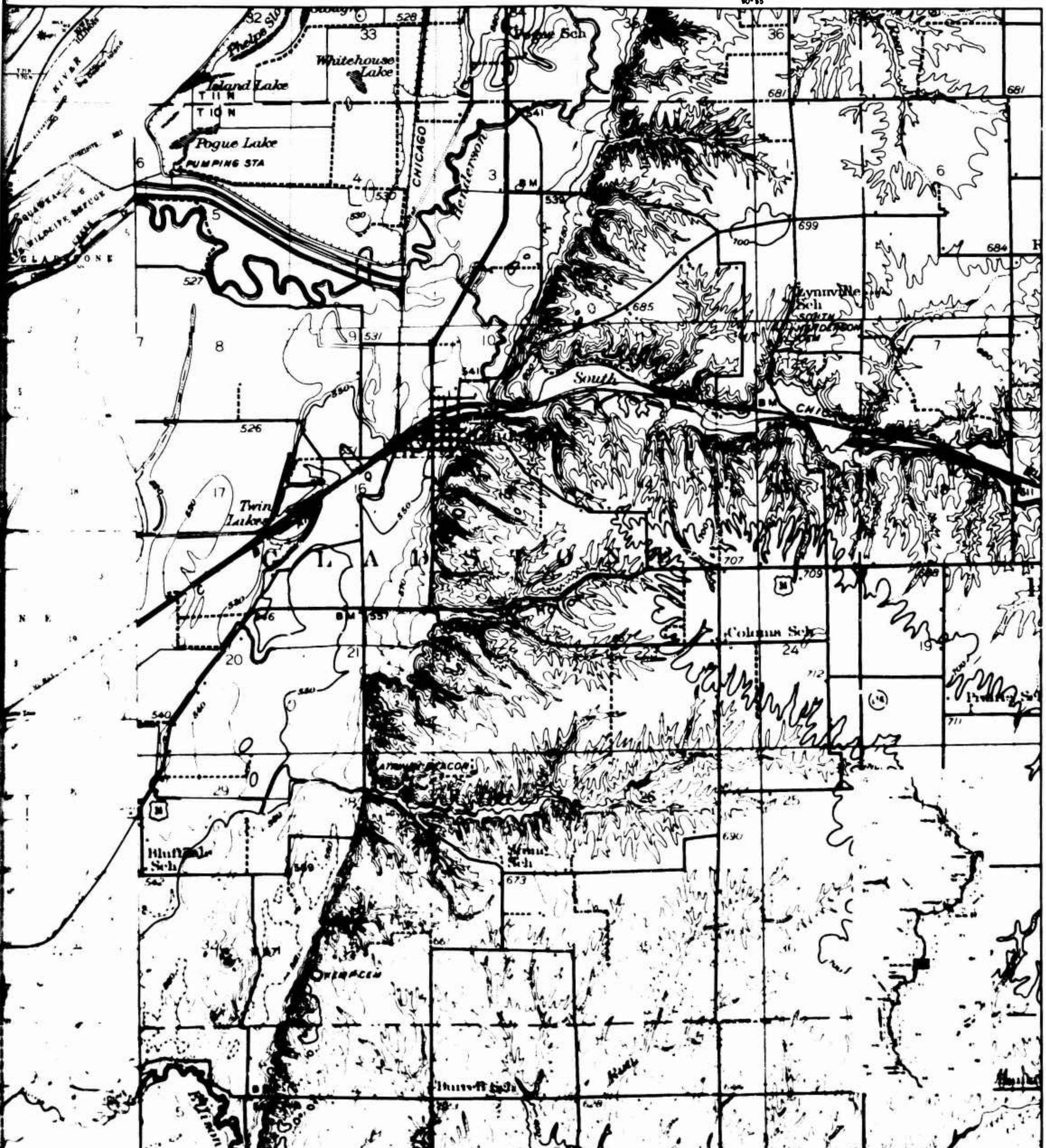
CHANNEL DREDGING PROJECTION



# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
(POOL 19 — LOCK AND DAM 18 TO MILE 404)



**UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS**
**(POOL 19 — MODULE 1)**



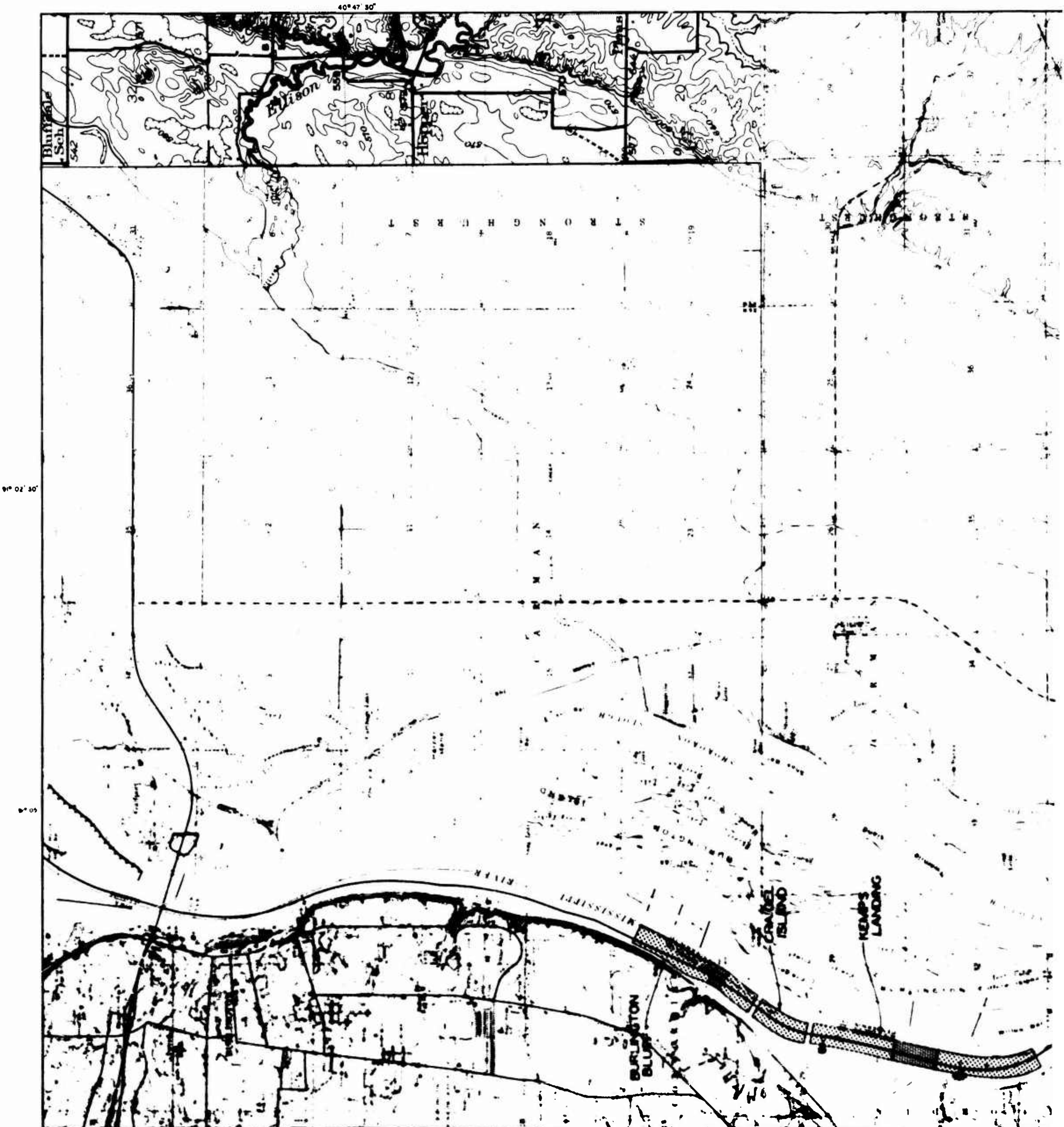

**LEGEND**

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT-DAYMARK
- MAIN CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

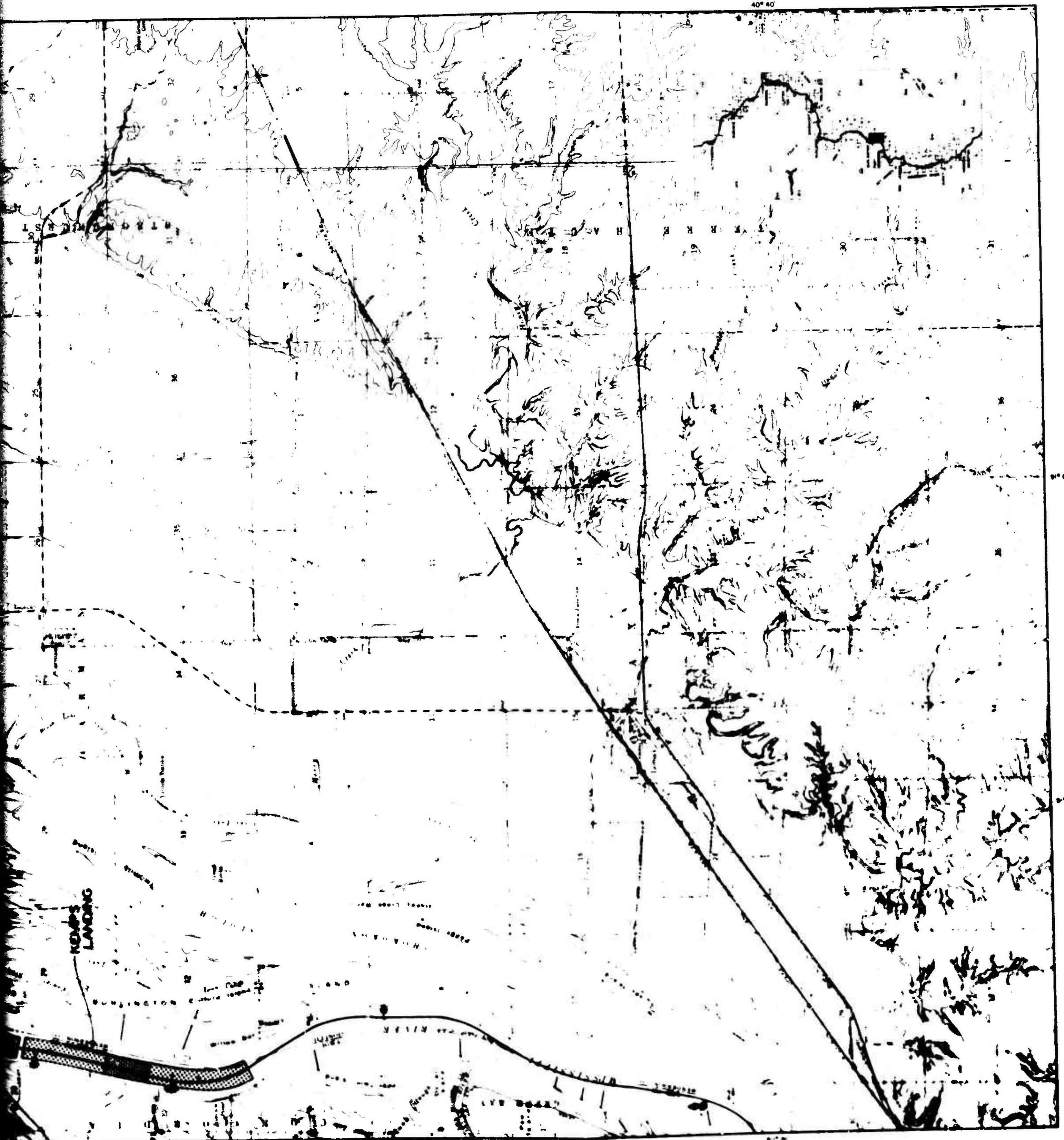
**UPPER MISSISSIPPI RIVER**
(POOL 19 — LOCK AND DAM 18 TO MILE 404)
(MODULE 1) NAVIGATION STRUCTURES

**PLATE 42**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 19 — MILE 404 TO MILE 396)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 19 — MODULE 2)

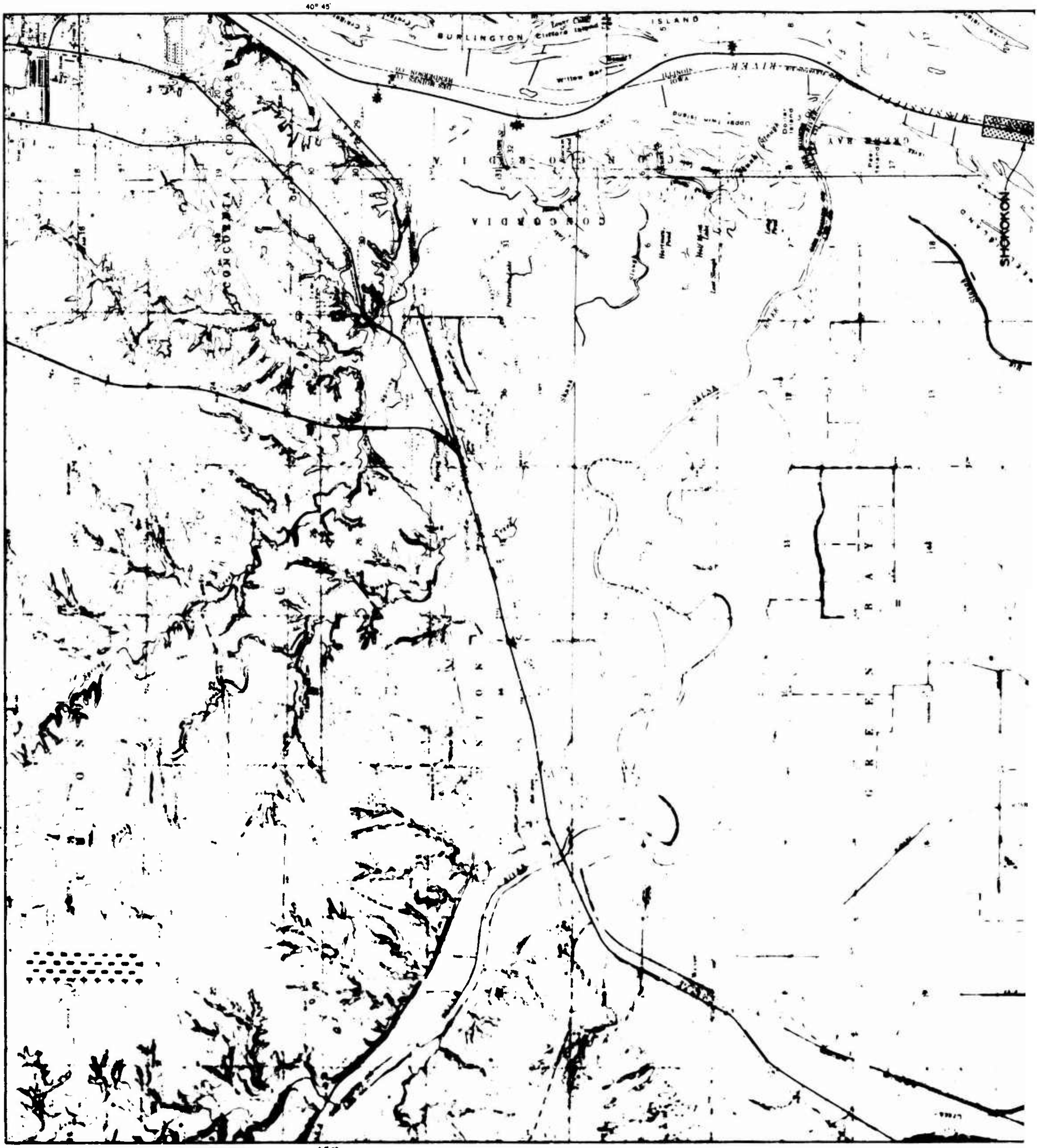



LEGEND

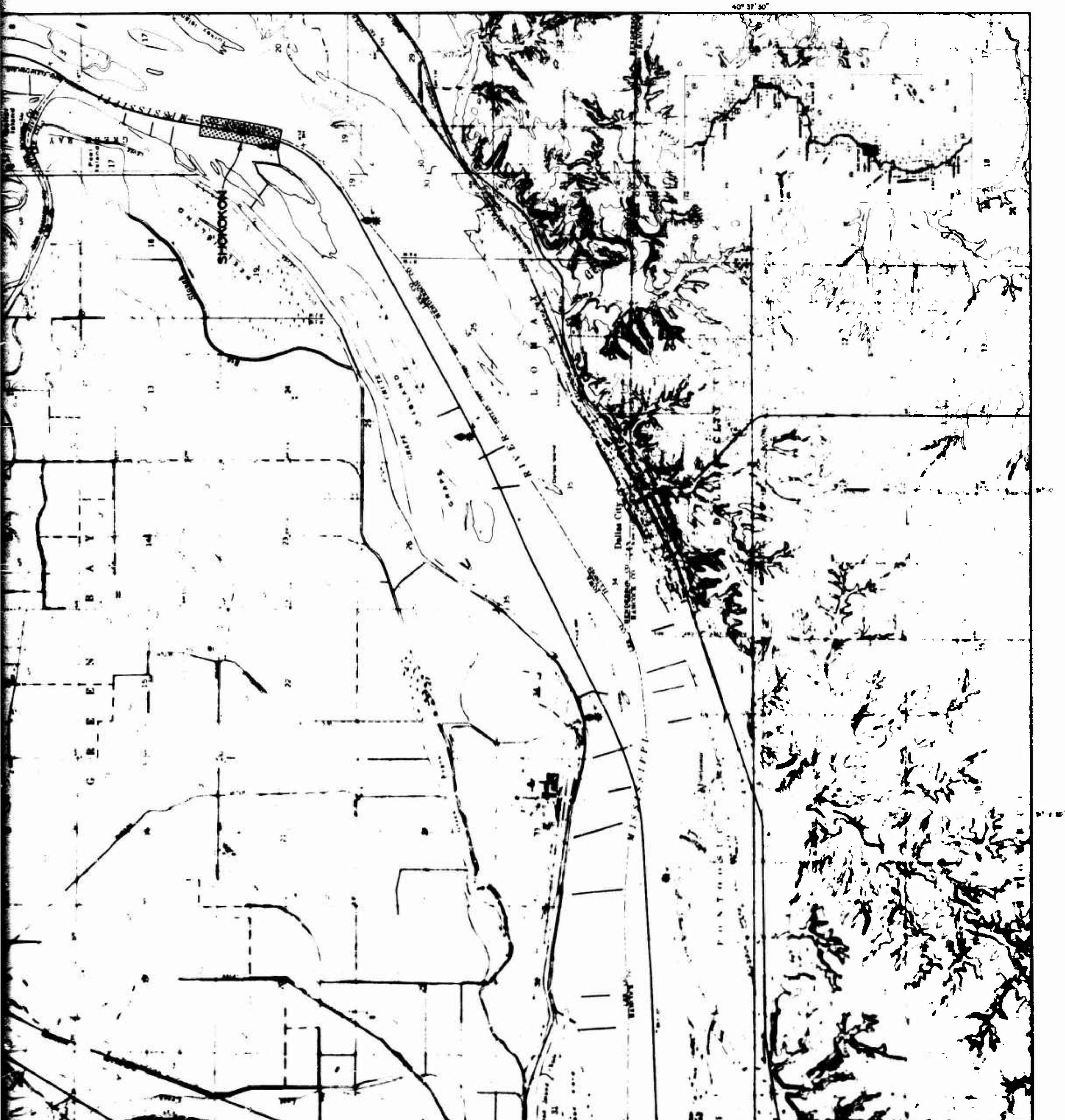
UPPER MISSISSIPPI RIVER

PLATE 43

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 19 — MILE 396 TO MILE 387)**



## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 19 — MODULE 3)




**LEGEND**

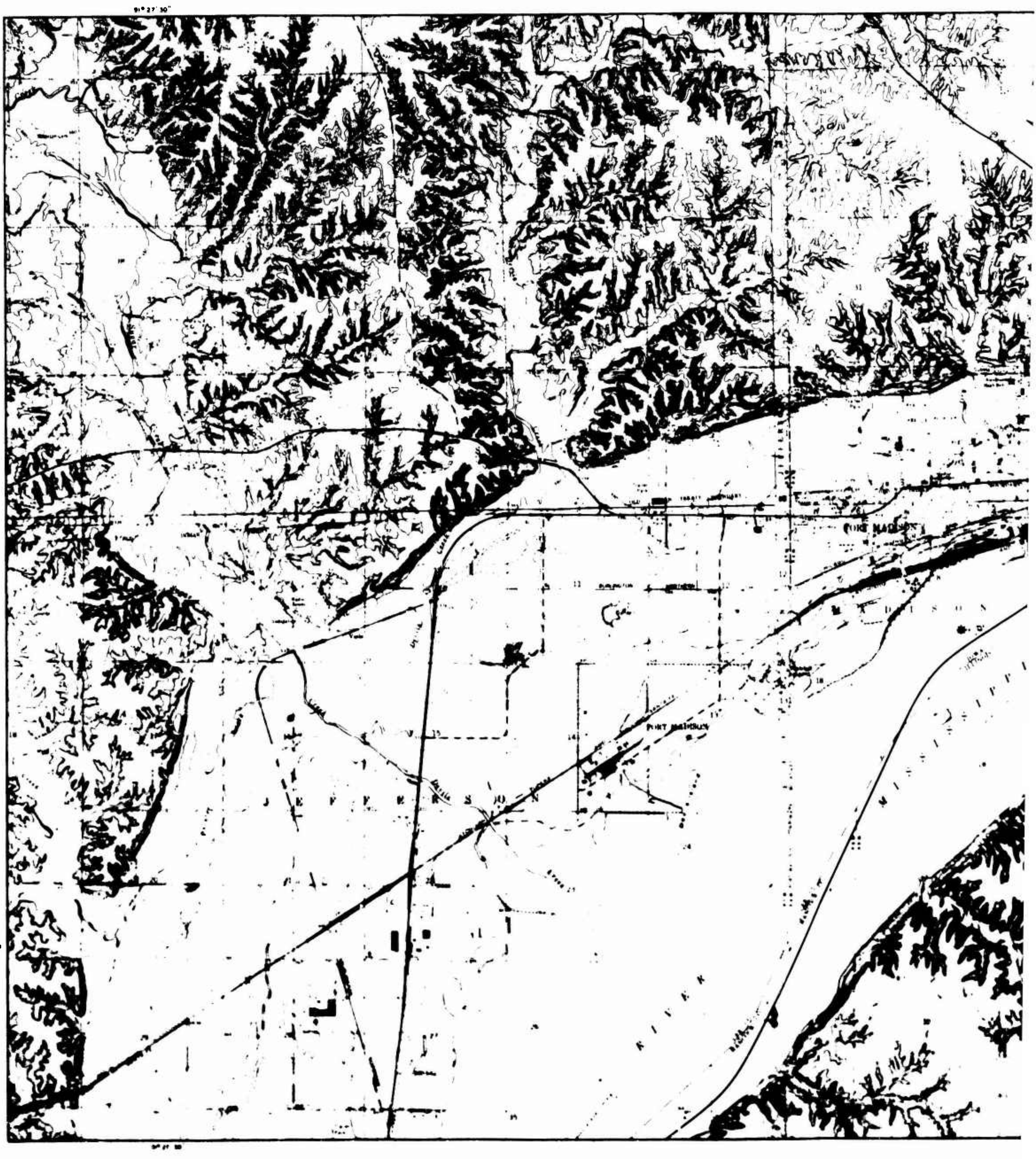
- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- MAIN CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

**UPPER MISSISSIPPI RIVER**
(POOL 19 — MILE 396 TO MILE 387)
(MODULE 3) NAVIGATION STRUCTURES

**PLATE 44**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 19 — MILE 387 TO MILE 378)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 19 — MODULE 4)

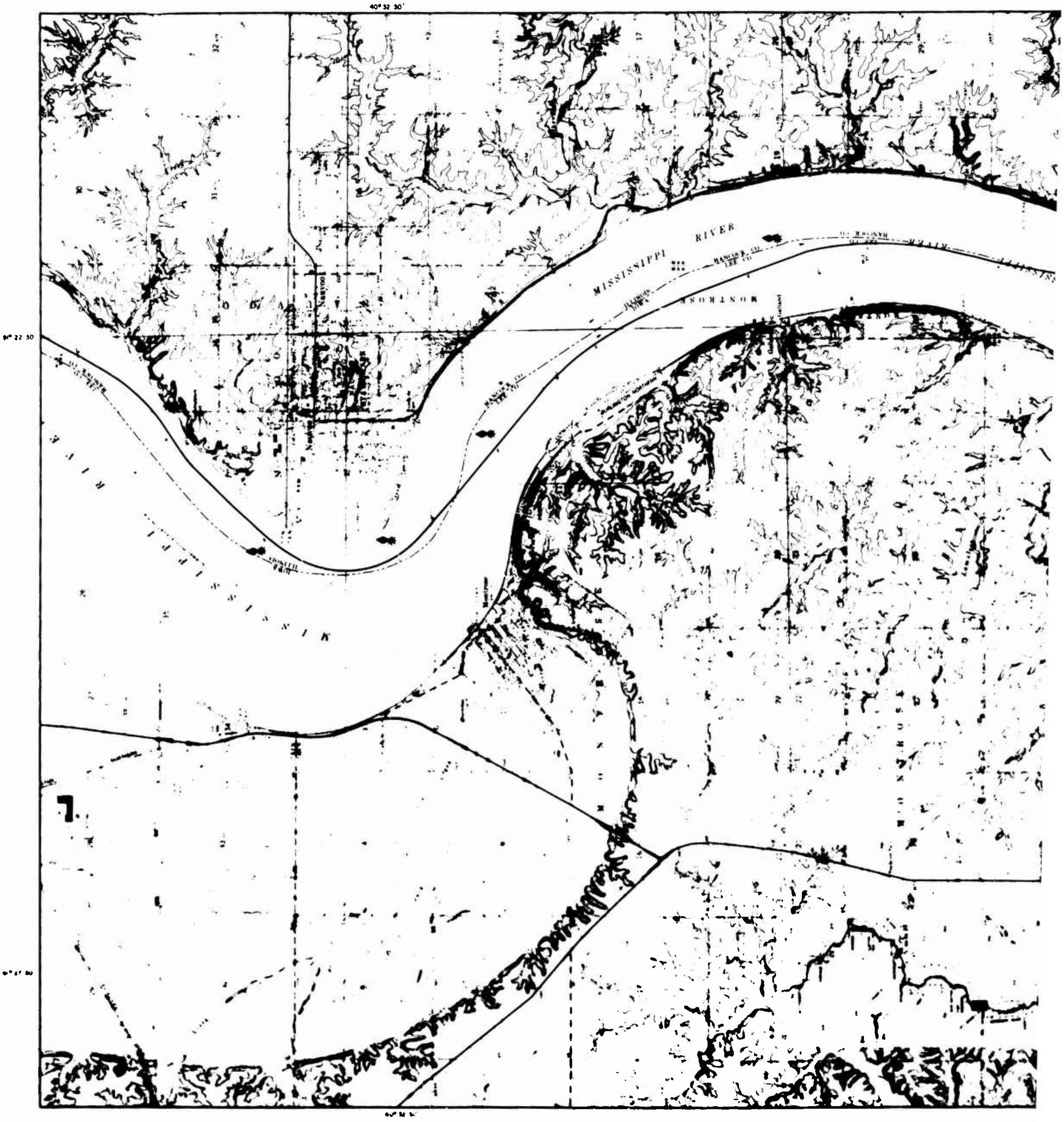

LEGEND

UPPER MISSISSIPPI RIVER
(POOL 19 — MILE 387 TO MILE 370)
(MODULE 4) NAVIGATION STRUCTURES

PLATE 45

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

(POOL 19 — MILE 378 TO LOCK AND DAM 19)



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

(POOL 19 — MODULE 5)


LEGEND

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT-DAYMARK
- GOVERNMENT LIGHTED BUOY
- MAIN CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

UPPER MISSISSIPPI RIVER

(POOL 19 — MILE 378 TO LOCK AND DAM 19)

(MODULE 5) NAVIGATION STRUCTURES

PLATE 46

## POOL 20

Extent and Frequency of Dredging - Channel maintenance dredging has totaled 4.41 million cubic yards from 12 locations since 1945. Chart 20A, Plate 47, illustrates the quantities, in thousand cubic yards, dredged by mile location and year. The annual summary of volumes dredged is extended to the right and the number of dredges for each river mile is extended directly beneath. For locations of past dredging operations, see the attached "Dredging and Disposal Sites" charts for Pool 20. Approximately 31 percent of the 21.0 river miles of channel in Pool 20 has been dredged since 1945.

The Warsaw small-boat harbor at UMR mile location 359.0 is maintained to a five-foot depth. Since 1965, dredging quantities there have been:

| Year | Cubic Yards |
|---|---|
| 1967 | 11,138 |
| 1968 | 2,354 |
| 1969 | 17,591 |
| 1970 | 8,790 |
| 1971 | 7,002 |
| 1972 | 6,221 |
| 1973 | 12,191 |

Areas of Recurrent and Recent Dredging - In Pool 20, of the twelve sites dredged in the past, nine are classified as nonrecurrent and the following are classified as recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recurrent | Fox Island | 354.5 - 356.1 |
| Recurrent | Gregory Lower | 351.2 - 351.6 |
| Recurrent | Buzzard Island | 349.0 - 349.5 |
| Recurrent | Warsaw Harbor | 359.0 |

Hydraulics - There are three chronic areas of dredging in Pool 20. Those are Fox Island, river mile 354.0 through 356.0; Gregory Lower, river mile 351.0 through 352.0; and Buzzard Island, river mile 348.8 through 349.6. Pool 20 has tributary drainage area of 15,300 square miles. Of all the pools in the Rock Island District, this pool has more tributary drainage area. In addition, the streams which produce the greatest amount of sediment are the streams which flow into Pool 20.

The first area, which is an area of chronic dredging, is called Fox Island. This is located between Mississippi river mile 354.4 and 355.8. This area has been dredged many times since 1945. The years with the heaviest dredging were 1957, 1962, 1965, 1967, 1972, 1973, and 1975. In 1967, 204,610 cubic yards were dredged from this area. It has been increasingly difficult to find a location to place dredged material. Deposition in this area is due to the reduction of velocities below river mile 356, a crossover from the left bank to the right bank, and some loss of flow through side channels. Examination of the regulating structures in Pool 20, particularly those in the upper reaches of the pool where the dredging has been the greatest, has found that the regulatory structures are not at the same level that they were when they were placed at the beginning of the Nine-Foot Channel Project. Because these structures are not at design grade, they are no longer as effective for movement of the sediment through this area. Reconstruction of the regulating structures in the Fox Island reach is recommended. Of all the locations in the Rock Island District, Pool 20 should receive the highest priority because of the greatest number of yards dredged over the historical period.

The next area downstream in Pool 20 which is a chronic dredging area is between river mile 351.2 and 351.6. Deposition in this area is caused by the channel crossing over from the right bank to the left bank. In addition, the flows coming from Hackley Chute, which constitute approximately 35% of the rivers flow, has an effect on the slowing down of the current in this reach, therefore, the velocities being reduced. With reduction of velocities the sediment has an opportunity to settle out in this entire area.

The area near Buzzard Island, river mile 349.0 to 349.8, is a chronic recurring area which will remain that way since much of the Mississippi River flow does not stay in the main channel. Dr. Jack Kennedy, Institute of Hydraulic Research, University of Iowa, has conducted two studies for GREAT II, and has identified the problems and solutions for this reach of the river. The first study was conducted in April 1977 and entitled, "Field Study of Sediment Transport Characteristics of the Mississippi River Near Fox Island, River Mile 355 Through 356, and Buzzard Island, River Mile 349 Through 350", NAKATO et al (1977). The second study was conducted in July 1979 and is entitled "Field Study of Sediment Transport Characteristics of the Mississippi River Near Buzzard Island, River Mile 347 to 355", NAKATO, et al (1979). The velocities which carry the sediment are sharply reduced in the thalwag of the river near Buzzard Island. This is due to the crossover effect and the reduction of flow from the bifurcation between Hunt and Huff Islands, and between Hunt Island and the Illinois shoreline. Present conditions indicate that 10% of the flow passes between the Illinois shoreline and Hunt Island, and 25% of the flow between Hunt Island and Huff Island, while only 5 to 10% of the flow is between Buzzard Island and the Missouri shore.

Presently, 25% of the suspended sediment and 30% of the bedload sediment is moving into the backwater areas and is not maintained in the main channel.

Recent water and sediment discharges at river miles 349.5, 349.24, and 348.98, have shown the following:

| Mile | Discharge (Cubic Feet Per Second) | Suspended Sediment (Tons/day) | Bedload Sediment (Tons/day) |
|---|---|---|---|
| 349.5 | 48,520 | 13,930 | 30 |
| 349.24 | 47,760 | 8,770 | 21 |
| 349.98 | 38,300 | 4,950 | 2 |

This again illustrates the loss of sediment, both suspended and bedload, in the area of shoaling.

Secondly, a significant reduction in flow will decrease the river's sediment transport capacity. Consequently, part of the sediment that was in suspension will settle out of the flow and become bed material. This area has a continual strong potential for building shoalings and closing off. Most of the time towboat traffic in the area has kept the Buzzard Island Reach open. It has been recently necessary to dredge to 12 feet just to maintain a channel during each navigation season. It will require dredging again next year and the following year if high flows exist and sediment is transported through the reach. Unless the regulatory structures in the area are repaired, the area will continue to have shoaling problems. The recommendations from Dr. Kennedy and the two studies mentioned above should be completed.

Future Dredging - In Pool 20, eight sites have been further identified as "chronic" dredging sites for the next 50 years based on expected river conditions, dredging requirements and practices. These sites, their expected frequency of dredging and quantities, are shown below:

| Location (UMR Mile No.) | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 361.9-362.0 | Keokuk Stump | 1 in 20 | 15,000 | 0.5 | 7,500 | 2.5 | 37,500 |
| 361.0-361.6 | 11 Des Moines River | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |
| 354.0-356.0 | 21 Fox Island | 1 in 3 | 55,000 | 3.3 | 101,000 | 16.5 | 907,000 |
| 351.0-352.0 | Gregory Lower | 1 in 4 | 30,000 | 2.5 | 75,000 | 12.5 | 375,000 |
| 348.0-349.0 | Buzzard Island | 3 in 10 | 40,000 | 3.0 | 120,000 | 15.0 | 600,000 |
| 344.0-345.3 | Meyer Light | 1 in 20 | 20,000 | 0.5 | 10,000 | 2.5 | 50,000 |
| 343.3-344.0 | L/D 20 Upper Approach | 1 in 10 | 30,000 | 1.0 | 30,000 | 5.0 | 150,000 |
| 350.0 | Warsaw Harbor | 9 in 10 | 5,000 | 9.0 | 45,000 | 4.5 | 225,000 |

1) At the Des Moines River site, the frequency of dredging is expected to increase in the next 50 years compared to dredging frequency in the past 40 years.

2) At the Fox Island site, the channel will be maintained narrower in the future than it has been in the past.

Projected Dredge Material Quantities - A projection for the next 50 years, based on the average of the past quantities dredged, is shown in Chart 20B, Plate 48, "Projected Dredging". The total amount of material expected to be dredged in Pool 20 in the next 50 years is expected to be approximately 2.47 million cubic yards. This amount is less than the amount that has been dredged in the last 20 years.

RECOMMENDATION #4009

The bank channel closure structures near the Fox Island in Pool 20 should be modified to reduce dredging required in the main channel.

# DISPLAY OF RECOMMENDATION & PRELIMINARY IMPACT ASSESSMENT

Recommendation Number 4009

Pool Number 20

River Mile Fox Island

Date Approved by Work Group 30 November 1979

1. General problem addressed (write out & use number from Att. #1):
   17. What solution, if any, on Fox Island, Pool 20, has come from the University of Iowa study?

2. Sub-problem addressed (write out - use only when necessary):
   Use results as a "case study" reference to solve similar future problems

3. Sub-objective addressed (taken from Att. #2 - write out):

4. Tasks accomplished to address problem (taken from Att. #3 - write out):
   8. Use of other studies- study completed by Iowa Instititute of Hydraulic Research and the recommendations addressed

5. Listing of alternatives to problem:
   a. No change - no modifications
   b. Continue to dredge areas as before
   c. Modify back channel closure structures only
   d. Modify main channel closures only
   e. Combination of alternative a & b above
   f.
   g.

6. Selected alternative c (write in the letter)

7. **Rationale for selection of alternative:**

Recommendation by contractor on Fox Island Study

8. **References used to select alternative (use tasks, support documents and/or discussions, studies, articles, etc.):**

A. Study conducted in April 77

B. Study conducted in July 79

9. **Rationale for elimination of other alternatives:**

Reduction of dredging in the area by modification of structures, based on studies conducted by Iowa Inst. of Hydraulic Resources and computer models of sediment transport, would not occur.

10. **Preliminary impact assessment of selected alternative. (List below all general impacts which can be identified by the work group. The level of detail required is only that for which the information is readily available.)**

1. The backwater area would have slower moving water with the potential of less depth.
2. The main channel velocities will become more swift.
3. Potential for impact on fish feeding and nursing areas.

11. **Reason for work group rejection of recommendation:**

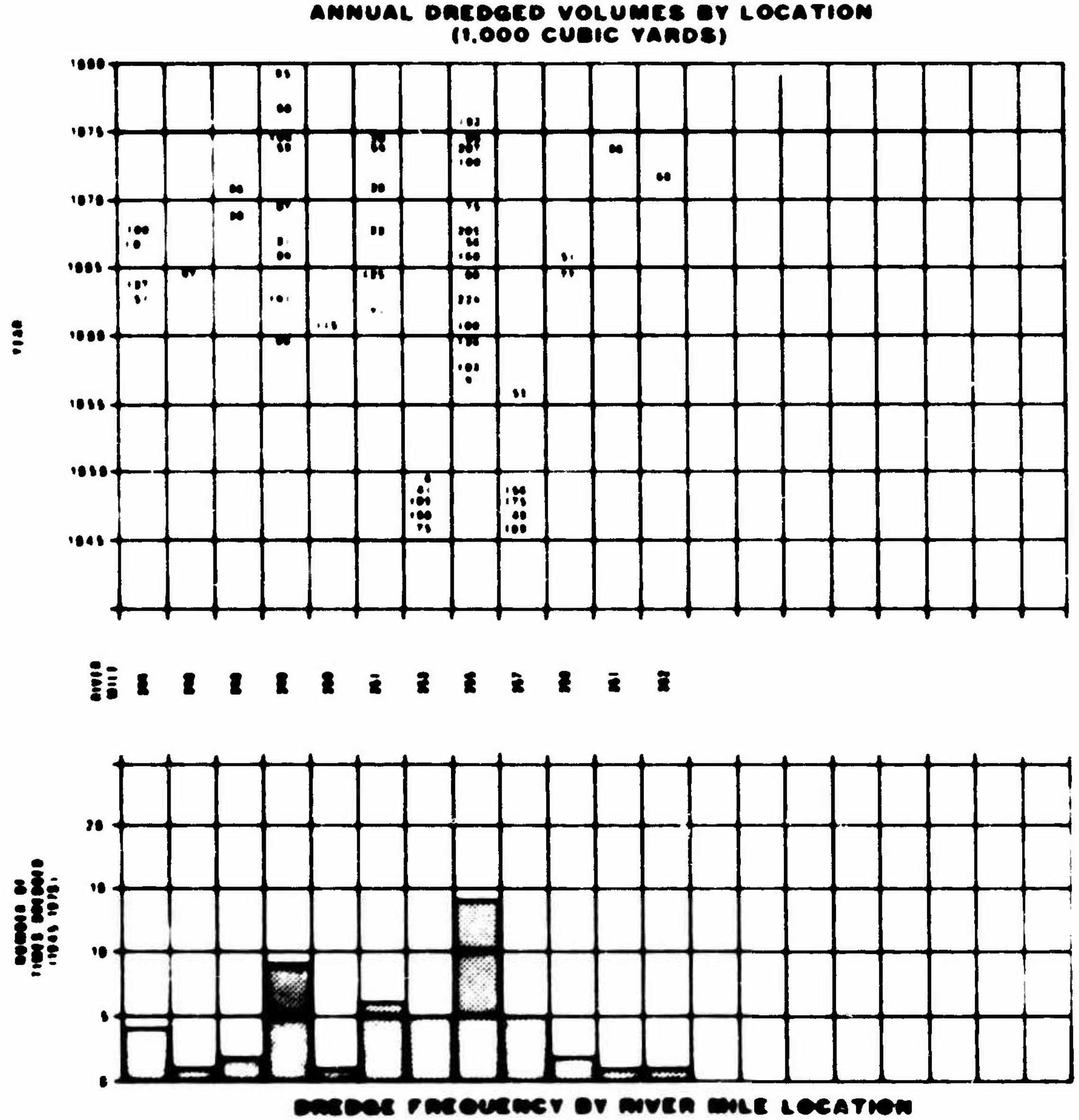
RECOMMENDATION # 4009
LOCATION (RIVER MILE) 350
POOL 20

RECOMMENDATION
IMPACT
ASSESSMENT FORM

ATTACHMENT NO. 7

| 1. LIST OF IMPACTS (SEE ATT. #5) | 2. UNITS TO BE MEASURED IN | 3. PRESENT CONDITION AS OF JAN. 1, 1979 FOR EACH IMPACT | 4. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITHOUT RECOMMENDATIONS | 5. DESCRIPTION OF MOST PROBABLE FUTURE (2025) WITH RECOMMENDATIONS | 6. MEASURE OF IMPACTS (COL. 5 MINUS COL. 4) |
|---|---|---|---|---|---|
| 6. Cost (Direct impact) | $15/Ton in place | Closing dam in side channel is in need of repair to restore to original condition. | No repairs made. | Cost of closing dam reconstruction. | $ 525,000 |
| 15. Man-made resource (Direct impact) | Tons of Rock for structure | Closing dam has deteriorated since its original construction. | No repairs made. | Closing dam repaired. | 35,000 |
| 16. Natural resources (Direct impact) | Biological productivity | Biological resources in backwater area are receiving water through break in closing dam. | Biological resources in backwater area are receiving water through break in closing dam. | Reconstruction of closing dam will result in no water flowing into backwater area. Aquatic life may be affected. | Unknown |
| 17. Water quantity (Direct impact) | CFS | Water is flowing through deteriorated closing dam into backwater area. | Water is flowing through deteriorated closing dam into backwater area. | Flow of water going into backwater area will be stopped. | Reduced dredging |
| 3. Aesthetic quality (Indirect impact) | Visual | Freshwater is flowing into backwater area. | Freshwater is flowing into backwater area. | No more freshwater flow, area becomes stagnant, eutrophication results. Odor & visual impacts occur. | Unknown |

No, or negligible, impacts on Impact Nos. 1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14.



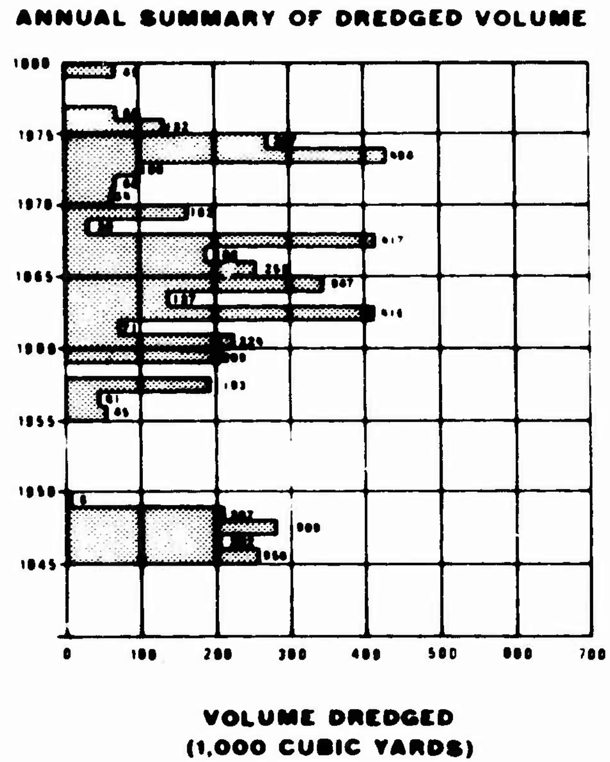
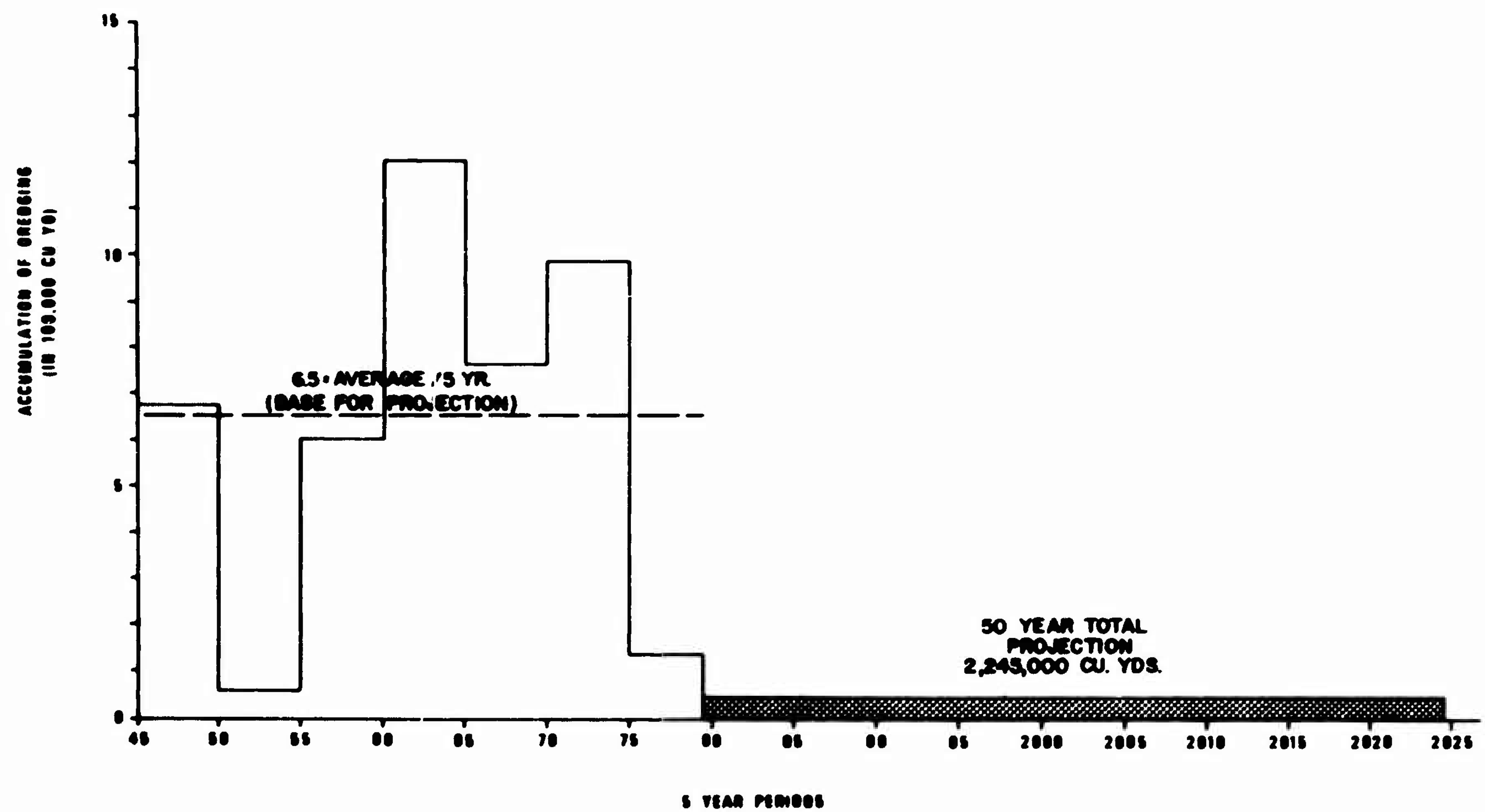



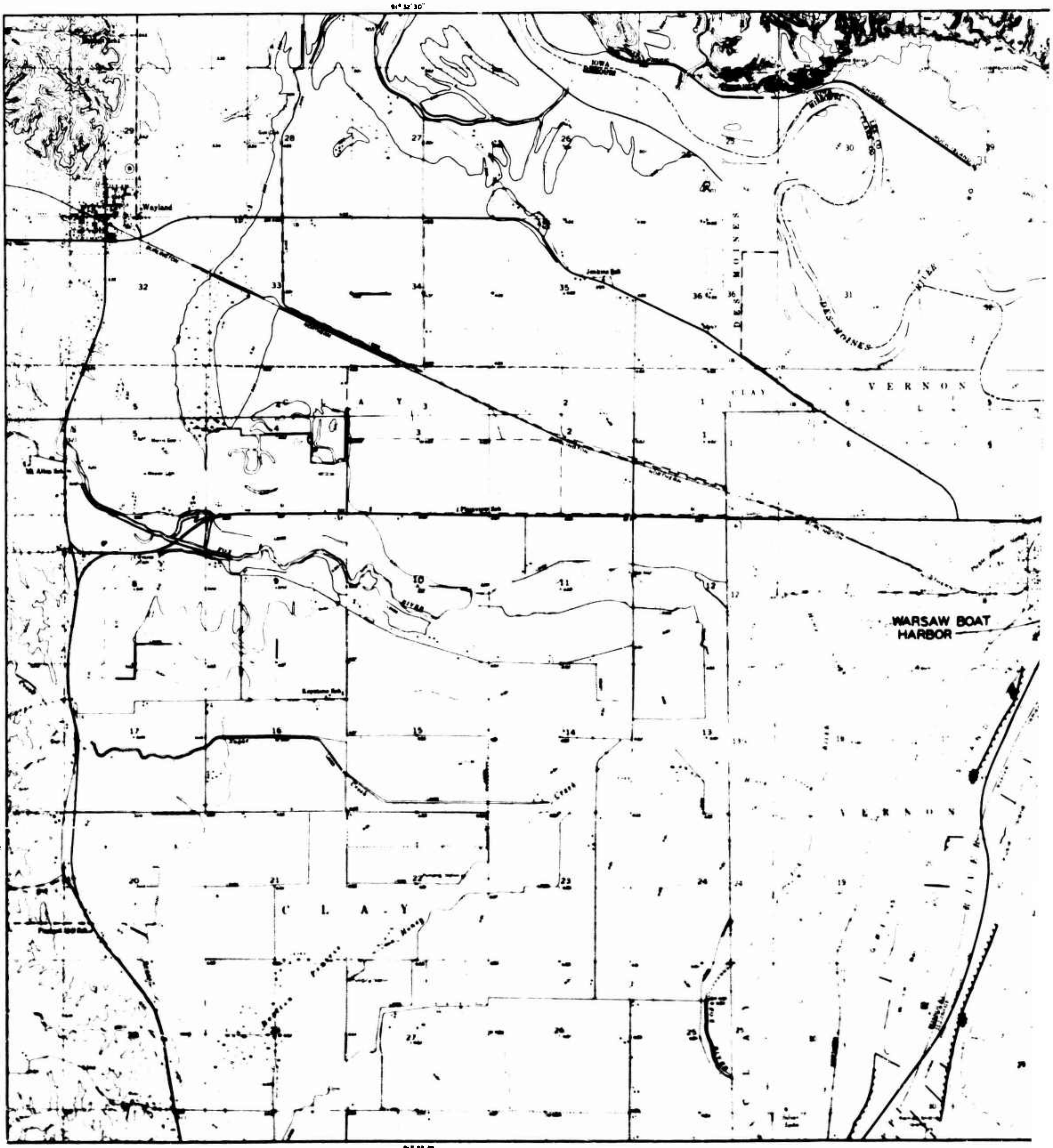

CHART 20A
EXTENT AND FREQUENCY
OF DREDGING
POOL 20

## CHART 20B – PROJECTED DREDGING POOL 20

CHANNEL DREDGING PROJECTION



# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
### (POOL 20 — LOCK AND DAM 19 TO MILE 356)

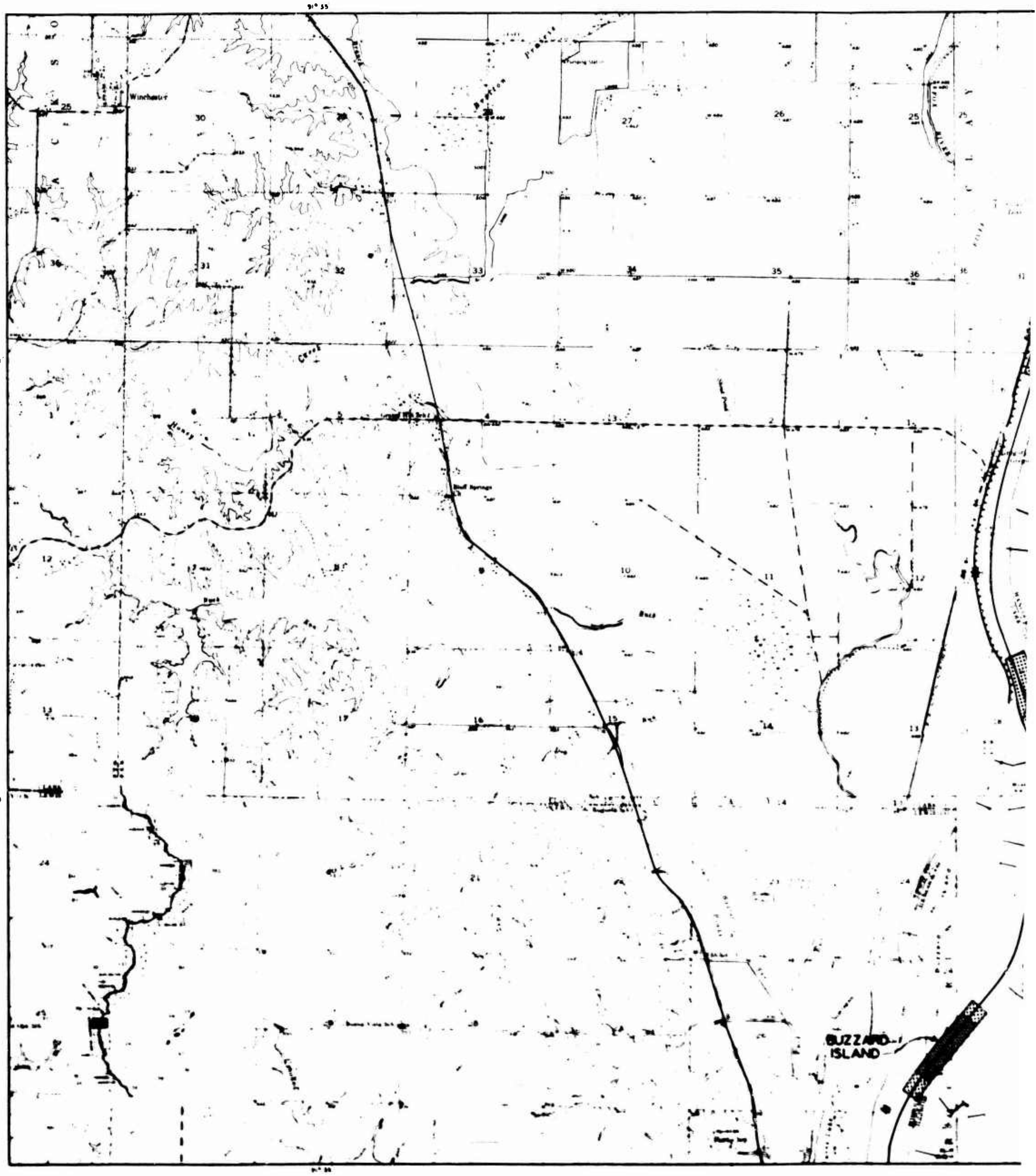


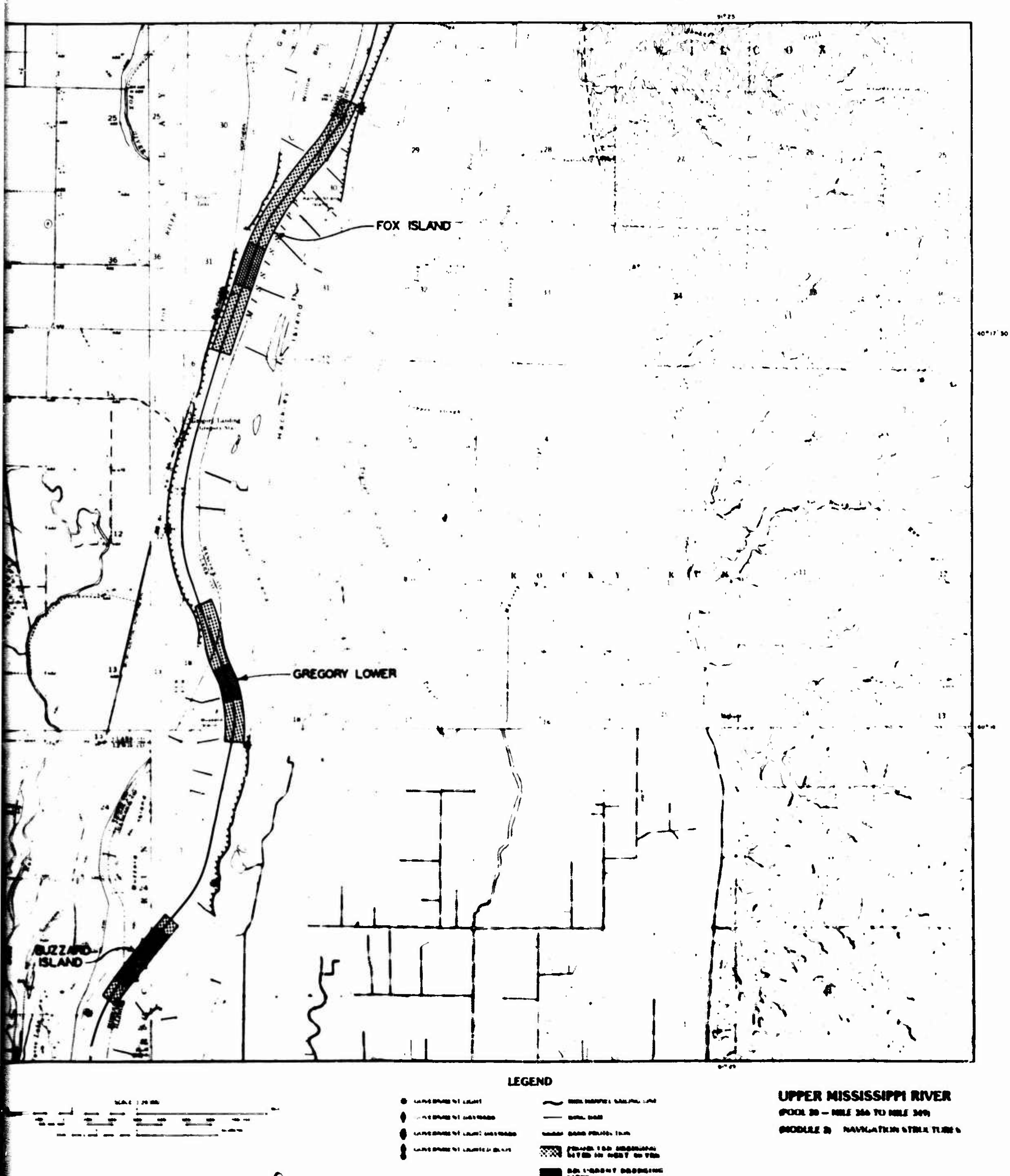
# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 20 — MODULE 1)


UPPER MISSISSIPPI RIVER
(POOL 20 — LOCK AND DAM 19 TO MILE [illegible])
(MODULE 1) NAVIGATION STRUCTURES

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

(POOL 20 — MILE 356 TO MILE 349)



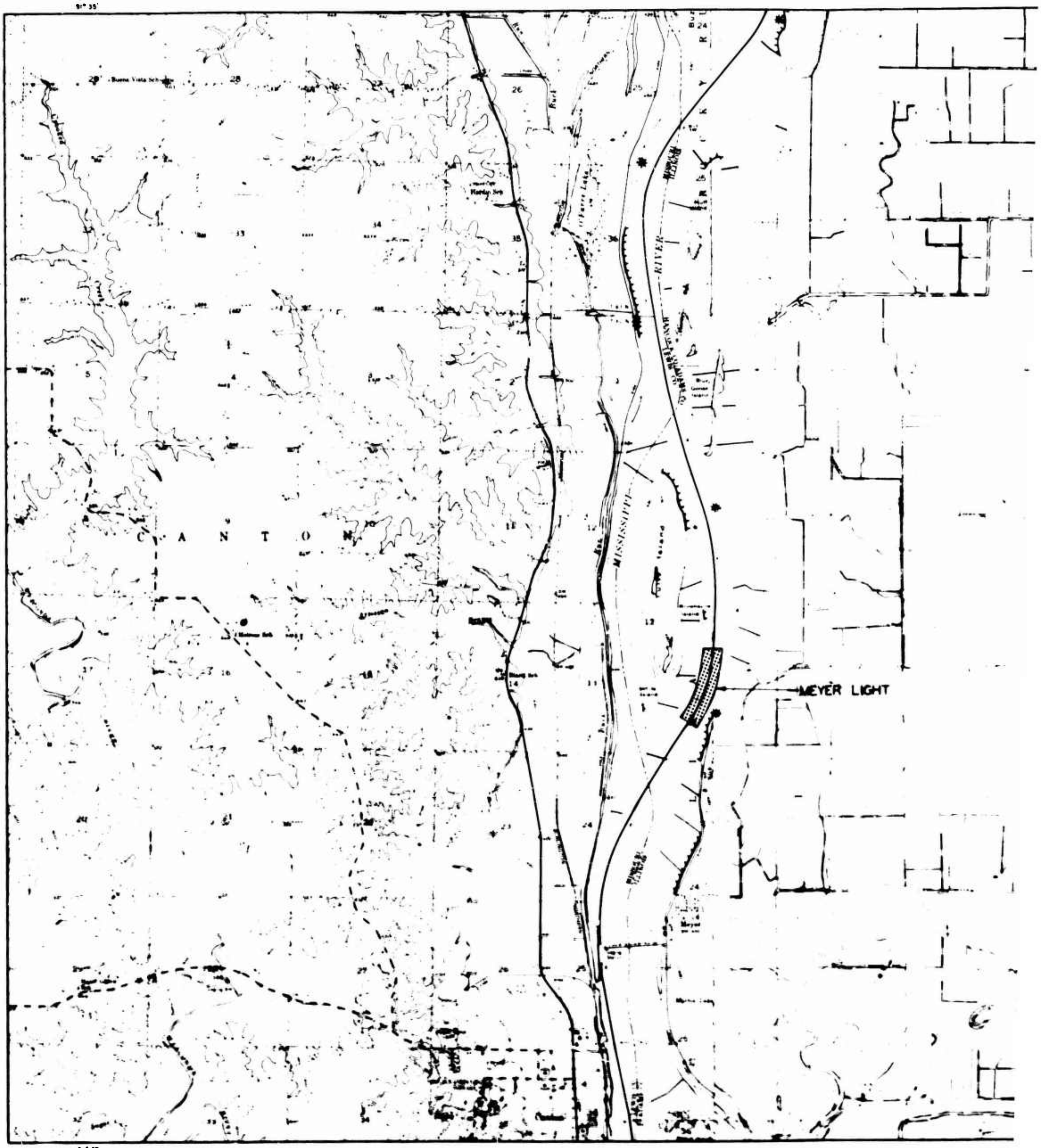



**UPPER MISSISSIPPI RIVER**

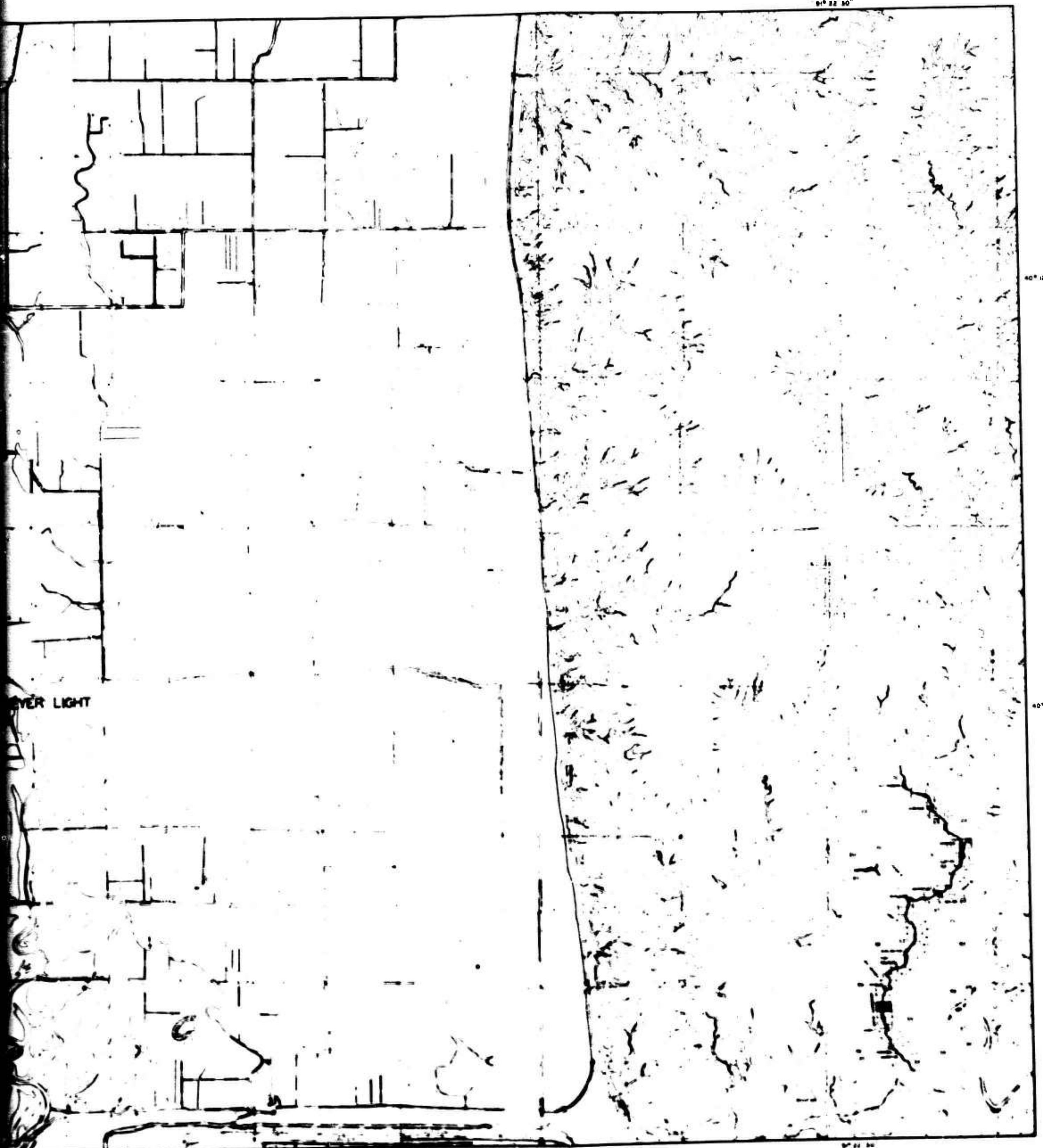
(POOL 20 — MILE [illegible] TO MILE [illegible])

(MODULE 2) NAVIGATION STRUCTURES

GREAT RIVER ENVIRONMENTAL ACTION TEAM
UPPER MISSISSIPPI RIVER (GREAT II)
(POOL 20 — MILE 349 TO LOCK AND DAM 20)



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 20 — MODULE 3)




LEGEND

UPPER MISSISSIPPI RIVER

(POOL 20 — MILE [illegible] TO LOCK AND DAM 20)

(MODULE 3) NAVIGATION STRUCTURES

PLATE 51

## POOL 21

Extent and Frequency of Dredging - Channel maintenance dredging has totaled 4.57 million cubic yards from 13 locations since 1945. Chart 21A, Plate 52, illustrates the quantities in thousand cubic yards by mile location. Dredge frequency per river mile and volume dredge per year are also illustrated in the accompanying bar diagrams. For locations of past dredging operations, see the attached "Dredging and Disposal Sites" charts for Pool 21. The 924,000 cubic yards shown for mile 328 reflect a relocation of the channel Approximately 37 percent of the 18.3 river miles of channel in Pool 21 has been dredged for maintenance since 1945.

The Squaw Chute small boat harbor at mile location 328.0 has not been dredged since its construction in 1966. The Quincy Bay small boat access at mile location 329.0 and Quincy Bay are maintained to a five-foot depth. The dredging quantities since 1966 have been:

| Year | Cubic Yards |
|---|---|
| 1968 | 6,741 |
| 1971 | 6,053 |
| 1972 | 8,028 |
| 1973 | 5,063 |

Areas of Recurrent and Recent Dredging - In Pool 21, there are 10 areas that are classified as non-recurrent and the following are classified as recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recurrent | LaGrange | 336.0 - 336.2 |
| Recurrent | Hogback Island | 331.5 - 332.6 |
| Recurrent | Quincy Bridge | 327.1 - 327.6 |
| Recurrent | Quincy Bay Access | 329.0 |

Hydraulics - There are four major sites in Pool 21 that are recurrent dredging areas. Those sites are LaGrange, river mile 336.0 to 336.2; Hogback Island, river mile 331.5 to 332.6; Quincy Bridge, river mile 327.1 to 327.6; and Quincy Bay Access, river mile 329.0.

LaGrange, Missouri, is located at river mile 335.9 and dredging has been recurrent in this area primarily in the last 30 years. After virtually every major flood, dredging has been required between river miles 336.0 and 336.6. The Wyaconda River enters the Mississippi River at river mile 337.3. Sediments from the Wyaconda River normally flow adjacent to the right bank of the Mississippi River during high flows and are dispersed more evenly throughout the main channel during lower Mississippi River flows. It is apparent from the amount of material being dredged in this reach that the flows in the Mississippi River are not totally flowing down the main channel. LaGrange Island 420 begins at river mile 336.8. Closing Dam No. 5 at river mile 336.4, which runs between Long Island and LaGrange Island, is not performing its function of forcing the majority into the main channel. As soon as the flow is bifurcated at the towhead of LaGrange Island, sediments begin to deposit in the main channel. At approximately the same location that the flow bifurcates, a crossover from the left bank to the right bank occurs. Therefore, the secondary velocities required to move the material are no longer available and both the suspended and the bedload sediments are deposited in this area. Examination of Wing Dams No. 12 and 14 on the right bank and Wing Dams 29, 15, 16, and 13, on the left bank is recommended, as well as the Closing Dam No. 5 between LaGrange Island and Long Island.

The next area downstream in Pool 21 is called Hogback Island and runs from approximately river mile 331 to 333.2. However, the majority of the dredging problem occurs between river mile 331.5 and 332.6. During 1963, 133,000 cubic yards were pumped from this area. In 1967, 432,000 yards were pumped from this area and placed on the left bank between Wing Dams 15 and 16 and 17. It was also placed on Willow Island and on Hogback Island. In this reach there are two crossovers, one from the left bank to the right bank beginning at river mile 333 and ending at river mile 332.1, and the second beginning at river mile 331.5 and ending at 330.8. The loss of the secondary velocity in this area has allowed sediments to accumulate. The adequacy of the regulating structures in this area are questioned due to the fact of the tremendous deposit of sediment. The regulating structures throughout this entire reach should be examined.

The area between river mile 327.1 and 327.6 is called Quincy Bridge. Substantial dredging has occurred here in the 1960's, however, the problem has decreased in the 70's. Some work has been performed on the wing dams on the right bank, and the sedimentation is less since the velocities have been increased.

The area called Quincy Bay Access, at river mile 329, has had some problems in the access channel. Sedimentation in this channel is due to sediment flowing from the Mississippi River into the Quincy Bay Access where the water velocity is considerably slower. The reduction in the velocities causes sediment accretion and reduces the access channel depth.

Future Dredging - In Pool 21, two sites have been further identified as "chronic" dredging sites for the next 50 years based on expected river conditions, dredging requirements and practices. These sites, their expected quantities and frequencies of dredging are shown below:

| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (10 Years) | Cubic Yards (10 Years) |
|---|---|---|---|---|---|---|---|
| 342-343 | L/D 20 Lower Approach | 1 in 20 | 10,000 | .5 | 5,000 | 2.5 | 25,000 |
| 338.0-339.0 | 11 Howards | 1 in 8 | 50,000 | 1.25 | 62,500 | 6.25 | 312,500 |
| 337.0-338.0 | LaGrange Upper | 1 in 10 | 25,000 | 1.0 | 25,000 | 5.0 | 125,000 |
| 335.5-336.5 | LaGrange | 1 in 4 | 25,000 | 2.5 | 62,500 | 12.5 | 312,500 |
| 332.0-332.6 | 21 Willow Island | 1 in 20 | 30,000 | .5 | 15,000 | 2.5 | 75,000 |
| 331.5-332.6 | Hogback Island | 1 in 8 | 35,000 | 1.25 | 43,750 | 6.25 | 218,750 |
| 330.5-331.5 | Lone Tree Light | 1 in 8 | 25,000 | 1.25 | 31,250 | 6.25 | 156,250 |
| 327.1-327.6 | 31 Quincy Bridge | 1 in 10 | 30,000 | 1.0 | 30,000 | 5.0 | 150,000 |
| 328.5 | Quincy Bay Access Channel | 1 in 4 | 2,500 | 2.5 | 6,250 | 12.5 | 31,250 |
| 327.4 | Squaw Chute Harbor | 1 in 15 | 2,500 | .7 | 1,750 | 3.5 | 8,750 |

1) At the Howards site, the channel will be maintained at a narrower width than in the past.

2) At Hogback Island, the frequency of dredging expected in the next 50 years is less than it has historically been.

3) At Quincy Bridge, commercial sand and gravel dredging operations are currently being done immediately adjacent to, or in, the channel.

Projected dredge material quantities for the next 50 years based on the average of past quantities dredged is shown in Chart 21B, Plate 53, "Projected Dredging". The total amount of material dredged in Pool 21 for the next 50 years is expected to be approximately 1.425 million cubic yards based on the last 35 years' average. This amount is significantly less than the amount dredged in the last 15 years.

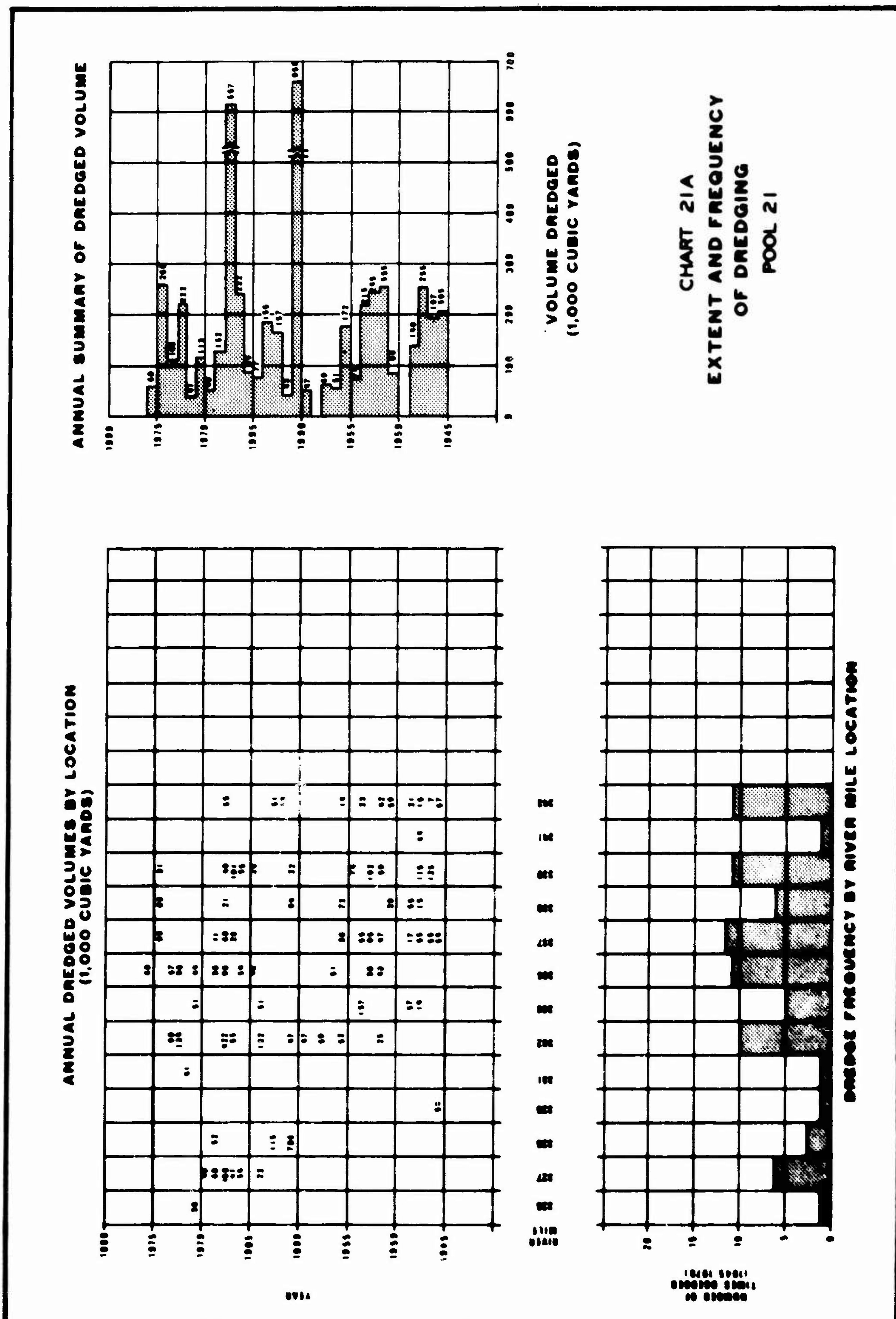


CHART 21A
EXTENT AND FREQUENCY
OF DREDGING
POOL 21
ANNUAL SUMMARY OF DREDGED VOLUME
VOLUME DREDGED
(1,000 CUBIC YARDS)
ANNUAL DREDGED VOLUMES BY LOCATION
(1,000 CUBIC YARDS)
DREDGE FREQUENCY BY RIVER MILE LOCATION

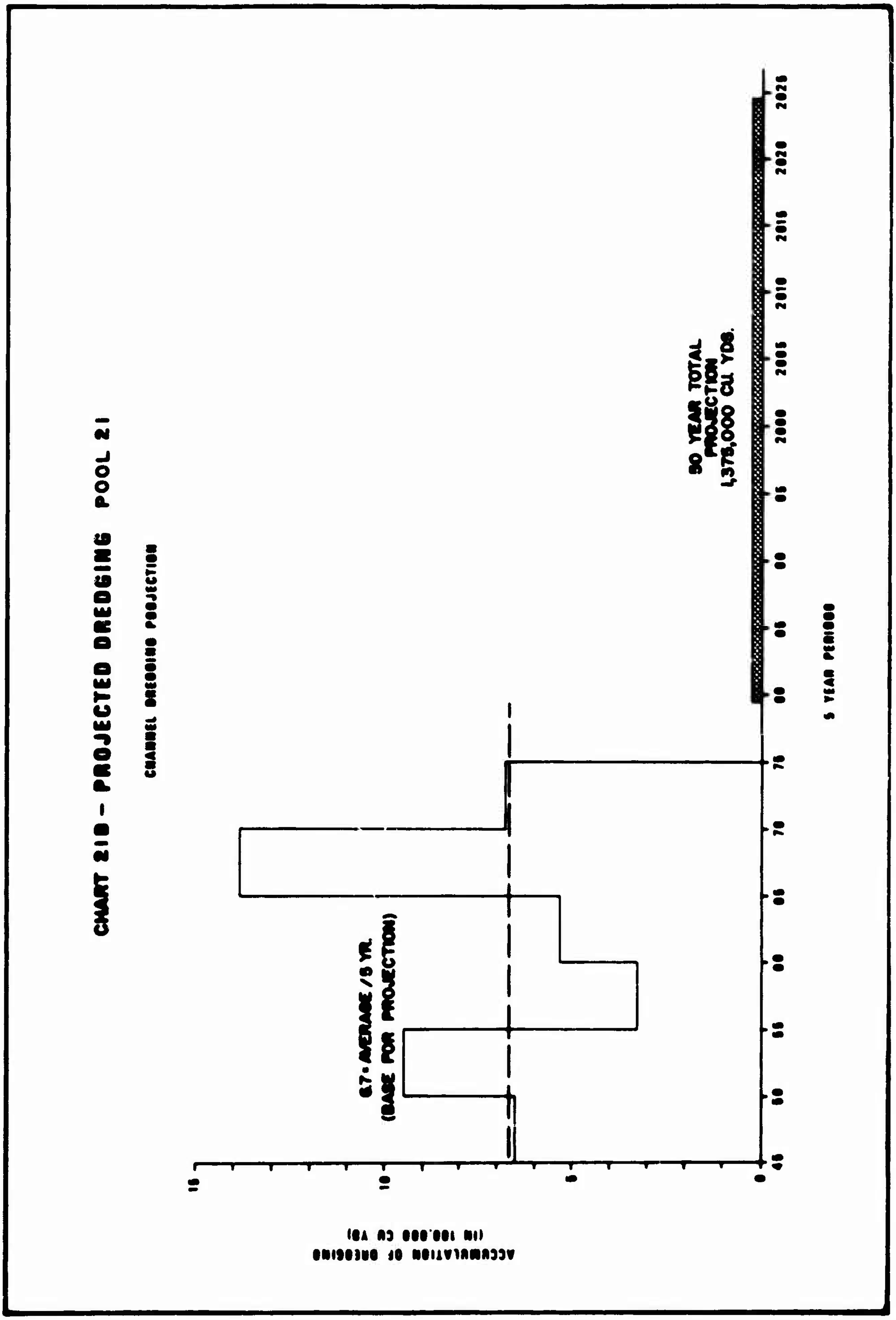
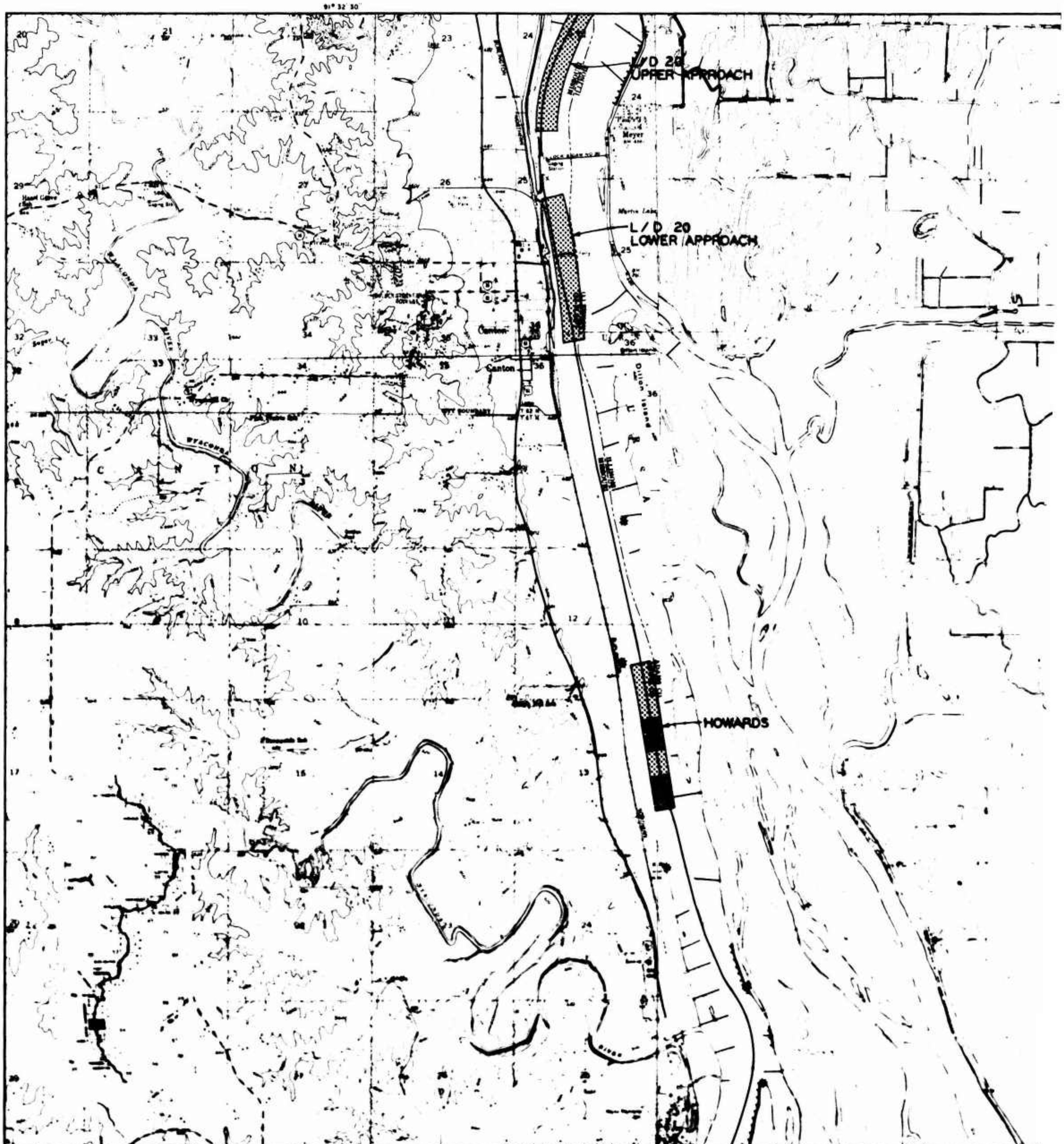


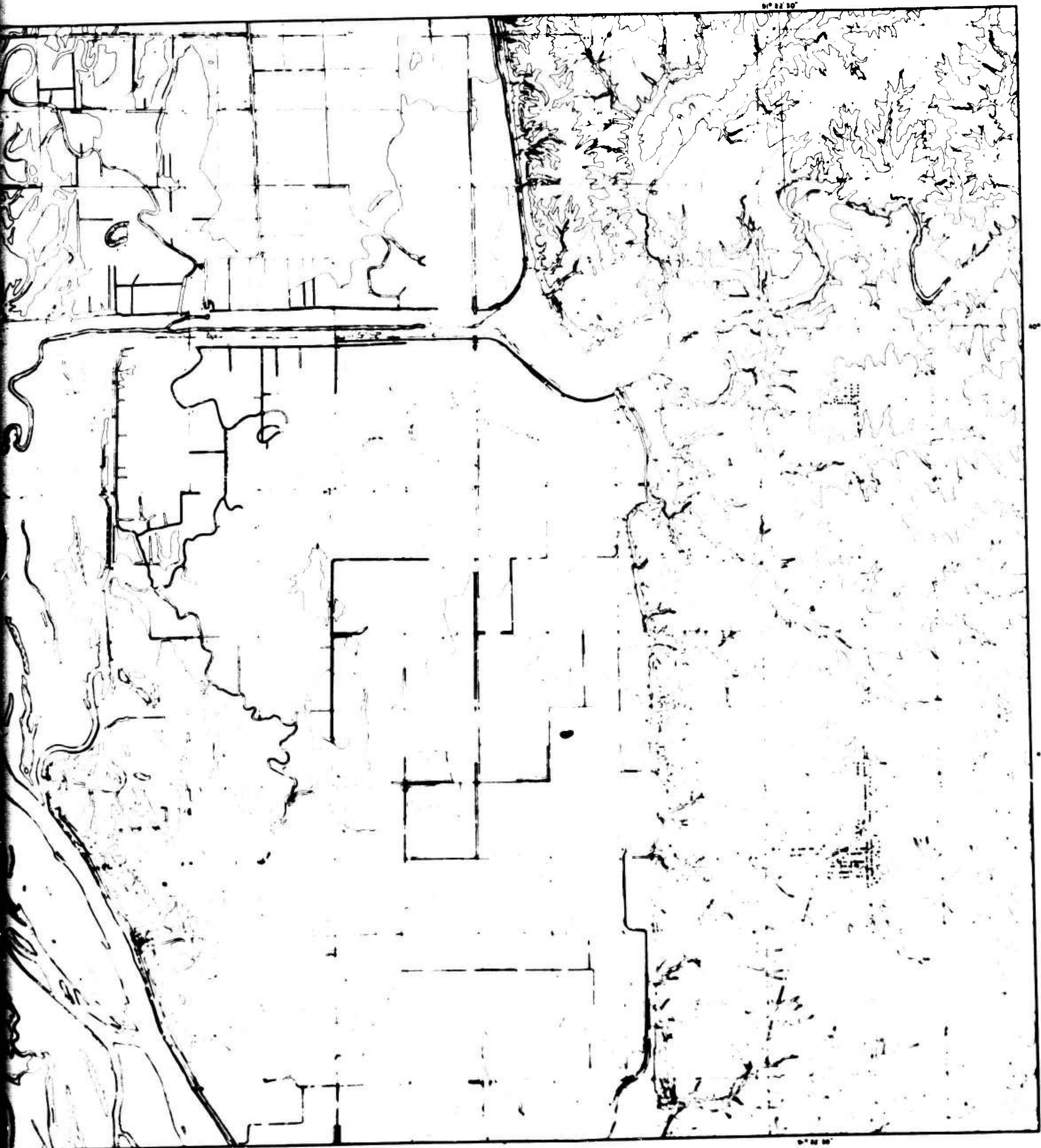
CHART 21B - PROJECTED DREDGING POOL 21
CHANNEL DREDGING PROJECTION
6.7 - AVERAGE / 5 YR.
(BASE FOR PROJECTION)
50 YEAR TOTAL
PROJECTION
1,375,000 CU. YDS.
ACCUMULATION OF DREDGING
(IN 100,000 CU YD)
0
5
10
15
45
50
55
60
65
70
75
80
85
90
95
2000
2005
2010
2015
2020
2025
5 YEAR PERIODS

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 21 — LOCK AND DAM 20 TO MILE 337)**



## UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 21 — MODULE 1)



LEGEND

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

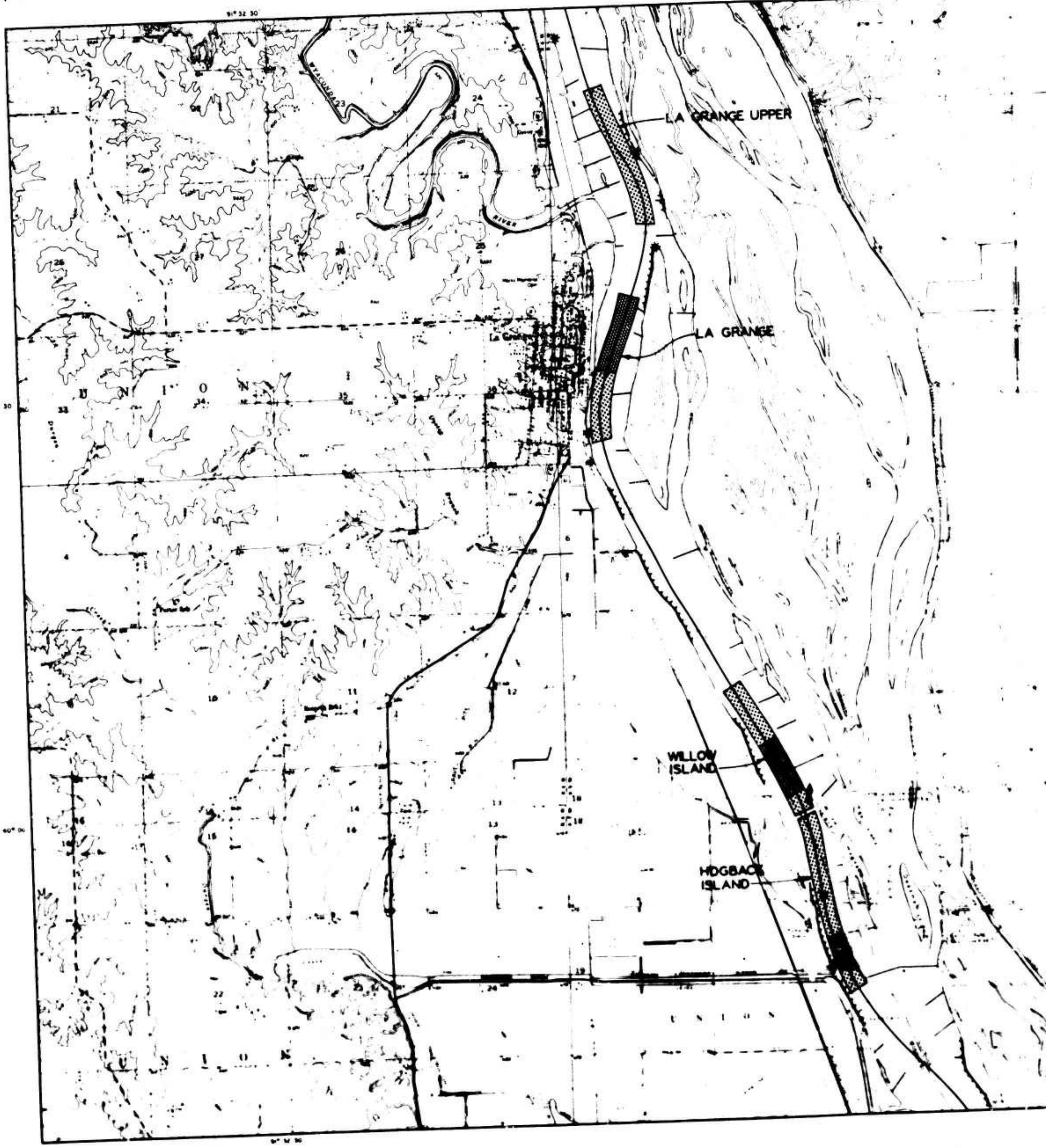
**UPPER MISSISSIPPI RIVER**

(POOL 21 — LOCK AND DAM 20 TO MILE 337)

(MODULE 1) NAVIGATION STRUCTURES

**PLATE 54**

**GREAT RIVER ENVIRONMENTAL ACTION TEAM**
**UPPER MISSISSIPPI RIVER (GREAT II)**
**(POOL 21 — MILE 337 TO MILE 331)**



UPPER MISSISSIPPI RIVER
ENVIRONMENTAL ATLAS
(POOL 21 — MODULE 2)

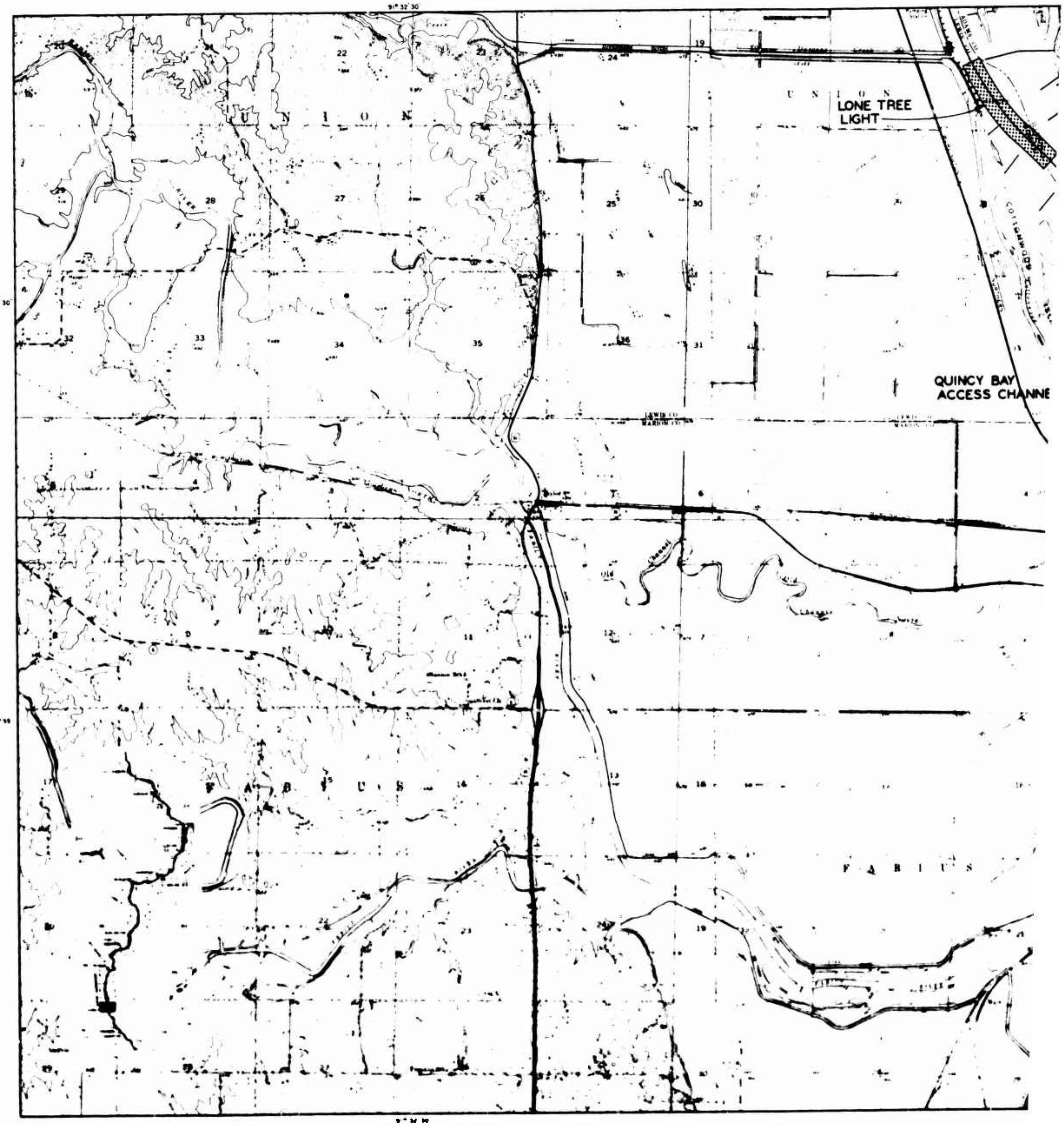

**UPPER MISSISSIPPI RIVER**

(POOL 21 — MILE 337 TO MILE 331)

(MODULE 2) NAVIGATION STRUCTURES

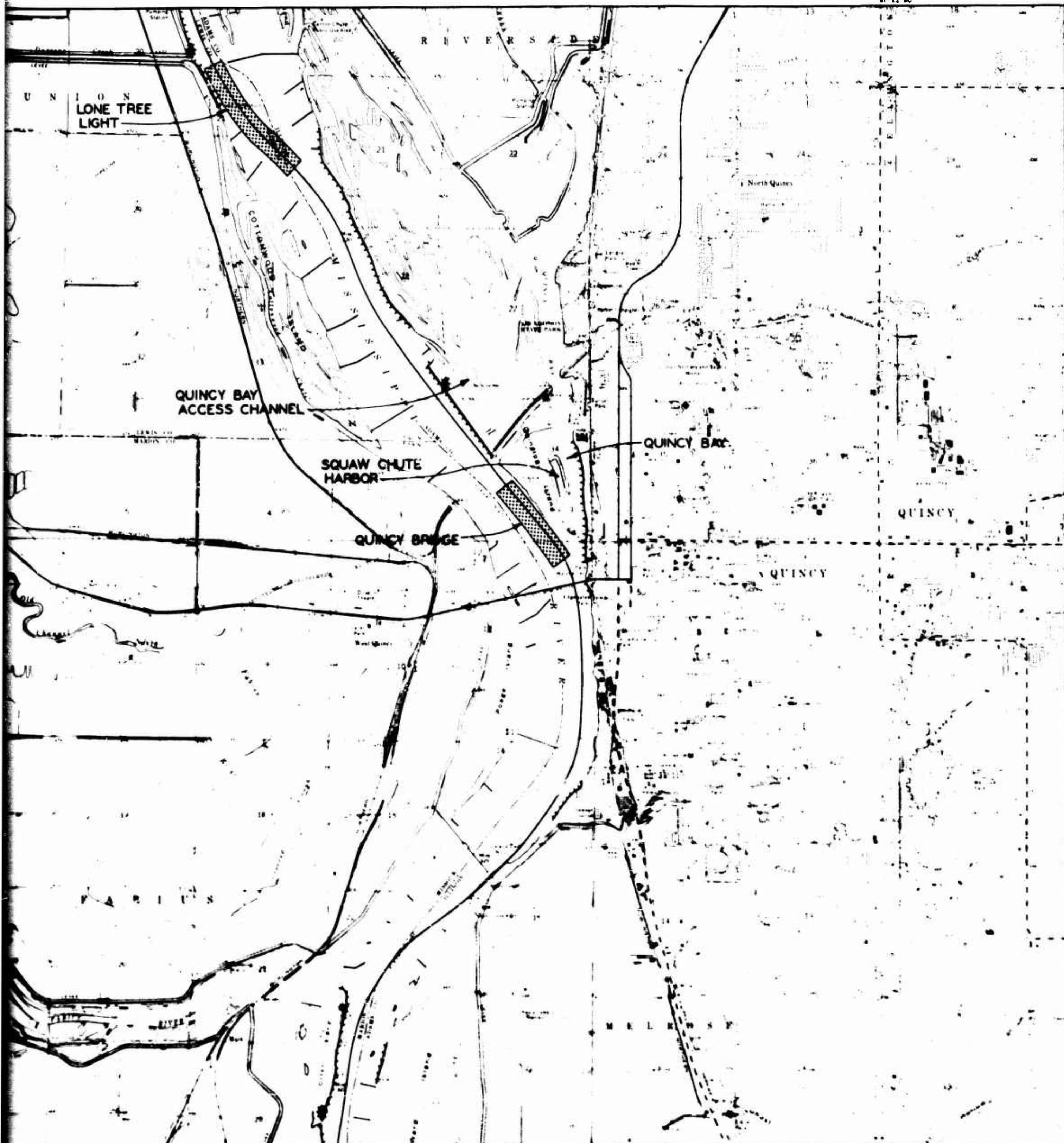
**PLATE 55**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
**(POOL 21 — MILE 331 TO LOCK AND DAM 21)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS

**(POOL 21 — MODULE 3)**




**LEGEND**

- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT-DAYMARK
- GOVERNMENT LIGHTED BUOY
- MAIN CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

**UPPER MISSISSIPPI RIVER**

(POOL 21 — MILE 331 TO LOCK AND DAM 21)

(MODULE 3) NAVIGATION STRUCTURES

**PLATE 56**

## POOL 22

Extent and Frequency of Dredging - Channel maintenance dredging, largely in the upper portion of the pool, has totaled 4.52 million cubic yards from 12 locations since 1945. See Chart 22A, Plate 57, below for the quantities dredged, in thousand cubic yards, by mile location and year dredged. Also shown in Chart 22A is the annual summary and frequency by location chart. For locations of past dredging operations, see the attached "Dredging and Disposal Site" charts for Pool 22. Approximately 25 percent of the 23.7 river miles of channel in Pool 22 has been dredged since 1945.

The Hannibal small boat harbor at mile 308.8 is maintained to a five-foot depth. The dredging quantities from 1965 have been:

| Year | Cubic Yards |
|---|---|
| 1965 | 14,160 |
| 1968 | 11,506 |
| 1972 | 3,697 |
| 1973 | 3,931 |

Areas of Recurrent and Recent Dredging - In Pool 22, of the twelve sites dredged in the past, seven are classified as non-recurrent and the following is recurrent or recent:

| Type | Site Name | UMR Mile Limits |
|---|---|---|
| Recent | L/D 21 Lower Approach | 323.6 - 324.7 |
| Recurrent | NE Mo Power | 319.8 - 320.5 |
| Recurrent | Beebe Island | 316.0 - 316.5 |
| Recurrent | Whitney Light | 313.2 - 313.7 |
| Recurrent | Turtle Island | 311.7 - 312.1 |
| Recurrent | Hannibal Boat Harbor | 308.8 |

### Hydraulics

Pool 22 has six major recurrent dredging areas, and are as follows:

River Mile 323.5 to 324.7, Lock and Dam 21 Lower Approach;

" Mile 319.5 to 320.5, Northeast Missouri Power;

" Mile 315.8 to 316.8, Beebe Island;

" Mile 312.6 to 314.3, Whitney Light;

" Mile 311.2 to 312.2, Turtle Island;

" Mile 302.0 to 303.5, Saverton.

The area between river mile 323.5 and 324.7 has been dredged more since 1969 than it has been during the earlier years of the nine-foot channel. At river mile 323.6 the river bifurcates and part of the flow of the Mississippi travels along the right bank behind Orton and Fabius Islands. This loss of flow at a critical turn in the river channel allows the velocities to be slowed and deposition to occur. During extremely high flows, the North, Middle, and South Fabius Rivers causes backwater to form above river mile 323.3 to Lock and Dam 21. This backwater effect also reduces velocities at this critical turn in the channel allowing deposition to occur. The wing dams, immediately downstream of Lock and Dam 21 and in the turn between Orton Island and the Illinois shore occurs, should be examined for adequacy.

The next area downstream, immediately below the mouth of the North and South River, is called Northeast Missouri Power, at river mile 320.0. The North River enters the main channel at river mile 321.1 and the South River enters the main channel at river mile 320.8. A portion of the Mississippi River flow passes behind Goose Island at river mile 320.5. Sediments from both the North and South River, as well as Fabius River sediments are carried down the bank channel slough between the Orton and Fabius Islands. These are dispersed into the main channel until the velocity is slow enough that deposition occurs. The main channel is narrow between Goose Island and the Missouri shore and deposition should not occur unless the wing dams have degraded and the velocities are not sufficient to carry the material downstream. The wing dams in the area between river mile 319.5 and 321 should be examined for adequacy.

The next area downstream in Pool 22 between river mile 315.8 and 316.8 is called Beebe Island. Recent surveys have shown that the water is quite deep at the lower end of Beebe Island and behind it. The upper end of the side channel behind Beebe Island is completely blocked by sediments at low-water stages. The depth of the water behind Beebe Island and the Illinois shoreline is generally good towards the upper end of the island where the sediment closure has occurred. Considerable dredging has been performed in this area, particularly through the decades of the 60's and the 70's. Ice jams are often reported between Whitney Island and Beebe Island and are a partial reason why deposition is occurring in this reach. Ice jams, increased velocities in the back channels, resuspending previously deposited sediments and placing them back in the main channel near the area where jams have occurred. It is recommended that an examination be made of the retaining structures along both the right bank and the left bank in this reach to determine if they are adequate to keep the material suspended. Continual accretion has been noticed during the last few years on the right bank of the channel between river miles 316 and 317. This accretion is occurring primarily on the inside of the bend, and because of this, a channel change was attempted in the late 1970's to return the channel to its original location. The success of this change, by dredging, is not entirely clear at this time.

The next area of dredging downsteam is at Whitney Island, located between river mile 312.6 and 314.3. Emergency dredging has been previously performed in this reach because of channel closeoffs. Flows in this reach are not only in the main channel but behind Whitney Island and Armstrong Island, which begins at mile 313.9. Ice jams normally occur at Whitney Island and immediately downstream of Whitney Island, and high flows have been observed between Whitney Island and the Missouri shoreline. Sediments from the back channel between Whitney Island and the Missouri shoreline are then moved out into the main channel and redeposited between river mile 314 and 314.5. Basically, nothing can be done for the elimination of ice jams in this area. However, the deposition problem will continue as these jams occur. An examination of Closing Dam No. 14 between Whitney Island and the Missouri shoreline is recommended to insure its adequacy, since many ice jams have occurred there. Every major flood has provided a sediment problem between river mile 312.6 and 314.0. A large amount of flow is passing between Armstrong Island and the Illinois shoreline. This flow re-enters the Mississippi between river mile 311 to 311.2 between Turtle Island and the Illinois shoreline. Because of the amount of water flowing between Armstrong Island and the Illinois shoreline, the velocities are slowed, thus, allowing deposition in the main channel. It is recommended that a closing dam be investigated for the upstream end of Armstrong Island, and Wing Dam No. 17 be examined to determine whether it is at design grade. This wing dam is important to direct the flow downstream between river mile 314 and 313. However, if the wing dams along the left bank or the right bank between river mile 313 and 314 are not at the length and grade in which they were designed, the velocities would be reduced and sedimentation would result.

Between river mile 311.2 and 312.2 is an area called Turtle Island. Flows of the Mississippi River which are re-entering the main channel from behind Armstrong Island at approximately river mile 311 to 311.2. In addition, at river mile 311.6 and 311.7 flows are also passing behind Glaveus Island in Stillwell Slough. The loss of flow in Stillwell Slough, and the backwater effect from water behind Turtle Island re-entering the Mississippi, has slowed the water sufficiently in this reach to allow deposition is occurring between 311.5 and 312.0. The adequacy of Wing Dam No. 12, just upstream from Stillwell Slough, should be examined.

The next area downstream is called Saverton, river mile 302.0 to 303.5, and has been dredged a number of times under emergency conditions. Both in 1973 and 1979 emergency conditions required that a dredge from St. Louis was brought in to make an emergency opening in the channel so that traffic could move through this reach. The channel conditions in the Mississippi River at mile 302 to 303.5 have changed drastically in the last six years. The majority of the flow has been passing along the Illinois shoreline. During a survey of 29 August 1979, the depth of water along the Illinois shore was found to be 24 to 29 feet deep while the water in the main channel was only 10 to 15 feet deep. Large shoals have been extending downstream from approximately Wing Dam No. 17 to river mile 302.5, growing in size each year downstream as far as Wing Dam No. 11. Surveys made in September of 1979 continue to show closeoff conditions beginning at river mile 302.5. This area is near the towhead of Island 445 and closeoffs from depths of 20 feet to depths of less than 5 feet were observed. Flows between Island 445 and the Illinois shore are significant and carry much of the flow which is needed in the main channel to keep sediments moving through the reach. Closing Dam No. 2 has been degraded so that water depths between 8 and 18 feet are common across the dam. This closing dam needs to be raised to between 3 and 5 feet below flat pool water surface so that much more flow can be redirected into the main channel. It is recommended that Closing Dam No. 2 be raised and the wing dams along the left bank and the right bank be examined to determine their adequacy.

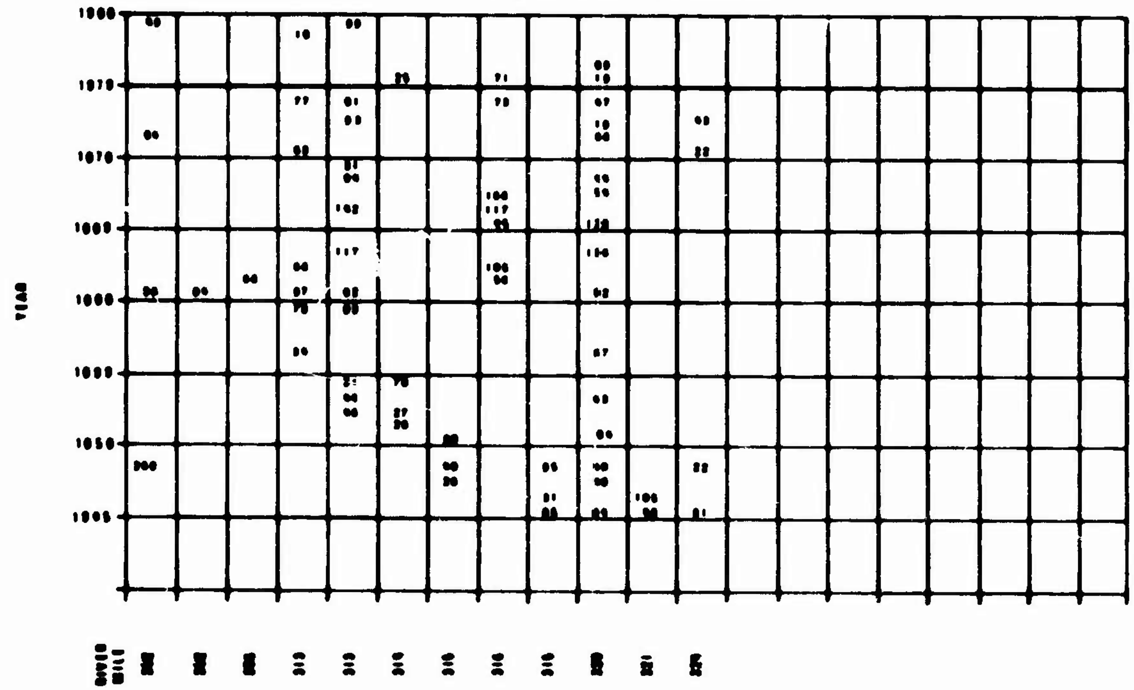
Future Dredging - In Pool 22, there are eight sites that have been further identified as "chronic" dredging areas for the next 50 years, based on expected river conditions, dredging requirements and practices. These sites, their expected quantities and frequencies of dredging are shown below:

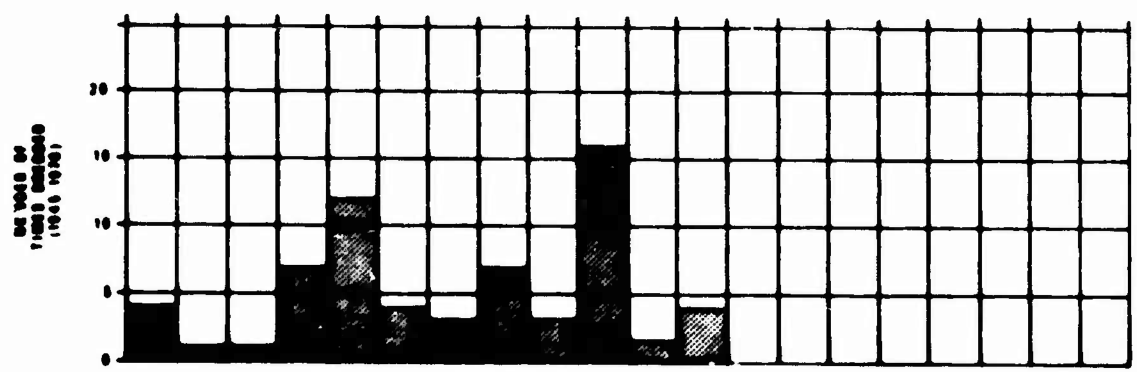
| Location UMR Mile No. | Site Name | Frequency (Years) | Cubic Yards Per Dredging | Frequency (10 Years) | Cubic Yards (10 Years) | Frequency (50 Years) | Cubic Yards (50 Years) |
|---|---|---|---|---|---|---|---|
| 323.5-324.7 | L/D 21 Lower Approach | 1 in 8 | 25,000 | 1.25 | 31,250 | 6.25 | 156,250 |
| 319.5-320.5 | NE MO Power | 1 in 4 | 40,000 | 2.5 | 100,000 | 12.5 | 500,000 |
| 315.8-316.8 | Beebe Island | 1 in 6 | 30,000 | 1.7 | 51,000 | 8.5 | 255,000 |
| 312.6-314.5 | 1)Whitney Light | 1 in 7 | 30,000 | 1.4 | 42,000 | 7.0 | 210,000 |
| 311.2-312.2 | Turtle Island | 1 in 5 | 25,000 | 2.0 | 50,000 | 10.0 | 250,000 |
| 302.0-303.5 | Saverton | 1 in 5 | 35,000 | 2.0 | 70,000 | 10.0 | 350,000 |
| 300.3-300.4 | L/D 22 Lower Approach | 1 in 10 | 15,000 | 1.0 | 15,000 | 5.0 | 75,000 |
| 308.8 | Hannibal Boat Harbor | 1 in 4 | 1,000 | 2.5 | 2,500 | 12.5 | 12,500 |

1) At Whitney Light and Turtle Island, the channel will be maintained narrower in the future than it has been in the past.

Projected Dredge Material Quantities - Projection for the next 50 years, based on the average of past quantities dredged is shown in Chart 22B, Plate 58, "Projected Dredging". The total quantity of material dredged in Pool 22 is expected to be approximately 1.796 million cubic yards, based on the last 35-year average. This amount is slightly less than the quantity dredged in the last 20 years.

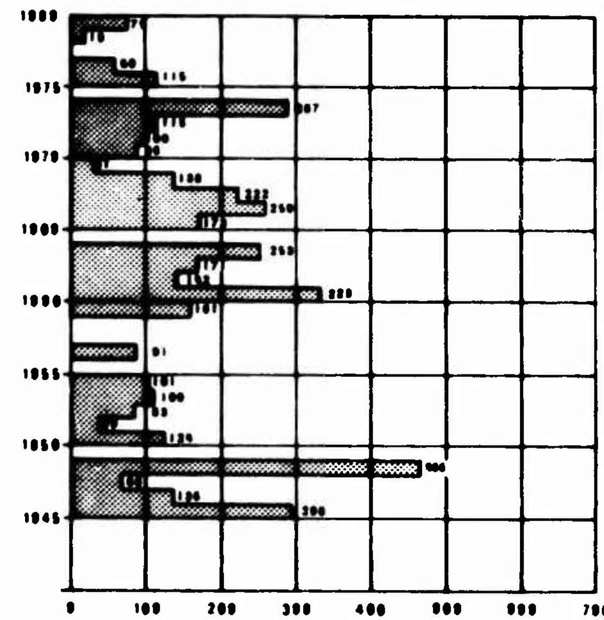
ANNUAL DREDGED VOLUMES BY LOCATION
(1,000 CUBIC YARDS)





DREDGE FREQUENCY BY RIVER MILE LOCATION

ANNUAL SUMMARY OF DREDGED VOLUME

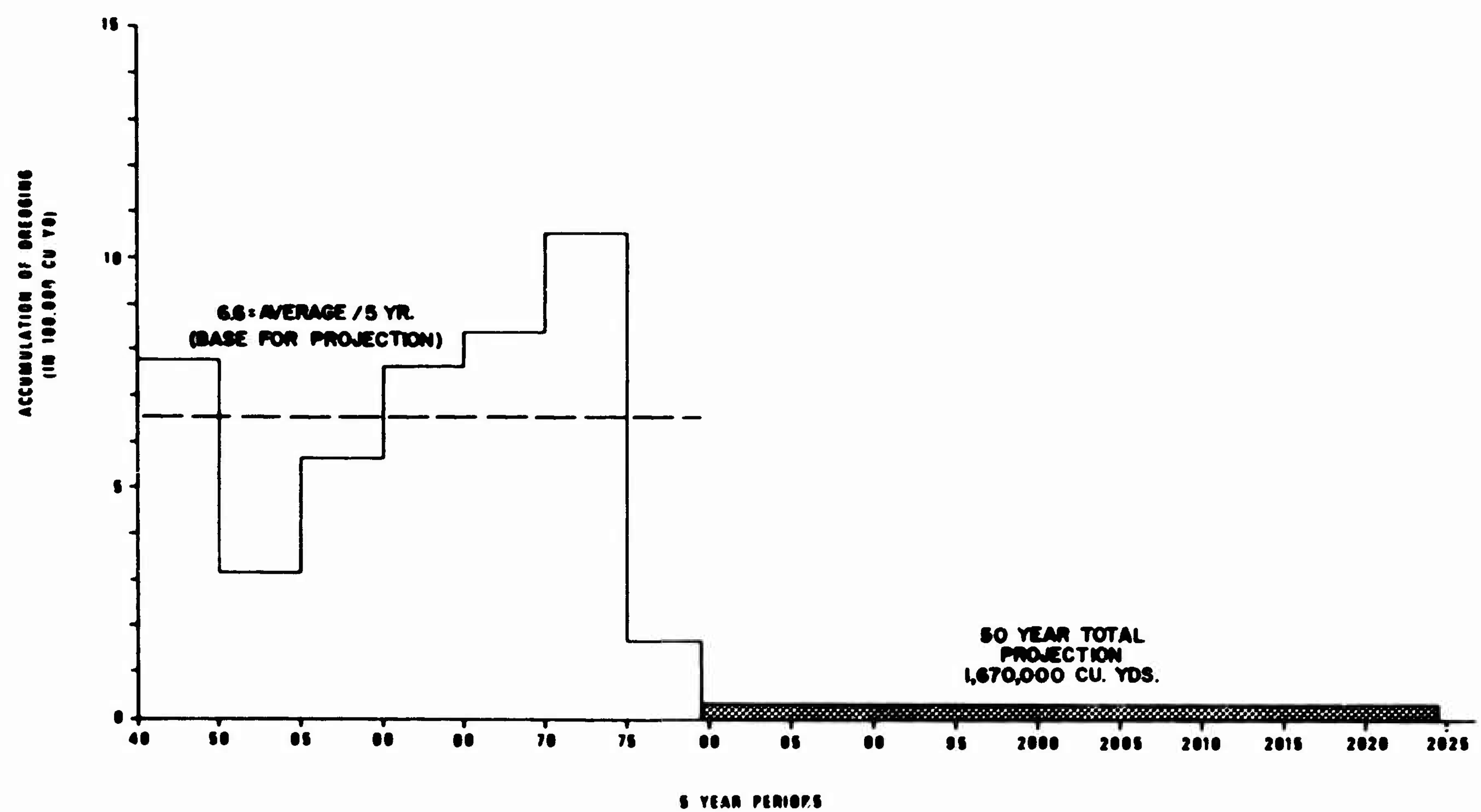


VOLUME DREDGED
(1,000 CUBIC YARDS)

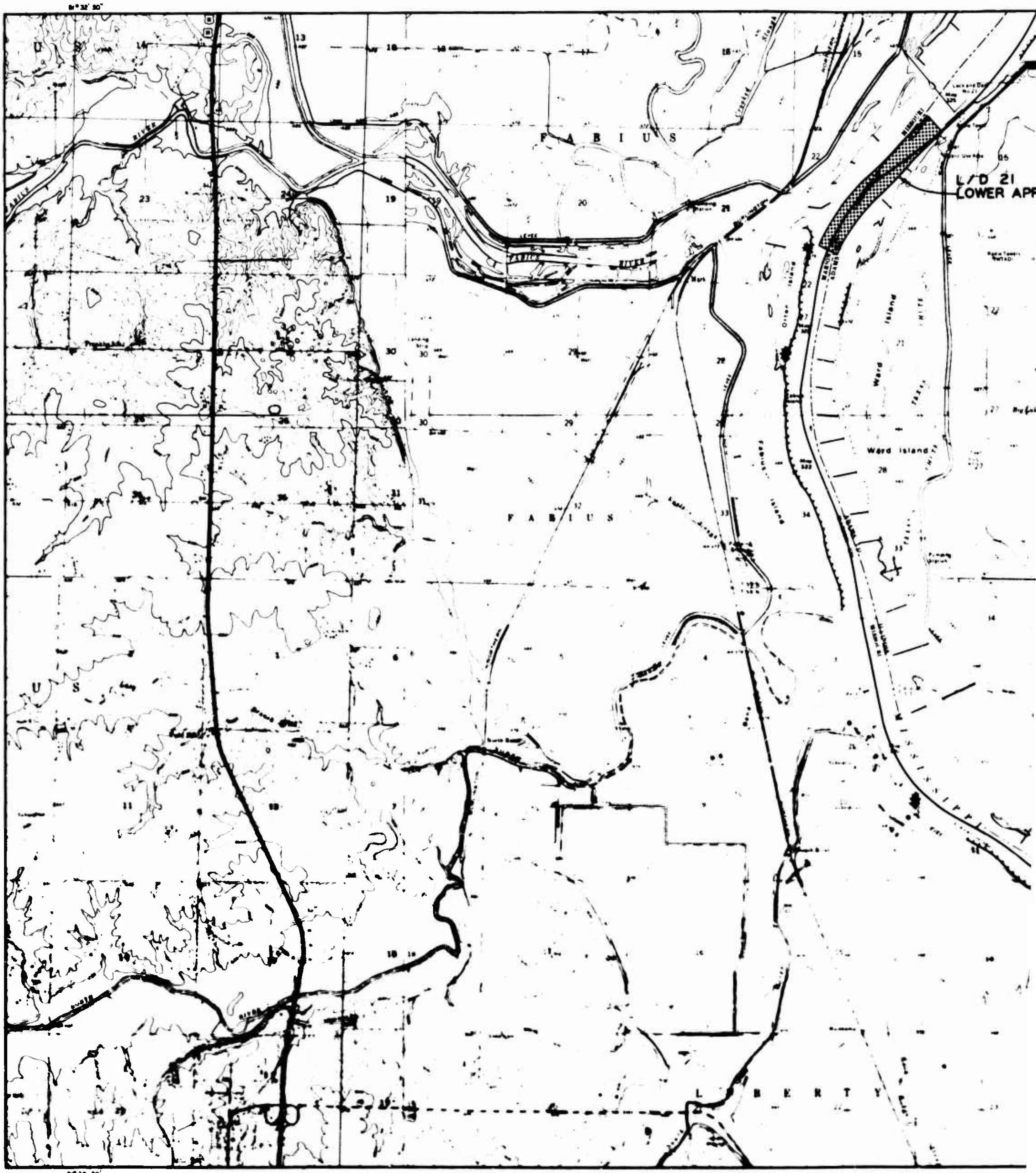
CHART 22A
EXTENT AND FREQUENCY
OF DREDGING
POOL 22

## CHART 22B – PROJECTED DREDGING POOL 22

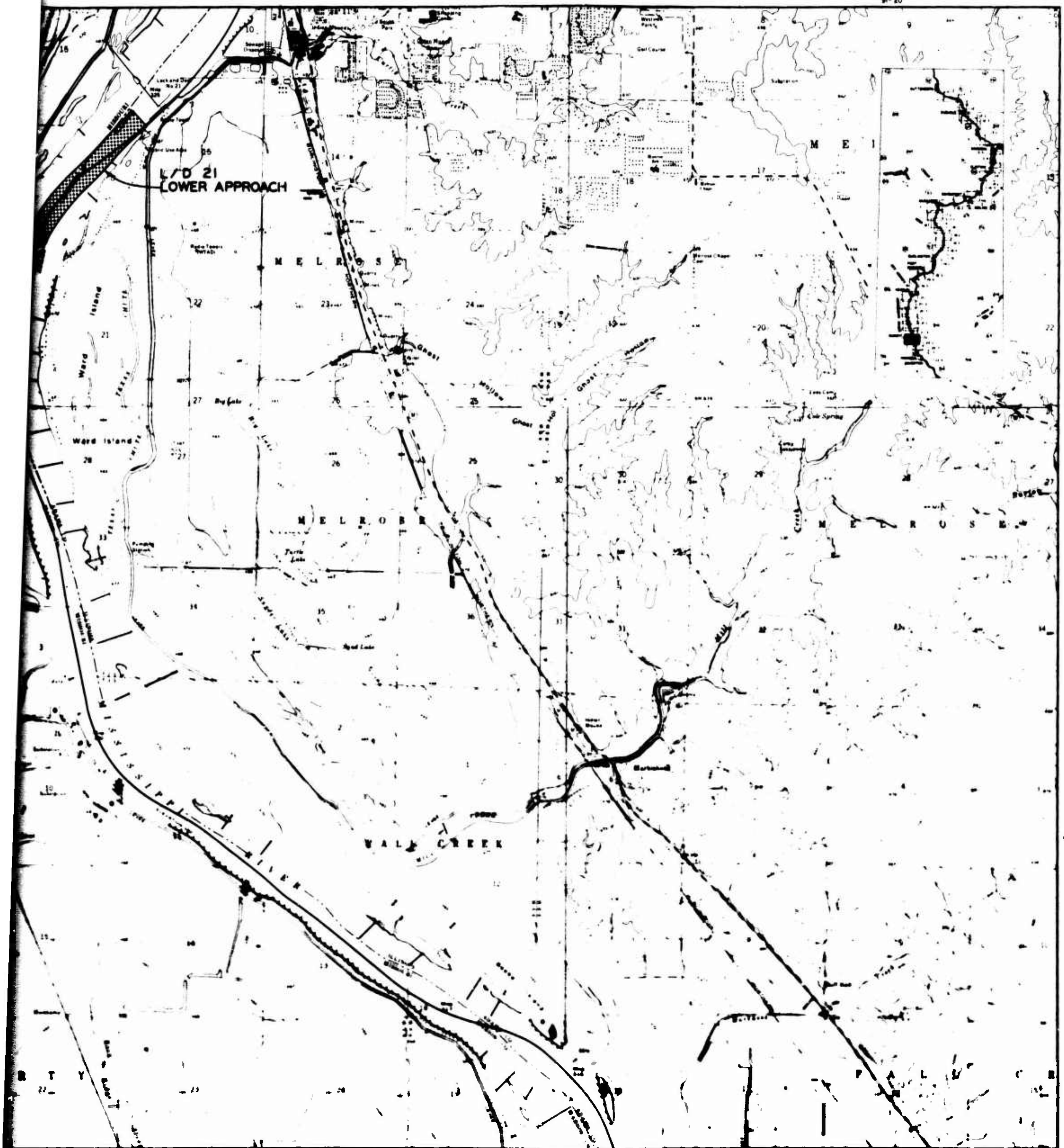
CHANNEL DREDGING PROJECTION



# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
### (POOL 22 — LOCK AND DAM 21 TO MILE 318)



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 22 — MODULE 1)

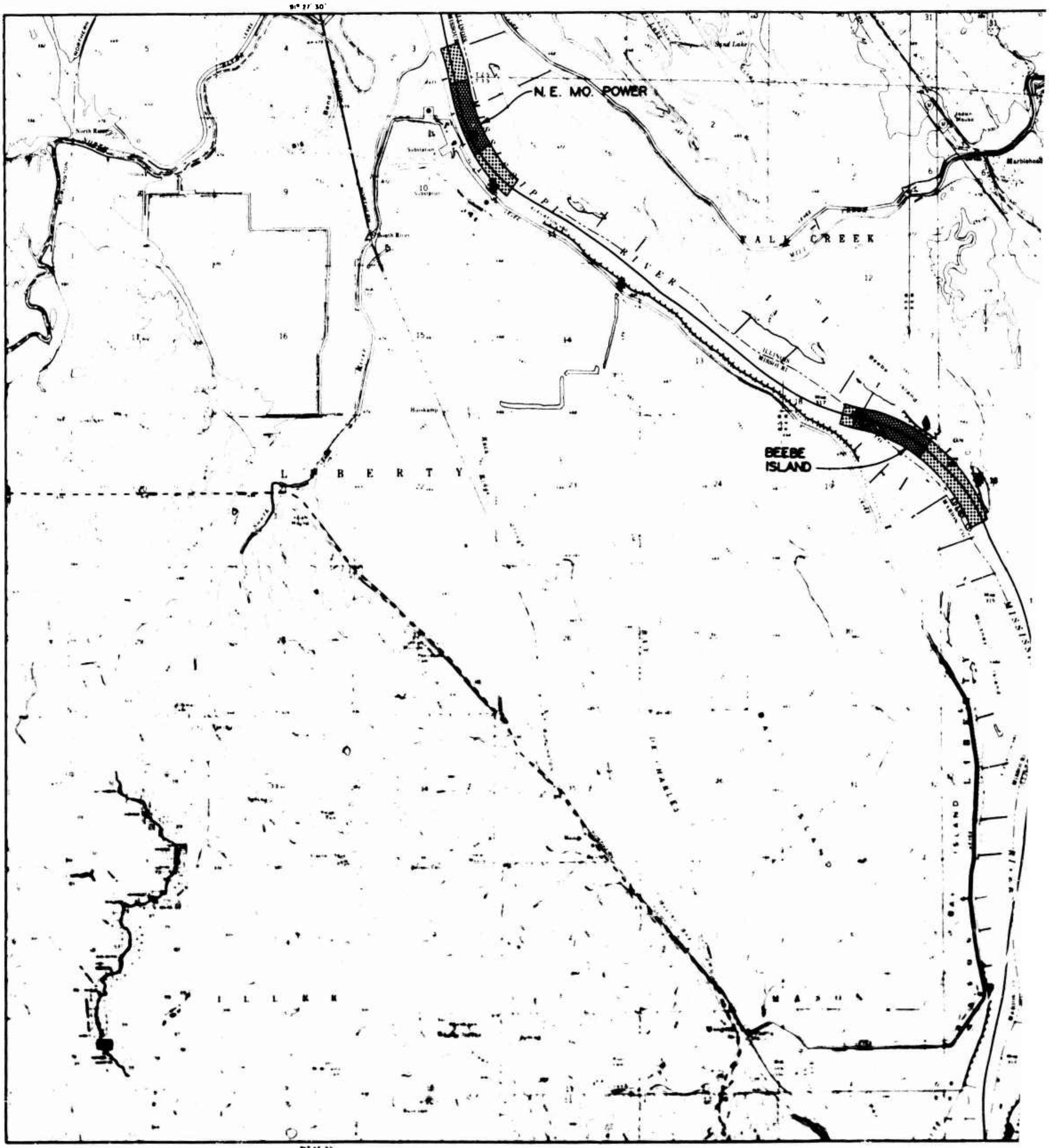



LEGEND

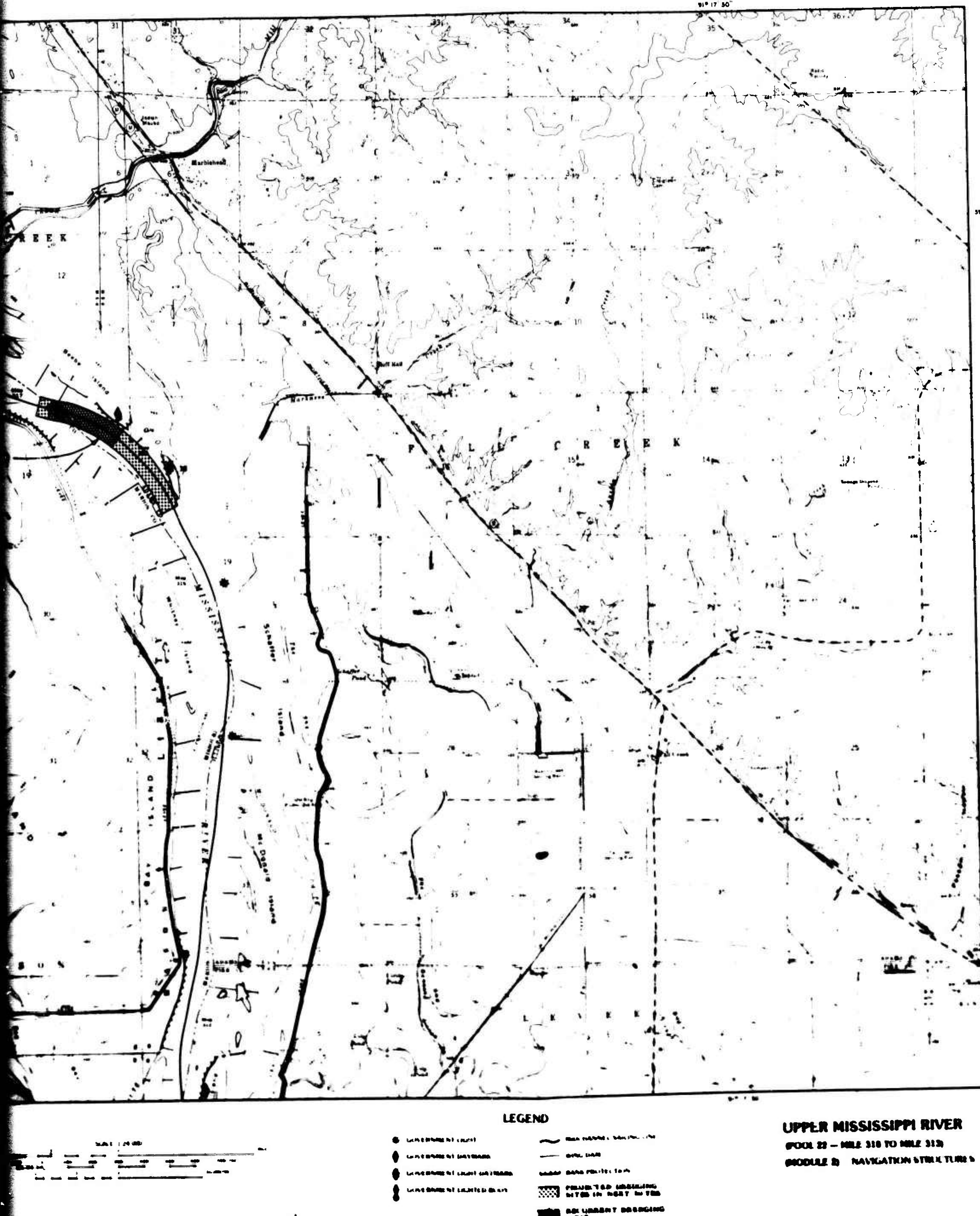
UPPER MISSISSIPPI RIVER
(POOL 22 — LOCK AND DAM 21 TO MILE 310)
(MODULE 1) NAVIGATION STRUCTURES

PLATE 59

**GREAT RIVER ENVIRONMENTAL ACTION TEAM**
**UPPER MISSISSIPPI RIVER (GREAT II)**
**(POOL 22 — MILE 318 TO MILE 313)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 22 — MODULE 2)

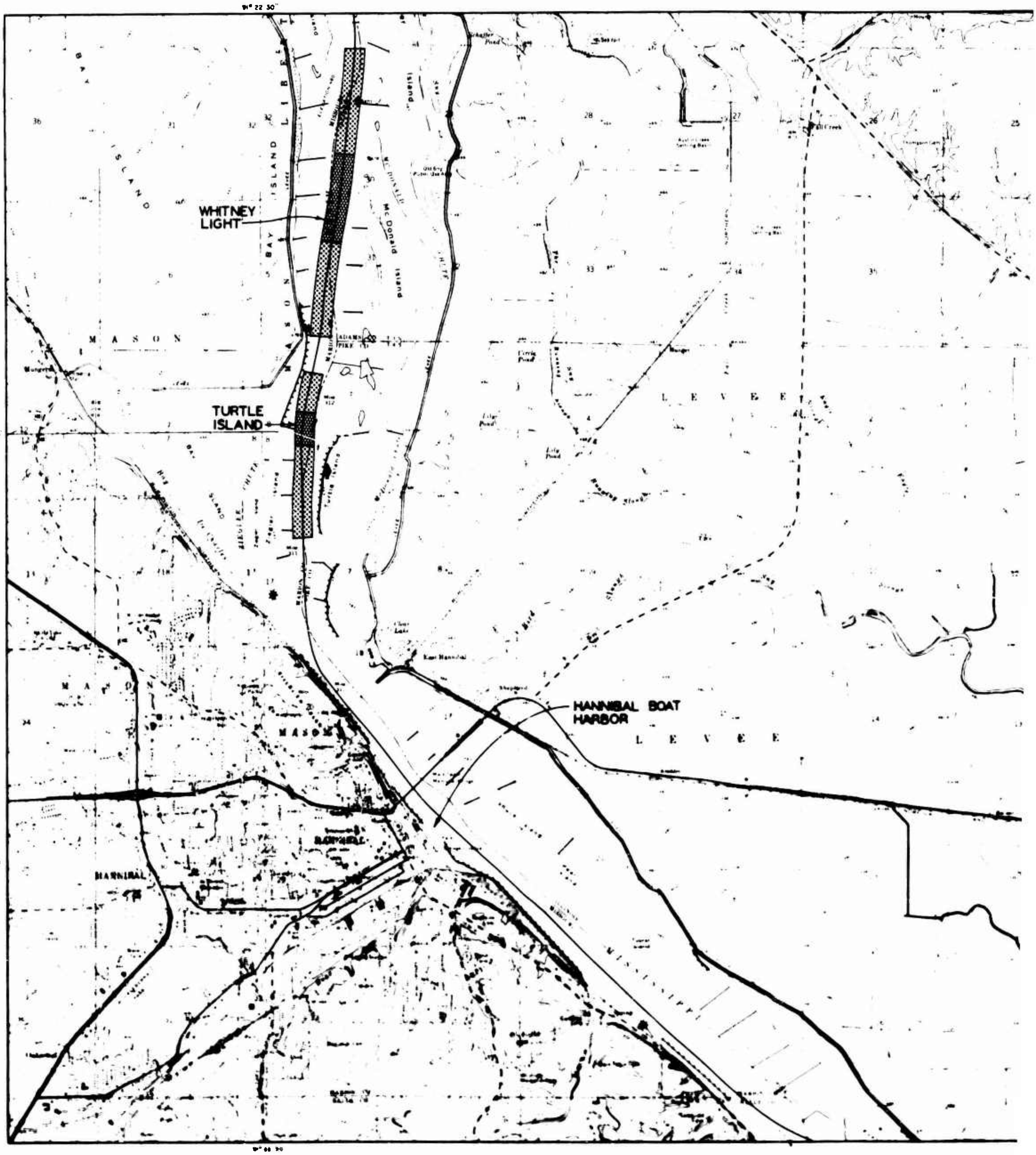



**UPPER MISSISSIPPI RIVER**
(POOL 22 — MILE 310 TO MILE 313)
(MODULE 2) NAVIGATION STRUCTURES

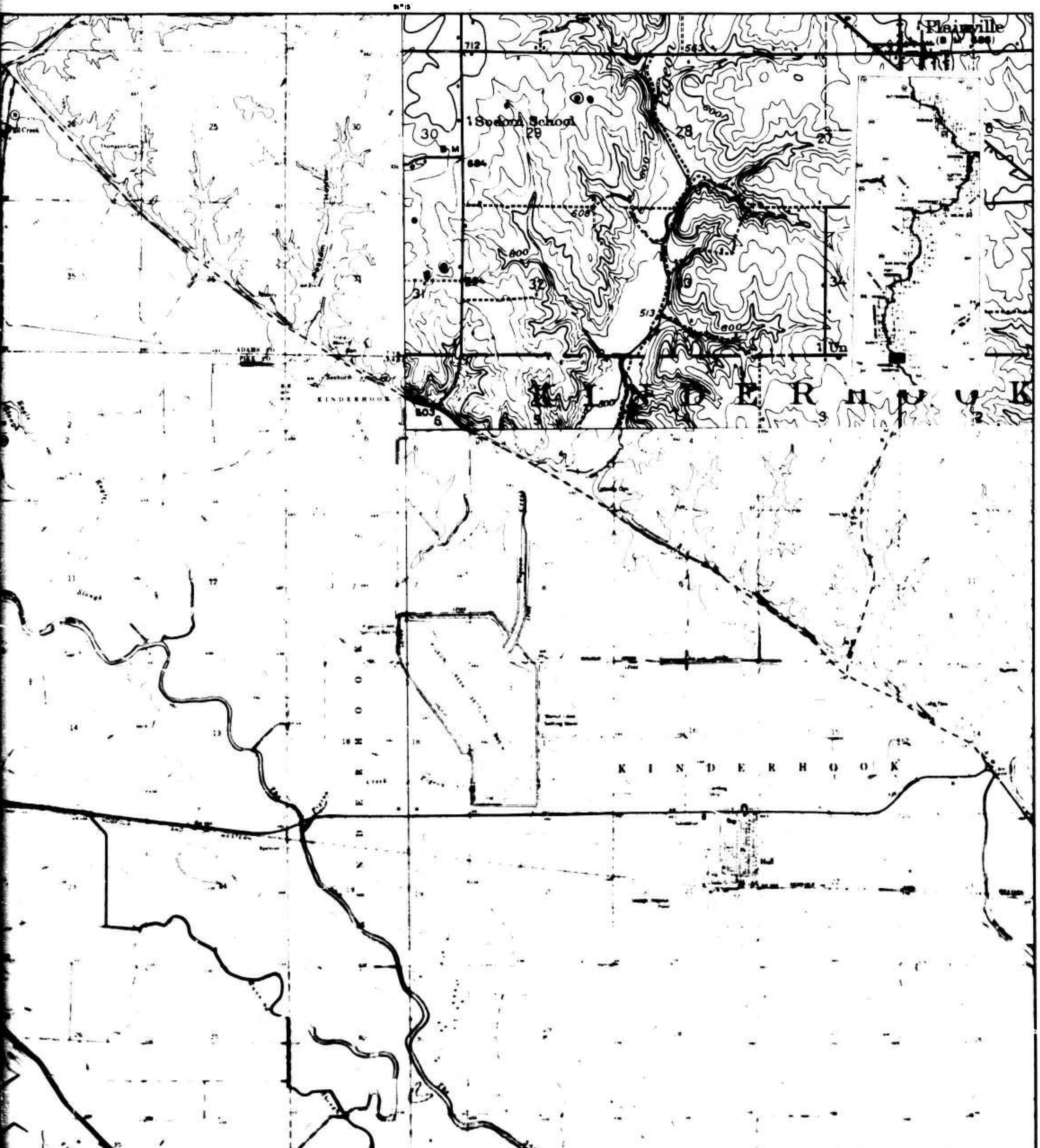
**PLATE 60**

## GREAT RIVER ENVIRONMENTAL ACTION TEAM
## UPPER MISSISSIPPI RIVER (GREAT II)

**(POOL 22 — MILE 313 TO MILE 306)**



# UPPER MISSISSIPPI RIVER ENVIRONMENTAL ATLAS
(POOL 22 — MODULE 3)




LEGEND

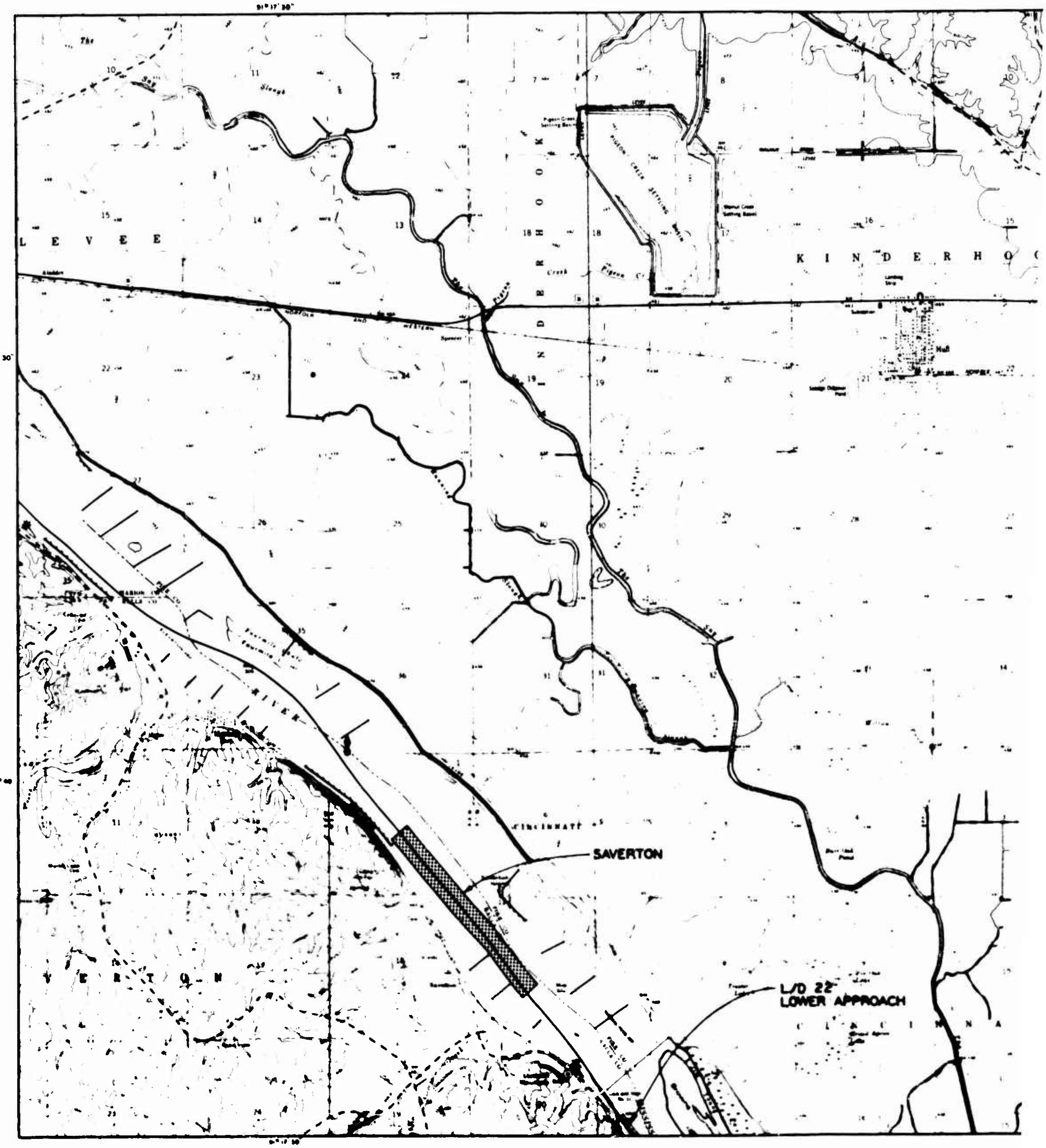
- GOVERNMENT LIGHT
- GOVERNMENT DAYMARK
- GOVERNMENT LIGHT DAYMARK
- GOVERNMENT LIGHTED BUOY
- CHANNEL SAILING LINE
- WING DAM
- BANK PROTECTION
- PROJECTED DREDGING SITES IN NEXT 10 YRS
- RECURRENT DREDGING SITES

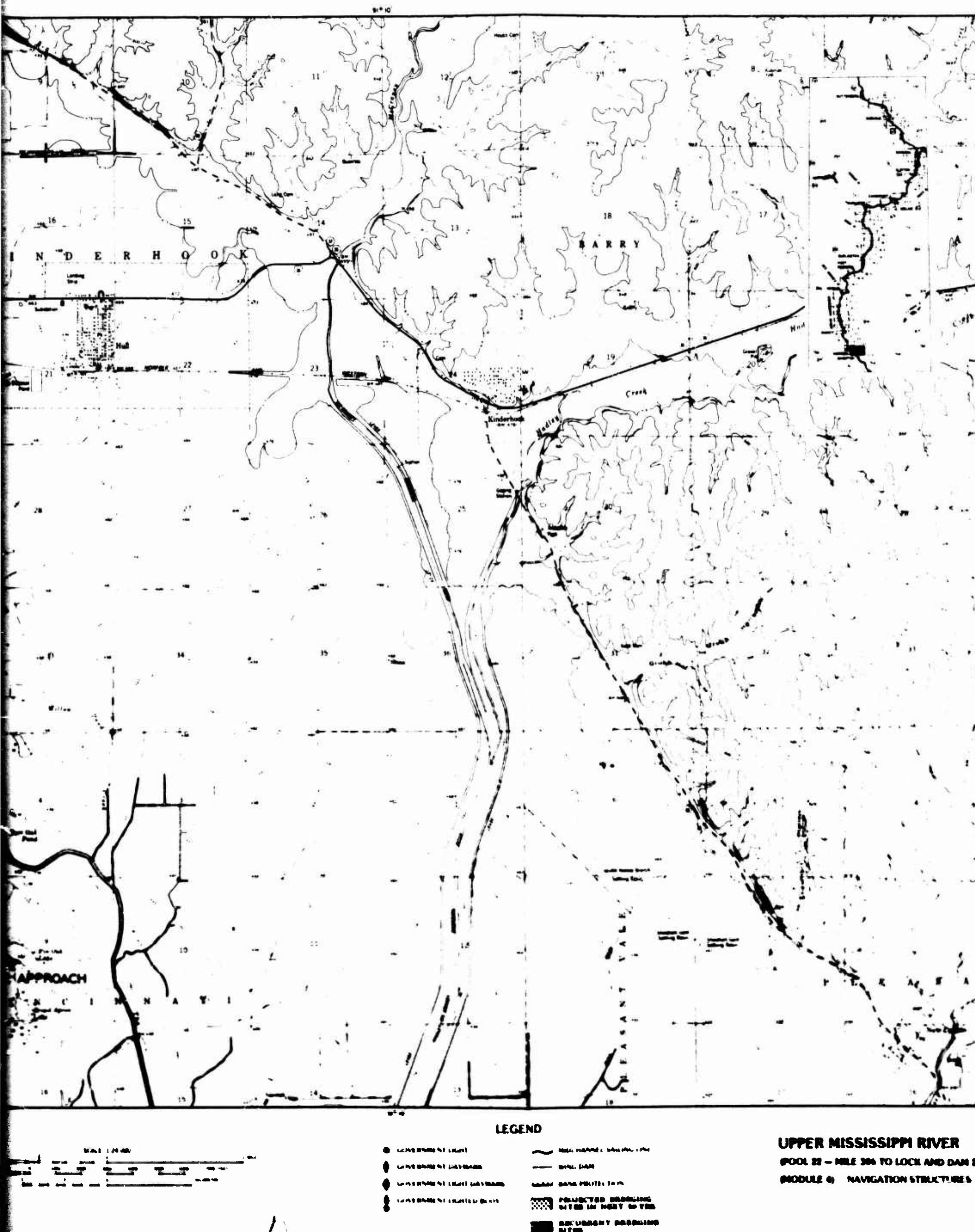
**UPPER MISSISSIPPI RIVER**
(POOL 22 — MILE 313 TO MILE 300)
(MODULE 3) NAVIGATION STRUCTURES

2

**PLATE 61**

# GREAT RIVER ENVIRONMENTAL ACTION TEAM
# UPPER MISSISSIPPI RIVER (GREAT II)
### (POOL 22 – MILE 306 TO LOCK AND DAM 22)






UPPER MISSISSIPPI RIVER
(POOL 22 — MILE [illegible] TO LOCK AND DAM 22)
(MODULE 4) NAVIGATION STRUCTURES

PLATE 62

# V - SUMMARY

# V - SUMMARY

The following is a summary of the twenty problems shown on Attachment #1 that the work group was to address during the study period.

## SUMMARY

Problem 1: There is a need to deterine sites that are available for placement of dredge material.

Task(s):
Work group participation on GREAT II disposal site selection task force.
Work group input to other work groups.

Results and Conclusions of Task(s):
The Corps of Engineers should dispose of dredged material at disposal sites recommended in the GREAT II channel maintenance plan. Selection of future disposal sites should utilize guidelines for disposal site selection established by GREAT II.

Recommendation:
#4001 - Dredge material should be disposed of by the Corps of Engineers by utilizing existing and new disposal sites following guidelines established by GREAT II.

Implementation Requirements:
The Corps of Engineers is to be the lead implementing agency. The Corps should coordinate with Federal and state environmental and conservation agencies when establishing new disposal sites utilizing guidelines established by GREAT II.

Problem 2: There is a need to reduce, as much as possible, the quantity of material dredged each dredging occurrence, short term.

Task(s):
Work group reviewed dredging records.
Work group meeting and discussions.
Input from other work groups.

Results and Conclusions of Task(s):
The present method of laying out dredge cuts on detailed hydrographic surveys to find the location, depth, and width of the best channel to minimize dredging requirements and the realigning of buoys as necessary to maintain a safe channel is utilizing the best method to reduce the quantity of material each dredging occurrence for the short term.

Recommendation:
#4002 - To reduce the quantities of material dredged each dredging occurrence in the short term, detailed hydrographic surveys of each prospective dredge site needs to be done to find the location, depth, and width of the best channel for that reach of the river to minimize the amount of dredging required. Navigation buoys should be realigned as necessary by the Coast Guard and they should be supported by the Corps of Engineers personnel and equipment to assure a safe and navigable channel. Buoys should be realigned to where the channel might stabilize as determined by the Corps of Engineers.

Implementation Requirements:
The Corps of Engineers is to be the lead agency for conducting hydrographic surveys and laying out dredge cuts, which is a continuation of present policy. The US Coast Guard is to be the lead agency for the realignment of the channel buoys, which is the present policy. The assistance provided by the Corps of Engineers would supplement the US Coast Guard, with buoys being moved after consultation with the US Coast Guard.

Problem 3: Definition of a nine-foot channel.

The definition of a nine-foot channel was addressed by Commercial Transportation Work Group Recommendation #5501.

Problem 4: Determine the effect of a nine-foot channel and dredging requirements.

As written, this is not a problem.

Problem 5: There is a need to determine the flow vs. depth vs. dredging requirements relationships.

Task(s):
Sediment transport model study conducted by University of Iowa, Iowa Institute of Hydraulic Research.

Results and Conclusions of Task(s):
Existing one-dimensional and two-dimensional sediment transport models have been tested for use in the GREAT II reach of the Mississippi River. However, due to the lack of basic data, no model has been calibrated for use in the GREAT II reach of the Mississippi River.

Recommendation:
#4003 - The Corps of Engineers should calibrate the existing two-dimensional sediment transport model to assess the regulatory structures effectiveness and further needs near chronic dredge cut areas and use the model to determine the optimum channel size for a given reach of the river, knowing the flow and depth conditions that exist there.

Problem 6: There is a need to determine the relationship between pool levels and dredging requirements.

Pool levels cannot be varied due to real estate.

Problem 7: There is a need to determine the relationship between channel width requirements vs. tow size.

The Corps is responsible for maintaining a 300-foot wide channel, therefore, as written, this is not a problem.

Problem 8: There is a need to determine the relationship between river traffic and dredging requirements.

At the present time, this is not a problem in the GREAT II reach of the Mississippi River.

Problem 9: The environmental and hydrological impacts of riverine disposal of dredge material are unknown.

Task(s):
Main channel disposal scope of work project.

Results and Conclusions of Task(s):

Recommendation:

Implementation Requirements:

Problem 10: There is a need for long-term reduction of dredging requirements through evaluation of the hydraulic factors of the river as they relate to navigation and channel maintenance.

Task(s):
Sediment tranport model study.
Review of dredging records.
Main channel disposal scope of work project.
Regulating structures assessment study by Corps of Engineers.

Results and Conclusions of Task(s):
The Corps of Engineers, Rock Island District, has established a committee for the assessment of regulatory structures. This committee will assess the regulatory structures within the GREAT II reach of the river. The committee will inventory the structures and evaluate existing regulatory structures for their effectiveness to keep sediments moving in the channel. The committee should use physical and mathematical models to determine the need for regulatory structures in chronic dredge areas, with the goal of long-term reduction of dredging requirements through evaluations of river hydraulics.

Recommendation:
#4006 - Corps of Engineers, Rock Island District, Committee for the Assessment of Regulatory Structures (CARS), should be adopted as a permanent means to evaluate regulatory structures and physical and mathematical models should be utilized to determine the need for regulatory structures in chronic dredge areas, with the goal of long-term reduction of dredging requirements through evaluation of river hydraulics.

Implementation Requirements:
The Corps of Engineers would be the lead agency. The Corps should coordinate with Federal and state environmental and conservation agencies when constructing or reconstructing regulatory structures.

Problem 11: There exists insufficient capability to maintain all of the navigation aids on the Mississippi River.

The maintenance of the navigation aids is the responsibility of the US Coast Guard and is addressed in Commercial Transportation Work Group appendix.

Problem 12: There is a need to determine the impacts of barge traffic on channel stability.

This is not a problem in the GREAT II reach of the Mississippi River.

Problem 13: There is little time between the identification of sites requiring dredging and when dredging is accomplished, for coordinating review and permit approval.

This will be a problem in the GREAT II reach of the Mississippi River depending on flows in the river because the river flows have to be stabilized before detailed hydrographic surveys can be made to find out if areas need to be dredged.

Problem 14: What are the possible impacts of contract dredging on capabilities.

Task(s):
Work group meetings and discussions.
Input from other work groups.

Results and Conclusions of Task(s):
Under the industry capability program, the Corps of Engineers is to contract channel maintenance dredging to the private sector where the dredging industry has the capability to perform. The Rock Island District, Operations Division, has met with dredging industry representatives and have been assured that they are interested in performing the District's channel maintenance dredging. The industry representatives indicate they would like a guaranteed quantity of dredging before contract agreed upon. The Rock Island District is going to contract the District's 1980 channel maintenance dredging. The industry may or may not have the equipment capability to meet the time constraints required to meet the dredging schedule.

Recommendation:
#4007 - Corps of Engineers should determine the optimum location to maintain dredge equipment for emergency and spot dredging and attempt to contract out the average annual amount of dredging to the private sector (i.e., chronic areas, boat harbors).

Implementation Requirements:
The Corps of Engineers should implement present policy and perform further studies to determine District's needs for emergency and spot dredging.

Problem 15: There is a need to determine equipment needs.

The Materials and Equipment Needs Work Group is addressing this in the M&ENWG appendix.

Problem 16: Dredged material disposal sites and secondary movement of material.

Task(s):
Work group discussions.
GREAT II disposal site selection task force.
Input to and from other work groups.

Results and Conclusion of Task(s):
There has been a secondary movement of dredged material from disposal sites and this will continue to be a problem in areas where disposal sites are exposed to flood waters. The Corps of Engineers should follow guidelines established by GREAT II for disposal site selection and disposal site containment and erosion control.

Recommendation:
#4001 - Dredge material should be disposed of by the Corps of Engineers by utilizing existing and new disposal sites following guidelines established by GREAT II.

Implementation Requirements:
The Corps of Engineers is to be the lead agency. The Corps should coordinate with Federal and state environmental and conservation agencies when establishing new sites.

Problem 17: What solution, if any, has come from the University of Iowa on Fox Island Study in Pool 20.

Task(s):
Study by Iowa Institute of Hydraulic Research, University of Iowa.

Results and Conclusions of Task(s):

The results of the University of Iowa study is tha the regulating structures need to be reconstructed to their original design grade.

Recommendation:
#4009 - The back channel closure structures near Fox Island in Pool 20 should be modified to reduce dredging in the main channel.

Implementation Requirements:
The Corps of Engineers should include this work in their maintenance plan.

Problem 18: A gentleman had a problem with the Corps of Engineers building a closing dam behind Fox Island. He feels that it will cut off all the flow into the backwater area, Gray Chute. Is there some other alternative for keeping the flow in the channel without depriving the backwaters?

There is no other alternative method to keep the flow in the main channel at Fox Island and the closing dam must be rebuilt.

Problem 19: Current regulatory laws may inhibit maintenance of a safe navigation channel.

Task(s):
Work group meetings and discussions.

Results and Conclusions of Task(s):
The four states, Illinois, Iowa, Missouri, and Wisconsin, that bound the GREAT II reach of the Mississippi River have different regulatory laws for dredging, dredge material disposal, and permitting requirements. They also have different department regulations for the definition of emergency dredging and time frame for permit actions. The Corps of Engineers has to coordinate the channel maintenance dredging and disposal with each state and obtain permits from each state for the dredging occurrences in each respective state. The Corps has to wait until the flow stabilizes in the river, normally in the middle of June, before accurate hydrographic surveys can be obtained of the areas where maintenance dredging may be required. Hydrographic surveys are performed from mid-June through August. An increase in the flow characteristics in the river will change the bottom on the river requiring new hydrographic surveys before a determination can be made if maintenance dredging is required. Maintenance dredging is normally performed during September and October. Due to the short time frame between when the river stabilizes and the performance of maintenance dredging, there is a problem of having the proper state permits and satisfying Section 404(t) in a timely manner. The state of Iowa has given the Corps a definition of emergency dredging which the states of Illinois and Missouri seem to agree with. However, within the boundary of the state of Wisconsin, the Corps cannot perform emergency dredging without a determination from the Secretary of the Army. In order for the Corps to perform its mission of maintaining the Mississippi River navigation channel, the states in the GREAT II reach of the river need to streamline their permitting process and have consistent laws relating to dredging and dredge material disposal.

Recommendation:
#4011 - The states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, should develop and implement a compact, based on the GREAT II report, to guide regulatory laws relating to dredging, dredge material disposal, definition of emergency dredging, permitting requirements, and time frame for permit actions.

Implementation:
The states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, will have to take the lead in implementing this recommendation.

Problem 20: Curent conditions of the regulatory structures in unknown.

Task(s):
Sediment transport model.
Work group meetings and discussions.
Regulating structures assessment study by Corps of Engineers.

Results and Conclusions of Task(s):
The Corps of Engineers, Rock Island District, has established a committee for the assessment of regulatory structures. This committee will assess the regulatory structures within the GREAT II reach of the river. The committee will inventory the structures and evaluate existing regulatory structures for their effectiveness to keep sediments moving in the channel. The committee should use physical and mathematical models to determine the need for regulatory structures in chronic dredge areas, with the goal of long-term reduction of dredging requirements through evaluation of river hydraulics.

Recommendation:
#4006 - Corps of Engineers, Rock Island District, Committee for the Assessment of Regulatory Structures (CARS), should be adopted as a permanent means to evaluate regulatory structures and physical and mathematical models should be utilized to determine the need for regulatory structures in chronic dredge areas, with the goal of long-term reduction of dredging requirements through evaluation of river hydraulics.

#4012 - The Corps of Engineers should initiate the recommended regulatory structures studies at the thirty potential "recurrent" dredging sites throughout the Rock Island District reach of the river as part of the CARS program as their number one priority.

Implementation Requirements:
The Corps of Engineers would be the lead agency. The Corps should coordinate with Federal and state environmental and conservation agencies when construction or reconstructing regulatory structures.

# VI - BIBLIOGRAPHY

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Nakato, Tatsuaki and Kennedy, John F., 1977, Field Study of Sediment Transport Characteristics of the Mississippi River Near Fox Island (R. M. 355-6) and Buzzard Island (R. M. 349-50), US Army Corps of Engineers, Rock Island District, Contract No. DACW25-76-C-0037.

Nakato, Tatsuaki and Vadral, John L., 1980, Field Data Collection and Evaluation of Four One-Dimensional Sediment Transport Numerical Models for Pool 20, of the Mississippi River, US Army Corps of Engineers, Rock Island District, Contract No. DACW25-78-C-0067.

Nakato, Tatsuaki, Baker, Richard M., and Kennedy, November 1979, Mississippi River Shoaling: A Diagnostic Study Journal of the Hydraulics Division, ASCE, Vol. 105, No. HY 11, Proc. Paper 14978, p.p. 1375-1391.

Simons, D. B., Chen, Y. H., Lagasse, P. F., and Schumm, 1976, A Summary of the River Environment, USDI, FWS. Twin Cities, Minnesota, Contract No. CER 75-76 DBS-YHC-PFL-SAS-18.

Ramberg, John S., 1975, Prediction of Dredging Sites and Amounts for the Year 1975, US Army Corps of Engineers, Rock Island District.

Simons, D. B., and Chen, Y. H., 1980, Planning of a Demonstration Project for Main Channel Disposal of Dredged Material, US Army Corps of Engineers, Rock Island District, Contract No. DACW25-80-C-0017.

# VII - APPENDICES

A - GLOSSORY

A - GLOSSARY

Aggradation - A process of raising a land surface by the deposition of sediment.

Alluvial Channel - A channel whose bed is composed of noncohesive sediment that has been or can be transported by the flow.

Alluvium (Alluvial Deposit) - Clay, silt, sand, gravel, pebble, or other detrital material deposited by water.

Backwater - Water backed up or retarded in its cource as compared with its normal or natural conditon of flow. In stream gaging, a rise in stage produced by a temporary obstruction, such as ice or weeds, or by the flooding of the stream below.

Backwater Curve - A longitudinal profile of the water surface in a stream where the water surface is raised above its normal level by a natural or artificial obstruction.

Bank - The margins of a channel. Banks are called right or left, as viewed facing the direction of the flow.

Bankfull Stage - The stage at which a stream first overflows its natural bank.

Bars - Bed forms having lengths of the same order as the channel width or greater, and heights comparable to the mean depth of the generating flow.

Bars, Middle (or Transverse) - Bars occuring in straight channels and occupying the full channel width.

Bars, Point - Bars occuring adjacent to the convex bank of channel bends.

Bars, Tributary - Bars occuring immediately downstream from points of lateral inflow into a channel.

Bed (Streambed) - The bottom of a water course.

Bed Configuration - A complex of bed forms covering the bed of an alluvial stream.

Bed Form - A generic term used to denote any irregularity produced on the bed of an alluvial channel by flowing water and sediment.

Bed Layer - A flow layer, several grain diameter thick (usually taken as two grain diameter thick) immediately above the bed.

Bed Load - That part of the total sediment load that moves by rolling or sliding along the bed. The term "bed load" may be used to designate either coarse material moving on or near the bed, or material collected in or computed from samples collected in a bed load sampler or trap. In other words, load which is not sampled by a suspension load sampler.

Bed-Load Discharge - The quantity of bed load passing any cross section of a stream in a unit of time.

Bed-Load Discharge Sampler - A device to measure the discharge of bed load over part or all of the stream width.

Bed Material - The material of which a streambed is composed.

Bed-Material Discharge - A sediment discharge that consists of particles large enough to be found in appreciable quantities in the streambed.

Bed-Material Load - That part of the total sediment load which is composed of grain sizes represented in the bed -- equal to the transport capacity of the flow

Beneficial Use Site - An area where dredged material is temporarily stored until it can be used for some purpose outside the flood plain.

Benthic Community - A group of plants or animals living in or on the streambed.

Braiding of River Channels - The successive division and rejoining (of riverflow) with accompanying islands is the important characteristic denoted by the synonymous terms, braided or anastomosing stream (Leopold and Wolman, 1957, p.40). A braided stream is composed of anabranches.

Capacity - The ability of a stream current to transport in terms of quantity.

Channel - (1) The deepest portion of a river bed, in which the main current flows. (2) A natural or artificial, clearly distinguished, waterway which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water.

Channel, Backwater - Side channels which do not carry appreciable flows even at high stages.

Channel, Side - Smaller channels in a reach of river where islands divide the reach into one or more channels. The larger is referred to as the main or thalweg channel.

Channel, Stable - A channel in which accretion balances scour on the average.

Channel, Straight - A channel having its sinuousity less than 1.5.

Chute - The natural or artificial steep-sloped reach of an open channel.

Chute and Pools - The flow phenomenon and bed configuration accompanying flows that occur at steep slopes and large bed-material discharges. The flow occurs at slopes steeper than for antidunes and consists of a series of pools in which the flow is tranquil, connected by steep chutes where the flow is rapid. A hydraulic jump forms at the downstream end of each chute where it enters the pool. The bed configuration consists of triangle-shaped elements with a steep upstream slope, a flat, almost horizontal back, and a gently downstream slope. The cutes and pools move slowly upstream.

Clay - Sediment finer than 0.004 mm (millimeters) regardless of mineralogical composition.

Competency - The ability of currents to transport, in terms of dimensions of particles.

Confluence - The joining, or the place of junction, of two or more streams.

Contact Load - Sediment particles that roll or slide along in almost continuous contact with the streambed (often used synonomously with bed load).

Control - A natural constriction of the channel, a long reach of the channel, a stretch of rapids, or an artificial structure downstream from a gaging station that determines the stage-discharge relation at the gage.

Critical Flow - Flow conditions at which the discharge is a maximum for a given specific energy, or at which the specific energy is minimum for a given discharge.

Crossing and Pool - A series of shoals (crossings or bars) and deep (pools) sequence exhibited in rivers.

Crossover - The relatively short and shallow length of a river between bends.

Cross Section (of a Stream) - That section of the stream at right angle to the main (average) direction of flow.

Cubic Feet Per Second ($ft^3/sec$)- A unit expressing rates of discharge. One cubic foot per second is equal to the discharge of a stream of rectangular cross section, 1 foot wide and 1 foot deep, flowing water an average velocity of 1 foot per second.

Cusec - This abbreviation for cubic foot per second, common in the British Commonwealth countries (except Canada), is not used by the US Geological Survey; instead, $ft^3/sec$ or c.f.s. is used.

Cut-off (Cutoff) - The direct channel, either natural or artificial, connecting two points on a stream, thus shortening the length of the channel and increasing its slope.

Degradation - The disintegration and wearing down of the surface of rocks, cliffs, strata, streambeds, etc., by atmospheric and aqueous action.

Delta - An alluvial deposit at the mouth of a river and the geographical and geomorphological unit which results from it.

Density, Water-Sediment Mixture - The bulk density which is the mass per unit volume including both water and sediment.

Depth-Integrated Sample - A water-sediment mixture that is accumulated continuously in a sampler that moves vertically at an approximately constant transit rate between the surface and a point a few inches above the bed of a stream, and that admits the mixture at a velocity about equal to the instantaneous stream velocity at each point in the vertical. Because the sampler intake is a few inches above the sampler bottom, there is an unsampled zone a few inches deep just above the bed of the stream.

Discharge - In its simplest concept, discharge means outflow; therefore, the use of this term is not restricted as to course or location and it can be applied to describe the flow of water from a drainage basin. If the discharge occurs in some course or channel, it is correct to speak of the discharge of a canal or of a river. It is also correct to speak of the discharge of a canal or stream into a lake, a stream, or an ocean.

Disposal, On-Land - The disposal of dredged material on land at locations where the materials are not subjected to the influence of water stage fluctuation.

Disposal, Open Water - The disposal of dredged material on islands, marshes, and along riverbanks at locations where these materials are subject to the influence of river stage fluctuations, or are readily washed back into the river by rainfall.

Disposal, Thalweg - The disposal of dredged material into the main channel.

Diversion - The taking of water from a stream or other body of water into a canal, pipe, or other conduit.

Diversion Dam - A dam built for the purpose of diverting part or all the water from a stream into a different course.

Drainage Basin - A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Drainage Divide - The rim of a drainage basin.

Dredging - A process by which sediments are removed from the bottom of streams, lakes, and coastal waters, transported by ship, barge, or pipeline, and discharged in open water or on land.

Fine Sediment - That part of the sediment discharge that consists of sediment so fine that it is about uniformly distributed in the vertical and is only an inappreciable fraction of the sediment in the streambed (referred to by some writers as washload). Its upper size limit at a particular time and cross section is a function of the flow as well as of the sediment particles.

Flood - An overflow or inundation that comes from a river or other body of water (Barros, 1948) and causes or threatens damage. Any relatively high stream flow overtopping the natural or artificial banks in any reach of a stream (Leopold and Maddock, 1954, pp. 249-251).

Flood-Frequenty Curve - (1) A graph showing the number of times per year on average, plotted as abscissa, that floods of magnitude, indicated by the ordinate, are equaled or exceeded. (2) A similar graph but with intervals of floods plotted as abscissa.

Flood Peak - The highest value of the stage or discharge attained by a flood; thus, peak stage or peak discharge. Flood crest has nearly the same meaning, but since it connotes the top of the flood wave, it is properly used only in referring to stage -- thus, crest stage, but not crest discharge.

Flood Plain - A strip of relatively smooth land bordering a stream, built of sediment carried by the stream and dropped in the slack water beyond the influence of the swiftest current. It is called a living flood plain if it is overflowed in times of highwater; but a fossil flood plain if it is beyond the reach of the highest flood.

Floodway - A part of the flood plain which, to facilitate the passage of floodwater, is kept clear of encumbrances.

Flow-Duration Curve - A cumulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded.

Flow, Open Channel - Flowing water having its surface exposed to the atmosphere.

Flow, Uniform - The flow in which the velocity vector is constant along every streamline.

Flow, Unsteady - The flow in which the velocity changes in magnitude or direction with respect to time.

Flow, Varied - The flow in which velocity or depth changes along the length of the channel.

Fluvial Sediment - Fragmentary material that originates from weathering of rocks and is transported by, suspended in, or deposited from water.

Froude Number - A dimensionless number that relates the inertia forces to the gravitational forces and is important wherever the gravity effect is dominating, such as with water waves and flow in open channels.

Gage Height - The water-surface elevation referred to some arbitrary gage datum. Gage height is often used interchangeably with the more general term stage although gage height is more appropriate when used with a reading on gage.

Gaging Station - A particular site on stream, canal, lake, or reservoir where systematic observations of gage height or discharge are obtained.

Geology - The science which treats of the earth, the rocks of which it is composed, and the changes which it has undergone or is undergoing.

Geomorphology - The study of the characteristics, origin, and developmen of land forms.

Hydraulic Jump - The sudden passage of water in an open channel from super-critical depth to sub-critical depth accompanied by energy dissipation.

Hydraulics - The science treating of the laws governing water or other liquids in motion and their applications in engineering.

Hydrograph - A graph showing stage, flow, velocity, or other properties of water with respect to time.

Islands - The vegetated areas within the channel banks separated from the mainland by the main channel and side channel.

Levee - A water-retaining earthwork used to confine streamflow within a specified area along the stream or to prevent flooding due to waves or tides.

Levee, Natural - Low alluvial ridge adjoining the channel of a stream composed of sediment deposited by flood water which has overflowed the banks of the channel.

Load (Sediment Load) - The sediment that is being moved by a stream. (Load refers to the material itself and not to the quantity being moved.)

Load, Bed - That part of the total sediment load that moves by rolling or sliding along the bed.

Load, Bed-Material - That part of the total sediment load which is composed of grain sizes represented in the bed -- equal to the transport capacity of the flow.

Load, Suspended - That part of the total sediment load that is supported by upward components of turbulence and that stays in suspension for an appreciable length of time.

Load, Total Sediment - The sum of the bed-material load and the washload, or bed load and suspended load, or measured and unmeasured load.

Load, Wash (Fine Material) - That part of the total sediment load which is composed of particle sizes finer than those represented in the bed -- determined by available bank and drainage area supply rate.

Lower Flow Regime - A category for flows producing bed forms of ripples, ripples on dunes, or dunes. In this flow regime, flow is tranquil, water-surface undulations are out of phase with bed undulations, and resistance to flow is large.

Meander - One curved portion of a sinuous or winding stream channel, consisting of two consecutive loops, one turning clockwise and the other counterclockwise.

Meander Belt - That part of the valley floor situated between two parallel lines tangential to successive, fully developed meanders at their extreme limits.

Meander Length - The distance along the river between two corresponding points at the extreme limits of two successive, fully developed meanders.

Meander Width - The amplitude of swing of a fully developed meander, measured from midstream to midstream.

Measured (Sampled) Zone - Due to the design of the various depth integrating sediment samplers, there is a physical constraint on the depth to which a sample can be taken. Most sediment samplers can measure to within 0.3 feet of the bed. Above this point is termed the sampled or measured; below, the unmeasured zone.

Median Diameter - The midpoint in the size distribution of sediment such that half the weight of the material is composed of particles larger than the median diameter and half is composed of particles smaller than the median diameter.

Morphology, Fluvial - The science of the formation of beds and flood plains and of forms of streams by the action of water.

One-Dimemsional - When applied to mathematical modeling of rivers, this means the variation of flo, velocity, depth, bottom elevation, etc., is only considered in one direction, along the centerline of the river.

Outdraft - The movement of flow in a direction not parallel to the main channel. Flow leaving the channel to a backwater area would cause an outdraft.

Ox-Bow - The abandoned part of a former meander, left when the stream cut a new, shorter channel.

Pool - A deep reach of a stream. The reach of a stream between two crossings. Natural streams often consist of a succession of pools and crossings.

Reach - (1) The length of a channel for which a single gage affords a satisfactory measure of the stage and discharge. (2) The length of a river between two gaging stations. (3) More generally, any length of river.

Regime - "Regime theory" is a theory of the forming of channels in material carried by the streams. As used in this sense, the word "regime" applies only to streams that make at least part of their boundaries from their transported load and part of their transported load from their boundaries, carrying out the process at different places and times in any one stream in a balanced or alternating manner that prevents unlimited growth or removal of boundaries. A stream, river, or canal of this type is called a regime stream, river, or canal. A regime channel is said to be "in regime" when it has achieved average equilibrium, that is, the average values of the quantities that constitute regime do not show a definite trend over a considerable period -- generally of the order of a decade. In unspecialized use "regime" and regimen" are synonyms.

River Bed - The lowest part of a river valley shaped by the flow of water and along which most of the sediment and runoff moves in interflood periods.

River Mile - A river mile of a section is the mileage between the section and a reference point along the river thalweg or main-flow path.

River Training - Engineering river works built in order to direct the flow, to lead it into a prescribed channel, or to incease the water depth for navigation and other uses.

River Width - The distance between vegetated banks taken normal to the general direction of flow in the river.

Sand - Sediment particles that have diameters between 0.062 and 2.0 mm.

Sandbar - A dune-shaped bed form whose upstream surface is extremely long in relation to the geometry of the channel (length, 2-3 times the width of the channel). The bar may often protrude above the flow.

Sand Waves - Crests and troughs (such as ripples, dunes, sandbars, antidunes, or standing waves) on the bed of an alluvial channel that are formed by the movement of the bed material.

Scour - Erosive action -- particularly, pronounced local erosion -- of water in streams in excavating and carrying away materials from the bed and banks.

Secondary Currents - Movement of water particles on a cross-section perpendicular to the longitudinal direction of the channel.

Sediment - Fragmental material that orginates from weathering of rock and is transported by, suspended in, or deposited by, water or air.

<u>Sediment Concentration</u> - The ratio of dry wright of sediment to total weight of the water-sediment mixture, expressed in parts per million.

<u>Sediment Discharge</u> - The amount of sediment that is moved by water past a section 'n a unit of time.

<u>Sediment Yield</u> - The total sediment outflow from a watershed or a drainage area at the point of reference and in a specified period of time. This is equal to the sediment discharge from the drainage area.

<u>Shear Stress</u> - The internal fluid stress which resists deformation.

<u>Shingle</u> - Gravel and cobblestones deposited by water to resemble lapped roofing pieces. The origin is "shingl" -- a Norweigan term for a small round stone.

<u>Shoaling</u> - The creation of a shallow area by a sand wave or bar.

<u>Silt</u> - Sediment particles whose diameters are between 0.004 and 0.062 mm.

<u>Simiesity</u> - The ratio between thalweg length to down valley distance.

<u>Stage</u> - The height of a water surface above an established datum plane, also gate height.

<u>Standing Waves</u> - Curved symmetrically shaped waves on the water surface and on the channel bottom that are virtually stationary. When standing waves form, the water and bed surfaces are roughly parallel and inphase.

<u>Stream</u> - A general term for a body of flowing water. In hydrology, the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term stream gaging, it is applied to the water flowing in any channel, natural or artificial. Streams in natural channels may be classified as follows:

<u>Perennial</u> - One which flows continuously.

<u>Intermittent or Seasonal</u> - One which flows at certain times of the year when it receives water from spring or from some surface source, such as melting snow in mountainous areas.

<u>Ephemeral</u> - One that flows only in direct response to precipitation, and whose channel is at all times above the water table.

<u>Stream Discharge (Water Discharge)</u> - The quantity of natural water passing through a cross section of a stream in a unit of time. (The natural water contains both dissolved solids and sediment.)

<u>Surface Areas, River</u> - The area between the vegetated riverbanks.

<u>Surface Areas, Riverbed</u> - The river surface area less the area of the islands.

Suspended Load - The sediment that is supported by the upward components of turbulent currents in the flow and that stays in suspension for an appreciable length of time.

Tailwater - The water located just downstream from a hydraulic structure on a stream.

Terrace - The berm or discontinuous segments of a berm, in a valley at some height above the flood plain, representing a former abandoned flood plain of the stream.

Thalweg - The line following the deepest part of a streambed or channel or of a valley.

Transistion - A category for flows that occur between the lower and upper flow regimes and produce bed forms ranging from those typical of the lower flow regime to those typical of the upper flow regime.

Trap Efficiency - The ability of a reservoir to trap and retain sediment. Expressed as a percent of sediment yield (incoming sediment) which is retained in the reservoir.

Turbidity - The condition of a liquid due to fine, visible material in suspension which impedes the passage of light through the liquid.

Two-Dimensional - When applied to mathematical modeling of rivers, this means that the variation of flow, velocity, depth bottom elevation, etc., is considered in two directions,usually along and perpendicular to the cneterline of the river.

Unmeasured (Unsampled Zone) - Most suspended-sediment samplers cannot sample within 3 or 4 inches of the streambed, and this 3 or 4 inches at the bottom of the sampling vertical is called the unmeasured zone in contrast to the measured zone above it.

Upper Flow Regime - A category for flows producing bed forms of plane bed with sediment moving, standing waves, antidunes, or chutes and pools. In the upper flow regime, water-surface undulations are in phase with bed undulations, except in breaking antidune or chute and pool flow.

Wash Load - That part of the total sediment load which is composed of particle sizes finer than those represented in the bed and which is determined by available bank and upslope supply rate.

Watershed - The divide separating one drainage basin from another and in the past has been generally used to convey this meaning. However, over the years, use of the term to signify drainage basin or catchment area has come to predominate, although drainage basin is preferred. Drainage divide, or just divide, is used to denote the boundary between one drainage area and another. Used alone, the term "watershed" is ambiguous and should not be used unless the intended meaning is made clear.

Water Year - In US Geological Survey reports dealing with surface-water supply, the 12-month period, 1 October through 30 September. The water year is designated by the calendar year in which it ends and which include nine of the 12 months. Thus, the year ended 30 September 1959, is called the 1959 water year.

B - MEETING MINUTES

B - MEETING MINUTES

The following are copies of the available meeting minutes.

## Great River Environmental Action Team

Chairman, GREAT II Dredging Requirements Work Group
Corps of Engineers, Rock Island District, Clock Tower Building
Rock Island, IL 61201 309-788-6361 FTS 360-6240

28 February 1978

TO: Members of the Dredging Requirements Work Group and all GREAT II Work Group Chairmen

### Minutes of DRWG Meeting 7 Feb 78

The Dredging Requirements Work Group meeting convened at 10:00 A.M. at the RID conference room.

Those in attendance were:

| | |
|---|---|
| Richard Fleischman | - Co-Chair GREAT II |
| Wendy Thur | - PPIWG |
| Bill Koellner | - Corps |
| Dick Baker | - Corps |
| Irving Olson | - Material & Equip Needs WG |
| Ted Yang | - NCD Corps |
| Bill Whetstine | - DRWG, Chairman |

Mr. Yang made a very good presentation of the various types of models available for model studies of the Mississippi River. There was much discussion on the various models, the outcome being that it was agreed the two-dimensional model would be the best available for our use.

Bill Koellner agreed to contact Dr. Jack Kennedy of the University of Iowa, Institute of Hydraulic Research, to see if the information the Corps contracted Dr. Kennedy to gather could be utilized in further studies. The meeting adjourned shortly after noon.

The next meeting will be 3/7/78 at 10:00 A.M. at the RID conference room. The main topics of discussion will be the model study and the problem identification.

WILLIAM C. WHETSTINE
Chairman, DRWG

TO:

FROM: William E. Barber, Chairman, DRWG

SUBJECT: Minutes of 31 July 1979 Meeting

The 31 July 1979 Meeting was held in the 3rd Floor Conference Room of the Clock Tower Building, Corps of Engineers, Rock Island, Illinois.

Call to Order 10:05 A. M.

I. Attendance:

William E. Barber, Corps of Engineers
William H. Koellner, Corps of Engineers
Marvin R. Martens, Corps of Engineers
Stephen M. Eckert, Corps of Engineers
Jon Duyvejonck, Corps of Engineers
William C. Whetstine, Corps of Engineers (Afternoon)
Robert Behrens, State of Wisconsin

II. Status Report on Contract for Main Channel Disposal Demonstration Project.

Barber - The notice has been printed in The Commerce Business Daily. There has been quite a few requests for The Scope of Work according to Paul VanHoorebeke.

III. Contract Status Report on Testing of Various Sediment Transport Computer Models.

Koellner - A report received from the University of Iowa was discussed by Mr. Koellner and after much discussion with the work group the resolution attached was recommended to the PFWG.

IV. Work Group Appendix Outline.

There was much discussion about the DRWG Appendix Outline and the results of the discussion was to have Nancy Beckwith attend the next DRWG meeting so as we could get the act together.

V. A brief discussion was held on Channel Structure Survey.

I told the group that Mark Ackelson, at a previous meeting, said the DRWG was responsible for a survey of all channel structures including wing dams. No one in the group could remember when this Task was presented to the group. I showed them the material that I had obtained from the records.

VI. On site Inspection Team Assignments.

Everyone in the group said they would be available for on site inspection as soon as the dredge sites dates become more fixed.

Adjourn 2:00 P. M.

The GREAT River

**Great River Environmental Action Team**
Chairman, GREAT II Dredging Requirements Work Group
Corps of Engineers, Rock Island District, Clock Tower Building
Rock Island, IL 61201 309-788-6361 FTS 360-6240

September 28, 1979

TO: Dredging Requirements Work Group

FROM: Jon Duyvejonck

SUBJECT: Minutes of August 23 Work Group Meeting

The monthly Dredging Requirements Work Group meeting was held from 9:00 AM to 4:00 PM at the Corps of Engineers Conference Room, Rock Island, Illinois.

Those in attendance were:

| | |
|---|---|
| Dick Baker | RICOE |
| Bill Barber (morning only) | RICOE |
| Nancy Beckwith | Report Writer |
| Jim Case | Iowa Geological Survey |
| Jon Duyvejonck | RICOE |

<u>Revision of Attachments</u>

Attachments 1, 2, and 3 were revised by discussion among work group members. It was felt that several of the problems and objectives in these attachments were inadequate or vague. The entire meeting was spent on these revisions.

Jon Duyvejonck
JON DUYVEJONCK
Member, Dredging Requirements Work Group

# Great River Environmental Action Team

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245

TO: Dredging Requirements Work Group

FROM: Jerry L. Crittenden, Chairman

SUBJECT: Minutes of 26 Sep 79 and 2 Oct 79 Meetings

1. The 26 Sep 79 meeting was held in the small conference room of the Clock Tower Annex, Corps of Engineers, Rock Island, Illinois.

a. Attendance:

| | |
|---|---|
| Jerry L. Crittenden | Corps of Engineers |
| Tim Mullen | Corps of Engineers |
| Mark Schroeder | Corps of Engineers |
| Jon Duyvejonck | Corps of Engineers |
| William H. Koellner | Corps of Engineers |

b. Status Report on Contract for Main Channel Disposal Demonstration Project Scope of Work.

Top four contractors were contacted by phone on 24 Sep 79. Engineering Research Center of Colorado State University and Environmental Research and Technology will give the Corps a best and final offer based on telephone discussion by 3 Oct 79.

c. Work Group Appendix.

Crittenden: The appendix is starting to be rough drafted by Tim Mullen and Mark Schroeder and is about one third complete. Koellner has written the portion on sediment model transport model studies conducted by the Institute of Hydraulic Research, University of Iowa, under contract.

After further discussion it was decided that the work group needs Mr. Dick Baker's input to help put together the finer point of the appendix completed to the present.

d. Work Group Dredge Requirements Recommendations.

The filling out of the attachment #4's was discussed. Since Dick Baker was not there it was decided to hold another meeting when he could attend.

SUBJECT: Minutes of 26 Sep 79 and 2 Oct 79 Meeting

2. The 2 Oct 79 meeting was held in the conference area of Design Branch, RID.

a. Attendance:

| | |
|---|---|
| Jerry Crittenden | Corps of Engineers |
| Tim Mullen | Corps of Engineers |
| Jon Duyvejonck | Corps of Engineers |
| William H. Koellner | Corps of Engineers |
| Dick Baker | Corps of Engineers |

b. Work group problems one, two, five, seven, nine, and ten were discussed and attachment #4's completed for each one.

CRITTENDEN

# Great River Environmental Action Team

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245


TO: Dredging Requirement Work Group

FROM: Jerry L. Crittenden, Chairman

SUBJECT: Minutes of 31 October 1979 Meeting

1. The 31 October 1979 meeting was held in the third floor conference room of the Clock Tower Building, Corps of Engineers, Rock Island, Illinois.

a. Attendance:

Jerry L. Crittenden - Corps of Engineers
Tim Muller - Corps of Engineers
Jon Duyvejonck - Corps of Engineers
Robert Behrens - Wisconsin DNR

b. Work Group Dredge Requirements Recommendations:

The attachment #4's that were mailed out to the work group on 19 October 1979 were discussed. Recommendations 4001, 4002, 4005, 4007, 4009, 4010, and 4014 were revised and accepted as revised. Recommendation 4016 was combined with recommendation 4001 and accepted. Recommendation 4020 was combined with recommendation 4010 and accepted. Recommendation 4015 was determined to be a problem that is to be addressed by the Materiel and Equipment Needs Work Group. Recommendation 4019 was accepted as written. Recommendations 4017 and 4018 were deferred because Mr. Bill Koellner was not able to attend the meeting. It was determined that Mr. Koellner was the best person to fill out these attachment #4's.

c. Work Group Appendix:

The preliminary draft, including in-house comments made prior to the meeting, was discussed. Since the draft has some missing sections, it was decided to move ahead with adding the missing sections and graphs and submit the revised draft to our Work Group and the Plan Form Group.

# Great River Environmental Action Team

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245

SUBJECT: Minutes of 31 October 1979 Meeting

2. In order to get the input from the whole work group, I would like you to review the attached recommendations and submit any comments you heve as soon as possible. These additional comments will be considered et the next work group meeting along with any comments submitted by persons on the work group mailing list.

3. The revised preliminary draft of the appendix will be mailed as soon as it is retyped.

JERRY L. CRITTENDEN
Chairman

CF:
✓Dist File (ED-D)

The GREAT River

**Great River Environmental Action Team**

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245


TO: Dredging Requirements Work Group

FROM: Jerry L. Crittenden, Chairman

SUBJECT: Minutes of 30 Nov 79 Meeting

The 30 Nov 79 meeting was held at 0830 hours in the Design Branch conference area of the Clock Tower Building, Corps of Engineers, Rock Island, Illinois.

a. Attendance.

| | |
|---|---|
| Jerry L. Crittenden | Corps of Engineers |
| William H. Koellner | Corps of Engineers |
| Tim Mullens | Corps of Engineers |
| Mark Schroeder | Corps of Engineers |
| Jon Duyvejonck | Corps of Engineers |
| Richard M. Baker | Corps of Engineers |
| Donn Williams | Williams Marine Enterprise |

b. The work group recommendations were discussed and approved.

c. The meeting adjourned at 1200 hours.

Jerry L. Crittenden

JERRY L. CRITTENDEN
Chairman, Dredging
Requirements Work Group

The GREAT River

**Great River Environmental Action Team**

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245

TO: Dredging Requirements Work Group

FROM: Jerry L. Crittenden, Chairman

SUBJECT: Minutes of 22 Feb 80 Meeting

The 22 Feb 80 meeting was held at 1330 hours in the Design Branch conference area of the Clock Tower Building, Corps of Engineers, Rock Island, Illinois.

a. Attendance.

| | |
|---|---|
| Jerry L. Crittenden | Corps of Engineers |
| William H. Koellner | Corps of Engineers |
| Jon Duyvejonck | Corps of Engineers |
| Richard M. Baker | Corps of Engineers |

b. The writing of the final draft was discussed. Mr. Baker's input seems to be the only thing left.

c. The meeting adjourned at 1430 hours.

Jerry L. Crittenden

JERRY L. CRITTENDEN
Chairman, Dredging
Requirements Work Group

The GREAT River

**Great River Environmental Action Team**

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245

TO: Dredging Requirements Work Group

FROM: Jerry L. Crittenden, Chairman

SUBJECT: Minutes of 4 Apr 80 Meeting

The 4 Apr 80 meeting was held at 0930 hours in the third floor conference room of the Clock Tower Building, Corps of Engineers, Rock Island, Illinois.

a. Attendance.

| | |
|---|---|
| Jerry L. Crittenden | Corps of Engineers |
| Jon Duyvejonck | Corps of Engineers |
| William H. Koellner | Corps of Engineers |
| Richard M. Baker | Corps of Engineers |
| Thomas E. Kenny | Wisconsin Barge Lines |
| Donn Williams | Williams Marine Enterprise |
| Loren A. Williams | Williams Marine Enterprise |
| Steve J. Butkovich | Mid American Transportation Co. |
| Jerry Tinkey | Mid American Transportation Co. |
| A. L. Rodgers | Mid American Transportation Co. |
| Francis J. Meyer | Federal Barge Lines |
| E. H. Vorwald | Federal Barge Lines |

b. The channel depths that are proposed in the appendix were discussed. The operations of the pool levels were also discussed.

c. The revised appendix was approved by the work group.

d. The meeting adjourned at 1130 hours.

Jerry L. Crittenden

JERRY L. CRITTENDEN
Chairman, Dredging
Requirements Work Group

The GREAT River

**Great River Environmental Action Team**

Jerry L. Crittenden, Chairman
Dredging Requirements Work Group - GREAT II
US Army Engineer District, Rock Island, Clock Tower Building
Rock Island, Illinois 61201 Phone: 309-788-6361, x-245

20 August 1980

TO: Dredging Requirement Work Group

FROM: Jerry L. Crittenden, Chairman

SUBJECT: Minutes of 19 August 1980 Meeting

1. The 19 August 1980 meeting was held in the third floor conference room of the Clock Tower Building, Corps of Engineers, Rock Island, Illinois. Those in attendance were:

Jerry L. Crittenden, Corps of Engineers
Jon Duyvejonck, Corps of Engineers
Dick Baker, Corps of Engineers

2. The comments from the public, State, and Federal Agencies were discussed. It was determined that we should proceed with the making the necessary changes in the Dredging Requirements Work Group Appendix report and publish it as a final work group product.

Jerry L. Crittenden

JERRY L. CRITTENDEN
Chairman, Dredging Requirments
Work Group

C - ETL 1110-2-225

DEPARTMENT OF THE ARMY ETL 1110-2-225
Office of the Chief of Engineers
DAEN-CWE-H Washington, D. C. 20314

Engineer Technical
Letter No. 1110-2-225 1 July 1977

Engineering and Design
CHANNEL WIDTHS FOR NAVIGATION IN BENDS

1. Purpose. This ETL describes a study authorized by the Office of the Chief of Engineers, dated 14 November 1974, to obtain better information on factors affecting channel widths for navigation in bends. It was undertaken by the U.S. Army Engineer Waterways Experiment Station utilizing small scale models in which conditions could be varied and controlled.

2. Applicability. This letter applies to all field operating agencies having Civil Works responsibilities.

3. Design Factors. Development of inland waterways for navigation must be based on the characteristics of the waterway and the requirements of the type of traffic for which it is designed. Most inland waterways utilize all or part of an existing stream which consists generally of alternating bends and straight reaches. Towboats and tows occupy greater channel widths when making a turn or negotiating bends than when moving in a relatively straight line. The width of channel occupied depends on many factors which have to be considered in the design of the navigation channels. Some of these factors include rate and amount of change in direction required in a given bend, current velocities and alignment of currents, length and width of towboat and tow, and speed and maneuverability of the tow. The specific objective of the study is to develop parameters which can be used by the design engineer in determining the channel widths required under various conditions.

4. Principles Involved. If the size of the tow, radius of the bend, and orientation assumed by the towboat and tow in negotiating the bend are known, the width of channel required can be determined. Since the first two factors are readily available, the only unknown is the orientation of the towboat. This can best be defined as the deflection angle $\alpha$ formed by the alignment of the boat and a chord on the curve of the bend equal to the length of the towboat and tow (Figure 1). If the deflection angle is known for a particular condition, a reasonably accurate channel width can be determined for that condition from one of the following equations:

a. $CW_1 = (\sin \alpha_d \times L_1) + W_1 + 2C$

b. $CW_2 = (\sin \alpha_u \times L_1) + W_1 + (\sin \alpha_d \times L_2) + W_2 + 2C + C_t$

where: $CW_1$ = channel width required for one-way traffic, ft

$CW_2$ = channel width required for two-way traffic, ft

$\alpha_d$ = maximum deflection angle of a downbound tow, deg

$\alpha_u$ = maximum deflection angle of an upbound tow, deg

L = length of tow, ft

W = width of tow, ft

C = clearance required between tow and channel limit for safe navigation, ft

$C_t$ = minimum clearance required between passing tows for safe two-way navigation, ft

The orientation (deflection angle) assumed by the tow under various conditions has not previously been clearly established and is the most difficult parameter to determine. Model studies are being used to determine the deflection angle which can be substituted in the equations to obtain channel widths.

5. The Channel Models. The channels being modeled for these studies are designed to provide the variables associated with channel configuration such as curvature of bend and current distribution, alignment, and velocity. In order to provide for some of these variables, the model reproduces a series of typical bends of uniform curvature and different radii with straight reaches between alternate bends. The models are molded in compacted sand to typical channel cross sections and can be readily remolded to provide for various curvatures of bend and different model scales. The models are adjusted by modifying the channel cross section to provide realistic current alignment and velocity distribution.

6. The Tow Models. The tows used in these tests are remote controlled and variable in length and width as required for the tests. All tows were loaded to a draft of 8 ft based on project depth of 9 ft. Results shown are based on an analysis of several runs with the speed of the tow maintained constant during each run. The speed of the tow is set at the minimum required to navigate against the current and provide adequate rudder control. Results of downbound tows are based on negotiating the bends without flanking. Tests are conducted with slack water (no flow) and with flows producing average velocities of about 3 and 6 ft/sec (Figures 2 and 3).

7. Test Conditions. Sufficient data have been collected to indicate the variations in the deflection angle for 90-deg bends as affected by bends with radii from 1500 to 3000 ft, tow sizes from 35 to 70 ft wide by 685 ft long to 105 ft wide by 600 ft long, and current velocities

between 0 and 6 ft/sec for downbound tows without flanking and for upbound tows.

8. Test Results. The effects of tow size and makeup on channel width required are illustrated in Figure 4. This illustration indicates that a shorter and wider tow will usually require less channel width in bends than a longer and narrower tow of the same tonnage. For instance, the 80- by 600-ft tow requires 10 ft less channel width than the 70- by 685-ft tow. As the radius of the bend decreases, the deflection angle increases; therefore, the required channel width increases (Figure 5). It should be noted that tow size has a somewhat lesser effect on the variation in deflection angle for upbound tows or tows moving in slack water than for downbound tows. It should also be noted that the deflection angle for tows moving in slack water is somewhat greater than for upbound tows moving in 3-ft/sec current. Given a radius of curvature and normal velocity distribution, the deflection angle can be obtained from Figure 5 and the required channel width computed for average conditions using equation a or b for the tow sizes indicated.

9. Environmental Constraints. River currents in natural streams are affected by factors other than the geometry of the immediate bendway; therefore, the data presented should not be applied indiscriminately. The alignment of the channel upstream and the existence of hard points or other anomalies can affect normal current patterns and must be considered. In the absence of anomalies, currents generally follow the thalweg around a bank during low water when channel widths and depths are minimum. This will be the limiting condition in most cases and the fact that currents follow a somewhat different alignment during high water should not be significant.

10. Carrier Constraints. The data presented are based on a towboat with the minimum power to adequately navigate under the conditions specified. Tows with greater power for the load can develop more rudder control and require less channel width than indicated. Also, tows that have greater maneuverability because of independent operation of their screws, specially designed rudders, or auxiliary steering devices will require less channel width than indicated by the results of the tests. Conversely, tows with insufficient power to properly handle the load would tend to slip sideways in making the turn and would require a greater channel width than indicated.

11. Conclusions. The studies completed to date indicate the following:

a. The channel width required in bends is greater than that in straight reaches for the same size tow. The width required will depend on the orientation of the tow with respect to the alignment of the channel while negotiating the bend.

b. The orientation of the tow in a bend can best be defined by the deflection angle, which is influenced by the curvature of the bend, size of the tow, alignment and velocity of currents, and power and maneuverability of the towboat with respect to the load.

c. The channel width required for short radius bends (1000 to 3000 ft) can be approximated from the preliminary results contained in Figure 5 and the equations in paragraph 4.

d. Channel widths and current direction and velocities in a stream will vary with stage and discharge and should be considered in determining the most critical conditions.

e. Shorter and wider tows usually require less channel width in bends than longer and narrower tows carrying the same load, particularly in short radius bends.

f. In streams carrying little or no sediment, it may be more economical to increase the width of channel than to increase the radius of the bend. In streams carrying a heavy sediment load, an increase in the channel width cannot be maintained without the addition of properly designed construction of training structures.

FOR THE CHIEF OF ENGINEERS:

1 Incl
Figures 1-5

HOMER B. WILLIS
Chief, Engineering Division
Directorate of Civil Works

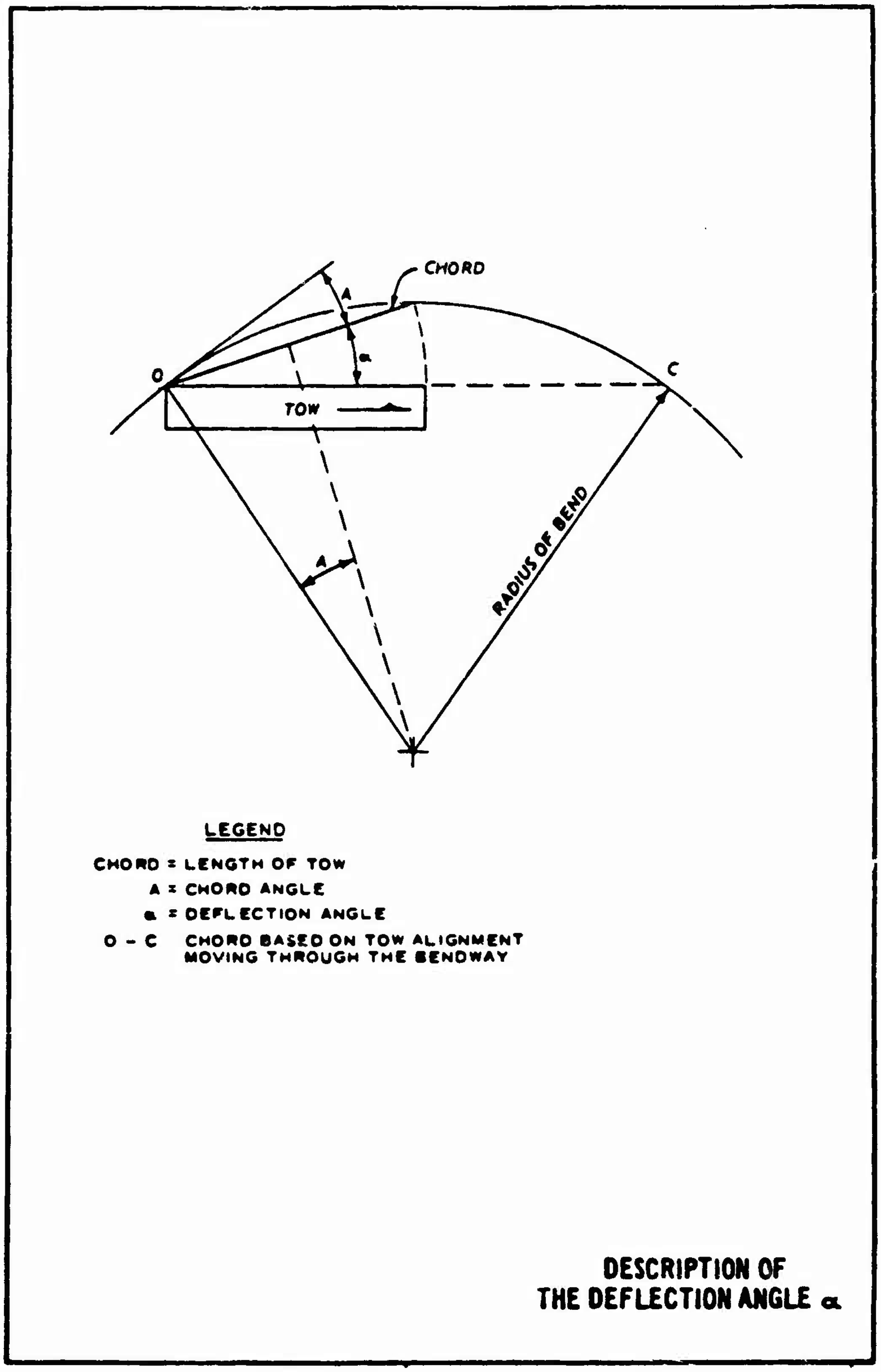

CHORD
A
α
O
C
TOW
A
RADIUS OF BEND
LEGEND
CHORD = LENGTH OF TOW
A = CHORD ANGLE
α = DEFLECTION ANGLE
O - C CHORD BASED ON TOW ALIGNMENT MOVING THROUGH THE BENDWAY
DESCRIPTION OF
THE DEFLECTION ANGLE α

Figure 1

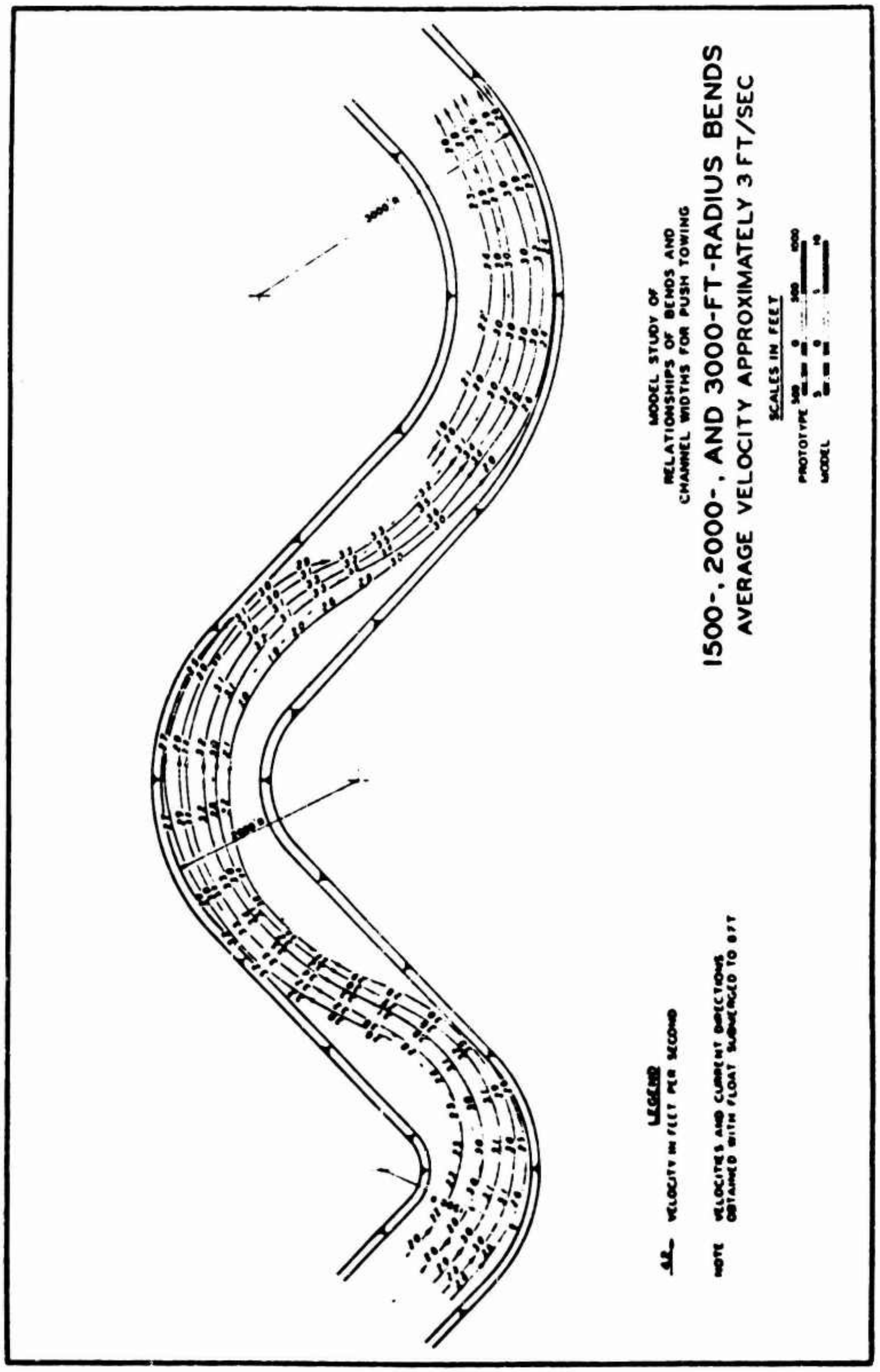

MODEL STUDY OF
RELATIONSHIPS OF BENDS AND
CHANNEL WIDTHS FOR PUSH TOWING
1500-, 2000-, AND 3000-FT-RADIUS BENDS
AVERAGE VELOCITY APPROXIMATELY 3 FT/SEC
SCALES IN FEET
PROTOTYPE
MODEL
LEGEND
VELOCITY IN FEET PER SECOND
NOTE
VELOCITIES AND CURRENT DIRECTIONS
OBTAINED WITH FLOAT SUBMERGED TO 8 FT

Figure 2

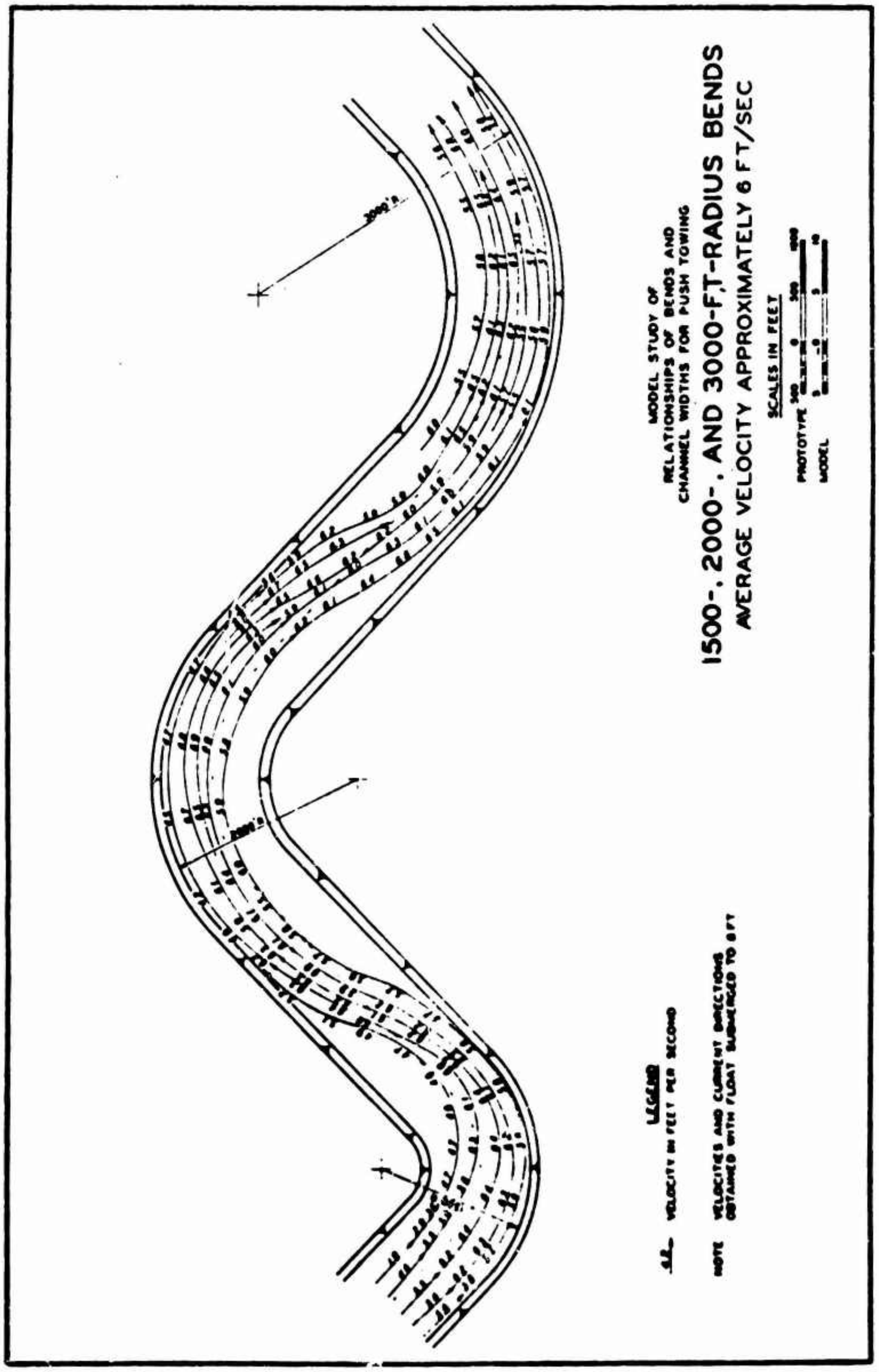
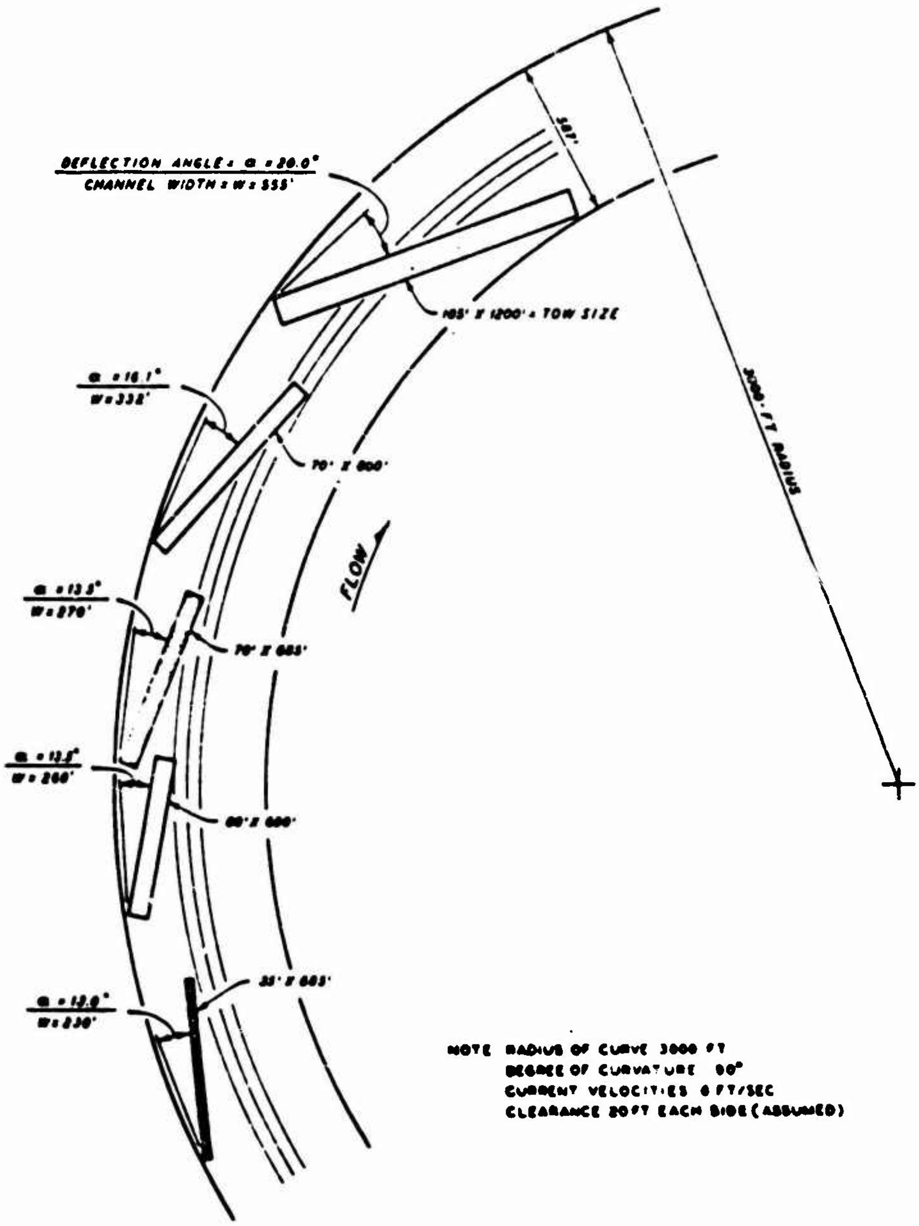

MODEL STUDY OF
RELATIONSHIPS OF BENDS AND
CHANNEL WIDTHS FOR PUSH TOWING
1500-, 2000-, AND 3000-FT-RADIUS BENDS
AVERAGE VELOCITY APPROXIMATELY 6 FT/SEC
SCALES IN FEET
PROTOTYPE
MODEL
LEGEND

Figure 3




VARIATION OF DEFLECTION ANGLE AND CHANNEL WIDTH WITH TOW SIZES

Figure 4

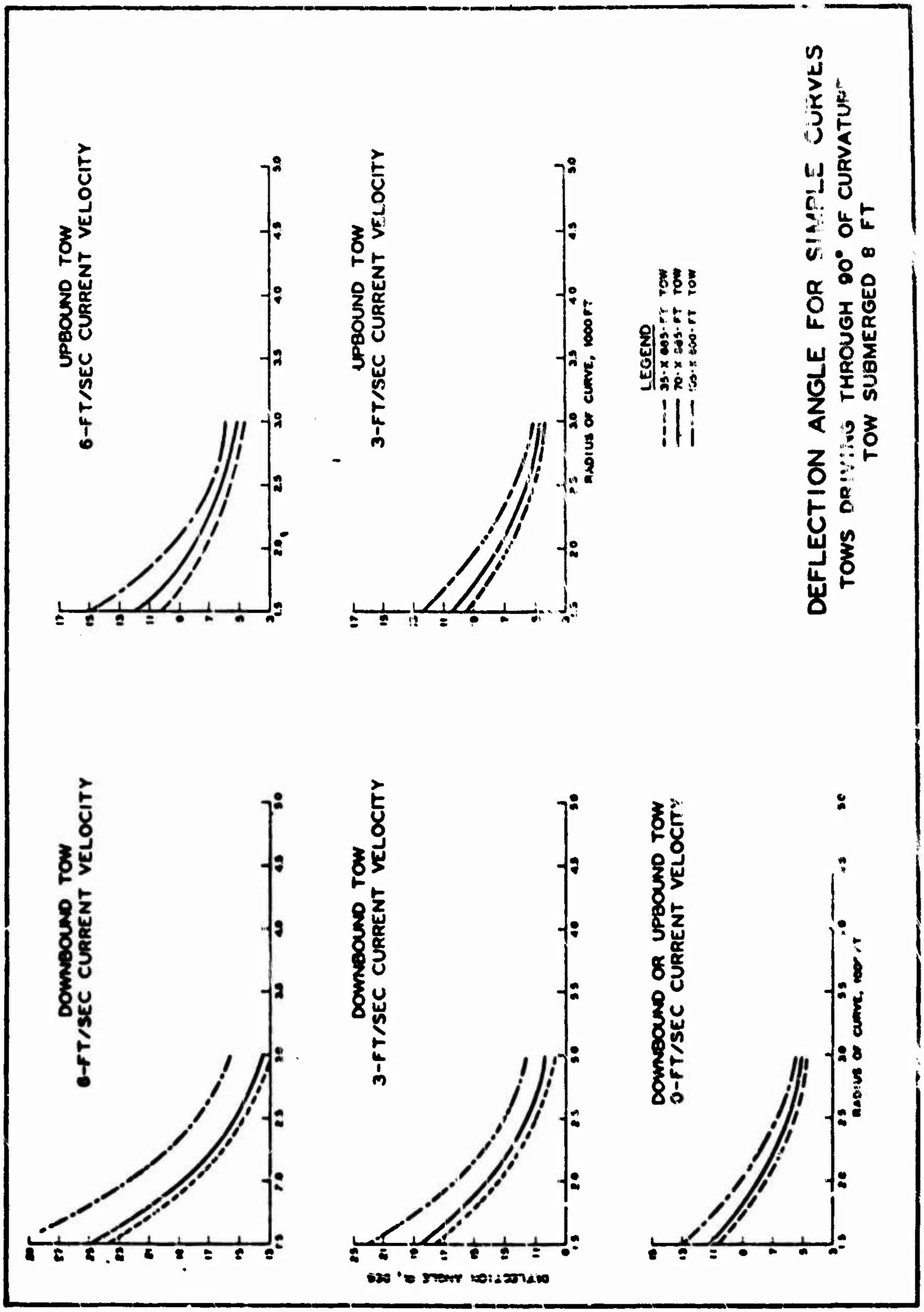

DEFLECTION ANGLE FOR SIMPLE CURVES
TOWS DRIVING THROUGH 90° OF CURVATURE
TOW SUBMERGED 8 FT
UPBOUND TOW
6-FT/SEC CURRENT VELOCITY
UPBOUND TOW
3-FT/SEC CURRENT VELOCITY
DOWNBOUND TOW
6-FT/SEC CURRENT VELOCITY
DOWNBOUND TOW
3-FT/SEC CURRENT VELOCITY
DOWNBOUND OR UPBOUND TOW
0-FT/SEC CURRENT VELOCITY
LEGEND
RADIUS OF CURVE, 1000 FT
DEFLECTION ANGLE

Figure 5

# D - CONTRACT REPORTS

D - CONTRACT REPORTS

A copy of the work group contract reports, as discussed in Section III - Work Group Activities and Accomplishments, is available from the following offices and libraries.

## MAILING LIST
## FOR DISTRIBUTION
## OF
## WORK GROUP REPORTS

US Army Engr Dist, Rock Island
ATTN: Library, Room 212
Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61201

Richard J. Fleischman
US Army Engr Dist, Rock Island
Corps of Engineers
Clock Tower Building
Rock Island, Illinois 61201

Upper Mississippi River Conservation Committee
Chairman
1830 Second Avenue
Rock Island, Illinois 61201

Upper Mississippi River Basin Commission
Federal Building, Room 510
Fort Snelling
Twin Cities, Minnesota 55111

US Army Engineer Waterways Experiment Station
ATTN: WESTL/Library Branch
P.O. Box 631
Vicksburg, Mississippi 39180

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Kathryn J. Gesterfield, Director
State Library
Office of the Secretary of State
Centennial Building
Springfield, Illinois 62706

Barry L. Porter, Director
State Library Commission
Historical Building, East Wing
East Twelfth and Grand Avenue
Des Moines, Iowa 50319

Charles O'Halloran, State Librarian
State Library
308 East High Street
Jefferson City, Missouri 65101

W. Lyle Eberhart, Assistant Supervisor
Divisicn for Library Services
Department of Public Instruction
126 Langdon Street
Madison, Wisconsin 53702