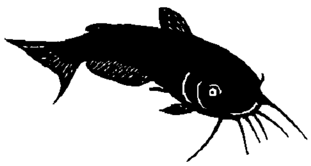
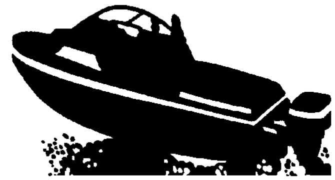
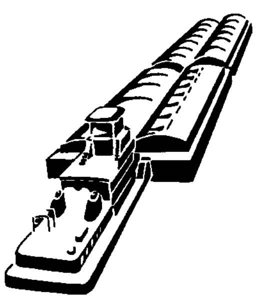
Interim Report For The Upper Mississippi River - Illinois Waterway System Navigation Study





Bank Erosion Field Survey Report of the Upper Mississippi River and Illinois Waterway



November 1997

US Army Corps of Engineers

St. Paul District
Rock Island District
St. Louis District

Preface

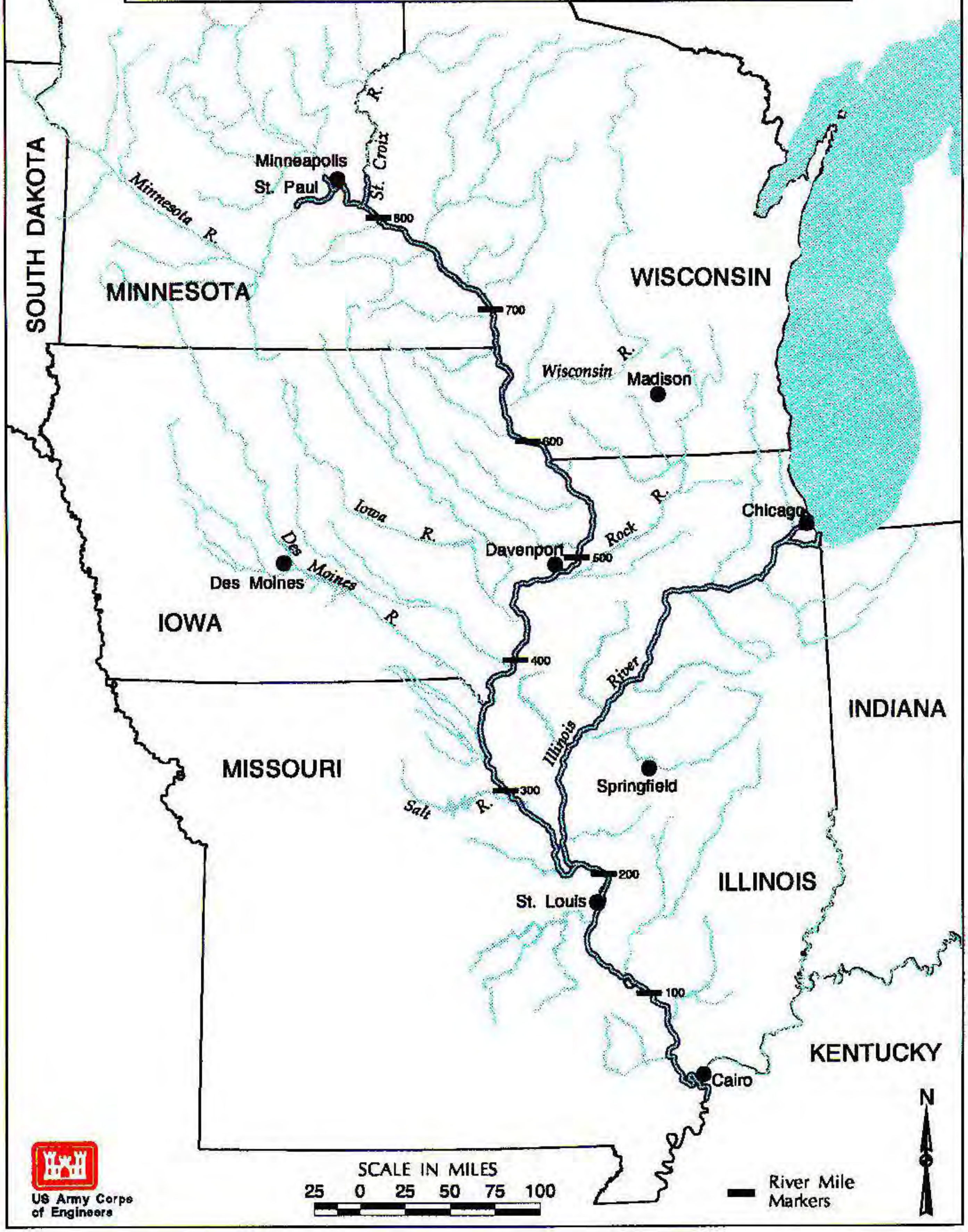
The work reported herein was conducted as part of the Upper Mississippi River-Illinois Waterway (UMR-IWW) System Navigation Study. The information generated for this interim effort will be considered as part of the plan formulation process for the system Navigation Study.

The UMR-IWW system navigation Study is being conducted by the U.S. Army Engineer districts of Rock Island, St. Louis, and St. Paul under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing and, in consideration of existing system lock constraints, will result in traffic delays which will continue to grow into the future. The system navigation study scope is to examine the feasibility of navigation improvements for the 50-year planning horizon from years 2000 through 2050. The final product of the System Navigation Study is a Feasibility Report, which is the decision document for processing to Congress.

The work for this interim effort was performed by principal investigators Nani Bhowmik, Ph.D., PE, and David Soong, Ph.D., PE, Illinois State Water Survey; Tatsuaki Nakato, Ph.D., Iowa Institute of Hydraulic Research; Mike Spoor, PE, Huntington District Corps of Engineers; Jeff Anderson, PG, CPG, Anderson Environmental Services and Dan Johnson, PE, Rock Island District Corps of Engineers.

Upper Mississippi River - Illinois Waterway System Navigation Study

Bank Erosion Field Survey Report of the Upper Mississippi River and Illinois Waterway



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Chapter 1. Abstract

This report summarizes findings from several phases of the Upper Mississippi River/Illinois Waterway (UMR/IWW) Bank Erosion Study. Tasks completed to date include a literature study of bank erosion, an aerial reconnaissance survey, and a field survey trip organized and conducted by the lead agency, the U.S. Army Corps of Engineers, Rock Island District. Major emphasis of this report is given to the findings from the field survey.

The research team included scientists and engineers from the Illinois State Water Survey (ISWS), the University of Iowa - Iowa Institute of Hydraulic Research (IIHR), and the U.S. Army Corps of Engineers, Rock Island, St. Paul, St. Louis, and Huntington Districts. The principal authors for this report are the ISWS and IIHR. A geomorphologist from Anderson Environmental Services also participated in the trip on the Upper Mississippi River. Field survey trips were conducted in the Fall of 1995 and covered reaches from River Mile (RM) 854 to RM 0 on the Upper Mississippi River, and from RM 286 to RM 0 on the Illinois Waterway. The research team assessed bank conditions on both sides of the main rivers and took detailed information at selected erosion sites where they formed opinions of the causative mechanisms for each location. In addition to describing the detailed data collected and analyses of these 72 individual sites, this report has included comprehensive erosion mapping of the entire length of both rivers in appendix J. Description of the study, data collection methodology, a database, and characterization of bank erosion are given in Chapters 1 - 5.

During the field survey, the team selected 72 erosion sites (29 sites on the Illinois Waterway and 43 sites on the Mississippi River) for further study. The bank sections, site photos, bank and subaqueous soil conditions, and site descriptions are given in chapter 6 for the IWW and chapter 7 for the UMR. During the analysis and report preparation stages, it was decided that the ISWS would take major responsibilities in writing the IWW portion of this report and that the IIHR would write the UMR portion with contribution from Anderson Environmental Services.

For the selected sites on the IWW (80 bank sections from 29 sites), the research team observed multiple erosion processes at most of the selected bank sections. The most frequently identified erosion mechanisms are seepage, stage fluctuations, flood flows, navigation traffic, wave activities, and eddies and disturbed flows. A more detailed summary of the IWW field survey data, analysis and discussion can be found in Chapter 6.

Bank failure and erosion conditions on the Upper Mississippi River also showed significant flood impacts. Analyses of surficial soil samples showed the banks were mantled by primarily sand and gravel in the upper reach of the river, silt and sand in the middle reach, and clay and silt in the lower reach. Most of the bank failure and erosion sites showed flood damage as the dominating erosion cause. Surficial, wave-induced erosion and erosion associated with direct barge impact, propeller wash and cabling to trees was present at some fleeting and mooring and lock approach sites.

Approximately fifty-one sites out of seventy-five of the UMR study sites (including observation sites) were within the upper portion of the navigation pools. Many of these active erosion sites are also historically dredged material placement sites. Below St. Louis, historical flood flow reworking of the channel margins was also observed. A more detailed summary of the UMR field survey data, analysis and discussion can be found in the summary section of Chapter 7.

A measurement of the length of severely eroded reaches, as marked on the navigation charts (appendix J), shows that there are approximately 115 bank miles on the IWW and 240 bank miles on the UMR. This represents that approximately 20 percent of the total bank length of the IWW and 14 percent of the UMR are actively eroding.

The appendices include the literature review, scope of work, stage histograms at each site, dredging history and the location of dredged material placement sites, fleeting areas, particle size distributions for collected samples, cross sectional profiles and UTM coordinates for the 72 erosion sites, geomorphology report, database of field notes, navigation charts with bank erosion marking, and field photos. Archeology sites reports and historic property are on file at the appropriate Corps of Engineers District offices.

Chapter 2. Introduction

Relationship to UMR/IWW System Navigation Feasibility Study

Navigation on the Mississippi River and the Illinois Waterway has proven to be an efficient and cost-effective means of transporting a variety of commodities. It is a vital part of our national economy. The importance of the Upper Mississippi River-Illinois Waterway as a shipping artery is reflected in the continual increase in tonnage shipped on the system. According to a recent study (Jack Faucett Associates, 1997), the aggregate traffic on the Upper Mississippi River is forecasted to increase slightly over 90 percent from 1991-93 to 2050. The comparable increase forecasted for the Illinois Waterway is slightly less, about 86 percent. Many of the locks were designed to accommodate a fraction of the current traffic using this transit system. All but two of the locks (Keokuk, Lock & Dam 19; and Melvin Price, Lock & Dam 26) on the system are 600 feet long; whereas many of the tows using the rivers are approximately 1200 feet long.

The Upper Mississippi River/Illinois Waterway (UMR/IWW) is also a national treasure in terms of its ecosystem and recreational values. Any improvements to the existing navigation system designed to move traffic through the system more efficiently must take into consideration their impact on the environment and recreation.

In view of all of these considerations, the "Upper Mississippi River/Illinois Waterway System Navigation Feasibility Study" is being conducted to determine how best to manage the Upper Mississippi River/Illinois Waterway system in a manner that balances navigational, environmental, and recreational needs.

The Upper Mississippi River/Illinois Waterway Bank Erosion Study is one of many studies being conducted to assess potential environmental impacts associated with possible improvements to the navigation system and will ultimately be included as supporting documentation for the System Environmental Impact Statement for the Upper Mississippi River/Illinois Waterway System Navigation Feasibility Study.

Project Overview

Hydraulics of flow, secondary circulation, turbulence characteristics, tow operation, increased commercial and recreation traffic, channel modifications, and or wind-generated waves and geotechnical processes to include piping, rapid recessional loading, cleft pressures, and slaking may all result in increased bank erosion or migration of existing bank erosion sites. Bank erosion, in turn, can result in the loss of cropland, forest, pasture, and residential, municipal, wetland, and riparian zones. This affects plant and animal uses of aquatic and terrestrial bankline areas, cultural resources and historic properties located along bankline areas, and human uses of bankline areas. In addition to direct erosion impacts to the bankline, eroded soils, fills, and recently deposited alluvium from the banks may increase sedimentation of the backwater areas and side channels, increase the dredging maintenance requirement, may increase water treatment costs and adversely affect the operating life of machinery, may affect shellfish quality, and may affect recreational uses and aesthetic qualities of the river ecosystem.

Rivers erode, transport, and deposit sediments from the back of the bank or the bank of a channel area. If banks are protected, related impacts could include channel bed degradation.

Streambank erosion is an extremely complex process, but there are primarily three types of causative mechanisms in the bank erosion process (USACE, 1981). These are: 1) mechanisms that displace soil particles from the bank surface; 2) mechanisms that destabilize the internal structure of the bank, resulting in failure of soil blocks or entire segments of the bank; and 3) mechanisms that transport the displaced soil particles or failed soil blocks away from the bank. Unless the stream can remove the displaced soil particles or the failed soil blocks through transport processes, the bank will tend toward a stable or aggrading condition. Soil displacement mechanisms include abrasion by ice and debris, biological processes, chemical processes, flow velocity, freeze-thaw, gravity, human activities, precipitation, waves, and wetting/drying processes. Internal soil failure mechanisms include slope instability, piping, liquefaction, tension cracks, swelling and shrinking, stresses from rapid recessional loading, cleft pressure, and surcharge. Transport mechanisms include gravity, human action, and water flow. A detailed discussion of the causative physical processes that produce these bank erosion conditions is presented in appendix A, "Upper Mississippi River System Bank Erosion Literature Study".

As part of the environmental impacts assessment effort for the Upper Mississippi River/ Illinois Waterway System Navigation Feasibility Study, a Bank Erosion Plan of Study was included in the Initial Project Management Plan (IPMP). It was determined that changes in bankline as a result of bank erosion could impact the riparian habitat of fish and wildlife and cultural resources along the bankline. It is also important to understand these processes as they relate to the potential loss of land and its effect on property ownership, structural integrity, etc. Therefore, the study proposed an investigation of the extent of existing bank erosion, the probable processes that cause bank erosion, and the potential for further bank erosion, particularly as related to navigation traffic.

Six tasks were identified in the IPMP for this effort with a decision point after Task 3. Task 1 was to conduct a literature search to identify applicable and available references for use in decision making in the other tasks; this literature review is presented in appendix A. Task 2 was to conduct a system-wide inspection of the Upper Mississippi River/Illinois Waterway systems with a multi-disciplinary team to quantify the present extent of bank erosion and to attempt to discern the most probable causes of that erosion. Based on the pertinent literature and the field inspections, Task 3 involves qualitatively assessing the relative significance of commercial navigation to existing bank erosion. If navigation effects on bank erosion cannot be discerned from other causative factors, or if navigation effects are not considered significant, the bank erosion study will terminate. Otherwise, Tasks 4 and 5 will require some type of "modeling" effort to establish future conditions, with and without the project, based on projections of future navigation traffic growth; and Task 6 would be a final report. The specific scope of this study and report is to address Tasks 2 and 3 and to make a recommendation regarding Tasks 4 and 5.

Study Design

This study was designed to identify and describe riverbank conditions and bank erosion sites on the entire Upper Mississippi River/Illinois Waterway. It was designed also to identify the major erosion sites, inventory those bank sites, identify bank soils and sediments, and provide opinions as to the erosion and failure mechanisms at each location.

The literature review completed prior to this study was available for reference throughout the design and completion of this study. Also, an aerial reconnaissance survey of bank conditions was completed prior to initiation of this study. During the aerial reconnaissance survey, oblique color video imagery and color still photos of every bank-mile adjacent to the navigation channel on the Upper Mississippi River/Illinois Waterway were obtained. The video imagery and still photos were indexed to ground-coordinated positions using global positioning system (GPS) equipment onboard an aircraft. This information also was available for review at the onset of this study.

Scope of Work and Tasks

The scope of work for this study identified the following work tasks:

1. Review the bank erosion study literature review conducted by the U.S. Army Corps of Engineers Waterways Experiment Station (Maynord and Martin, 1996 - appendix A).
2. Develop a classification system for all significant bank erosion sites.
3. Review the aerial video imagery and available mapping for preliminary selection of at least 60 sites for detailed study and data collection during the boat reconnaissance survey.
4. Conduct a boat reconnaissance survey, with a multi-disciplinary study team, of the Upper Mississippi River/Illinois Waterway to document existing bank conditions. Field data will be collected from a minimum of 60 sites, and the team will provide opinions as to the erosion and failure mechanisms at each site.
5. Select five sites for detailed traffic impact studies — these studies were not done.
6. Prepare a report that includes a review of historical and technical information; a review of video photography and mapping, a detailed description of the classification system and resulting attribute database development; a report of the boat reconnaissance, including detailed descriptions of each of the approximately 60 sites selected for detailed investigations, opinions as to what initiated bank failure mechanisms and processes, a description of the five sites selected for detailed traffic impact studies and reasons why these sites were selected; opinions regarding the relative significance of bank failure and erosion mechanisms and navigation effects on bank erosion and failure; and complete mapping of all recorded eroding banks and photographs taken during the boat reconnaissance.
7. Prepare an electronic database file containing all bank erosion classification system attribute data collected for the approximately 60 sites selected for detailed investigations.

The scope of work required the study team to identify and describe riverbank conditions and bank erosion sites on the entire Upper Mississippi River System, including the Illinois Waterway. The study focused on the Upper Mississippi from the confluence with the Ohio River (River Mile, or RM 0) to the Upper St. Anthony Falls Lock (RM 854), and on the Illinois Waterway from Grafton, Illinois (RM 0), to Joliet, Illinois (RM 286).

The detailed scope of work for this study is contained in appendix B. Some deviation from the scope of work occurred during the study process, and these deviations are discussed in the appropriate locations throughout this report.

Past Studies

The literature review presented in appendix A addresses all literature found to be pertinent to the Upper Mississippi River/Illinois Waterway Bank Erosion Study. Several studies have been conducted on the Upper Mississippi River and the Illinois Waterway specifically to address commercial and recreational navigation impacts on bank erosion. Most notable of these are: Bhowmik and Schicht (1980); Bhowmik, Demissie, and Guo (1982); Hagerty (1988, unpublished); Spoor and Hagerty (1989); and Johnson (1994). These authors present a variety of opinions on the subject of bank erosion and the relative significance of navigation traffic-generated waves as an erosion mechanism.

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Bhowmik, N.G. and R.J. Schicht. 1980. *Bank Erosion of the Illinois River*. Report of Investigation 92, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820, 52p.

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Initial Project Management Plan. 1994. *Upper Mississippi River-Illinois Waterway System Navigation Study, Baseline Initial Project Management Plan*. U.S. Army Corps of Engineers, Rock Island District.

Jack Faucett Associates. 1997. *Waterway Traffic Forecasts for the Upper Mississippi River Basin.* Volume I: Summary. JACK FAU-97-405-10. Jack Faucett Associates, 4550 Montgomery Ave., Suite 300 North, Bethesda, Maryland 20814. Submitted to Institute for Water Resources, U.S. Army Corps of Engineers.

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Spoor, M.F. and D.J. Hagerty. 1989. *Bank Failure and Erosion on the Illinois Waterway*. Proceeding, International Symposium on Sediment Transport and Modeling. ASCE, New York, N.Y.:600-605.

U.S. Army Corps of Engineers. 1981. *Final Report to Congress: Main Report* -- *The Streambank Erosion Control Evaluation and Demonstration Act of 1974.* Section 32, Public Law 93-251.

Chapter 3. Data Collection

Basic data collection followed the procedures outlined by Bhowmik et al. (1990) and by Bhowmik and Schicht (1980) and Hagerty (1989). All the data collected and/or measured have been entered in a database.

During 1995, the project principals formed a multi-disciplinary study team to conduct the reconnaissance boat trip with members from the Illinois State Water Survey, the University of Iowa – Iowa Institute of Hydraulic Research, and the U.S. Army Corps of Engineers Rock Island and Huntington Districts. The intent was to conduct a survey by boat and occasional shore expeditions along the Illinois River from Dresden Island Lock and Dam (RM 271.4) to Grafton (RM 0), and along the Mississippi River from St. Paul, Minnesota (RM 830.1) to Cairo, Illinois (RM 0).

Two objectives were accomplished during the boat trips: documenting bank conditions along both sides of the river on navigation charts, and selecting representative sites, collecting data on each site and forming opinions about the causes of erosion at each site. Originally, it was proposed to select and collect data from 20 sites along the Illinois Waterway and 40 sites along the Upper Mississippi River. The total number of sites where field data were collected exceeded these numbers. Moreover, data also were collected from several island sites, and some data were collected from several observation sites.

Boat Trip

This section will describe in general the boat trips that were conducted on the Illinois and Upper Mississippi Rivers. It was not possible to conduct the boat trips in a continuous fashion because of the logistical and personnel needs. Field trip participants included staff and personnel from the Illinois State Water Survey; the U.S. Army Corps of Engineers Rock Island, Huntington, St. Paul, and St. Louis Districts; the University of Iowa — Iowa Institute of Hydraulic Research; and the Illinois Natural History Survey.

Each boat had a team assigned to conduct one or more specific tasks. All the daily activities were planned and coordinated in advance. The daily activity normally started with pre-selecting the potential sites for field data collection based on an evaluation of the aerial photographs and video prior to arriving at the boat docks, checking equipment and supplies, and then starting field work.

Communication among boats was maintained through the use of cellular phones and marine radios. A chase vehicle on the shore provided logistical support throughout the day.

The entire team normally was divided into three or four sub-teams, and each sub-team was assigned a specific task. Sub-team 1 was assigned to the main boat where all the necessary supplies were stored. The main boat was used also as the mapping boat where judgments were made as to the severity of the erosion along both sides of the river, and these judgments were recorded on navigation charts. Sub-team 1 partially was responsible for identifying potential field sites for additional data collection. Sub-team 1 also was responsible for coordinating overall data collection and providing the necessary support on the river.

Sub-team 2 was responsible for locating the latitude and longitude of each site by using a Global Positioning System. This team also measured the river cross section at the midsection of the selected site. Occasionally, cross sections of the channel, including eroding banks, were measured at the upstream and downstream ends of the site.

Sub-teams 3 and 4 were responsible for surveying at least three bank sections at each selected site. Bank section measurements were taken near the upstream and downstream ends of the reach and at the midsection. The team was responsible also for collecting bank soil samples, which included core samples and sediment samples from the river within wading depths. These two teams took shore-based photographs of the sites. A geomorphologist also worked on the Upper Mississippi River as part of the team.

All of the boat trips on the Illinois Waterway and the Upper Mississippi River were coordinated with the waterway operation personnel of the U.S. Army Corps of Engineers. Figures 3-1 and 3-2 are photographs depicting the field data collection activities.

Trip on the Illinois Waterway (IWW)

The study team completed the Illinois River survey on two different trips. From August 24-31, 1995, the team completed reconnaissance and site surveys from Ottawa (RM 240) to Grafton, Illinois (RM 0). From September 18-20, 1995, the team completed the remaining upper section from downstream of Brandon Road Lock and Dam (RM 282.5) to Ottawa (RM 240).

Figure 3-1. Field data collection on the Illinois Waterway

Figure 3-2. Field data collection on the Upper Mississippi River

The trip from August 24-31, 1995, was the first reconnaissance boat trip for the team. As planned, the team divided into four groups, each traveling by boat, to conduct the survey. A 36-foot field boat the *Richardson,* owned by the State of Illinois, was the home base for the study team. This boat was used to map bank conditions, store camp supplies and miscellaneous equipment, and provide shelter during inclement weather. Normally, the *Richardson* moved slowly and kept moving while other faster boats collected data from specific sites, and then caught up with the *Richardson*.

The second trip on the Illinois Waterway was completed September 18-20, 1995, when the field crew traveled from Brandon Road Lock and Dam (RM 286) to Ottawa (RM 240). During these two trips, 29 sites were selected and these sites were located on the Illinois Waterway Navigation Chart shown in figure 3-3. Table 3-1 provides the dates when these sites were selected and their locations.

Trip on the Upper Mississippi River (UMR)

The trip on the UMR was completed in three sections: from RM 838, St. Paul, Minnesota, to RM 484, Rock Island, Illinois (September 11-18, 1995); from Rock Island to Louisiana, Missouri, RM 283 (October 2-6, 1995); and from Louisiana to Cairo, Illinois, RM 0 (from October 12-17, 1995). During these trips a total of 43 sites were selected, as shown in figure 3-4. Table 3-2 shows the dates when these sites were selected and gives their locations.

Site Selection

One primary goal for the boat trip was to collect detailed information from representative sites for further testing and evaluation. A total of 29 sites on the Illinois River and 43 sites on the Mississippi River were selected for the detailed data collection and analysis. Information available to the team members selecting representative sites included an aerial oblique videotape, photographs, and information from the operation and maintenance personnel from the Corps of Engineers. Corps of Engineers personnel from the Huntington District reviewed all the videotape and aerial photographs and tentatively selected sites for detailed data collection from both rivers. This information and the input from the Operation and Maintenance personnel of the Corps of Engineers guided the selection of the sites before the field trip was initiated.

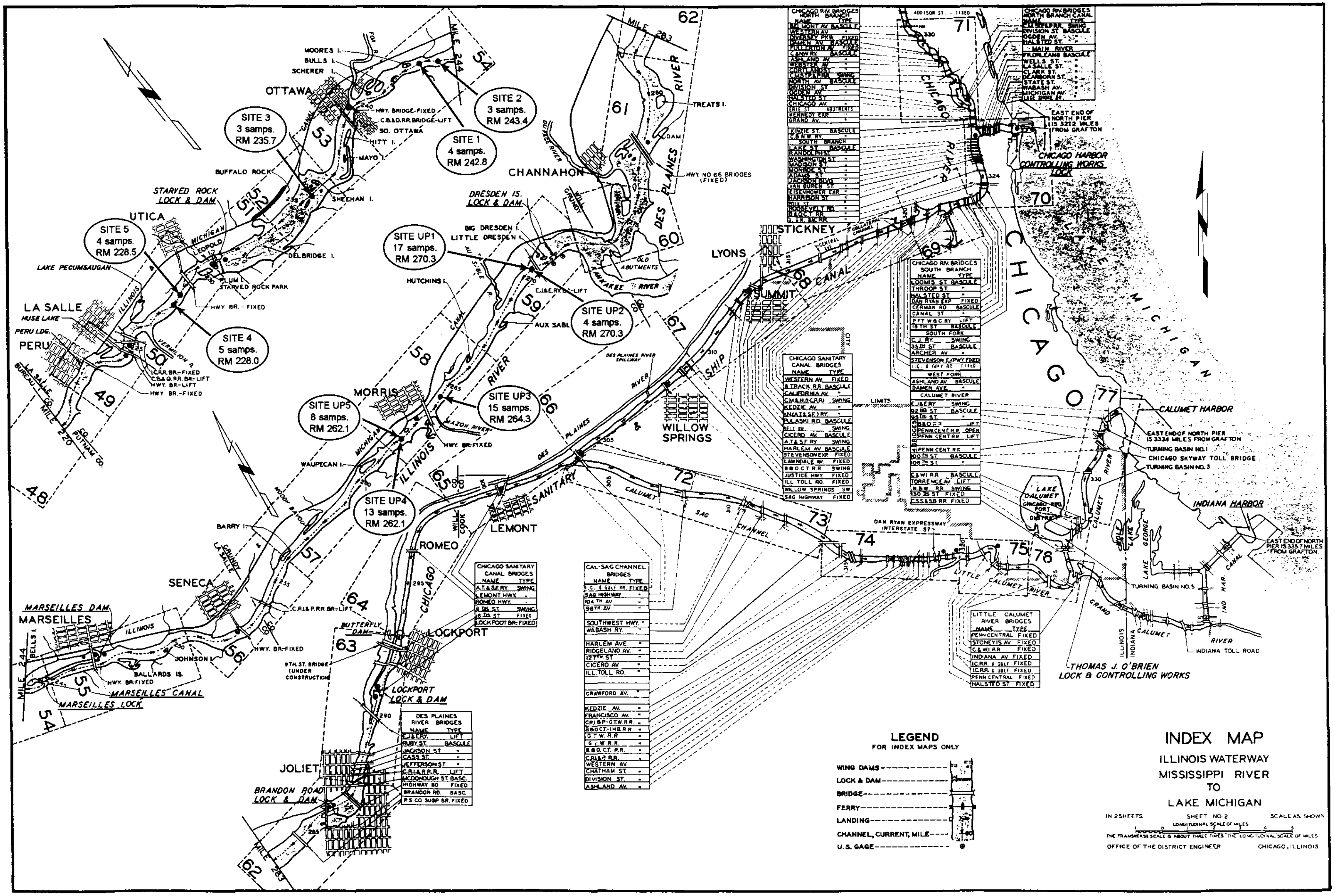

Figure 3-3. Location of field sites on the Illinois River

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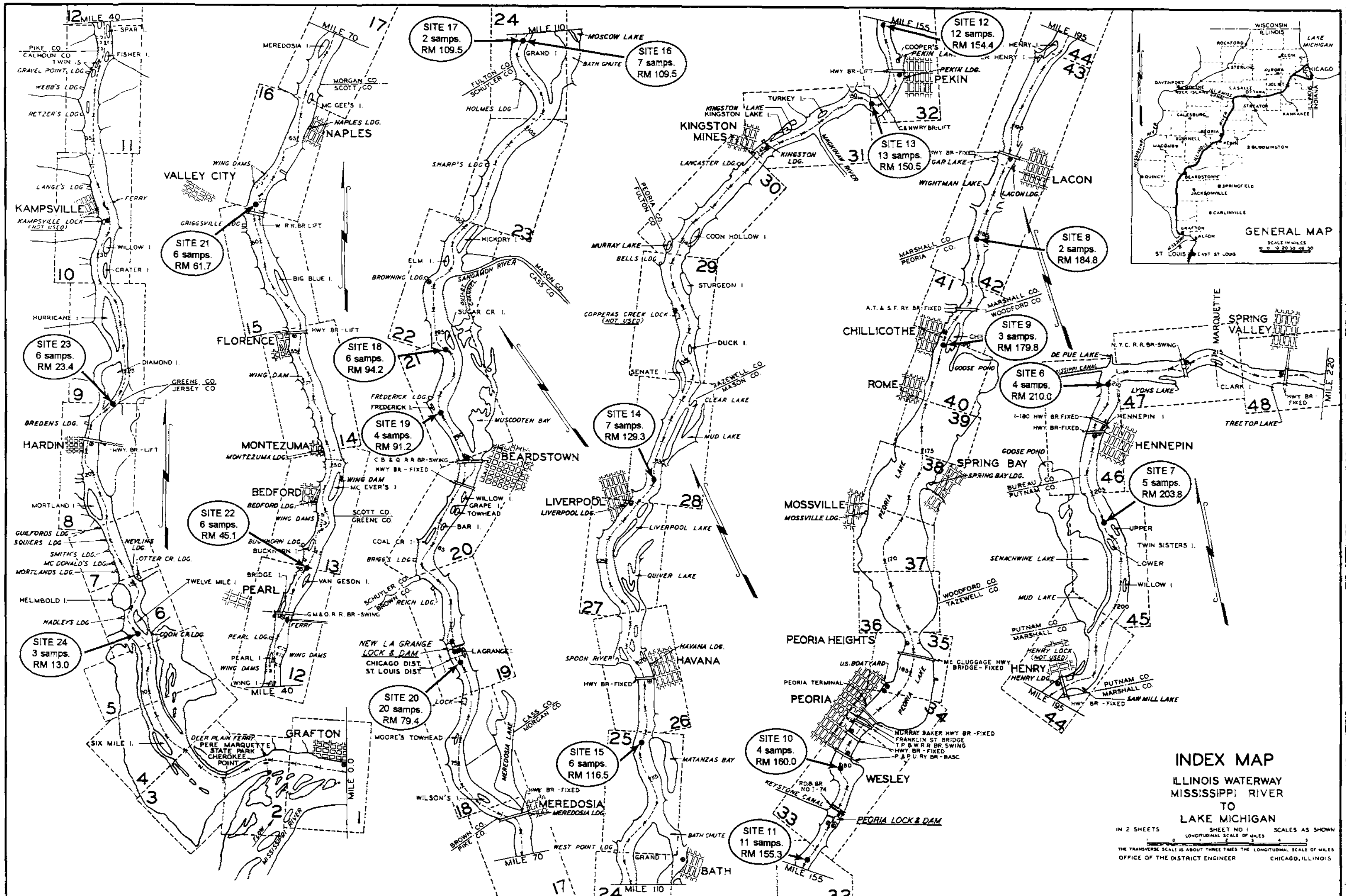


Figure 3-3. Concluded

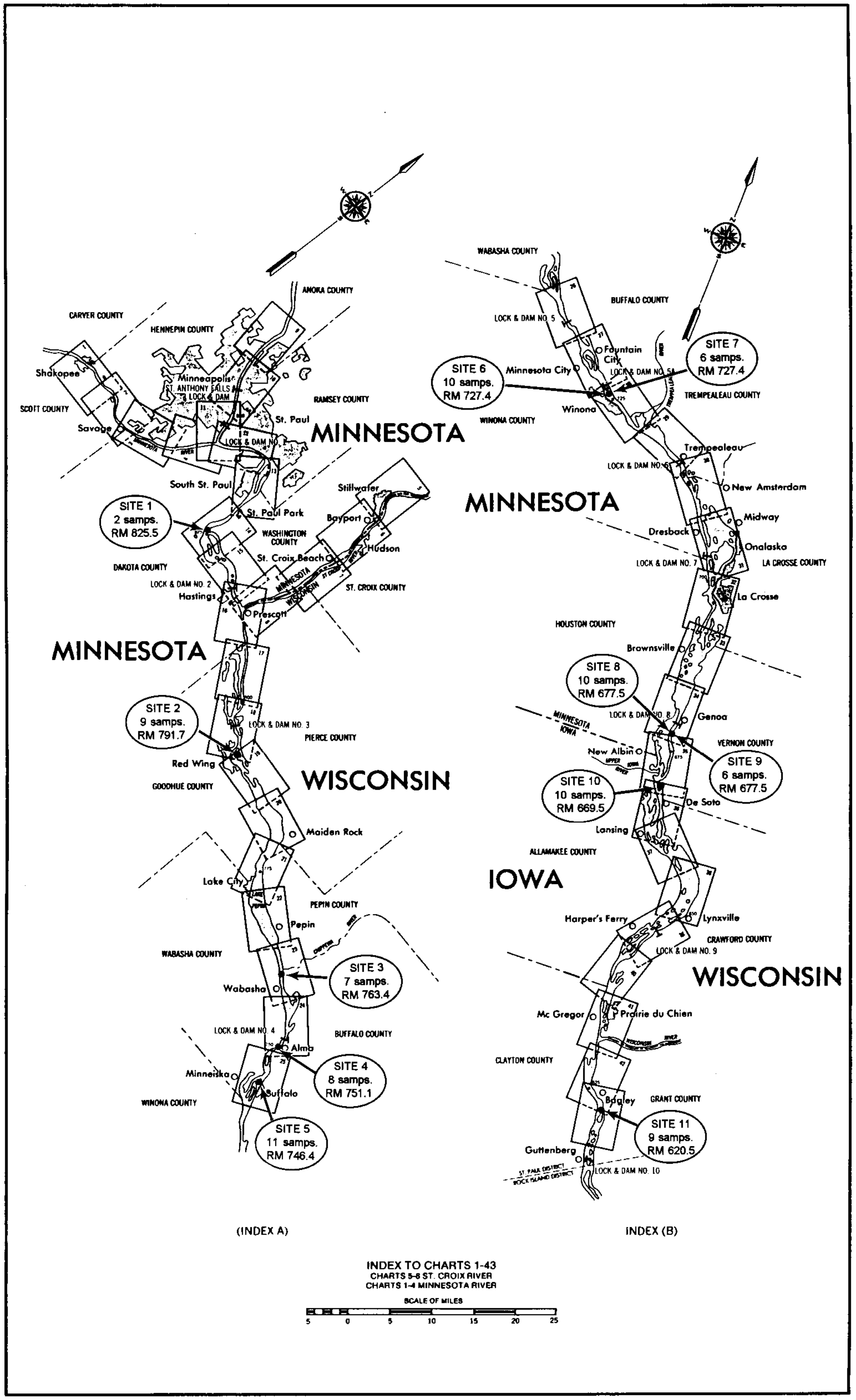
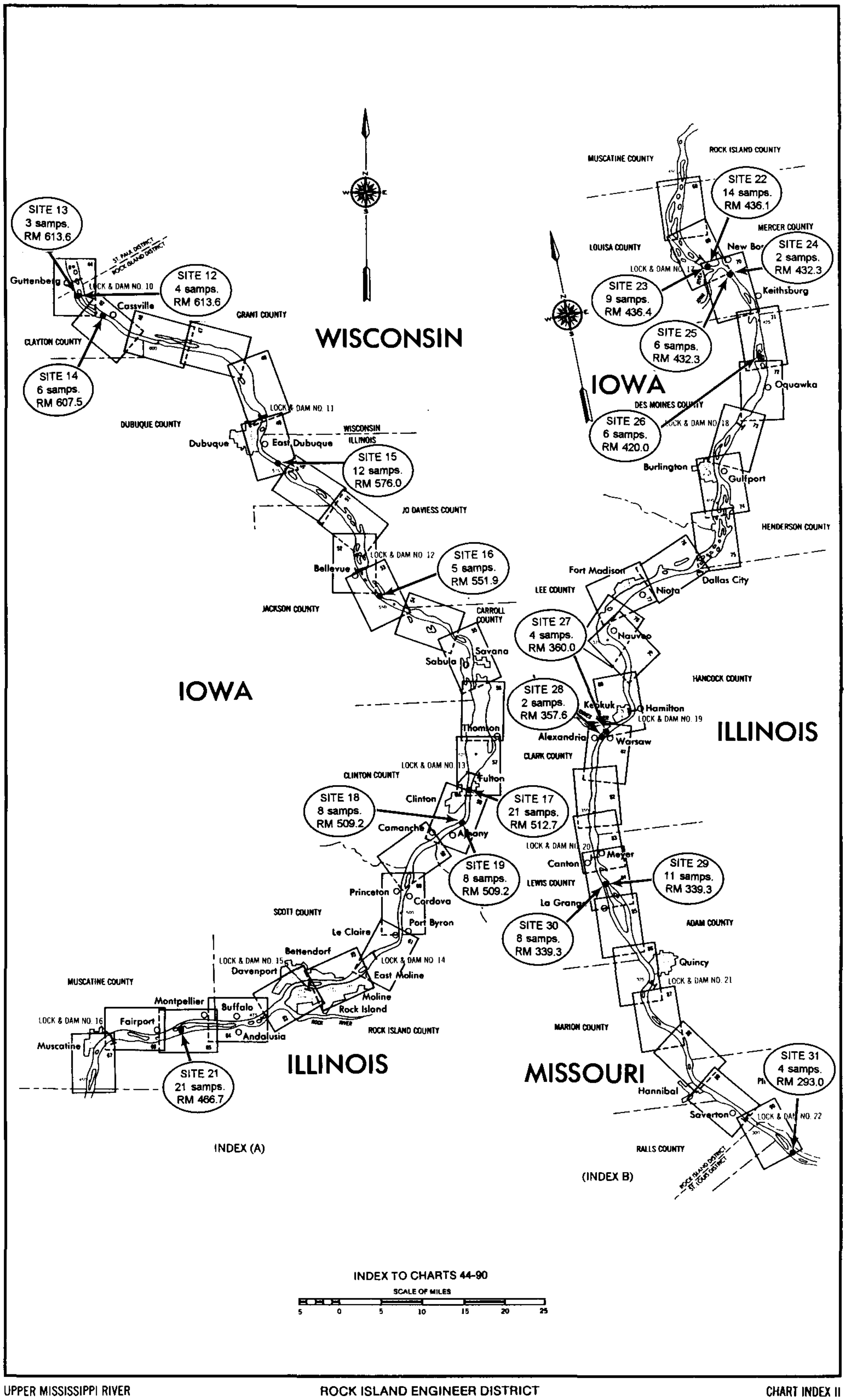
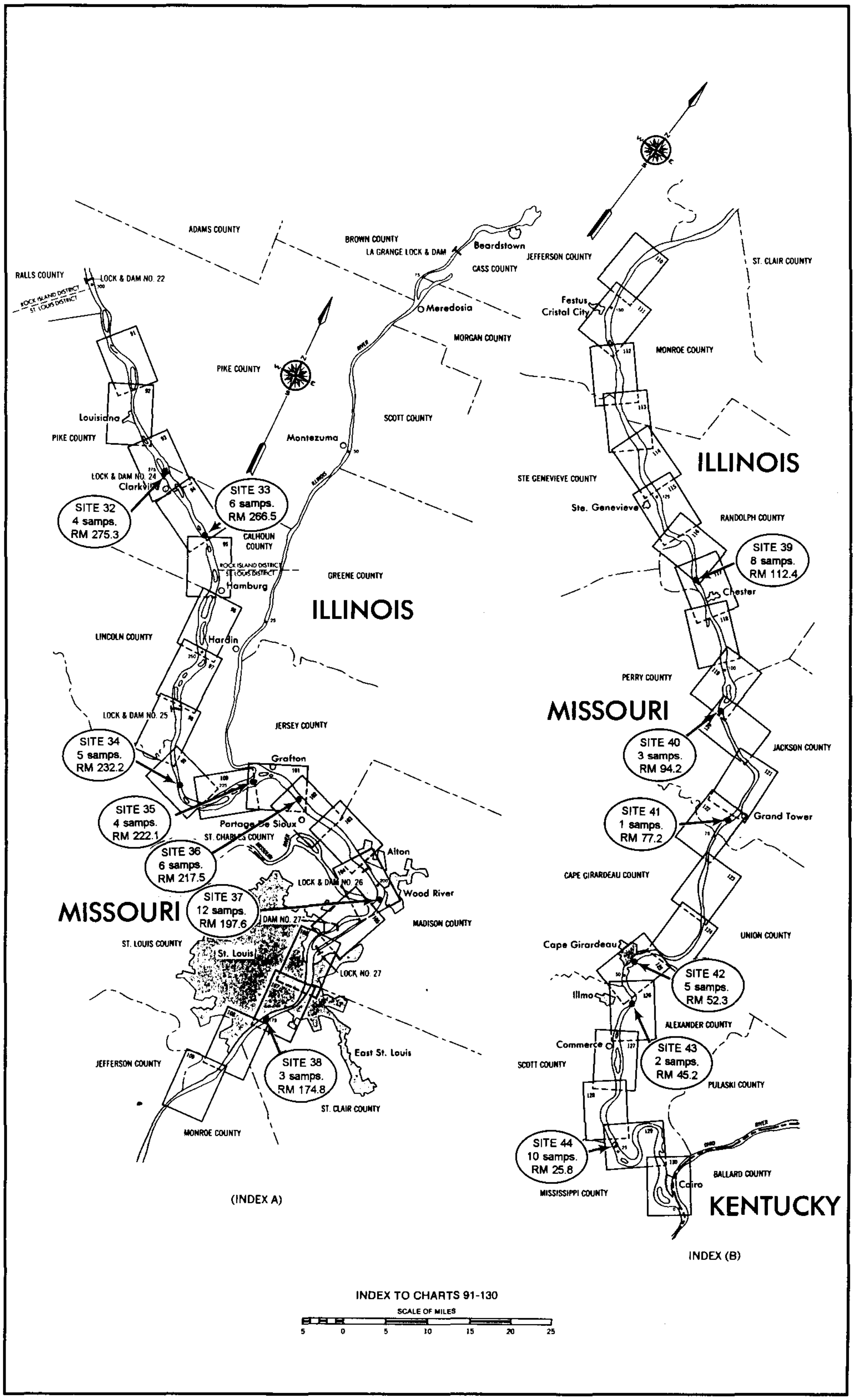


Figure 3-4. Location of field sites on the Upper Mississippi River



UPPER MISSISSIPPI RIVER ROCK ISLAND ENGINEER DISTRICT CHART INDEX II

Figure 3-4. Continued



UPPER MISSISSIPPI RIVER ST. LOUIS ENGINEER DISTRICT CHART INDEX III

Figure 3-4. Concluded

Table 3-1. Field Sites on the Illinois River: Date of Selection and River Miles

Date	*Rivers miles traveled*	*Sites selected*
9/18/95	RM 263 - RM 282.5-RM 263	UP1, UP2
9/19/95	RM 263 - RM 264.3 - RM 263	UP3
9/19/95	RM 263 - RM 244	UP4, UP5
8/28/95	RM 240 - RM 244 - RM 225.6	Sites 1, 2, 3, 4, 5
8/29/95	RM 225.6 - RM 160	Sites 6, 7, 8, 9, 10
8/30/95	RM 160 - RM 116.5	Sites 11, 12, 13, 14, 15
8/31/95	RM 116.5 - RM 79.4	Sites 16, 17, 18, 19, 20
9/1/95	RM 79.4 - RM 0.	Sites 21, 22, 23, 24

**Table 3-2. Field Sites on the Upper Mississippi River:
Dates of Reconnaissance and the River Miles**

Date	*River miles traveled*	*Sites selected*
9/11/95	838-793	1
9/12/95	793-753	2, 3, 4 (up, mid sections)
9/13/95	753-725	4 (downstream), 5, 6, 7
9/14/95	725-663	8, 9
9/15/95	663-620	10
9/16/95	620-583	11, 12, 13, 14
9/17/95	583-522.5	15, 16
9/18/95	522.5-484	17, 18, 19
10/2/95	484-437.3	21
10/3/95	437.3-410.5	22, 23, 24, 25, 26
10/4/95	410.5-343.2	27, 28
10/5/95	343.2-309	29, 30
10/6/95	309-283.1	31
10/12/95	283.1-241.5	32, 33
10/13/95	241.5-203	34, 35, 36
10/14/95	203-150	37, 38
10/15/95	150-109.9	39
10/16/95	109.0-53	40, 41
10/17/95	53-0	42, 43, 44

During the field reconnaissance trip many sites were found to be suitable for further data collection. The number of sites suggested by the Corps of Engineers generally exceeded the sites that the study team could examine each day. Moreover, the video tape did not reveal actual field conditions, especially at sites covered by vegetation. In some instances, dredge disposal sites appeared in the aerial photographs and videotape to be sites with severe erosion. Consequently, the team used two approaches to select a site for detailed data collection. First, the team prepared a list of potential sites based on aerial photographs and videotape review, indicating geomorphic characteristics of the sites (straight reach, crossover, inside or outside bends, etc.). The team then determined the sites that would be visited that day. At significantly eroded sites where the team could not obtain complete data, personnel recorded the main features and called those sites "observation" sites. An observation site was a site that either had features similar to those measured at other sites, or the site was not sufficiently representative to conduct a full-scale survey. A limited amount of data was collected at observation sites.

Erosion Site Mapping

Sub-team 1 was responsible for indicating on navigation charts the various degrees of erosion on both sides of the river by means of a color scheme to indicate the severity of erosion. Evaluations noted on the charts are all approximate, not based on measurements. In spite of these shortcomings, the navigation charts with erosion sites marked still will provide extremely valuable information about the current bank erosion of these two rivers.

Navigation charts were colored to indicate the severity of erosion at various locations, ultimately only four major colors will be included:

red	severe erosion clear scarp with approximate height 4 feet or higher
orange	medium erosion scarp with approximate height less than 4 feet
blue	minor erosion; moderate scarp bare bench
green	stable, almost no erosion

Notes were also written on any navigation features discernible from the boat. Figures 3-5 and 3-6 show two pages from the navigation charts with field notes inscribed. Marked and colored navigation charts were a separate product of this study (appendix J).

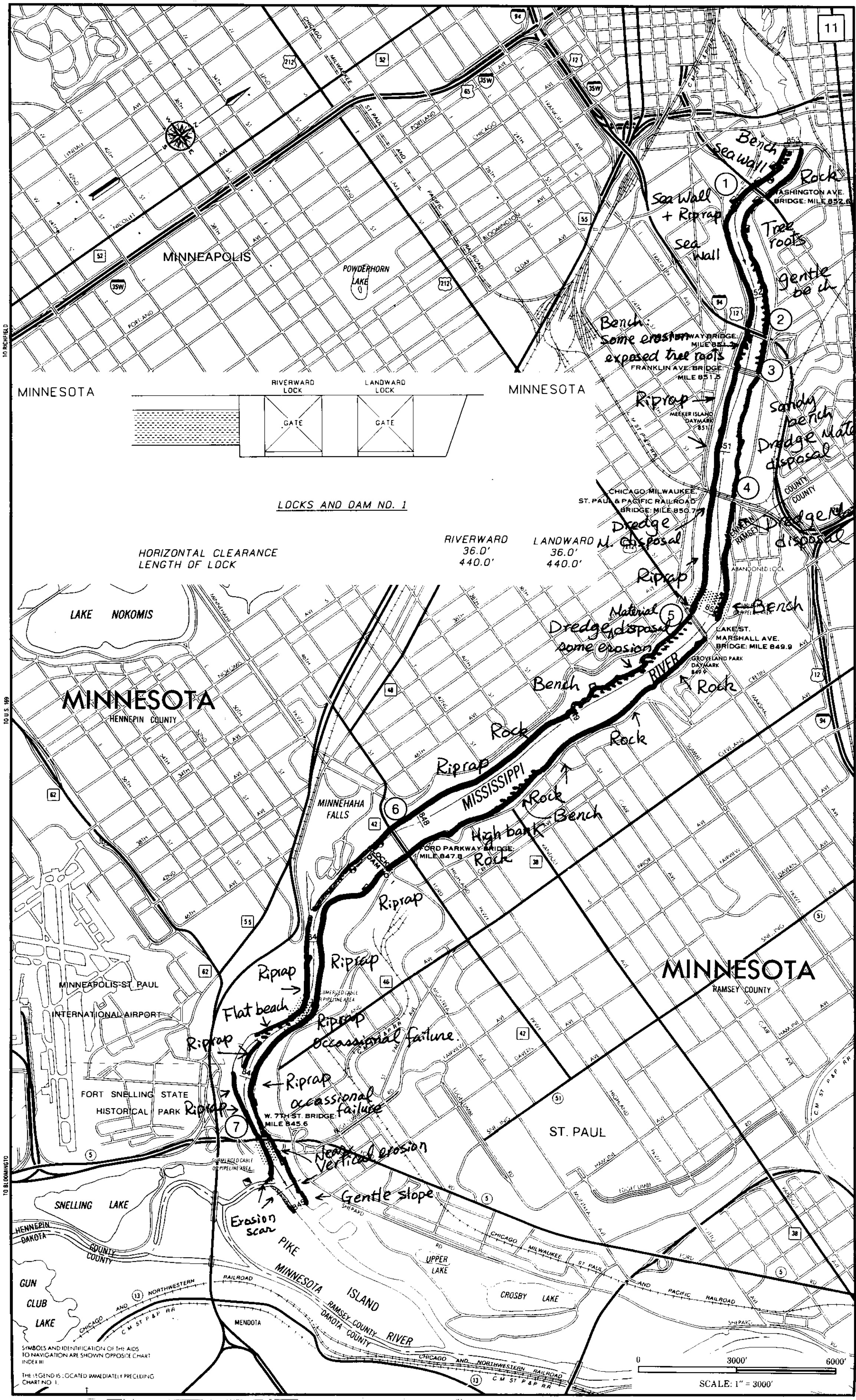


Figure 3-5. Field notation on the Upper Mississippi River navigation chart
This reach extends from approximately RM 845 to RM 853

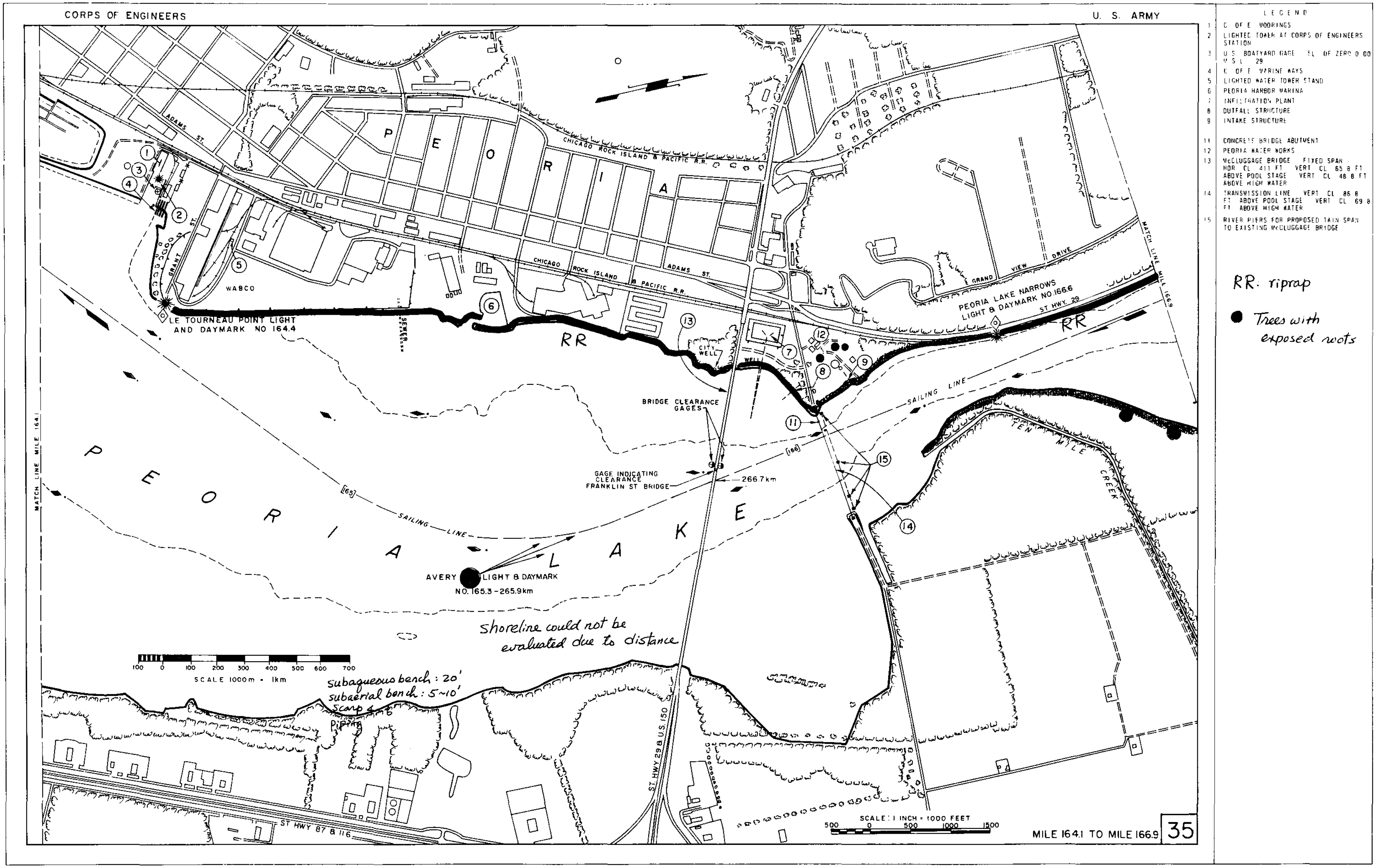


Figure 3-6. Field notation on the Illinois Waterway navigation chart This reach extends from approximately RM 144.8 to RM 150.6

Field Data Sheets

The study team developed standard field data sheets that were used for the trips on the UMR and the IWW. Figure 3-7 shows a sample data sheet used to record information in the field from the selected site.

Data collected from the observation sites were recorded on an “Observation Data Sheet Form” (figure 3-8). Again, the main information included the location of the observation site, and a description of the surrounding areas, including vegetation, soil types, and in some cases one or more sketches of the bank section. Information collected can be divided into four categories, including bank sections extended from bank crest to a near channel depth of 2 or 3 feet; and soil samples – surficial samples from the bank crest, failure faces, berm, or bench, and core samples from nearshore areas (at depths of 1 or 2 feet); and vegetation, land use, exposed root, and adjacent appearance. Protocols for data collection have been prepared and are given in the sampling section of this chapter that describes sampling activities.

In many instances, three bank sections were chosen at the main site and three data sheets were prepared. For observation sites, normally only one sheet was completed.

Sampling

The field team was divided into two to four sub-teams. Sub-team 1 was responsible for marking the upstream and downstream limits of each site reach and also for collecting data at upstream and downstream quartile points. Sub-team 2 was responsible for the bulk of the data collection effort, concentrated at the midpoint section: a detailed bank section; a river cross section; surficial bank sampling (including core sampling of shallow water soils and sediment); photographing bank soils at each sampling point; and drawing site sketches.

Data collection from the upstream and downstream ends essentially consisted of measuring bank sections occasionally measuring river cross sections, and in a few instances, bank soil and sediment core sampling. Figure 3-9 shows photographs of typical data collection activities at a site on the Illinois River.

0	Recorder's Name(s) -- First/Last	
1	Date & Time (e.g., 8/16/95 13:30)	
2	Weather	
3	River (ILWW/UMR)/Discharge (cfs)	
4	Navigation Pool No.for UMR/Name for ILWW	
5	Flat Pool Elevation (ft)	
6	Local Pool Elevation (ft) (Rising/Falling?)	
7	Site #: (RM @ Midpoint)	
8	Bank Profile (UP/MP/DN?)	
9	Right Bank/Left Bank/Island (Tip/LT/RT/End?)	
10	Approx. RM of Erosion Site (miles)	
11	U/S RM of Erosion Reach (miles)	
12	D/S RM of Erosion Reach (miles)	
13	U/S UTM (x,y)	
14	D/S UTM (x,y)	
15	Natural or Revetted Bank (N/R)	
16	Geomorphic Characteristics (see Codes)*	
17	Surrounding Structures (see Codes)**	
18	Archaeological Site (Y/N)	
19	Recreational Boat Traffic (L/M/H)	
20	Commercial Boat Traffic (Mean Daily Traffic?)	
21	Distance from Edge of Navigation Channel (ft)	
22	Land Use on Bank Crest (see Codes)***	
23	Vegetation at Bank Ledge (see Codes)****	
24	Vegetation on Bank Face (see Codes)****	
25	Assessment of Root Exposure on Bank Face	
26	Alongshore Vegetation (see Codes)*****	
27	Bank Failure Face Height (ft)	
28	Bank Failure Face Slope (ft/ft)	
29	Basal Berm Height (ft)	
30	Basal Berm Width (ft)	
31	Nearshore Underwater Slope (ft/ft)	
32	Bench Description	

Page 1: @ RM ________ on (ILWW/UMR: Pool # _______)

Figure 3-7. Sample data sheet for bank-erosion reconnaissance work group
Upper Mississippi River/Illinois Waterway navigation impact study: streambank erosion

*Code for #16	**Code for #17	***Code for # 22
C: Crossover I: Inside bend L: Island O: Outside bend S: Straight reach	C: Side-channels closure structure D: Boat Docks F: Fleeting area M: Mooring area W: Wingdams (I.D. #) & Conditions	A: Agriculture (Type?) G: Grass/Weeds (Species?) H: Highway I: Industrial L: Levee R: Railroad embankment U: Urban W: Wooded (Species?)

****Code for #23 & #24	*****Code for #26
A: Agricultural rows (Type?) G: Grass/Weeds (Type?) W: Wooded (Species?)	N: Nonsubmerged vegetation (Type?) S: Submerged vegetation (Type?)

33	Stage Variability (High, Moderate, Low)	
34	Erosional /Failure Features(Y/N); Description and Location Relative to Measured Profiles	
35	Overbank/Bank Drainage (Y/N); Extent and Location Relative to Measured Profiles	
36	Bank Erosion/Failure Type, Structure, Geometry & Causative Factors (see Code*#)	
37	Bank Failure Face Soil Type (see USC Sheet)	
38	Basal Berm Soil Type (see USC Sheet)	
39	Nearshore Soil Type (see USC Sheet)	
40	Channel Profiles Taken (Y/N?) If Y, how many?	
41	Soil Samples Taken (Y/N?) If Y, how many?	
42	Photographs Taken (Y/N?) If Y, how many?	
43	Video with Naration Taken (Y/N?)	
44	Potential for Future Field Investigations?	
45	Additional General Remarks:	

*#Code for #36	*# Code for #36	
F: Fall RS: Rotational Slump PG: Planar Glide LS: Lateral Spreading DS: Debris Slide	C: Cantilevers S: Slabs B: Blocks L: Loose	SL: Slaking P: Piping W: Wave&Prop Rework&Transport

Page 2: @ RM ________ on (ILWW/UMR: Pool # ________)

Figure 3-7. Continued

<Bank-Erosion Site Sketches>

A)

B)

Page 3: @ RM ________ on (ILWW/UMR: Pool # ________)

Figure 3-7. Concluded

1	Date/Time	
2	River Mile (Left/Right)	
3	Navigation Pool Number	
4	UTM Coordinates	
5	Bank Type	
6	Geomorphic Characteristics (see codes)	
7	Surrounding Features	
8	Land Use	
9	Vegetation	
10	Bank Description	
11	Soil Type and Description	
12	Photographs	
13	Geologic Context LSA (see Anderson)	
14	Additional Comments	
15	Bank Sketch - on back (Y/N)	

Figure 3-8. Sample observation site data sheet for bank-erosion reconnaissance work group Upper Mississippi River/Illinois Waterway navigation impact study: streambank erosion

<Bank-Erosion Site Sketches>

A)

B)

@ RM ________ on (ILWW/UMR: Pool # ________)

Bank Sections

Bank sections at most sites were measured using standard surveying equipment, and procedures:

- A temporary benchmark on the bank was established.
- A standard level, leveling rod, and measuring tapes were used to measure the elevations of the bank at various locations on a transit starting from the top of the bank.
- Bank elevation measurements extended from the top of the bank to the water's edge and beyond, into 2-4 feet of water depth.
- All the measurement points, including distances and elevations, were recorded on field notes.
- A sketch of the bank section was also made on the field note pad.
- Similar measurements were occasionally repeated at the upstream or the downstream measuring section.

Bank Soils

Procedures used to collect bank soil samples follow:

- At least three surficial samples were collected at all the midsection measuring sections.
- These samples were collected by using either an ordinary garden shovel or a scraper.
- All the samples were preserved in zip-lock bags and clearly identified with time and date, river, location, river mile, and sample location relative to the bank section.
- Specific sample locations were measured and noted in field notes. Numbered posts in figure 3-9 were the locations where soil samples were taken.
- In general, three to nine samples were collected at each measuring section.
- When deemed necessary, core samples above the water's edge also were collected.

Subaqueous Core Samples

Subaqueous core sampling determined the composition and particle size distribution of these surficial soils and sediment. The sampling procedures were as follows:

- Sampling was done at 1 and 2 foot depths along each profile line.
- A WILDCO core sampler was used with a graduated sample tube.
- The sampler was inserted as far as manually possible, then removed.
- The sampler was kept upright (vertical) after the sample was taken and while the contents of the tube were removed.

- For each sample, the total core length and the length of each separate horizon (with zero at the surface) were recorded on the appropriate sampling bag.
- After the length measurements were made, the sample was removed from the inner graduated tube and placed on a wooden sampling board. The core was divided into horizon samples which were placed in labeled sample bags.
- After each sample was taken the sample tube, corer tip, and corer threads were cleaned thoroughly.

Global Positioning System

A global positioning system (GPS) was used to locate the midsection, upstream limit and downstream limits, and positions of any other important points on each site, to an accuracy of ± 3 meters. Figure 3-10 shows a photograph of the boat and clearly marked antennas used to measure the cross section.

River Cross sectional Profile

Procedures used to measure the cross section of the river are as follows:

- A boat equipped with a sonar depth sounder with an accuracy of ± 0.3 meters and a GPS unit were used.
- Once the midsection was located, two end points defining the cross section where depths were to be measured were identified, and the sounding boat was brought as close to the shore as possible.
- Tick marks with distances were noted on the sounding chart, and the exact distance from the starting point was noted on the strip chart. Figure 3-11 shows such two strip charts for sites 4 and 5 on the Illinois River at RM 228.1 and RM 228.5, respectively.
- Strip charts and associated data were subsequently used to develop cross sections of the rivers.

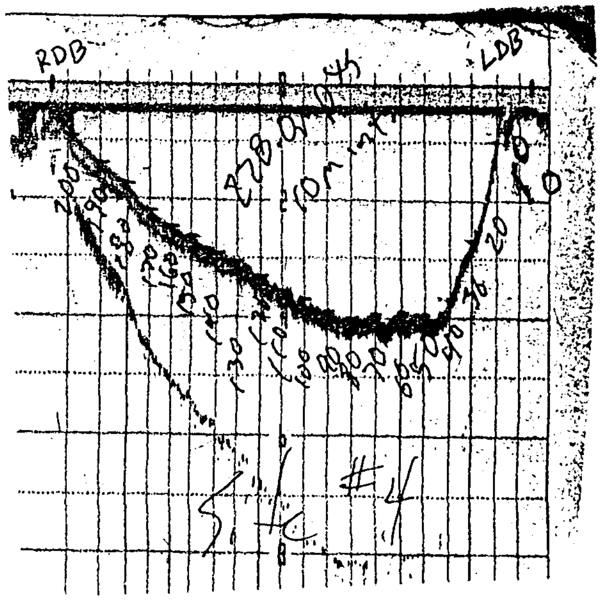
Island Sites

Many island erosion sites displayed similar patterns of bank morphology, erosion, and deposition. The following procedures were used when island sites were sampled:

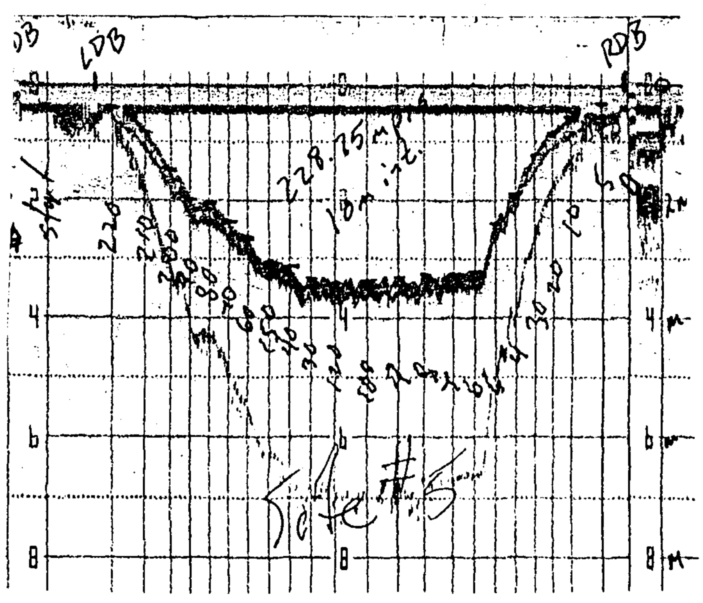
- Island sites were chosen by consensus of the study team from reaches adjacent to the navigation channel.

Figure 3-9. Typical data collection activities at a bank erosion site

Figure 3-10. River cross section measurement by
A ISWS boat equipped with the GPS and Sonnar



RM 228.1
Site 4



RM 228.5
Site 5

Figure 3-11. Strip chart showing river cross sections on the Illinois River

- In addition to the three bank sections sampled for bank erosion sites, bank sections were taken at the upstream (head) and downstream (tail) ends of the island. Bank sections were also taken on the back of the island (side away from the navigation channel).
- Bank soil and core samples were collected at the midpoint section, and at the upstream and downstream limits.
- At the upstream and downstream limits of a reach, a minimum of one bank sample and one core sample at a 2 foot depth were collected. Additional samples were collected at these locations as necessary, four samples at each location.
- At island sites, bank core samples were collected at the midpoint section. Additional bank cores were collected at the upstream and downstream ends of the island.
- A cross-channel section was measured along the line of the midpoint bank section. Additional cross-channel sections were measured, provided there was sufficient evidence to suggest changes in the channel section along the length of the island.
- Longitudinal profile at several locations along the length of the island approximately 20-30 feet from the edge of water were also measured.

Twenty-nine sites on the IWW and 43 sites on the UMR were selected for detailed data collection during the field visits.

Other Information

The data sheets developed to collect various data from each of the erosion sites also contained information on vegetation, presence of bank revetments, wing dams, tributary mouths, general appearance of the banks, dredge material disposal site close by (if any), land use on bank crest, exposed roots, bench description, bank drainage, presence of seepage, and other related data. This information was contained in the field notes (figure 3-7).

References

Bhowmik, N.G., A.C. Miller, and B.S. Payne. 1990. *Techniques for Studying the Physical Effects of Commercial Navigation Traffic on Aquatic Habits*. Environmental Research Program, U.S. Army Corps of Engineers Technical Report, EL-90-10, 129p.

Bhowmik, N.G. and R.J. Schicht. 1980. *Bank Erosion of the Illinois River*. Report of Investigation 92, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820, 52p.

Hagerty, D.J. 1988. *Illinois Waterway Bank Evaluation*. Unpublished report submitted to the U.S. Army Corps of Engineers, Rock Island District, 64p

U.S. Army Corps of Engineers. 1974. *Navigation Charts of the Illinois Waterway*. U.S. Army Corps of Engineers District, Chicago. 46p.

U.S. Army Corps of Engineers. 1989. *Navigation Charts of the Upper Mississippi River*. U.S. Army Corps of Engineers districts: Rock Island, St. Louis, St. Paul. 131p.

Chapter 4. Classification Parameters and Database Structure

This chapter illustrates the set of parameters used in the field to classify the bank erosion sites from the IWW and the UMR; and the organization of a database.

Site Location

- River
- Navigation pool
- Right or left descending bank
- Upstream river mile
- Downstream river mile
- Upstream UTM coordinates
- Downstream UTM coordinates

Site Attributes (limited to selected erosion sites)

Anthropic characteristics. These data were developed prior to boat reconnaissance.

- Natural or revetted bank
- Presence/absence of wing dam(s) (as noted)
- Presence/absence of archaeological sites
- Recreational or commercial traffic levels
- Distance from center of navigation channel as shown on the navigation charts.
- Land use on bank crest

  Urban
  Industrial
  Agricultural
  Wooded
  Grasses and weeds
  Levees
  Railroad tracks

Geomorphic characteristics.

- Inside bend
- Outside bend
- Straight reach
- Transition reach
- Island

Erosion attributes (limited to the sites selected for detailed investigations). The study team adapted a nearshore bank failure model in bank assessment. A typical bank section consists of three features, i.e., scarp, berm and bench (figure 4-1). This portion of the data was recorded at each site or developed shortly after field survey.

- Failure scarp height
- Failure scarp slope
- Basal berm height
- Basal berm width
- Failure scarp soil type
- Basal berm soil type
- Underwater slope
- Nearshore sediment type
- Vegetation at top of failure scarp
    - Wooded
    - Grasses and weeds
    - Agricultural row crops

Additional parameters that were measured whenever possible include the height and extent of exposed tree roots and heights of seepage and/or wave-wash created scarps.

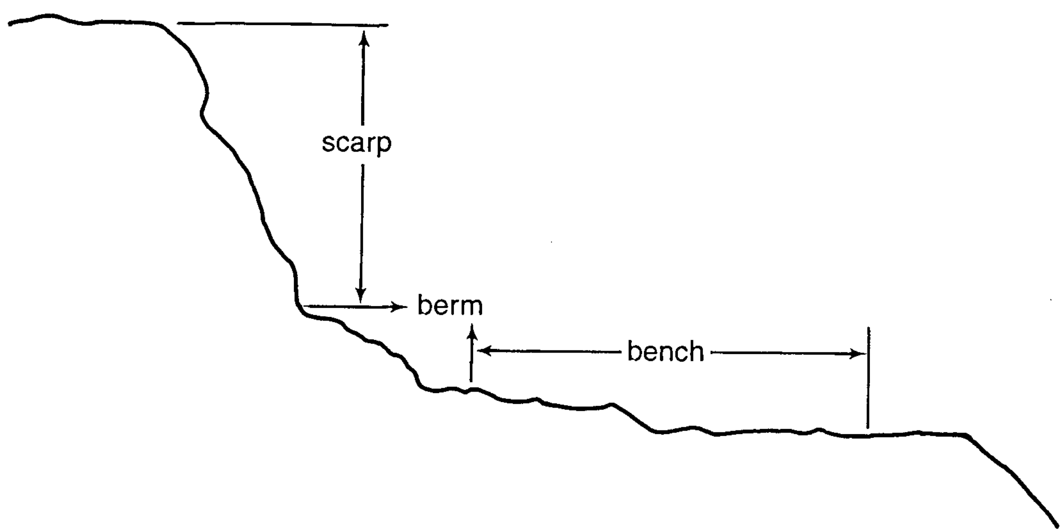


Figure 4-1. Definition sketch for scarp, berm, and bench

Database Development

To organize the parameters described above, two database systems were developed for the IWW and UMR, respectively (appendix I). Each database contains information summarized from the field notes or calculated from measured data, as shown in table 4-1.

Table 4-1. Information Organized in the Database

Site #
  Date
  Time
River
  River mile at midpoint
Bank Section
RDB or LDB
Location Name
  Geomorphic characteristics
Bank Type
Bank Section
Bank Type
Wing Dam
Archeological Site
Surrounding Structures
Commercial Traffic Level
Recreation Traffic Level
Distance to the Sailing Line
Land Use on Bank Crest
Bank Crest Vegetation Type
Scarp/berm Vegetation Type
Alongshore Vegetation
Assessment of Root Exposure on Bank Scarp/Berm

Bank Section
Failure Feature
Bank Drainage
Bank Crest Type
Failure Scarp Height
Failure Scarp Slope
Failure Scarp Soil Type
Berm Height
Berm Width
Berm Soil Type
Underwater Slope
Nearshore Sediment Type

River Mile at Midpoint
Bank Section
Channel Profile Taken (Y/N)
Soil Sample Taken (Y/N)
Photographs Taken
Potential for Future Field Investigation
Bench Description

Chapter 5. Characterization of Bank Erosion and Failure Mechanisms

This section will describe in general terms some of the characteristics of the riverbanks and near-bank benches (e.g., soils, slopes, depositional features, failure, and erosion mechanisms). Stage histograms (appendix C) were also developed to facilitate the evaluation of the bank failure and erosion processes of the UMR and the IWW.

Soil Classification

The soil classification system used for this project was based on the Unified Soil Classification System as shown in table 5-1, (WES, 1982). In this classification system, the soils are classified according to their texture, consistency, particle size distribution, and a combination of these parameters. This system was used as a guide in the field to classify surficial bank soils.

Bank Erosion and Failure Mechanisms

Bank failure and erosion on any stream can result from instability of bed and/or banks. Channelization or other stream modifications often change the stream gradient and can cause erosion. Therefore natural and man-controlled rivers can have different causes and extent of bank failure and erosion. Hydraulic and geotechnical evaluations should be conducted to determine the causes of bank retreat, and enable the resource agencies to address major mechanisms of streambank failure and erosion. Several interrelated processes define failure and erosion extent, severity, and resultant topography. These can be described as velocity and turbulence of flowing water, wave action, and tow transiting and mooring effects, including physical impacts, runout and runup, bank recharge and discharge, rapid recessional loading, cleft pressures, piping, slaking, ice wedging, plucking, and gorging. Within river systems with permanently retained navigation pools (where water levels are no longer allowed to drop below certain elevations, as opposed to natural fluctuations in open rivers), the relative significance and occurrence of some of the referenced mechanisms can be modified by increased channel cross sectional area for discharge of low and moderate flows, limited extents of recession from high stages, reductions in cleft pressures and seepage velocities, and restriction of areas subject to slaking and ice wedging. The effects of persistent seepage and wave action, within near normal pool elevations, have most probably resulted in the formation of benches. Lower bank benches found on controlled-stage waterways are locations of failed soil and recently deposited sediment reworking and erosion. Scarp and failed soil berms are effected by precipitation freezing-thaw, wetting and drying, seepage, stage, and flood flows and somewhat remote from the normal pool land/water contact and were not directly affected by persistent erosion processes within bench areas. Extensive erosion of banks, berms, and benches can occur during flood events.

A study of streambank erosion in the United States by the U.S. Army Corps of Engineers (1981) determined that 575,000 bank miles were eroded, and that 142,000 river miles were eroded seriously. In the Upper Mississippi River basin, about 14,800 bank miles were eroded along 198,200 stream miles (USACE, 1981).

Keown et al. (1977) identified six types of streambank erosion:

1. Attack at the toe of the underwater slope, leading to bank failure and erosion. Bank failure normally occurs in a falling river at a medium stage or lower.
2. Erosion of soil along the bank caused by current action.
3. Sloughing of saturated cohesive banks, i.e., banks incapable of free drainage due to rapid drawdown.
4. Flow slides (liquefaction) in saturated silty and sandy soil banks.
5. Erosion of the soil by seepage out of the bank at relatively low channel velocities.
6. Erosion of the upper bank or river bottom or both due to wave action caused by wind or passing boats.

A more detailed list of streambank failure mechanisms was compiled in a final report to Congress by the U.S. Army Corps of Engineers (1981), as shown in figure 5-1.

More recently, Neill and Yaremko (1989) compiled a list of 14 causes of bank erosion, seven in natural environments and seven in disturbed environments. In watersheds without human disturbance, the causes are: 1) the geological (geomorphic) process of valley widening, 2) meandering in alluvial floodplains, 3) extreme floods, 4) debris and vegetation, 5) coarse sediment, 6) ice and frozen banks, and 7) geotechnically unstable banks. Vegetation is usually considered a stabilizing factor, but protruding trees can cause erosion, and fallen trees may become debris and cause rapid local scour. Neill and Yaremko's list of causes in disturbed watersheds includes: 1) development and land use change, 2) removal of bank vegetation, 3) boat-generated waves, 4) constructed bridge crossings, 5) bank protection and river training works, 6) mining of sand and gravel from streambeds, and 7) stream straightening and channelization.

Table 5-1. Unified Soil Classification System

Major Division		*Type*	*Letter symbol*	*Typical names*
COARSE-GRAIN SOILS >50 percent of material is retained on #200 sieve	GRAVELS (>50 percent of coarse fraction is retained on #4 sieve)	Clean gravels	GW	gravel, well graded, gravel-sand mixtures, little or no fines
			GP	gravel, poorly graded, gravel-sand mixtures, little or no fines
		Gravels with fines	GM	silty gravel, gravel-sand-silt, mixtures
			GC	clayey gravel, gravel-sand-clay mixtures
	SAND >50 percent of coarse fraction passes #4 sieve	Clean sands	SW	sand, well graded, gravelly sands
			SP	sand, poorly graded, gravelly sands
		Sands with fines	SM	silty sand, sand-silt mixtures
			SC	clayey sand, sand-clay mixtures
FINE-GRAINED SOILS >50 percent of material passes a #200 sieve		Silts and clays LL <50	ML	silt & very fine sand, silty or clayey find sand or clayey silt
			CL	lean clay, sandy clay, silty clay, of low to medium plasticity
			OL	organic silts and organic silty clays of low plasticity
		Silts and clays LL >50	MH	silt, fine sandy or silty soil with high plasticity
			CH	fat clay, inorganic clay of high plasticity
			OH	organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	peat, and high organic soil

Notes:

#4 sieve: particles with diameter of 4.75 mm or less can go through.
#200 sieve: particles with diameter of 0.075 mm or less can go through.
LL: Liquidation Limit

	Mechanism	*Description*
A.	Surficial	Stresses within a streambank are changed by particular actions at the bank surface. Examples of surficial actions that affect bank stability are: 1. Severe surface deterioration caused by a number of physical, chemical, biological, and human actions may result in an unstable bank configuration. Erosion at the toe of the bank slope due to streamflow, erosion at the water surface due to waves, and erosion along the bank surface due to overbank and seepage flows are three common occurrences. 2b. Deep tension cracks due to excessive drying of a cohesive soil or similar structural change may cause the streambank to weaken and become unstable. Slaking may occur if excessive drying is followed by submergence. 3c. Overburden placed along top-of-bank may cause an otherwise stable streambank configuration to become unstable.
B.	Moisture	Stresses and the ability of the bank material to withstand stress without failing are both affected by moisture variation within the bank. Examples of these moisture-induced effects are: 1. The slope of a cohesionless bank may be temporarily steeper than the angle of repose of the bank material due to capillarity or other nonpermanent stabilizing effect; when the nonpermanent effect is removed (usually by submergence and saturation of the bank material) the bank becomes unstable. 2. During piping, cohesionless material is eroded from a location on the bank surface by seepage flow; a cavity develops and extends rapidly into the bank along a dominant seepage path. 3. Liquefaction relates to fine-grained and loosely structured materials subject to a rapid increase in pore pressure (such as occurs during rapid drawdown or earthquake loading) and results in a large segment of bank material flowing downslope as a fluid-like mixture. 4. During periods of high water table and low stream levels an added hydraulic loading is placed on the bank structure; this added load may directly cause failure unless relieved otherwise (say by seepage or piping). 5. Swelling and shrinking during wetting and drying, respectively, affect the stability of clay soils. Substantial hydraulic pressures may result from water flowing freely into deep tension cracks (see Surficial, above) and into openings between different bank materials. 6. The shear strength of clay soils is highly dependent on pore pressure (slow versus quick shear) and by degree of saturation.
C.	Miscellaneous	Because of the nonhomogeneous (heterogeneous, interbedded, stratified, etc.) character of most streambanks, combinations of failure mechanisms are common; examples are: 1. Artesian or gravity flow within a cohesionless or porous layer that evacuates sediment particles by piping can result in shear failures of layers higher in the bank. 2. A thin clay layer that weakens and compresses during saturated bank conditions can also cause shear failures in the upper bank. 3. Lubrication by water and high hydrostatic pressures along interfaces between bank materials that cause low resistance to sliding may result in a massive bank failure.

Source: After U.S. Army Corps of Engineers (1981)

Figure 5-1. Streambank failure mechanisms

Streambank erosion contributes to the total sediment load in a stream. It was estimated that about 7 percent of the total sediment yield in the nation was from streambank erosion. Many Midwestern streams and rivers contribute heavily to this total volume of eroded sediment (USDA, 1975, USDS-SCS, 1973).

Bank erosion processes can be divided into two broad classes: those closely related to the geotechnical aspect of the soils and those related to the fluvial activities of the stream. Erosion itself, however, is the result of the dynamic interactions between these two broad divisions. Each is dependent on the other within any stream ecosystem (Bhowmik, 1983).

Streambanks can be of cohesive or noncohesive materials. Most natural banks are actually of composite materials, and some are presented in layered structures. Channel morphology often is also indicative of bank erosion. Bank erosion occurs often on the outside bank of a bend where water velocities and depths increase greatly. During floods bed scours may occur at the outside bank and make bank slope much steeper, in many cases almost vertical, thus increasing its instability.

Cohesive bank soils may be subject to a variety of failure mechanisms. Slip failures in cohesive bank soils are often brought about by rapid drawdown or rapid fluctuations of water levels. Other typical bank failure mechanisms in streams, rivers, and lakes are given in figure 5-2. In some instances, when a bank is saturated, a tension crack may develop on a horizontal surface due to hydrostatic pressure, which then exerts tensile forces on the bank soil. Rapid drying of the saturated bank can also produce vertical desiccation cracks accompanied by bank failure. Flood flow initiated erosional undercutting is a common type of failure for many cohesive and composite banks and can result in failure of the overhanging portion of the bank mass: 1) shear failure, 2) beam failure, and 3) tensional failure.

Bank Slopes

The slopes of riverbanks vary widely and from place to place. If a riverbank is composed of noncohesive materials without vegetation and tree roots, then the slope would tend to have a shape very close to the angle of repose of these soils. Since a natural riverbank is seldom composed of homogeneous soils, the bank slopes will vary. A nine-unit land-surface model proposed by Dalrymple et al. (1968) is shown in figure 5-3 to illustrate the various slope patterns that could be present in a land surface environment.

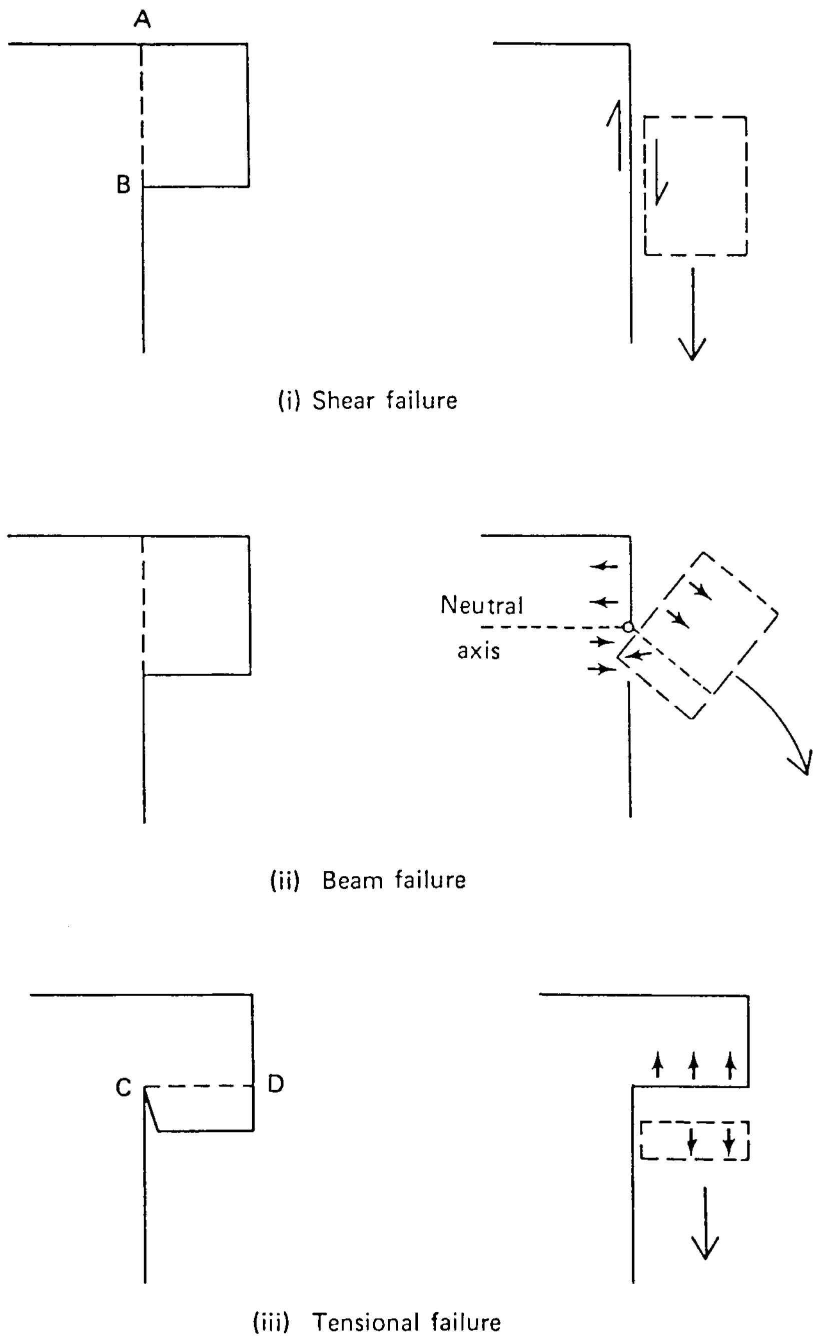


Figure 5-2. Modes of failure for cantilever overhang banks (from Bhowmik et al., 1983)

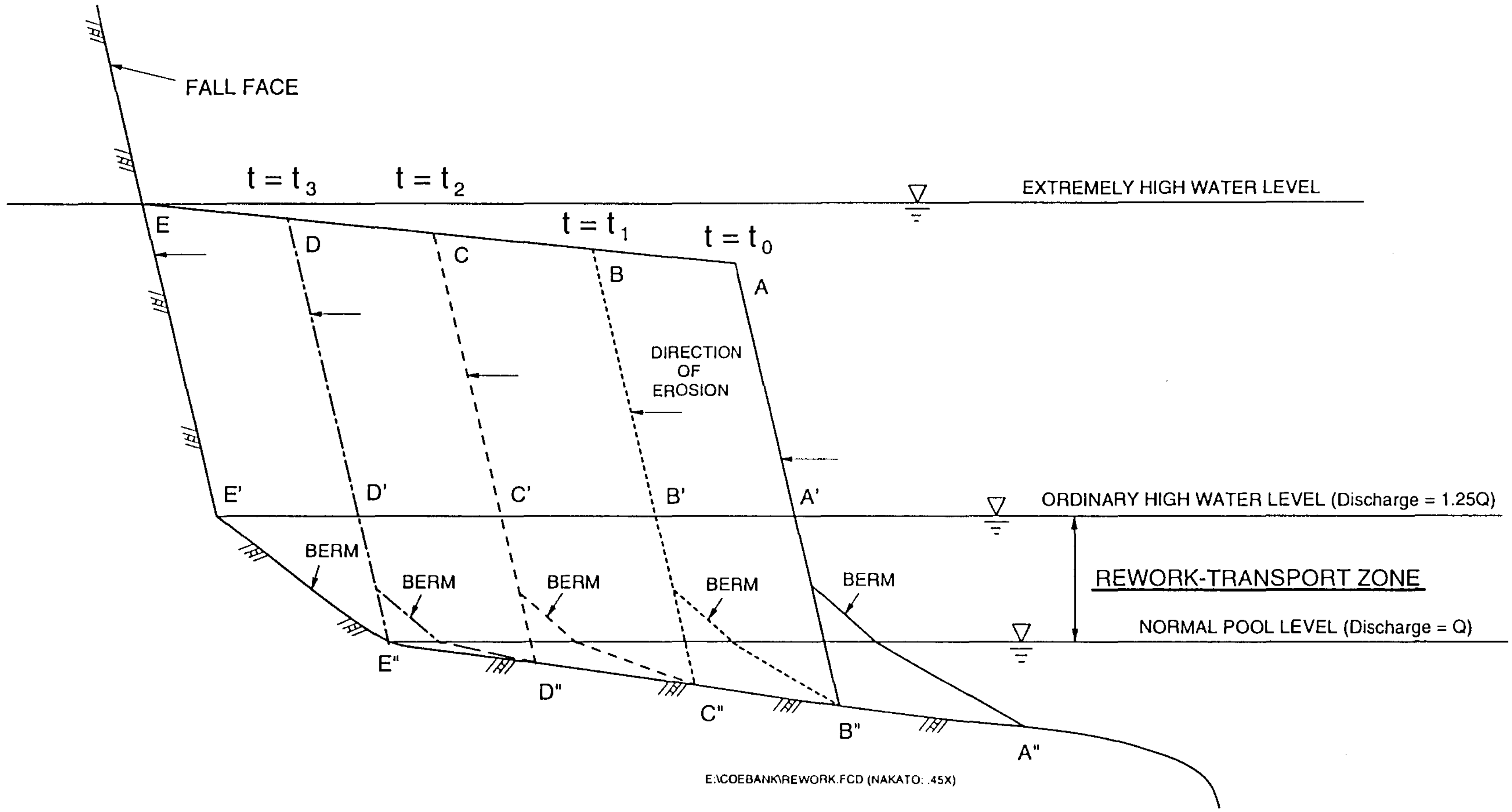


Figure 5-3. A hypothetical nine-unit land-surface model proposed by Dalrymple et al. (1968)

Another theoretical erosion pattern at and below the extremely high water mark in a free flowing system is shown in figure 5-4. This type of block failure was observed at several locations on the open river portion of the UMR shown by two sets of photographs in figures 5-5 and 5-6 for two water levels. Figure 5-5 shows a set of five photographs at RM 605, tip of the Sweezy Island on the UMR, taken when the water level was quite high and the bank eroded by waves overtopping. Figure 5-6 shows a riverbank at RM 52.3, site 42 on the UMR where bank failure took place due to failure of a sandy layer. Similar failure mechanisms were observed on the Illinois River. Again, riverbank failure and erosion can be interrelated with dominated erosional process and have been categorized in following these concepts. The following sections describe exactly what was done for both the Illinois and Mississippi Rivers.

Bank Soils

All the bank soil and core samples collected for this project were analyzed to determine particle size distribution, Standard Deviation, σ, and uniformity coefficient, U. These parameters are defined as follows:

Standard Deviation, $\sigma = 1/2 \left[\frac{d84.5}{d50} + \frac{d50}{d15.9} \right]$ (5-1)

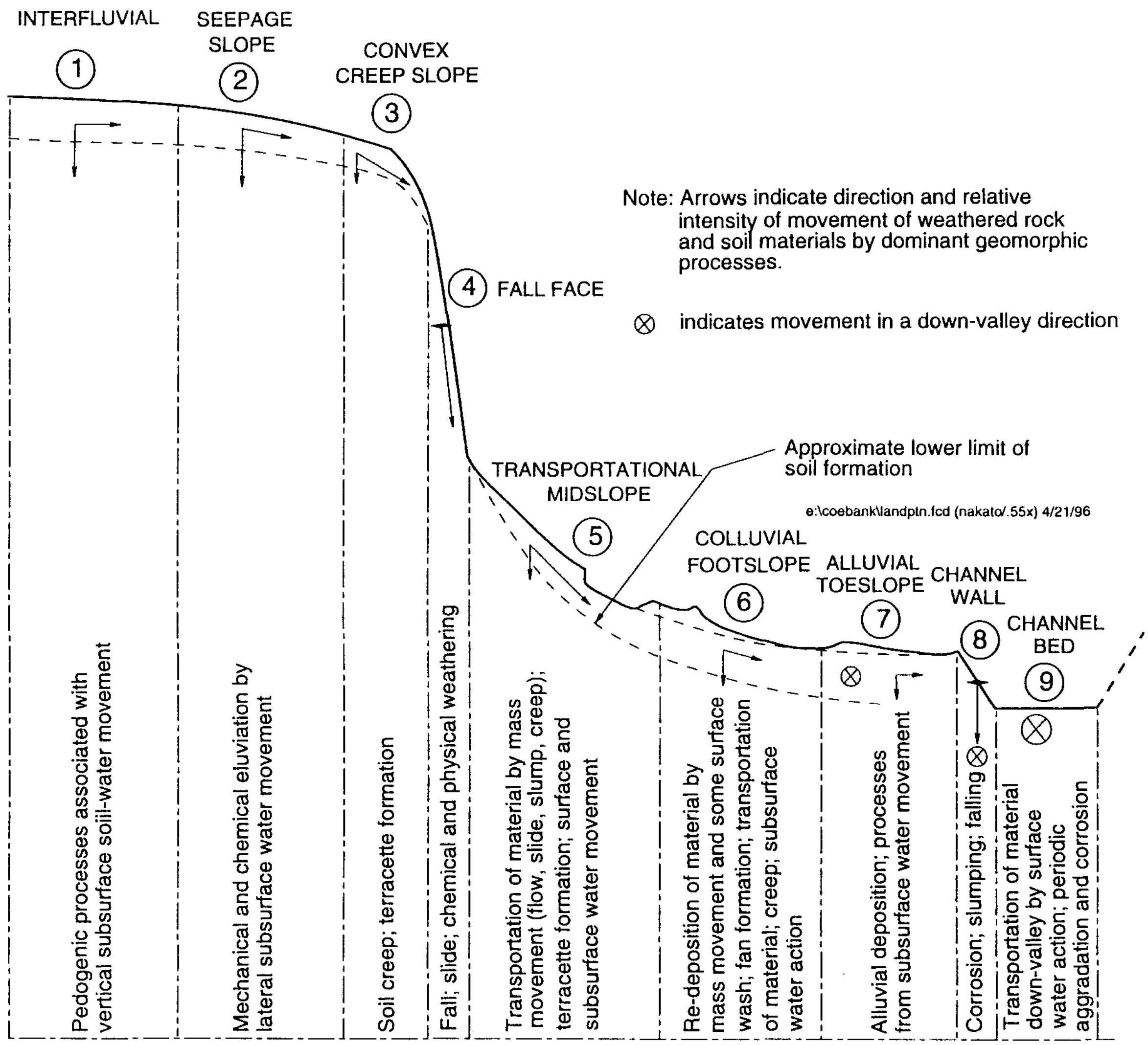
and

uniformity coefficient, $U = \frac{d60}{d10}$ (5-2)

The size distribution of the bank and core samples and the values of σ and U are described with the individual river basins in chapters 6 and 7.

Stage Histograms

During and after the field trip on the UMR and IWW, study teams found evidence that erosion patterns, bank slopes, and other features could be related to stage-duration data. It was decided that an analysis of stages at various locations would be done to compare with bank section features.



Re-drawn after Dalrymple et al., "A hypothetical nine-unit land surface model," Zeitschrift fur Geomorphologie, vol.12, 1968.

Figure 5-4. Near bank rework-transport zone

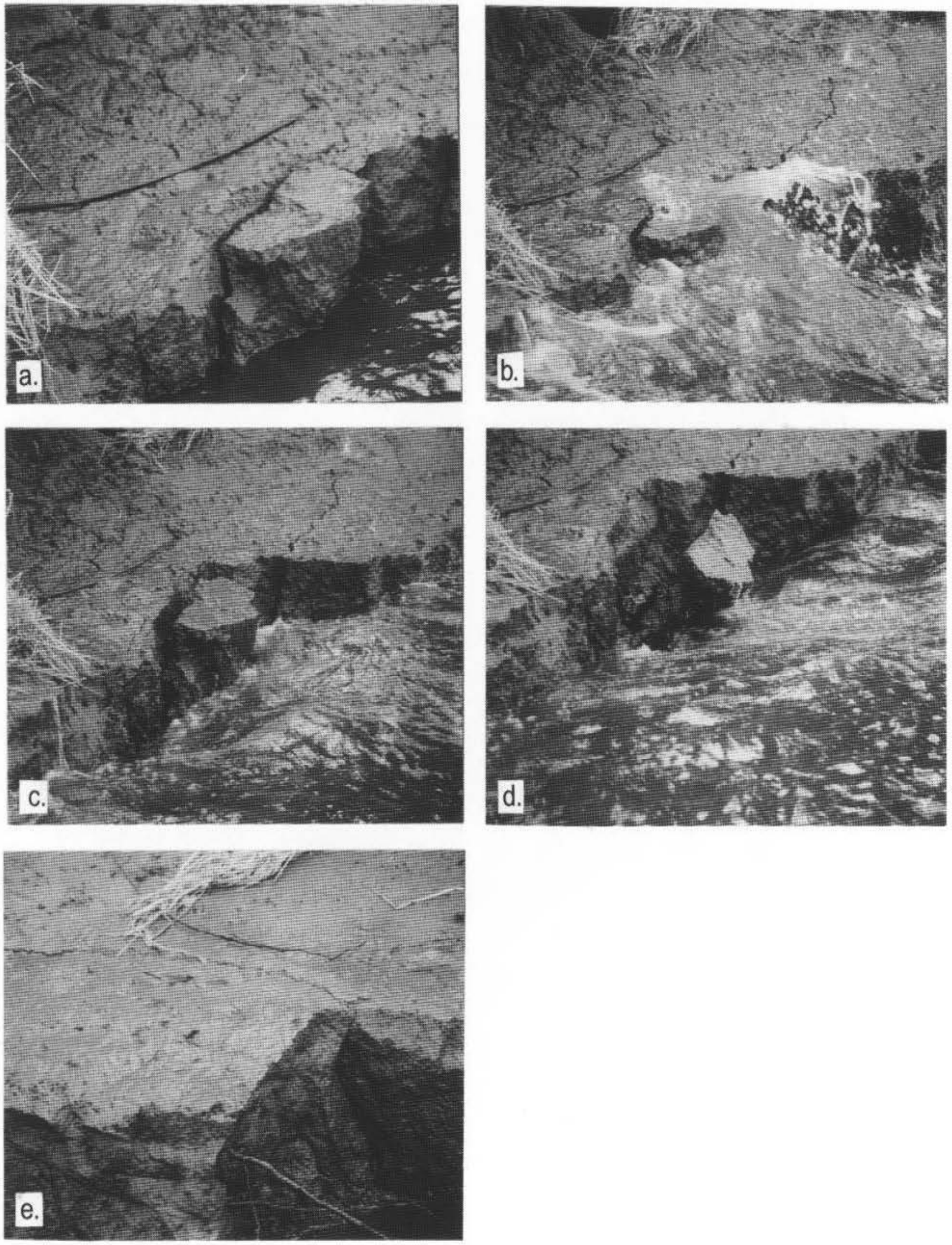


Figure 5-5. Bank erosion due to overtopping, RM 605, UMR

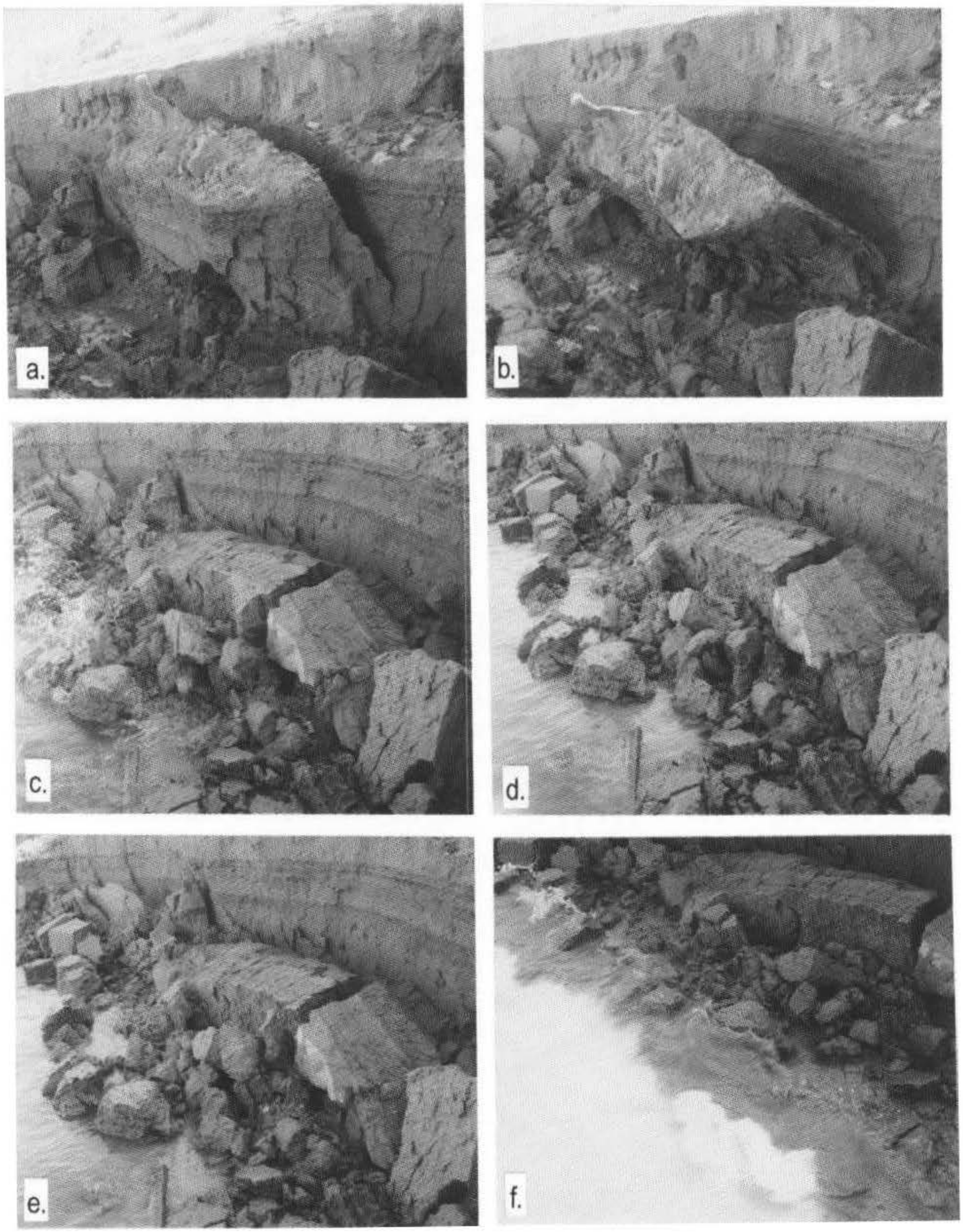


Figure 5-6. Bank erosion due to undercutting, RM 52.3, UMR

Consequently, data on daily water stages at stations close to the selected erosion sites on both the UMR and IWW were gathered for 1985-1994, from records kept by the U.S. Army Corps of Engineers and subjected to a statistical analysis to determine the histograms of water stages at the selected locations.

When stage data at each selected site was not available, the nearest available stage gage site within two miles was used in this analysis. Table 5-2 shows the stage gaging sites used to develop the stage histograms in connection with the IWW study. Table 5-3 shows similar information for the UMR study sites.

Data collected for the streambank sections at all the bank erosion study sites were plotted including information such as the Ordinary High Water Level (OHWL) and Low Operating Pool Level (LOPL). Note that LOPL and NP (normal pool) are used interchangeably in the test. Each plot of the bank section collected at each site was plotted with the stage histograms on the same sheet. Figure 5-7 corresponds to site UP1 on the IWW, and figure 5-8 corresponds to site 22 on the Mississippi River. Similar plot have been developed for all selected sites from both rivers (appendix C).

It should be noted here that figures 5-7 and 5-8 and all other similar plots were prepared to show the general orientation of the erosion sites. For example, site UP1 on the IWW is on the Right Descending Bank (RDB) of the river and site 22 on the UMR is on the Left Descending Bank (LDB) of the Mississippi River. Thus the bank sections were plotted on the right side of the figure looking from the top of the illustration to the bottom. Similarly, site 22 on the Mississippi River is on the LDB, and as such the bank sections were plotted on the left side of the illustrations looking from the top to bottom of the illustrations.

Subsequent sections describe the specific correlation between the stage histograms shown in figures 5-7 and 5-8, and the shapes of the bank sections.

Table 5-2. Stage Gaging Locations Used for the IWW Study Sites

Site #	*River mile*	*Gage used*	*Gage location, RM*
UP1	270.8	tail water gage of Dresden Island	271.5
UP2	270.8	tail water gage of Dresden Island	271.5
UP3	264.3	IL River near Morris, IL	263.1
UP4	262.1	IL River near Morris, IL	263.1
UP5	262.1	IL River near Morris, IL	263.1
1	242.8	tail water gage of Marseilles Pool	244.6
2	243.4	tail water gage of Marseilles Pool	244.6
3	235.7	Pool gage of Starved Rock Pool	231.0
4	228.0	tail water gage of Starved Rock Pool	231.0
5	228.5	tail water gage of Starved Rock Pool	231.0
6	210.0	IL River near Henry, IL	196.0
7	203.8	IL River near Henry, IL	196.0
8	184.8	IL River near Henry, IL	196.0
9	179.8	IL River near Henry, IL	196.0
10	160.0	gage of Peoria Pool	157.7
11	155.3	tail water gage of Peoria Pool	157.7
12	154.4	tail water gage of Peoria Pool	157.7
13	150.5	IL River near Kingston Mines, IL	145.4
14	129.3	IL River near Copperas Creek, IL	139.9
15	116.5	IL River near Havana, IL	119.6

Table 5-2. Stage Gaging Locations Used for the IWW Study Sites (Concluded)

Site #	*River mile*	*Gage used*	*Gage location, RM*
16	109.5	IL River near Havana, IL	119.6
17	109.5	IL River near Havana, IL	119.6
18	94.2	IL River at Beardstown, IL	88.3
19	91.2	IL River at Beardstown, IL	88.3
20	79.4	tail water gage of La Grange Pool	80.2
21	61.7	IL River near Valley City, IL	61.3
22	45.1	IL River at Pearl, IL	43.2
23	23.4	IL River at Hardin, IL	21.6
24	13.0	IL River at Hardin, IL	21.6

Table 5-3. Stage Gaging Locations Used for UMR Study Sites

Site #	*River mile*	*Gage used*	*Gage location, RM*
1	825.5	Pool gage of L&D 2	815.2
2	791.7	tail water gage of L&D 2	797.1
3	763.4	Pool gage of L&D 4	752.8
4	751.1	tail water gage of L&D 4	752.8
5	746.4	Pool gage of L&D 5	738.1
6	727.4	tail water gage of L&D 5A	728.5
7	727.4	tail water gage of L&D 5A	728.5
8	677.7	tail water gage of L&D 8	679.08
9	677.5	tail water gage of L&D 8	679.08
10	669.5	tail water gage of L&D 8	679.08
11	620.5	Pool gage of L&D 10	615.1
12	613.6	tail water gage of L&D 10	615.1
13	613.6	tail water gage of L&D 10	615.1
14	607.5	tail water gage of L&D 10	615.1
15	576.0	tail water gage of L&D 11	583.0
16	551.9	tail water gage of L&D 12	556.7
17	512.7	Mississippi River near Camanche, IA	511.9
18	509.2	Mississippi River near Camanche, IA	511.9
19	509.2	Mississippi River near Camanche, IA	511.9
21	466.7	Pool gage of L&D 16	457.2
22	436.1	tail water gage of L&D 17	437.1
23	436.4	tail water gage of L&D 17	437.1
24	432.3	tail water gage of L&D 17	437.1
25	432.3	tail water gage of L&D 17	437.1

Table 5-3. Stage Gaging Locations Used for UMR Study Sites (Continued)

Site #	*River mile*	*Gage used*	*Gage location, RM*
26	420.0	Pool gage of L&D 18	410.5
27	360.0	tail water gage of L&D 19	364.3
28	357.6	tail water gage of L&D 19	364.3
29	339.3	tail water gage of L&D 20	343.2
30	339.3	tail water gage of L&D 20	343.2
31	293.0	Mississippi River near Mindys Landing, MO	293.0
32	275.3	Mississippi River @ L&D 24; Clarksville, MO	273.2
33	266.5	Mississippi River at Mosier Landing, IL	260.3
34	232.2	Mississippi River at Dixon Landing, IL	228.3
35	222.1	Mississippi River at Grafton, IL	218.0
36	217.5	Mississippi River at Grafton, IL	218.0
37	197.6	Mississippi River at Hartford, IL	196.8
38	174.8	Mississippi River at Engineers Depot, MO	176.8
39	112.4	Mississippi River at Chester, IL	109.9
40	94.2	Mississippi River at Bishop Landing, MO	100.8
41	77.2	Mississippi River at Grand Tower, IL	81.9
42	52.3	Mississippi River at Cape Girardeau, MO	52.1
43	45.2	Mississippi River at Grays Point, MO	46.3
44	25.8	Mississippi River at Price Landing, MO	28.2

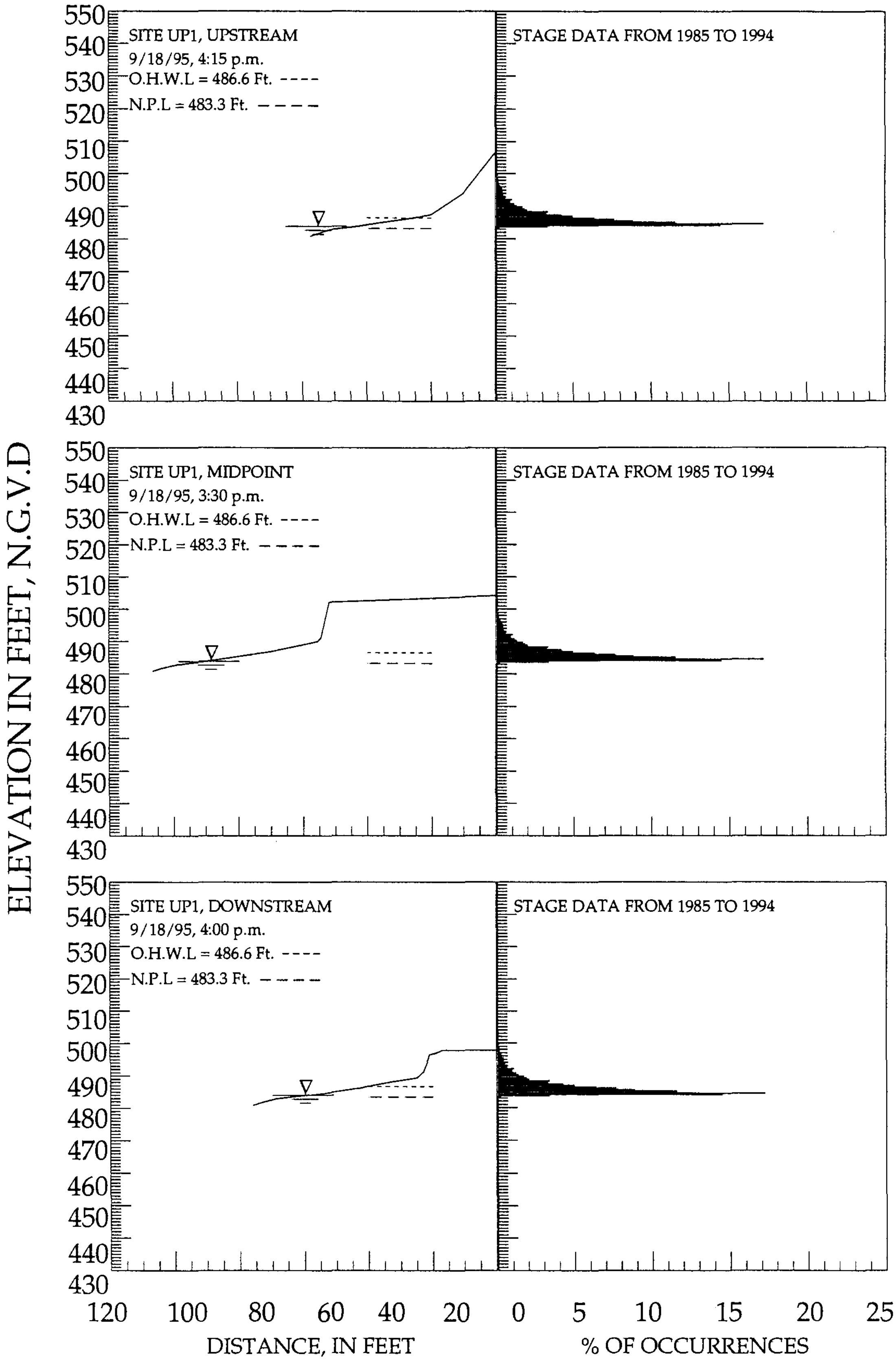


Figure 5-7. Bank profile at site UP1 in Marseilles Pool of the Illinois River, RM 270.8, RDB stage histogram at tail gage of Dresden Island Pool, RM 271.5

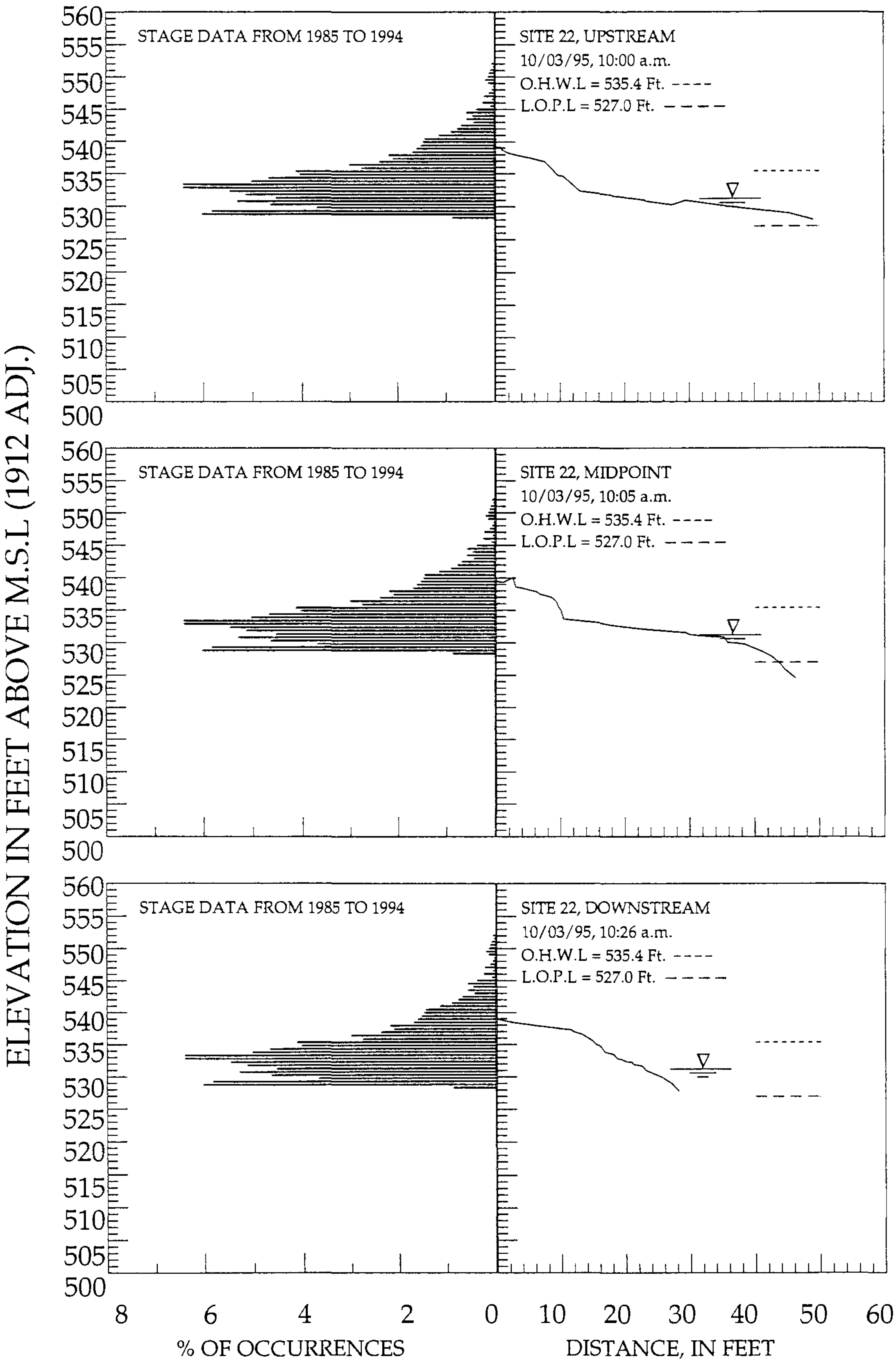


Figure 5-8. Bank profile at site 22 in Pool 18 of the Mississippi River, RM 436.1, LDB stage histogram at tail water gage of L&D 17, RM 437.1

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Chapter 6. The Illinois Waterway

This section describes the data collected from the Illinois Waterway and the analyses that were performed. Some of the background materials are taken from Bhowmik and Schicht (1980).

Background

The Illinois River and its main tributaries form one of the main waterways in Illinois and stretch from Milwaukee, Wisconsin, and South Bend, Indiana, to Grafton, Illinois. The tributaries of this river basically drain farmlands. Figure 6-1 shows the drainage basin of the Illinois River, which has a drainage area of 28,906 square miles.

The upper part of the Illinois River flows basically east to west and has a narrow channel. The riverbed has steeper slopes and the drop between Lockport and Starved Rock (upstream of Hennepin, Figure 6-1) is about 2.3 feet per mile. The river turns a south-westerly direction after passing De Pue. Below Starved Rock and until the mouth of the Illinois River, the channel becomes wider and meandering. The average slope is only about 1.6 inches per mile. Lubinski (1993) divides the Illinois River into the following two reaches:

- From confluence of the Kankakee and Des Plaines Rivers to Hennepin, Illinois. The river passes through a young geologic valley and has a relatively high gradient, narrow floodplain, and three navigation dams.

- From Hennepin, Illinois, to the Mississippi River. This section of the Illinois River is geologically older and wider than the upper reach. It was used by the Mississippi River before recent glacial activity redirected the Mississippi westward. It has a very shallow gradient, extensive levees, and two navigation dams.

Physiographically, the river basin is located in the till plains section of the central United States (Fenneman, 1928). Large-scale relief features are absent within Illinois; however, there are some local relief features which effectively change the physiography of the basin from one location to another.

Leighton et al. (1948) divided the State of Illinois into a number of physiographic divisions on the basis of the topography of the bedrock surface, glaciations, area of the drift, and other factors. The Illinois River flows through about five of these physiographic divisions characterized

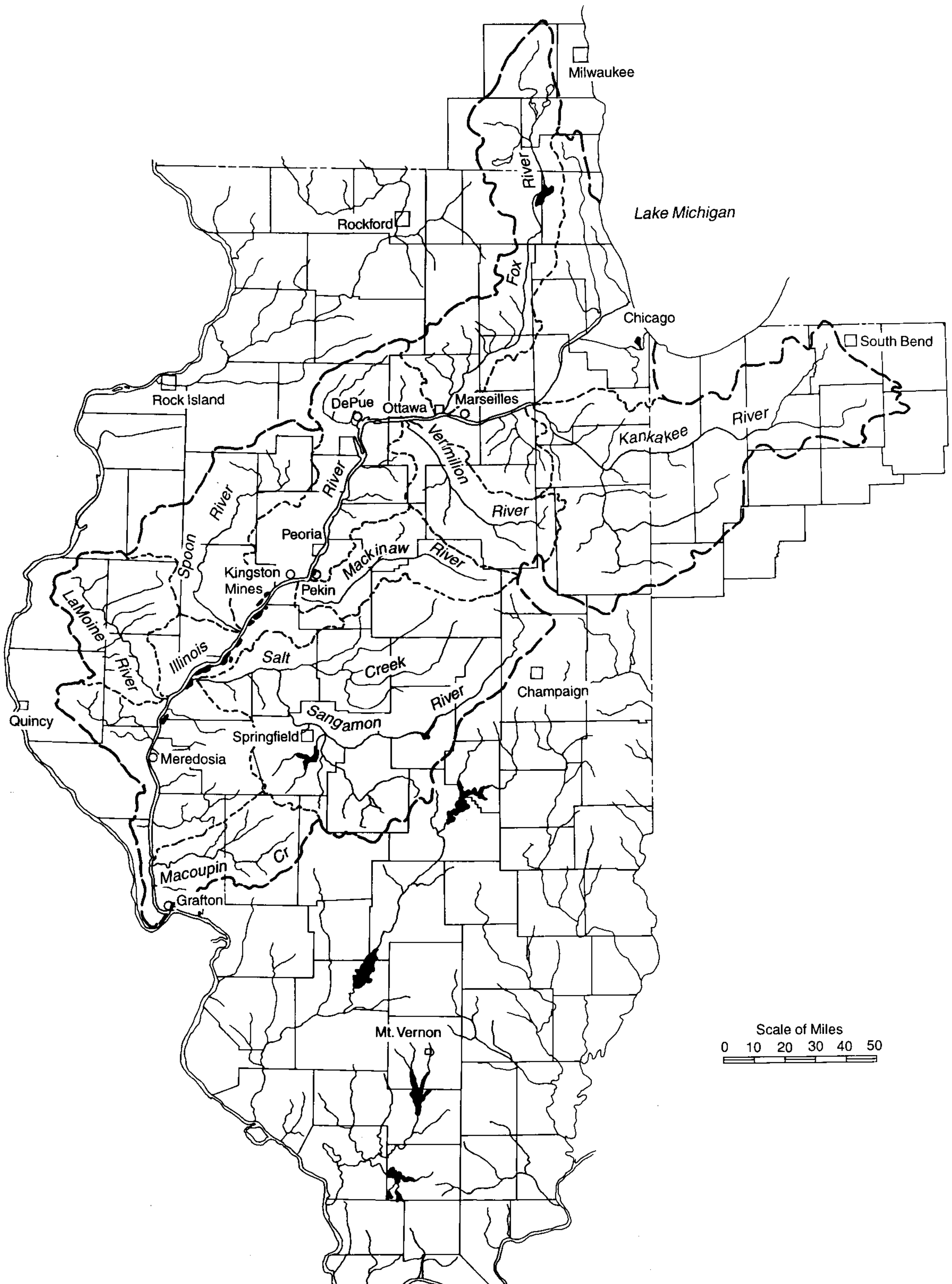


Figure 6-1. Drainage basin of the Illinois River

by broad till plains in the youthful stages of erosion. The alluvial soils near the river are most often layered and lensing alluvium.

The upper part of the river above the big bend near De Pue has a broad flat bottom valley with steep walls. Between De Pue and Peoria, the floodplains are rather narrow; downstream from Meredosia, the floodplain gradually narrows until the Illinois meets the Mississippi River near Grafton.

The Illinois River in its present form consists of a series of pools created by eight locks and dams. These locks and dams control the water surface profiles and the average depths of flow.

The U.S. Army Corps of Engineers maintains a 9-foot navigational channel along the length of the river for vessels that draw 9 feet of water. This major waterway has carried a large amount of barge traffic since the opening of the locks and dams in 1933. More than 46 million tons (1990 data, IPMP, 1994) of traffic traverse the river in a year. Tows operating on the river may have as many as 15 barges (each capable of carrying 1,500 tons) pushed by a 5,000 horsepower tow boat. A tow and barge configuration (nearly 105 feet wide and 1,100 feet long) can move at a speed in excess of 8 miles per hour with a draft of 9 feet and could move 1,100 cubic feet of water per second through its propeller (Adams, 1991).

Prior Erosion Studies

Three prior studies of bank erosion on the Illinois River have been done: Bhowmik and Schicht (1980), Warren (1987), and Hagerty (1988).

Bhowmik and Schicht (1980) Study. This study was conducted with the following objectives:

- To document present bank erosion areas.
- To develop present plan view of severely eroded banks at about 20 selected reaches.
- To make bank stability analyses for each reach.
- To attempt to assess the effect of the increase in the Lake Michigan diversion on bank erosion.
- To propose a monitoring system to document any future changes in bank conditions.
- To suggest future research areas that should be undertaken to better identify the causes of the bank erosion of the Illinois River.

A five-day boat trip on the Illinois River was taken from July 17-21, 1978, to document the severity of bank erosion. The trip started at Joliet and ended at Pere Marquette State Park near Grafton.

During the trip, severely eroded banks were photographed, and surficial soil samples from the eroded banks and the riverbed were collected at intervals of 3 to 4 miles. Figure 6-2 shows the location of the 24 river reaches, each on only one side of the river, selected during the field trip for initial analysis and further study.

Whenever a portion of the riverbank appeared to be severely eroded, the site was selected for data collection. Data collection included taking photographs and sampling bank and bed material. Surficial bank soil was photographed using a 2 foot by 2 foot grid with a fine mesh of 0.1 foot by 0.1 foot. Only the bank soils on the top layer of the bank were sampled. Subsequently, a surveying crew was engaged to survey the selected site, including detailed bank sections. Figure 6-3 shows the locations where bank and bed material samples were collected. Figure 6-4 shows sample plan forms that subsequently developed from a detailed survey by Bhowmik and Schicht (1980).

The bank slope is an important parameter in the stability analysis of any riverbank. For the 1980 Bhowmik and Schicht study, the surveying crew determined the bank slope at each selected reach for three to six sections. Data were plotted for each reach separately, with the bed of the river taken as the datum. The plot shows the lateral displacements of the bank with each foot of drop from the top of the bank. Figures 6-5 and 6-6 show two typical plots that were developed for Reaches 3 and 14, respectively. Data from Reaches 1-4, 7-9, 13, 15, 17-20, and 24 indicated that a single average bank slope determined from plots similar to figure 6-5 can be used as the representative bank slope for each one of these reaches. However, data analyzed from Reaches 5, 6, 12, 14, 22, and 23 indicated that either of two distinct slopes existed in the same reach, similar to one shown in figure 6-6, or different parts of the sample reach have different slopes. The bank slopes for all the reaches vary from 1V:3.5H to 1V:9H.

Altogether, 67 surficial bank material samples were collected from different locations (figure 6-3) along the Illinois River. All of the samples were analyzed by both sieve and pipette techniques to determine the particle size distribution. Plots were developed showing the percent

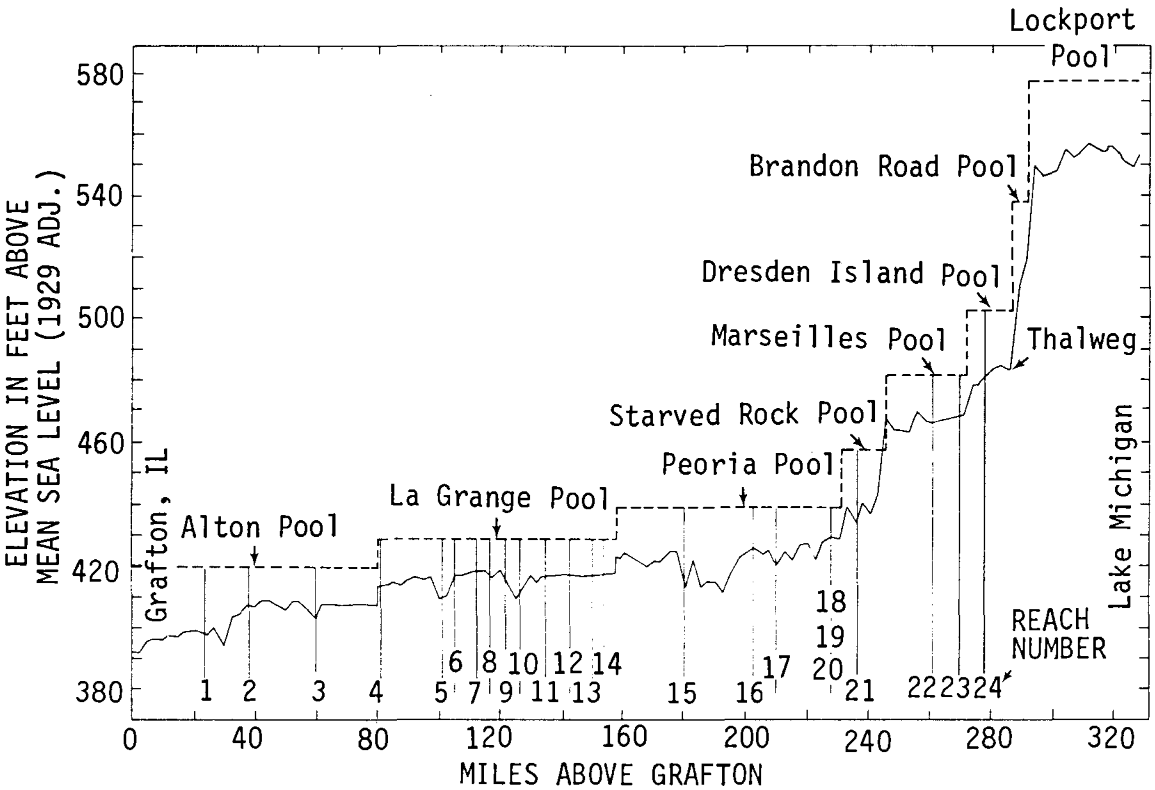


Figure 6-2. Profile of the Illinois River and the location of the reaches selected for further bank erosion investigations by Bhowmik and Schicht (1980)

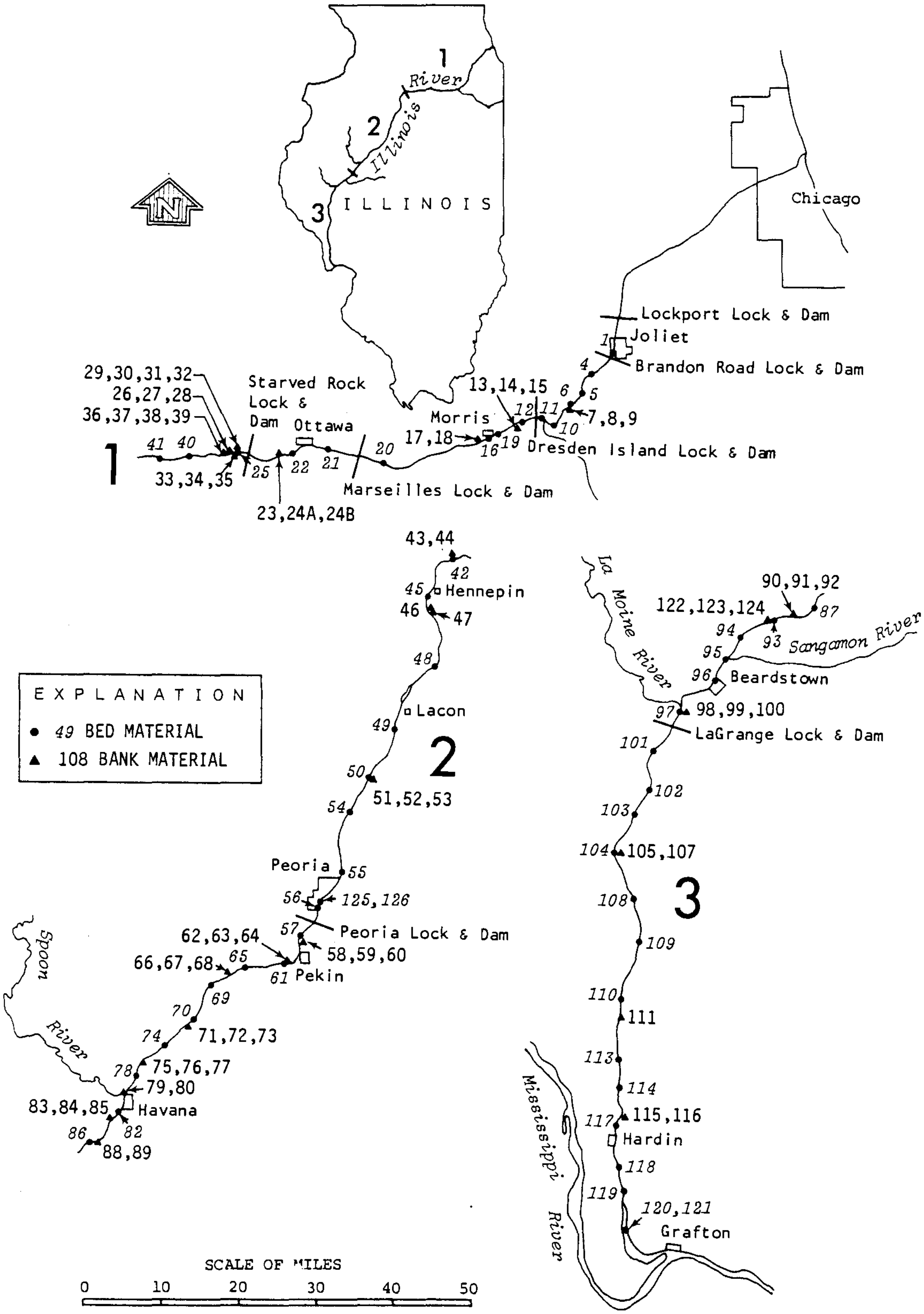


Figure 6-3. Locations where bed and bank material samples were collected by Bhowmik and Schicht (1980)

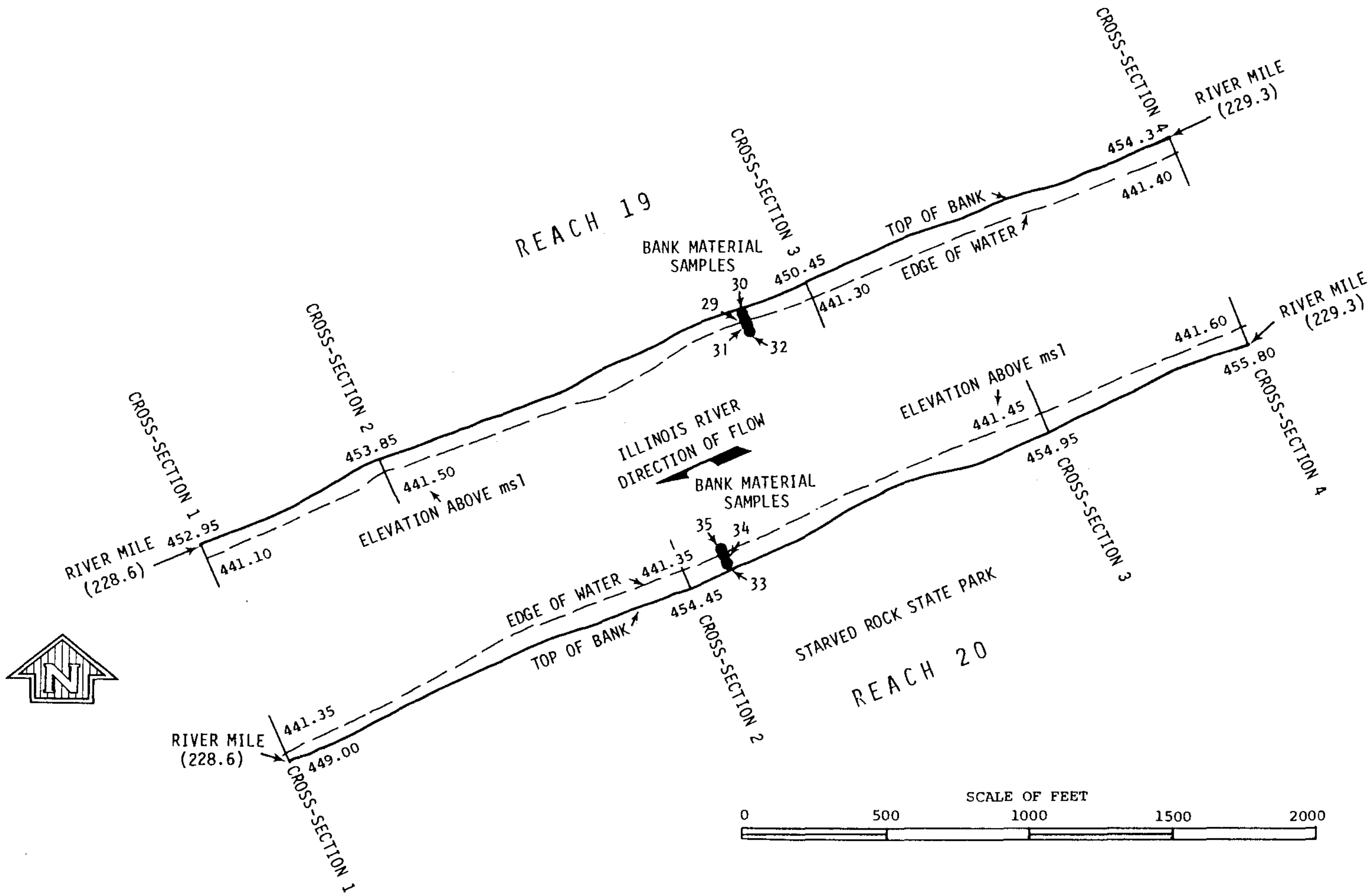


Figure 6-4. Typical plan profiles developed by Bhowmik and Schicht (1980) for the bank erosion study of the Illinois River

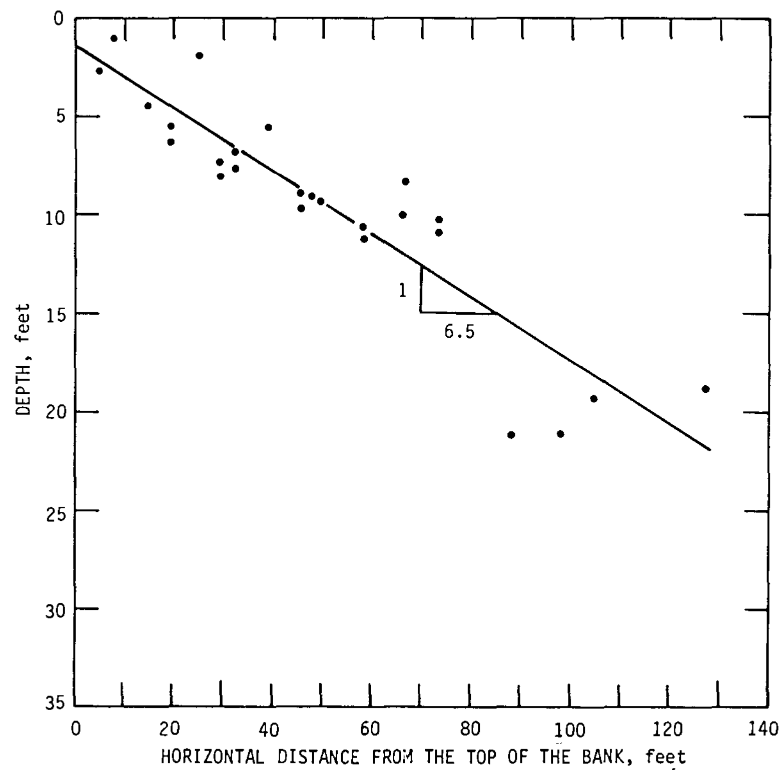


Figure 6-5. Typical plot showing the bank slope for Reach 3, after Bhowmik and Schicht (1980)

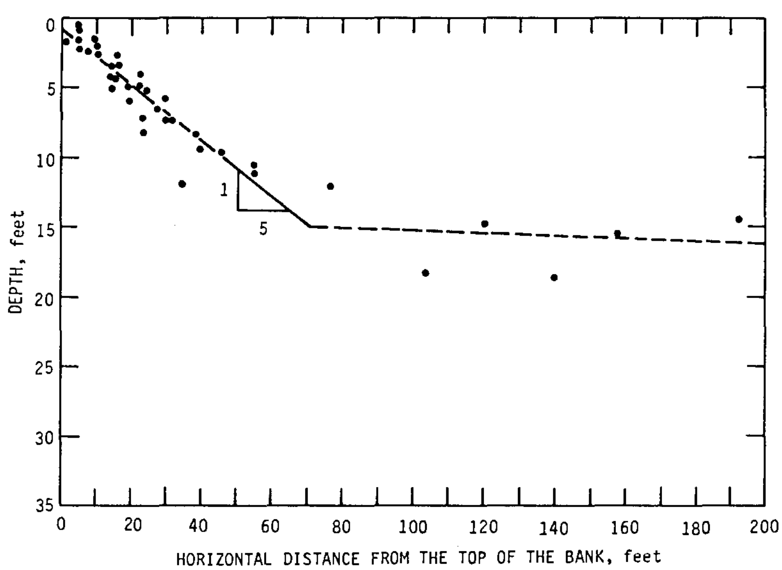


Figure 6-6. Typical plot showing the bank slope for Reach 14, after Bhowmik and Schicht (1980)

by weight versus the particle size for each one of the samples. These data were used to develop histograms of the surficial bank material. Other parameters generated from these analyses included σ and U, which are the standard deviation (σ) and uniformity coefficients (U) respectively. These two parameters indicate a measure of gradation of the particles. Higher values of σ and U indicate a well-graded material, whereas lower values of σ and U demonstrate more uniform materials. These two values are also shown in the histograms.

Figure 6-7 shows the histograms for the d_{50} and d_{95} sizes of the bank soils. For d_{50} sizes, it is obvious that 63 of the 67 bank soil samples have a median diameter smaller than 2 mm. The middle figure shows that out of these 63 samples, 38 have d_{50} values less than 0.1 mm. The top figure shows that 15 of the samples have d_{50} sizes within the range of 0.01 to 0.02 mm, indicating that these materials are in the clay to silty ranges.

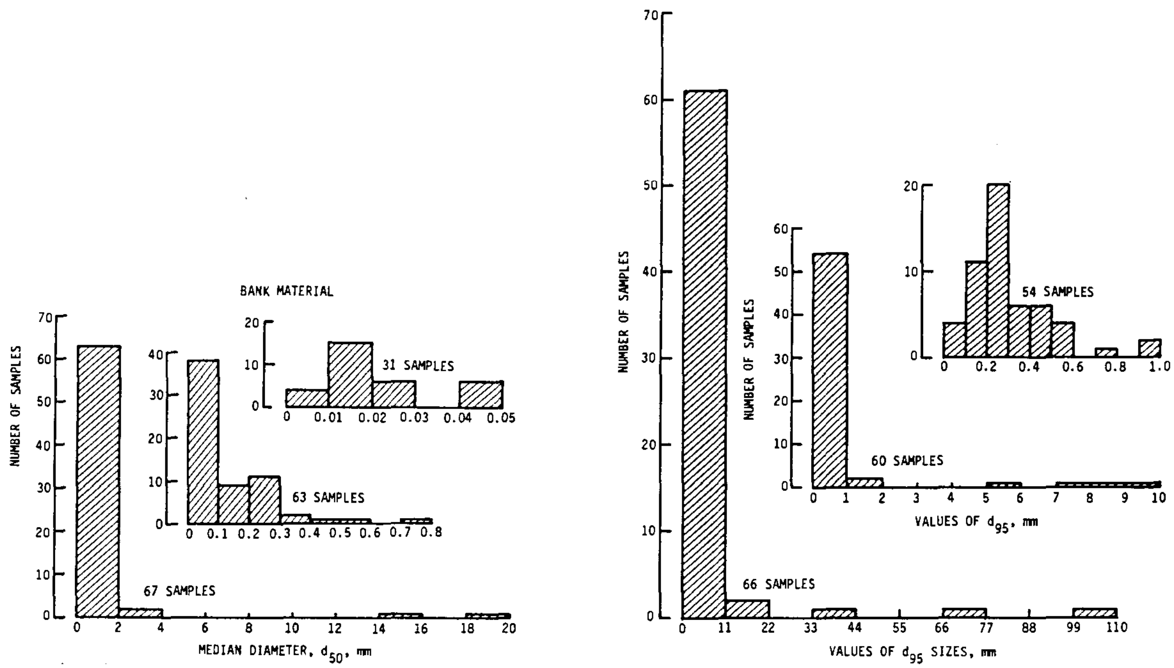
For d_{95} sizes, 60 out of 67 samples have d_{95} values less than 11 mm. Similarly, 63 out of 67 samples have d_{95} values of less than 1 mm and 20 of the samples have d_{95} values in the range of 0.2 to 0.3 mm, indicating that they are basically sandy materials.

Figure 6-8 shows the frequency distribution for the standard deviation (σ) and the uniformity coefficient (U). Although no definitive statement can be made as to the uniformity characteristics of these materials, they are basically well-graded materials, although some of the samples consist of uniform materials for almost 60 to 70 percent of their volume.

Data analyzed for the bank soils definitely indicate that wherever serious bank erosion existed on the Illinois River, the surficial bank soils are usually of fine-grained sands to silts.

Based on their investigation, Bhowmik and Schicht (1980, page 1) made the following observations. "Banks of the Illinois River have been eroding because of natural and man-made acts. In many places the erosion is very severe; in other places the banks are stable. The bank erosion of the river was investigated in detail to ascertain the probable effects of increased Lake Michigan diversion on bank stability or erosion. Hydraulic parameters were either computed or estimated, and the stability of the banks at all 20 locations was tested following accepted methods and techniques in hydraulics.

"The stability analysis based on hydraulic and gravity forces assuming noncohesive bank materials was done for discharges with and without additional Lake Michigan diversions for three typical water years. In general, the silty, sandy, and clayey materials of these severely eroded



a. Frequency distribution of the median diameter

b. Frequency distribution of the d_{95} sizes

Figure 6-7. Frequency distribution of the median diameter of the bank materials, after Bhowmik and Schicht (1980)

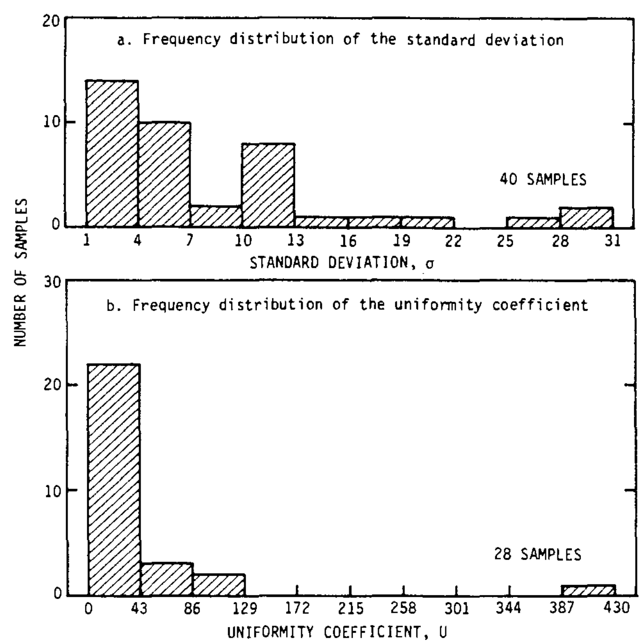


Figure 6-8. Frequency distribution of standard deviation (σ) and uniformity coefficient (U) of the bank material, after Bhowmik and Schicht (1980)

banks should be stable against the action of tractive force and flow velocity. However, preliminary computations indicated that the banks are unstable as far as the wind-generated wave action is concerned. It is possible that river-traffic-generated wave action also has a similar effect. A monitoring program is outlined, and a future research project related to the wave action on the banks is suggested." It should be noted that no geotechnical analysis was performed for this study.

Warren (1987). Warren (1987) based on historical observations, found the Illinois River had been geologically stable until the early 20th century. His summary stated: "Although it is difficult to judge the amount of bank erosion that occurred along the Illinois River under natural conditions, there is little question that erosion rates are much higher today. The modern channel is still straight, but a variety of artificial changes in the regime of the Illinois have both reinforced old causes and introduced new causes of erosion… some of the more important of these changes include the heightened water-surface elevation of the river; the increased frequency and magnitude of flooding along the river; the increase in wave action generated by vessel traffic and, perhaps, by wind; the introduction of drawdown as a new erosive force; and probably also the feedback between these various factors and the modern characteristics of cutbanks along the river. Together, these man-made causes and conditions have helped to create a severe erosion problem along many stretches of the Illinois River.

"A field study was conducted at five archaeologically important sites on the Illinois River. Rates of erosion were measured both horizontally and vertically over a period of approximately 6 months. At all but one site, banks were generally eroding. A statistical analysis using multi-regression of 14 variables related to site characteristics and erosion measurements was conducted. (None of the variables related to processes such as wind energy, or vessel waves, etc.) The average horizontal erosion rate at the five sites was 1 mm/day, with a high of 2.5 mm/day at one site and a low of -1 mm/day at another. Extrapolation of these rates indicates a 35-cm loss of bank deposits per year along the lower Illinois River. The author concluded that since erosion occurred on both sides of the river in both convex and concave channel areas, natural phenomena could not have caused the erosion; therefore, much of the erosion must be due to vessel traffic" (quoted from Maynord and Martin, 1996, page 50, on Warren's report).

Hagerty (1988) Study. Hagerty (1988) conducted an investigation on the conditions of banks along the IWW during June 1988. The purpose of this investigation was to observe bank conditions of the river, determine significant failure and erosion mechanisms on those banks, and describe the relative significance of each mechanism. Riverbanks were inspected by helicopter on a reconnaissance trip from St. Louis to Joliet (RM 286) and a bank inspection trip by boat from Joliet to Grafton. Hagerty (1988) summarized his observations about the channel morphology and surrounding structures after the helicopter overflight in his 1988 report and concluded (Hagerty, 1988, page 11):

- Significant bank erosion was not present along the IWW.
- Extensive reaches of high bare bank were not seen.
- Many long reaches with apparent bank stability were observed.
- Large bodies of water were noted adjacent to low bare banks with seepage marks.

The boat trip was conducted from June 8-14, 1988, from Joliet to Grafton, and the team marked and color-coded bank conditions on navigation charts. The team also stopped at erosion sites to inspect the occurrence and sequence of erosion and deposition. At each site the team assessed the mechanisms of erosion on the basis of soil exposed in dug bank trenches, information on the operation of the Illinois Waterway and dredging practices, the geologic formation of the river valley, and specific characteristics present on the bank and bench. The team inspected 20 sites previously inspected by Bhowmik and Schicht (1980) and selected 12 additional sites for evaluation. At each site, the team collected the following information:

- site photographs
- bank sections, and
- soil samples

Hagerty (1988) commented on the conditions found at each site. The soil samples were analyzed to determine the particle sizes. From the bank inspection, Hagerty derived the following conclusions: bank conditions vary significantly from pool to pool, but bank conditions are quite similar within long reaches of the waterway.

Based on observed bank conditions, sites with the potential for erosion were divided into five categories. The following passages are excerpted from Hagerty's 1988 report (pages 23, 24).

Figure 6-9 shows a sketch of a "Type 5 site: At this category site, the subaqueous bench was very gently sloping and extended far out under the water. Sediments had been deposited within shallow water near bank bench areas. Seasonal grasses and tree seedlings were often encountered on the lower bank at these sites. Somewhat steeper midbank areas often contained slumped alluvium and recently deposited sediments. This intermediate bank zone was 2 to 3 feet high and typically was sloped at 1 vertical on about 6 horizontal. Above the zone of recent sediment accumulation the variable bank slope increased slightly. Numerous trees and dense brush were found on the upper bank. These type 5 site conditions were indicative of relative bank stability" (page 23).

Figure 6-10 shows a "Type 4 site: The subaqueous bench on this type of site was very similar to that at a type 5 site, but did not extend as far channelward. The gently sloping lower bank was also narrower than at a type 5 site. Accumulations of failed soils and recently deposited sediments formed berms within the midbank. The midbank sloped from 1 vertical on 6 horizontal, to 1 vertical on 4 horizontal, and the height varied between 1 and 4 feet. These berms were deeply cut by runnels. Sparse seasonal grasses were growing in this area of the bank. The upper bank contained seasonal vegetation and willow above several nearly vertical faces 0.5 to 1.0 feet high" (pages 23-24).

Figure 6-11 shows a "Type 3 site: The type 3 site included a gently sloping lower bank bench and wide berm of recently deposited sediments and failed soils from upper bank collapse. Typically, this area of failed soil accumulations was 3 to 4 feet high on a slope of approximately 1 vertical on 4 horizontal. Above the berm a nearly vertical bare face 1 to 3 feet high was encountered. Pronounced runnels cut through middle bank berms. Tree roots were typically exposed within upper bank faces" (page 24).

Figure 6-12 shows a "Type 2 site: At this site, the subaqueous bench dropped off steeply. The lower bank subaerial bench was narrow. Recently deposited sediments and failed soil accumulations formed berms 1 to 3 feet high in the middle portion of the bank. These berms contained deep runnels and seasonal vegetation. Nearly vertical faces 4 to 6 feet high were encountered within upper bank areas" (page 24).

Figure 6-13 shows a "Type 1 site: At this site, the gently sloping subaqueous bench was narrow or absent. The subaqueous bench dropped steeply away from the gently slopping lower bank. Midbank benches and berms were narrow. Above these berms, the bank was nearly vertical with bare faces 6 to 9 feet high or higher. Cavities were encountered within and at the base of these upper bank faces. Vegetation on these sites was sparse, except for floodplain areas adjacent to the top of bank" (page 24).

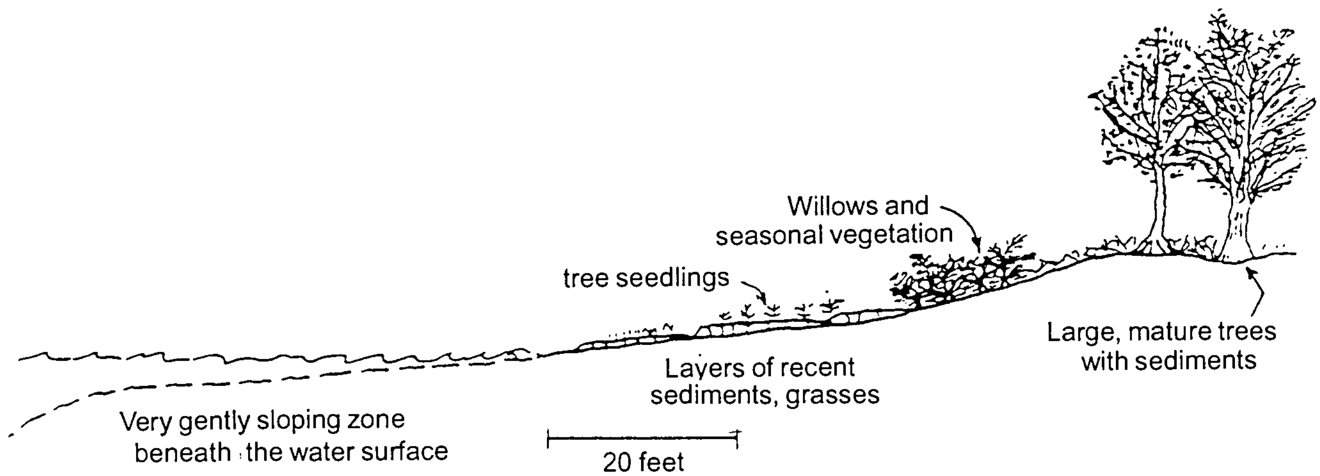


Figure 6-9. Type 5 site--relatively stable with significant deposition and relatively dense vegetation cover, after Hagerty (1988)

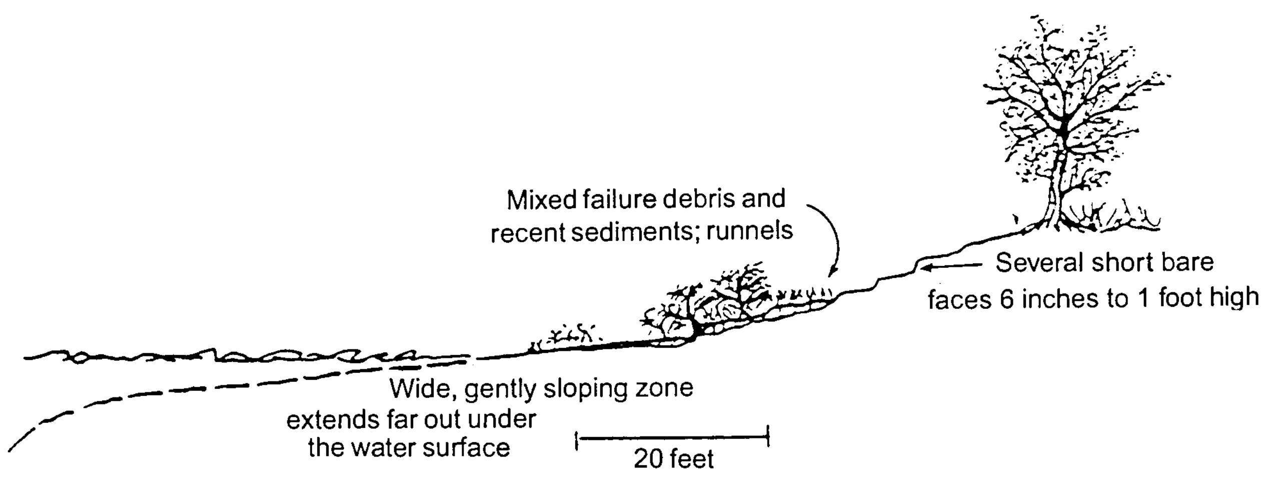


Figure 6-10. Type 4 site--site of only slight apparent erosion; deposition and accumulation of failure debris on middle and lower bank, with willows and seasonal vegetation cover, after Hagerty (1988)

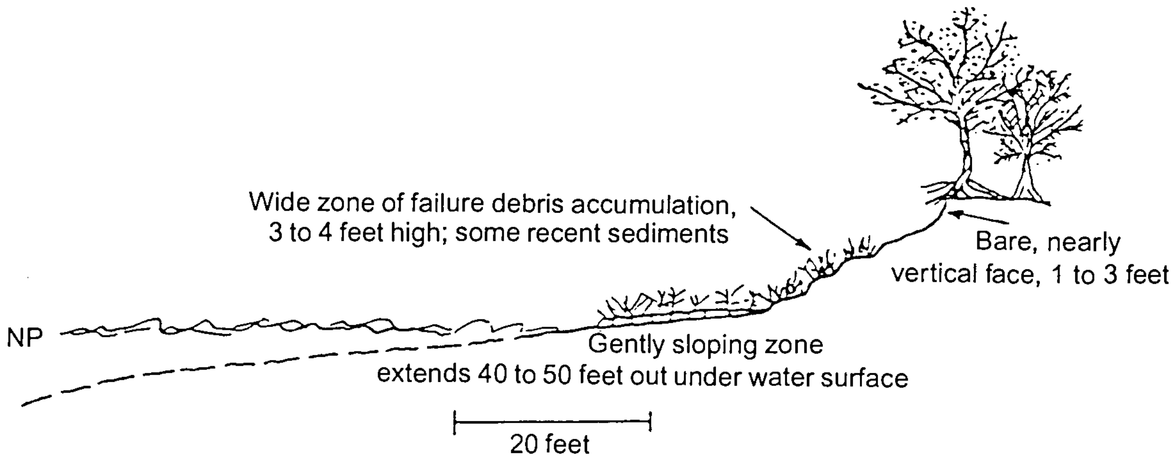


Figure 6-11. Type 3 site--site of moderate to slight erosion, with some sedimentation and moderate vegetation cover, after Hagerty (1988)

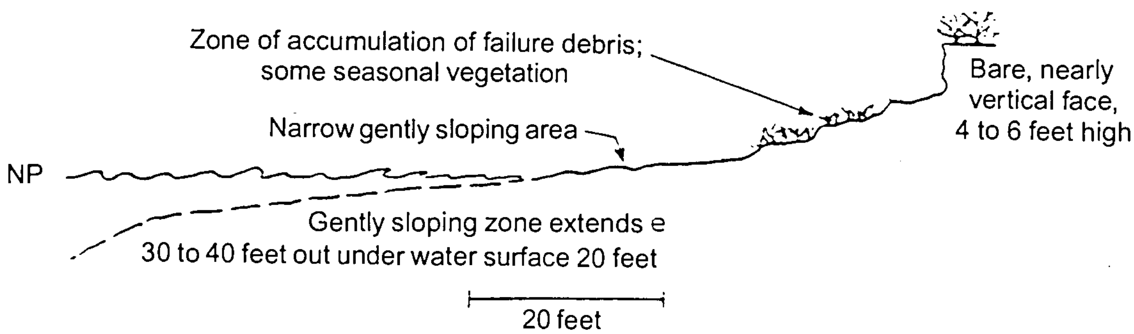


Figure 6-12. Type 2 site--apparently active site of moderate erosion very sparse cover of vegetation, after Hagerty (1988)

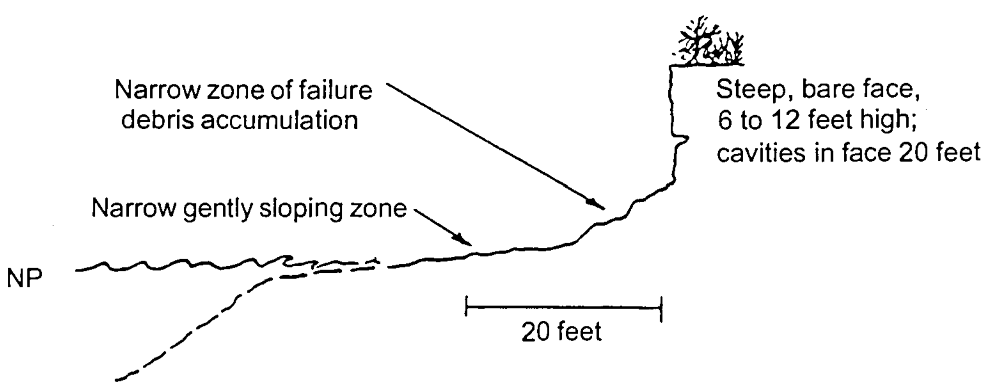


Figure 6-13. Type 1 site--apparently active site of most severe erosion little or no vegetation cover, after Hagerty (1988)

The bank conditions described by Hagerty (1988) can be summarized as:

Condition	*Left Descending Bank (%)*	*Right Descending Bank (%)*
Severely eroded	1.84	2.35
Moderately eroded	16.27	14.46
Artificial	17.47	21.09
Apparently stable	63.58	60.76
Bedrock outcrop	0.84	1.34

In a later report, Spoor and Hagerty (1989) stated: "Investigations conducted in 1988 along the Illinois Waterway indicated that bank failure and erosion are initiated by the flow of water out of the banks and removal of soil particles by piping/sapping…. Wave swash did not appear to be a significant mechanism for removal of inplace soils, although levee notching indicated erosion by a combination of waves and tractive forces during floods. Propeller turbulence was a cause of only very localized bed/bench scour…. Waterway bank erosion was not severe or widespread; even within the pools where erosion was most extensive, only 6 percent of the total bank length was severely eroded" (Maynord and Martin, 1996, page 51).

Hydrological Conditions during Field Surveys

Hydrological conditions prior to the three field studies could have influenced the studies: 1988 was a drought year, the Mississippi River experienced record floods during 1993, while the Illinois River had a major flood in 1995. These hydrological events are described here briefly using existing analyses. In the discussion, "water year" refers to the period from October of the previous year until the end of September of the current year. Bhowmik and Schicht's survey was conducted from July 17-21, 1978; Warren's study duration was from winter 1984 - 1985 (October 30, 1984 to February 14, 1985) to summer 1985 (May 31 to June 8) at five sites in the lower Illinois River valley, including Persimmon, Mortland Island, Woods Creek, Maude, and Napoleon Hollow; and Hagerty conducted the helicopter flight on June 6, 1988 and the field survey from of June 8-4, 1988.

Water Year 1978. "Streamflow was above normal as the 1978 water year began. The winter months produced record amounts of snowfall that exceeded the previous year's record snowfall…. Snowmelt in March produced some minor local flooding in central and southern Illinois. Heavy thunderstorms during June and July produced locally severe flooding in parts of northern Illinois. Total streamflow for the year was about normal in central and southern Illinois, but was below normal in northern Illinois" (USGS, 1979, page 2). These overall hydrologic conditions were indicative of the field conditions. Flows were above normal for the middle and lower portions of the Illinois River but were below normal for the northern part. However, the northern portion of the Illinois River had yearly high flows at the end of June due to the thunderstorms.

Water Year 1986. "For the sixth consecutive year, precipitation was above the 30-year average in Illinois. This is the longest above-average period in the last 120 years.… Long-term, average-annual precipitation ranged from 36 inches in the north to 44 inches in the south. However, below-normal precipitation occurred statewide during the months of January, March, April, and August. During December and June, precipitation was below normal in the southern half of the State.…Excessive runoff occurred at all three index stations (Figure 6-14). Runoff at the northern index station (Pecatonica River at Freeport) was 174 percent of its median for the period 1951-80, whereas that of the central index station (Sangamon River at Monticello) was 176 percent of its median. Runoff at the southern index station (Skillet Fork at Wayne City, IL) was 149 percent of the station's median.… The only months that had a deficit are January, April, May, and August at the central index station, and the months of January, March through June, August, and September at the southern index station" (USGS, 1987).

Water Year 1987. " Annual precipitation was below the 30-year average for the first time in several years. The long-term, average precipitation in the State ranged from 36 inches in the north to 44 inches in the south. During the 1987 water year, runoff was excessive in the north and deficient in the central and southern parts of the State. Runoff at the northern index station was excessive every month, except during March. Runoff was deficient at the central index station each month from January through September, except during February and August; runoff at the southern index station was deficient each month from December through September, except during July. Flow at the southern index station averaged only 9 percent of normal during June and September. During October, above-average rainfall occurred throughout the State. Heavy rains occurred in northeastern Illinois during the first 10 days of October following heavy rains in the last half of September. The areas most acutely affected by flooding were communities along the Des Plaines River and its tributary, Salt Creek at northern Illinois" (USGS, 1988).

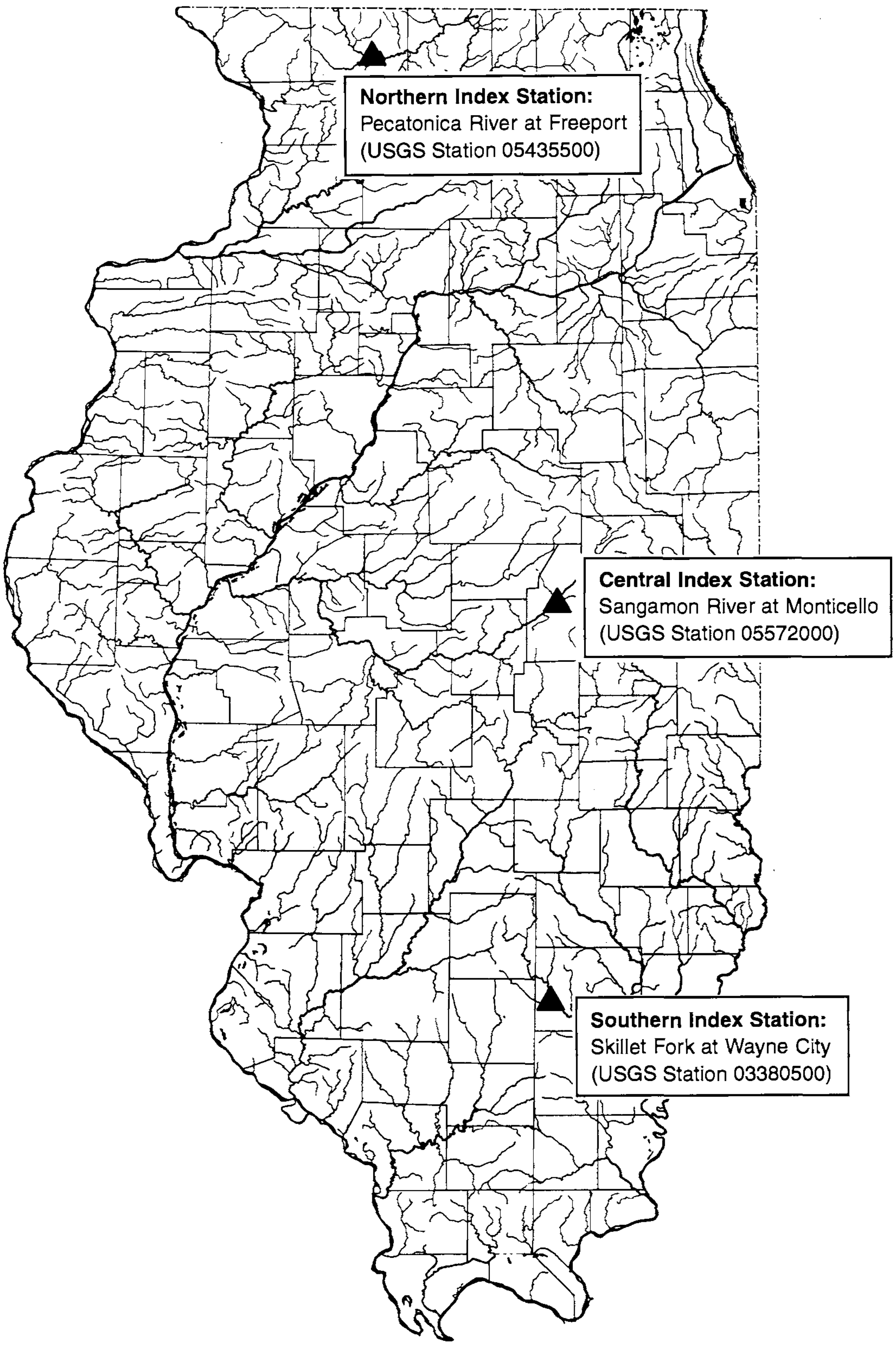


Figure 6-14. Locations of the USGS northern, central, and southern index stations

Water Year 1988. 1988 was a drought year in Illinois. During the 1988 water year, annual precipitation was below the 1951-80 average for the second consecutive year. "Runoff was normal in the northern part of the State, deficient in the central part, and excessive in the south. Runoff at the northern index station was excessive from December through February and normal for the remaining months. At the central index station, runoff was excessive in December and deficient in October and from May through September. Runoff at the southern index station was excessive from December through February and deficient in October, May, June, August, and September" (USGS, 1989).

The 1993 Flood. Although the main stem of the Mississippi River experienced new peak stages at many stations between Savanna, Illinois, and Thebes, Illinois, high stages on the Illinois River occurred mostly on its lower portion because of backwater effects from the Mississippi River and only Hardin experienced a new peak stage record. The following table is taken from a report by McConkey et al. (1994).

Illinois River Stations and Peak Stage Records

Gaging station	*River mile*	*Gage datum (feet)*	*Flood stage (feet)*	*1993 Peak stage (feet)*	*1993 Peak stage (date)*	*Feet over flood stage*	*Historical peak stage (feet)*	*Historical peak stage (date)*	*Difference from record (feet)*
Henry	196.0	425.88	19.0	26.75	4/22	7.8	32.67	3/22/79	-5.9
Kingston Mines	144.4	428.00	20.0	21.41	4/23	1.4	26.02	5/25/43	-4.6
Meredosia	71.3	418.00	14.0	26.96	7/28	13.0	28.61	5/26/43	-1.7
Hardin	21.5	400.00	25.0	42.4	8/3	17.4	38.2	4/29/73	4.2

Water Year 1995. The 1995 survey was conducted from August 24-31 for the reach from Ottawa to Grafton, and from September 18-20 for the reach from Brandon Road to Ottawa, Illinois. "Average precipitation statewide was slightly above the 30-year average during the 1995 water year…. Average annual streamflows at the three index stations were above average (30-year average) at the central and southern Illinois index stations and below average at the northern Illinois index station. Flow was generally near normal for all three stations during most of the year. All three sites had excessive flows during May. Excessive flows also occurred at Monticello and Wayne City because of flood events during January, March, and August. Below normal flows occurred at Monticello and Wayne City during September…. Record-breaking floods occurred throughout central and southern Illinois during May 17-30, 1995. More than 12 inches of rain fell in parts of southern Illinois during May. Torrential rains (5-8 inches) fell throughout central and southern Illinois during May 16-19. The excess runoff caused flooding throughout central and southern Illinois"(USGS, 1996).

Flow conditions during the survey period were generally lower than the long-term averages. When the trip started on August 24, 1995 from Ottawa, the discharge at Marseilles was approximately equal to 90 percent of its long-term average value. At other stations downstream, flows were approximately 75 percent of the long-term mean discharges at each corresponding gaging station. When the crew started on Brandon Road Lock and Dam on September 18, the flows at the northern part of the Illinois River were low. The discharges at Marseilles station for that study period were approximately equal to 25 percent of the long-term mean discharge.

Historical Navigation Traffic

The locations of lock and dams on the Illinois River are also shown in figure 6-2. Data on the navigation traffic in terms of empty and loaded barges moving either upstream or downstream, from 1980-1995 were provided by the U.S. Army Corps of Engineers, Rock Island District. These data are presented in Appendix E. In general, the number of barges per year (either empty or fully loaded) increases in the downstream direction. Traffic associated with the Mississippi River should increase as one moves from the headwaters of the Illinois River toward its confluence with the Mississippi River.

Data showed a significant increase in the navigation traffic in 1993. During the 1993 flood, traffic on the Mississippi River was completely halted for more than a month (July 11 to August 22). High water stages on the Mississippi River may have diverted many barges to the IWW. On the other hand, traffic level in 1995 was lower than that in 1994. The IWW was closed 60 days for river rehabilitation work, and near record flooding on the mid- to lower Illinois River may have contributed to the decrease in traffic volume in 1995. Traffic in recent years appears to be increasing. Figure 6-15 shows the average annual navigation traffic for 1980-1994 for empty and loaded barges for all locks on the Illinois River.

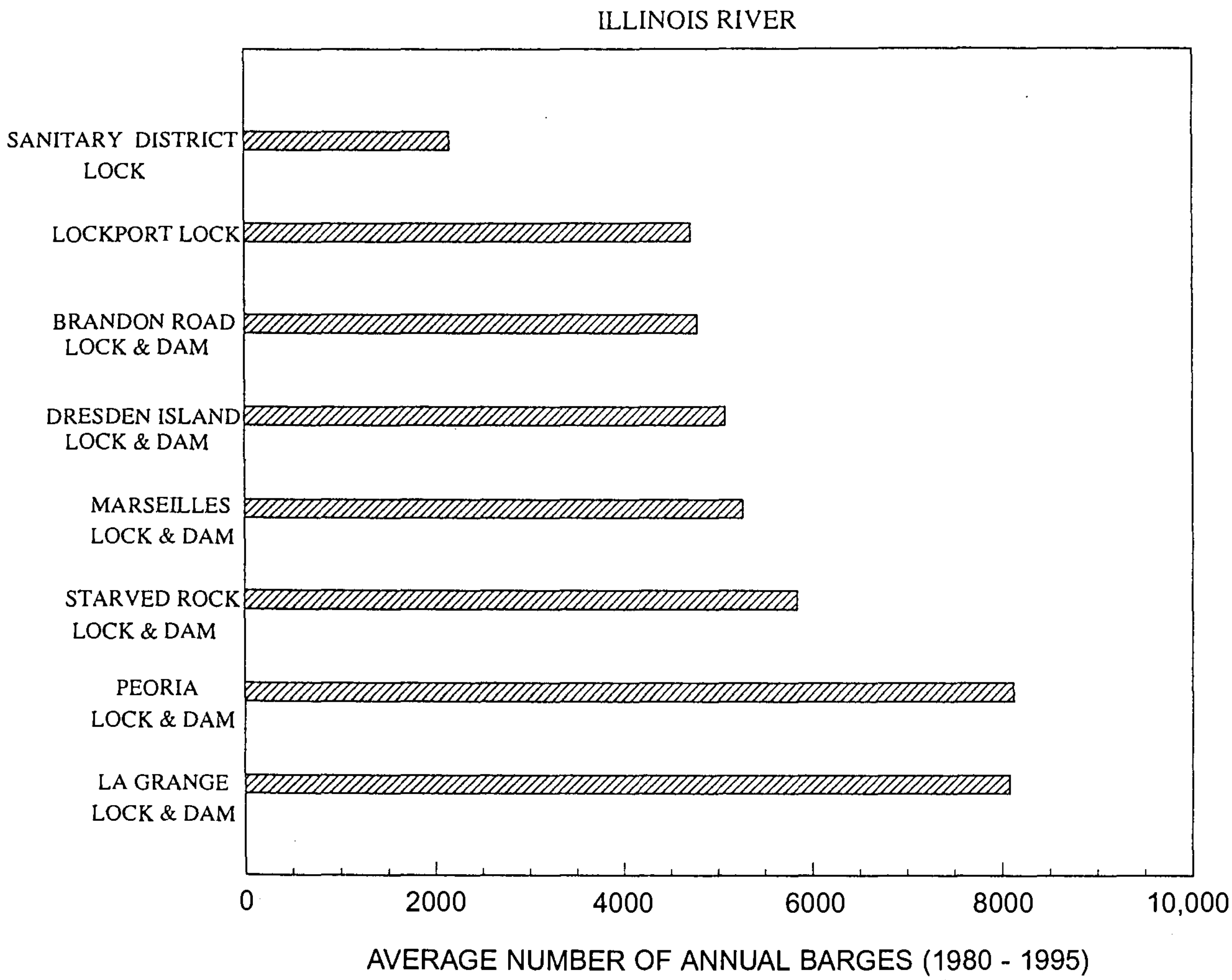


Figure 6-15. Average number of annual barges (empty, loaded, upstream bound and downstream bound) at various Lock and Dams on the Illinois River, 1980-1985. Data for Alton Pool were not available

Dredging History and Dredged Material Placement

Appendix D presents the dredging history, including dredge cut location, year dredged, dredged amount, and placement site, including the type of placement. Information included in this appendix was provided by the U.S. Army Corps of Engineers, Rock Island District.

Fleeting Areas and Mooring Sites

Appendix E also presents the terminal sites, fleeting locations, pool, fleeting capacity, name of operator and fleet destinations for the IWW and UMR, provided by the U.S. Army Corps of Engineers, Rock Island District.

Present Study

Site Locations

Twenty nine sites were selected for the present study. Figure 6-16 shows the locations of the present study sites and those selected by Bhowmik and Schicht (1980) and Hagerty (1988). Sites selected in 1995 are fairly equally distributed along the entire length of the river except in the Marseilles Pool and close to the Peoria Lock and Dam.

Sampling at Sites

After a site was selected, the limits of the site were delineated by placing temporary stakes on the bank. Then quarter points and midsection were located visually for further data collection. Figure 6-17 shows the sampling locations selected for site UP4 on the Illinois River. The primary section is the place where a detailed bank section was measured, and surficial and core samples were collected, and a river cross section was also measured. At the two quarter points, normally the bank sections were surveyed, some bank and core material samples were collected, and occasionally, a river cross section was measured.

Site Parameters

After the field trip, the team organized the field information and determined the length of each site based on the GPS coordinates measured in the field. Table 6-1 shows various parameters associated with all 29 sites on the Illinois River, including the site number, date and time when

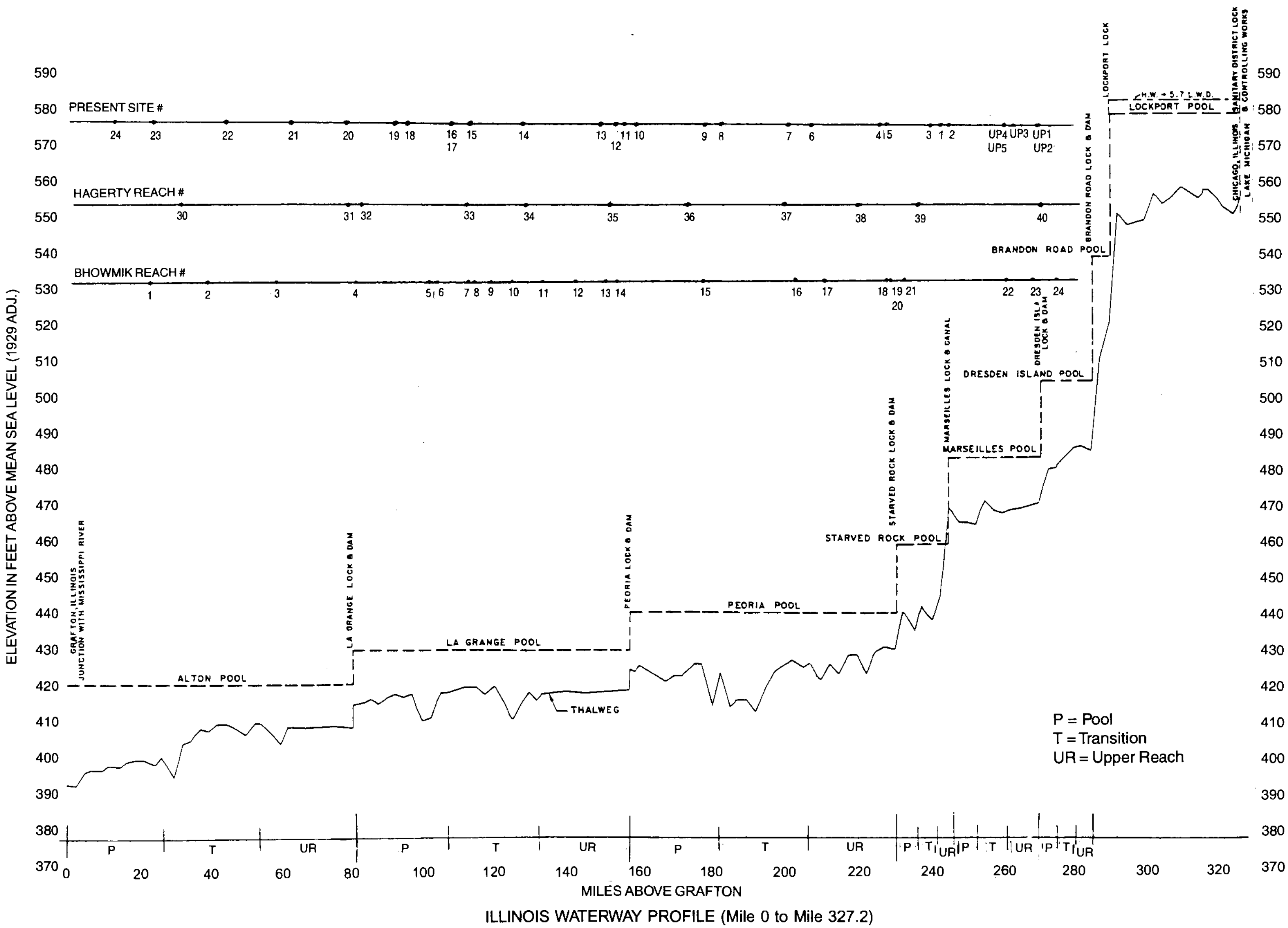


Figure 6-16. ILWW showing the relative location of sites selected for the present study and those selected by Bhowmik and Schicht (1980) and Hagerty (1988)

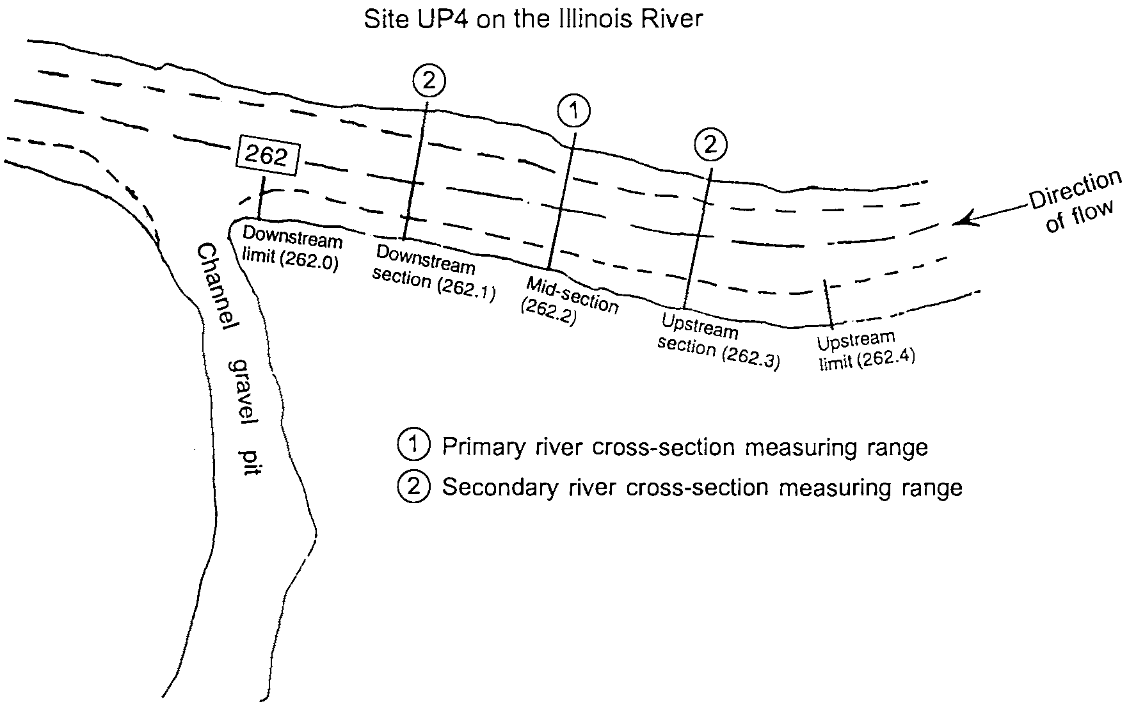


Figure 6-17. Typical sampling locations at a site

data were collected, river mile, location of the midpoint, upstream point and downstream point, right or left descending bank of the river where the site is located, length of the sites in miles, water surface stage when the data were collected, recurrence frequency corresponding to the stage, and ordinary high water level and normal pool level.

Generalized Bank Types

After examining the field data associated with these 29 sites, and comparing them in conjunction with failure mechanisms, six “Bank Types” have been grouped to facilitate the description of individual sites on the Illinois river (see Figures 6-18 through 6-23). It can be understood that the degree of failure mechanisms acting upon a bank will vary with the bank’s size, geometry, soil structure; and with the extent and slope of the corresponding bench. These mechanisms are subjected to the fluctuating water levels at that site. Therefore the most likely erosion processes are identified for each bank type and called “erosion potentials.” Table 6-2 shows the corresponding main features and erosion potential with these bank types.

General Characteristics of Selected Erosion Sites

River Widths and Maximum Depths. River cross sections were measured at the 29 sites. The top width, W_T, at the midpoint, during the field data collection period, varied from about 525 to 919 feet. The maximum depths, D_{max}, also at the midpoint, varied from about 12 to 21 feet. Figures 6-24 and 6-25 show the histograms of W_T and D_{max} measured at the midpoints at all the sites.

Bank Slopes. Three bank slopes were determined at each one of the bank sections measured at all the sites: scarp slope; berm slope; and bench slope. Figure 6-26 shows a definition sketch for these parameters. It can be seen that these slopes are best approximations to the field conditions. After the field data were checked and bank sections were plotted, the study team then selected the representative portion for each of these three features; and the slopes were determined.

Table 6-1. Erosion Sites Selected on the Illinois Waterway for Detailed Data Collection

Site #	*Date*	*Time*	*RM*	*up/mp/dn*	*RDB/LDB*	*Pool*	*Length (miles)*	*Stage (msl)*	*Stage Recurrence Frequency (%)*	*OHW (msl)*	*NP (msl)*
UP1	18-Sep-95	04:15 PM	270.8*	up	RDB	Marseilles Pool		483.9	90	486.6	483.3
UP1	18-Sep-95	03:30 PM	270.8	mp	RDB	Marseilles Pool		483.9	90	486.6	483.3
UP1	18-Sep-95	04:00 PM	270.8*	dn	RDB	Marseilles Pool		483.9	90	486.6	483.3
UP2	18-Sep-95	04:30 PM	270.8	mp	LDB	Marseilles Pool		483.9	90	486.6	483.3
UP3	19-Sep-95	08:20 AM	264.3	up	LDB	Marseilles Pool		483.7	80	485.7	483.3
UP3	20-Sep-95	07:30 AM	264.3	mp	LDB	Marseilles Pool	0.15	483.7	80	485.7	483.3
UP3	20-Sep-95	08:00 AM	264.3	dn	LDB	Marseilles Pool		483.7	80	485.7	483.3
UP4	20-Sep-95	10:30 AM	262.2	up	LDB	Marseilles Pool		483.7	90	485.5	483.3
UP4	20-Sep-95	10:00 AM	262.1	mp	LDB	Marseilles Pool	0.34	483.7	90	485.5	483.3
UP4	20-Sep-95	10:20 AM	262.0	dn	LDB	Marseilles Pool		483.7	90	485.5	483.3
UP5	20-Sep-95	11:00 AM	262.1	mp	RDB	Marseilles Pool		483.7	90	485.5	483.3
1	28-Aug-95	12:45 PM	242.9	up	LDB	Starved Rock Pool		458.6	90	460.0	458.5
1	28-Aug-95	10:45 AM	242.8	mp	LDB	Starved Rock Pool	0.24	458.8	90	460.1	458.5
2	28-Aug-95	11:45 AM	243.4	mp	LDB	Starved Rock Pool		459.4	50	460.3	458.5
3	28-Aug-95	04:00 PM	235.7	up	RDB	Starved Rock Pool		459.0	75	459.5	458.5
3	28-Aug-95	04:13 PM	235.7	mp	RDB	Starved Rock Pool	0.14	459.0	75	459.3	458.5
3	28-Aug-95	03:20 PM	235.7	dn	RDB	Starved Rock Pool		459.0	75	459.3	458.5
4	28-Aug-95	06:25 PM	228.1	up	LDB	Peoria Pool		441.6	75	446.1	440.0
4	28-Aug-95	06:40 PM	228.0	mp	LDB	Peoria Pool	0.24	441.6	75	446.0	440.0
4	28-Aug-95	07:00 PM	228.0	dn	LDB	Peoria Pool		441.6	75	446.0	440.0
5	28-Aug-95	07:40 PM	229.0	up	RDB	Peoria Pool		441.6	75	446.4	440.0
5	28-Aug-95	07:25 PM	228.75	mp	RDB	Peoria Pool	0.21	441.6	75	446.2	440.0
5	28-Aug-95	07:30 PM	228.5	dn	RDB	Peoria Pool		441.6	75	446.3	440.0
6	29-Aug-95	10:35 AM	210.0	up	RDB	Peoria Pool		441.1	75	444.3	440.0
6	29-Aug-95	10:40 AM	210.0	mp	RDB	Peoria Pool	0.34	441.1	75	444.3	440.0
6	29-Aug-95	11:15 AM	209.7	dn	RDB	Peoria Pool		441.1	75	444.2	440.0
7	29-Aug-95	12:15 PM	203.8	up	LDB	Peoria Pool		441.1	75	443.9	440.0
7	29-Aug-95	12:00 PM	203.8	mp	LDB	Peoria Pool	0.20	441.1	75	443.9	440.0
7	29-Aug-95	12:45 PM	203.5	dn	LDB	Peoria Pool		441.1	75	443.9	440.0

Note: River mile at the mid-point of a reach is used if the river miles at the upstream or downstream points are unknown.

Table 6-1. Erosion Sites Selected on the Illinois Waterway for Detailed Data Collection (Continued)

Site #	*Date*	*Time*	*RM*	*up/mp/dn*	*RDB/LDB*	*Pool*	*Length (miles)*	*Stage (msl)*	*Stage Recurrence Frequency (%)*	*OHW (msl)*	*NP (msl)*
8	29-Aug-95	02:45 PM	184.9	up	LDB	Peoria Pool		441.1	73	442.6	440.0
8	29-Aug-95	02:30 PM	184.8	mp	LDB	Peoria Pool	0.26	441.1	73	442.6	440.0
8	29-Aug-95	03:05 PM	184.7	dn	LDB	Peoria Pool		441.1	73	442.6	440.0
9	29-Aug-95	03:50 PM	179.9	up	LDB	Peoria Pool		440.6	90	442.4	440.0
9	29-Aug-95	03:45 PM	179.8	mp	LDB	Peoria Pool	0.21	440.6	90	442.4	440.0
9	29-Aug-95	04:05 PM	179.7	dn	LDB	Peoria Pool		440.6	90	442.4	440.0
10	29-Aug-95	06:25 PM	160.0	up	RDB	Peoria Pool		440.5	50	441.4	440.0
10	29-Aug-95	06:20 PM	160.0	mp	RDB	Peoria Pool	0.11	440.5	50	441.4	440.0
10	29-Aug-95	06:45 PM	160.0	dn	RDB	Peoria Pool		440.5	50	441.4	440.0
11	30-Aug-95	11:00 AM	155.5	up	RDB	La Grange Pool		432.8	70	440.8	429.5
11	30-Aug-95	08:15 AM	155.3	mp	RDB	La Grange Pool	0.54	432.8	70	440.8	429.5
11	30-Aug-95	11:30 AM	155.1	dn	RDB	La Grange Pool		432.8	70	440.8	429.5
12	30-Aug-95	08:45 AM	154.6	up	LDB	La Grange Pool		432.8	70	440.7	429.5
12	30-Aug-95	09:40 AM	154.4	mp	LDB	La Grange Pool	0.62	432.8	70	440.7	429.5
12	30-Aug-95	10:40 AM	154.2	dn	LDB	La Grange Pool		432.8	70	440.7	429.5
13	30-Aug-95	12:15 PM	150.6	up	LDB	La Grange Pool		432.3	75	440.5	429.5
13	30-Aug-95	12:10 PM	150.5	mp	LDB	La Grange Pool	0.18	432.3	75	440.5	429.5
13	30-Aug-95	12:45 PM	150.5	dn	LDB	La Grange Pool		432.3	75	440.5	429.5
14	30-Aug-95	04:15 PM	129.4	up	RDB	La Grange Pool		431.2	80	438.5	429.5
14	30-Aug-95	04:15 PM	129.3	mp	RDB	La Grange Pool	0.28	431.2	80	438.5	429.5
14	30-Aug-95	04:45 PM	129.2	dn	RDB	La Grange Pool		431.2	80	438.5	429.5
15	30-Aug-95	06:35 PM	116.7	up	RDB	La Grange Pool		430.8	75	437.0	429.5
15	30-Aug-95	06:45 PM	116.5	mp	RDB	La Grange Pool	0.95	430.8	75	437.0	429.5
15	30-Aug-95	07:10 PM	116.3	dn	RDB	La Grange Pool		430.8	75	437.0	429.5
16	31-Aug-95	11:05 AM	109.5	up	LDB	La Grange Pool		430.6	75	435.8	429.9
16	31-Aug-95	10:25 AM	109.5	mp	LDB	La Grange Pool	0.18	430.6	75	435.7	429.9
16	31-Aug-95	10:38 AM	109.5	dn	LDB	La Grange Pool		430.6	75	435.6	429.9
17	31-Aug-95	10:00 AM	109.6	up	RDB	La Grange Pool		430.6	75	435.7	429.9
17	31-Aug-95	09:15 AM	109.5	mp	RDB	La Grange Pool	0.18	430.6	75	435.7	429.9

Table 6-1. Erosion Sites Selected on the Illinois Waterway
for Detailed Data Collection (Concluded)

Site #	*Date*	*Time*	*RM*	*up/mp/dn*	*RDB/LDB*	*Pool*	*Length (miles)*	*Stage (msl)*	*Stage Recurrence Frequency (%)*	*OHW (msl)*	*NP (msl)*
17	31-Aug-95	10:30 AM	109.4	dn	RDB	La Grange Pool		430.6	75	435.7	429.9
18	31-Aug-95	02:40 AM	94.2	up	RDB	La Grange Pool		429.9	75	433.7	429.9
18	31-Aug-95	02:15 PM	94.2	mp	RDB	La Grange Pool	0.09	429.9	75	433.7	429.9
18	31-Aug-95	02:20 PM	94.2	dn	RDB	La Grange Pool		429.9	75	433.7	429.9
19	31-Aug-95	03:05 PM	91.2	up	RDB	La Grange Pool		429.9	65	433.3	429.9
19	31-Aug-95	04:00 PM	91.2	mp	RDB	La Grange Pool	0.22	429.9	65	433.3	429.9
19	31-Aug-95	04:30 PM	91.1	dn	RDB	La Grange Pool		429.9	65	433.3	429.9
20	31-Aug-95	07:40 PM	79.6	up	RDB	Alton Pool		420.6	90	NA	NA
20	31-Aug-95	07:15 PM	79.4	mp	RDB	Alton Pool	0.67	420.6	90	NA	NA
20	31-Aug-95	07:20 PM	79.2	dn	RDB	Alton Pool		420.6	90	NA	NA
21	01-Sep-95	11:00 AM	61.8	up	RDB	Alton Pool		420.6	80	NA	NA
21	01-Sep-95	10:45 AM	61.7	mp	RDB	Alton Pool	0.23	420.6	80	NA	NA
21	01-Sep-95	10:40 AM	61.6	dn	RDB	Alton Pool		420.6	80	NA	NA
22	01-Sep-95	01:00 PM	45.1	up	RDB	Alton Pool		419.9	85	NA	NA
22	01-Sep-95	12:50 PM	45.1	mp	RDB	Alton Pool	0.14	419.9	85	NA	NA
22	01-Sep-95	01:30 PM	45.1	dn	RDB	Alton Pool		419.9	85	NA	NA
23	01-Sep-95	04:30 PM	23.5	up	RDB	Alton Pool		419.3	90	NA	NA
23	01-Sep-95	04:20 PM	23.4	mp	RDB	Alton Pool	0.18	419.3	90	NA	NA
23	01-Sep-95	04:45 PM	23.3	dn	RDB	Alton Pool		419.3	90	NA	NA
24	01-Sep-95	06:30 PM	13.1	up	RDB	Alton Pool		419.3	90	NA	NA
24	01-Sep-95	06:00 PM	13.0	mp	RDB	Alton Pool	0.24	419.3	90	NA	NA
24	01-Sep-95	06:15 PM	12.9	dn	RDB	Alton Pool		419.3	90	NA	NA

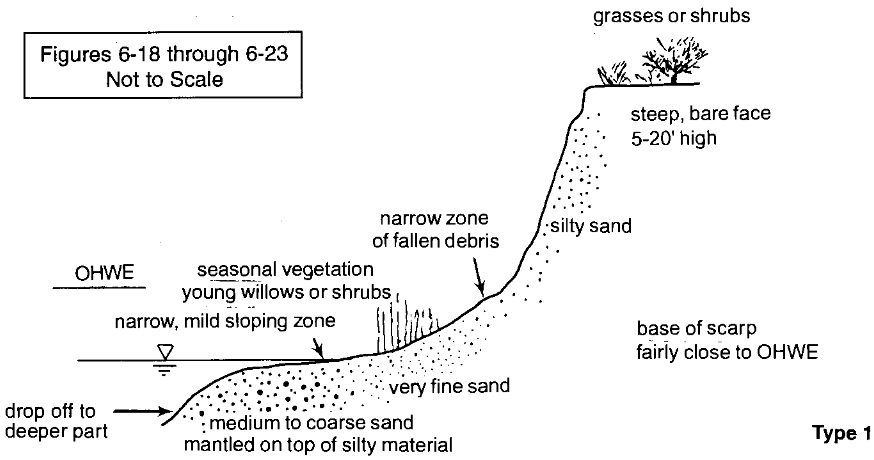


Figure 6-18. Type 1 bank on the ILWW: steep bank with high bare face. The ordinary high water elevation is low as compared to the bank elevation

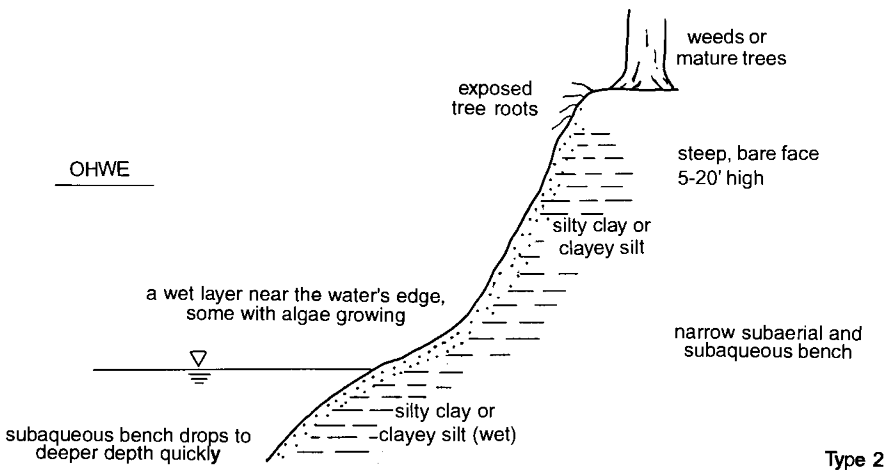


Figure 6-19. Type 2 bank on the ILWW: steep bank with high bare face. The ordinary high water elevation is comparable to the elevation at top of the bank

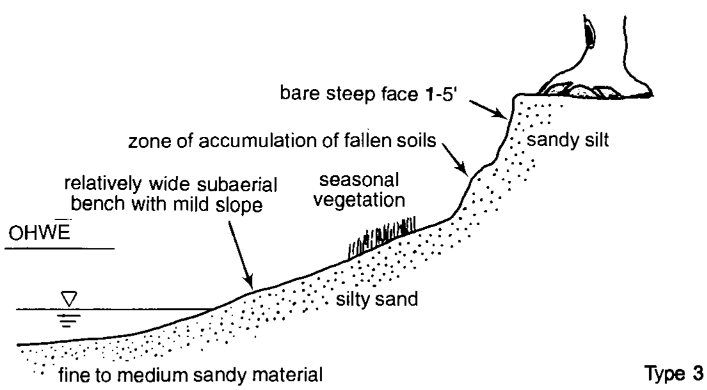


Figure 6-20. Type 3 bank on the ILWW: short scarp face and fairly long bench. The ordinary high water elevation is low as compared to the bank elevation

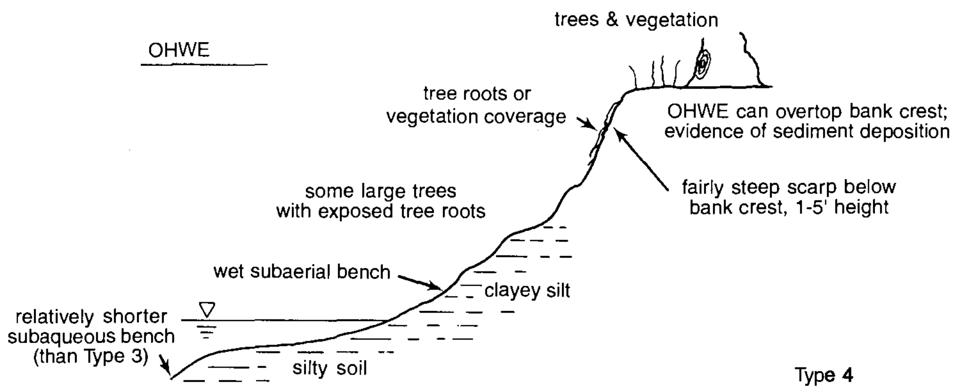


Figure 6-21. Type 4 bank o the ILWW: small scarp face with bare bank. The ordinary high water elevation can overtop bank crest or reach the face of scarp.

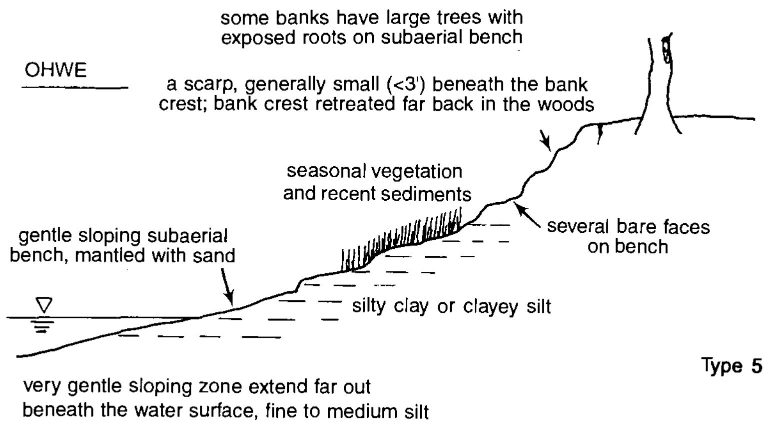


Figure 6-22. Type 5 bank on the ILWW: small scarp face and fairly long bench. The subaqueous bench has a gentle slope and extends far-out.

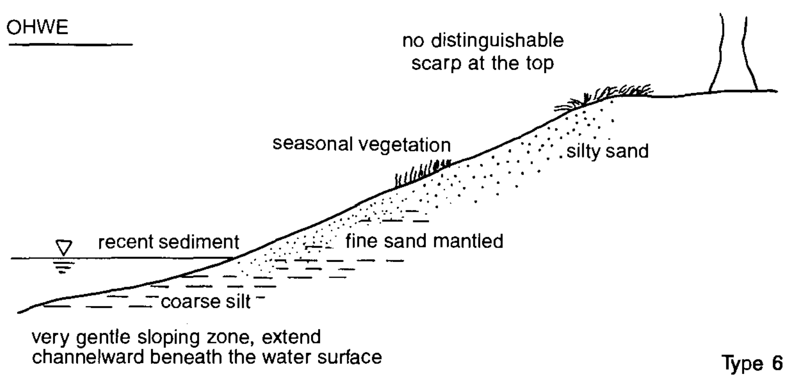


Figure 6-23. Type 6 bank on the ILWW: a gently slope bench with extended subaqueous bench.

Table 6-2. Bank Erosion Types, Main Features, and Erosion Potential on the Illinois Waterway

Type	*Main Features*	*Erosion Potential*
Type 1	• Steep to fairly steep scarp face, 5' ~ 20' height • Roots drape or exposed roots on upper portion of the bank • A narrow, mild slopping subaerial bench, some seasonal vegetation growing • Limited extend of subaqueous bench, drop-off at deeper part • Primarily silty sand to sandy materials • Near bank and underwater materials have similar characteristics • OHWE is close or falls below the base of scarp	• Rework, transport of failed soils or recent sediment by waves and currents. Basal failure induces further bank slips • Piping or seepage sluice out coarse material, weakens basal support • Overland drainage • Man-made disturbance • Debris induced flow disturbance • Freeze/thaw cycles, weathering processes • Removal of surficial bank materials by waves and currents during high water or floods
Type 2	• Steep to fairly steep scarp face, 5' ~ 20' height • Exposed roots or vegetation cover on scarp • Narrow subaerial and subaqueous bench • Subaquesous bench drop to deeper depth quickly • Primarily silty clay or clayey silt materials • A persistent wet layer near the water's edge, some with algae growing • OHWE is on the scarp	• Piping or seepage-processes weakens the basal support or strength of the bank • Scour by waves and currents; Bank slips follows the failure of basal support • Surficial block failures by waves or high water after the formation of tension cracks • Freeze - thaw - desiccation cycles, weathering processes • Debris induced local flow disturbances • Overland drainage • Man-made impact
Type 3	• Steep scarp face below bank crest, 1' ~ 5' height • A fairly extended subaerial bench with mild slope • Berm section is relatively wide • Extended subaqueous bench with gentle slope • Subaerial bench has recent sediment, some with desiccation cracks, seasonal vegetation growing • Primarily silty sand or sandy silt materials • OHWE is close to or fall below base of scarp	• Transport of bench materials by waves and currents • Removal of surficial bank materials during high stages or floods • Overland drainage induced rill erosion on bench • Freeze - thaw - desiccation cycles, weathering • Piping or seepage induced failure • Wet and dry cycle induced tension cracks

Table 6-2. Bank Erosion Types, Main Features, and Erosion Potential on the Illinois Waterway (Concluded)

Type	*Main Features*	*Erosion Potential*
Type 4	• Fairly steep scarp below bank crest, 1'~5' height • Tree roots exposed on scarp • Sediment deposition on top of bank • Subaerial bench has a mild slope • Smaller scarps on subaerial bench • Generally subaerial bench is wet or has springs • Trees with exposed roots on bench zone • Shorter subaqueous bench than Type 3 • Primarily silt or silty clay materials • OHWE is on the scarp or higher than bank top	• Transport bench material or recent sediment by waves and current • Piping and seepage related process • Removal of surficial bank materials during high water or floods • Overland drainage • Wave wash and seepage creates scarps on bench area • Freeze - thaw - desiccation cycles, weathering processes
Type 5	• A small scarp (< 3') remain on top of bank section, some with several bare scarps on the upper bank • Sediment deposition on top of bank, buried tree roots • No clear division of berm and bench • Gentle sloping bench, mantled with sand (recent sediment) • Gentle sloping subaqueous bench, extends far out • Primarily fine to medium silt materials • OHWE may submerge bank crest	• Transport bench materials by waves and currents • Removal of surficial bank materials during high water or floods • Overland drainage • Seepage related process
Type 6	• Seldom has distinguishable scarp or bare faces • Sediment deposition on bank crest, deposition around trees • No distinguishable berm and bench • Recent sediment on bench area • Gentle sloping bench zone • Very gentle bench slope, subaqueous bench extend far into channel • Primarily fine to medium silt materials • OHWE may overtop the bank	• Rework and transport of bench materials by waves and current • Removal of surficial bank materials during high water or floods • Seepage related process (wet/dry, poor drainage, piping) • Overland drainage

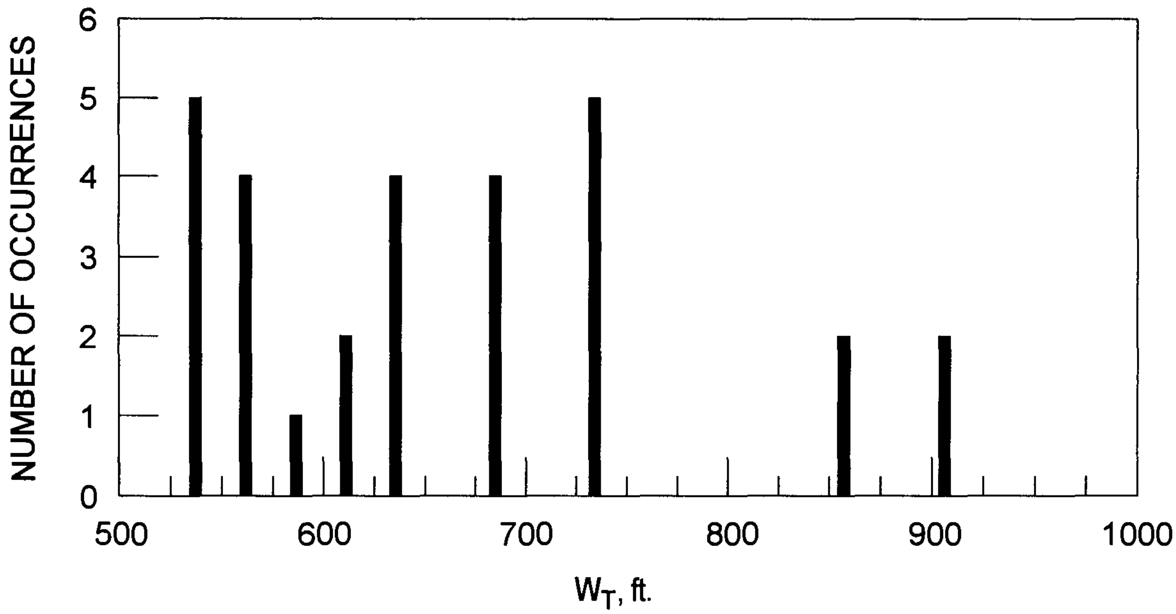


Figure 6-24. Histogram of the top widths, W_T, at the mid section measuring station of the Illinois River

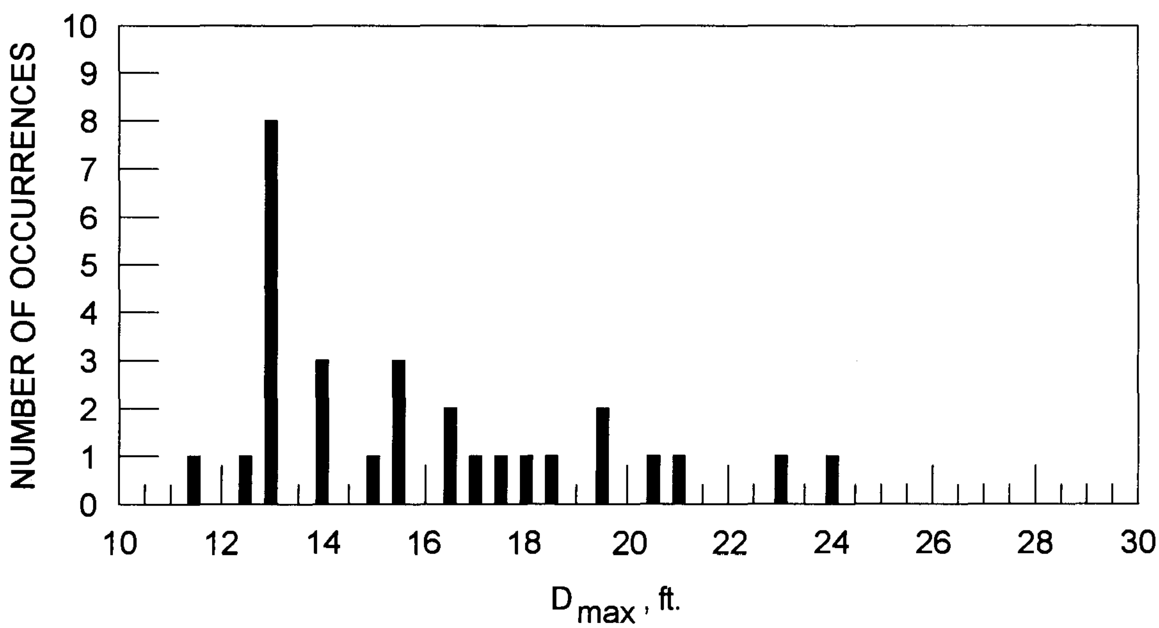


Figure 6-25. Histogram of the maximum depths, D_{max}, at the mid section measuring station of the Illinois River

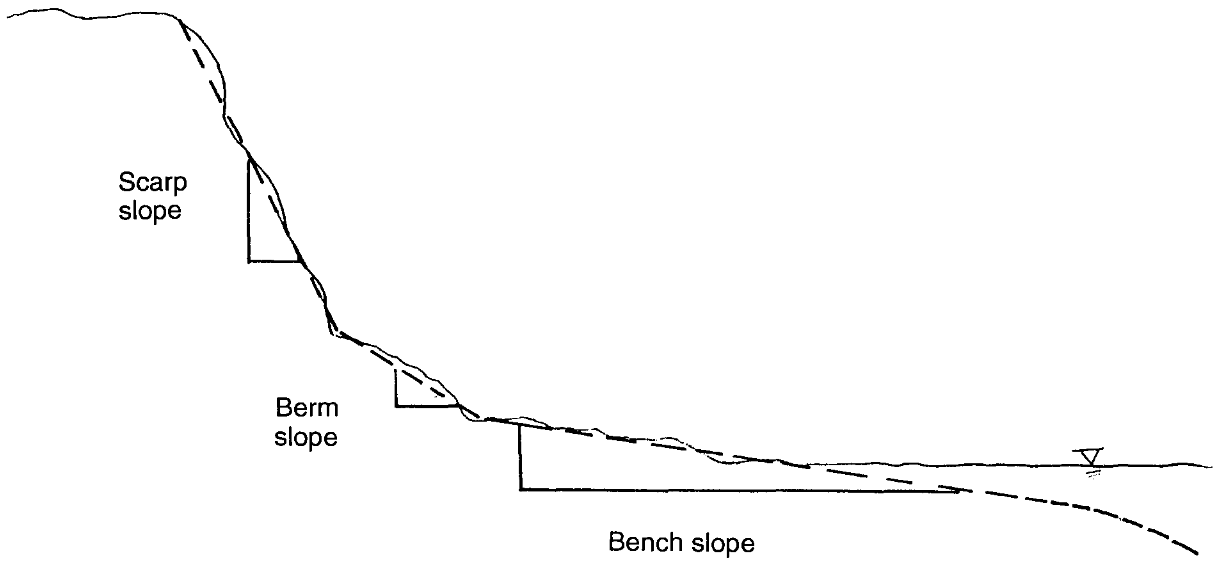


Figure 6-26. Definition sketch for scarp, berm and bench slopes

Figures 6-27 shows plots of histograms for these three parameters, respectively. The scarp slope varied from 1V:3.2H to 1V:0.04H with a median value of 1V:95H. Similarly, the berm slope varied from 1V:8.33H to 1V:0.83H with a median value of 1V:2.84H and a Standard Deviation of 0.23. The bench slope varied from 1V:81.00H to 1V:1H with a median value of 1V:11.1H.

Scarp and bench slopes did not vary as much as the berm slopes. The majority of the scarp slopes were close to 1V:0.71H or 1V:0.48H, and most bench slopes were between 1V:20H and 1V:10H. Most berm slopes, on the other hand, were between 1V:3.33H and 1V:2.5H.

Bank soils. A total of 174 surficial bank samples, including 81 core samples, were analyzed. Figure 6-28 shows histograms of d_{50} and d_{85} sizes of the bank soils and core samples collected from the Illinois River. For 141 of the samples, the d_{50} was in the range of 0.002 mm to 0.696 mm. The median value was 0.024 mm and the standard deviation was 0.133. The surficial soils and sediments at the eroded sites are well graded.

For about 151 samples, the d_{85} values range from 0.014 mm to 5.073 mm. The median value is equal to 0.169 mm with a standard deviation of 0.802 mm. From the figures it is safe to state that the most frequent occurrence of d_{50} values is less than 0.015 mm.

The uniformity of the bank soils is examined by the value and spread of standard deviation, σ, and uniformity coefficient, U. Histograms for these two values for all the samples are given in figure 6-29. Whenever the particles are quite uniform, then the values of σ and U approach one. Significant deviations from the value of 1 indicate the presence of graded materials. Figure 6-29 indicates that the values of σ and U are close to 2 or more, showing that the surficial soils and sediments at the eroded sites are well graded.

Site Lengths. These length limits were accurately determined using a portable GPS, which was mentioned earlier. Figure 6-30 shows the distribution of these measured site length vary from a minimum of 0.09 mile to about 0.95 mile. The median values is 0.22 mile with a standard deviation of 0.21 mile. Most of the sites clustered around values of 0.15 mile to 0.25 mile (figure 6-30).

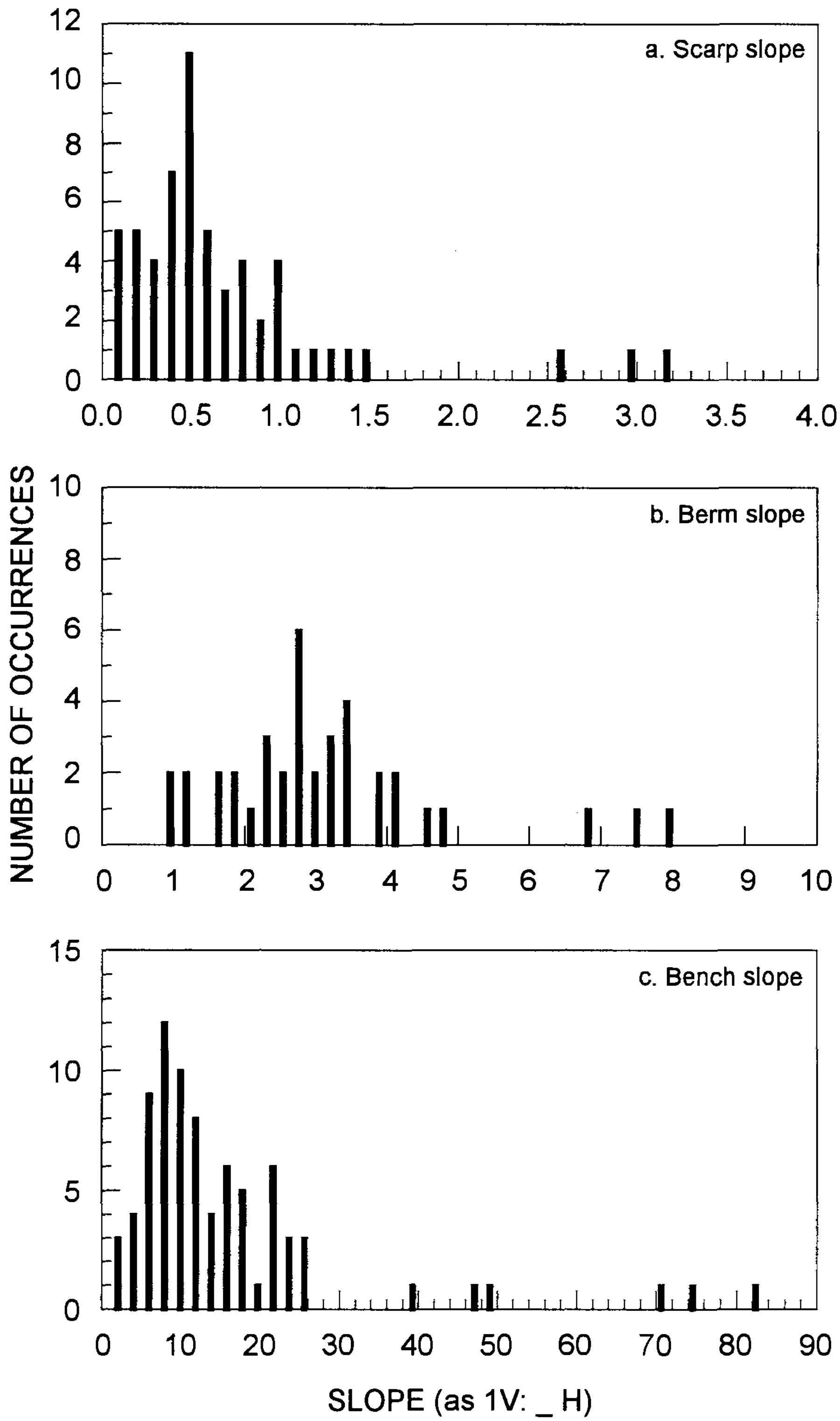


Figure 6-27. Histograms of scarp, berm, and bench slopes for the Illinois Waterway

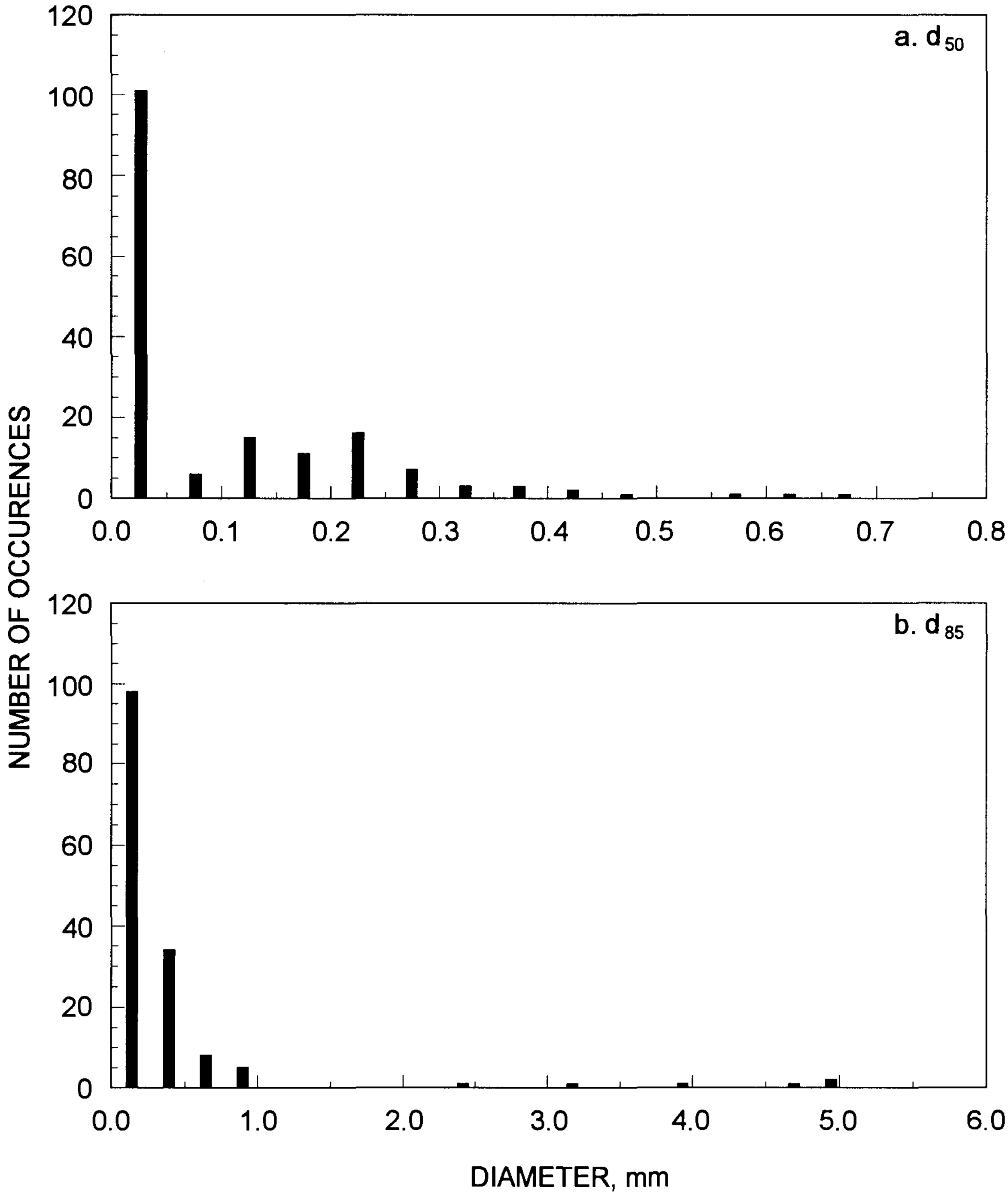


Figure 6-28. Histograms of d_{50} and D_{85} sizes of the bank materials on the Illinois Waterway

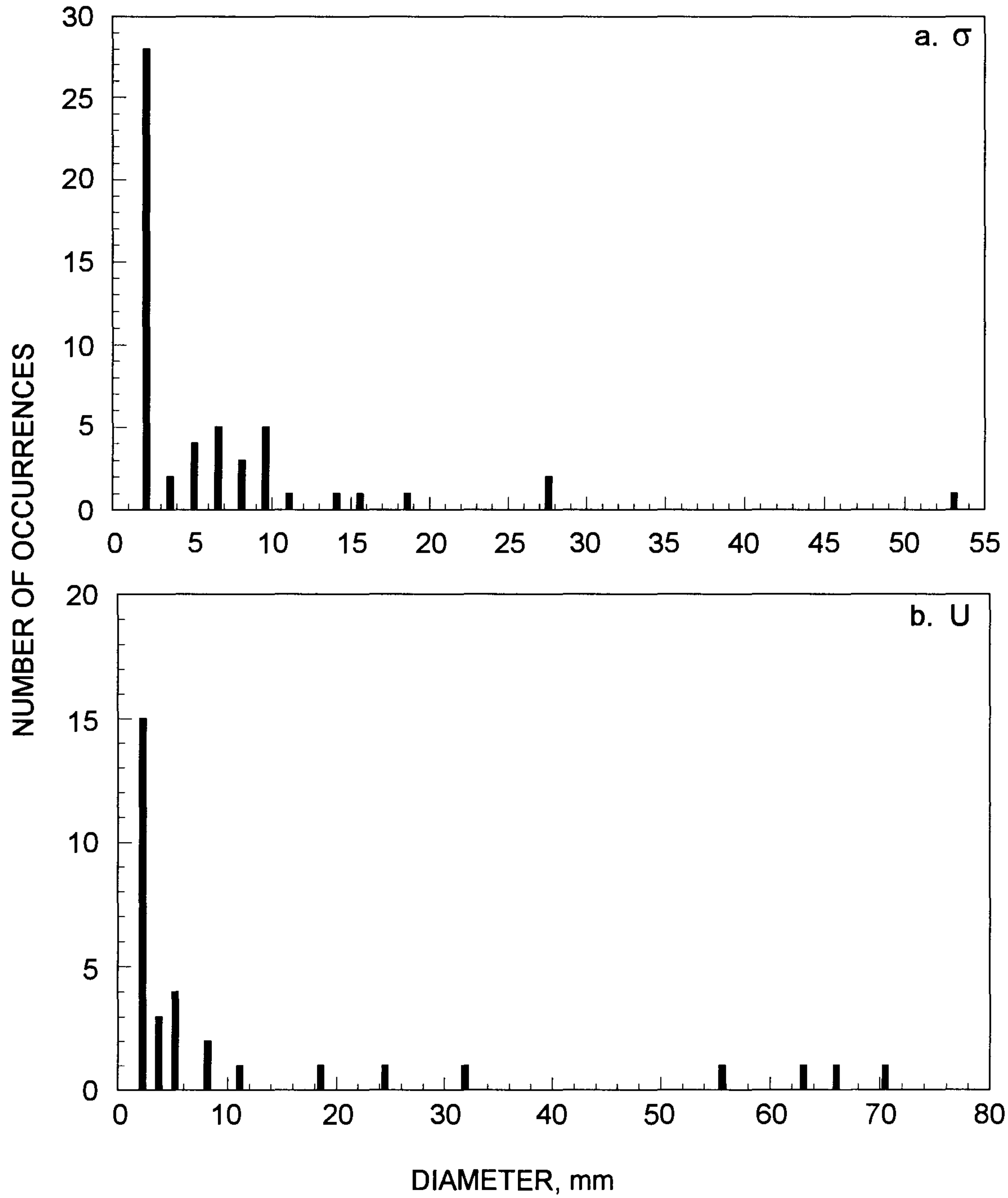


Figure 6-29. Histograms of σ and U for all the bank materials from the Illinois Waterway

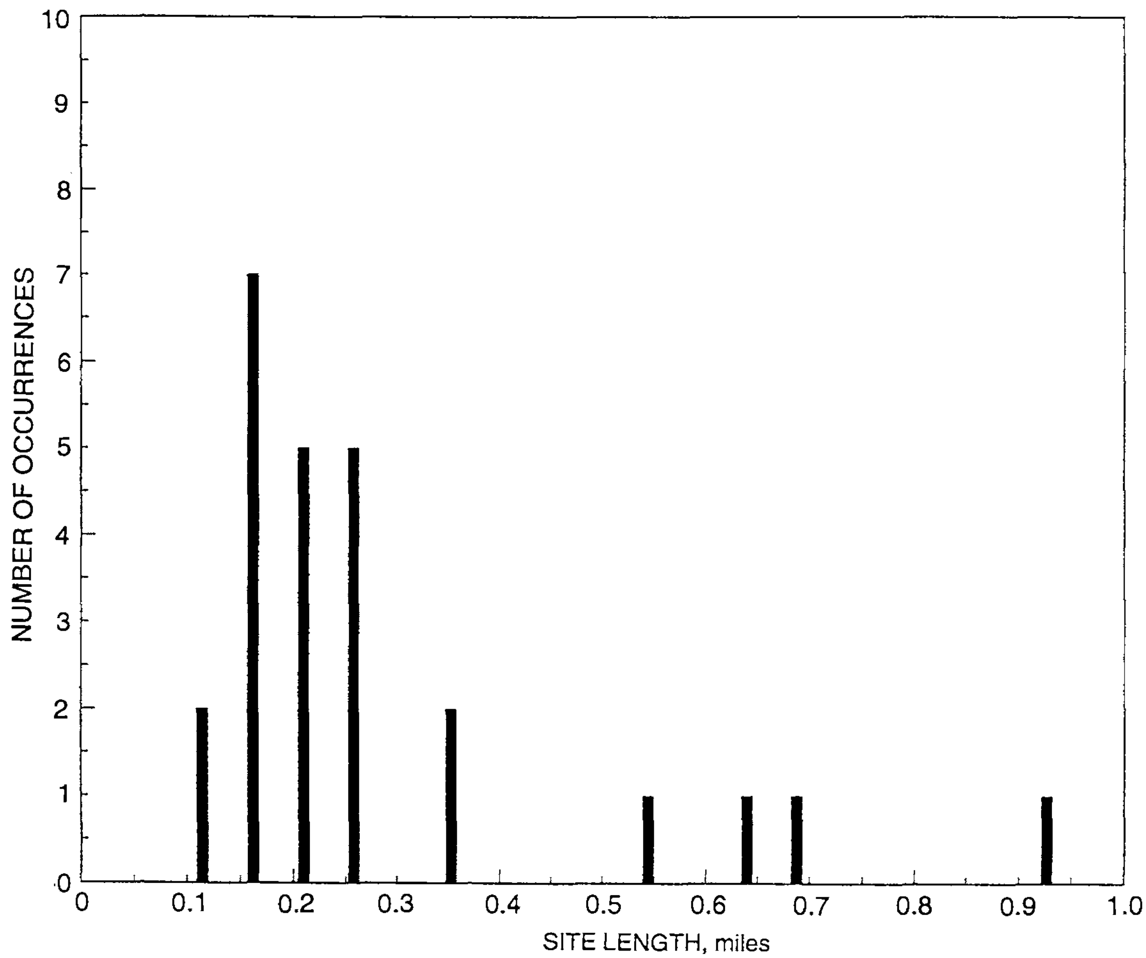


Figure 6-30. Histograms of site lengths for the Illinois Waterway bank erosion study

Geomorphic and Land Cover Characteristics For the sites where field data were collected, geomorphic characteristics were listed as Right Descending Bank (RDB), Left Descending Bank (LDB), straight or curve reaches, inside or outside of a bend, crossover position, and island sites. Land covers on the bank crests were recorded as: urban, agriculture, grass/weeds, and wooded.

Figure 6-31 shows geomorphic characteristics and land cover. Examination of this illustration shows that 17 sites on the RDB, 12 sites on the LDB, 13 sites on the straight reaches, 11 sites on the outside of the bank, 3 sites on the inside of the bank, and only 2 sites on the crossover. The dominant land covers on the bank crest were wooded followed by agricultural crops, grasses, or weeds. Furthermore, most of the selected sites were natural banks, with the remaining belonging to levees and railroad embankment.

The geomorphic parameters are also indicated on the IWW profiles map and are shown in figure 6-32. Most of the straight-reach sites selected for the present study were from the upper- and lowermost portions of the waterway, whereas erosion sites selected from the outside bank are distributed over the entire river length. Three inside-bend sites are all located in the La Grange Pool. Only one site is located on a crossover, in the Peoria Pool.

Table 6-3 shows the relative positions of these sites with respect to portions of the pools.

Table 6-3. Location of Surveyed Site in Navigation Pool, the Illinois Waterway

Pool	*Upper 1/3*	*Middle 1/3*	*Lower 1/3*
Marseilles	UP1, UP2, UP3, UP4 UP5		
Starved Rock	1, 2	3	
Peoria	4, 5, 6	7, 8	9, 10
La Grange	11, 12, 13	14, 15, 16, 17	18, 19
Alton	20, 21	22	23, 24

Summary:
13 sites are in the upper 1/3 of a pool
8 sites are in the middle 1/3 of a pool
8 sites are in the lower 1/3 of a pool

Table 6-4 provides additional parameters associated with the IWW erosion sites. Table 6-5 is a summary of bank characteristics, which can serve as the basis for selecting future study sites.

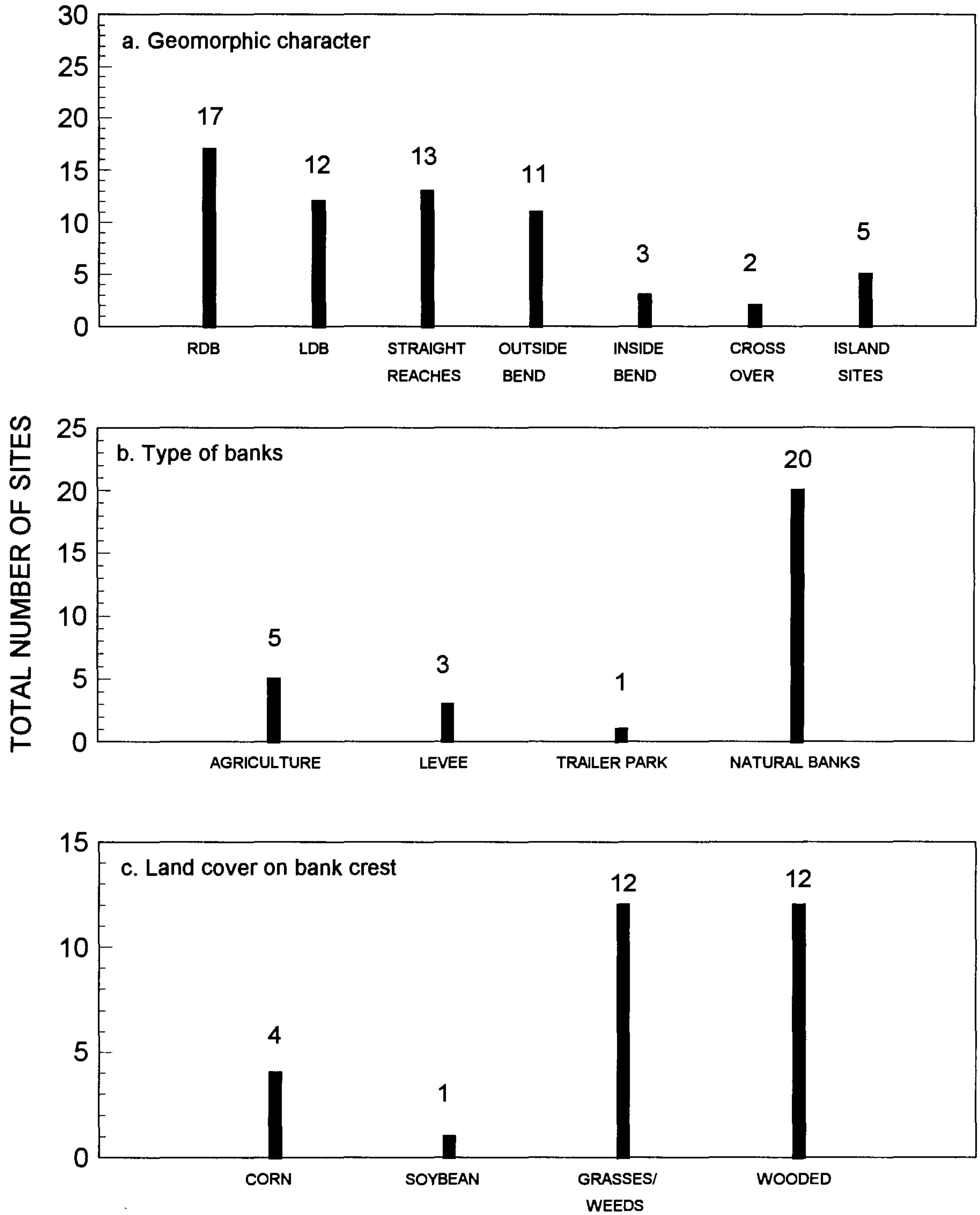


Figure 6-31. Histograms of geomorphic and land use characteristics of the erosion sites on the Illinois Waterway

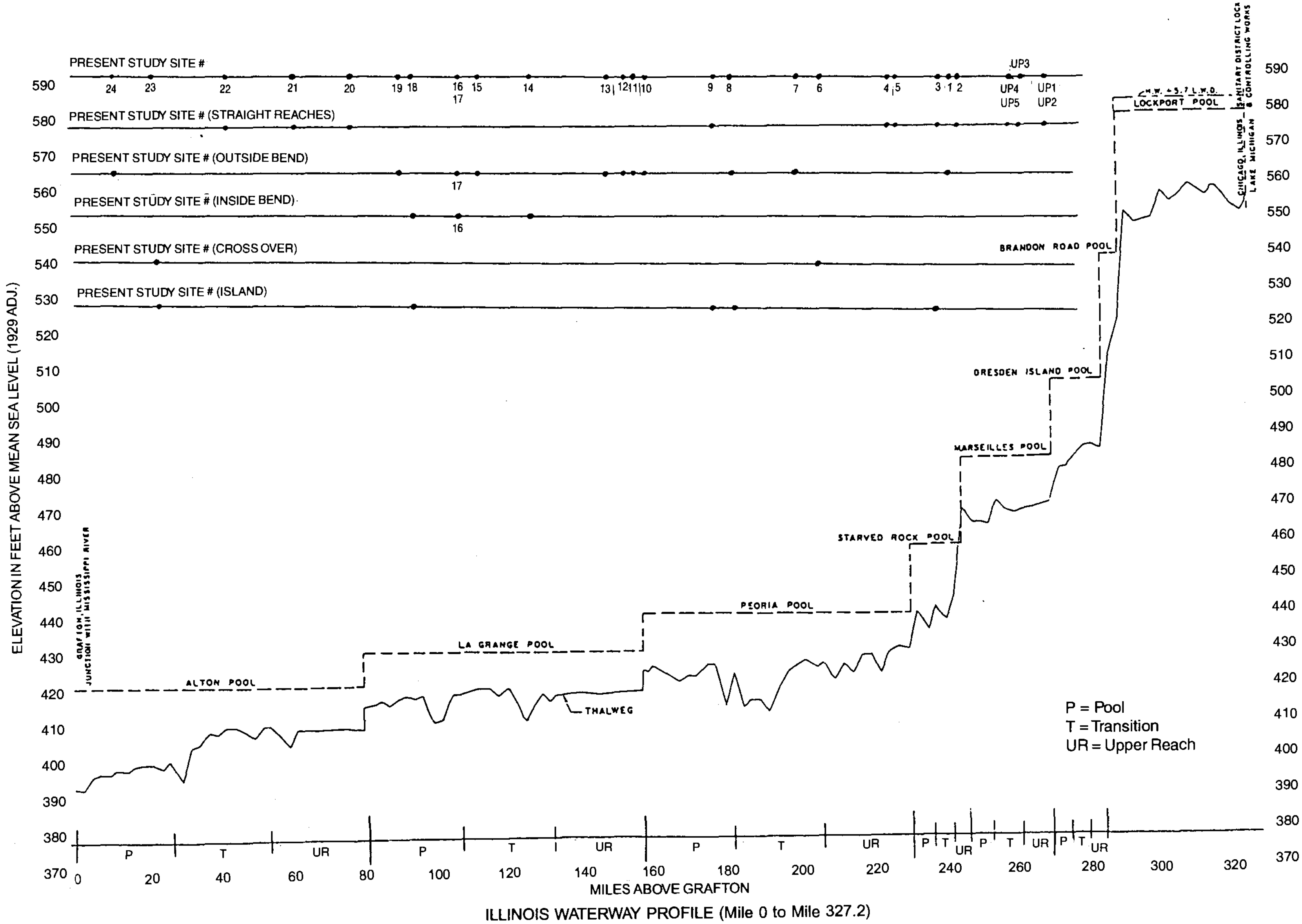


Figure 6-32. Relative locations of selected sites on the Illinois Waterway

Table 6-4. Selected Parameters Associated with the Illinois Waterway Erosion Sites

Site#	*Date in 1995*	*Time*	*RM*	*Section*	*Side*	*Pool*	*Length (miles)*	*Stage (msl)*	*f (%)*	*OHW (msl)*	*NP (msl)*	*Type*	*Remarks*
UP1	18/09	04:15 PM	270.8	up	RDB	Marseilles		483.9	90	486.6	483.3	1&3	
UP1	18/09	03:30 PM	270.8	mp	RDB	Marseilles		483.9	90	486.6	483.3	1&3	
UP1	18/09	04:00 PM	270.8	dn	RDB	Marseilles		483.9	90	486.6	483.3	1&3	
UP2	18/09	04:30 PM	270.8	mp	LDB	Marseilles		483.9	90	486.6	483.3	5	
UP3	19/09	08:20 AM	264.3	up	LDB	Marseilles		483.7	80	485.7	483.3	3	
UP3	20/09	07:30 AM	264.3	mp	LDB	Marseilles	0.15	483.7	80	485.7	483.3	3	
UP3	20/09	08:00 AM	264.3	dn	LDB	Marseilles		483.7	80	485.7	483.3	3	
UP4	20/09	10:30 AM	262.2	up	LDB	Marseilles		483.7	90	485.5	483.3	2&3	Fleeting Area
UP4	20/09	10:00 AM	262.1	mp	LDB	Marseilles	0.34	483.7	90	485.5	483.3	2&3	Silty clay bank, sandy bench
UP4	20/09	10:20 AM	262.0	dn	LDB	Marseilles		483.7	90	485.5	483.3	2&3	
UP5	20/09	11:00 AM	262.1	mp	RDB	Marseilles		483.7	90	485.5	483.3	4&5	Silty clay bank, subaqueous scour
1	28/08	12:45 PM	242.9	up	LDB	Starved Rock		458.6	90	460.0	458.5	1	Aggregated silt blocks
1	28/08	10:45 AM	242.8	mp	LDB	Starved Rock	0.24	458.8	90	460.1	458.5	1	
2	28/08	11:45 AM	243.4	mp	LDB	Starved Rock		459.4	50	460.3	458.5	2&6	extended shallow bench
3	28/08	04:00 PM	235.7	up	RDB	Starved Rock		459.0	75	459.5	458.5	1&6	extended shallow bench
3	28/08	04:13 PM	235.7	mp	RDB	Starved Rock	0.14	459.0	75	459.3	458.5	1&6	
3	28/08	03:20 PM	235.7	dn	RDB	Starved Rock		459.0	75	459.3	458.5	1&6	
4	28/08	06:25 PM	228.1	up	LDB	Peoria		441.6	75	446.1	440.0	5	
4	28/08	06:40 PM	228.0	mp	LDB	Peoria	0.24	441.6	75	446.0	440.0	5	
4	28/08	07:00 PM	228.0	dn	LDB	Peoria		441.6	75	446.0	440.0	5	
5	28/08	07:40 PM	229.0	up	RDB	Peoria		441.6	75	446.4	440.0	3&5	downstream of a barge terminal
5	28/08	07:25 PM	228.75	mp	RDB	Peoria	0.21	441.6	75	446.2	440.0	3&5	piping at lower bank,
5	28/08	07:30 PM	228.75	dn	RDB	Peoria		441.6	75	446.3	440.0	3&5	wave wash on bench area
6	29/08	10:35 AM	210.0	up	RDB	Peoria		441.1	75	444.3	440.0	4	subaqueous scour
6	29/08	10:40 AM	210.0	mp	RDB	Peoria	0.34	441.1	75	444.3	440.0	5	
6	29/08	11:15 AM	209.7	dn	RDB	Peoria		441.1	75	444.2	440.0	6	
7	29/08	12:15 PM	203.8	up	LDB	Peoria		441.1	75	443.9	440.0	5	
7	29/08	12:00 PM	203.8	mp	LDB	Peoria	0.20	441.1	75	443.9	440.0	5	levee
7	29/08	12:45 PM	203.5	dn	LDB	Peoria		441.1	75	443.9	440.0	5	

Note: River mile at the mid-point of a reach is used if the river miles at the upstream or downstream points are unknown.

Table 6-4. Selected Parameters Associated with the Illinois Waterway Erosion Sites (Continued)

Site#	*Date in 1995*	*Time*	*RM*	*Section*	*Side*	*Pool*	*Length (miles)*	*Stage (msl)*	*f (%)*	*OHW (msl)*	*NP (msl)*	*Type*	*Remarks*
8	29/08	02:45 PM	184.9	up	LDB	Peoria		441.1	73	442.6	440.0	4&5	piping at lower scarp, extended
8	29/08	02:30 PM	184.8	mp	LDB	Peoria	0.26	441.1	73	442.6	440.0	4&5	subaqueous bench
8	29/08	03:05 PM	184.7	dn	LDB	Peoria		441.1	73	442.6	440.0	4&5	
9	29/08	03:50 PM	179.8	up	LDB	Peoria		440.6	90	442.4	440.0	6	
9	29/08	03:45 PM	179.9	mp	LDB	Peoria	0.21	440.6	90	442.4	440.0	6	
9	29/08	04:05 PM	179.7	dn	LDB	Peoria		440.6	90	442.4	440.0	6	
10	29/08	06:25 PM	160.0	up	RDB	Peoria		440.5	50	441.4	440.0	4&5	
10	29/08	06:20 PM	160.0	mp	RDB	Peoria	0.11	440.5	50	441.4	440.0	4&5	extended subaqueous bench
10	29/08	06:45 PM	160.0	dn	RDB	Peoria		440.5	50	441.4	440.0	4&5	
11	30/08	11:00 AM	155.5	up	RDB	La Grange		432.8	70	440.8	429.5	6	
11	30/08	08:15 AM	155.3	mp	RDB	La Grange	0.54	432.8	70	440.8	429.5	6	
11	30/08	11:30 AM	155.1	dn	RDB	La Grange		432.8	70	440.8	429.5	6	
12	30/08	08:45 AM	154.6	up	LDB	La Grange		432.8	70	440.7	429.5	5	
12	30/08	09:40 AM	154.4	mp	LDB	La Grange	0.62	432.8	70	440.7	429.5	5	
12	30/08	10:40 AM	154.2	dn	LDB	La Grange		432.8	70	440.7	429.5	5	
13	30/08	12:15 PM	150.6	up	LDB	La Grange		432.3	75	440.5	429.5	4	water surface on scarp face
13	30/08	12:10 PM	150.5	mp	LDB	La Grange	0.18	432.3	75	440.5	429.5	4	may be scraped by traffic
13	30/08	12:45 PM	150.5	dn	LDB	La Grange		432.3	75	440.5	429.5	4	
14	30/08	04:15 PM	129.4	up	RDB	La Grange		431.2	80	438.5	429.5	4	
14	30/08	04:15 PM	129.3	mp	RDB	La Grange	0.28	431.2	80	438.5	429.5	4	levee
14	30/08	04:45 PM	129.2	dn	RDB	La Grange		431.2	80	438.5	429.5	4	subaqueous scour
15	30/08	06:35 PM	116.7	up	RDB	La Grange		430.8	75	437.0	429.5	3&5	
15	30/08	06:45 PM	116.5	mp	RDB	La Grange	0.95	430.8	75	437.0	429.5	3&5	levee
15	30/08	07:10 PM	116.3	dn	RDB	La Grange		430.8	75	437.0	429.5	3&5	
16	31/08	11:05 AM	109.5	up	LDB	La Grange		430.6	75	435.8	429.9	2	
16	31/08	10:25 AM	109.5	mp	LDB	La Grange	0.18	430.6	75	435.7	429.9	2	
16	31/08	10:38 AM	109.5	dn	LDB	La Grange		430.6	75	435.6	429.9	3	near Anderson Lake
17	31/08	10:00 AM	109.6	up	RDB	La Grange		430.6	75	435.7	429.9	5	
17	31/08	09:15 AM	109.5	mp	RDB	La Grange	0.18	430.6	75	435.7	429.9	5	
17	31/08	10:30 AM	109.4	dn	RDB	La Grange		430.6	75	435.7	429.9	4	
18	31/08	02:40 AM	94.2	up	RDB	La Grange		429.9	75	433.7	429.9	4	
18	31/08	02:15 PM	94.2	mp	RDB	La Grange	0.09	429.9	75	433.7	429.9	2&4	
18	31/08	02:20 PM	94.2	dn	RDB	La Grange		429.9	75	433.7	429.9	4	

Table 6-4. Selected Parameters Associated with the Illinois Waterway Erosion Sites (Concluded)

Site#	*Date in 1995*	*Time*	*RM*	*Section*	*Side*	*Pool*	*Length (miles)*	*Stage (msl)*	*f (%)*	*OHW (msl)*	*NP (msl)*	*Type*	*Remarks*
19	31/08	03:05 PM	91.2	up	RDB	La Grange		429.9	65	433.3	429.9	2&4	downstream of barge terminals
19	31/08	04:00 PM	91.2	mp	RDB	La Grange	0.22	429.9	65	433.3	429.9	2&4	
19	31/08	04:30 PM	91.1	dn	RDB	La Grange		429.9	65	433.3	429.9	2&4	
20	31/08	07:40 PM	79.6	up	RDB	Alton		420.6	90	NA	NA	2	d/s La Grange L & D
20	31/08	07:15 PM	79.4	mp	RDB	Alton	0.67	420.6	90	NA	NA	2	
20	31/08	07:20 PM	79.2	dn	RDB	Alton		420.6	90	NA	NA	2	
21	01/09	11:00 AM	61.8	up	RDB	Alton		420.6	80	NA	NA	5	wet bench
21	01/09	10:45 AM	61.7	mp	RDB	Alton	0.23	420.6	80	NA	NA	4	small scarp on top of bank, wet
21	01/09	10:40 AM	61.6	dn	RDB	Alton		420.6	80	NA	NA	5	bench, shorter subaqueous bench
22	01/09	01:00 PM	45.1	up	RDB	Alton		419.9	85	NA	NA	4&5	
22	01/09	12:50 PM	45.1	mp	RDB	Alton	0.14	419.9	85	NA	NA	4&5	
22	01/09	01:30 PM	45.1	dn	RDB	Alton		419.9	85	NA	NA	4&5	
23	01/09	04:30 PM	23.5	up	RDB	Alton		419.3	90	NA	NA	4	
23	01/09	04:20 PM	23.4	mp	RDB	Alton	0.18	419.3	90	NA	NA	4	
23	01/09	04:45 PM	23.3	dn	RDB	Alton		419.3	90	NA	NA	2	
24	01/09	06:30 PM	13.1	up	RDB	Alton		419.3	90	NA	NA	2&5	
24	01/09	06:00 PM	13.0	mp	RDB	Alton	0.24	419.3	90	NA	NA	2&5	
24	01/09	06:15 PM	12.9	dn	RDB	Alton		419.3	90	NA	NA	2&5	

Note: OHW = Ordinary High Water Level; NP = Normal Pool Level

Table 6-5. Classification of the Erosion Sites on the Illinois Waterway

Parameters	*Most frequent values*	*Second most frequent values*
Bench Slopes	18* (0.025-0.05)	15 (0.1-0.125)
Berm Slopes	4 (3 ranges)	3 (3 ranges)
Scarp Slopes	16 (1.4-2.1)	13 (0.7-1.4)
d_{50}	101 (0.0-0.05)	16 (0.18-0.23)
d_{85}	98 (0.0-0.14)	34 (0.14-0.39)
σ	28 (2-3)	5 (6-7; 9-10) (2 ranges)
U	15 (2-3)	4 (5-6)
Site Lengths	7 (0.15-0.2)	5 (0.2-0.25) (2 ranges)
Sites with Natural Banks	28	---
Top Width	5 (525-550) (2 ranges)	4 (550-575) (3 ranges)
Max Depth	8 (12.5-13.0)	3 (14-14.5) (2 ranges)

Relative Locations: 17 on the RDB, 12 on the LDB;
13 on straight reach, 11 on outside bend, 3 on inside bend, and 2 on cross-over;
5 sites were located on islands

Note: number of occurrence; a and b in the parenthesis (a:b) represent the lower and upper values of a range.

Site Descriptions

Overall, 80 bank sections at 29 sites were measured during the field trip, 183 bank soil samples were collected, and 174 samples were analyzed. River cross sections were also measured at 29 locations.

For each site, a site location map, a representative site photograph, all the bank sections and channel cross sections measured for the site are presented. In the bank section plots, d_{50} values (in mm) at surficial sampling locations, the ordinary high water surface elevation (OHW) and the normal pool elevation (NP), noted soil classifications (see Table 5-1 for acronyms) and other observations are noted. Readers are referred to figure 6-16 and table 6-1 for specific locations. All the sites are described starting at the upstream end of the IWW. Types of erosion at each site will be cross-referenced with the "Types" shown in figures 6-18 - 6-23 and described in table 6-2. In order to reduce the number of illustrations within the main body of the report, all the plots associated with the determination of the bank soil size distributions and the river cross sections are included in appendices F and G, respectively.

Site UP1, Marseilles Pool, 9/18/95. This site is located on the Right Descending Bank (RDB) of the Illinois River at RM 270.8, a straight reach approximately 0.8 miles downstream of the Dresden Island L&D (RM 271.5). Figure 6-33 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-34 shows one photograph of the site.

The site is about 180 feet from the sailing line and no major tributary enters the IWW at this location. An Elgin Joliet and Eastern Railroad bridge is located at RM 270.6. In two earlier studies Bhowmik and Schicht (1980) indicated erosion on the RDB while Hagerty (1988) indicated erosion on both banks.

An almost vertical failure face approximately 15 to 20 feet high is present at this site. Recession of the bank line is close to the support of a nearby powerline frame. One of the four legs of a nearby powerline support was only 3 feet away from the bank face.

Only one river cross section was measured at this site, and the detailed cross section and coordinates are shown in appendix G. Three bank sections were measured at this site, as given in figure 6-35 with the computed values of bench slopes and median diameters of the bank soils. For site UP1, the OHW is at 486.6 and NP is at 483.3 feet above msl, respectively. The NP elevation

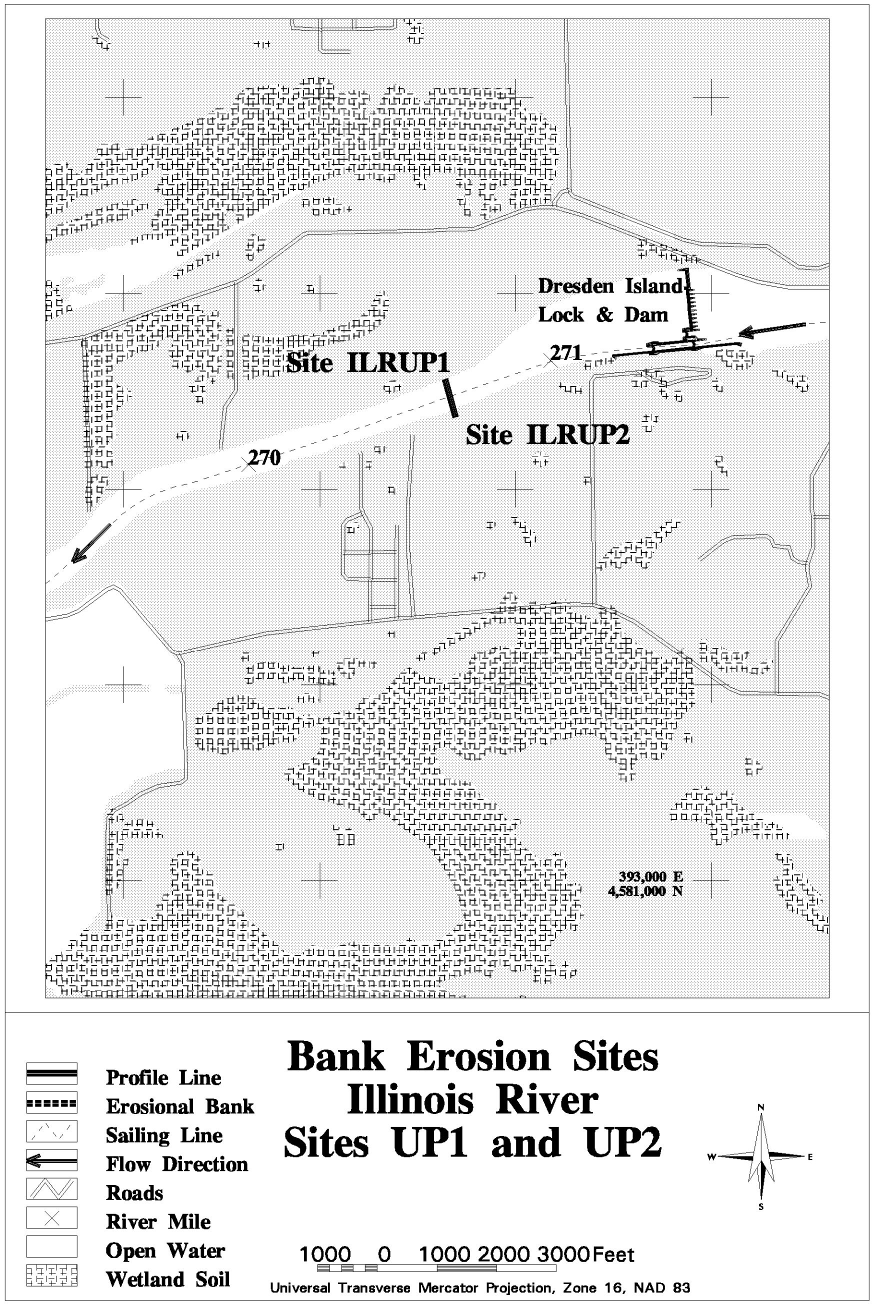
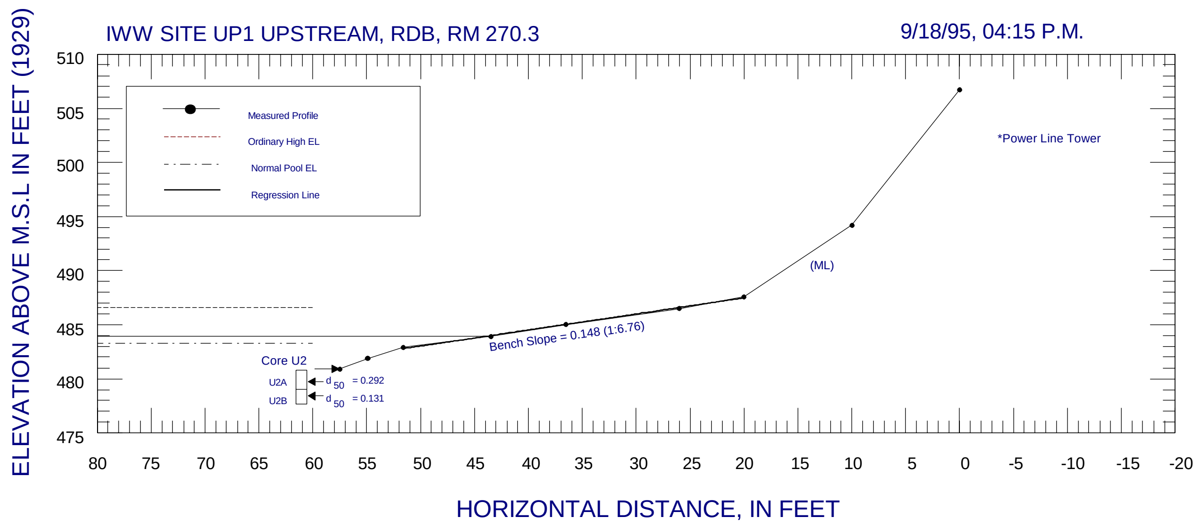


Figure 6-33. Locations of sites UP1 and UP2 on the Illinois Waterway

Figure 6-34. Site UP1 on the Illinois Waterway

corresponds to a break in the subaqueous bench slope. There were weeds growing on the bench near the base of the scarp. The bank above the OHW line is relatively high as compared to local stage fluctuations. According to 10-year stage data (see table 6-6), the OHW reaches the base of the scarp and only high stages (less than 10% exceedence frequency, or approximately at 489.9 feet) can reach the existing scarp face. Otherwise, normal stage fluctuations (the range between OHW and NP) occur mostly on the bench area.



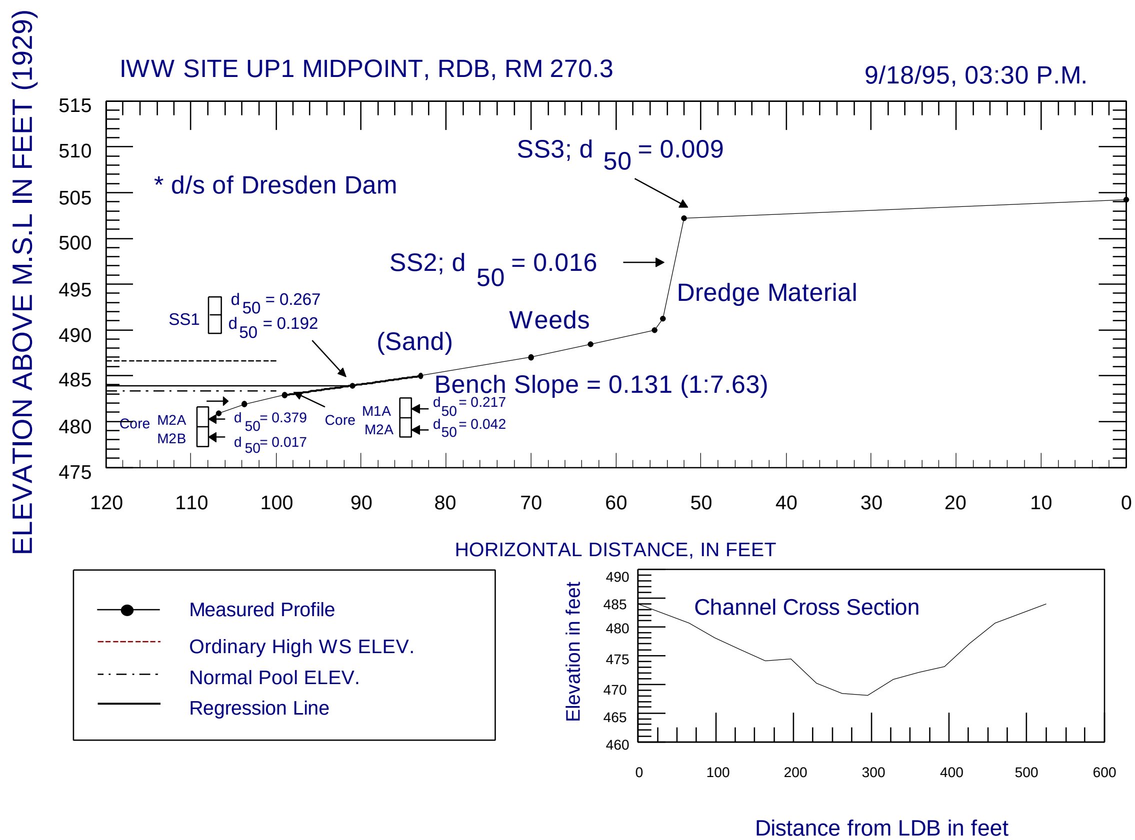


Figure 6-35. Bank sections at site UP1

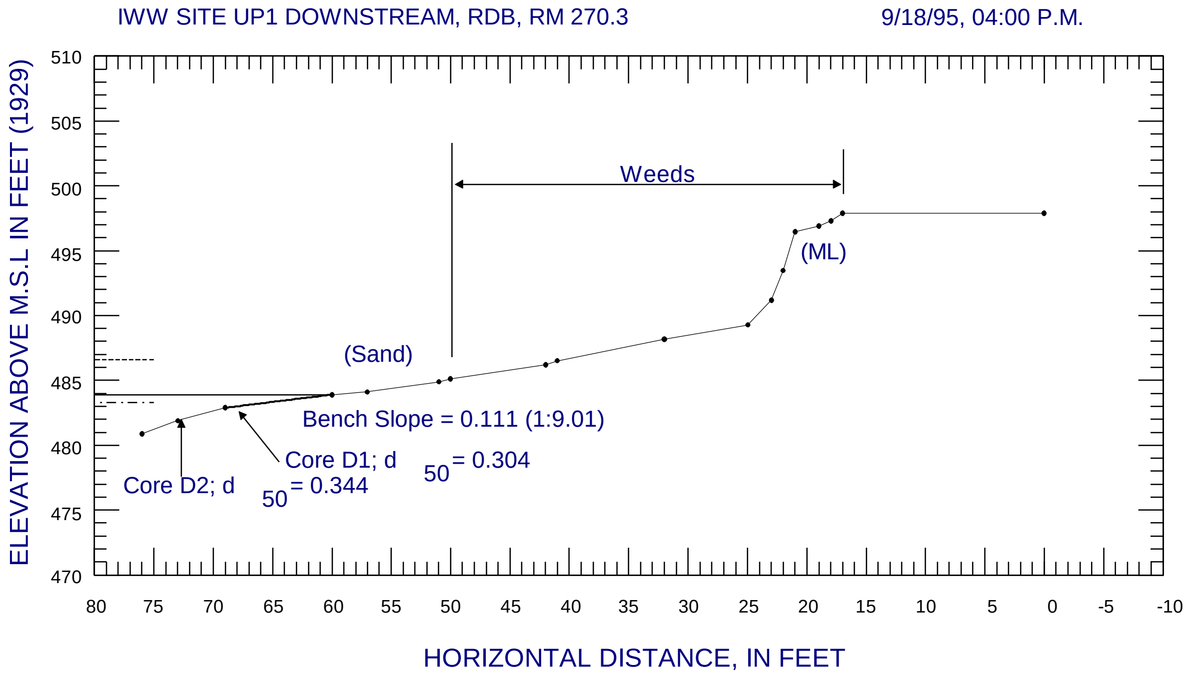


Figure 6-35. Bank sections at site UP1 (concluded)

The gradation plots of bank soils and nearshore sediment are presented in appendix F. At the midsection, the d_{50} varies from 0.009 mm at the top surface of the bank to 0.379 mm at the upper part of a core sample at a depth of about 2 feet of water.

The bench slope varied from 1V:6.8H to 1V:9.H. The bank at this site can be classified as a combination of types 1 and 3 (figure 6-18, 6-20, table 6-4). Floods and high water stages could be the major cause of bank erosion. There was a collapsed bank section. Failure could be due to erosional oversteeping. Several holes were observed on bank face indicating that piping could also be a factor in bank failure.

Site UP2, Marseilles Pool, 9/18/95. This site is located on the Left Descending Bank (LDB) at RM 270.8, opposite site UP1. Figure 6-33 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-36 shows one photograph of the site.

The site is about 280 feet from the sailing line and no major tributary enters the IWW at this location. In Bhowmik and Schicht’s (1980) note, this side was marked as a dredge material displacement site. Trees and grass covered an obvious scarp approximately 3 feet in height 100 feet from the water's edge. The bench was composed of coarse sand, gravel, and boulders. More boulders were encountered between the scarp face and the bench.

Figure 6-37 shows the plot of the bank sections and a cross section. Only one river cross section and one bank section were measured at this site. The OHW is the same as site UP1 at 486.6 feet above msl, and NP at 483.3 feet above msl. On this side of the river, the OHW is on the bench area and only stages exceeding 10% occurrence level (table 6-7) can reach to the base of the minor scarp face at about 494 feet above msl.

Table 6-6. Site UP1

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	484.2	• Bench (slope varied from 1V:9H to 1V:6.8H)	• d_{50} (core) @ 2' of water varied (0.017-0.379)
75	484.6	• Bench	• d_{50} @ 1' of water varied (0.042-0.304)
50	485.5	• Bench	
25	487.3	• Toe of berm	
10	489.9	• Berm • Berm (slopes varied from 1V:1.05H to 1V:5H)	• d_{50} = 0.016
0-9	>490.0	• Toe of scarp • Scarp (slope varied from 1V:1.05H to 1V:0.38H)	• d_{50} = 0.009

Note: Tail water gage of Dresden Island @ RM 271.5 was used for stage histogram; WSE = 483.9'; OHW = 486.6'; NP = 483.3'.

Table 6-7. Site UP2

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	484.2	• Bench	• d_{50} = 0.617
75	484.6	• Bench	• d_{50} (core) @ 1' of water varied (0.239-0.589)
50	485.5	• Bench	• d_{50} (core) @ 2' of water = 0.429
25	487.3	• Bench	
10	489.9	• Bench (slope = !v:11H)	
0-9	>490.0	• Scarp (slope = 1V:9.2H)	• d_{50} varied (0.013-0.138)

Note: Tail water gage of Dresden Island @ RM 271.5 was used for stage histogram; WSE = 483.9'; OHW = 486.6'; NP = 483.3'.

Figure 6-36. Site UP2 on the Illinois Waterway

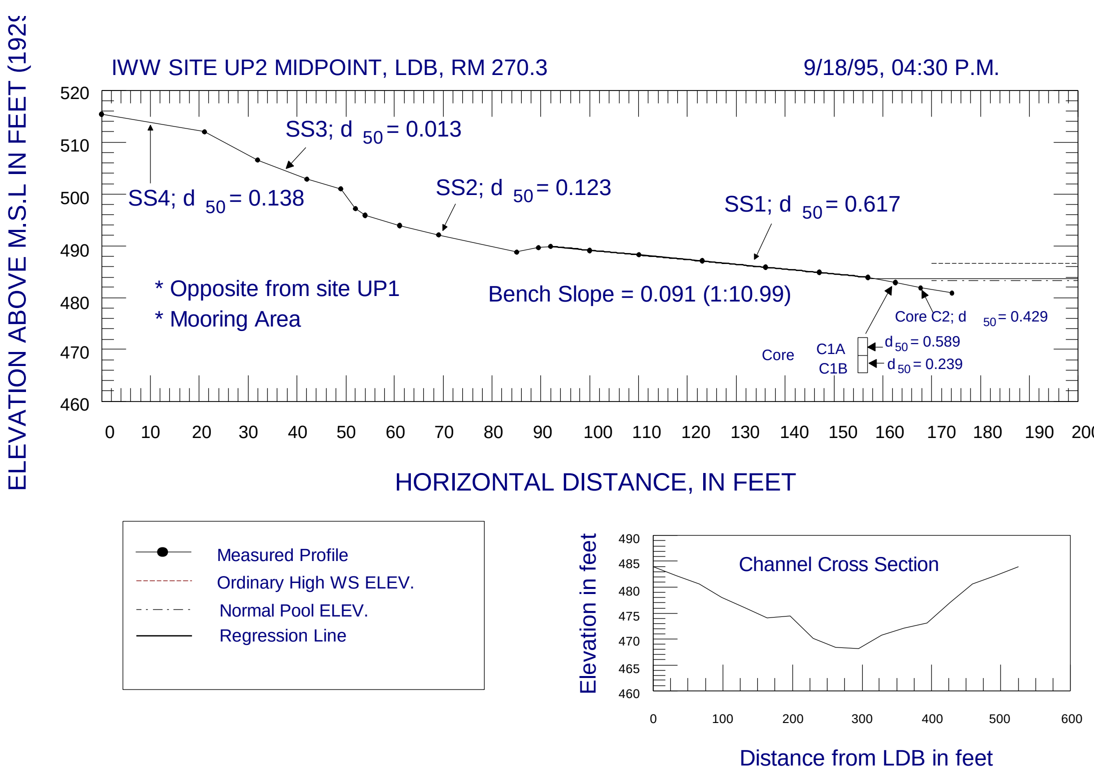


Figure 6-37. Bank section at site UP2, midsection

The d_{50} varied from 0.138 mm at the top surface of the bank to 0.429 mm for a core sample at a depth of about 2 feet of water. Another core sample at 1 foot of water showed coarse sand (d_{50} = 0.589 mm) on top and fine sand (d_{50} = 0.239) at the bottom. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

The bench slope was 1V:11.H, and the bench was covered with noncohesive sandy soil. This site can be classified as type 5 (see figure 6-22 and table 6-4). The scarp was above OHW stage. Erosion could have occurred during flood stages. The base of the scarp showed sand deposits indicating that seepage at the base could weaken the bank. Waves and currents could remove/transport failed soils that mantle the bench.

Site UP3, Marseilles Pool, 9/19/95. This site is located on the LDB at RM 264.3; the reach is fairly straight. The Morris Boat Club Dock and Vogler Gravel Company are located across the river at RM 264.5. No major tributary enters this site. Figure 6-38 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-39 shows one photograph of the site.

The site is about 250 feet from the sailing line as measured from the navigation chart. Both Bhowmik and Schicht (1980) and Hagerty (1988) indicated the existence of a significantly long stretch of bank erosion on the LDB. The site is currently used as a trailer park located at the top of the bank, and boat docks were installed. An abandoned boat ramp was found at the upstream end of the site. Quite a few boulders were found in the nearshore area. When taking core samples, the crew noted that sediments showed a very high level of oil staining, and oil emerged when the crew split samples.

An obvious scarp approximately 5 to 10 feet high was present at this site. Erosion of the bench area, if not retreat of the bank line, could be described as significant when compared with a 1988 photo. Figure 6-40 shows the three measured bank sections and a reduced cross section. At the downstream section, a concave bank face was observed. The OHW is at 485.7 feet and NP is at 483.3 feet above msl. The NP elevation corresponds to a break in the subaqueous bench slope. The OHW reaches to the upper part of the bench and corresponded well with the lower end of the weed zone. The bank top is relatively high and only high stages exceeding the 10% occurrence frequency (at 488 feet, see table 6-8) can reach the berm or the scarp.

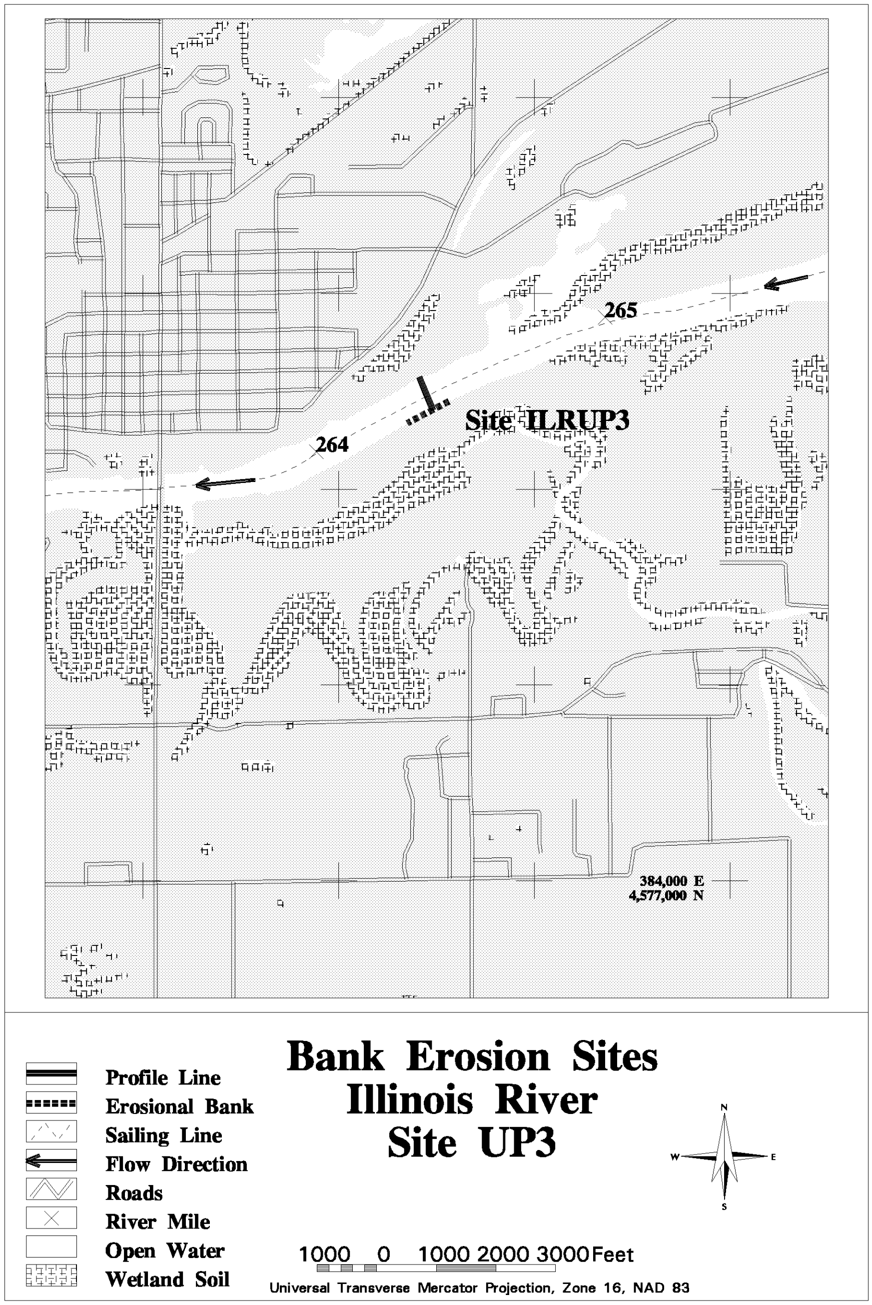


Figure 6-38. Location of site UP3 on the Illinois Waterway

Figure 6-39. Site UP3 on the Illinois Waterway

At the midsection, the d_{50} varies from 0.023 mm at the top surface of the bank to 0.419 mm for a core sample at a depth of about 2 feet of water. Gradation plots of bank soils and nearshore sediment cores are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied only slightly from 1V:21.7H, and the bench was covered with noncohesive sandy materials. This site can be classified as type 3 (see figure 6-20 and table 6-4). Erosional undercutting, rework and transport by waves and currents at high stages or during floods could be major causes of erosion at this site. After the flood receded, the bank soil may slip and fall as blocks, as shown in the downstream section. Land use as a trailer park can be a factor at this site too. Seepage at the recession stage of a flood could also play a significant role in bank failure. Waves and disturbances created by local boating activities can cause entrainment of recently deposited sediments from bench areas.

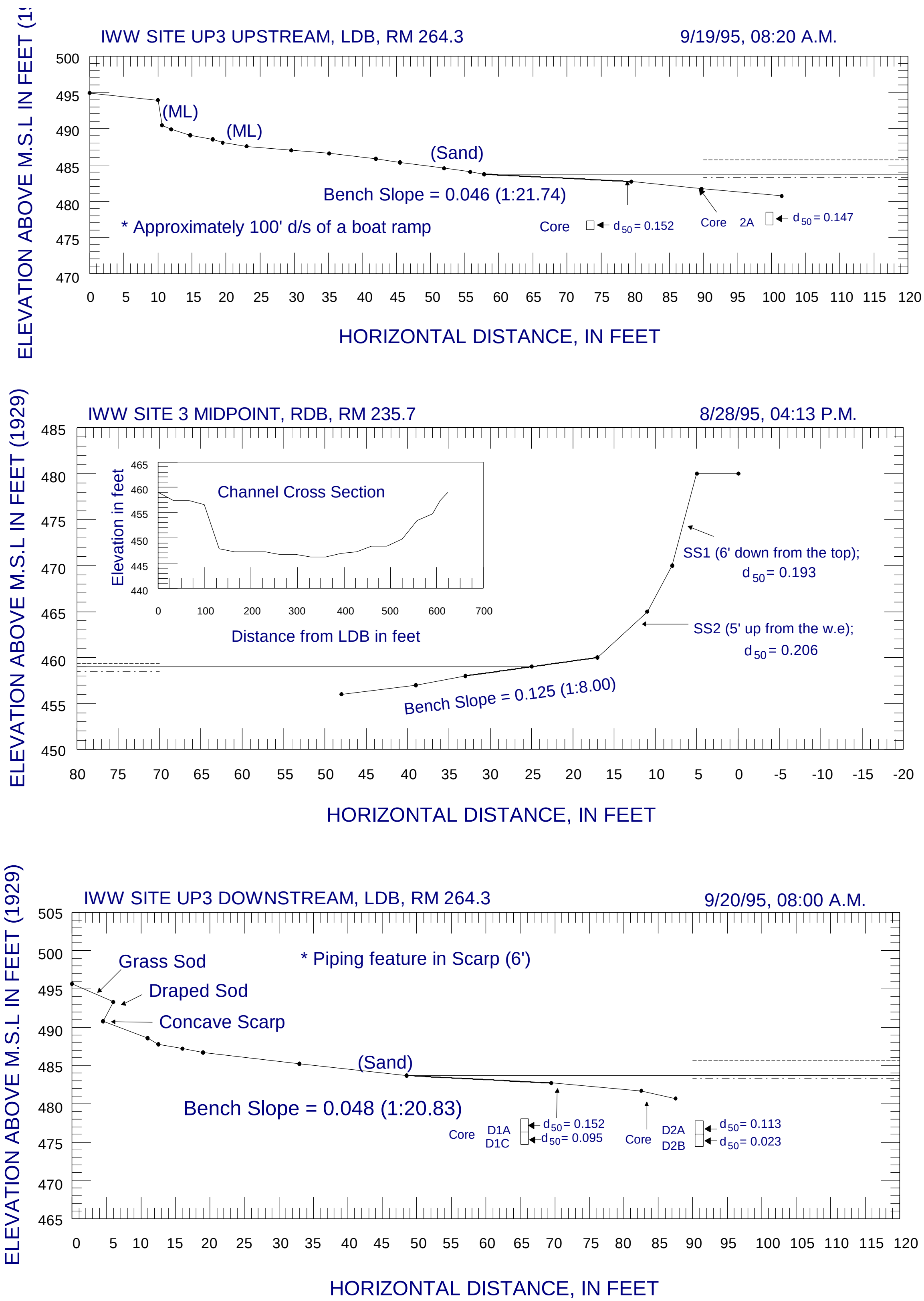


Figure 6-40. Bank sections at site UP3

Table 6-8. Site UP3

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	483.7	• Bench (slopes varied from 1V:21.7H to 1V:20.8H)	• d_{50} (core) @ 1' of water varied (0.095-0.152)
75	484.0	• Bench	• d_{50} (core) @ 2' of water varied (0.023-0.419)
50	484.6	• Bench	
25	486.0	• Bench	
10	488.0	• Bench	
0-9	>488.0	• Berm • Berm (slopes varied from 1V:3.8H to 1V:1.6H) • Scarp (slopes varied from 1V:0.85H to 1V:0.17H)	• d_{50} varied (0.059-0.062) • d_{50} (top of bank) = 0.023

Note: Gage on the Illinois River near Morris, IL @ RM 263.1 was used for stage histogram. WSE = 483.7'; OHW = 485.7'; NP = 483.3'.

Site UP4, Marseilles Pool, 9/20/95. This site is located on the LDB at RM 262.1. Figure 6-41 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-42 shows one photograph of the site. Higher velocity can be expected on this side as it is in a straight reach downstream from a mild bend. Hagerty (1988) indicated erosion on the LDB but also marked a long stretch of erosion on the opposite bank. Bhowmik and Schicht (1980) marked this as an erosion site.

Site UP4 is in a fleeting area where the distance to a red buoy marking the navigation channel was less than 50 feet from shore. Land use on top of the bank was agriculture (corn), and tall weeds were encountered on the bank crest. A scarp 5 to 10 feet high had its top portion covered with exposed roots and its lower portion had piping holes. The lower bank was a narrow sand bench. Failed riprap existed downstream of the site at an entrance channel to a gravel pit. Local tow traffic at this reach can be very frequent. Figure 6-43 shows the three measured bank sections and a reduced cross section. A slumped bank face was observed at the downstream section. The OHW is at 485.5 feet and NP is at 483.3 feet above msl. Except at the downstream section, the base of the scarp is slightly higher than the OHW level. At higher stages (10% occurrence frequency, 488 feet, see table 6-9) wave and current can have a direct contact on the scarp.

At the midsection, the d_{50} varied from 0.035 mm at the top of the bank to 0.185 mm for the top portion of a core sample at a water depth of about 2 feet. The bank scarp consisted of

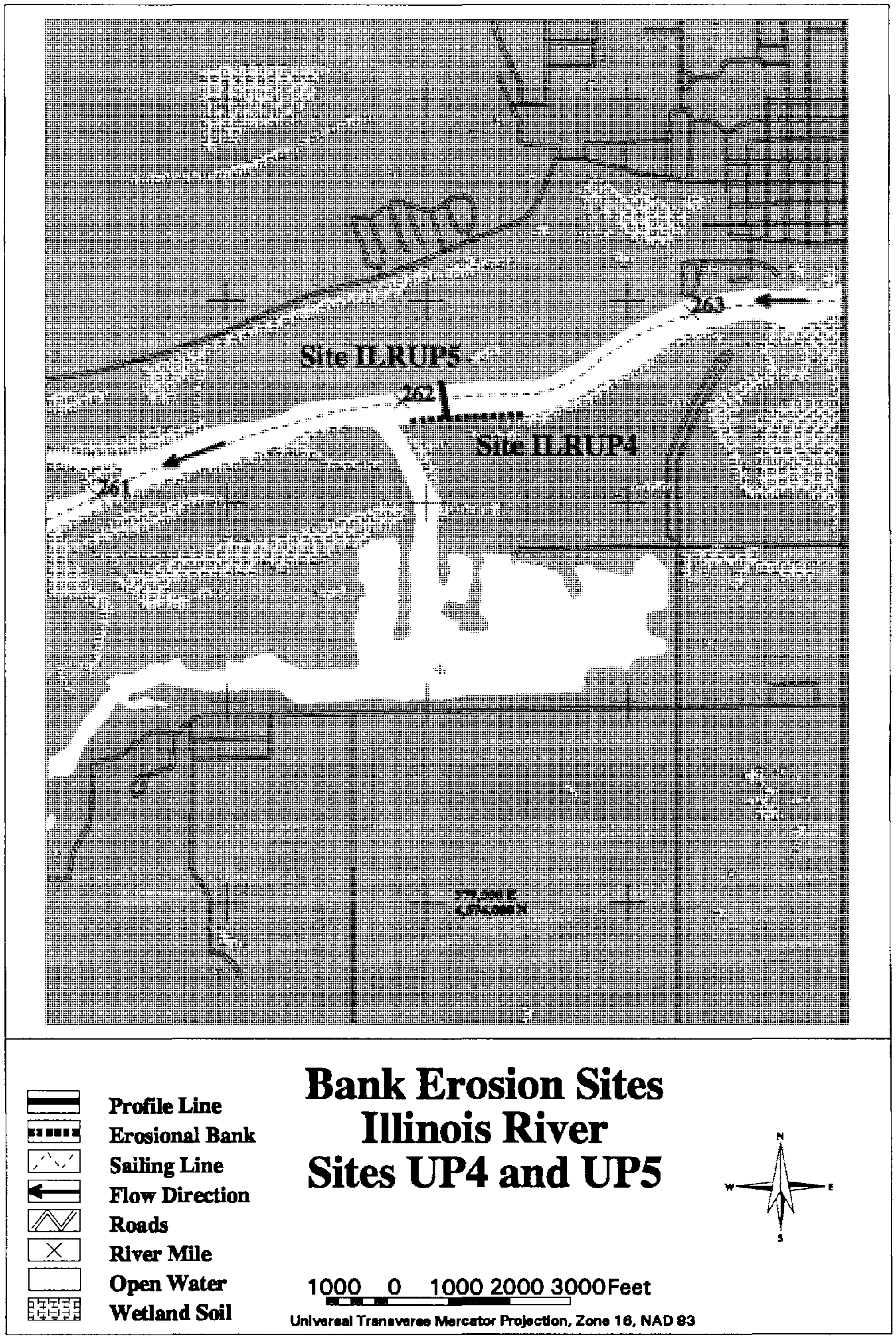


Figure 6-41. Locations of sites UP4 and UP5 on the Illinois Waterway

cohesive materials and the sediments are of fine sand fairly consistently at three sections. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Figure 6-42. Site UP4 on the Illinois Waterway

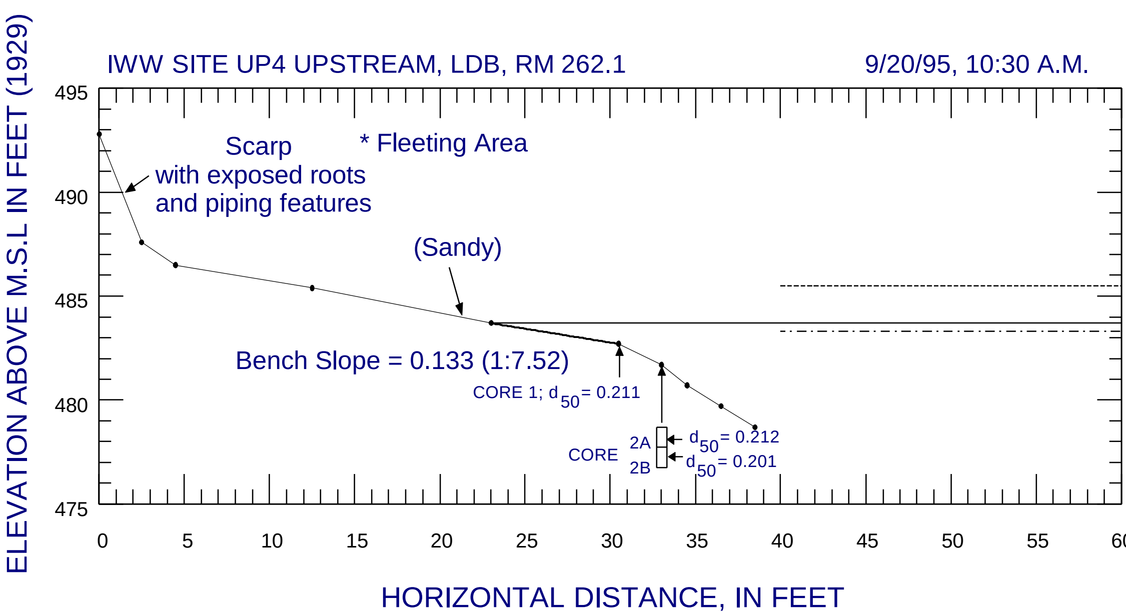


Figure 6-43. Bank sections at site UP4

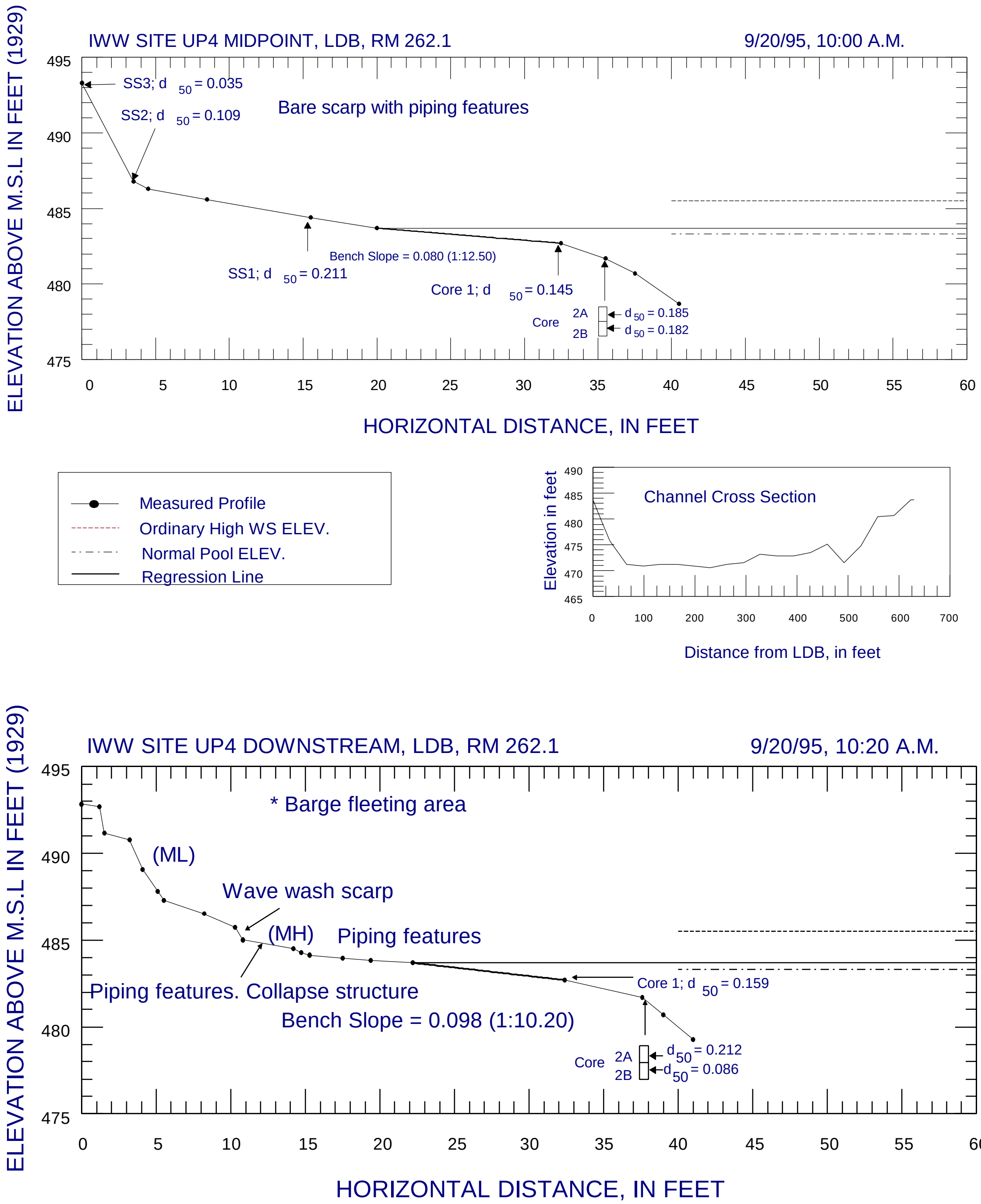


Figure 6-43. Bank sections at site UP4 (concluded)

Table 6-9. Site UP4

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	483.7	• Bench (slopes varied from 1V:12.5H to 1V:7.5H)	• d_{50} (core) @ 1' of water varied (0.145-0.211)
75	484.0	• Bench	• d_{50} (core) @ 2' of water varied (0.086-0.212)
50	484.6	• Bench	• d_{50} = 0.211
25	486.0	• Berm/bench • Berm (slopes varied from 1V:3H to 1V:1.8H)	• d_{50} = 0.109
10	488.0	• Scarp base	
0-9	>488.0	• Scarp • Scarp (slopes varied from 1V:0.8H to 1V:0.5H)	• d_{50} = 0.035 (T.O.B.)

Note: Gage on the Illinois River near Morris, IL @ RM 263.1 was used for stage histogram. WSE = 483.7'; OHW = 485.7'; NP = 483.3'.

Bench slopes varied from 1V:12.5H to 1V:7.5H, and the subaqueous bench becomes steeper. Piping holes at the scarp and moist soils on the lower portion of the bank were noted. This site can be classified as a combination of types 2 and 3 (see figures 6-19, 6-20, and table 6-4). The bank soils appeared to be cohesive, but the bench was sandy with several clay outcrops. Seepage could weaken the base support and cause the bank to slip, as shown at the downstream section. Failed soils and/or recently deposited sediment on the bench are reworked and transported by wind or tow-generated waves. The steep dropoff in subaqueous benches is indicative of effects of direct vessel contact or traffic-induced velocities.

Site UP5, Marseilles Pool, 9/20/95. This is at the bank opposite site UP4. Figure 6-41 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-44 shows one photograph of the site. Site UP5, is in a straight reach downstream from a mild bend. Bhowmik and Schicht (1980) marked this site as an erosion site and also indicated dredge material displacement on this bank. A 1 by 1 loaded barge passed in the upstream direction while the team was on the bank. Although the barge slowed down at the site, the drawdown induced by this traffic event was approximately 1.5 feet vertically. Four to five large waves with crests approximately 0.9 feet higher than pool level came in after the drawdown.

The site is about 300 feet from the sailing line and there is no major tributary at this location. The bank section has a scarp with exposed roots and piping holes. However, the bench was wet and did not have heavy sand deposition as on the opposite bank. A subaqueous scarp was found at the water's edge. Figure 6-45 shows one measured bank section and a reduced cross section. The OHW is at 485.5 feet and NP is at 483.3 feet above msl. The subaqueous bench extends at least about 100 feet from the water's edge. A 10-year stage data analysis (table 6-10) shows that stages higher than 25% recurrence frequency (the OHW) would submerge the base of the scarp; those higher than 10% recurrence frequency (above 490 feet) will overtop the bank.

At the midsection, the d_{50} varies from 0.129 mm at the top surface of the bank to 0.279 mm for the top portion of a core sample at a water depth of about 2 feet. Core samples are similar to those at site UP4. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

The bench slope was 1V:26H. Some algae were observed on the subaerial bench. This site is classified as a combination of types 4 and 5 (see figures 6-21 and 6-22 and table 6-4). Banks are susceptible to erosion by tractive forces from flows at OHW or during floods. Piping, seepage, and weathering could loosen the bank soils which are then subject to removal by currents and waves. At this site, traffic-induced currents and waves can erode failed soils and recently deposited sediments within bench areas during periods of normal pool stages.

Figure 6-44. Site UP5 on the Illinois Waterway

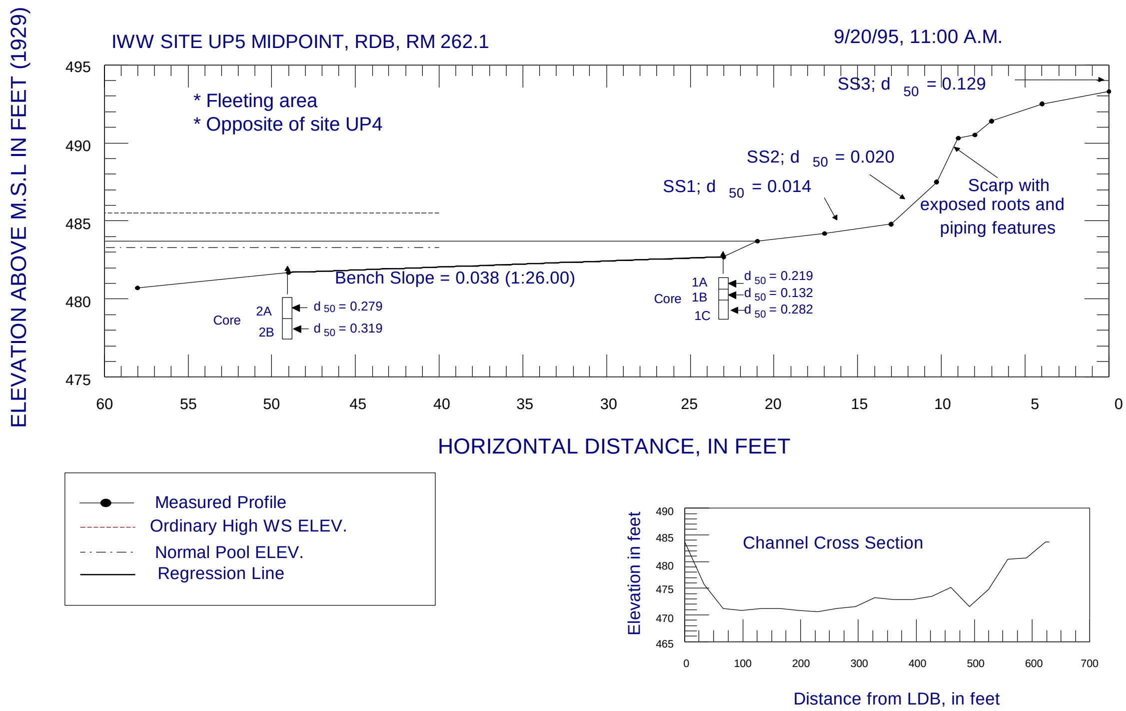


Figure 6-45. Bank section at site UP5

Table 6-10. Site UP5

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
	<483.7	• Bench (underwater)	• d_{50} (core) @ 2’ of water varied (0.28-0.32)
>90		• Slope = 0.038	
90	483.7	• Berm	• d_{50} = 0.014
		• Slope = 1V:2.6H	
75	484.0	• Berm	
50	484.6	• Toe of scarp	
25	486.0	• Scarp	• d_{50} = 0.020
		• Slope = 1V:2.6H	
10	488.0	• Scarp	
0-9	>490.0	• Top of the bank	• d_{50} = 0.129
			• d_{50} (core) @ 1’ of water varied (0.132-0.282)

Note: Gage on the Illinois River near Morris, IL @ RM 263.1 was used for stage histogram. WSE = 483.7’; OHW = 485.7’; NP = 483.3’.

Site 1, Starved Rock Pool, 8/28/95. This site is located on the LDB at RM 242.9, on the outside of a sharp bend. Figure 6-46 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-47 shows one photograph of the site. The site is about 400 feet from the sailing line, and Moores Creek enters the IWW downstream of this site.

Neither Bhowmik and Schicht (1980) nor Hagerty (1988) observed erosion at this site. Hagerty (1988) noted rock instead. During this survey a near vertical scarp about 8 feet high was encountered. Exposed tree and grass roots covered the top of the scarp, and some leaning tall trees were found on the scarp. Flat slabs or rocks approximately 1 to 2 inches in length and only about quarter inch in thickness were found on the bench at the foot of the scarp. Rocks increased in size to about 4 or 5 inches long near the waters edge. Rock crops out along the Moores Creek. Figure 6-48 shows the two measured bank sections and a reduced cross section. Available stage data from the Marseilles Lock and Dam is used for interpolating stage information at this site (table 6-11). The OHW is at 460 feet and NP is at 458.5 feet above msl. Stages higher than 461.8 feet will submerge the scarp.

At the midsection, the d_{50} varies from 0.010 mm at the surface of the bank to 0.696 mm at the edge of water to 0.025 mm for a core sample at a depth of about 1 foot of water. Gradation plots of bank soils, and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:6.1H to 1V:17.2H. This site can be classified as type 1 (figure 6-18 and table 6-4). Surficial bank materials slake and are loosened by weathering with subsequent collapse. Reworking and transport of failed materials and recently deposited sediments occurs within bench areas during high flows.

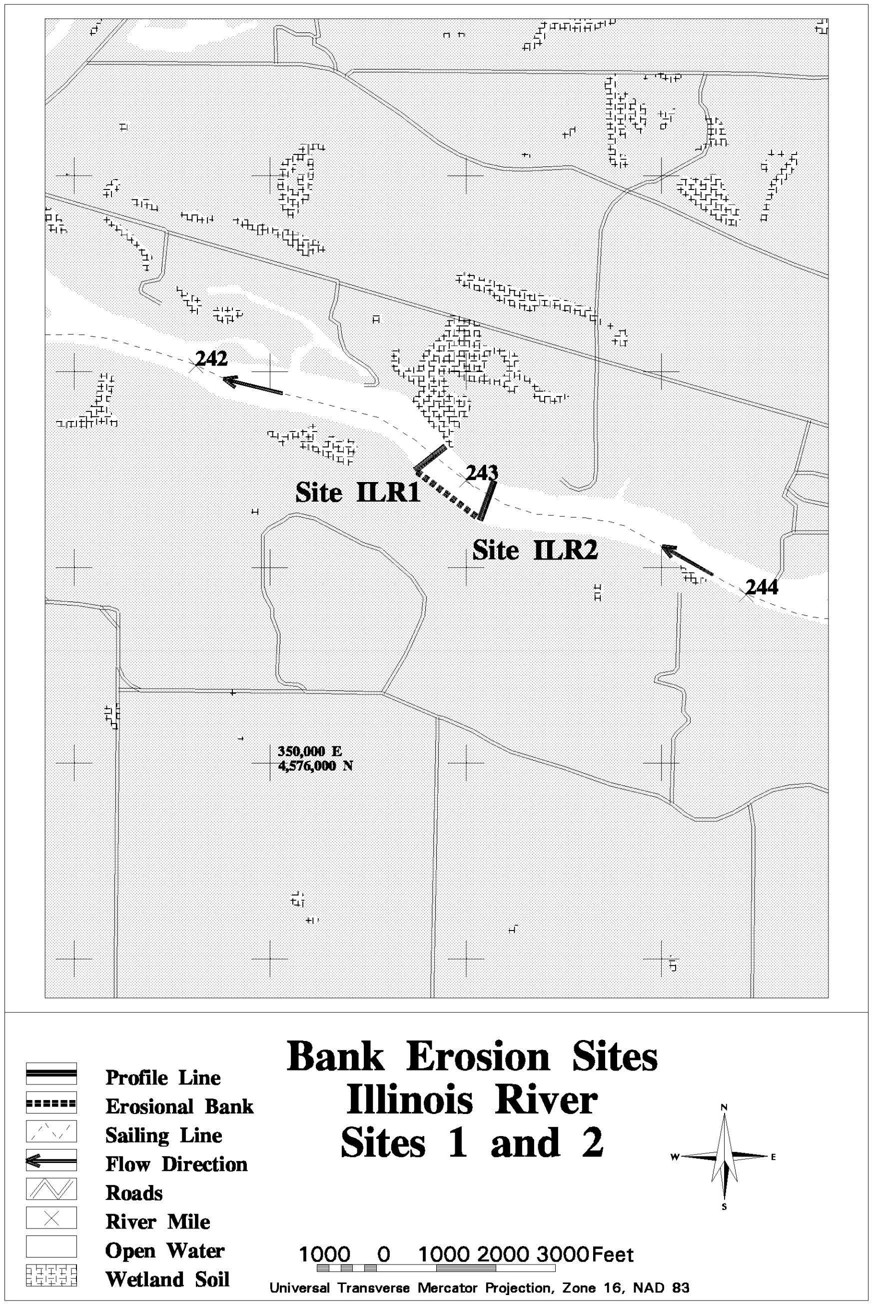


Figure 6-46. Locations of sites 1 and 2 on the Illinois Waterway

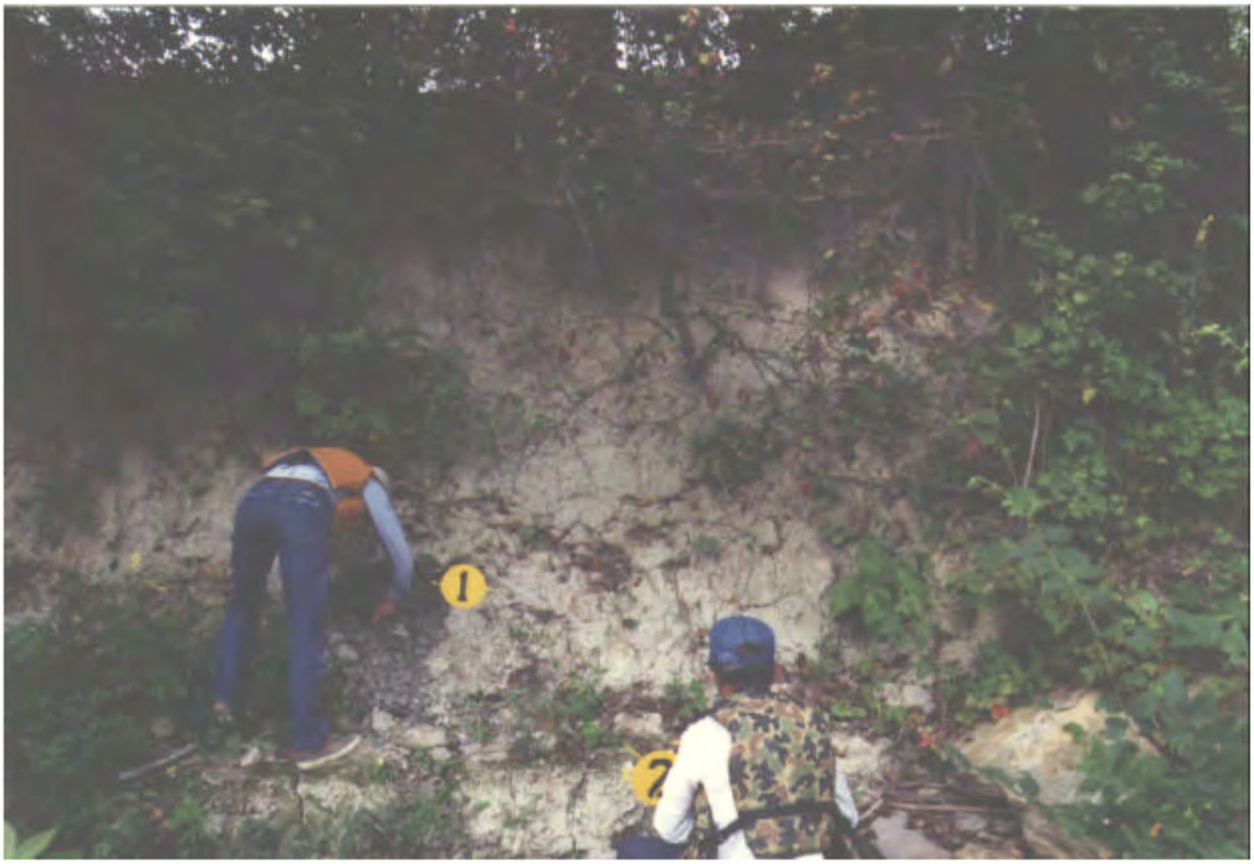


Figure 6-47. Site 1 on the Illinois Waterway

Table 6-11. Site 1

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	459.0	• Bench (slopes varied from 1V:40H to 1V:6.1H)	
75	459.2	• Bench	
50	459.6	• Bench	
25	460.4	• Bench	
10	461.8	• Bench/toe of scarp	• d_{50} varied (0.014-0.696)
0-9	>461.8	• Scarp (slopes varied from 1V:0.8H to 1V:0.53H)	• d_{50} = 0.010

Note: Tail water gage of Marseilles Pool @ RM 244.6 was used for stage histogram. WSE = 458.8'; OHW = 460.1'; NP = 458.5'.

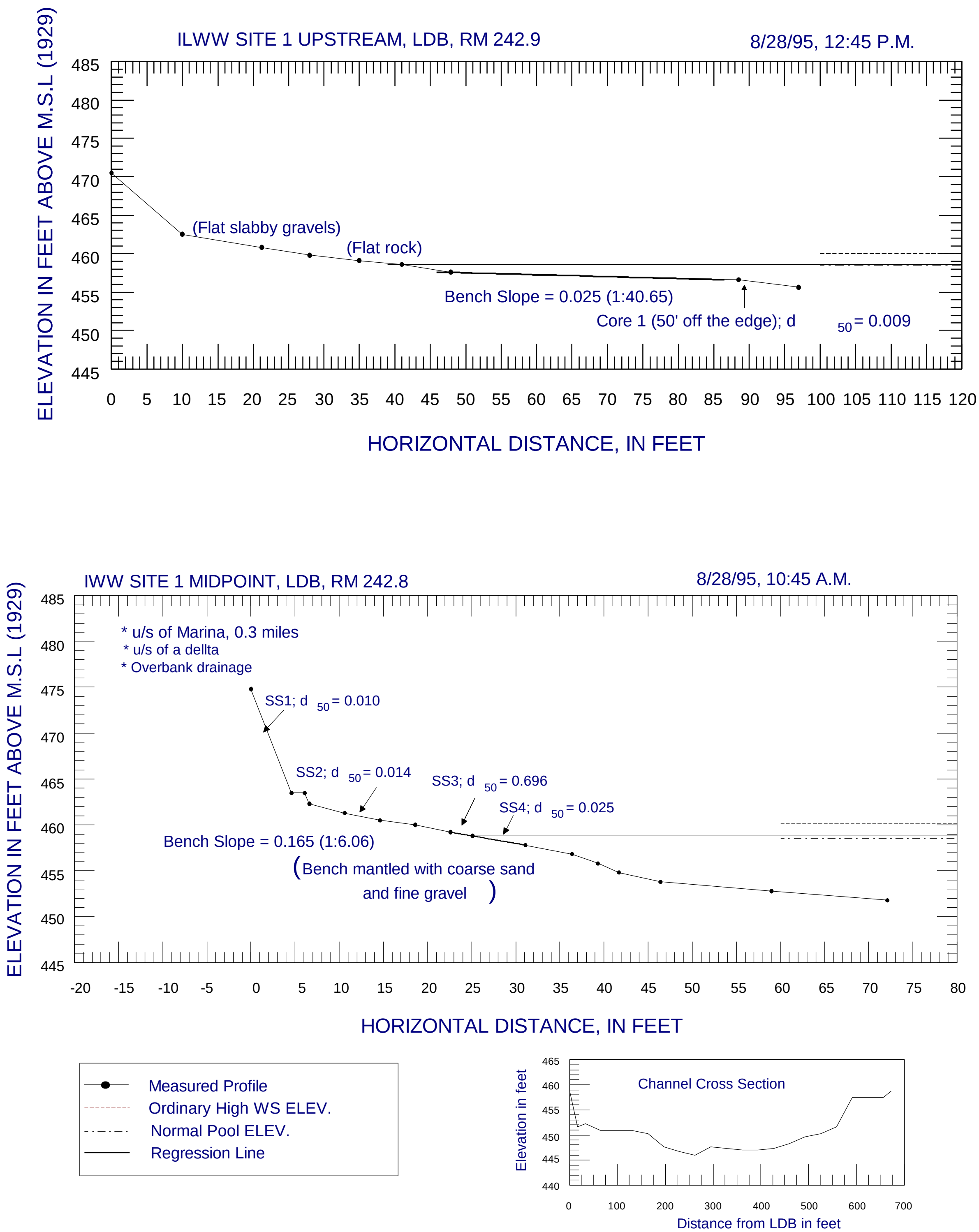


Figure 6-48. Bank sections at site 1

Site 2, Starved Rock Pool, 8/28/95. This site is located on the LDB at RM 243.4 upstream of site 1. The entrance to the Marseilles Canal is at RM 244.6. Figure 6-46 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-49 shows one photograph of the site. The bank at this site is about 250 feet from the sailing line. No tributary enters the IWW at this location.

Hagerty (1988) noted erosion, but Bhowmik and Schicht (1980) indicated riprap at this site. During the survey there was a fairly long stretch of eroded bank with a nearly vertical scarp about 6 to 7 feet in height. Trees of 6 inch diameter stood at the edge of the scarp, some with extensive root exposure on the bank face, and some downed trees were lying on the bench. The relatively narrow bench was covered with fine sand. Nearshore materials were mostly fine sand on soft silt.

Figure 6-50 shows the measured bank section and a reduced cross section. The OHW is 459.5 feet and NP is 458.5 feet above msl. According to 10-year stage data (Table 6-12), stages with 25% or less exceedence frequencies will reach the base of the scarp, and any stage higher than OHW elevation will be on the scarp.

Figure 6-49. Site 2 on the Illinois Waterway

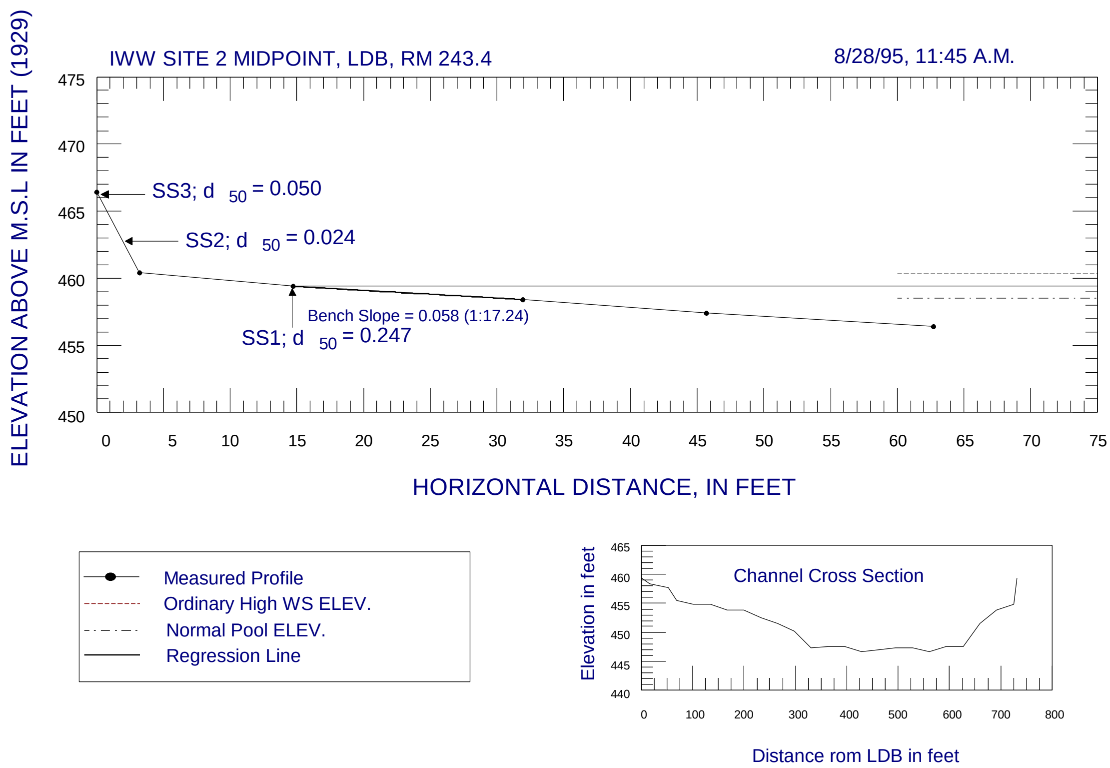


Figure 6-50. Bank section at site 2

Table 6-12. Site 2

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	459.0	• Bench (underwater)	• d_{50} = 0.247
75	459.2	• Bench	
50	459.6	• Bench	
25	460.4	• Scarp toe	
10	461.8	• Scarp	• d_{50} varied (0.024-0.050)
0-9	>462.0	• Scarp	

Note: Tail water gage of Marseilles Pool @ RM 244.6 was used for stage histogram. WSE = 459.4'; OHW = 460.3'; NP = 458.5'.

The d_{50} varied from 0.050 mm at the top of the bank face to 0.247 mm for a core sample at the edge of water. Gradation plots of bank soils and nearshore sediment are presented in appendix F. the detailed cross section and coordinates are shown in appendix G.

The bench slope was 1V:17.2H, and the bench was covered with noncohesive sandy materials. This site was considered as the combination of types 2 and 6 (figures 6-18 and 6-23, and table 6-4). The scarp was nearly vertical and covered with fine roots. There was a moist layer at the base of the scarp and the subaerial bench was narrow and covered with sand. Several factors contribute to bank failure: tractive forces during floods, wave and current actions at stages above OHW, and seepage at the base of scarp could all contribute to the rework and erosion of failed bank soils and recently deposited sediment.

Site 3, Starved Rock Pool, 8/28/95. This site is located on the RDB at RM 235.8. The reach is fairly straight, and the site is on Sheehan Island. Behind this bank is a lake and the top width of the levee is only 5 to 6 feet. The levee appeared to be wider on the navigation chart that Bhowmik and Schicht (1980) used. However, the navigation chart that Hagerty (1988) used in 1988 showed a very thin levee. Figure 6-51 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-52 shows one photograph of the site.

Site 3 is about 550 feet from the sailing line, and no major tributary enters the IWW at this location. Bhowmik and Schicht (1980) noted erosion along RM 235.4 of the LDB, while Hagerty (1988) noted erosion at RM 235.8.

The bank consisted of a bare face approximately 15 to 20 feet high. Toppled trees halfway up the bank face supported stems re-grown to upright directions. Fine sand and gravel were found at the water's edge. Although the reach is straight, the three sections surveyed all were measured from locally concave banklines. These concavities were about 50 feet wide, and all had either gravel or trees at the water's edge, at the upstream end. Several mass failures had occurred at the downstream ends, which indicated the concave sections were widening.

Figure 6-53 shows the three measured bank sections and a reduced cross section. The bank slopes were steeper towards the downstream limit. The OHW is 459.3 feet and NP is 458.5 feet above msl. This range of fluctuation is within the bench area. Ten-year stage data (table 6-13) shows that only stages with less than 10% recurrence frequency can reach the base of the bank face.

At the midsection, the d_{50} varied from 0.193 mm at the upper part of bank surface to 0.206 mm at the base of the bank. A core sample at 2 feet of depth on the upstream section had d_{50} of 0.202 mm. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

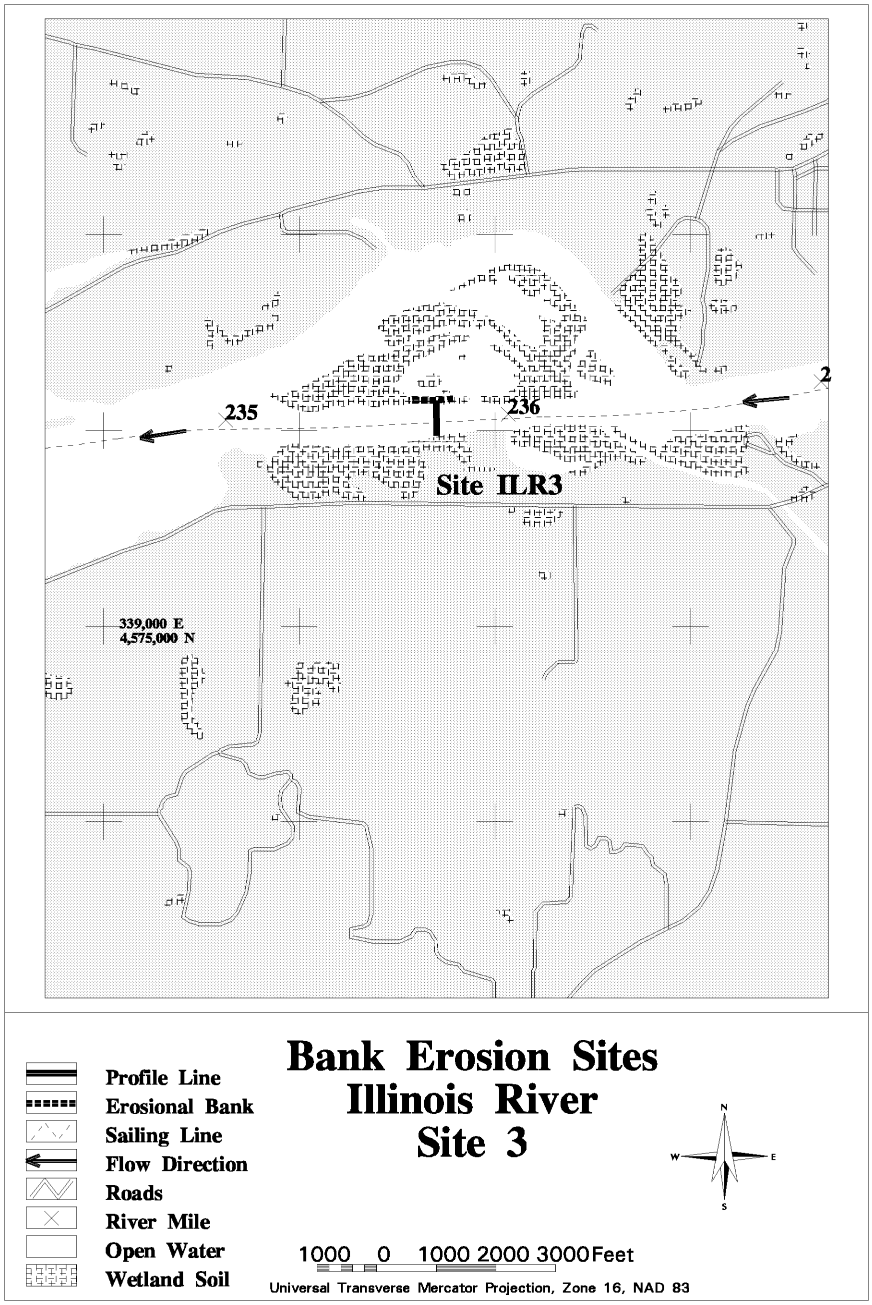


Figure 6-51. Location of site 3 on the Illinois Waterway

Figure 6-52. Site 3 on the Illinois Waterway

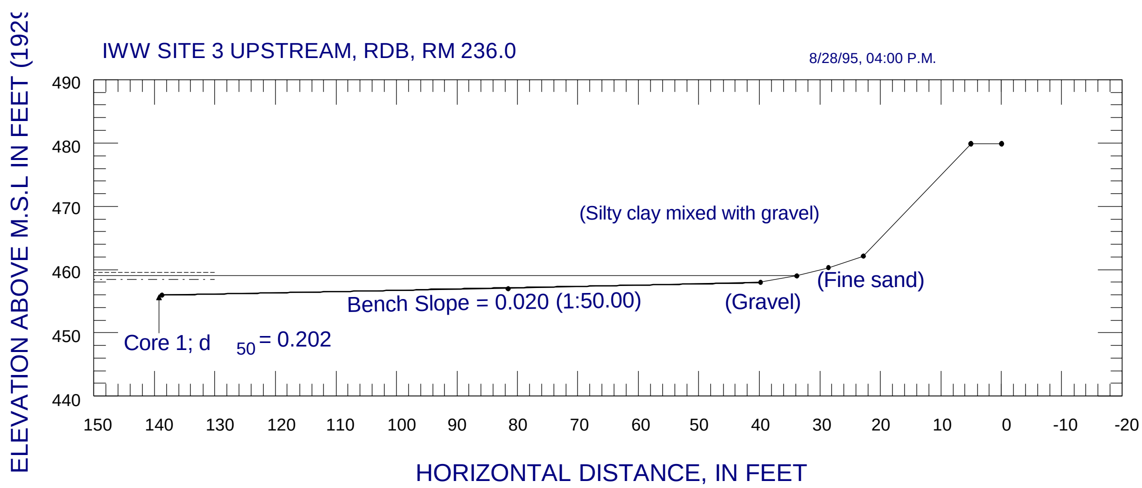


Figure 6-53. Bank sections at site 3

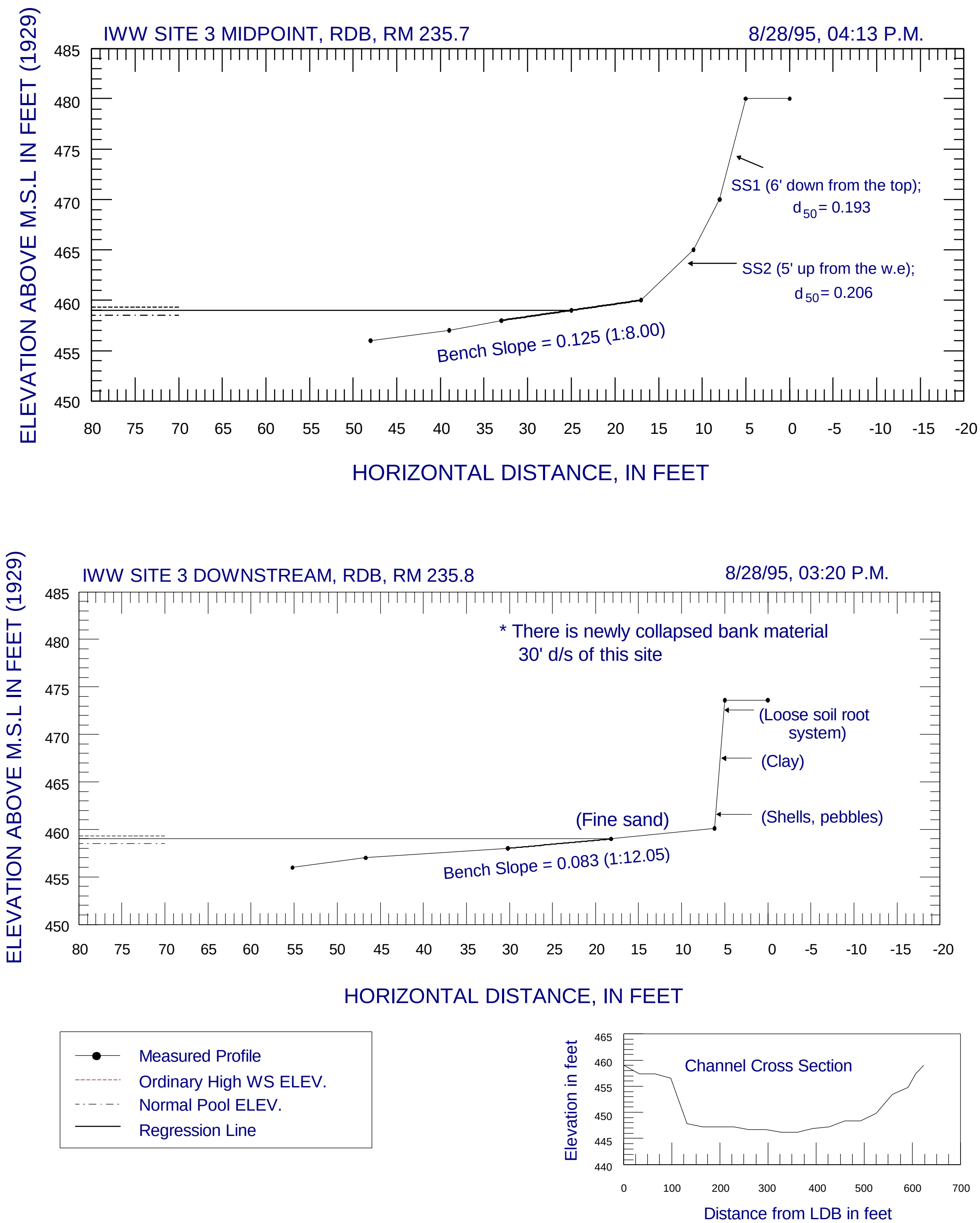


Figure 6-53. Bank sections at site 3 (concluded)

Table 6-13. Site 3

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	458.7	• Bench (underwater) • Bench (slopes varied from 1V:5H to 1V:8H)	• d_{50} (core) @ 1' of water = 0.202
75	458.8	• Bench (underwater)	
50	458.8	• Bench (underwater)	
25	458.9	• Bench (underwater)	
10	458.9	• Berm/bench (1V:1.2H) • Berm slope	• d_{50} = 0.206
0-9	>459.0	• Scarp	• d_{50} = 0.193

Note: Pool gage of Starved Rock Pool @ RM 231.0 was used for stage histogram. WSE = 459.0'; OHW = 459.3'; NP = 458.8'.

Bench slopes varied from 1V:50H at the upstream section to 1V:8H at the midsection. The bank consisted mostly of noncohesive sandy materials. The three sections can be classified as a combination of types 1 and 6 because of the extended subaqueous bench width (figures 6-18 and 6-23, and table 6-4). Rework and transport of failed soils and recently deposited sediment occur during floods. Eddy currents induced by the trees or gravel upstream of concave sections can cause bank failure and eddies are generated at stages when the flows are disturbed by trees or gravel.

Site 4, Peoria Pool, 8/28/95. This site is located on the LDB at RM 228.1 in a long, straight reach downstream from the Starved Rock L&D (RM 231). Figure 6-54 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-55 shows one photograph of the site.

Site 4 is about 360 feet from the sailing line. No major tributary enters the IWW at this location, but a state highway bridge crosses the river at RM 229.6. Bhowmik and Schicht (1980) selected both banks as erosion sites (sites 18 and 19) with surveys completed on the RDB and one survey on the LDB (site 20). Erosion of these two sites was indicated on Hagerty's (1988) chart also. At site 4, a mildly sloped bench lies under a small scarp, with mature trees growing behind the scarp. The bench was very wide, sandy, and mostly covered with tall weeds. Tall trees survive in an area between the weed zone and scarps with roots exposed to the air. The root crown is approximately at the same level as the top of the bank. The bench is clay mantled with sand mixed with shells.

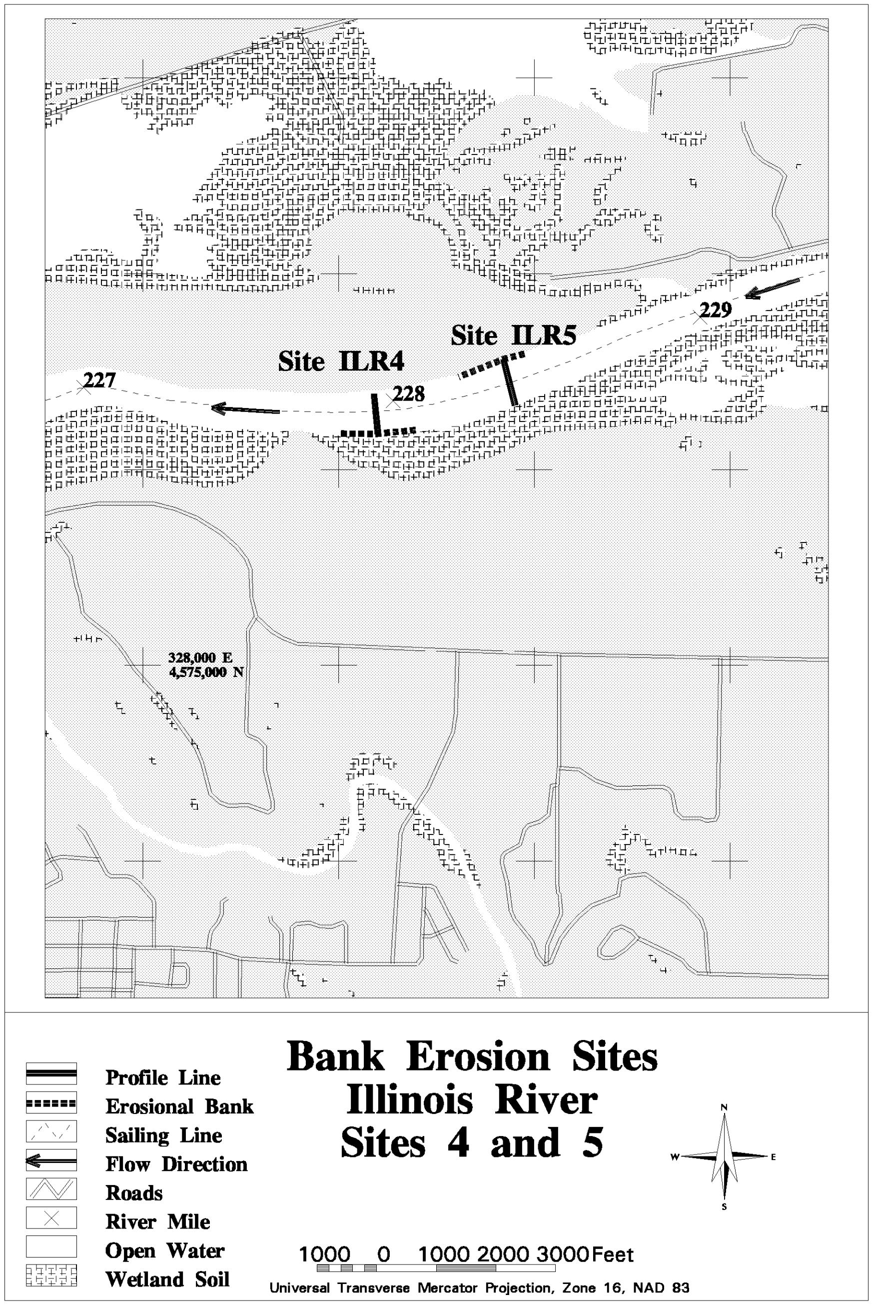


Figure 6-54. Locations of sites 4 and 5 on the Illinois Waterway

Figure 6-55. Site 4 on the Illinois Waterway

Figure 6-56 shows the three measured bank sections and a reduced cross section. Bank sections were fairly uniform at this site. The OHW is 446 feet and NP is 440 feet above msl. The range of fluctuation between the OHW and NP covers the entire bench.

At the midsection, the d_{50} varied from 0.373 mm for materials on the scarp under the exposed tree roots of a mature tree to 0.029 mm on the bench. Mean particle size at the upstream section varied from 0.009 mm at the top surface of the bank to 0.008 mm for a core sample at a water depth of about 1 foot. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

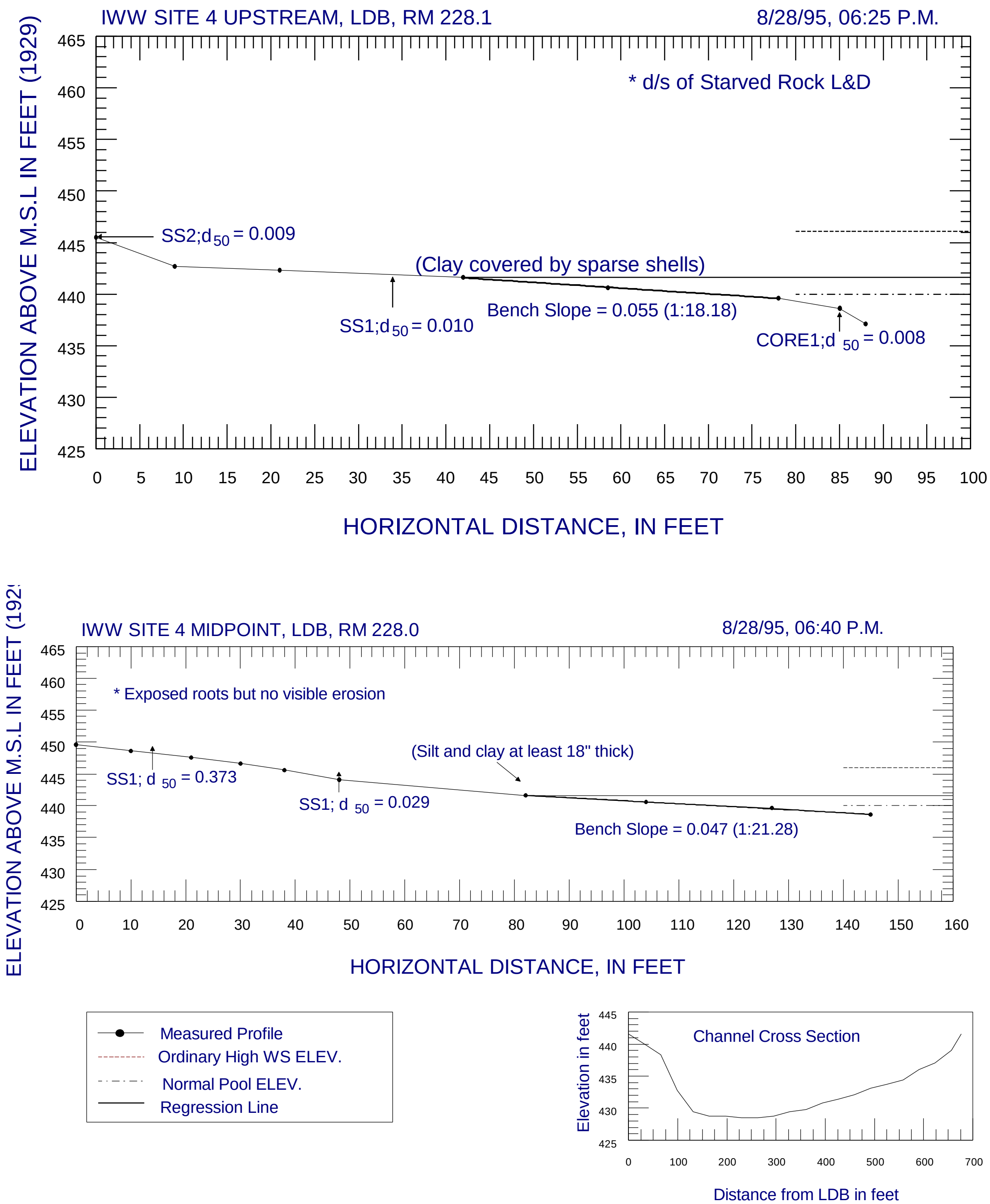


Figure 6-56. Bank sections at site 4

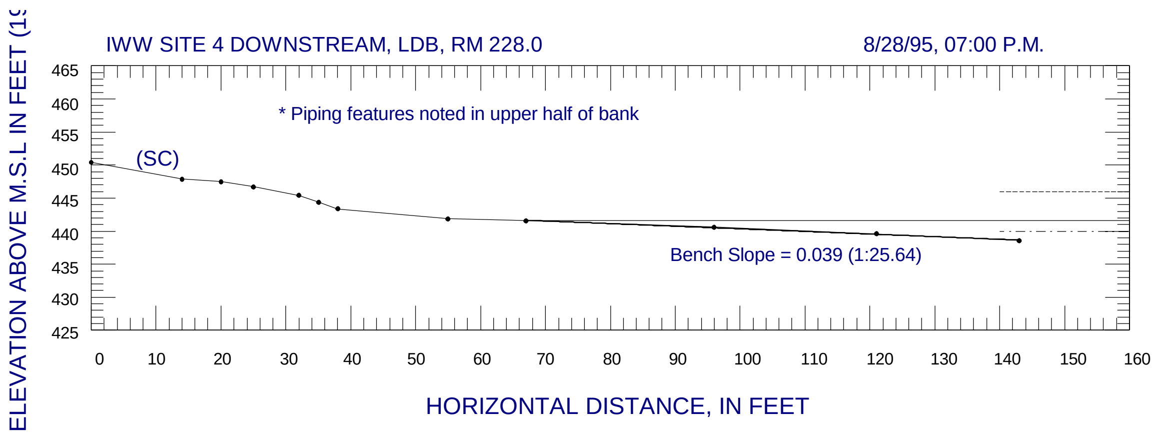


Figure 6-56. Bank sections at site 4 (concluded)

Table 6-14. Site 4

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	441.2	• Bench (underwater) • Slope varied from 1V:25.6H to 1V:18.2H	• d_{50} varied (0.010-0.029)
75	441.9	• Bench	
50	443.8	• Scarp/bench	
25	447.1	• Bank with gentle slope	• d_{50} = 0.373
10	450.6	• Bank with gentle slope	
0-9	>450.6	• Top of bank	• d_{50} = 0.009

Note: Tail water gage of Starved Rock Pool @ RM 231.0 was used for stage histogram. WSE = 441.6'; OHW = 446.0'; NP = 440.0'.

Bench slopes varied slightly from 1V:18.2H at the upstream section to 1V:25.6H at the downstream section. This site can be classified as type 5 (figure 6-22 and table 6-4). The bank seemed to be stable in 1995 but was an eroded site in 1978 (Bhowmik and Schicht, 1980). The elevation of the scarp was fairly high compared to NP or OHW stages where piping was noted. Erosion of bench soils or recently deposited sediments can occur during flow at stages higher than OHW.

Site 5, Peoria Pool, 8/28/95. This site is located on the RDB at RM 228.5, slightly upstream from site 4 on the LDB. Figure 6-54 shows the position of the site on a GIS-based map of the Illinois navigation chart.

Site 5 is about 375 feet from the sailing line. No major tributary enters the IWW at this location, but there is a state highway bridge at RM 229.6. The upstream end of this reach is about 150 feet downstream from a barge terminal. Bank sections were similar to those for site 4, but the scarp at the upper part of the bank was higher and contained piping holes. Agriculture (corn) was the land use on top of the bank. Tall weeds were growing below the scarp on the sand-covered bench. The team dug a trench on the bench and seepage water filled the hole very quickly. Subaqueous sediment near the shore was mostly sand, and the bench slope was mild.

Figure 6-57 shows the three measured bank sections and a reduced cross section. The OHW is 446.2 feet and NP is 440.0 feet above msl. The OHW elevation was at the base of the scarp at all three sections, while the NP was at a break in the subaqueous slope at the upstream section. According to the stage analysis using 10-year data (see table 6-15), river stages with 25% or less occurrence frequency reach the scarp and stages with 10% or less occurrence frequency top the bank.

At the midsection, the d_{50} varied from 0.023 mm at the top surface of the bank to 0.161 mm for a core sample at a water depth of about 1 foot. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied slightly between 1V:23.8H and 1V:17.2H. With a scarp over a gentle bench slope, this site is classified as a combination of types 3 and 5 (figures 6-20 and 6-22, and table 6-4). The scarps have layered failure features and were initiated by piping and surface drainage. Waves and currents at OHW cause erosion of failed soil or recent sediments on the bench area.

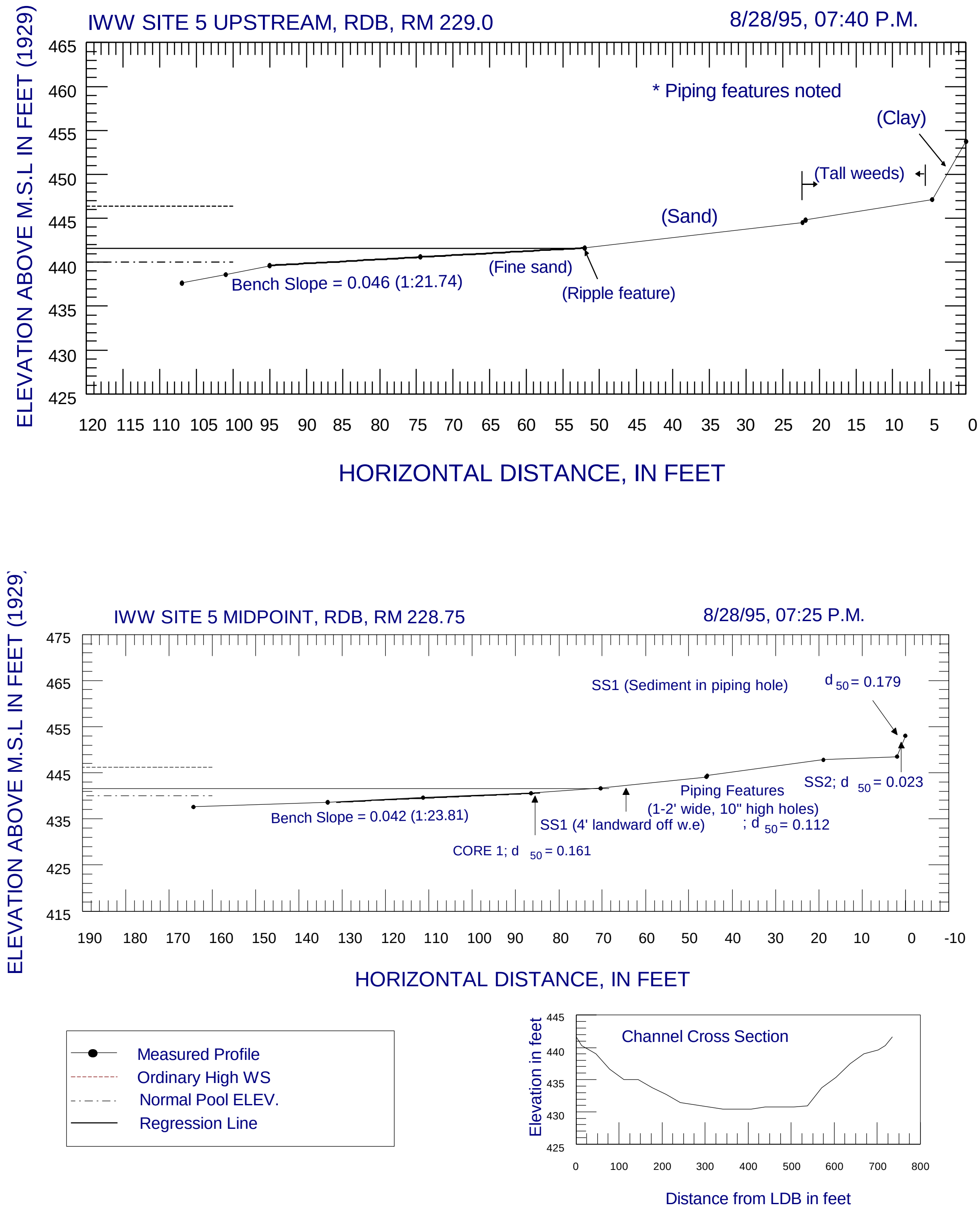


Figure 6-57. Bank sections at site 5

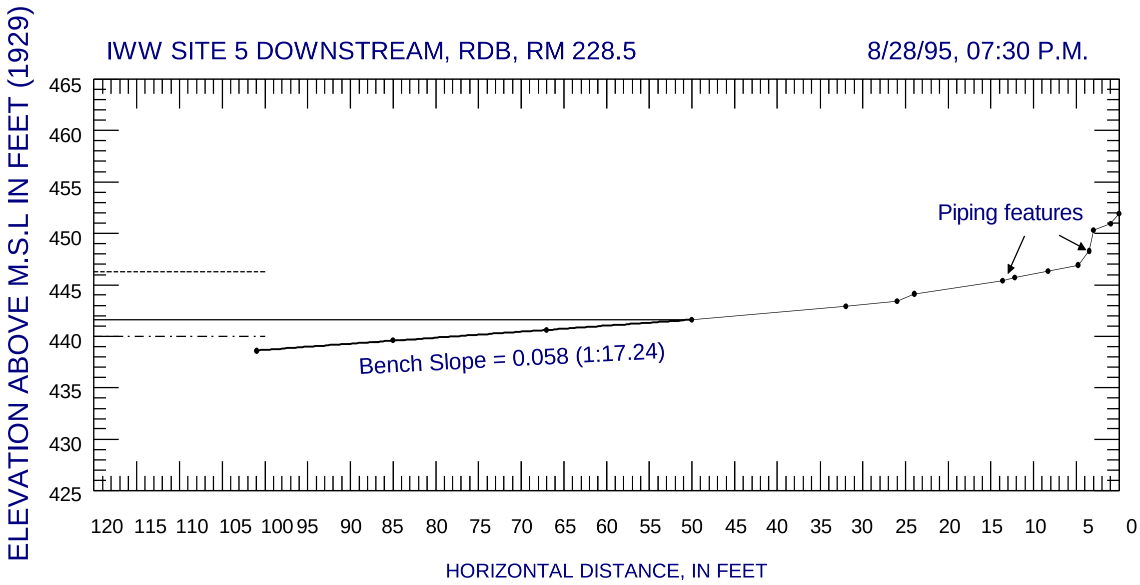


Figure 6-57. Bank sections at site 5 (concluded)

Table 6-15. Site 5

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	441.2	• Bench (underwater)	• d_{50} (core) = 0.161 • d_{50} = 0.112
75	441.9	• Bench (slopes varied between 1V:23.8H and 17.2H)	
50	443.8	• Berm/bench slope = 1V:6.7H	
25	447.1	• Toe of scarp	
10	450.6	• Scarp slope (1V:0.69H) • Piping feature	
0-9	>450.6	• Scarp/Top of the bank	• d_{50} = 0.179

Note: Tail water gage of Starved Rock Pool @ RM 231.0 was used for stage histogram. WSE = 441.6'; OHW = 446.2'; NP = 440.0'.

Site 6, Peoria Pool, 8/29/95. This site is located on the RDB at RM 210.0, immediately downstream of the outlet of Spring Lake. Figure 6-58 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-59 shows one photograph of the site.

The site is about 310 feet from the sailing line. In plan form it is on the outer side of a bend. Bhowmik and Schicht (1980) observed erosion on both banks, while Hagerty (1988) noted erosion only on the RDB, but his site extended further upstream and downstream from the entrance of the lake. The bank contains small scarps, and the top of the bank is covered with some fine tree roots. Agriculture (corn) is the land use for the upstream section and woods cover the bank for the other two sections. At the most upstream end point of this reach (immediately downstream from the lake outlet), the subaqueous bench dropped more than 11 feet right off the water's edge, a feature not observed at the remaining sections. Judging from the plan form this truncation could be caused by tow-induced current passing through the bend. Small worm holes existed on the truncated bench face near the water's edge.

Figure 6-60 shows the three measured bank sections and two reduced cross sections. The thalweg was farther away from the water's edge downstream. The OHW is 443.2 feet and NP is 440.0 feet above msl. Mature trees were growing at the water's edge; the midsection and downstream section were measured between trees. Banks between the trees were eroded. The crown of the tree roots appeared to be higher than the bank top. A flood stage higher than 10% recurrence frequency will overtop the bank (see table 6-16). Standing (but dead) trees were in place in water at the NP level.

At the midsection, the d_{50} varied from 0.003 mm at the top surface of the bank to 0.012 mm on the bench. A core sample at a depth of about 1 foot of water on the downstream section had d_{50} equal to 0.025 mm. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross-section and coordinates are shown in appendix G.

Bench slopes varied only slightly from 1V:16.1H at the midsection and downstream section. The three sections, from upstream to downstream, are classified as types 4, 5, and 6 (figures 6-21, 6-22, 6-23, and table 6-4). Traffic-induced currents appear to be a significant factor for the subaqueous scarp at the upstream section. Small worms nesting in the bank soils also will weaken the bank strength. Eddy currents, induced by fallen trees or nearshore land features, exist at the midsection and downstream section. These eddy currents can cause local scours. Other erosion mechanisms include surface drainage for the upstream section, piping, and floods for the whole reach.

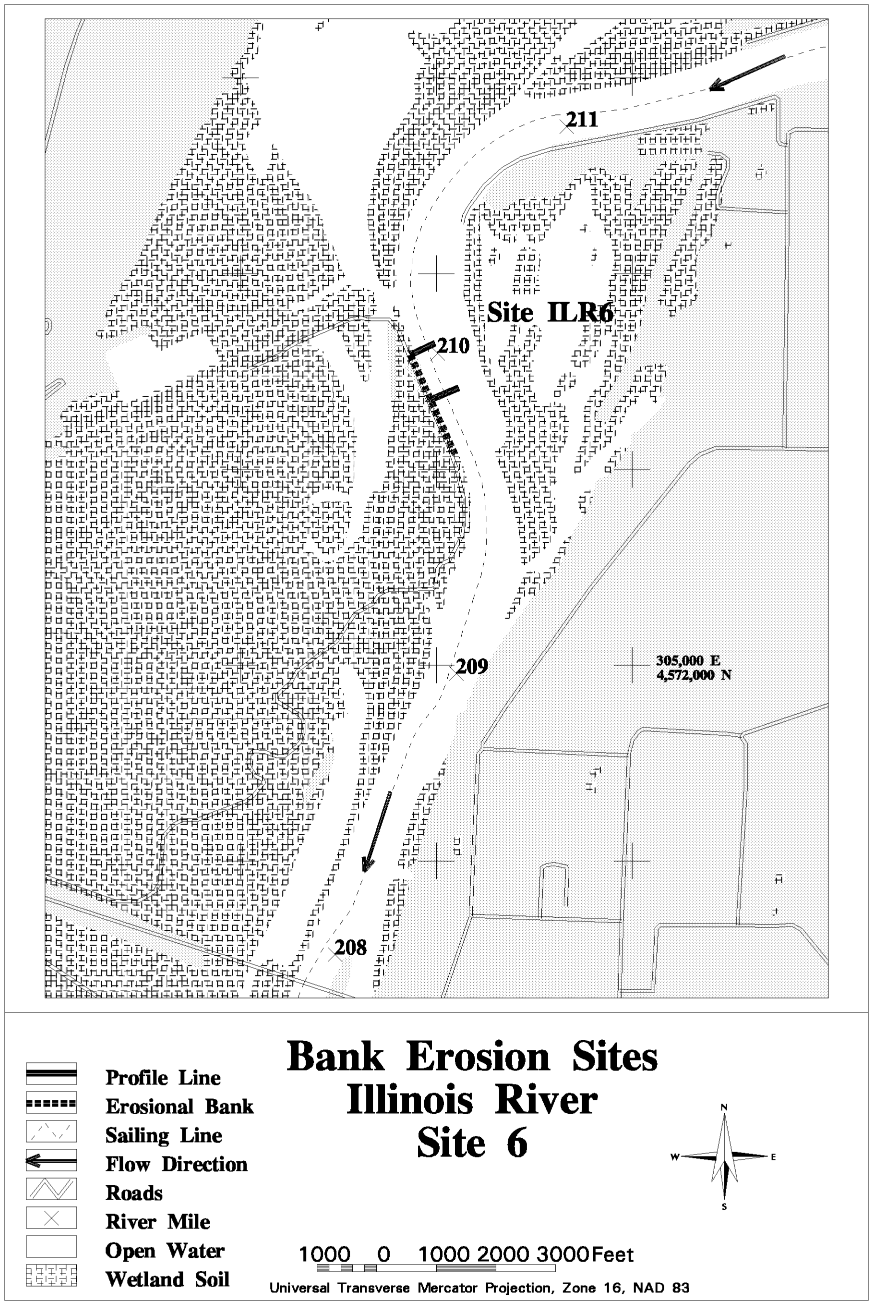
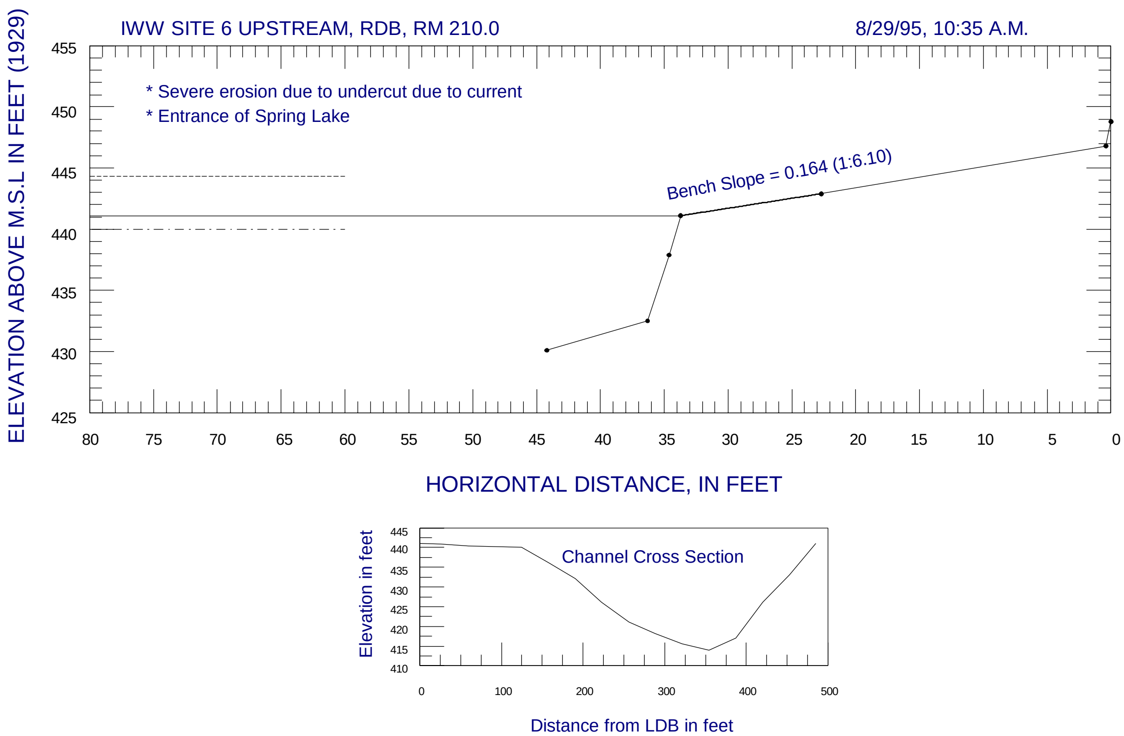
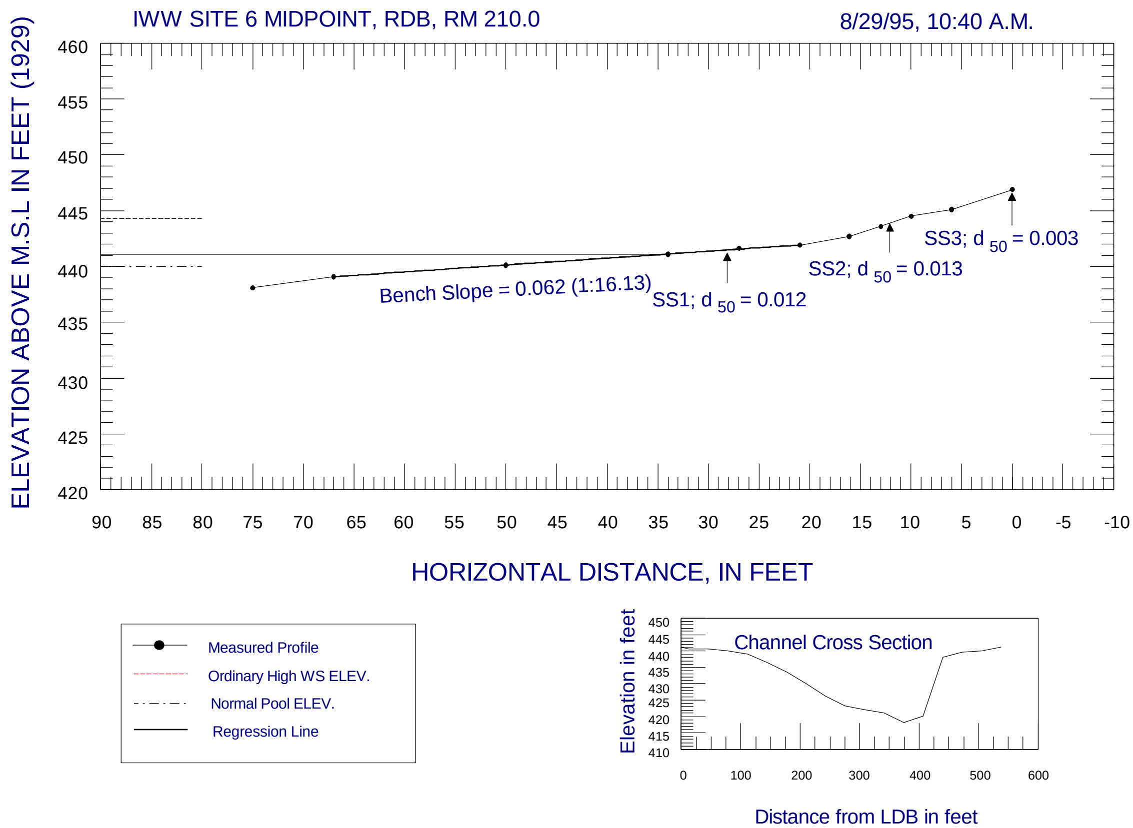


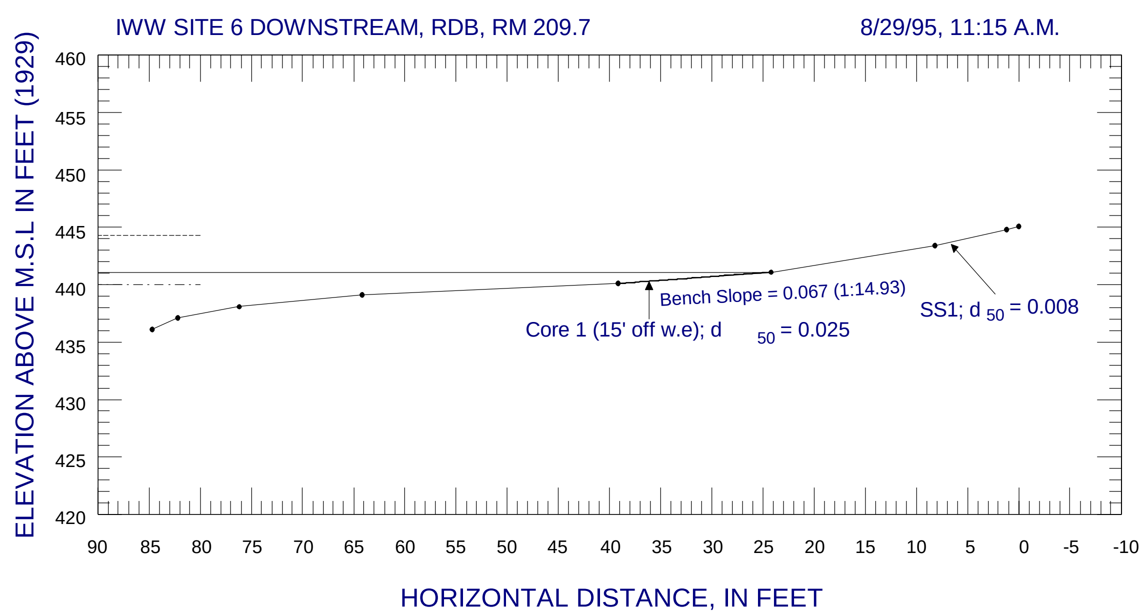
Figure 6-58. Location of site 6 on the Illinois Waterway

Figure 6-59. Site 6 on the Illinois Waterway



Figures 6-60. Bank sections at site 6





Figures 6-60. Bank sections at site 6 (concluded)

Table 6-16. Site 6

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	440.5	• Steep subaqueous drop at upstream section • Bench (underwater)	• d_{50} = 0.025
75	440.8	• Bench (underwater) slope varied between 1V:16.1H and 1V:6.1H	
50	441.6	• Bench	• d_{50} = 0.012
25	444.1	• Bench/scarp	• d_{50} = 0.008
10	447.5	• Scarp	• d_{50} = 0.013
0-9	>447.5	• Top of the bank	• d_{50} = 0.003

Note: Gage on the Illinois River near Henry, IL @ RM 186.0 was used for stage histogram. Gage is14 miles away from the site. WSE = 441.1'; OHW = 444.3'; NP = 440.0'.

Site 7, Peoria Pool, 8/29/95. This site is located on the LDB at RM 203.8 in a straight reach just downstream from a small bend. Upper Twin Sister Island is located at the downstream end between RM 203.1 and 203.3. Figure 6-61 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-62 shows one photograph of the site.

Site 7 is at the Hennepin Levee System about 400 feet from the sailing line, and no tributaries enter the site. Bhowmik and Schicht (1980) noted almost the entire riverbank from the Upper Twin Sister Island to site 6 as eroding bank. Hagerty's observation (1988) was similar to that of Bhowmik and Schicht (1980), but the erosion reaches indicated by Hagerty (1988) were shorter and were shown mostly on the RDB. Hagerty (1988) also noted erosion on both the Upper and Lower Twin Sister Islands on the sides facing the channel. The back side (facing levee) of Upper Twin Sister Island also had a long reach of overhanging matted roots as noted by Hagerty (1988).

At the site, a scarp 3-5 feet high was located about 2 to 4 feet below the levee crown. Tall weeds were growing on the berm and many small scarps were observed on the bench. Figure 6-63 shows the three measured bank sections and a reduced cross section. The OHW is 443.9 feet and NP is 440.0 feet above msl. The OHW corresponded well with the lower edge of the weed zone on the shore where debris was found, in the bench area. Stages above 447.5 feet (about 10% recurrence frequency, see table 6-17), reach the base of the scarp near the top of the levee.

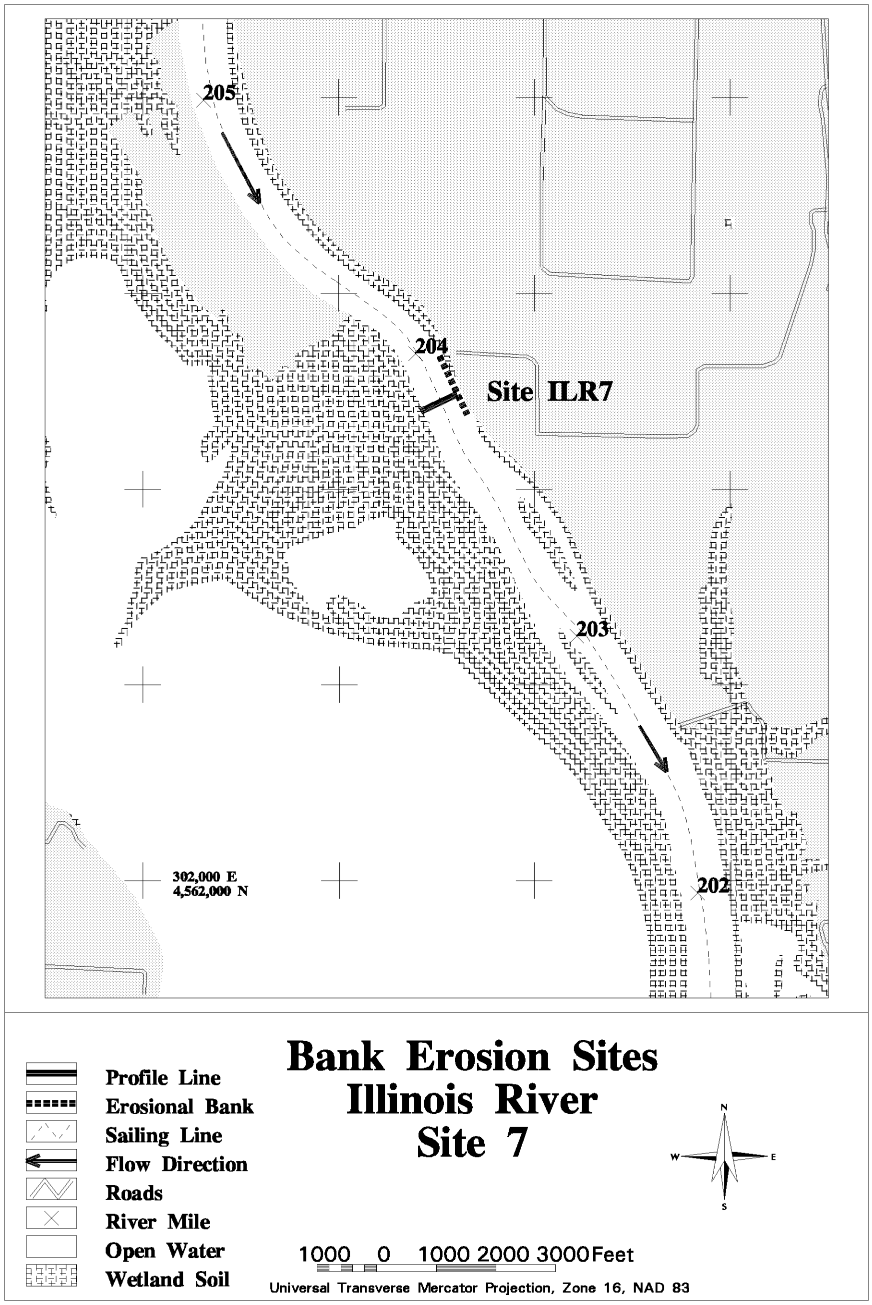


Figure 6-61. Location of site 7 on the Illinois Waterway

Figure 6-62. Site 7 on the Illinois Waterway

At the upstream section, the d_{50} varied from 0.018 mm at the surface of the scarp to 0.021 mm for a core sample at a water depth of about 1 foot. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied only slightly from 1V:23.3H. This site can be classified as type 5 (figure 6-22 and table 6-4). The scarp was located above most flood stages. Rework and transport by wave and currents are major factors in removing failed soil or recent sediments from the bench.

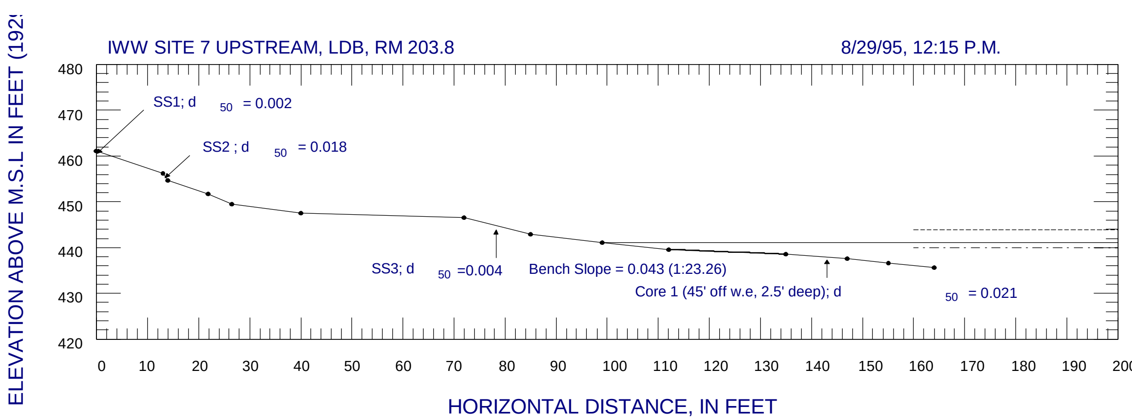


Figure 6-63. Bank sections at site 7

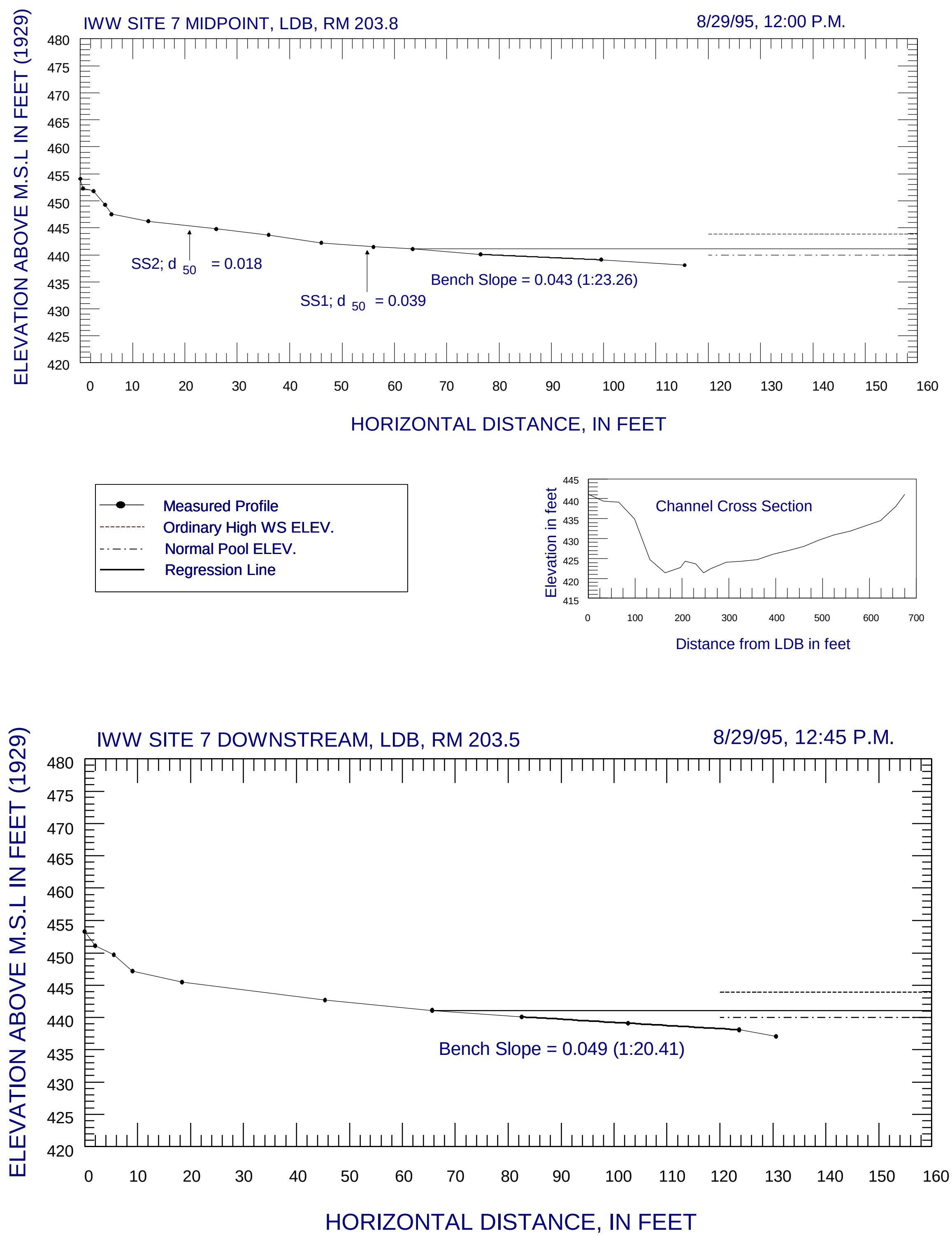


Figure 6-63. Bank sections at site 7 (concluded)

Table 6-17. Site 7

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	440.5	• Bench (underwater) (slope varied between 1V:23.2H and 1V:20.4H)	• d_{50} (core) = 0.021
75	440.8	• Bench (underwater)	
50	441.6	• Berm/bench	• d_{50} varied (0.039-0.004)
25	444.1	• Berm (slope varied between 1V:8.3H and 1V:7.7H)	
10	447.5	• Scarp (slope varied between 1V:1.4H and 1V:0.63H)	• d_{50} = 0.018
0-9	>447.5	• Top of the bank	• d_{50} = 0.002

Note: Gage on the Illinois River near Henry, IL @ RM 196.0 was used for stage histogram. Gage is 7.8 miles away from site. WSE = 441.1'; OHW = 443.9'; NP = 440.0'.

Site 8, Peoria Pool, 8/29/95. This site is located on the LDB at RM 184.8 on the lower end of Woodyard Island and upstream from the opening into Babbs Slough, in an inner bend reach. The slough opening was completely closed by historical deposits. Figure 6-64 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-65 shows one photograph of the site.

The site is about 330 feet from the sailing line. Hagerty (1988) recorded this site as severely eroded, while Bhowmik and Schicht (1980) noted erosion at the opposite bank. The opposite bank had several moored barges at the time of the survey. The site had a steep scarp right on the edge of the water. The scarp is about 3 to 5 feet high and covered with fine roots on the top. These roots belonged to the mature trees inside the bank area, but the top of the bank is covered with tall seasonal vegetation. The scarp was composed of cohesive soil and contains piping holes or holes that riverine animals use, generally with a diameter of 1 to 4 inches. The subaqueous bench was gently sloping, extends far out, and was covered with silt and clay.

At the midsection, the d_{50} varied from 0.005 mm at the surface of the top of the bank to 0.018 mm for a core sample at a water depth of about 1 foot. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Figure 6-66 shows the three measured bank sections and a reduced cross section. The OHW is 442.6 feet and NP is 440.0 feet above msl. The OHW corresponds to the base of the scarp. Floods with stage higher than 447.5 feet (about 10% recurrence frequency) overtop the bank (table 6-18).

Bench slopes varied from 1V:83.3H to 1V:47.6H. This site is classified as a combination of types 4 and 5 (figures 6-21, 6-22, and table 6-4). Bank failures are initiated by piping or burrowing activities from riverine animals. Rework and transport of failed bank soils by wave action at NP appeared to be significant. Wave action probably was responsible for an erosion scarp at water's edge.

Table 6-18. Site 8

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	440.5	• Subaqueous bend (slope varied between 1V:83.3H and 1V:47.6H	• d_{50} (core) = 0.018
75	440.8	• Subaqueous bench	
50	441.6	• Berm (slope varied between 1V:2.8H and 1V:2.5H)	
25	444.1	• Scarp (slope varied between 1V:0.48H and 1V:0.07H)	• d_{50} = 0.017
10	447.5	• Top of the bank	• d_{50} = 0.005
0-9	>447.5		

Note: Illinois River near Henry, IL Gage @ RM 196.0 was used for stage histogram. Gage is 11.2 miles away from the site. WSE = 441.1'; OHW = 442.6'; NP = 440.0'.

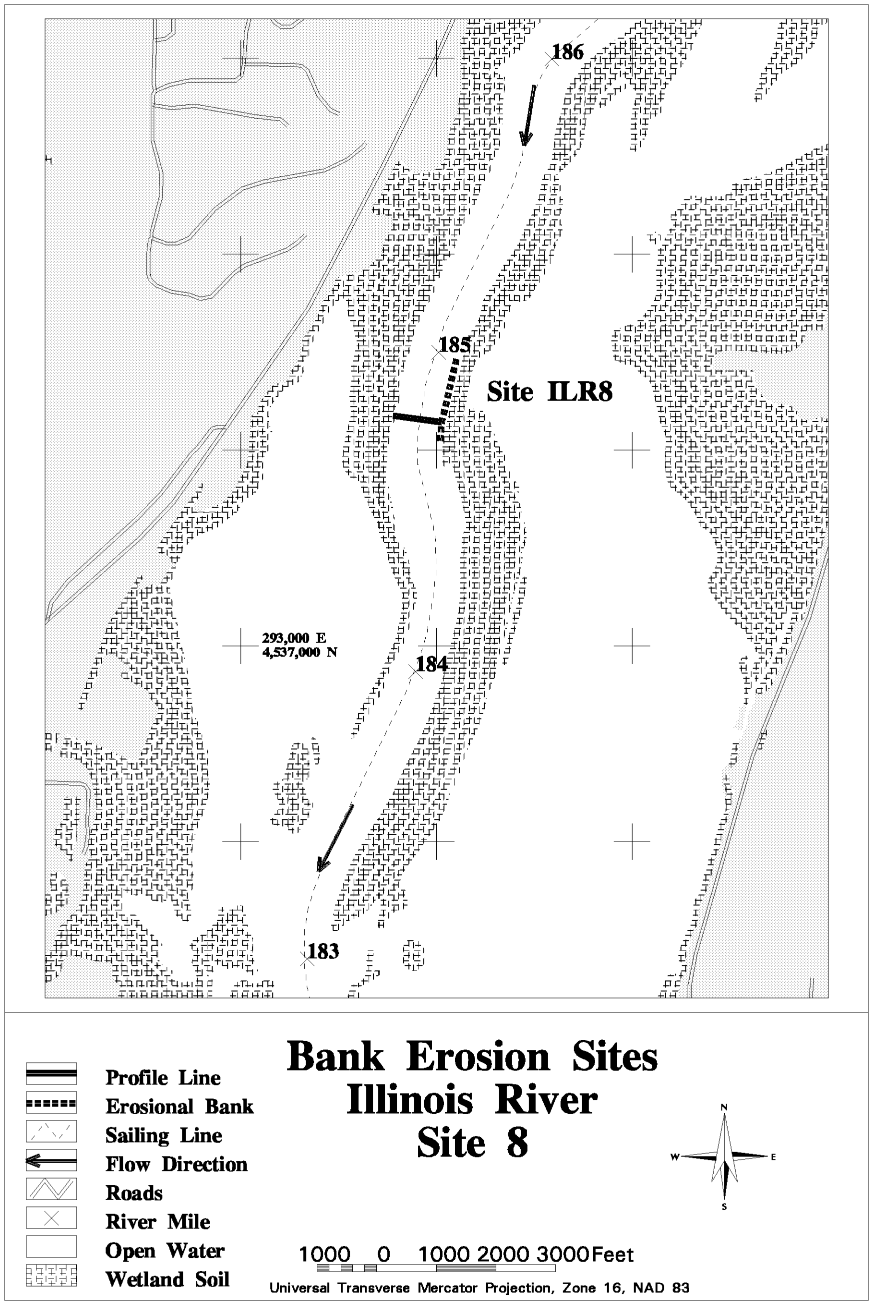


Figure 6-64. Location of site 8 on the Illinois Waterway

Figure 6-65. Site 8 on the Illinois Waterway

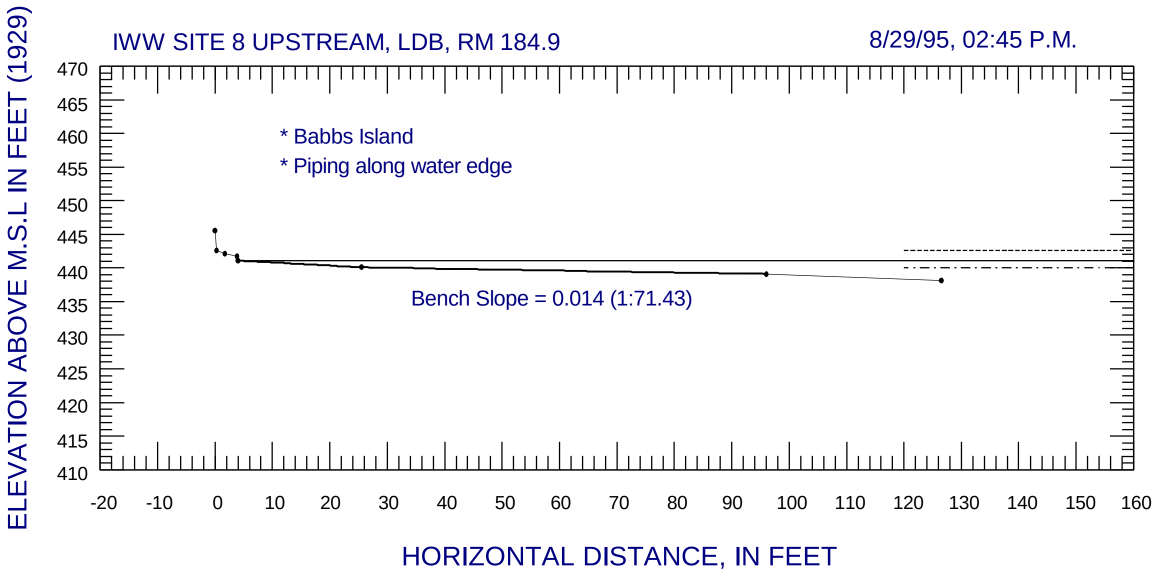
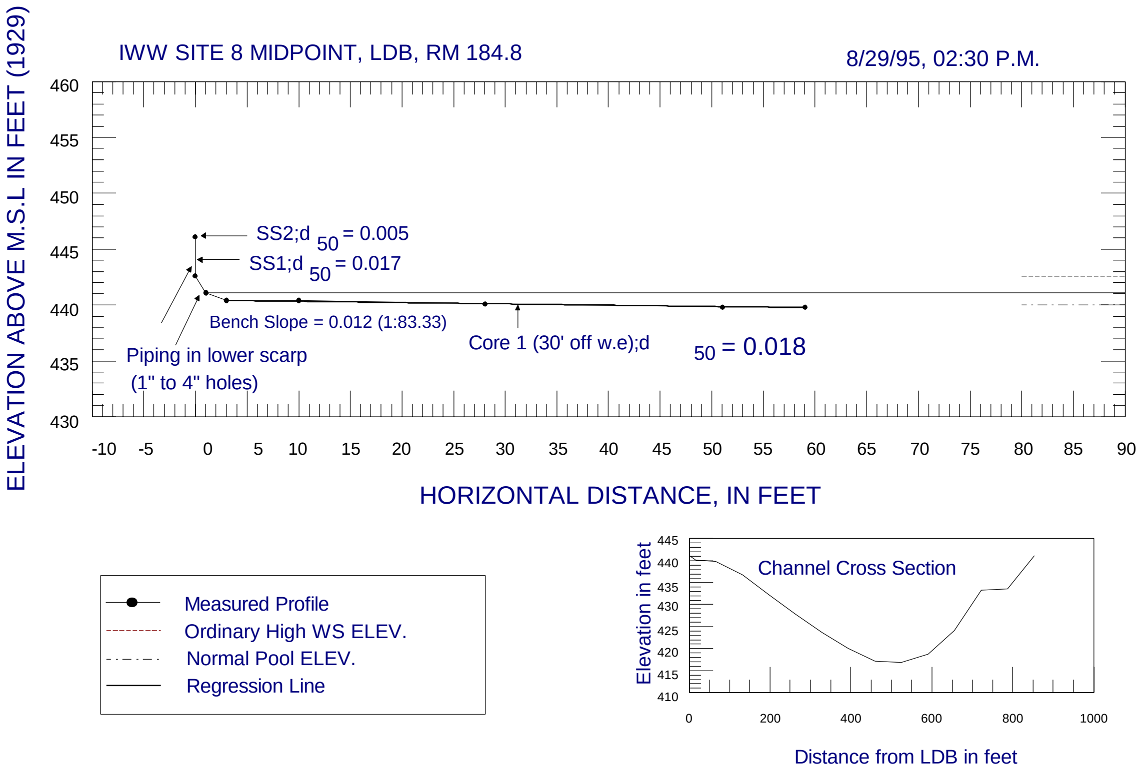


Figure 6-66. Bank sections at site 8



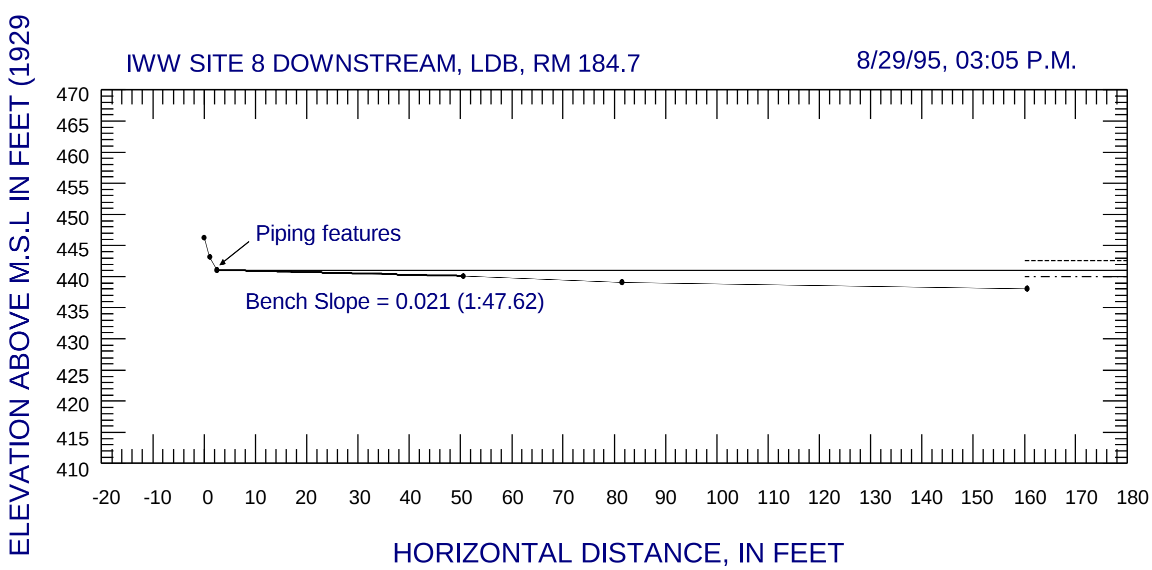


Figure 6-66. Bank sections at site 8 (concluded)

Site 9, Peoria Pool, 8/29/95. This site is located on the LDB at RM 179.8 on Chillicothe Island, immediately upstream of the opening into Peoria Lake. Figure 6-67 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-68 shows a photograph of the site.

The site is about 310 feet from the sailing line, and the Chillicothe Sports & Marine Small Boat Harbor is located across the river. Bhowmik and Schicht (1980) and Hagerty (1988) marked this as an erosion site. The bank was mildly sloped and covered with weeds of medium density. The foundation of an old monument on shore was exposed for about a foot. A scarp about 0.3 feet high existed on the lower bank where the weed zone ends, above sandy bench. A scarp also existed at the water's edge. The wet bench did not support large weights. Submerged nearshore material, however, was hard clay mantled with sand.

Figure 6-69 shows the three measured bank sections and a reduced cross section. The OHW is 442.4 feet and NP is 440.0 feet above msl. The OHW corresponds well to the lower edge of the weed zone. Stage exceeding 447.5 feet (10% recurrence frequency, table 6-19) submerges the entire bank.

The d_{50} on the bench varied from 0.208 mm at the upstream section to 0.035 mm at the downstream section. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:21.3H at the upstream section to 1V:14.1H at the downstream section. This site is classified as types 4 and 6 (figure 6-23, and table 6-4). The combinations of wave actions and seepage within bench near NP elevations could be the major causes of erosion at this site. Recreational and commercial traffic volumes are high at site 9. Traffic-induced waves and current can also be the cause of erosion at this site.

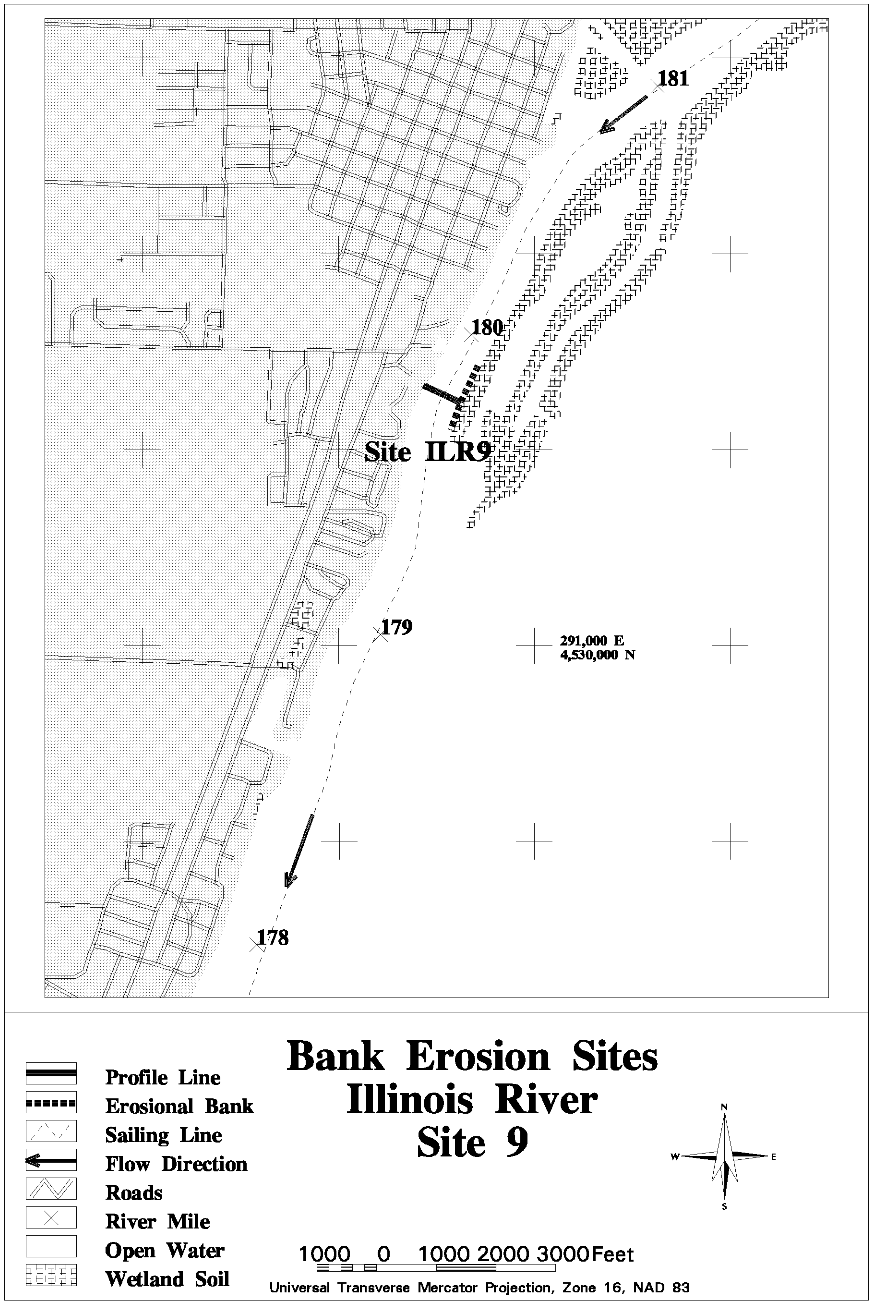


Figure 6-67. Location of site 9 on the Illinois Waterway

Figure 6-68. Site 9 on the Illinois Waterway

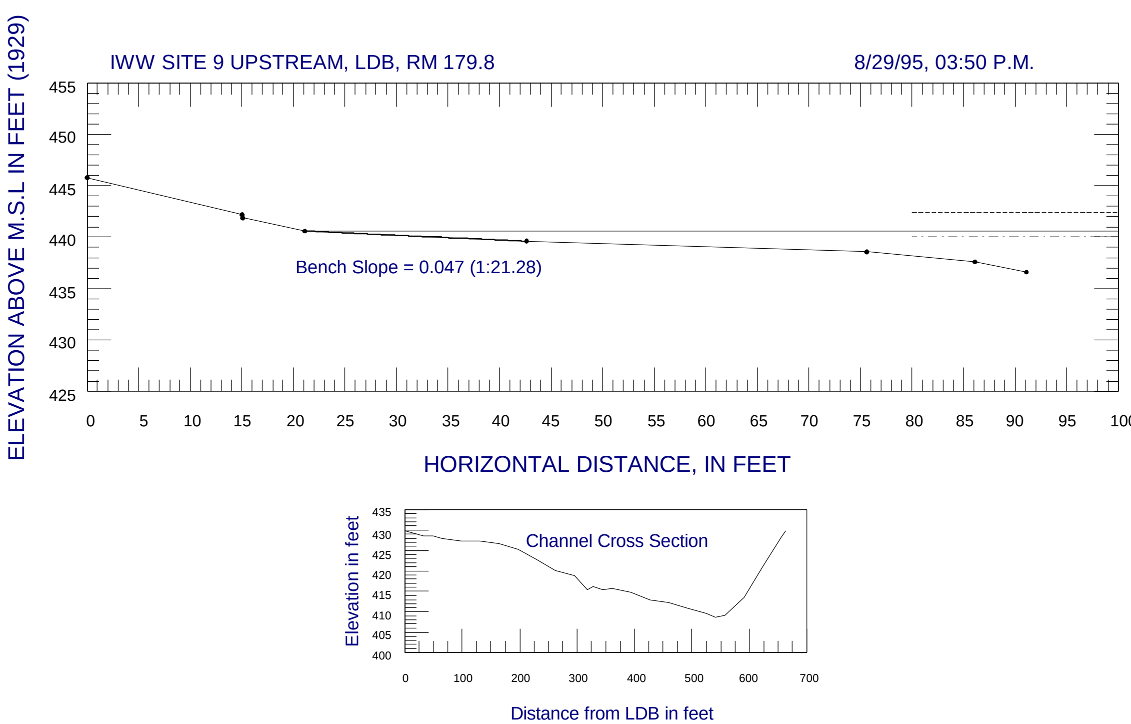


Figure 6-69. Bank sections at site 9

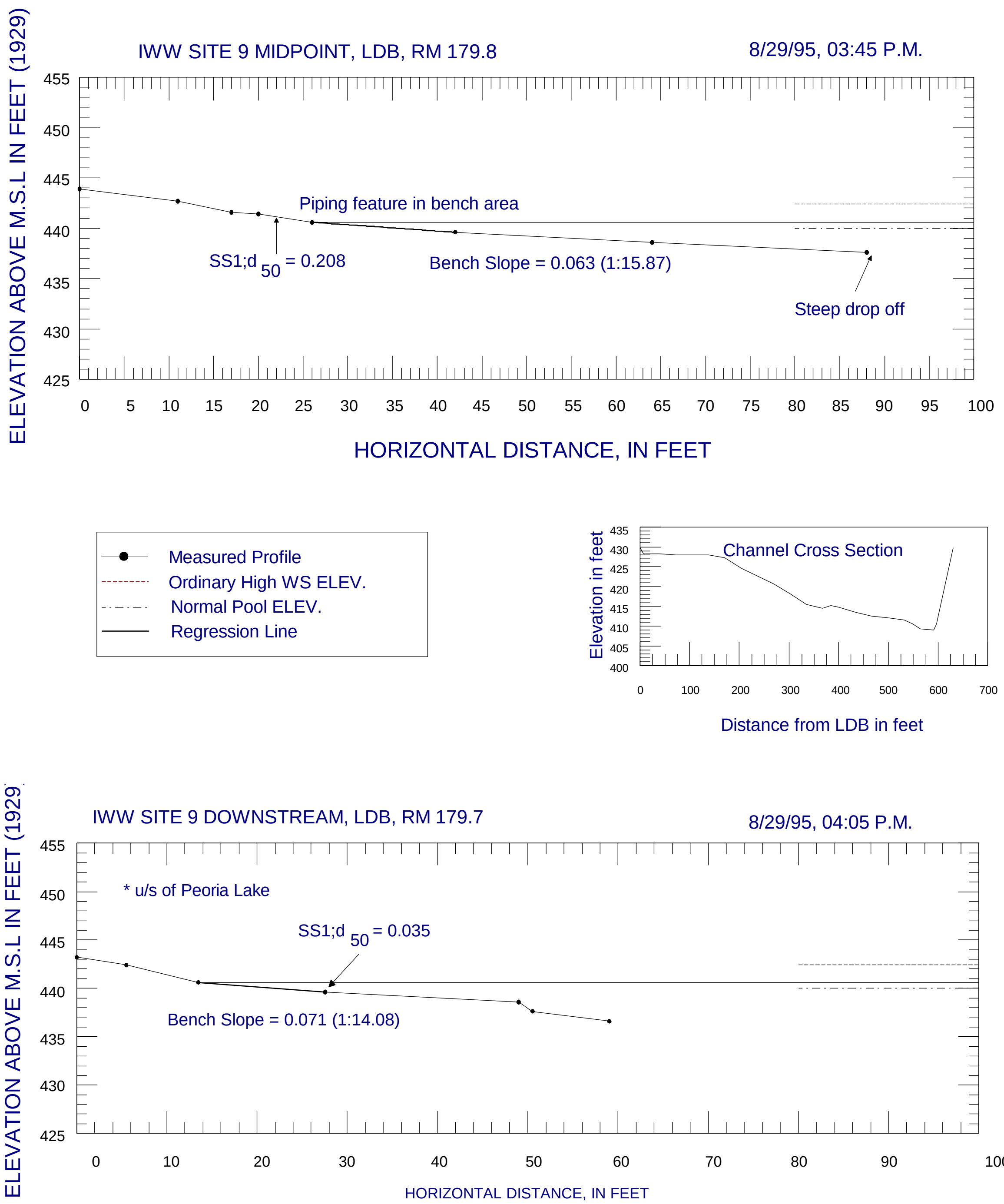


Figure 6-69. Bank sections at site 9 (concluded)

Table 6-19. Site 9

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	440.5	• Bench (underwater)	• d_{50} (core) = 0.35
75	440.8	• Bench (slope varied between 1V:21.3H and 1V:14.1H)	• d_{50} = 0.208
50	441.6	• Bench/berm	
25	444.1	• Scarp with gentle slope	
10	447.5	• Top of the bank	• d_{50} = NA
0-9	>447.5		

Note: Gage on the Illinois River near Henry, IL @ RM 196.0 was used for stage histogram. Gage is 16.2 miles away from the site. WSE = 440.6'; OHW = 442.4'; NP = 440.0'.

Site 10, Peoria Pool, 8/29/95. This site is located on the RDB and at the outside of a sharp bend at RM 160.0. Peoria L&D is located downstream at RM 157.8. Figure 6-70 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-71 shows a photograph of the site.

Site 10 is about 430 feet from the sailing line. Kickapoo Creek enters the IWW at RM 159.6 on the RDB. At the upstream end of the site a drawbridge is located at RM 160.8. Neither Bhowmik and Schicht (1980) nor Hagerty (1988) recorded the site as an erosion site. Parked barge fleets were noted on the LDB about 1,000 feet upstream from this site. This bank bore some resemblance to site 8, but trees were growing at the water's edge, and there was not much seasonal vegetation on top of the bank. A scarp 3 to 5 feet high and some piping holes were observed near the water's edge. The underwater bench extended four toward the channel, and a thick layer of fine materials was noted on the subaqueous bench. Strong currents were encountered near the bank.

Figure 6-72 shows the three measured bank sections and a reduced cross section. The OHW is 441.4 feet and NP is 440.0 feet above msl. Water surface elevation was at the base of the scarp. At stages corresponding to OHW, the scarp is mostly submerged. Floods of stage higher than 445.4 (10% recurrence frequency, table 6-20) overtop the bank crest. There was sediment deposition on top of the bank.

At the midsection, the d_{50} varied from 0.015 mm at the top surface of the bank to 0.013 mm at the upper portion of the scarp. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied between 1V:15.0H and 1V:5.6H, and the subaqueous bench extends more than 70 feet. Soils on the scarp were cohesive. The site can be classified as a combination of types 4 and 5 (figures 6-21 and 6-22, and table 6-4). Piping related internal erosion weakens the bank. Soils exposed and displaced by bank failures are susceptible to removal by wave and current actions during normal stages. Traffic is heavy at this site and could add to the tractive forces by waves and currents.

Table 6-20. Site 10

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	439.7	• Bench (underwater) (slopes varied between 1V:14.9H and 1V:5.6H)	• d_{50} (core) @ 2' of water = 0.025
75	440.1	• Bench (underwater)	
50	440.4	• Bench (underwater)	
25	441.8	• Scarp/berm • Berm slope = 1V:2.7H	
10	445.4	• Scarp (slope varied between 1V:0.8H and 1V:0.56H)	• d_{50} varied (0.013-0.015)
0-9	>445.4	• Top of the bank	• d_{50} = 0.018

Note: Pool level gage of Peoria Pool @ RM 157.7 was used for stage histogram. WSE = 440.5'; OHW = 441.4'; NP = 440.0'.

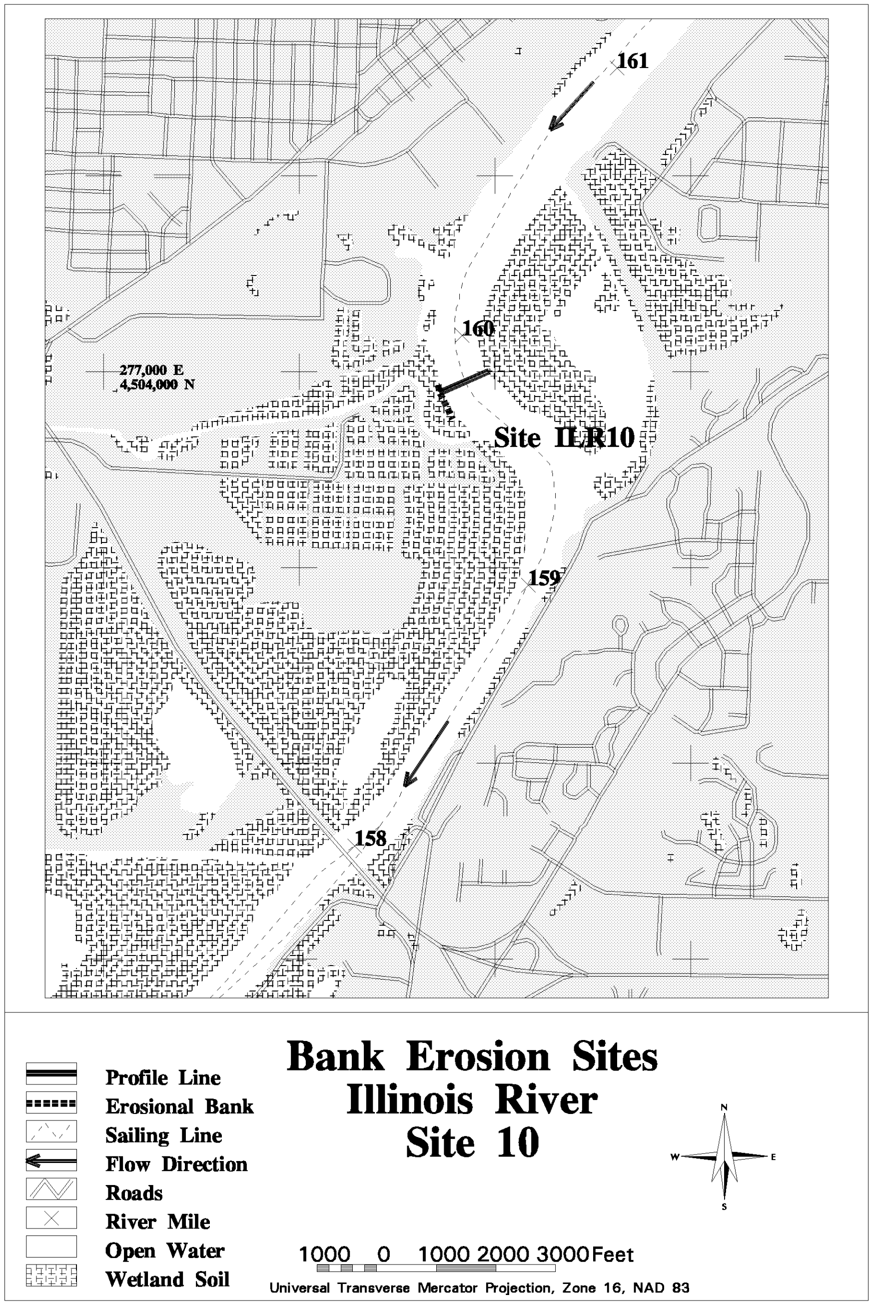


Figure 6-70. Location of site 10 on the Illinois Waterway

Figure 6-71. Site 10 on the Illinois Waterway

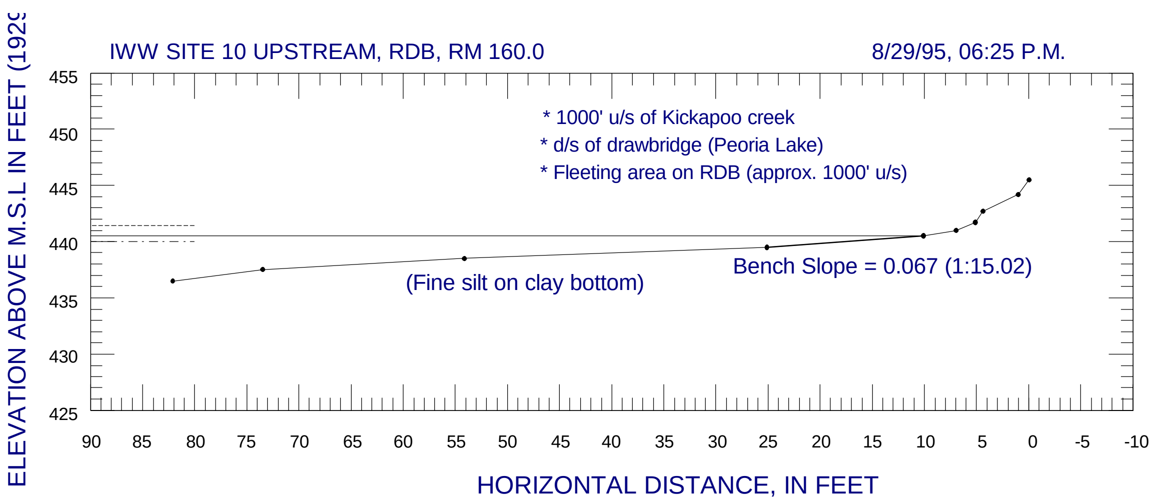


Figure 6-72. Bank sections at site 10

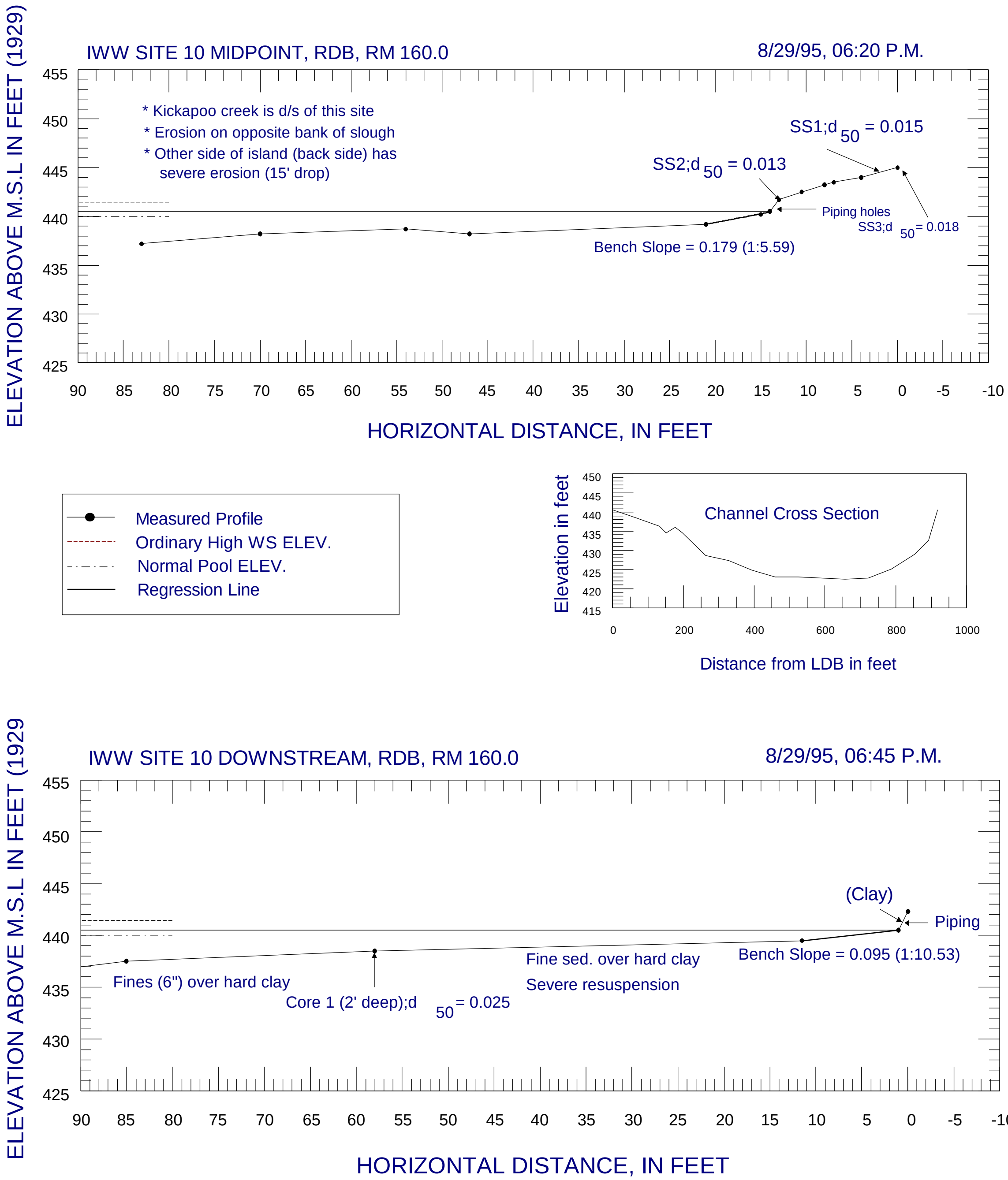


Figure 6-72. Bank sections at site 10 (concluded)

Site 11, La Grange Pool, 8/30/95. This site is located on the RDB at RM 155.3. The reach is fairly straight, but the site is at the entrance to a sharp bend between RM 154.5 and 149. Other surrounding structures include the Peoria L&D upstream at RM 157.8 and a docking facility approximately 500 feet downstream. Figure 6-73 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-74 shows a photograph of the site.

The navigation sailing line is near the RDB at site 11, (the distance from the navigation chart is about 250 feet). Lick Creek enters the IWW from the LDB at RM 156.5. Bhowmik and Schicht (1980) noted some erosion on both banks around RM 156, while Hagerty (1988) noted dredged material cited on the navigation chart for both banks.

Figure 6-75 shows the three measured bank sections and a reduced cross section. The whole bank is mildly sloped with a small scarp remote from the water at the top of the bank. Trees with exposed roots exist at the crest of the bank, above a weed zone and a bare bench with several small wave scarps covered with recent sediments. The OHW is 440.8 feet and NP is 429.5 feet above msl. Stage fluctuations at the upper part of the pool are generally large, and banks often are presented with mildly sloped benches. The OHW can reach the upper part of the bank close to the base of a small scarp at the downstream section. Table 6-21 shows the recurrence frequencies for various stages at this site.

At the midsection, the d_{50} varied from 0.235 mm at the top of the bank to 0.158 mm from the upper part of a core sample at a water depth of about 2 feet. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied slightly between 1V:11.2H and 1V:9.0H. This site is classified as type 6 (figure 6-23 and table 6-4). Wave actions are primarily responsible for rework and transport of failed soil or recently deposited sediments on the bench at various stages within the normal range of pool level fluctuations.

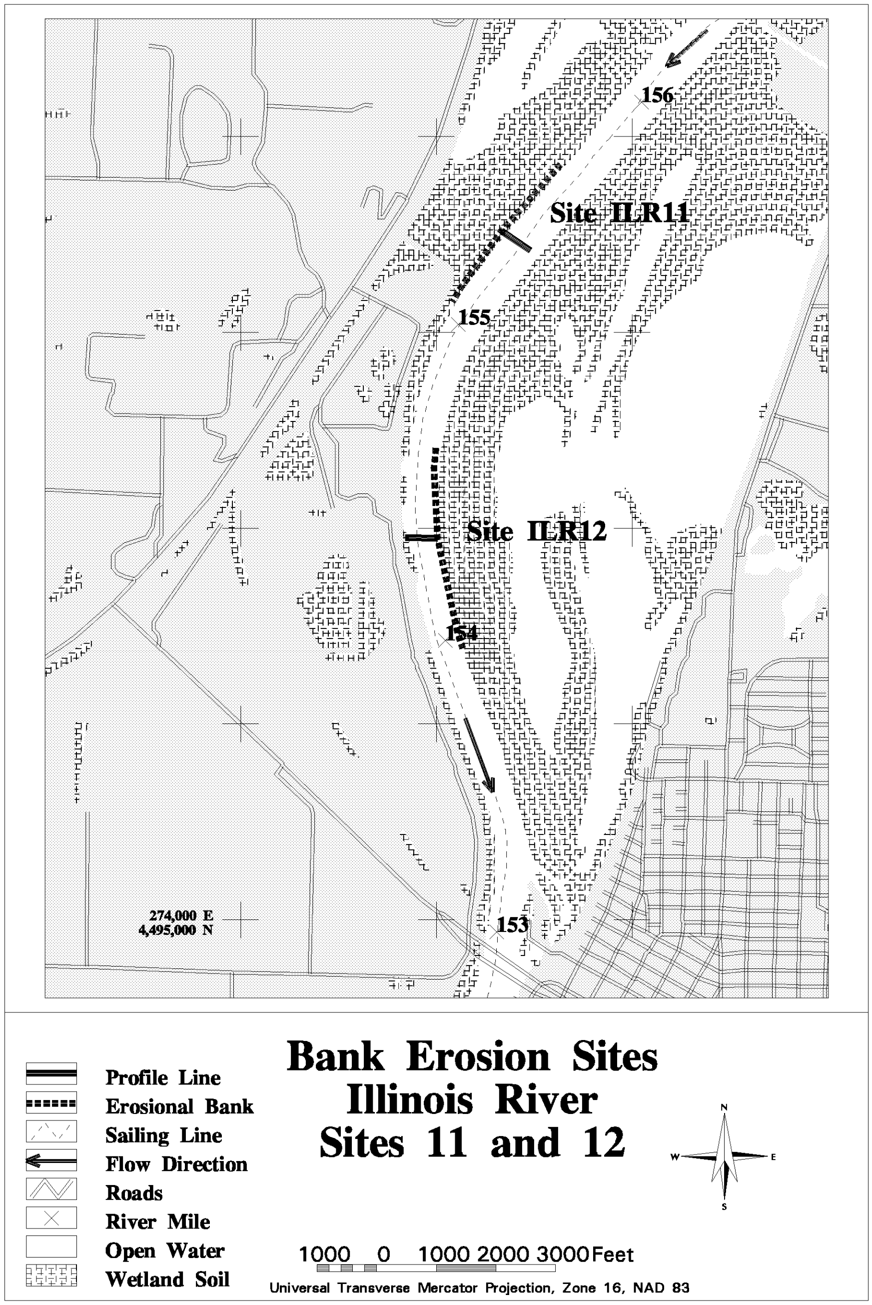


Figure 6-73. Locations of sites 11 and 12 on the Illinois Waterway

Figure 6-74. Site 11 on the Illinois Waterway

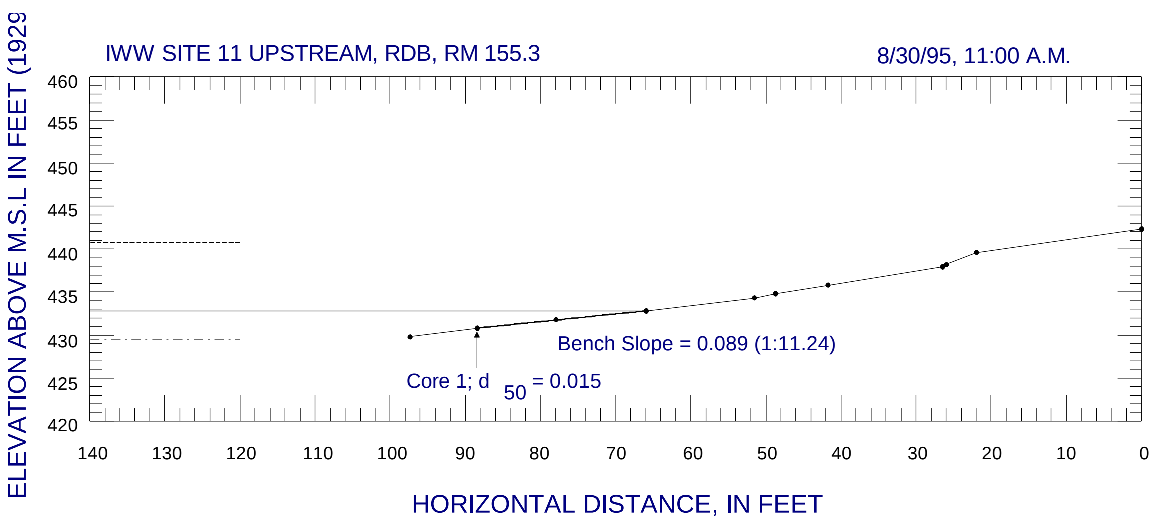
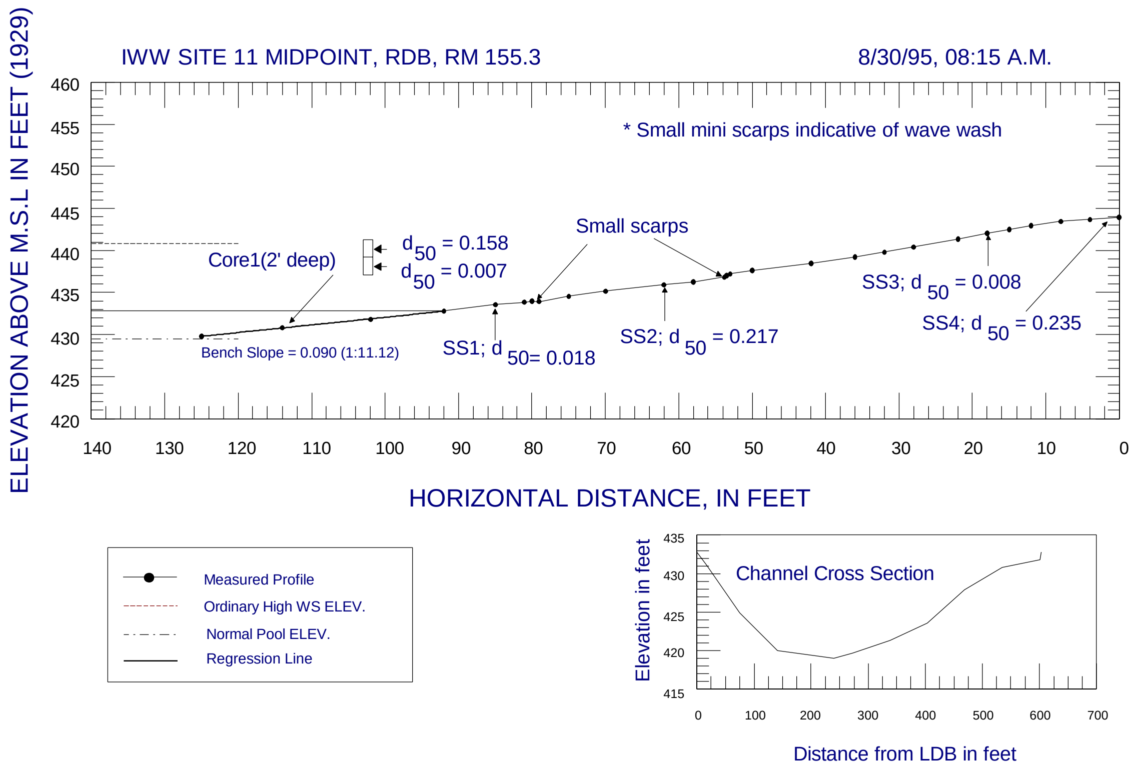


Figure 6-75. Bank sections at site 11



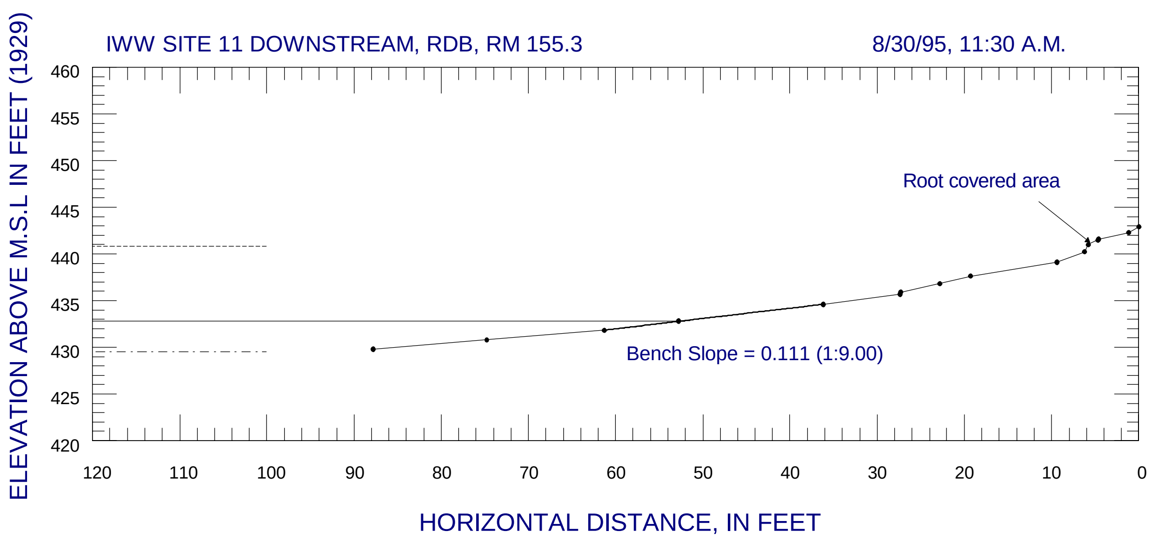


Figure 6-75. Bank sections at site 11 (concluded)

Table 6-21. Site 11

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	431.65	• Bench (underwater), slopes varied between 1V:11.2H and 1V:9.0H	• d_{50} (core) @ 1' of water = 0.015 • d_{50} (core) 2' of water varied (0.007-0.158)
75	432.95	• Bench • Small scarps	• d_{50} varied (0.018-0.217)
50	436.0	• Small scarps • Berm	
25	441.1	• Scarp	• d_{50} = 0.008
10	444.25	• Top of the bank	• d_{50} = 0.235
0-9	>444.3		

Note: Tail water gage of Peoria Pool @ RM 157.7 was used for stage histogram. WSE = 432.8'; OHW = 440.8'; NP = 429.5;.

Site 12, La Grange Pool, 8/30/95. This site is located on the LDB at RM 154.4 on the inside of a mild bend; a sharp bend is present downstream from the site. A power plant across the river has docking facilities for barges. The Lake of the Woods is located approximately 1,000 feet behind this bank. Figure 6-73 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-76 shows a photograph of the site.

Figure 6-76. Site 12 on the Illinois Waterway

Site 12 is about 320 feet from the sailing line, and no major tributary enters the IWW at this location. Bhowmik and Schicht (1980) and Hagerty (1988) noted erosion on both sides of this reach of the waterway.

An obvious scarp was present at the water's edge. Figure 6-77 shows the three measured bank sections and a reduced cross section. The wide bench has a mild slope. At the top of the bank, tall trees and a scarp were hidden behind a belt of tall weeds and young willows. Vegetation formed a band approximately 90-100 feet wide on the bank. A berm was present inside the vegetation zone and its soils were desiccated. The open bench area was wet and clayey, and had piping features. The OHW is 440.7 feet and NP is 429.5 feet above msl. At OHW, the water would submerge some of the vegetation on the bank. Small scarps in the vegetation zone were below the OHW level and the scarp at the upstream section was at the water's edge. Table 6-22 gives the recurrence frequencies for various stages at this site.

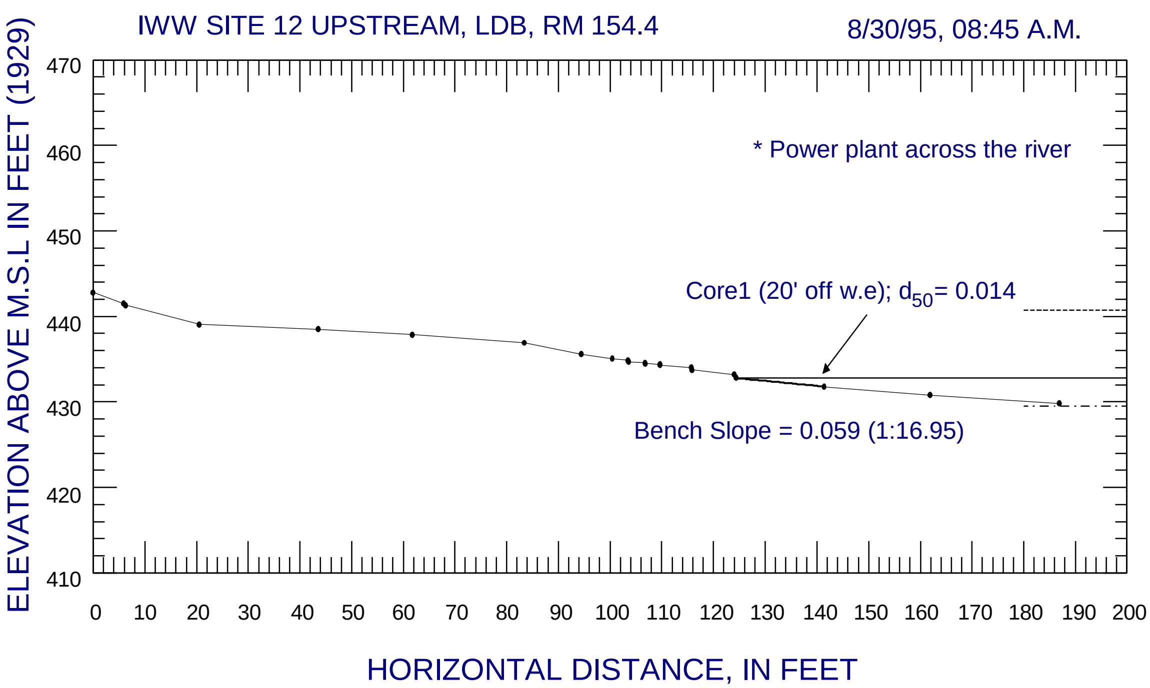


Figure 6-77. Bank sections at site 12

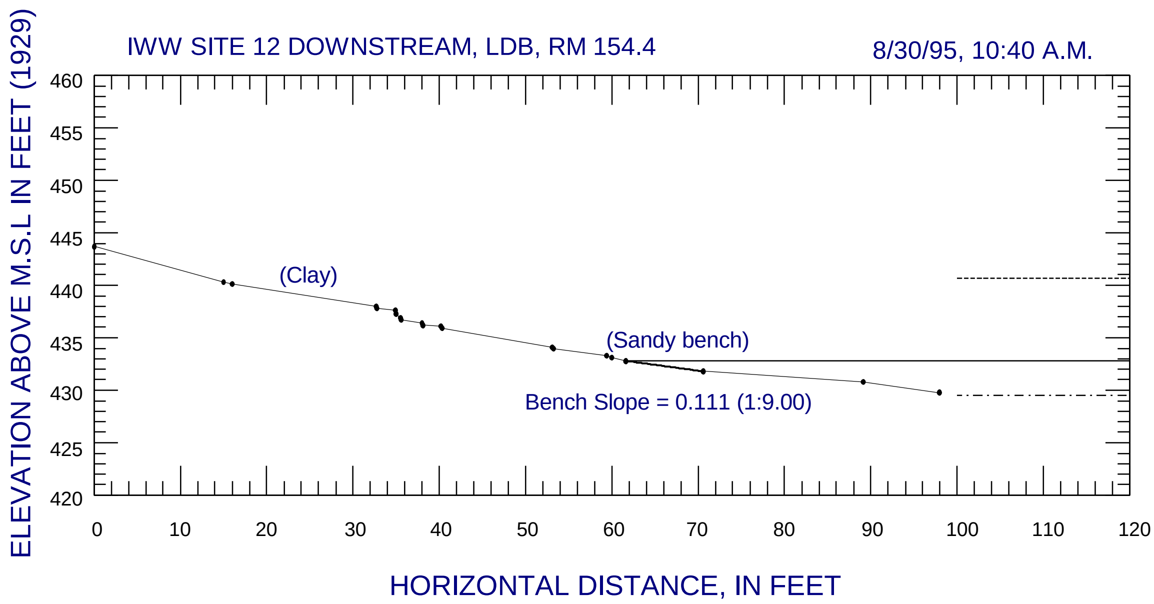


Figure 6-77. Bank sections at site 12 (concluded)

Table 6-22. Site 12

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	431.65	• Bench (underwater)	• d_{50} (core) varied (0.014-0.022)
75	432.95	• Bench (slope varied between 1V:16.9H and 1V:9.0H	• d_{50} varied (0.046-0.077)
50	436.0	• Bench	
25	441.1	• Scarp	
10	444.25	• Top of the bank	• d_{50} = 0.046
0-9	>444.3	• Top of the bank	

Note: Tail water gage of Peoria Pool @ RM 157.7 was used for stage histogram. WSE = 432.8'; OHW = 440.7'; NP = 429.5'.

At the midsection, the d_{50} varied from 0.046 mm at the top surface of the bank to 0.022 mm at the top portion of a core sample at a water depth of about 1 foot. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied between 1V:16.9H and 1V:9.0H. This site is classified as type 5 (figure 6-22 and table 6-4). Wave action is suspected to be one of the main mechanisms for erosion, because of the scarps on the sloping bank. Piping also was noted at the lower subaerial bench. Rework and transport could be significant at various stages within the normal range of pool-level fluctuations at this site.

Site 13, La Grange Pool, 8/30/95. This site is located on the LDB at RM 150.6 on the outside of a sharp bend. A 3 by 5 barge tow would have considerable difficulty in maneuvering through this sharp bend. A delta at the upstream end (RM 150.9) near the mouth of a small creek further reduced the maneuvering space for barge tows and increased flow velocity. The Chicago and Northwestern Railway bridge crosses the river at RM 151.2. All these factors may be responsible for changes in bank sections from upstream to downstream. Figure 6-78 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-79 shows a photograph of the site.

The site is about 370 feet from the sailing line, and there are two barge canals for a coal pit on the LDB at RM 150.9. Hagerty (1988) marked this site as severely eroded and included it as a study site. Bhowmik and Schicht (1980) did not mark this site but marked a reach at the downstream end at about RM 149.5-150.0. A vertical scarp was present right at the water's edge. When tows pass near this bank reach, direct impact is likely, especially when water stages are low. There were multiple scarps on the upper bank. Dredged materials had been deposited here, and two layers of different soils were observed on the bank. There were dense small holes on the bank surface, which may be created by worms. Bhowmik and Schicht (1980) and Hagerty (1988) referenced erosion on both banks at this river mile.

At the midsection, the d_{50} varied from 0.117 mm at the top surface of the bank to 0.005 mm at the upper portion of a core sample at a water depth of about 2 feet. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Materials on the scarp are cohesive. This site can be classified as type 4 (figure 6-21 and table 6-4). Under normal stages, waves and turbulence created by traffic are causes for bank erosion. Rework and transport by current at stages within the normal range of pool level fluctuation can be significant. Seepage and nesting worms can also weaken bank strength.

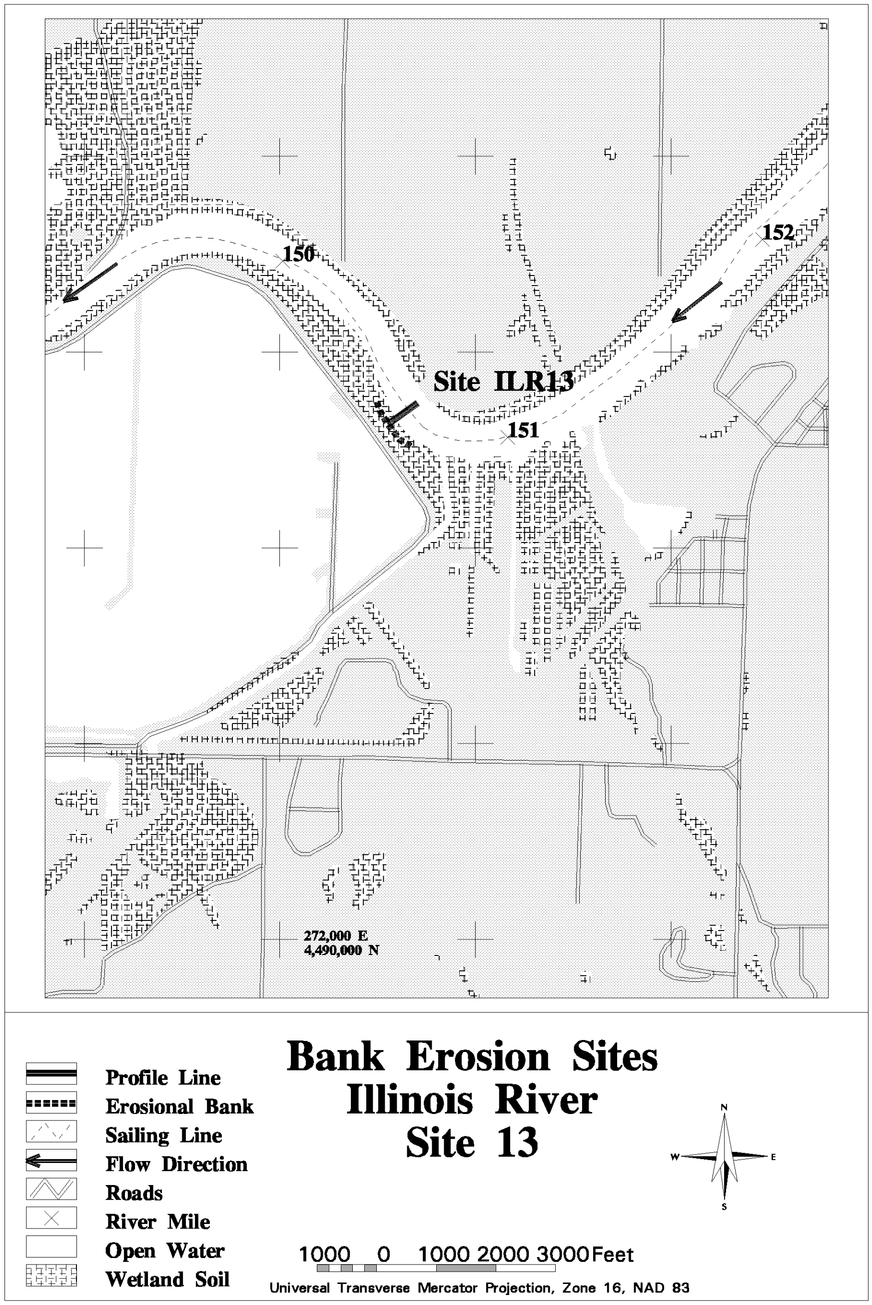


Figure 6-78. Location of site 13 o the Illinois Waterway

Figure 6-79. Site 13 on the Illinois Waterway

Figure 6-80 shows the three measured bank sections and a reduced cross section. The OHW is 440.5 feet and NP is 429.5 feet above msl. The NP elevation is about at the base of the berm, and the OHW reaches the upper part of the bank. Table 6-23 gives the stages for various recurrence frequencies at this site.

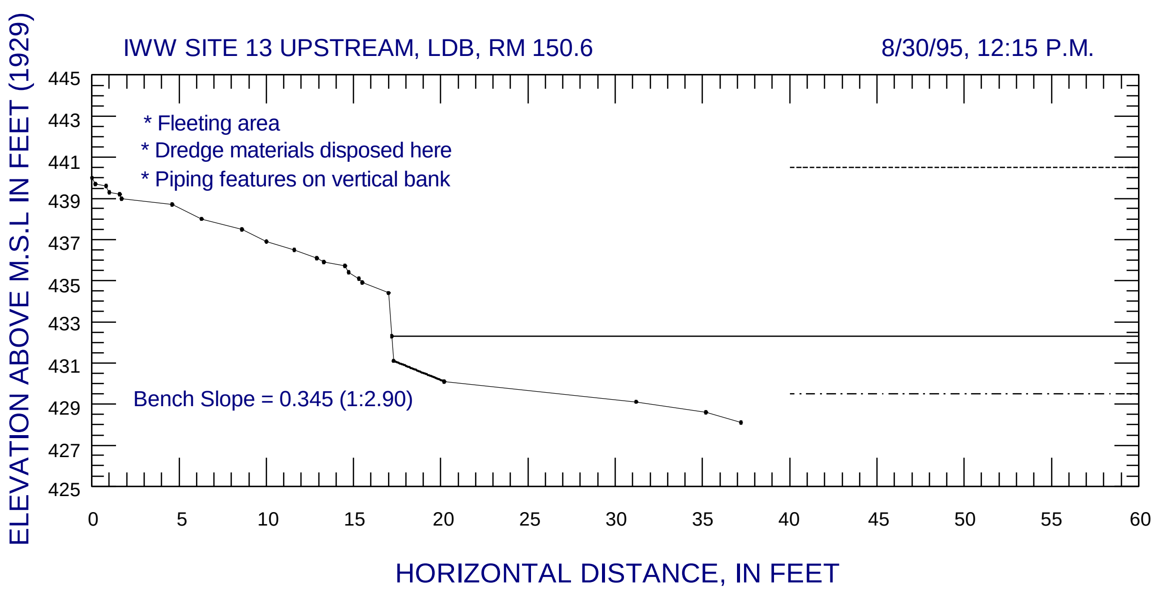


Figure 6-80. Bank sections at site 13

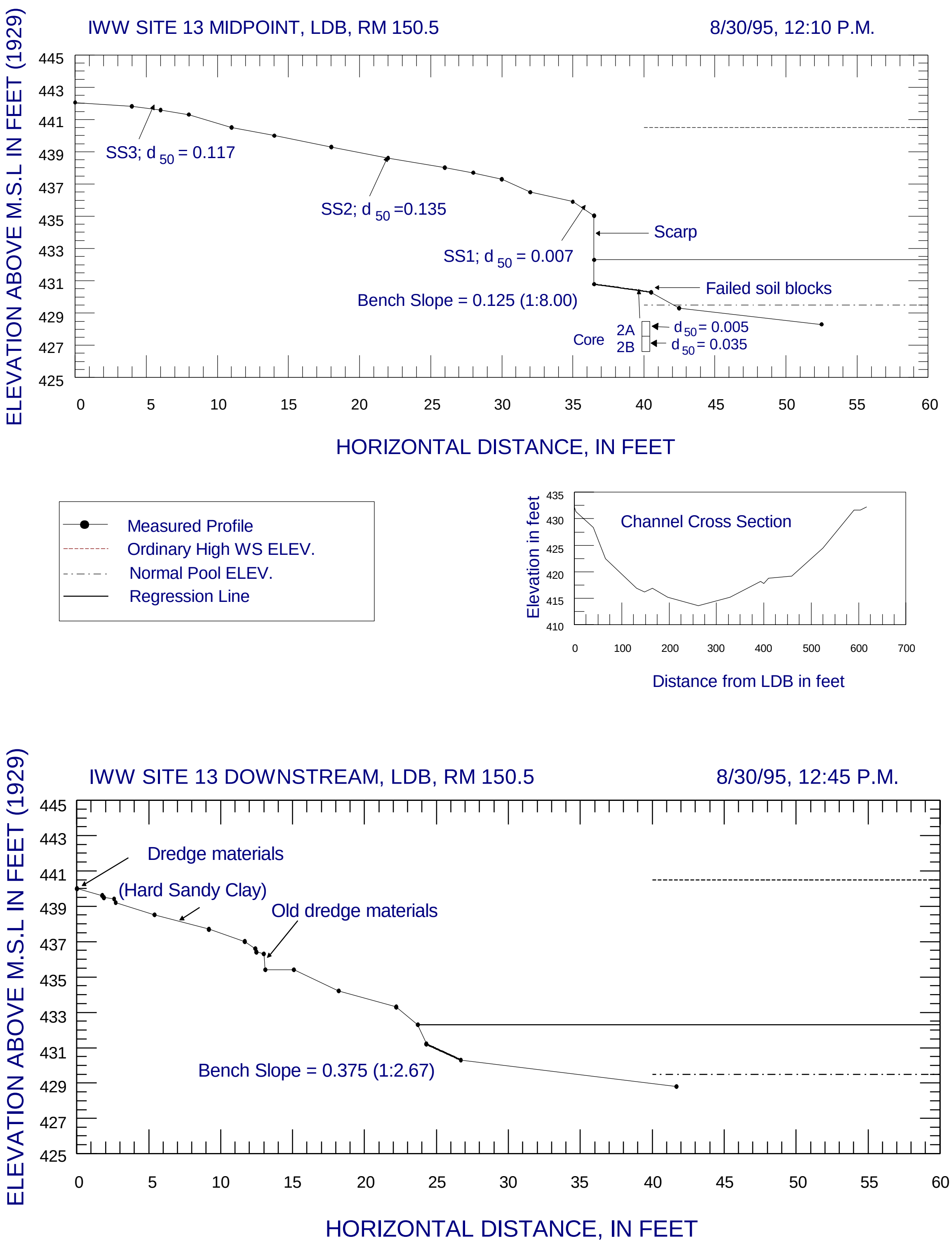


Figure 6-80. Bank sections at site 13 (concluded)

Table 6-23. Site 13

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
<90	<430.0	• Bench (underwater), slopes varied between 1V:10H and 1V:8.5H	• d_{50} (core) 2’ of water varied (0.005-0.035)
90	431.3	• Scarp/berm, slopes of scarp: 1V:0.58H to 1V:0.09H	
75	432.5	• Scarp/berm • Berm slopes vary between 1V:4H and 1V:2.6H	
50	435.8	• Top of the bank/scarp	
25	440.7		• d_{50} varied (0.117-0.135)
10	443.99		
0-9	>444.0		

Note: Gage on the Illinois River near Kingston Mines, IL @ RM 145.4 was used for stage histogram. WSE = 432.3’; OHW = 440.5’; NP = 429.5’.

Site 14, La Grange Pool, 8/30/95. This site is located on the RDB at RM 129.3, at the beginning of an inside bend. Upstream from RM 129.9, the river is fairly straight. Figure 6-81 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-82 shows a photograph of the site.

Site 14 is about 270 feet from the sailing line, and no major tributary enters the IWW at this location. Approximately 600 feet behind this site is the East Liverpool Levee System. Bhowmik and Schicht (1980) marked erosion on the opposite bank on an island. Hagerty observed erosion on this bank but not on the opposite bank. Trees are close to the bank crest at many locations at this site, and some roots extended beyond the bank face. A scarp about 1.5 feet high was located on the upper part of the bank, which was covered by seasonal grasses. Several breaks in the bank sections appeared to correspond to different erosion mechanisms at this site. Dislodged peds and some micro-scale piping existed on a bare bench area. The bench between the scarp and the water’s edge was covered with moist, soft clay.

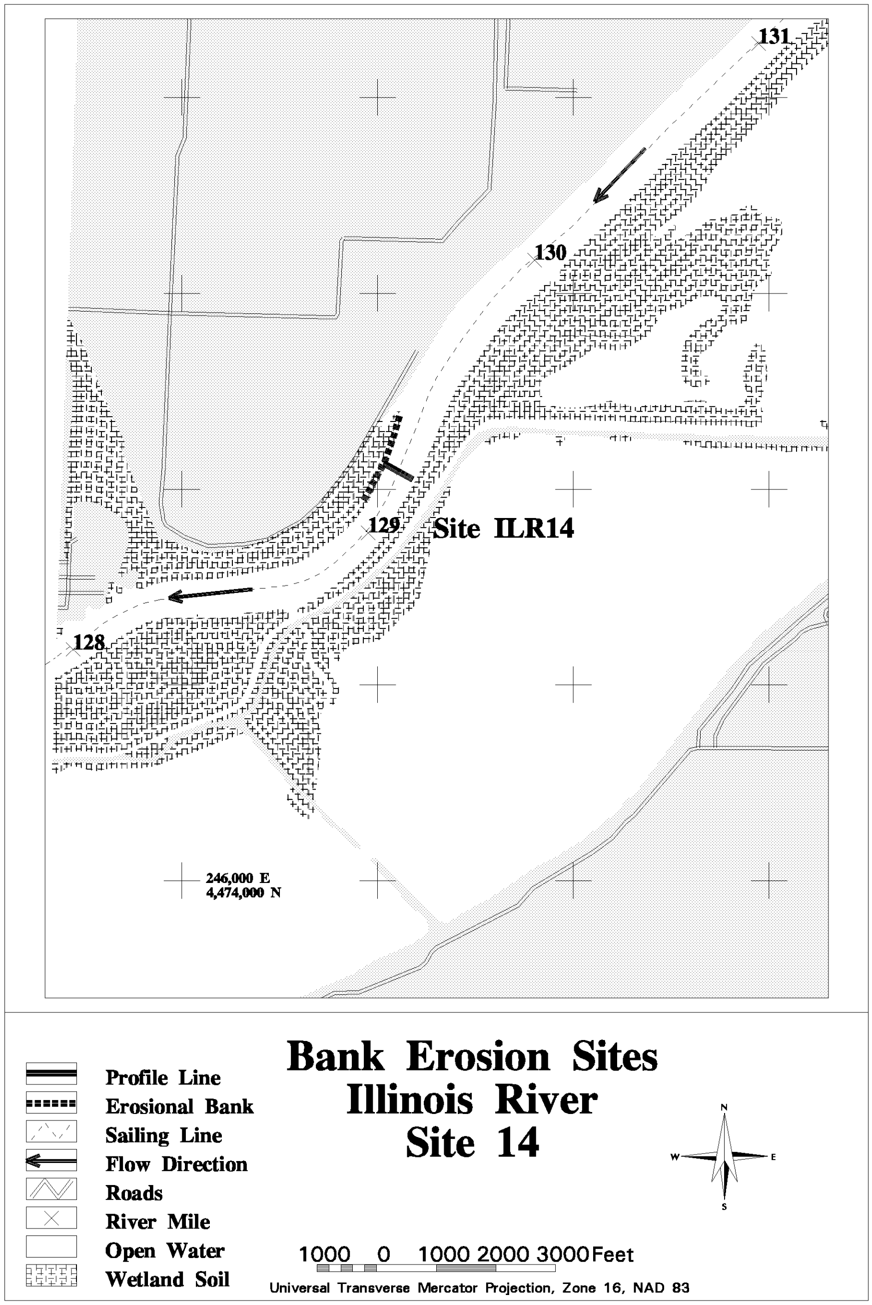


Figure 6-81. Location of site 14 on the Illinois Waterway

Figure 6-82. Site 14 on the Illinois Waterway

Figure 6-83 shows the three measured bank sections and a reduced cross section. The OHW is 438.5 feet and NP is 429.5 feet above msl. A scarp was noted at the downstream section, where the NP elevation matched the base of the scarp. The OHW elevation is about the same height as the short scarp at the midsection, and any stages higher than the OHW elevation will top the bank (see table 6-24 for the recurrence frequencies for various stages).

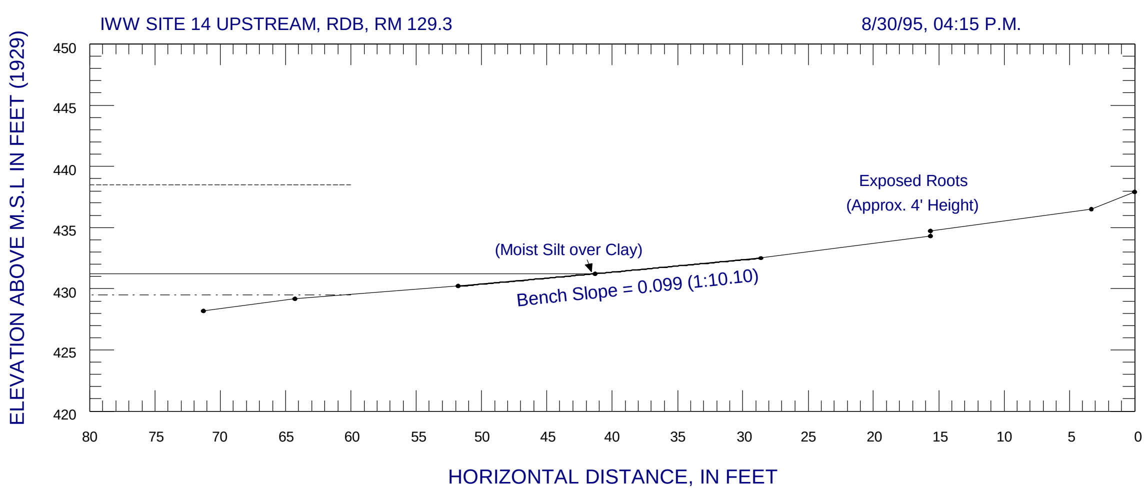
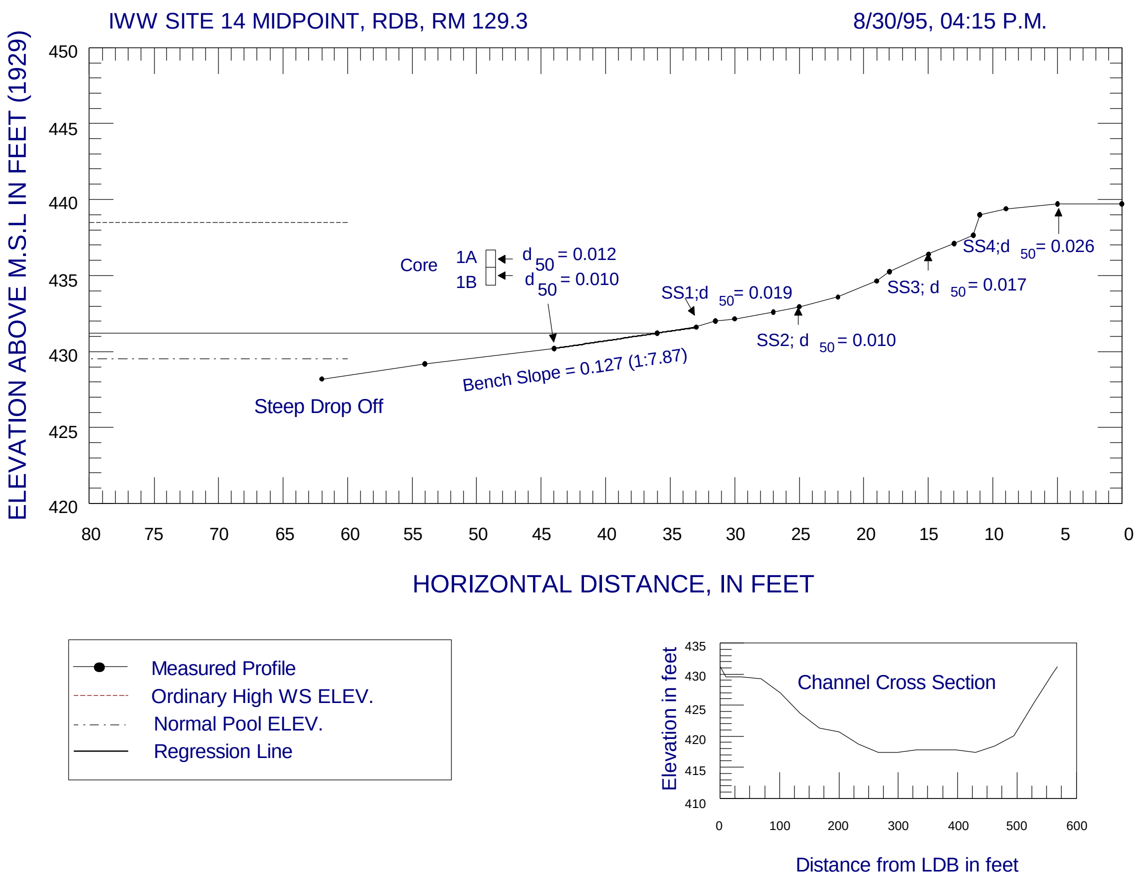


Figure 6-83. Bank sections at site 14



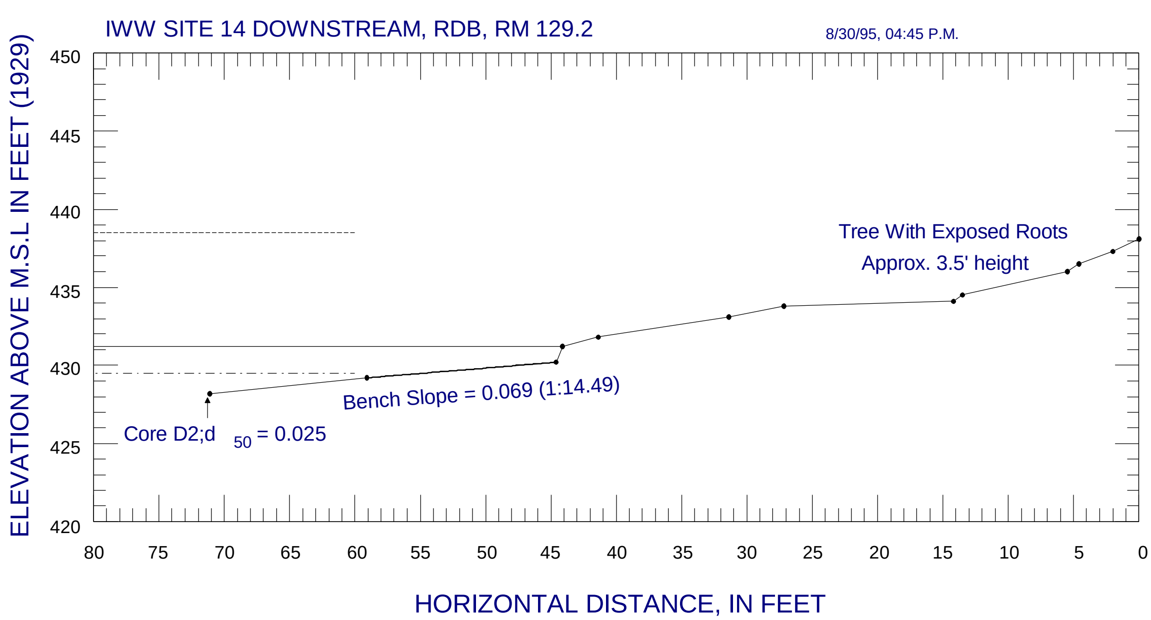


Figure 6-83. Bank sections at site 14 (concluded)

Table 6-24. Site 14

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	430.9	• Bench (underwater). slopes vary between 1V:14.5H and 1V:7.9H	• d_{50} (core) varied (0.010-0.012)
75	432.3	• Bench	• d_{50} varied (0.010-0.019)
50	435.3	• Berm (slopes varied between 1V:4.6H and 1V:2.6H)	• d_{50} = 0.017
25	440.0	• Top of the bank	• d_{50} = 0.026
10	443.1		
0-9	>443.1		

Note: Gage on the Illinois River near Copperas Creek @ RM 139.9 was used for stage histogram. WSE = 431.2'; OHW = 438.5'; NP = 429.5'.

At the midsection, the d_{50} varied from 0.026 mm at the top surface of the bank to 0.012 mm at the upper part of a core sample at a depth of about 1 foot of water. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:10.1H at the upstream section to 1V:7.9H at the midsection. The slope for the subaqueous bench was 1V:14.5H below a water's edge scarp at the downstream section. The site is classified as type 4 (figure 6-21 and table 6-4). The subaerial bench was wet due to poor drainage. Wave wash, in combination with piping, appeared to have created the downstream small scarp on the bench. Rework and transport of failed soils and recently deposited sediments at stages within the normal range of pool-level fluctuations could be significant.

Site 15, La Grange Pool, 8/30/95. This site is located at the RDB at RM 116.5, where an embankment lies on the outside of a gentle bend. The embankment is part of the Lacey, Langellier, West Matanzas & Drainage Levee System. Figure 6-84 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-85 shows a photograph of the site.

The site is about 310 feet from the sailing line. No major tributary enters the IWW at this location. Bhowmik and Schicht (1980) noted erosion along a long stretch of this side of the river, while Hagerty (1988) marked dredged material at the site as well as some old dredged material on the opposite bank. Tall grass covered the bank face, with scarps inside the grass zone. The bench below the grass zone contained a series of small scarps.

Figure 6-86 shows the three measured bank sections and a reduced cross section. The OHW is 437.0 feet and NP is 430.8 feet above msl. The NP elevation corresponds to a break in the subaqueous slope. From figure 6-86, the OHW elevation corresponds to the base of a small scarp.

At the midsection, the d_{50} varied from 0.008 mm at the top surface of the bank to 0.265 mm at the upper part of a core sample at a water depth of about 2 feet. The nearshore sediment was stratified. Gradation plots of bank soils and nearshore sediment are presented in appendix F. A detailed cross section is shown in appendix G.

Bench slopes varied from 1V:8.1H at the upstream section to 1V:11H at the downstream section. This site is classified as a combination of types 3 and 5 (figures 6-20 and 6-22, and table 6-4). The existing scarp was located at higher elevations that could be caused by floods. The peds indicated seepage activities. Rework and transport by waves and currents on failed soils or recent sediments could also be important at this site.

Table 6-25. Site 15

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	430.1	• Bench (underwater) (slopes varied between 1V:11H and 1V:8.1H)	• d_{50} (core) varied (0.03-0.299)
75	431.1	• Bench	• d_{50} = 0.363
50	433.7	• Bench	
25	438.1	• Berm/bench (slopes varied between 1V:3.5H and 1V:2.8H)	• d_{50} = 0.008
10	441.5	• Scarp/berm (scarp slopes varied between 1V:0.45H and 1V:0.04H)	
0-9	>441.5	• Top of the bank	• d_{50} = 0.008

Note: Gage on the Illinois River near Havana, IL @ RM 119.6 was used for stage histogram. WSE = 430.8'; OHW = 437.0'; NP = 429.5'.

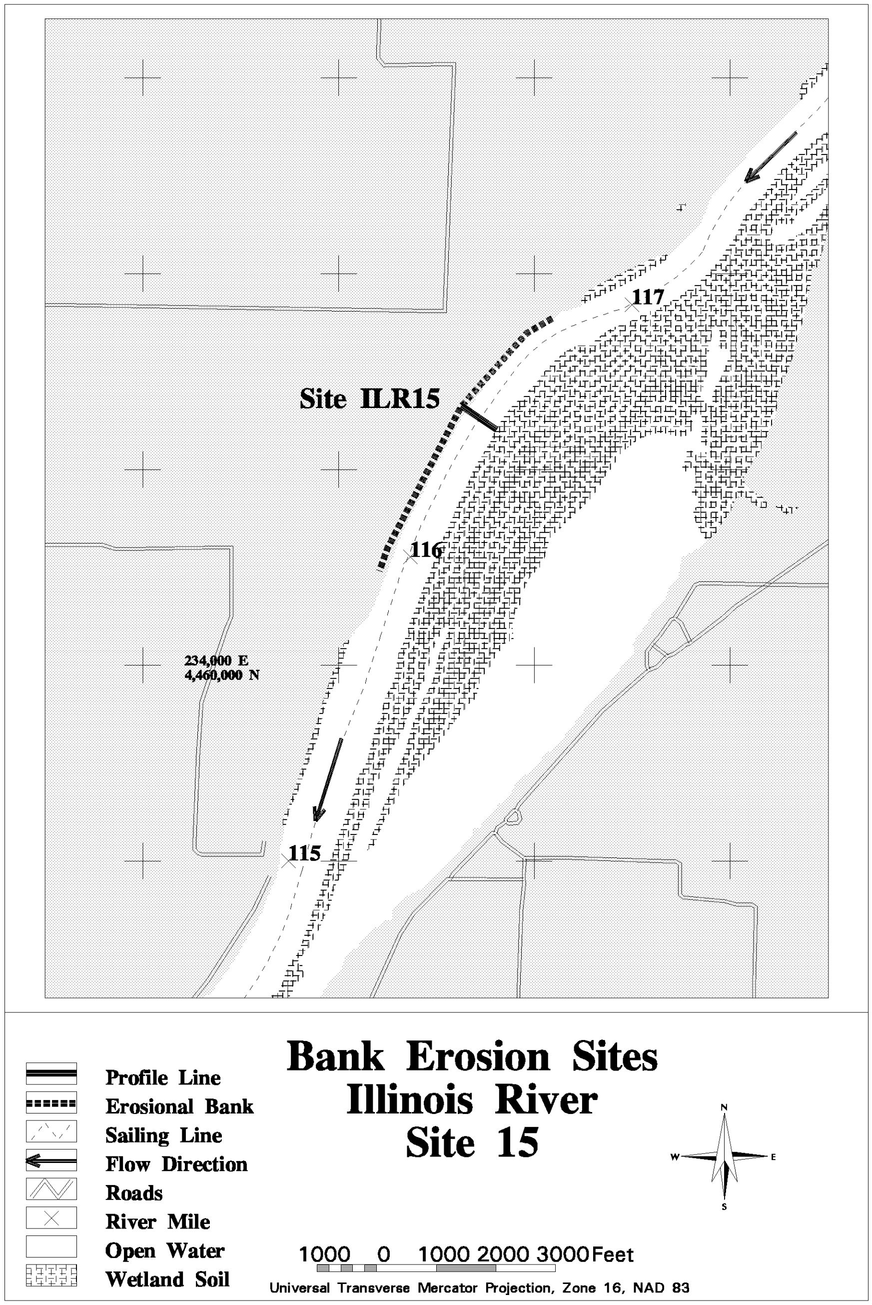


Figure 6-84. Location of site 15 on the Illinois Waterway

Figure 6-85. Site 15 on the Illinois Waterway

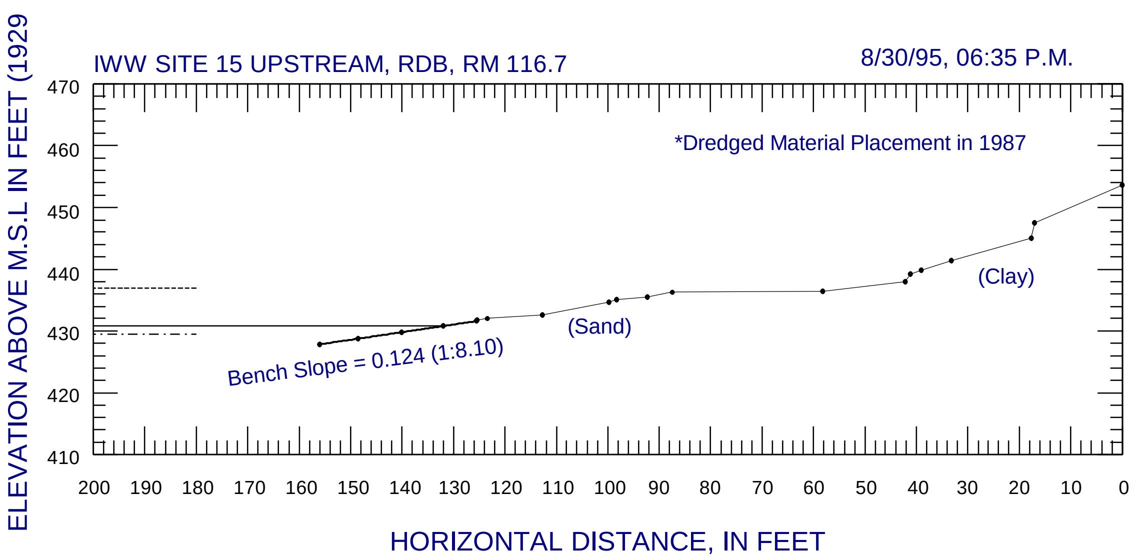
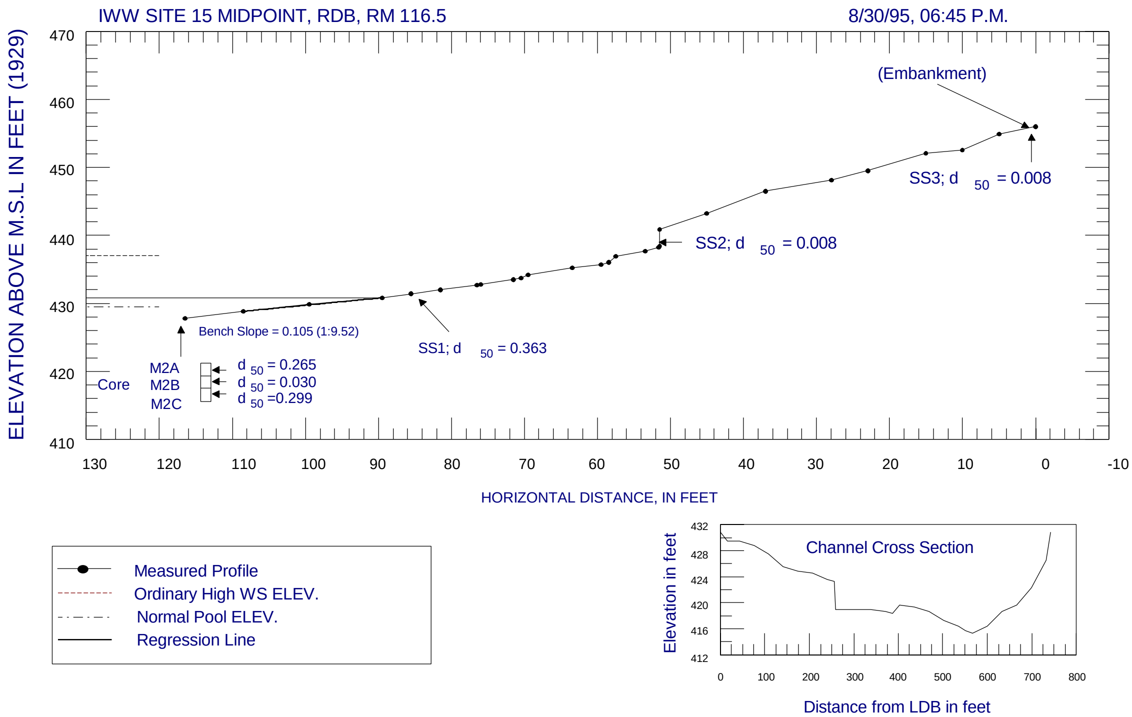


Figure 6-86. Bank sections at site 15



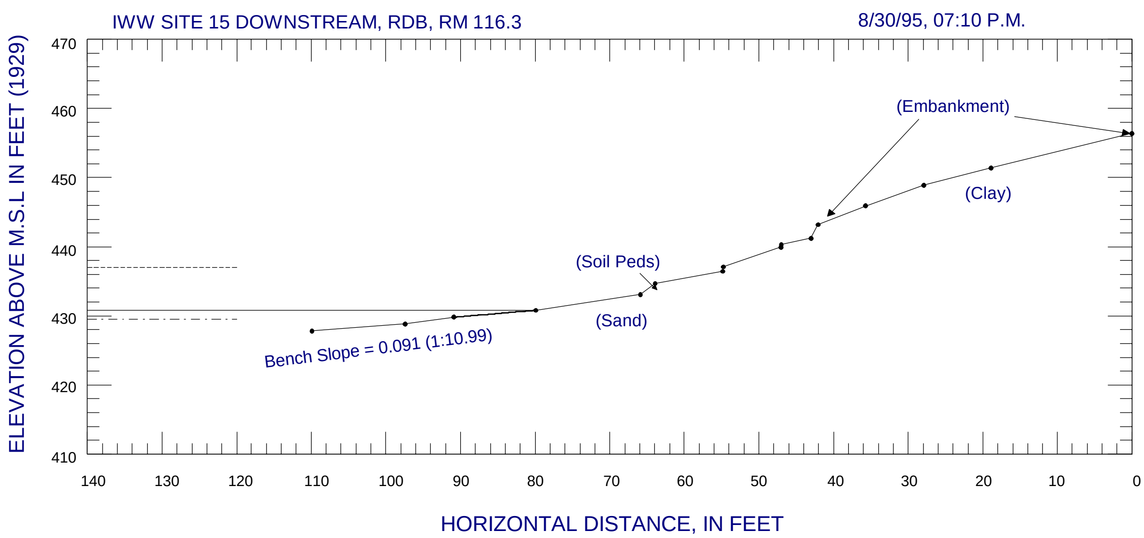


Figure 6-86. Bank sections at site 15 (concluded)

Site 16, La Grange Pool, 8/31/95. This site is located on the LDB of RM 109.5 at a crossover of a bend within the Anderson Lake Conservation Area. Figure 6-87 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-88 shows a photograph of the site.

Site 16 is about 250 feet from the sailing line, and large lakes are located on both sides of the river. No tributary enters the IWW at this location. According to Bhowmik and Schicht (1980), erosion was occurring at an upstream reach above RM 110.2 on both sides of the river, but approximately between RM 109.5 and 109.8, only an LDB reach was eroded. Hagerty (1988) indicated both banks were eroded. The present study also observed that both banks were eroded. Large debris (dead trees) crowded the bank. There was also a steep scarp near the upstream section, and the opposite side was designated as site 17.

Trees were present at the bank crest, and the bank had an almost vertical scarp. Fine roots extended over the upper portion of the bank. At the bottom of the scarp, sparse vegetation had grown on the berm. A bare bench with a series of small scarps extended to the water's edge. The bench is covered with desiccated clay and holes dug by microorganisms. A passing barge generated fairly large bow-push and drawdown, stranding some juvenile fish on the bench.

Figure 6-89 shows the three measured bank sections and two reduced cross sections. The OHW is 435.7 feet and NP is 429.9 feet above msl. The NP elevation corresponds well to a break in the subaqueous bench slope. Water at the OHW elevation generally reaches the base of the scarp or submerges part of the scarp; higher stages (table 6-26) overtop the bank. Most of the lower scarp and recent sedimentation were observed between NP and OHW.

Table 6-26. Site 16

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	430.1	• Bench (underwater) (slopes varied between 1V:14.5H and 1V:7.0H)	• d_{50} (core) varied (0.005-0.015)
75	431.1	• Bench	• d_{50} = 0.015
50	433.7	• Berm/bench (slopes varied between 1V:3.9H and 1V:2.3H)	• d_{50} = 0.010
25	438.1	• Scarp (slopes varied between 1V:0.48H and 1V:0.26H)	
10	441.5	• Top of the bank	• d_{50} = 0.011
0-9	>441.5		

Note: Gage on the Illinois River near Havana, IL @ RM 119.6 was used for stage histogram. Gage is 10.1 miles away from the site. WSE = 430.6'; OHW = 435.7'; NP = 429.9'.

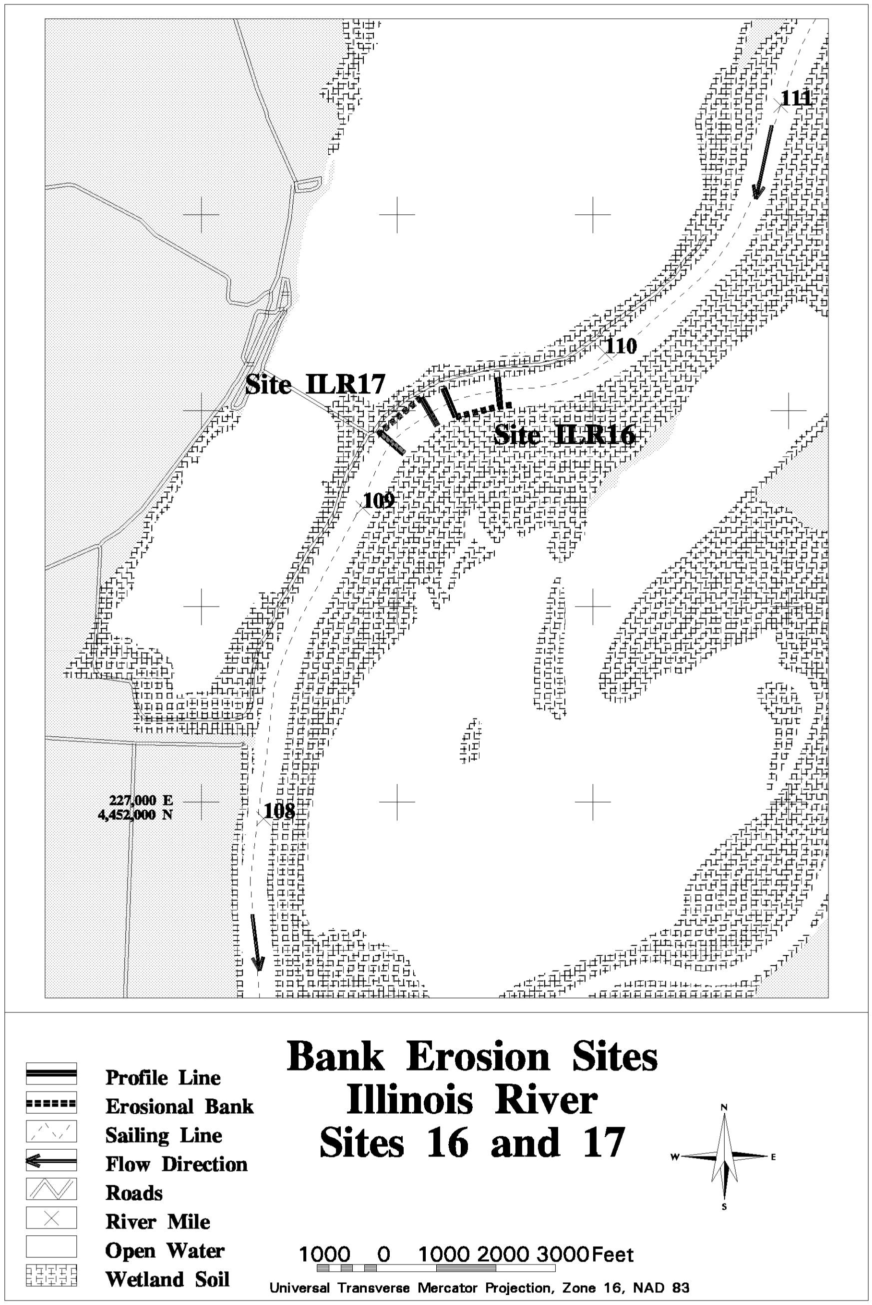


Figure 6-87. Locations of sites 16 and 17 on the Illinois Waterway

Figure 6-88. Site 16 on the Illinois Waterway

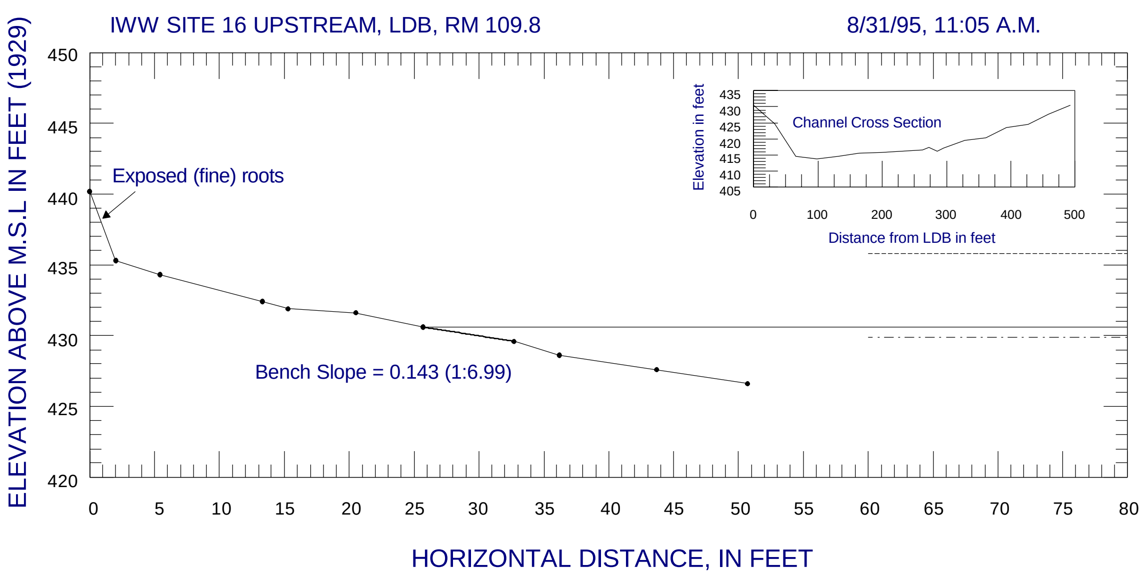


Figure 6-89. Bank sections at site 16

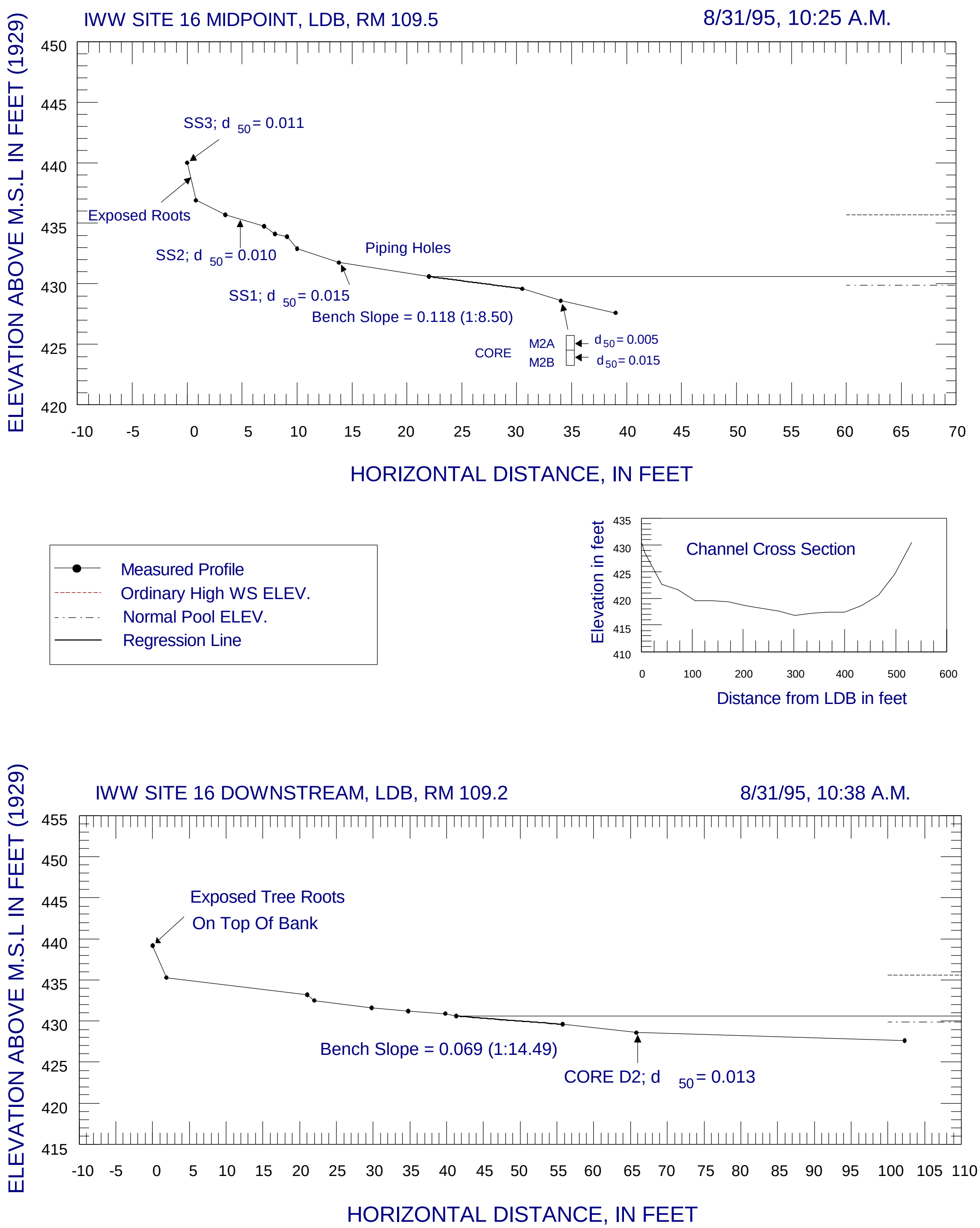


Figure 6-89. Bank sections at site 16 (concluded)

At the midsection, the d_{50} varied from 0.011 mm at the top surface of the bank to 0.005 mm at the upper portion of a core sample at a water depth of about 2 feet. The d_{50} of the lower portion of this core sample, 0.015 mm, is similar to that of other materials found on the bank Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied rapidly from 1V:7.0H at the upstream section to 1V:14.5H at the downstream section. The upstream section and midsections are classified as type 2, and the downstream section is classified as type 3 (figures 6-19, 6-20, and table 6-4). Rework and transport of bench materials occur at stages within the normal range of pool-level fluctuations. Erosion of in-place soils occurs at stage above OHW. Seepage and piping affect the extent of failure during recession periods when the river stages can drain.

Site 17, La Grange Pool, 8/31/95. This site is located at the outside of the bend across the river from site 16. The whole area is within Anderson Lake Conservation Area. Figure 6-87 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-90 shows a photograph of the site.

Table 6-27. Site 17

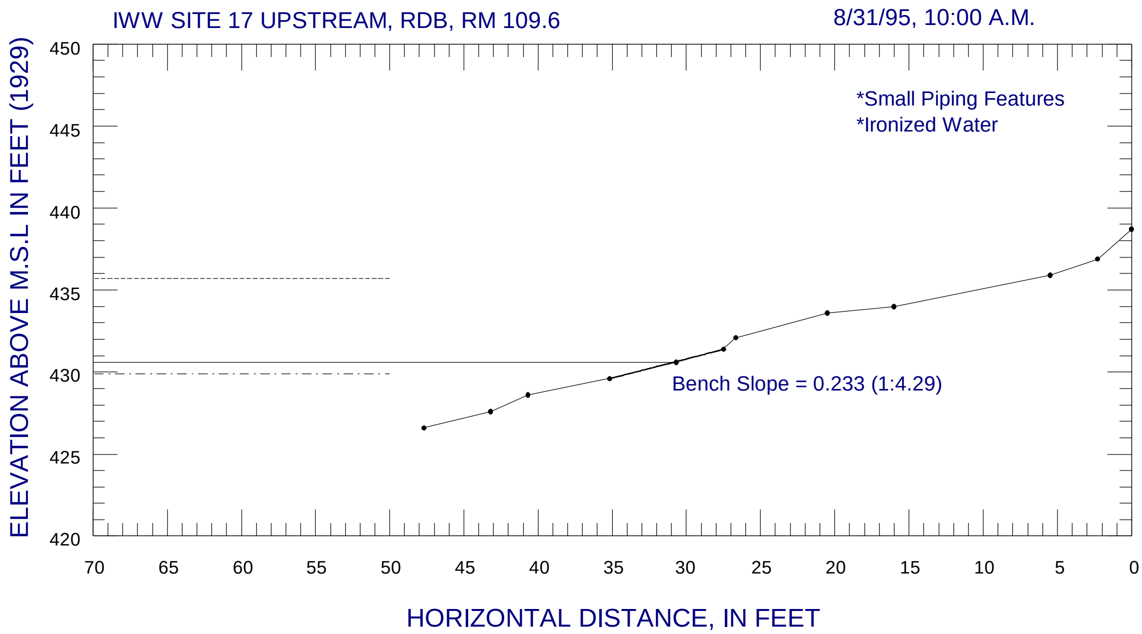
Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	430.1	• Bench (underwater) (slopes varied between 1V:4.3H and 1V:3.4H)	
75	431.1	• Bench	• d_{50} = 0.009
50	433.7	• Berm/bench (slopes = 1V:2.8H)	• d_{50} = 0.010
25	438.1	• Scarp (slopes = 1V:0.47H	
10	441.5	• Top of the bank	• d_{50} = 0.005
0-9	>441.5		

Note: Gage on the Illinois River near Havana, IL @ RM 119.6 was used for stage histogram. Gauge is 10.1 miles away from the site. WSE = 430.6’; OHW = 435.7’; NP = 429.9’.

Figure 6-90. Site 17 on the Illinois Waterway

The site is about 280 feet from the sailing line. This site was described as severely eroded by Hagerty (1988). According to Corps personnel, this was formerly a dredged material placement site, containing about 8 feet of dredged materials. However, floods apparently have removed all the dredged materials. Seepage flows containing oxidized iron (brownish color) were observed along the bank. Seepage may be attributed to the presence of adjacent Anderson Lake behind this site.

Figure 6-91 shows the three measured bank sections and two reduced cross sections. The OHW is 435.7 feet and NP is 429.9 feet above msl. There is a scarp near the water's edge and downslope from areas of seepage flows; the OHW elevation is above a zone of seasonal grasses. The OHW elevation corresponds well to the base of a scarp on the upper portion of the bank. Other stages and corresponding features are given in table 6-27.



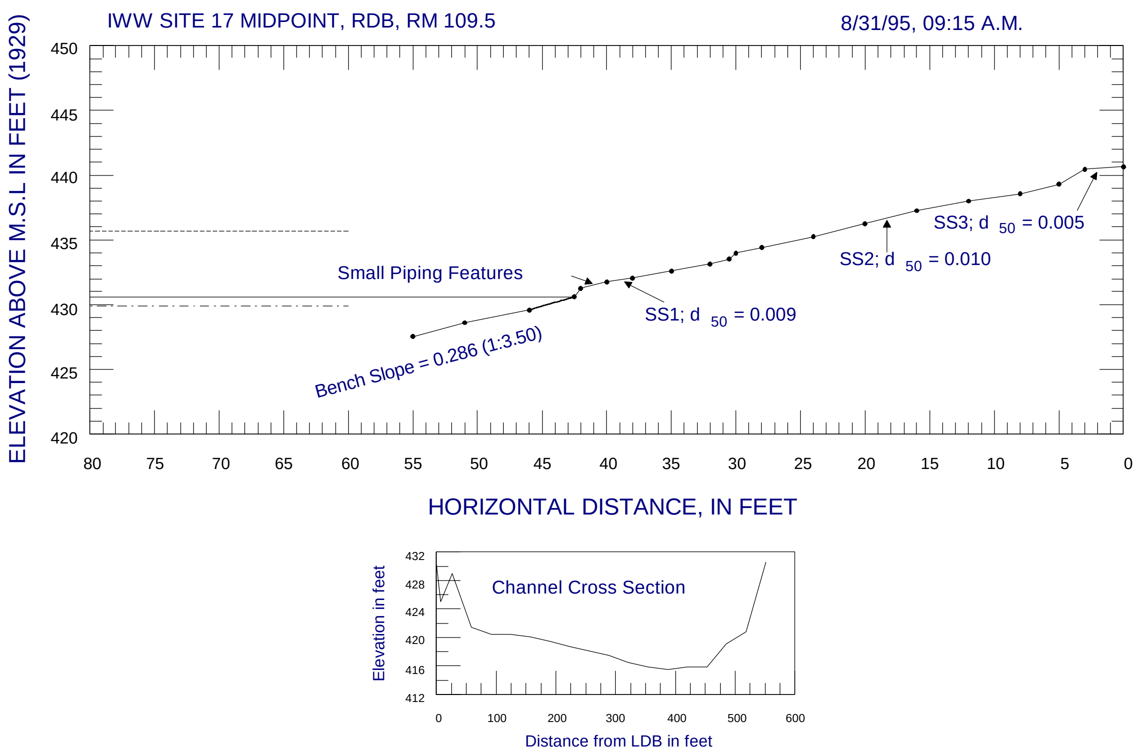


Figure 6-91. Bank sections at site 17

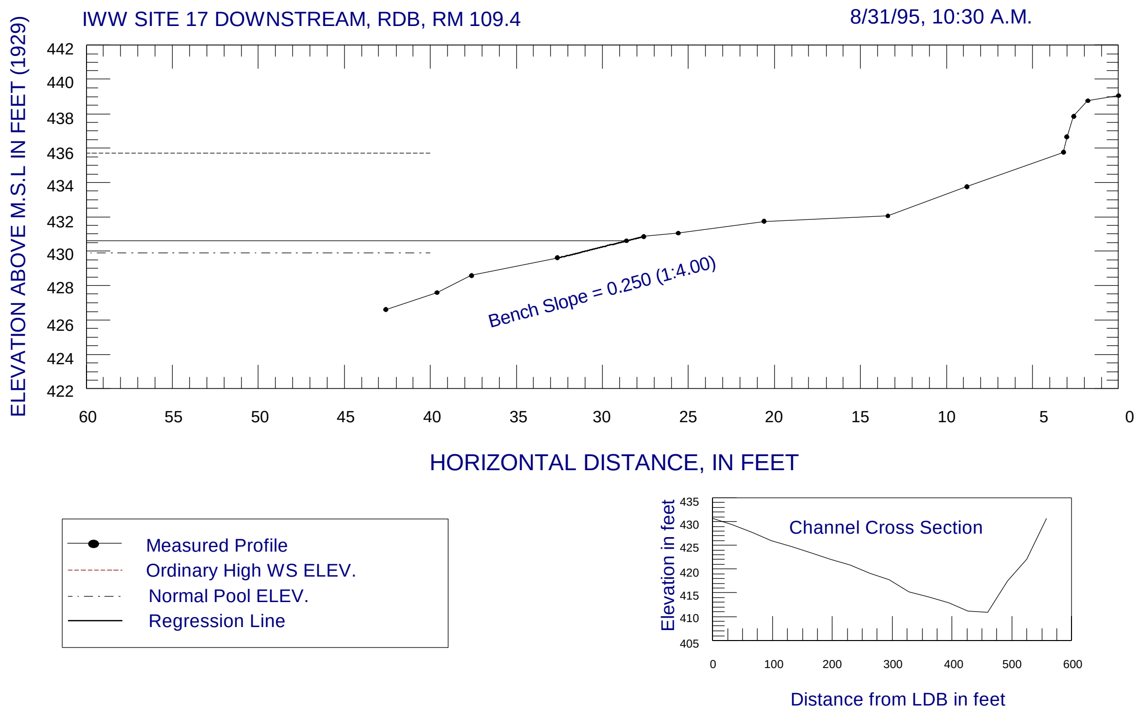


Figure 6-91. Bank sections at site 17 (concluded)

At the midsection, the d_{50} varied from 0.005 mm at the top surface of the bank to 0.009 mm near the water's edge. Bank materials are similar. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed cross section and coordinates are shown in appendix G.

Bench slopes varied around 1V:4.0H. Both the upstream section and midsection are classified as type 5, and the downstream section is classified as type 4 (figures 6-21, 6-22, and table 6-4). Seepage at NP stages could weaken the bench materials and wave wash could create scarps on the bench. As at site 16, the subaerial bench was moist. Waves and currents at stages within the normal range of pool fluctuations cause erosion on bench and berm. These forces move failed soil or recent sediment away from the bank sections also.

Site 18, La Grange Pool, 8/31/95. This site is located on the RDB at RM 94.3. Sugar Creek Island is located on the other side of the river. The mouth of Sugar Creek is located at RM 94.5. The site is located in a crossover between bends. Figure 6-92 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-93 shows a photograph of the site.

The site is about 250 feet from the sailing line. Both Bhowmik and Schicht (1980) and Hagerty (1988) observed erosion immediately upstream and downstream from the mouth of Sugar Creek, but did not indicate erosion at the current site. However, scarps and displaced trees were found on the bank in this trip. The bank had a thick cover of sand over exposed clay in several places. Dredged material was placed here in the 1960s, according to Corps personnel. In this 1995 trip, the previously eroded section was covered with sand, with shells and gravel at the water's edge. For comparison purposes, the upstream section was taken from that previously eroded section.

Figure 6-94 shows the three measured bank sections and a reduced cross section. All three sections were cut by a scarp, but scarp elevations were different. At this site, the OHW is 433.7 feet and the NP is 429.9 feet above msl. The scarp was above the OHW elevation at the upstream section, but the scarp elevations were lower for the midsection and downstream sections. The midsection and downstream section had small scarps in the stage range between the OHW and NP, but the upstream section did not have such scarps. Table 6-28 contains the stages with corresponding recurrence frequencies at this site.

At the midsection, the d_{50} varied from 0.016 mm at the top surface of the bank to 0.015 mm at the upper part of a core sample at a water depth of about 2 feet. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

The bench slopes varied from 1V:7.4H at the upstream section to 1V:13.0 at the downstream sections. The subaqueous bench dropped off quickly at the midsection at this site. Both the upstream and downstream sections are classified as type 4, but the midsection is classified as a combination of types 2 and 4 (figures 6-19, 6-21, and table 6-4). The bank crest was covered by dense vegetation, and roots from that vegetation provided additional bonds to bank materials. The bank showed vertical cracks, which apparently were caused by basal scour. Sandy materials underneath the scarp seeped out after rapid stage recession. Waves and currents can rework and transport failed soils or recent sediments at stages within the normal range of pool-level fluctuations.

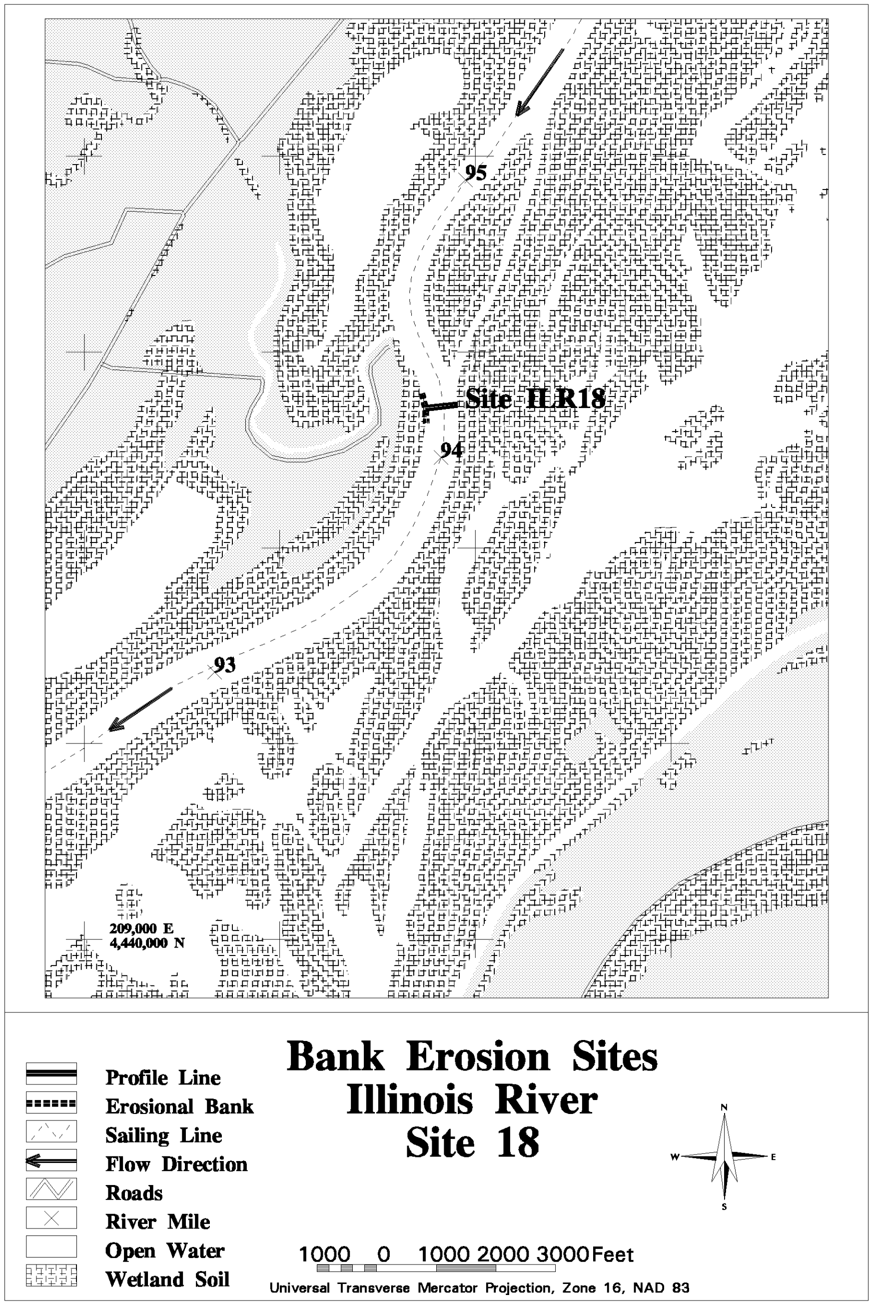


Figure 6-92. Location of site 18 on the Illinois Waterway

Figure 6-93. Site 18 on the Illinois Waterway

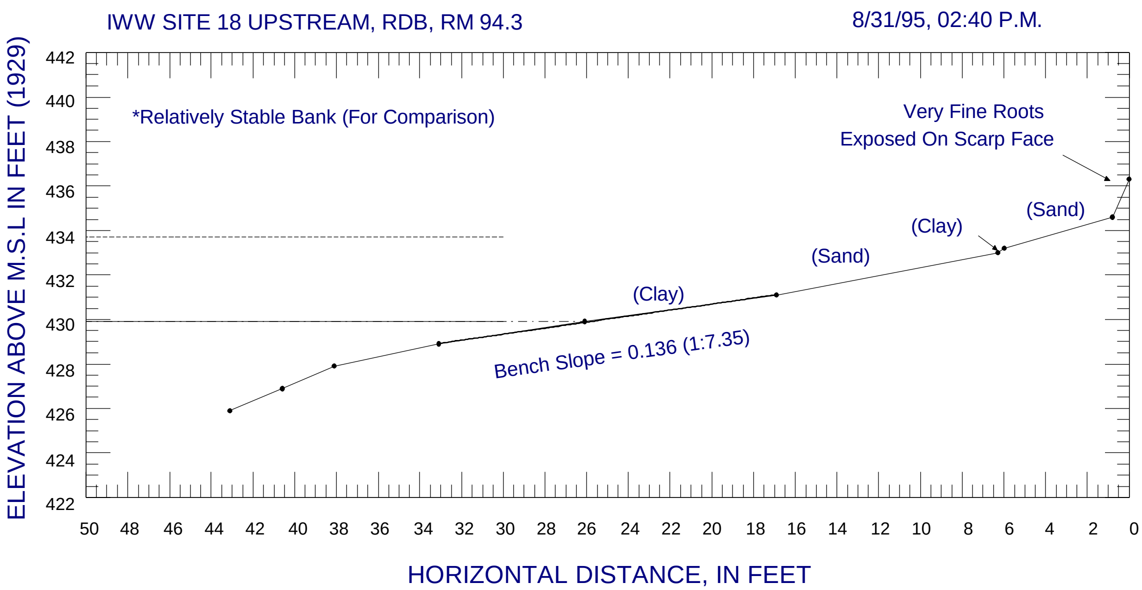


Figure 6-94. Bank sections at site 18

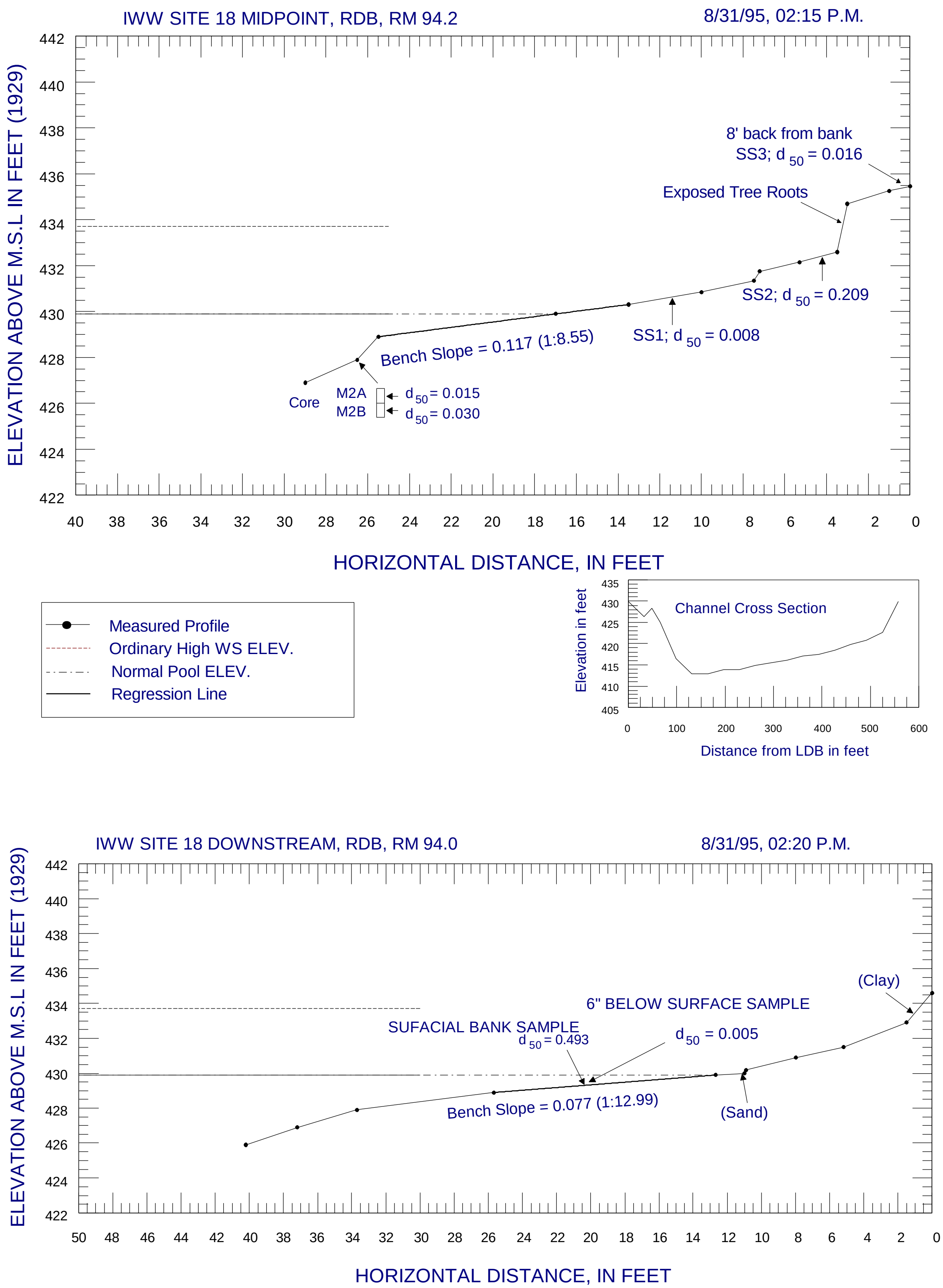


Figure 6-94. Bank sections at site 18 (concluded)

Table 6-28. Site 18

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	429.4	• Bench (underwater) (slopes varied between 1V:13.0H and 1V:7.4H)	• d_{50} (core) varied (0.015-0.030) • d_{50} varied (0.005-0.493)
75	429.6	• Bench (underwater)	
50	430.2	• Bench	
25	433.6	• Bench/berm (slope varied between 1V:3.4H and 1V:3.3H)	• d_{50} = 0.209
10	438.15	• Top of the bank • Scarp (slopes varied between 1V:0.88H and 1V:0.24H)	• d_{50} = 0.016
0-9	>438.15		

Note: Gage on the Illinois River near Beardstown, IL @ RM 88.3 was used for stage histogram. WSE = 429.9'; OHW = 433.7'; NP = 429.9'.

Site 19, La Grange Pool, 8/31/95. This site is located on the RDB at RM 91.2 outside a gentle bend. The Peabody Coal Company barge terminal is located at RM 91.7, and the Farmers Grain Company barge terminal is located at RM 91.1. Both terminals are located on the RDB. Figure 6-95 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-96 shows a photograph of the site.

The site is about 310 feet from the sailing line. A Chicago Burlington & Quincy railroad line is located just behind the site. Hagerty (1988) marked this site as an erosion site, but it appeared to be stable when Bhowmik and Schicht (1980) surveyed. A depression between the bank and the railroad embankment will retain floodwater or rainwater, and cause seepage to the bank. The depression was a borrow pit for the construction of the railroad embankment. Some large dead trees and exposed roots were observed. Velocities were relatively high at a close distance from the shore.

A scarp approximately 4 to 6 feet high was present. The lower bank and berm area contained several scarps and a moist soil layer at the toe. Some sand deposition was found on the narrow bench area. Figure 6-97 shows the three measured bank sections and a reduced cross section. The upstream bank section was extended approximately 160 feet to include the top of the embankment for the Chicago Burlington & Quincy Railroad. The OHW is 433.3 feet and NP is 429.9 feet above msl. The OHW elevation is at the base of the large scarp. The stage at the time of the field visit was at NP level.

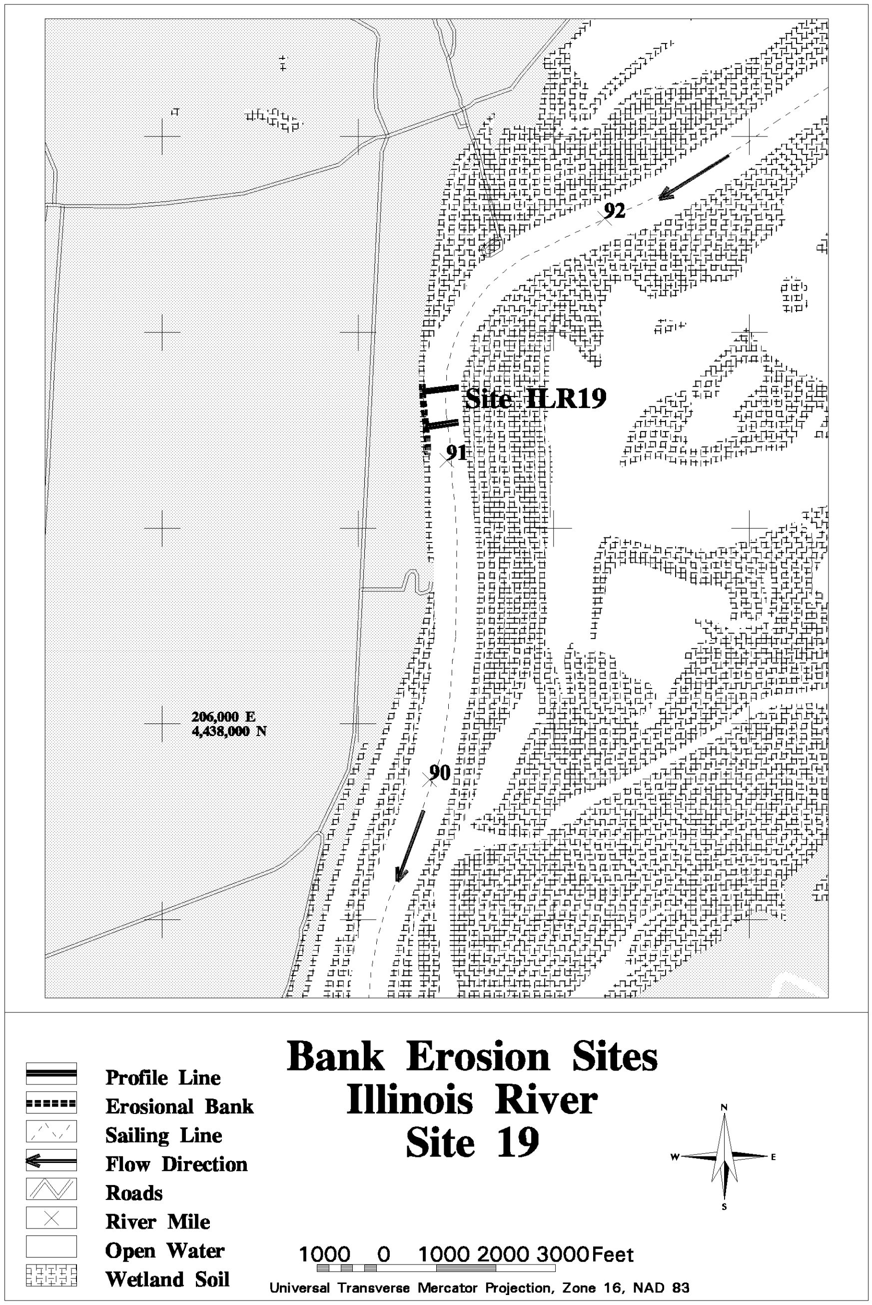


Figure 6-95. Location of site 19 on the Illinois Waterway

Figure 6-96. Site 19 on the Illinois Waterway

At the midsection, the d_{50} varied from 0.027 mm at the top surface of the bank to 0.014 mm at the upper part of a core sample at a water depth of about 2 feet. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:4.8H at the upstream section to 1V:10H at the downstream section. This site is classified as a combination of types 2 and 4 (figures 6-19, 6-21, and table 6-4). Seepage initiated bank failure, rework and transport of failed soils occurred at stages within the normal pool-level fluctuations. Traffic-induced disturbances should be considered because the closeness to the barge terminal. Rapid drop of depth at mid- and downstream sections may reflect such a factor.

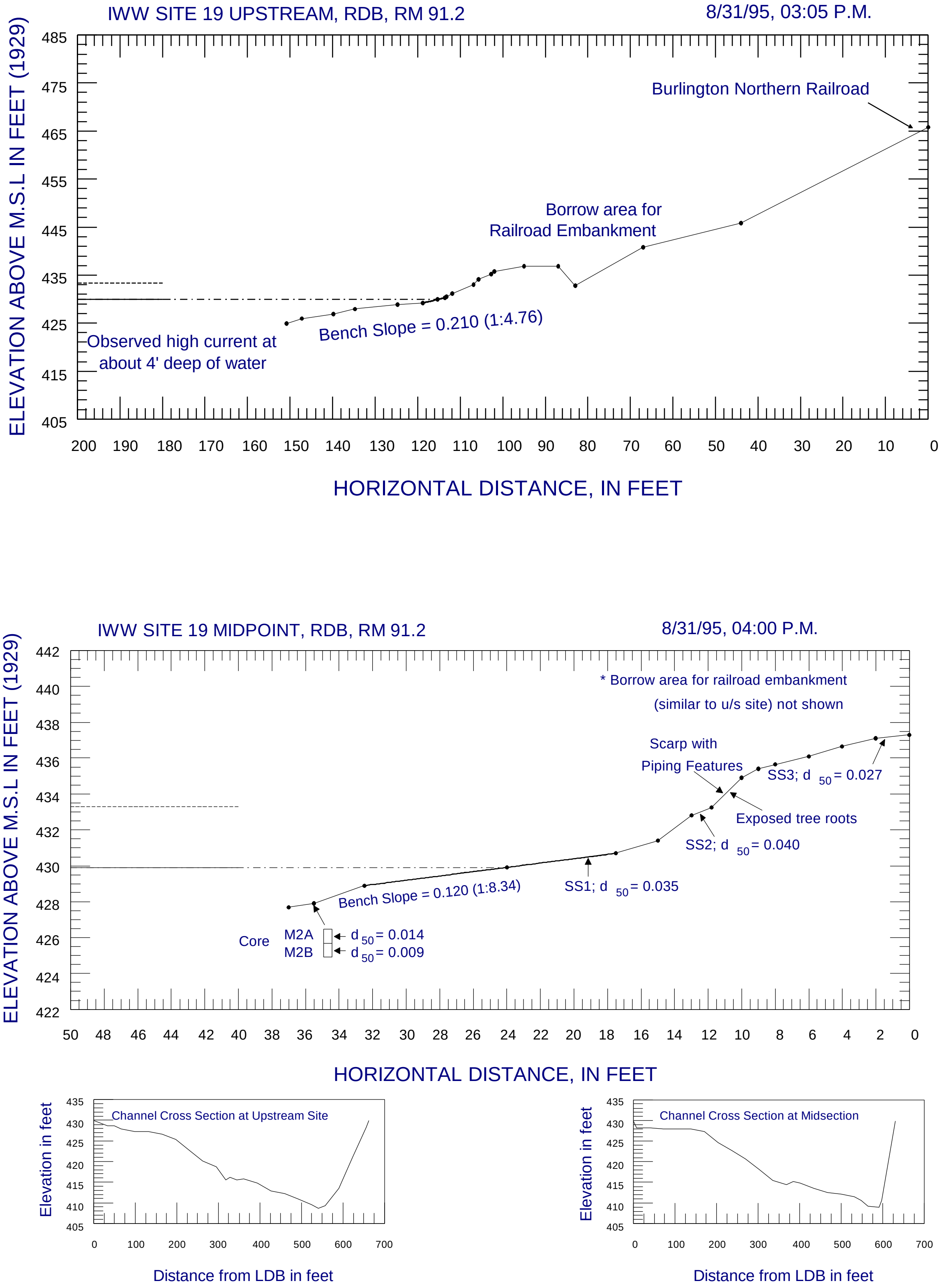


Figure 6-97. Bank sections at site 19

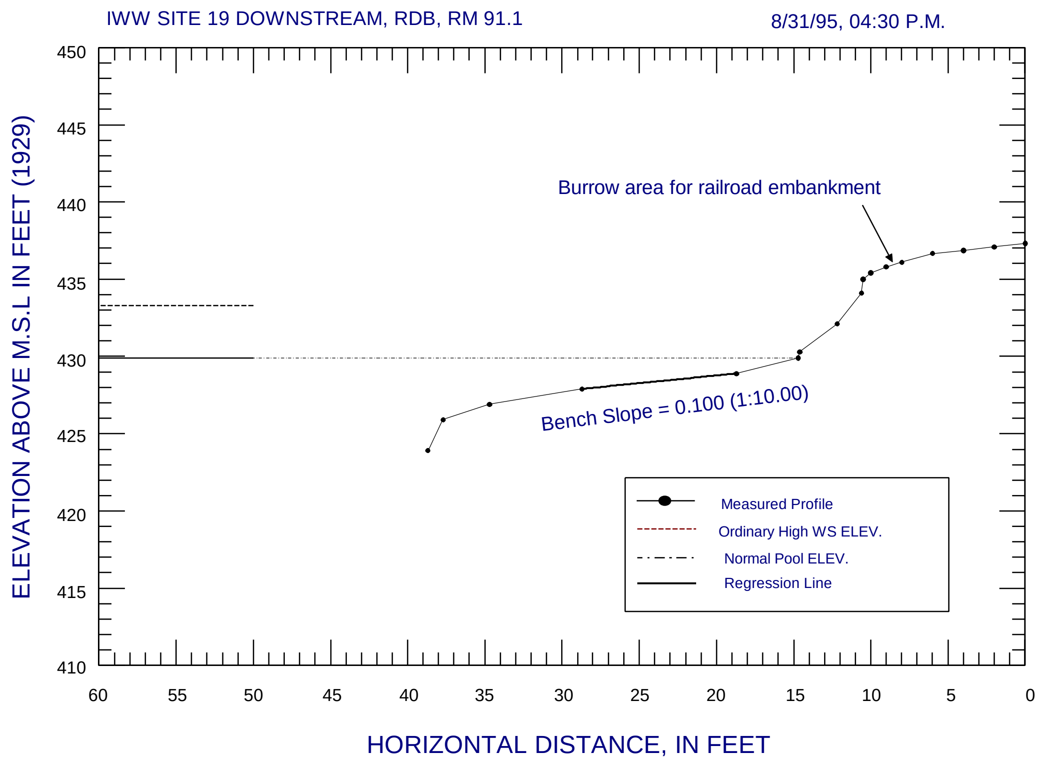


Figure 6-97. Bank sections at site 19 (concluded)

Table 6-29. Site 19

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	429.4	• Bench (underwater) (slopes varied between 1V:10H and 1V:4.8H)	• d_{50} (core) varied (0.009-0.014)
75	429.6	• Bench (underwater)	
50	430.2	• Bench	• d_{50} = 0.035
25	433.6	• Bench/berm/scarp • Berm slope = 1V:2.2H • Scarp slope = 1V:1.1H	• d_{50} = 0.040
10	438.15	• Top of the bank	• d_{50} = 0.027
0-9	>438.15		

Note: Gage on the Illinois River near Beardstown, IL @ RM 88.3 was used for stage histogram.
WSE = 429.9'; OHW = 433.3'; NP = 429.9'.

Site 20, Alton Pool, 8/31/95. This site is located on the RDB at RM 79.4 just downstream of La Grange L&D at RM 80.2. The lock is located on the RDB. The site is in a straight reach. Figure 6-98 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-99 shows a photograph of the site.

The navigation channel is fairly close to site 20; the bank is about 230 feet from the sailing line. No major tributary enters the IWW at this location. The opposite side of the river is used as a mooring area as barges wait for lockage. Bhowmik and Schicht (1980) noted erosion on both sides of the river downstream from the L&D. Hagerty (1988) selected this site for further survey and also indicated scarps about 12-14 feet high. In 1995, the face of the bank was bare, and the upper bank covered with short grasses. A fairly clear wet/dry line was present at the lower portion of the bank. The subaqueous bench dropped very quickly toward the channel. The land use on the top of the bank is agriculture (corn).

Figure 6-100 shows the three measured bank sections and two reduced cross sections. The bench narrowed at the downstream section. The OHW and NP elevations were not available for the Alton Pool, but analysis of the historical data indicated that the river stage at the time of survey had a recurrence frequency of about 90%. As shown in table 6-30, the bare bank area lies between the NP level and the 50% recurrence frequency stage (425.7 feet above msl).

At the midsection, the d_{50} varied from 0.023 mm at the top surface of the bank to 0.004 mm near the water's edge. Seepage water quickly filled a trench dug on the bank (figure 6-99) even though the bank material was hard and cohesive. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:5.4H to 1V:15.9H to 1V:0.99H from upstream to downstream sections. This site can be classified as type 2 (figure 6-19 and table 6-4). Traffic approaching the L&D gets close to this site. High velocity flows released from the lock of the La Grange L&D, and turbulence induced by navigation traffic appeared to be the major cause of erosion at this site, but seepage effects also appeared to be significant.

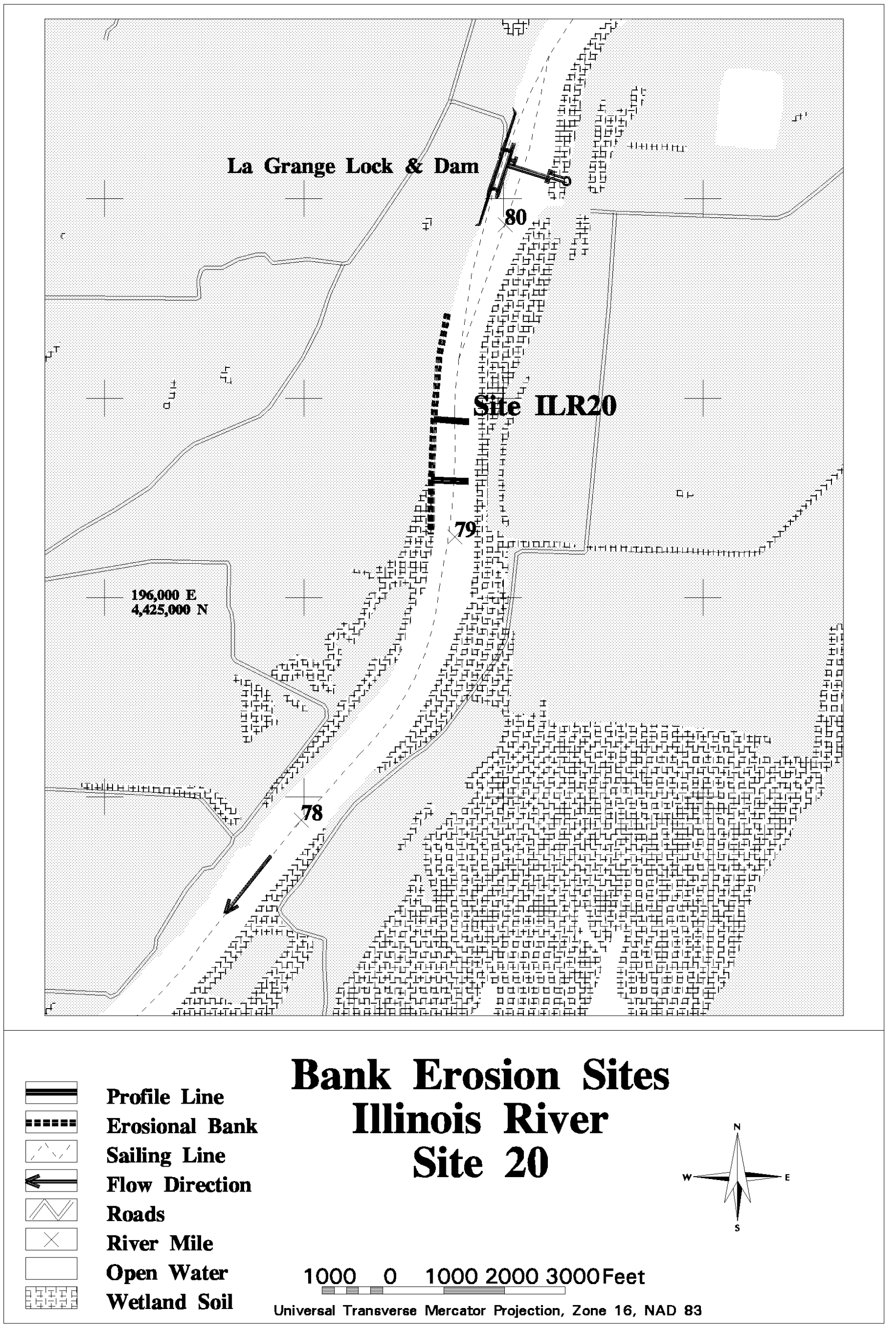


Figure 6-98. Location of site 20 on the Illinois Waterway

Figure 6-99. Site 20 on the Illinois Waterway

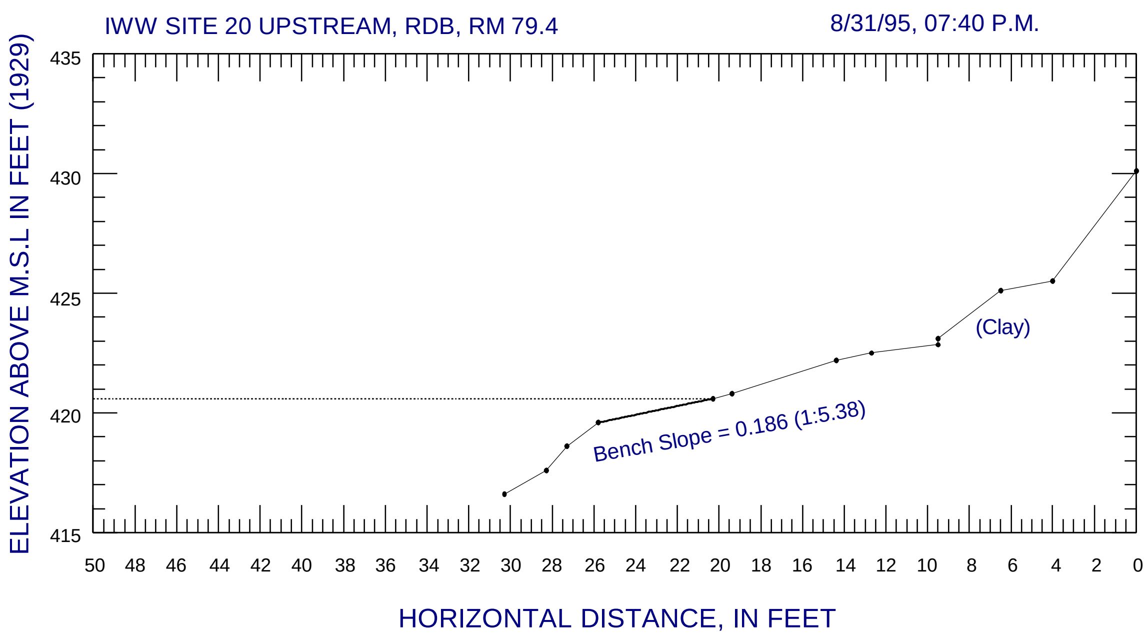
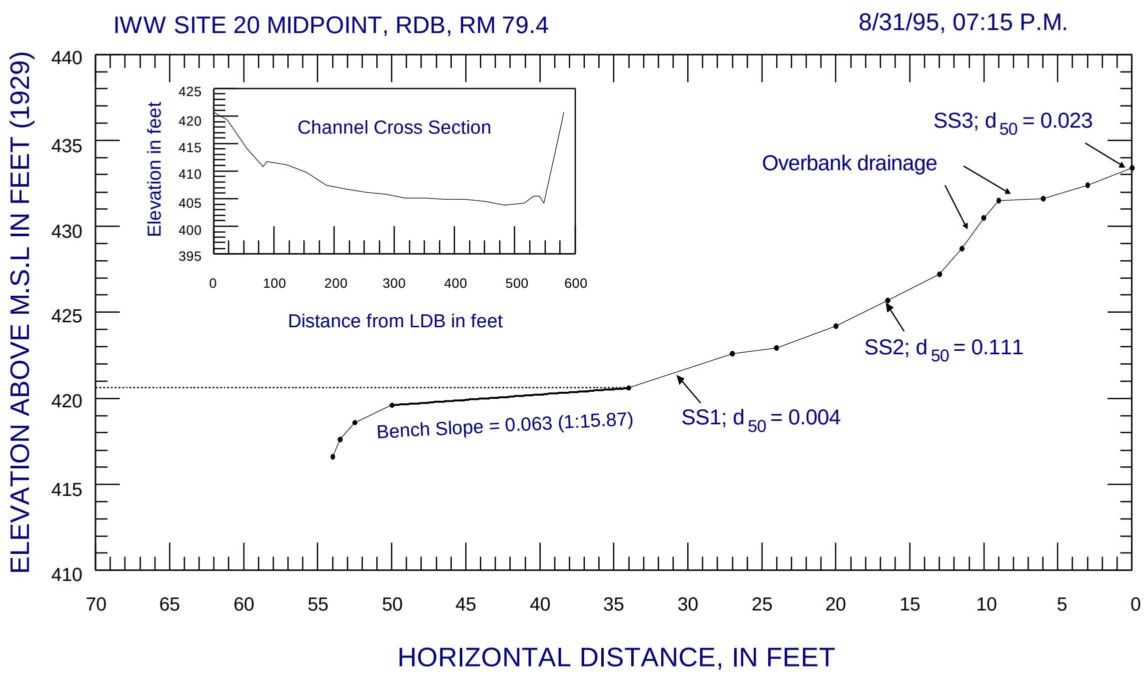


Figure 6-100. Bank sections at site 20



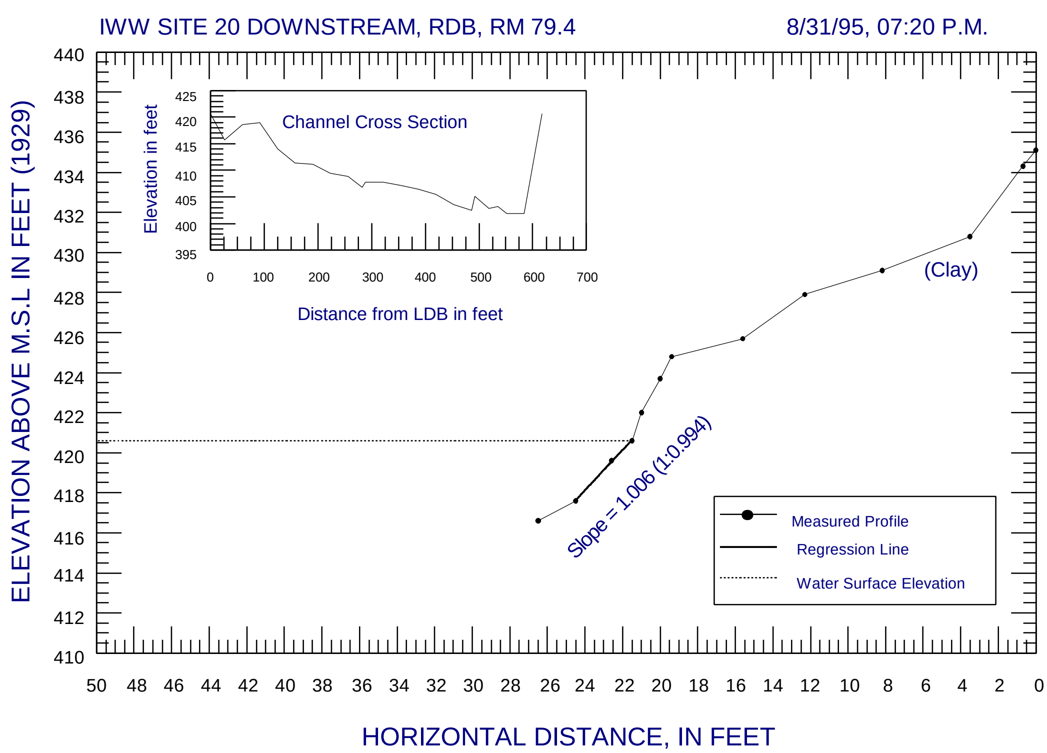


Figure 6-100. Bank sections at site 20 (concluded)

Table 6-30. Site 20

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	420.8	• Bench (slopes varied between 1V:15.9H and 1V:5.4H)	• d_{50} = 0.004
75	422.2	• Bench/berm	
50	425.7	• Scarp/bench	• d_{50} = 0.11
25	430.7	• Berm	
10	435.2	• Scarp	
0-9	>435.2	• Top of the bank/scarp	• d_{50} = 0.023

Note: Tail water gage of La Grange Pool @ RM 80.2 was used for stage histogram. WSE = 420.6'; OHW: (NA); NP: (NA).

Site 21, Alton Pool, 9/1/95. This site is located on the RDB at RM 61.7, in a straight reach with the navigation channel close to this bank. According to the navigation chart, there is a wing dam field on the LDB at RM 61.9. Surrounding structures include a bridge at RM 61.4 and a slough about 200 feet behind the bank at this site. Figure 6-101 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-102 shows a photograph of the site.

The navigation channel is close to this site; the bank is about 230 feet from the sailing line. A pumping station is located on the opposite bank, and there are several wing dams upstream in this reach. Bhowmik and Schicht (1980) did not note erosion in 1978, but Hagerty (1988) observed erosion around RM 61.9 on this bank. Silver maples are growing on the edge of the bank. Slaked blocks were mantled with grass and trees; tree roots extended out on the scarp.

Seasonal grasses were growing on the upper portion of the bank face. A bare bench with springs coming out of a clay layers extended from the failed soil blocks to the water's edge. Dead trees were present on the upper part of the bench.

Figure 6-103 shows the three measured bank sections and a reduced cross section. The bank sections at the midsection differs from the up- or downstream sections. The stage at the time of survey corresponded to approximately 90% recurrence frequency. The scarps observed in the upstream and downstream sections were present in the range of stage fluctuation between 50% to 25% (424.5 and 429.1 feet, respectively, see table 6-31); this was also the range of scarp in the midsection.

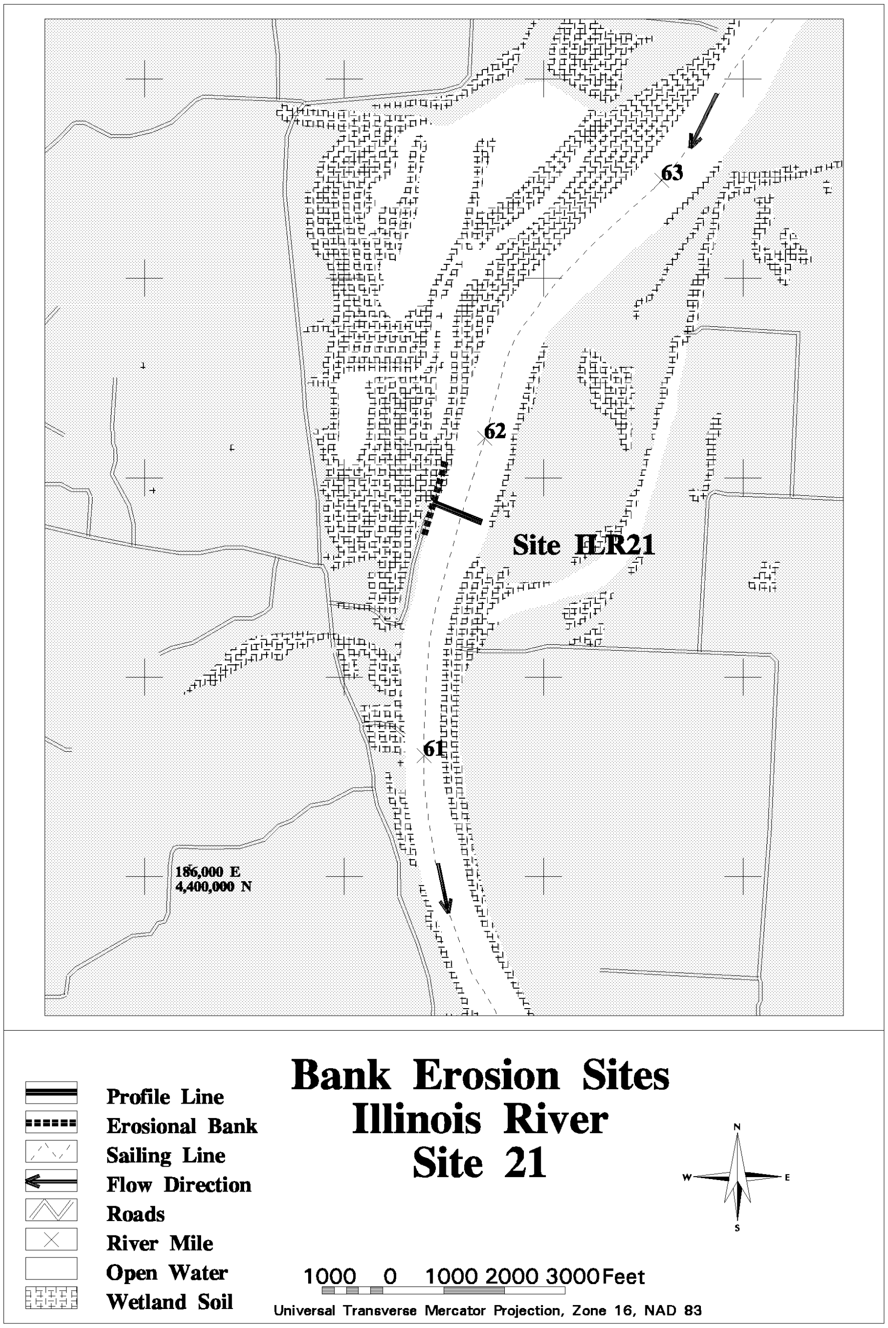


Figure 6-101. Location of site 21 on the Illinois Waterway

Figure 6-102. Site 21 on the Illinois Waterway

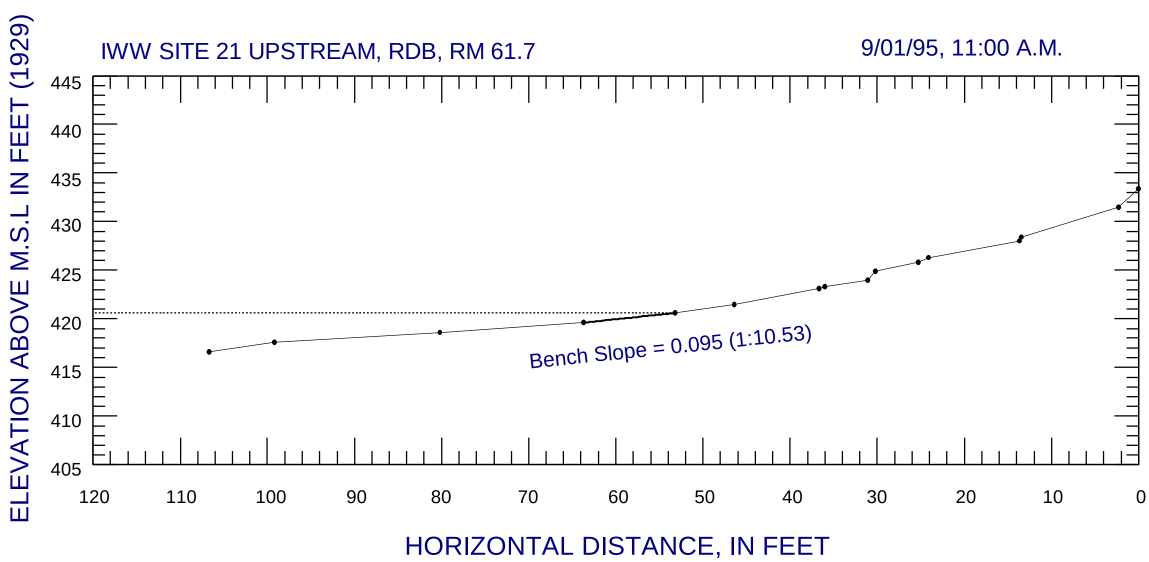
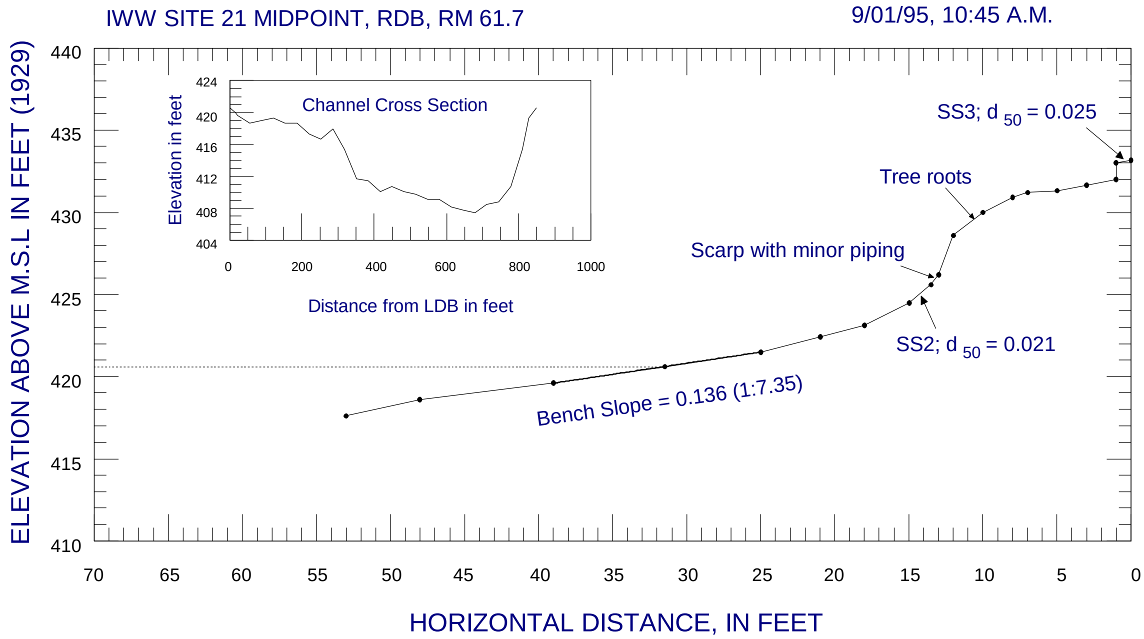


Figure 6-103. Bank sections at site 21



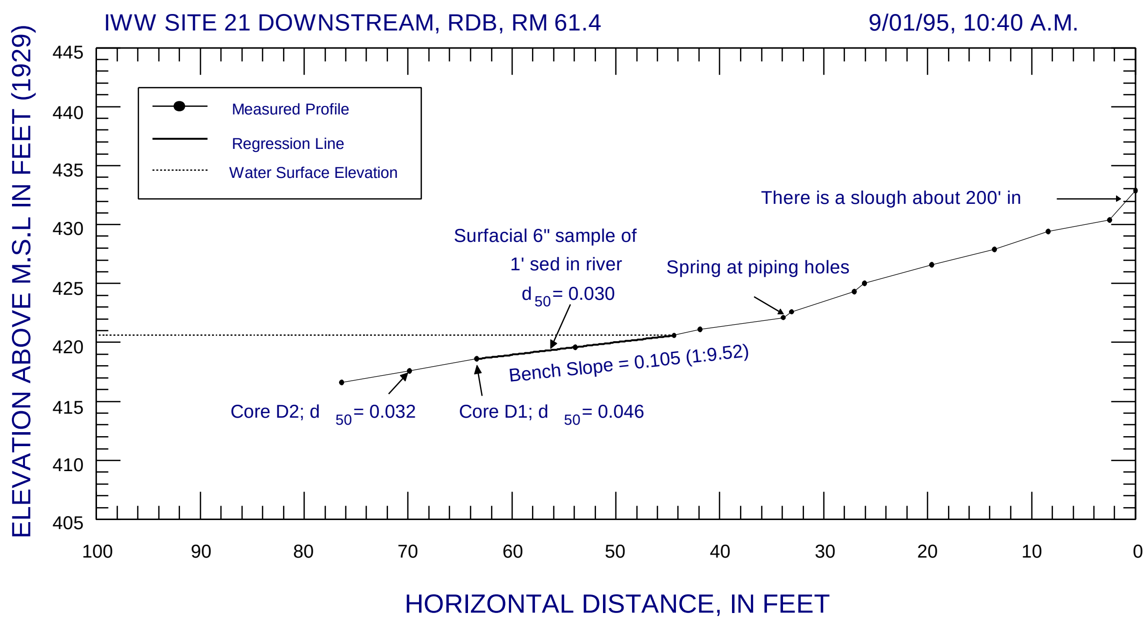


Figure 6-103. Bank sections at site 21 (concluded)

Table 6-31. Site 21

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	420.2	• Bench (underwater) (slopes varied between 1V:10.5H and 1V:7.4H)	• d_{50} (core) varied (0.032-0.046)
75	421.2	• Bench	• d_{50} = 0.030
50	424.5	• Bench/berm	• d_{50} = 0.021
		• Berm (slope = 1V:1.6H)	
25	429.1	• Scarp (slope vary between 1V:1H and 1V:0.42H)	
10	433.7	• Top of the bank	• d_{50} = 0.025
0-9	>433.7		

Note: Gage on the Illinois River near Valley City, IL @ RM 61.3 was used for stage histogram. WSE = 420.6'; OHW: (NA); NP: (NA).

At the midsection, the d_{50} was 0.025 mm at the top surface of the bank. The d_{50} from the core samples at the downstream section was 0.046 at 1 foot and 0.032 at 2 feet of water depth. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:10.5H to 1V:7.4H. The upstream and downstream sections are classified as type 5, and the midsection is classified as type 4 (figure 6-21 and 6-22 and table 6-4). Wave wash apparently produced some small scarps on the bench area. Springs and seepage weakened the bench soils and made them susceptible to wave erosion. Currents at high stages or during floods can erode in-place bank soils.

Site 22, Alton Pool, 9/1/95. This site is located on the RDB at RM 45.1. The reach from RM 44 to 47 can be considered a straight reach typical of the Illinois River. Buckhorn Island is located upstream at RM 46.1. Figure 6-104 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-105 shows a photograph of the site.

The navigation channel is close to site 22; the bank is about 300 feet from the sailing line. No major tributary enters the IWW at this location. Neither Bhowmik and Schicht (1980) nor Hagerty (1988) observed erosion at this location. A wing dam field exists on the RDB at RM 45.5, where Hagerty (1988) marked erosion.

Behind the top of the bank is a soybean field. The upper bank was covered by a zone of dense grasses with some tall matured trees. The grass zone ends at a scarp about 12-18 inches high. Below the scarp, a bench was composed of very soft silty soil with many peds on the silt surface. The bench was fairly moist.

Figure 6-106 shows the three measured bank sections and a reduced cross section. The stage at the time of measurement corresponded approximately to the 85% recurrence frequency. The 50% and 25% recurrence stages (see table 6-32) are 422.4 and 425.9 feet above msl, respectively. The base of the scarp at the end of the weed zone was about 422.4 feet above msl.

At the midsection, the d_{50} varied from 0.017 mm at the top surface of the bank to 0.036 mm for a core sample at a water depth of about 2 feet. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 0.143 1V:7.0H to 1V:5.5H. This site can be classified as a combination of types 5 and 4 (figure 6-22 and 6-21, and table 6-4). Apparent erosion mechanisms were emergent to seepage on the subaerial bench, rework and transport by waves and currents at various stages between NP and OHW.

Table 6-32. Site 22

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	419.7	• Bench (underwater) (slopes varied between 1V:7.0H and 1V:5.5H)	• d_{50} (core) varied (0.017-0.036)
75	420.2	• Bench	• d_{50} varied (0.007-0.024)
50	422.4	• Bench/berm/scarp • Scarp (slopes varied between 1V:0.5H and 1V:0.14H) • Berm slope = 1V:4.2H	
25	425.9	• Top of the bank	
10	430.3		• d_{50} = 0.017
0-9	>430.3		

Note: Gage on the Illinois River at Pearl, IL @ RM 43.2 was used for stage histogram. WSE = 419.9'; OHW: (NA); NP: (NA).

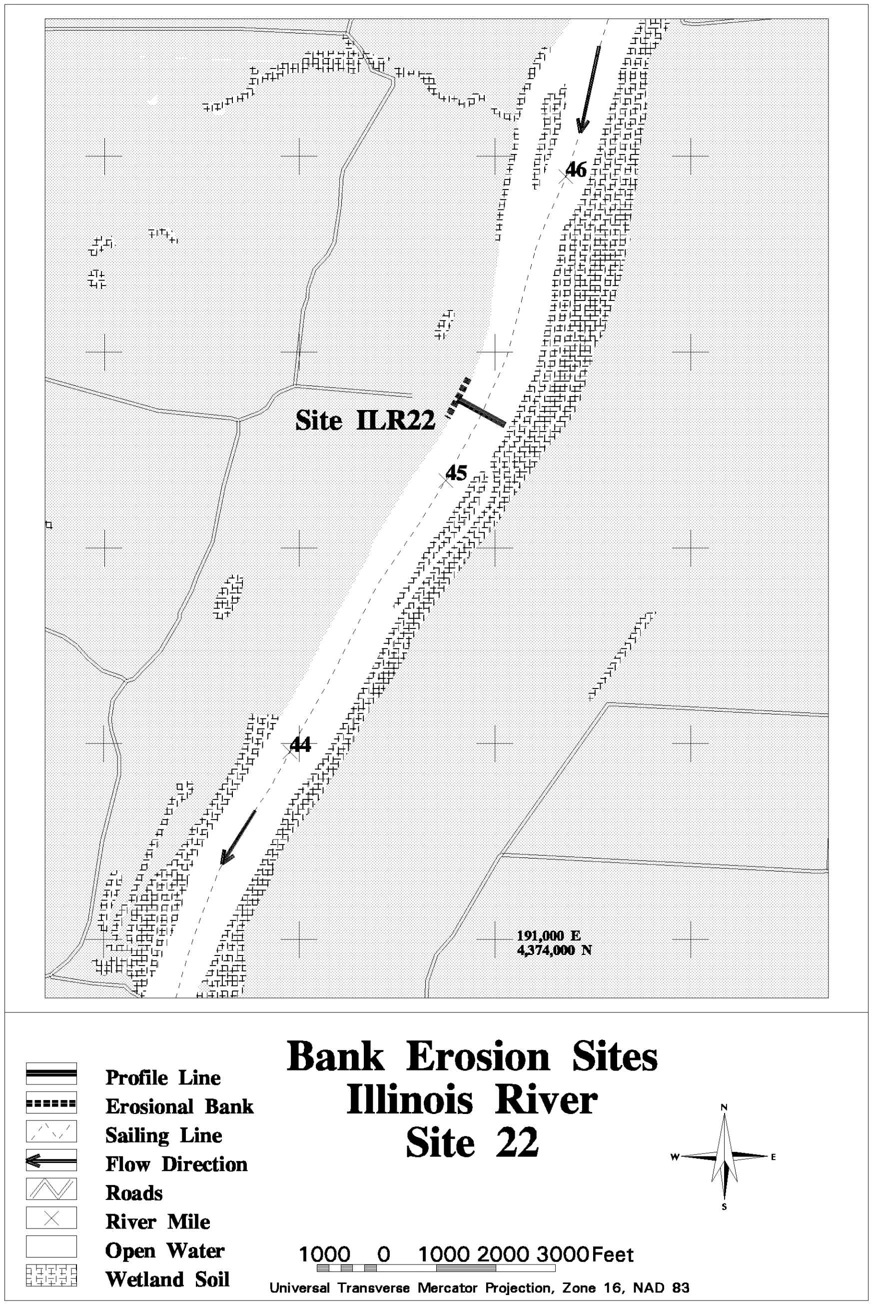


Figure 6-104. Location of site 22 on the Illinois Waterway

Figure 105. Site 22 on the Illinois Waterway

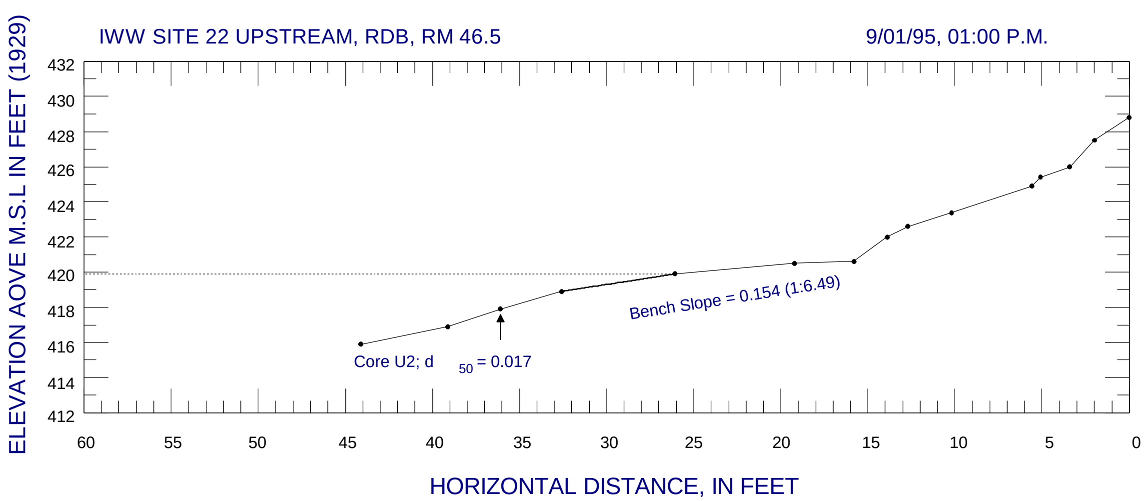
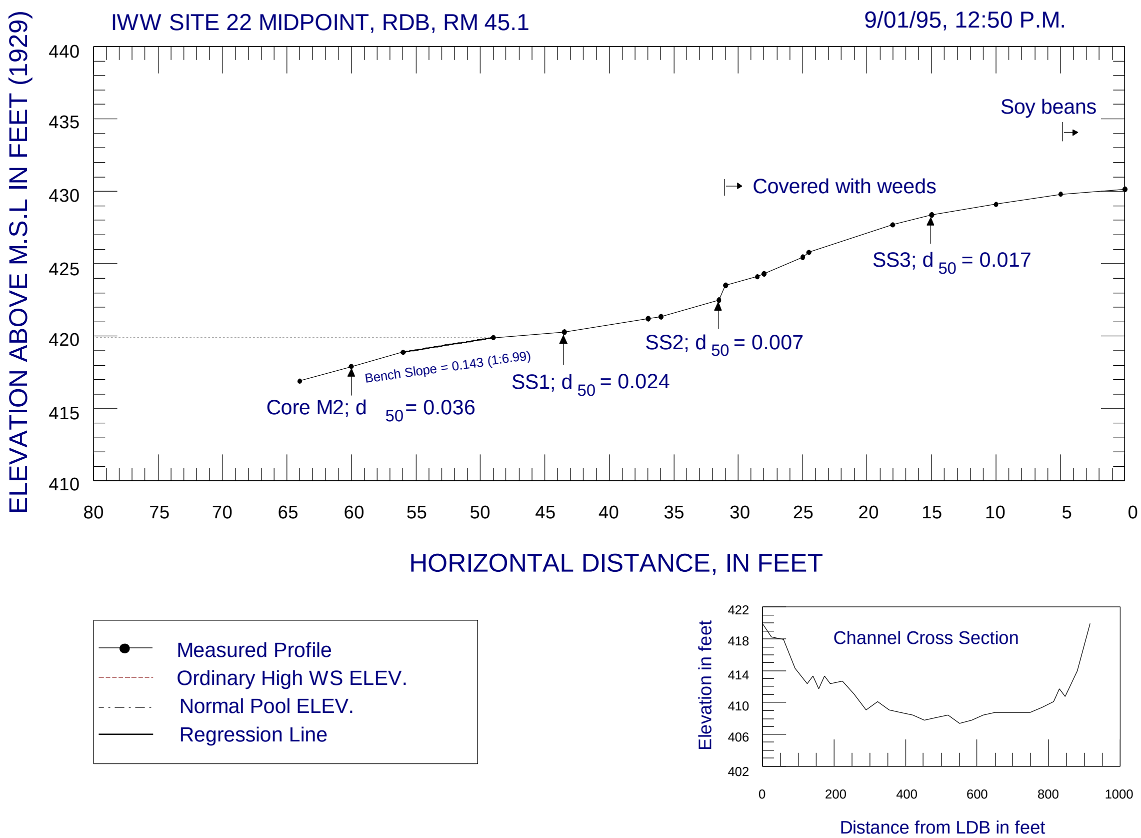


Figure 106. Bank sections at site 22



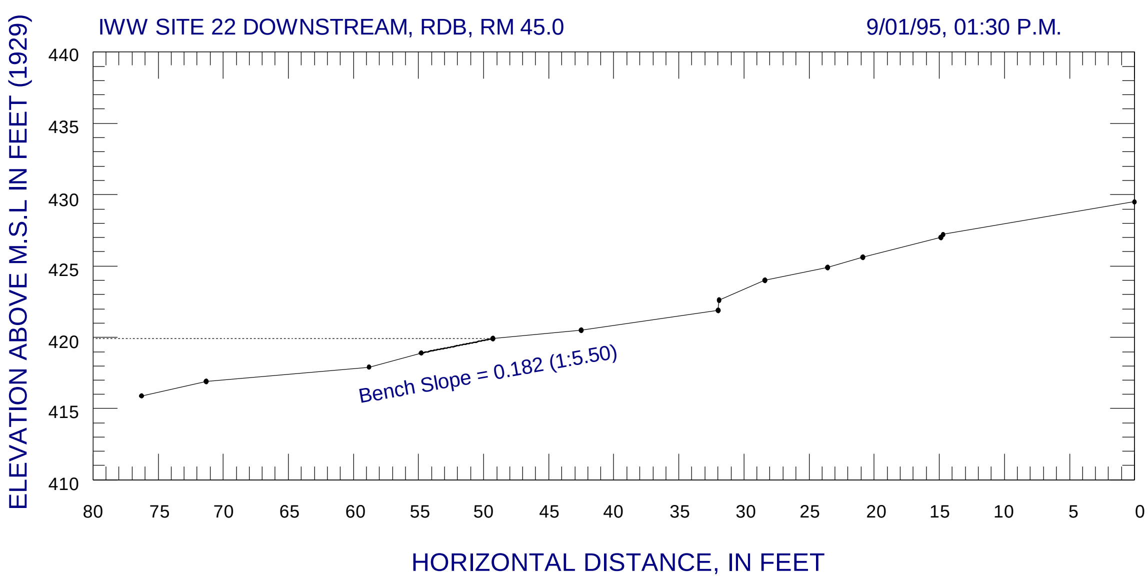


Figure 106. Bank sections at site 22

Site 23, Alton Pool, 9/1/95. This site is located on the RDB at RM 23.5 in a crossover from a gentle bend. This site is near the downstream tail of Diamond Island; Dark Chute runs from the back (west) side of the island and to the confluence with the Illinois River at RM 22.7. Figure 6-107 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-108 shows a photograph of the site.

The navigation channel is close to this site; the bank is about 180 feet from the sailing line. Bhowmik and Schicht’s (1980) Reach 1 was located at RM 24.0 on the opposite bank. Hagerty (1988) marked erosion on both bank sections, but eroded reaches were shown in several segments. For this site, Hagerty (1988) noted 6 feet of bare scarp.

Figure 6-109 shows the three measured bank sections and a reduced cross section. The stage at the time of survey was at about the 90% recurrence frequency stage. Dense seasonal vegetation covered the upper portion of the bank face, and the bank slope was steeper downstream. Bank materials were similar to those at other bank sections in the Alton Pool, with a hard clayey layer at the upper part of the bank, and a lower bank covered by moist, soft clayey soil. Algae were growing near the water’s edge. As shown in table 6-33, the bare bank face corresponds well to the stage ranging between 50% and 25% recurrence frequencies. The 50% recurrence stage is about 420.3 feet at the base of the scarp.

At the midsection, the d_{50} varied from 0.016 mm at the surface of the bank to 0.020 mm at the upper part of a core sample at a water depth of about 2 feet. The d_{50} values were very uniform at the midsection. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:12.5H at the upstream section to about 1V:5.0H at the midsection and downstream section. The upstream section and midsection are classified as type 4 and the downstream section is classified as type 2 (figures 6-21 and 6-19 and table 6-4). There was erosion due to surface drainage; other apparent causes are seepage, rework, and transport by levees and currents at various stages of pool-level fluctuations.

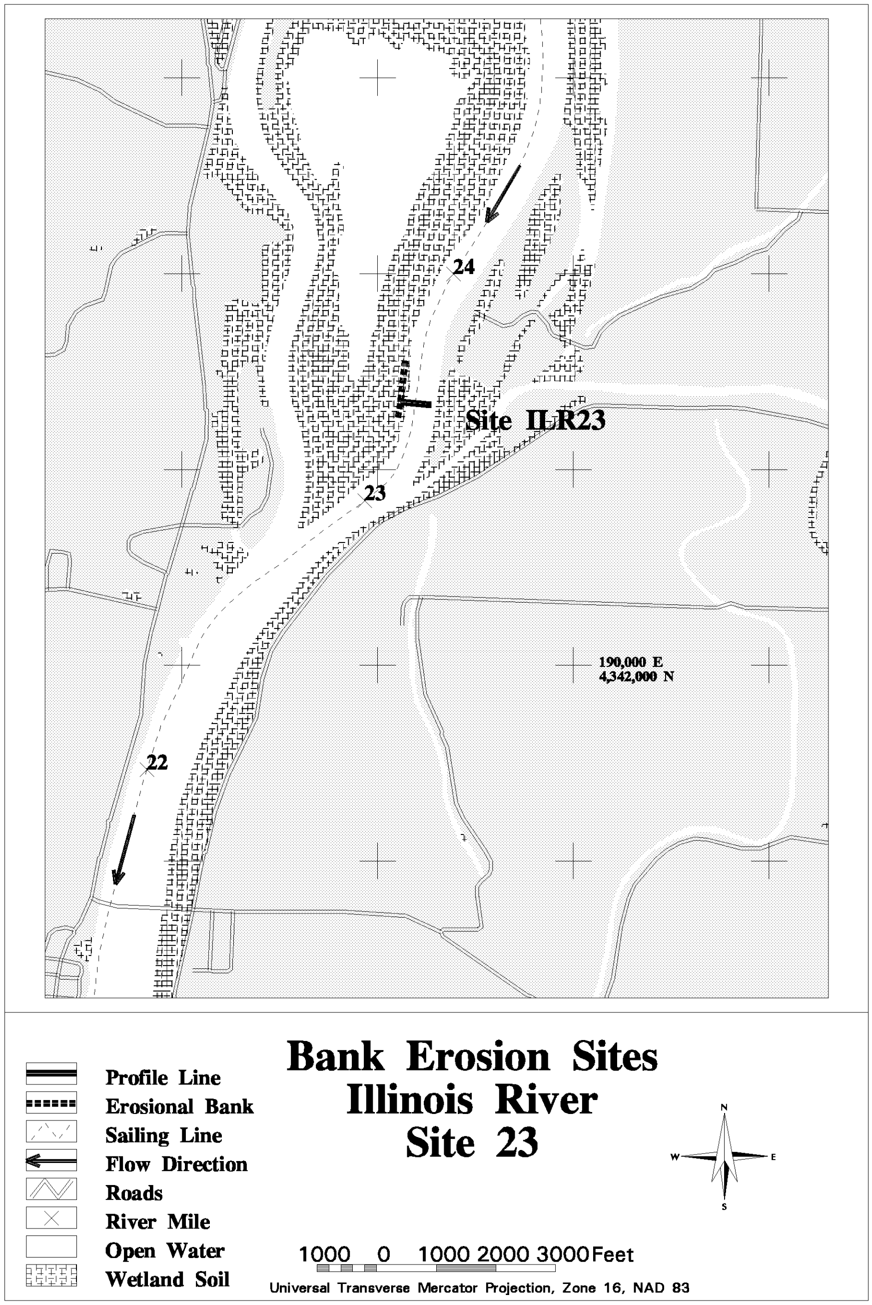


Figure 6-107. Location of site 23 on the Illinois Waterway

Figure 6-108. Site 23 on the Illinois Waterway

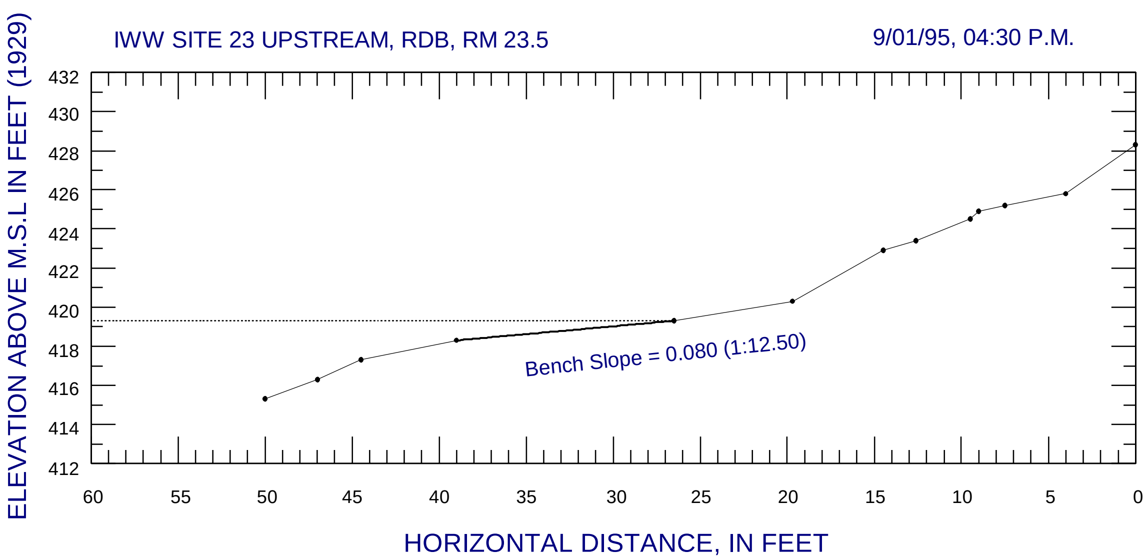
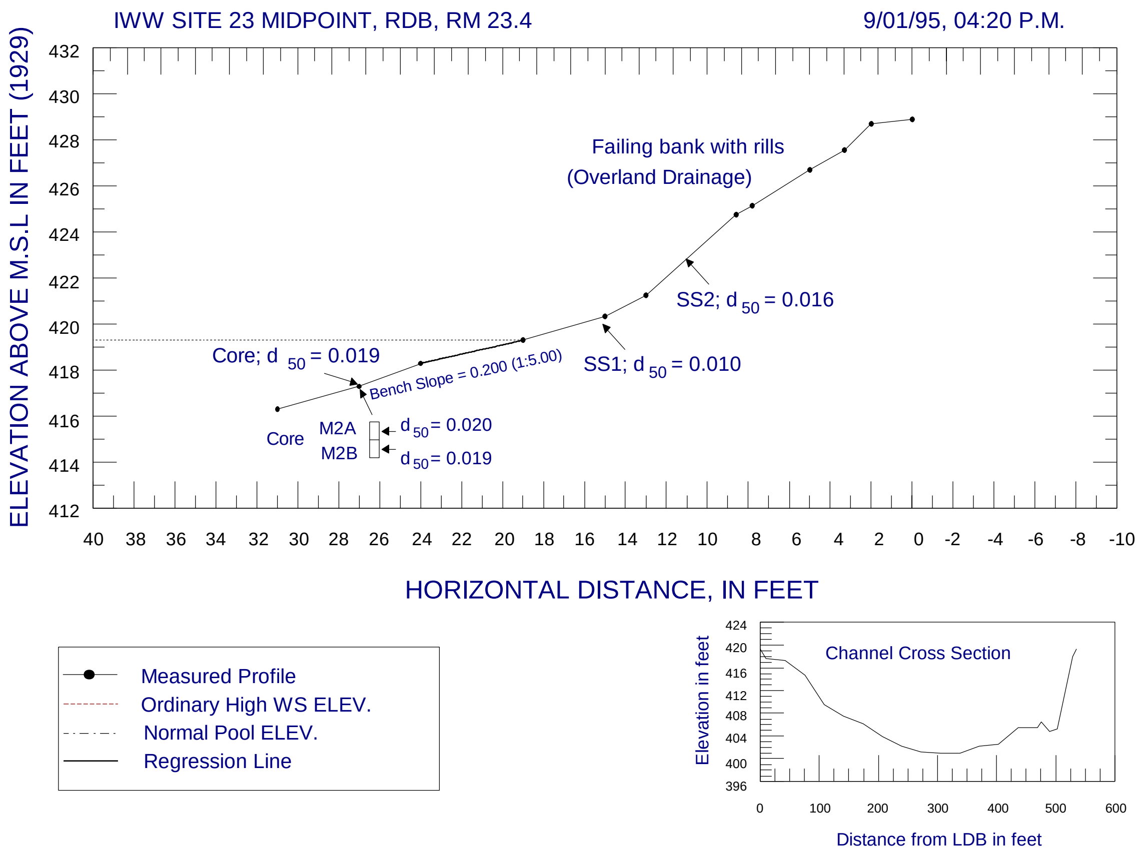


Figure 6-109. Bank sections at site 23



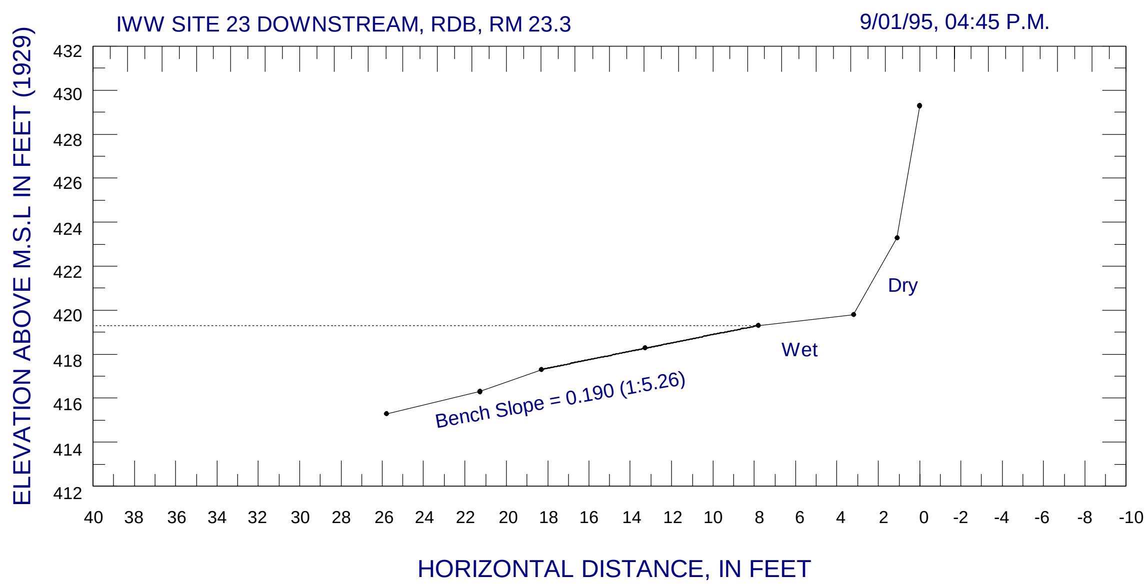


Figure 6-109. Bank sections at site 23 (concluded)

Table 6-33. Site 23

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	419.2	• Bench (underwater) (slopes varied between 1V:12.5H and 1V:5.0H)	• d_{50} (core) varied (0.019-0.020)
75	419.5	• Bench	• d_{50} = 0.010
50	420.3	• Bench/berm (slope = 1V:2.2.H)	• d_{50} = 0.016
25	422.5	• Berm/scarp • Scarp (slopes varied between 1V:1.3H and 1V:0.34H	
10	426.6	• Scarp/Top of the bank	
0-9	>426.6	• Top of the bank	

Note: Gage on the Illinois River at Hardin, IL @ RM 21.6 was used for stage histogram. WSE = 419.3'; OHW: (NA); NP: (NA).

Site 24, Alton Pool, 9/1/95. This site is located on the RDB at RM 13.1 on the outside of a bend. Upstream on the RDB is the (old) Hadley's Landing (RM 13.4) and across the river is Twelve Mile Island. Figure 6-110 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-111 shows a photograph of the site.

The site is about 430 feet from the sailing line, and no major tributary enters the IWW at this location. Bhowmik and Schicht (1980) marked the site as a "Wave Study" site. Hagerty's 1988 erosion site was at RM 13.4 immediately downstream from Hadley's Landing.

The bank characteristics are similar to those at other sites in the Alton Pool. Figure 6-112 shows the three measured bank sections and a reduced cross section. Land cover on the top and upper portion of the bank was dense seasonal vegetation, mostly above the water line. The sloping bank below the vegetation zone was bare; the base of the bare area was moist and algae was growing near the water's edge. The stage at the time of the survey was at about the 90% recurrence frequency stage. The subaqueous bench at the site was broader and flatter than the bench at site 23. The bench was covered with a layer of thick sediment in the nearshore area, but farther riverward the bench surface was hard. The stage analysis (table 6-34) indicated that the bare bank face was located between the 50% and 25% recurrence stages. The 50% recurrence stage, 420.3 feet, was at the base of the scarp.

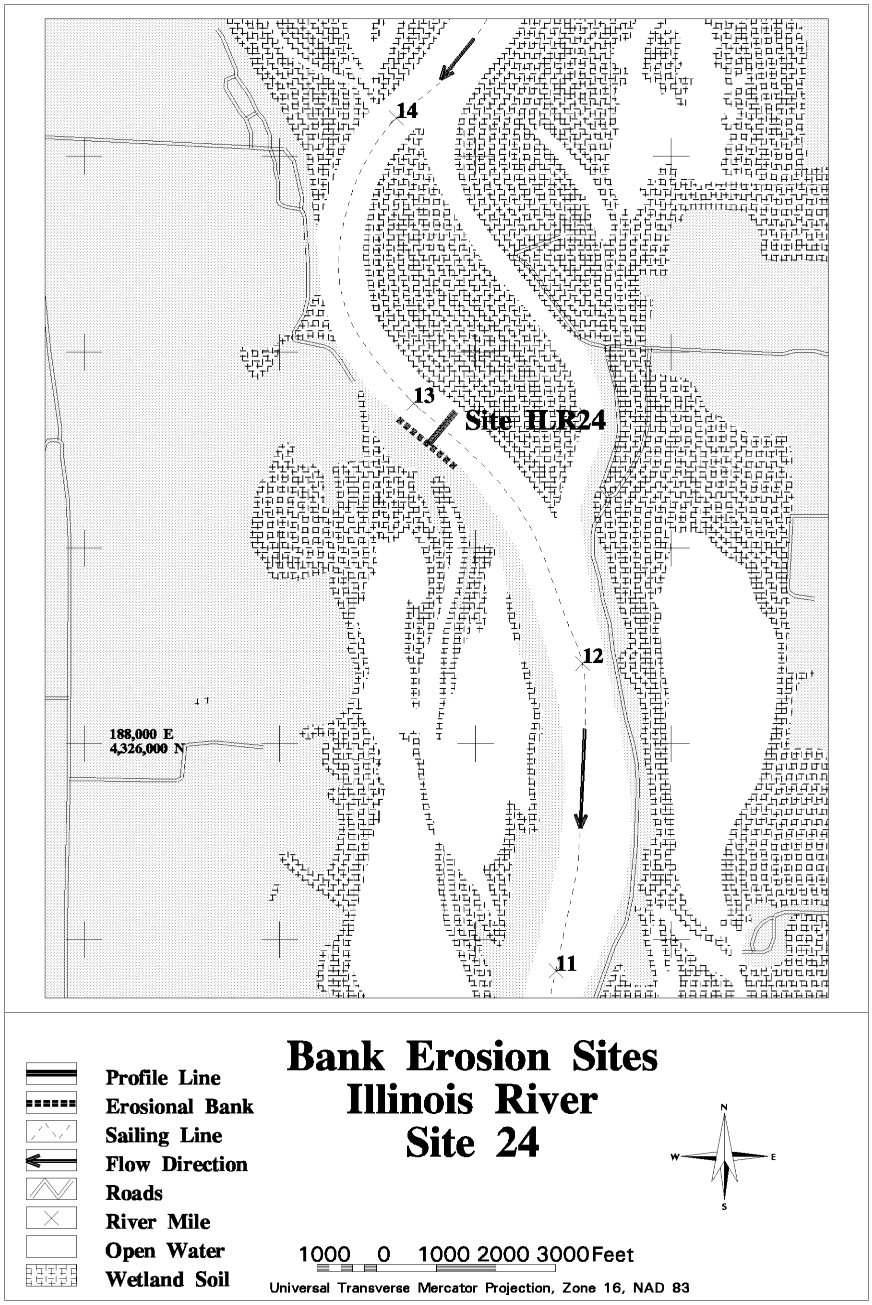


Figure 6-110. Location of site 24 on the Illinois Waterway

Figure 6-111. Site 24 on the Illinois Waterway

At the midsection, the d_{50} varied from 0.019 mm at the surface of the bank to 0.020 mm at the upper portion of a core sample at a water depth of about 2 feet. The d_{50} for the lower core sample is 0.019 mm. A detailed river cross section is shown in appendix G, while gradation plots of bank soils and nearshore sediment are presented in appendix F.

Bench slopes varied slightly from 1V:25.0H to 1V:15.9H in this reach. The bank soils were cohesive. This site can be classified as a combination of types 2 and 5 (figures 6-19, 6-22, and table 6-4). Erosion processes could be traced as initiated by piping; debris-induced local currents and wave wash extend the erosion; rework and transport by waves and currents at various stages of pool-level fluctuation then remove the failed soils or recently deposited sediment.

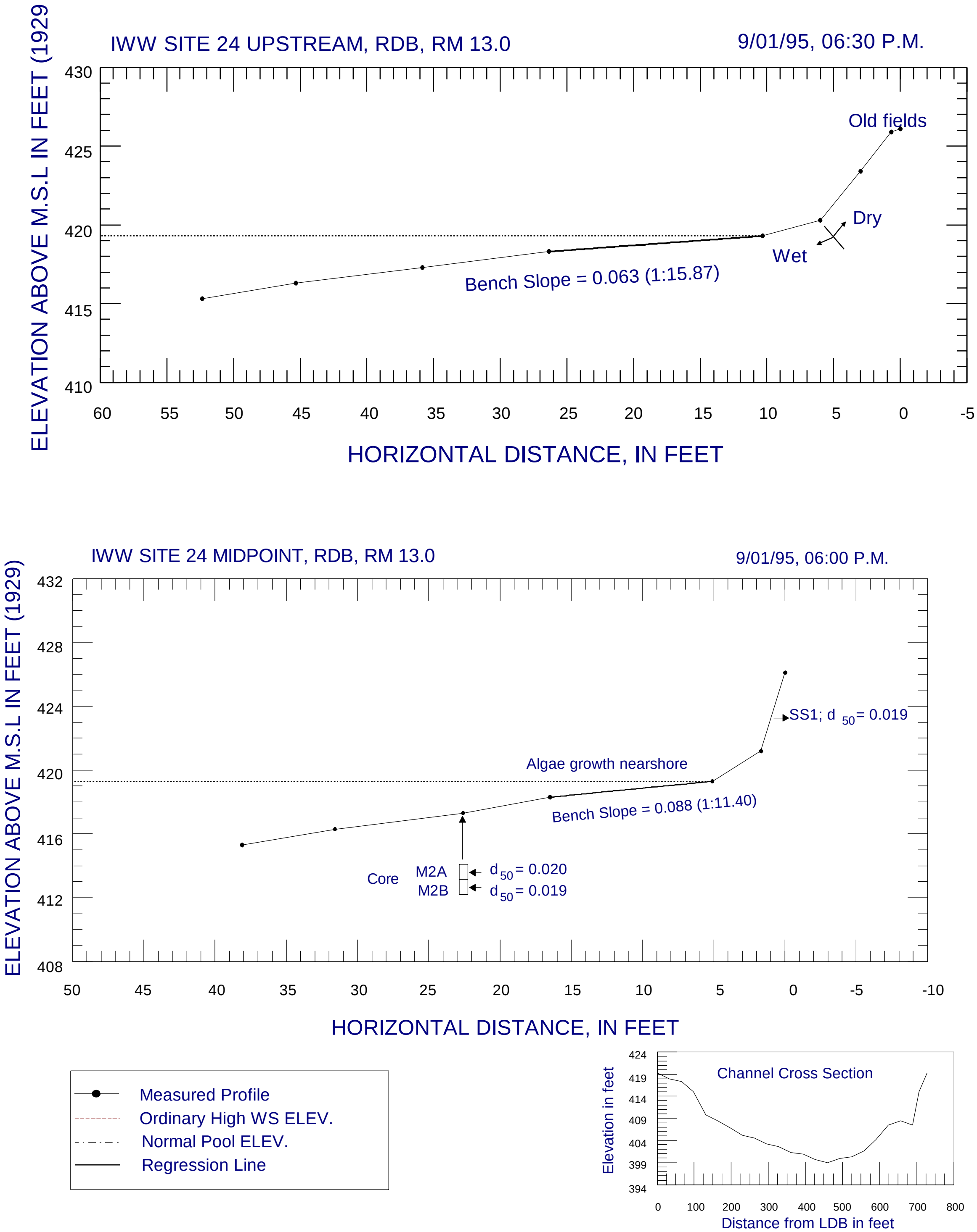


Figure 6-112. Bank sections at site 24

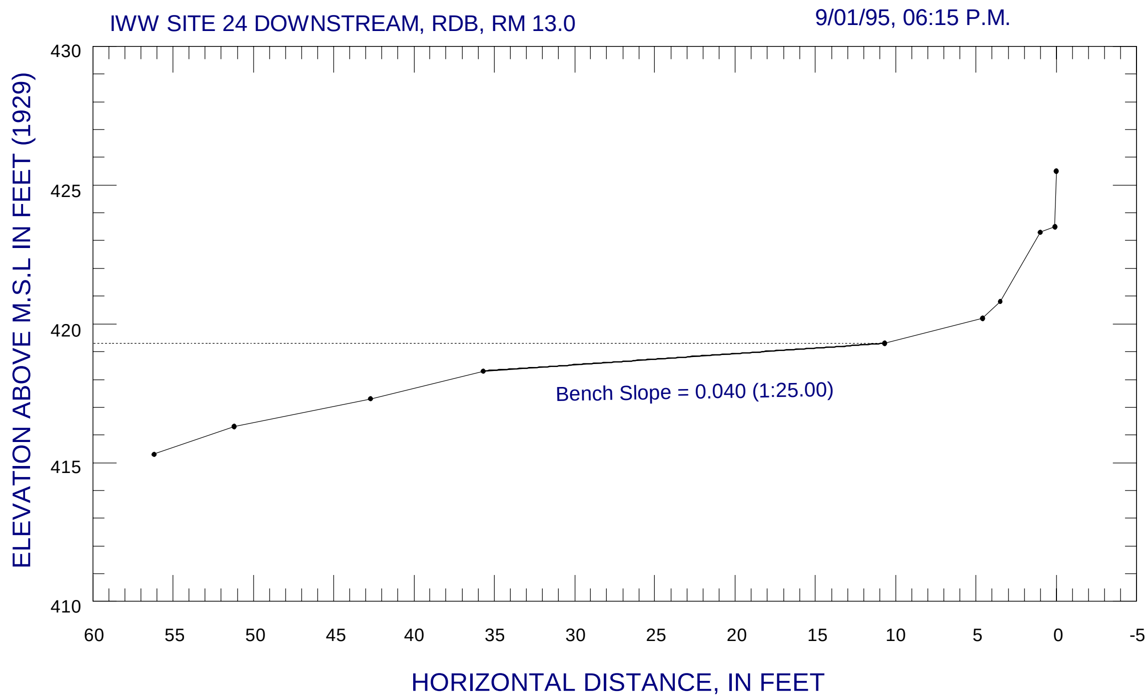


Figure 6-112. Bank sections at site 24 (concluded)

Table 6-34. Site 24

Percentage of occurrence	*Stage above msl, in ft*	*Topographical features*	*Bank/bed material, mm*
90	419.2	• Bench (underwater) (slopes varied between 1V:25.0H and 1V:15.9H)	• d_{50} (core) varied (0.019-0.020)
75	419.5	• Bench	
50	420.3	• Bench/berm (slopes varied between 1V:1.8H and 1V:1.2H)	
25	422.5	• Scarp/berm • Scarp (slopes varied between 1V:0.34H and 1V:0.05H)	• d_{50} = 0.019
10	426.6	• Top of the bank	
0-9	>426.6		

Note: Gage on the Illinois River at Hardin, IL @ RM 21.6 was used for stage histogram. Gauge is 8.6 miles away from the site. WSE = 419.3'; OHW: (NA); NP: (NA).

Summary

This chapter described the data collected from the Illinois Waterway in 1995 in connection with the field survey study of bank erosion. The field visits and data collection were conducted from August 24-31, and from September 18-20, 1995. A summary of information presented in the report is as follows:

- Bank erosion of the entire Illinois Waterway was studied previously by Bhowmik and Schicht (1980) and Hagerty (1988). Warren (1987) also investigated the rate of bank erosion at five selected sites. Their major findings have been summarized.
- Historical data on navigation traffic on the waterway indicated an increasing trend in traffic volumes.
- Dredging summaries for the navigation pools are included in appendix D of this report.
- Fleeting sites, fleeting locations and other related data are included in appendix E of this report.
- Detailed field data were collected a total of 29 study sites and 3 observation sites.
- The distribution of sites with respect to various pools is as follows:

  Marseilles - 5 sites (pool length = 24.5 miles)
  Starved Rock - 3 sites (pool length = 15.8 miles)
  Peoria - 7 sites (pool length = 73.3 miles)
  La Grange - 9 sites (pool length = 77.7 miles)
  Alton - 5 sites (pool length = 80.1 miles)
- Observation sites were located as follows: one in Dresden Pool and two in Marseilles Pool. The length of Dresden Pool is 14.3 miles.
- Both of the bank lines from RM 286 to RM 0 have been mapped on navigation charts of the river. Eroded and stable reaches were identified on these charts, and included in appendix J of this report.
- At all the selected sites, bank sections, bank and core samples, and at least one river cross section at the midpoint were obtained. Photographs of the sites, including panoramic and feature-specific were taken. All the sites were located by using a portable GPS system.
- A total of 80 bank sections from 29 eroded sites were measured.
- The river widths varied from 529 to 919 feet, and the maximum depths varied from 12 to 21 feet.
- Bank sections were measured to determine the slopes of scarp, berm, and bench. Scarp slopes varied from about 1V:0.83H to 1V:0.04H, berm slopes varied from 1V:8H to 1V:0.83H, and bench slopes varied from 1V:83.3H to 1V:1H. Scarp and bench slopes did not show too much variation, whereas berm slopes showed quite a bit of variation.

- A total of 174 surficial bank and nearshore bed material samples were analyzed, 93 samples from the riverbanks and 81 core samples. For about 141 of the samples, d_{50} varied from 0.002 mm to 0.696 mm. Surficial bank materials consisted of fine sand and silt within the upper portion of the waterway and became silty and clayey within the lower reach of the waterway. Almost all the surficial bank material samples appeared to be well graded.
- Erosion reaches selected varied from a minimum length of 0.09 mile to a maximum length of 0.95 miles.
- All selected bank sections had natural coverings. Among the 29 study reaches, 17 were located on the Right Descending Bank (RDB) and 12 on the Left Descending Bank (LDB); 13 on the straight reaches of the river, 11 on the outside bank, 3 on the inside bank, and 2 in crossover. The dominant land cover on the bank face was grass or weeds. The dominant land cover on the bank crest was woody vegetation.
- Most of the 1995 bank sections were located within the straight portion of the river. Sites selected from the outside bank are distributed throughout the waterway.
- During field data collection, the field team identified the probable cause or causes of erosion at all the bank sections where bank sections were measured. The probable causes are organized for evaluating the percentage of each cause presented in these 80 bank sections. The data from the 80 bank sections indicated that:
    - ♦ although large floods could be the dominant cause of erosion on natural rivers, this study found erosion at many bank sections located within the normal range of stage fluctuation (between the Ordinary High Water and Normal Pool stages) which cannot completely be attributed to large floods. Among these bank sections, 27% of the bank sections showed erosion occurring only at high stages while 63% had erosion occurring at stages within the normal range of stage fluctuations. The rework and transport processes, as caused by waves and currents, are significant during these stages.
    - ♦ 74% of the bank sections had evidence of seepage effects. About 26% of these bank sections had piping holes or springs, the remaining 48% had wet subaerial benches.
    - ♦ 28% of the bank sections had small scarps on bench that could have been formed by waves, seepage, or a combination of these causes.
    - ♦ 24% of the bank sections showed evidence of traffic-induced disturbance. These include impact from direct contacts and undercut in submerged banklines near fleeting areas.
    - ♦ 10% of the bank sections showed erosion associated with eddy/disturbed flow induced by riparian trees or gravel.
    - ♦ 11% of the bank sections had the presence of surface drainage; five bank sections located adjacent to water bodies (lakes, borrow pit).

- ♦ 4% of the site showed erosion associated with weathering (freeze/thaw) of surficial soils.

- All the measured bank sections were divided into six erosion types on the basis of the height of scarp, types of soils, and widths of subaerial and subaqueous benches. Each measured bank section was subsequently analyzed to determine which type or types describe that particular profile. In this categorization, types 1 and 2 indicate high potential for erosion, types 3 and 4 indicate moderate potential for erosion, and types 5 and 6 indicate active but less severe erosion.
- Analyses of the erosion mechanisms at all the measured bank sections (80 cross section) indicated the following distribution:

  Type 1: 2 bank sections (i.e., 2.5% of the total measured bank sections)
  Type 2: 6 bank sections (7.5%)
  Type 3: 4 bank sections (5.0%)
  Type 4: 13 bank sections (16.25%)
  Type 5: 15 bank sections (18.75%)
  Type 6: 7 bank sections (8.75%)

  The remaining bank sections showed some deviation from the types as defined earlier. They are presented as a combination of different types. These are:

  Types 1 and 2: 3 bank sections (3.75%)
  Types 1 and 6: 3 bank sections (3.75%)
  Types 2 and 3: 3 bank sections (3.75%)
  Types 2 and 4: 4 bank sections (5.0%)
  Types 2 and 5: 3 bank sections (3.75%)
  Types 2 and 6: 1 bank section (1.25%)
  Types 3 and 5: 6 bank sections (7.5%)
  Types 4 and 5: 10 bank sections (12.5%)

- Several erosion mechanisms were present at many bank sections, and this field survey was not designed to identify all the specific erosion mechanisms. However, the analysis for potential causes indicated that erosion at approximate 63% of the measured bank sections could be attributed partially to rework and transport processes (waves and currents) associated with stages variations within the normal range of pool fluctuations. The waves can be generated by winds or navigation traffic and the currents can also be part of natural flows or turbulence from traffic or other causes. It is recommended that further studies be conducted to investigate the sources of these causes.

- A classification of all the bank sections indicated that future site-specific field experimentation should include bank sections with the following characteristics: bench slopes: 1V:50H to 1V:20H; berm slopes about 1V:4H; scarp slopes about 1V:0.7H to 1V:0.5H; d_{50} about 0.05 mm, and σ about 2 to 3. It should be noted that bank sections with other similar characteristics would also be suitable for detailed field experimentation.
- Detailed descriptions of all the individual bank sections and related photographs and other data are also included with this report.
- Site-specific field experimentation should be conducted to estimate the rate of bank erosion due to the movement of river traffic at representative bank sections. On the basis of such scientific information, an equation or a set of equations can be developed which could be systematically applied to the entire UMR and IWW and cover the wide variety of bank conditions existing on these two rivers.

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Chapter 7. The Upper Mississippi River

Introduction

A Task 1 bank-erosion literature review by Maynord and Martin (1996) lists fourteen specific references for the Upper Mississippi River system. Eight of the references deal specifically with the impacts of traffic-generated waves on bank erosion for the Upper Mississippi River system, including the Illinois Waterway. The report by Maynord and Martin (1996), included as Appendix A, presents a brief summary for each reference (refer to Appendix A, pp.46-53). Therefore, no duplication is made in this report. Maynord and Martin (1996) also refers to three reports by Great River Environmental Action Teams (GREAT), GREAT-I (COE, St. Paul District), GREAT-II (COE, Rock Island District), and GREAT-III (COE, St. Louis District) (refer to Appendix A, pp.26-28). However, these studies were conducted to estimate overall bank-erosion characteristics for entire watersheds of these districts and no particular emphasis was placed on navigation-induced bank erosion.

Stage histograms and bank sections for the selected study sites for the Mississippi River are included in Appendix C. Records of dredging history and dredged material placement for the Mississippi River are included in Appendix D, and fleeting areas on the Mississippi River are listed in Appendix E. Appendix F shows sediment particle-size distributions obtained for all the soil samples collected in the study. Appendix G contains detailed river cross-section data, and a geomorphology study is described in Appendix H.

General Site Characteristics

A total of forty-three major study sites (Site 1 through Site 44 excluding Site 20), distributed through Minnesota, Wisconsin, Iowa, Illinois, and Missouri, was selected during the study period from 11 September 1995 to 17 October 1995, and forty-five additional sites were selected upstream and downstream of the major sites. Among the forty-three major sites, thirty-six sites were located in eighteen separate pools between Pool 2 and Pool 27, and seven sites were located in an open-water river section downstream from Lock & Dam No. 27. The locations of these major sites, including the site numbers (note that there is no Site 20), river miles (RM), and the right and left descending bank identifications, are shown in figure 7-1. Figure 7-1 also shows the locations of confluences of several major tributaries, such as the Chippewa River, the Wisconsin River, the Turkey River, the Rock River, the Iowa River, the Des Moines River, the Illinois River, and the Missouri River. The longitudinal location of each major site relative to the Locks and Dams and the major tributaries can easily be seen in this figure drawn at a linear longitudinal scale.

The average water-surface slope between Site 1 (RM 825.5) and Site 37 (RM 197.6) for the pool section during the study period was about 8.62×10^{-5} (5 inches/mile), and that of the open-water section between Site 38 (RM 172.1) and Site 44 (RM 25.8) was 1.08×10^{-4} (7 inches/mile). In addition to the forty-three major sites, fifty-four observation sites were selected during the field study. These observation sites were judged by the team members to be sufficiently significant to be noted in the study. Although some observation sites were investigated in detail, systematic data collection similar to that for the major sites was not done at the observation sites; therefore, they are not described in detail in this report. However, the original data sheets for the observation sites are on file at the COE-RID for review.

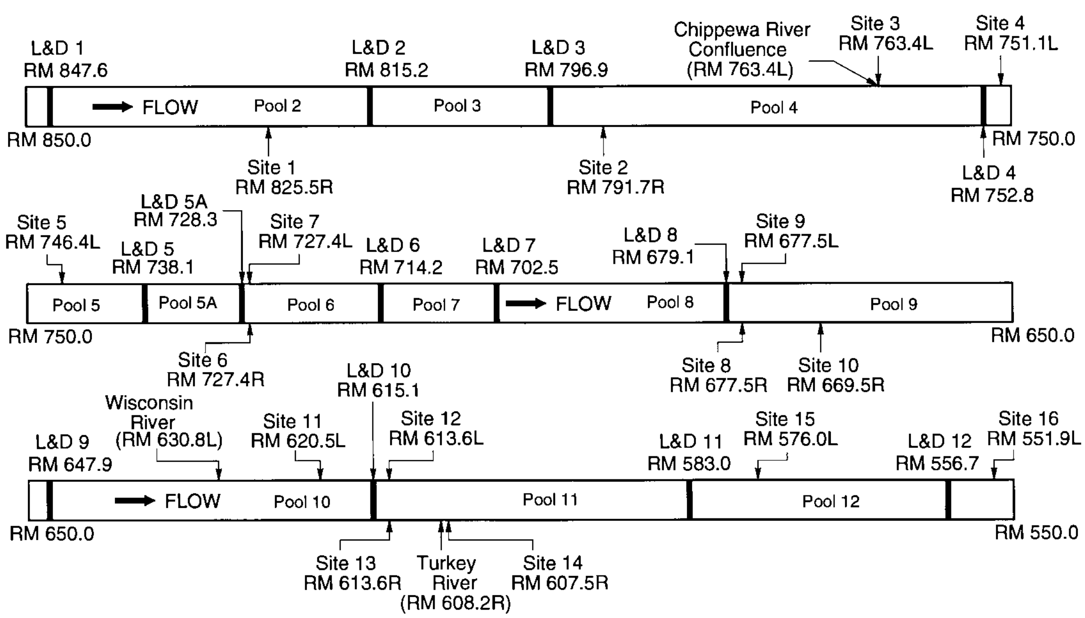


Figure 7-1a Site locations along the Mississippi River (RM 550-850)

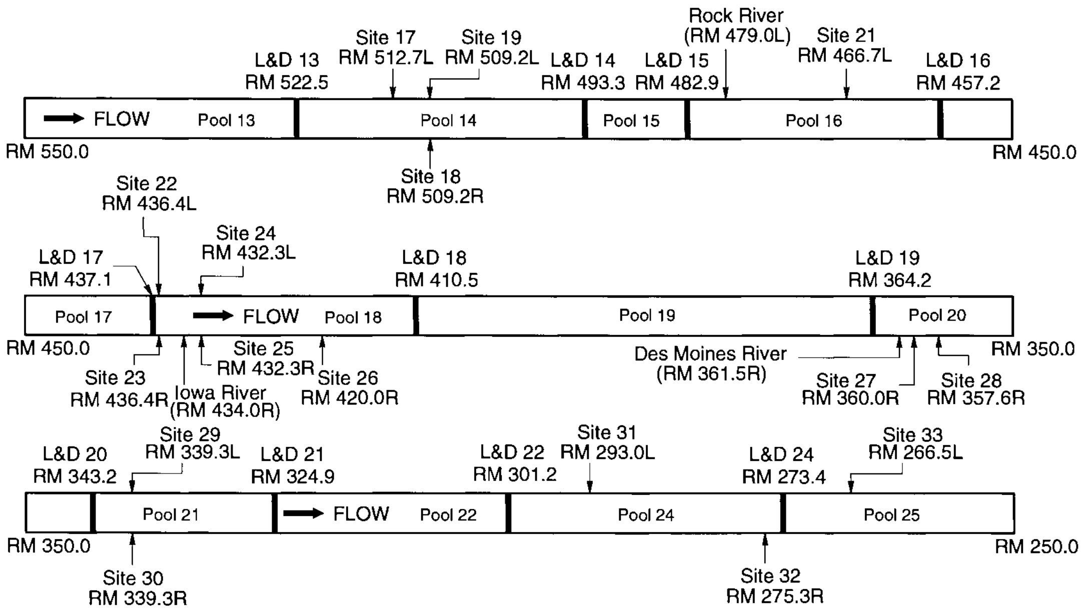


Figure 7-1b Site locations along the Mississippi River (RM 250-550)

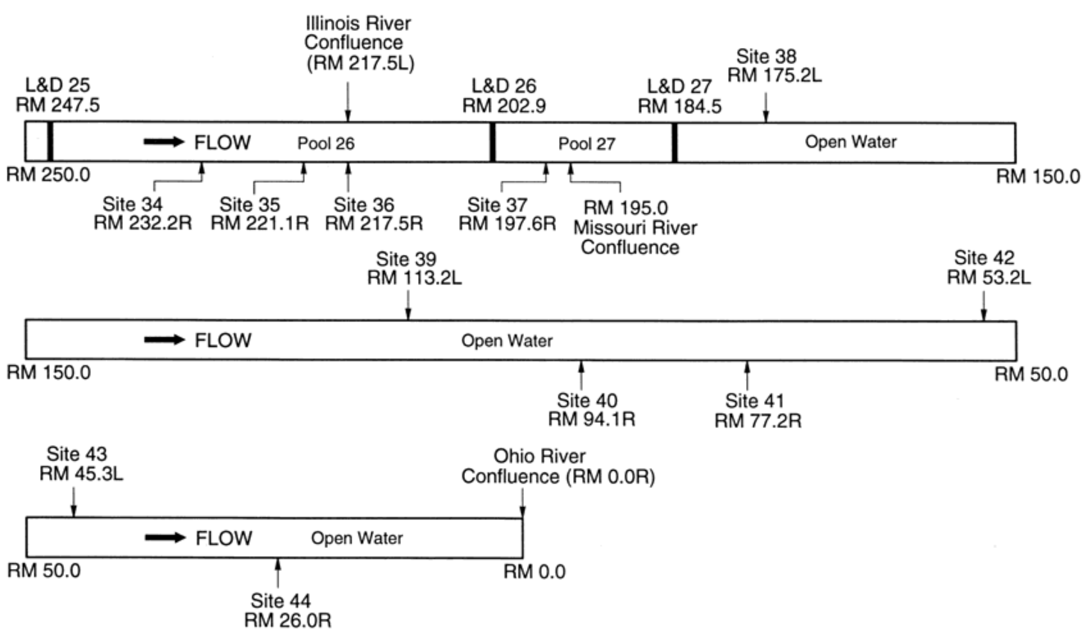


Figure 7-1c Site locations along the Mississippi River (RM 0-250)

As shown in table 7-1, twelve major sites were located on the outsides of bends, twelve on the insides of bends, sixteen in straight river reaches, and three sites in crossovers. Just over half of the major sites (twenty-four sites) were located close to thalweg sailing lines and the remainder (nineteen sites) were far from thalweg sailing lines. Among these forty-three major sites, twenty two were located on or near islands and six were located in barge fleeting areas.

Table 7-1 Geomorphic characteristics of the major sites along the UMR

Geomorphic Characteristics	Site Number
Outside Bend (12 sites)	1, 2, 4, 5, 6, 8, 10, 12, 24, 40, 41, 42
Inside Bend (12 site)	7, 9, 13, 14, 15, 16, 25, 31, 32, 37, 39, 44
Straight Reach (16 sites)	3, 17, 18, 19, 21, 22, 23, 26, 27, 29, 30, 34, 35, 36, 38, 43
Crossover Reach (3 sites)	11, 28, 33
Island Reach (22 sites)	5, 6, 7, 9, 11, 12, 13,15,16, 17, 18, 21, 23, 25, 26, 28, 29, 31, 33, 35, 39, 44

Site Selection and Data Collection Campaign

As mentioned in Section 2.c, an aerial reconnaissance survey, which generated oblique color video imagery and color still photographs, was conducted over the entire study reach. Survey information was used by the study team to pre-select potential field study bank-erosion sites which were visited by boat in the field. Not all of the potential sites were determined solely from aerial video and still photographs. The team also considered dredged material disposal sites or sites where bank erosion was not severe. Actual bank-erosion sites could only be selected during field site visits. Nonetheless, the aerial information was very useful for an overview and for listing potential sites.

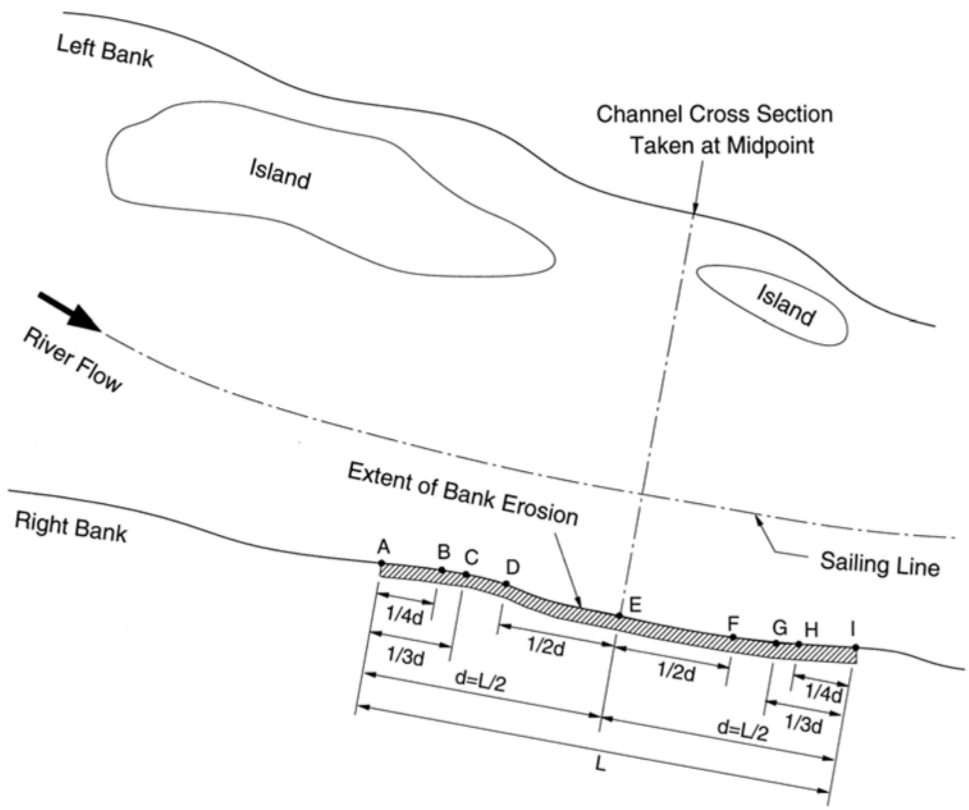
At each major site, a midpoint section (point E, as shown in figure 7-2) first was established at the approximate center of the extended bank-erosion reach, and upstream point (point D) and downstream points (point F) were established generally around the midpoints of both the upstream and downstream halves of the reach. Besides these three primary points (Upstream, Midpoint, and Downstream points), several additional points, such as points A through C and G through I, were established, particularly on island sites, in order to observe detailed longitudinal changes in bank sections along the islands.

At each midpoint section, a detailed bank section was taken first, extending generally from the top of the bank to subaqueous depths of up to 3 ft - 4 ft. A channel cross section, from one bank to the opposite bank, was taken at each midpoint section. Several surficial soil samples were collected at each distinct part of the bank section, such as the bench, berm, scarp, top of the bank, etc. These surficial soil samples were collected generally from soil layers no deeper than 12 in. Subaqueous soil core samples were collected at upstream, midpoint, and downstream sections at water depths of 1 ft and 2 ft, and occasionally at 3 ft or 4 ft depth. Photographic documentation at each midpoint section included typical site characteristics, upstream and downstream views of the erosion site, close-up views of bank soil samples, and locations where samples were collected, and other features, such as traffic-induced wave patterns, zebra-mussel habitats, etc. Field data which were collected at the auxiliary sections are summarized in figure 7-2. In addition to the data described above, a number of tube soil-core samples reflecting geomorphic features were collected at various eroded bank sites by Jeff Anderson, a geomorphologist, of Anderson Environmental Services.

Individual Site Characteristics

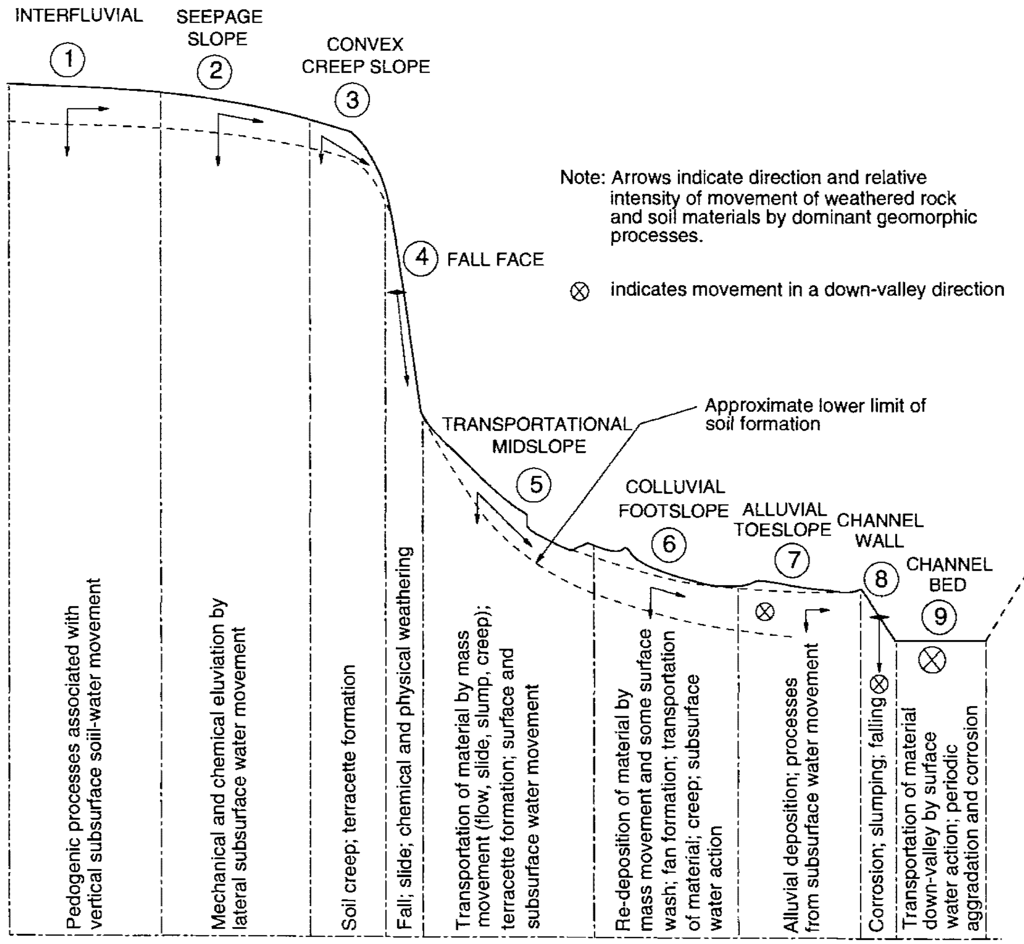
In order to display as much as possible of the information which was collected during the field investigation in one graph, the working team developed a method to incorporate all the principal information into one form, including the site location, date of work, channel cross section, measured bank sections, regression line of the bench section, bench slope, water-surface elevation on the date of survey, normal pool (NP – the lowest operating water level) elevation (for pool sections only), ordinary high water level (OHWL – the 25-percent occurrence water level) elevation (for pool sections only), geomorphic soil-core map, types of soil for individual surficial and subaqueous soil and sediment samples, and miscellaneous characteristics of the erosion site as observed during the field work.

Besides incorporating principal field information into one graph, an attempt to classify bank-erosion sites into six different types for the Mississippi River reach between RM 26.0 and RM 825.5 was made, as Dalrymple, et al. (1968) did for a hypothetical



Point	Location	Data Acquired	Comments
A	Upstream Limit	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
B	Upstream 1/4 Point	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
C	Upstream 1/3 Point	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
D	**Upstream Point**	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
E	**Midpoint**	• Bank Section • Subaqueous Core Samples (SCS) • Bank Soil Samples • Cross Section • Photos	SCS samples were taken generally at water depths of 1' and 2'.
F	**Downstream Point**	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
G	Downstream 1/3 Point	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
H	Downstream 1/4 Point	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.
I	Downstream Limit	• Bank Section • Subaqueous Core Samples (SCS) • Photos	SCS samples were taken generally at water depths of 1' and 2'.

Figure 7-2 A definition sketch showing bank-erosion field-study site locations



Re-drawn after Dalrymple et al., "A hypothetical nine-unit land surface model," Zeitschrift fur Geomorphologie, vol.12, 1968.

Figure 7-3 A hypothetical nine-unit land surface model proposed by Dalrymple et al. (1968)

nine-unit land surface model, which is shown in figure 7-3 for hillslope forms and their processes. Although it was extremely difficult to fit all the features of the Mississippi River sites into those nine categories, it was recognized during the field study that several features out of the nine units were easily identified at various sites. Six distinct bank-erosion site types were developed for the Mississippi River study reach, as sketched in figure 7-4. Synoptic bank-soil descriptions and erosion specifics for each type are given in table 7-2. These six types of eroded banks are all susceptible to specific features, such as "currents and waves," "river-stage variations," "overland drainage conditions," "internal and surficial seepage," and "wet-dry and freeze-thaw cycles." It should be noted that several types found in the UMR study sites appear identical to types described by Dalrymple, et al. (1968). For each site, erosion type was determined on the basis of the bank section and subaerial and subaqueous soil properties. Variations in the eroded-bank site types along the Mississippi River will be treated later in detail. Type A bank profile can be illustrated by a photo taken at Site 28 (RM357.6), a combination of Type A and Type B profiles by a photo taken at Site 44 (RM 26.0), Type C profile by a photo taken at Site 36 (RM 217.5), a combination of Type D and Type E profiles by a photo taken at Site 18 (RM 509.2), and Type F by a photo taken at Site 3 (RM 763.4), as shown in Photos 7-1, 7-2, 7-3, 7-4, and 7-5, respectively.

The work group also developed a schematic to illustrate the so-called rework-transport zone of the bank segment, as shown in figure 7-5. The process within this zone will be described when site-specific bank sections are presented.

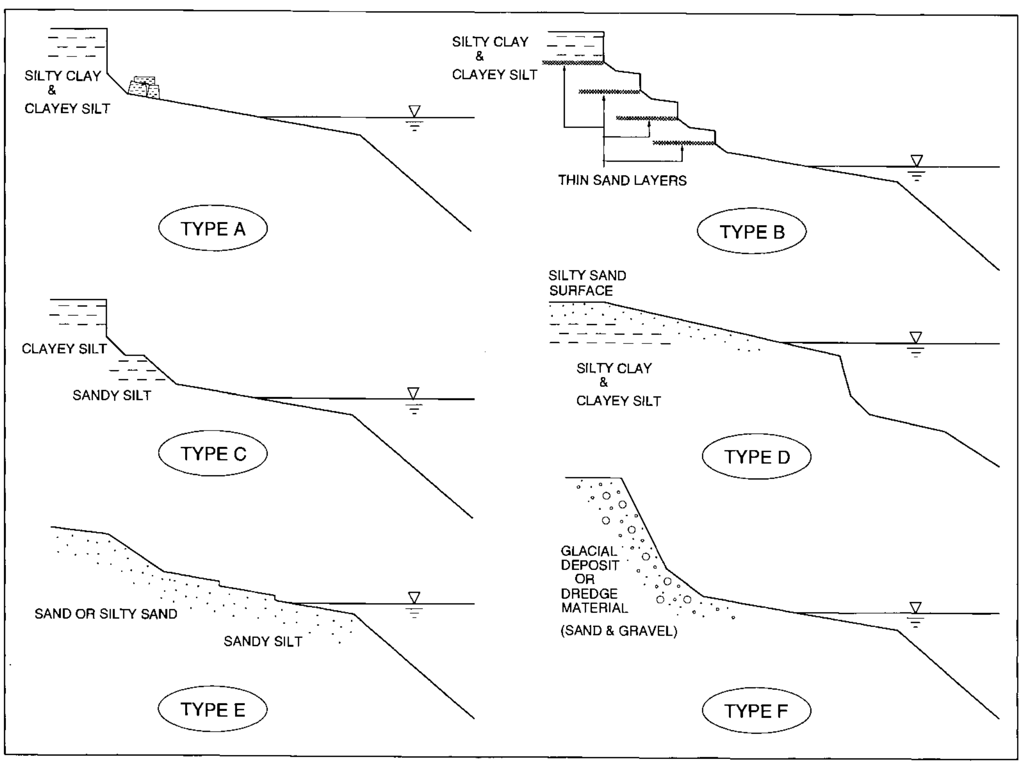


Figure 7-4 Classification of eroded-bank site types observed in the Mississippi River study reach

Table 7-2 Classification of eroded-bank site types which were observed during the field reconnaissance

Type	Principal Features
Type A	• Primarily silty clay and clayey silt • Similar to TYPE B but without sand layers • Nearly vertical scarp face • Internal and external cracks • Large scale block failures • Near-bank and underwater berms may form from fallen soil blocks • Piping features seen at scarp faces
Type B	• Multiple layers of silty clay and clayey silt deposit with thin layers of silty-sand and sandy-silt lenses • Scarp faces nearly vertical • Terracette formation at each sandy layer • Fallen blocks frequently found in terraces at different levels • Piping features seen at different scarp faces
Type C	• Upper layer of clayey silt and silty clay • Upper scarp face nearly vertical • Lower layer of sandy silt • Contains silty-sand and sandy-silt lenses • Berm structure with terracette formation • Piping features
Type D	• Clayey silt and silty clay covered by layers of silty sand or sand • Bank with modest slope • No significant subaerial scarps • Severe near-shore subaqueous bank erosion • Typically found in fleeting area and outside of bend close to thalweg sailing line
Type E	• Primarily sand or silty sand characterized by bank with modest slope • Typically seen along small islands or downstream tips of large islands • Multiple miniature scarp faces affected by river-stage variations
Type F	• Noncohesive glacial deposit or dredge disposal material composed primarily of sand and gravel • On placement bank slope nearly equal to angle of repose • Typical along the Upper Mississippi River above St. Louis and along the Illinois Waterway

Photo 7-1 Type A eroded-bank site (Site 28, RM 357.6)

Photo 7-2 Combination of Type A and Type B eroded-bank sites (Site 44, RM 26.0)

Photo 7-3 Type C eroded-bank site (Site 36, RM 217.5)

Photo 7-4 A combination of Type D and Type E eroded-bank sites (Site 18, RM 432.3)

Photo 7-5 Type F eroded-bank site (Site 3, RM 763.4)

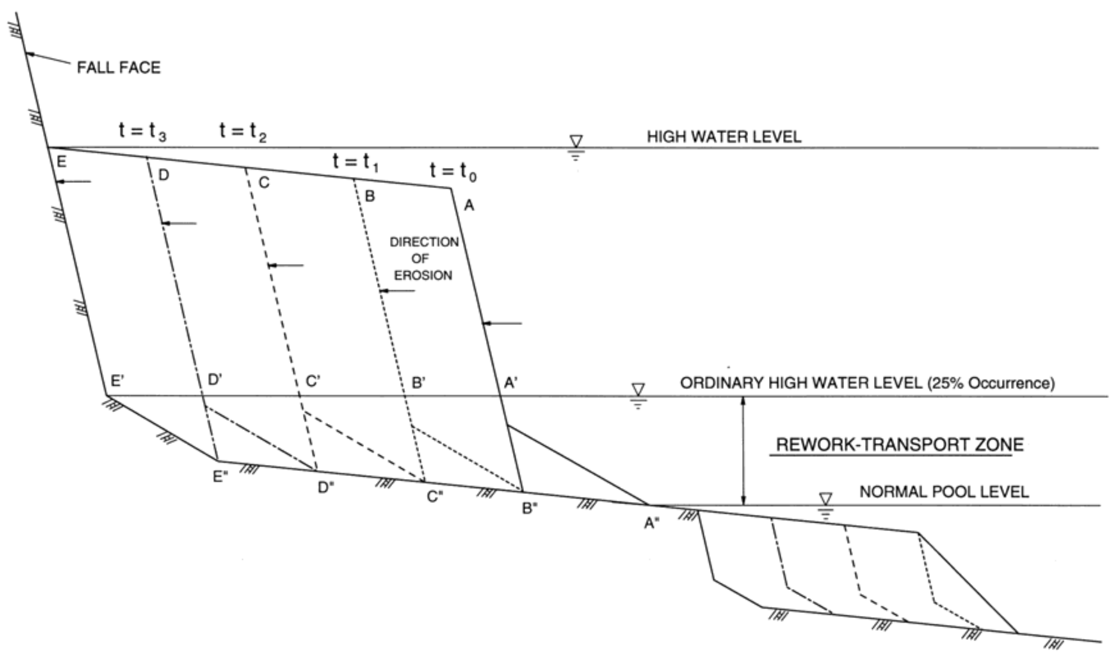


Figure 7-5 A schematic showing typical bank sections within the river rework-transport zones

Geological and Soils Investigation

Geological and soils investigations also were conducted at selected sites along the Mississippi River from St. Paul, Minnesota, to Cairo, Illinois. These investigations were conducted in order to provide the erosion study team a geological overview of the Mississippi River near-channel landscapes at erosion sites. Additional directives for the geological portion of the study included:

1. to evaluate the recent historical deposits;
2. to identify, if possible, the relative ages of the depositional units (landscape sediment assemblages-LSAs) below the historical deposit;
3. to identify buried soils (paleosols) of older Holocene age;
4. to describe the deposits according to the Unified Soil Classification System (USCS) and according to USDA soil taxonomy; and
5. to evaluate the relative impacts to cultural resources along this reach of the Mississippi River and, specifically, at the bank erosion sites.

Geologic studies of the Mississippi River have been more numerous since 1980 than in prior years; consequently, more is known about the evolution of the Upper Mississippi River Valley, particularly during the Holocene. Most of the Quaternary geologic work has been done in the Rock Island District COE jurisdiction. Bettis and Anderson (report in progress) are currently conducting an inventory of geologic work in the Upper Mississippi River Valley between St. Paul, Minnesota and Cairo, Illinois. The recent completion of Rock Island District work has resulted in the production of a set of landscape sediment assemblage (LSAs) maps on 7.5-minute topographic quadrangles (Bettis et al. 1996). The maps identify Wisconsinan and Holocene depositional units within the Mississippi River Valley walls from Pool 11 through Pool 24. The LSA information is available on the internet from the COE, Rock Island District and the reference section of this report contains additional citations of Mississippi River Valley work.

Paleozoic-aged sedimentary rock occurs along the margin of the Mississippi River Valley. Sedimentary rocks, including sandstone, siltstone, shale, limestone, and dolomite, are exposed along this portion of the Mississippi River Valley. Some of the carbonates are cherty. Generally, bedrock dips southwestward and downstream in the Mississippi River system.

The oldest Cambrian rocks occur along the valley wall in southeastern Minnesota. Younger Paleozoic rocks are exposed downstream in Illinois, Iowa, and Missouri. Generally, the sedimentary rocks in the valley are of the Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian Periods. The youngest rocks occur in the Mississippi Embayment area of extreme southeastern Missouri and include rocks from the Cretaceous and Tertiary Periods.

Willman and Frye (1970) indicate that major Mississippi River Valley erosion and drainage development occurred during the Pleistocene between Nebraskan and Kansan (pre-Illinoian) times. It appears that the Mississippi Valley was in its present position upstream from Clinton, Iowa, but was diverted by glaciation to the southeast passing north of Rock Island through the Meridosia Channel (Anderson 1968). Drainage continued to flow from the southeast through the Princeton Bedrock Valley, joining the Illinois River Valley near Hennepin, Illinois. Drainage continued southward through central Illinois, re-joining the contemporary Mississippi Valley near Grafton, Illinois.

Glacial advances during the early Pleistocene moved eastward out of Iowa, diverting flow to the east of the ancient Mississippi/Illinois River Valley. The pre-Illinoian glacial events were followed by Yarmouth Interglacial times which began about 500,000 years ago. During the relatively long interglacial period, the ancient Mississippi River drainage system re-occupied the Princeton Bedrock Valley and joined the Illinois River Valley from Hennepin, Illinois to Peoria and southward toward St. Louis.

Drainage patterns changed during Illinoian glaciation about 250,000 years ago. During the maximum Illinoian glacial advance, the Mississippi River drainage was diverted westward into Iowa, west of Davenport and Muscatine. Following Illinoian glaciation, the Mississippi River drainage reverted back through the Princeton Bedrock Valley and into the Illinois River Valley. By about 20,000 years ago, the impacts of Wisconsinan glaciation finally diverted the Mississippi River westward to its present course through the Port Byron and Andalusia Gorge south of Clinton, Iowa (Benn et al. 1988, 1989; Anderson 1968).

At the close of the late Wisconsinan, episodes of glacial lake discharges through the Mississippi River system occurred between about 12,000 and 9,500 yeas ago (Matsch 1983; Flock 1983). Episodes of major valley alluviation followed by degradation produced high outwash terraces primarily along the margins of the Mississippi River Valley, and up into the lower reaches of tributaries.

Since the last glacial discharges around 9,500 years ago, a period of valley incision followed by valley alluviation occurred in the Mississippi River Valley. The extent and magnitude of the early incision appears to have varied greatly throughout the river system. Meanwhile, hillslope valley margin deposits, sediment loadings from small tributaries and larger trunk streams produced Holocene fills in the valley beginning after 9,500 years ago. Tributary fan and hillslope sediment loadings have continued to the present. Major valley alluviation continued during the late Holocene, and the development of mid-channel islands began (Anderson et al. 1988, 1989; Benn et al. 1988, 1989, 1994; Bettis and Anderson 1990; Bettis et al. 1996).

Recent human activities have produced major impacts on the Mississippi River system. One of the most significant human impacts has been accelerated historical valley alluviation (Knox 1977, 1987; Magilligan 1985). The historical alluvial deposit is a result of Euro-American settlement and subsequent destructive land use. Removal of the original vegetation cover has exposed and mobilized the highly erodible native surface soils (Anderson 1991). Upland erosion has led to temporal sediment storage throughout the drainage hierarchy. However, historical erosion recently has caused valley incision and remobilized stored sediment in the upper tributary reaches.

Erosion occurring in the upper tributary reaches has accelerated main valley alluviation. The historical deposit occurs as a laminated silty to sandy deposit near the present Mississippi River channel. Away from the main channel, this alluviation is massive, thickly-bedded fine grained deposits.

In the Upper Mississippi River Valley and tributaries, thick historical deposits are found:

1. adjacent to the main channel;
2. along island margins and swales;

3. in backwater sloughs, abandoned channels, and flood chutes;
4. in lower reaches of tributary valleys particularly where they enter larger valleys; and
5. along valley margin footslopes (Anderson and Bettis 1989).

In the Rock Island District, the distribution of historical alluvium is influenced by the lock and dam system that has been in place since the late 1930s. Thick-bedded fine-grained deposits tend to accumulate in the lower pool reaches, while lesser amounts are found in the upper reaches of the pools.

This erosion study focused on locations where major erosion is active along the margins of the main channel. Because of the reconnaissance nature of the erosion study, geological observations were made at each erosion study site and considered in the context of earlier more detailed geological studies previously conducted by Jeff Anderson and his colleagues. Note that the sampling tube cores and observations are biased due to their location near the main Mississippi River channel where the major erosional impacts are found. Furthermore, some heavily impacted areas were sandy dredged-spoil material placement sites, particularly in the St. Paul District. As a result, cores and bank sections often revealed only historical deposits. Holocene-aged surfaces were not observed, but were expected to occur at least some distance away from the erosion site and below the historical deposits.

The Upper Mississippi River is an integrated system composed of specific reaches. Parameters, such as (1) valley width and gradient, (2) bedrock geology, (3) sediment loadings from within the reach and from major tributaries, and (4) late glacial impacts, have strongly influenced main valley evolution and the distribution and relative age of deposits. For example, within narrow valley reaches the Mississippi River generally reworks valley floors and confines older Holocene and late Wisconsinan deposits along the valley margins. These are net erosional or transportational reaches of the river. Where valley widening occurs, especially downstream from a narrow reach, multiple-aged Holocene and late Wisconsinan surfaces are observed across the valley. These portions of the valley are net storage reaches.

For the purposes of simplicity, the Mississippi River System from St. Paul to Cairo can be divided into a few major reach categories based on the predominant sediment type, or sediment loadings. More detailed work has defined four major reaches in the Rock Island District from Pool 11 through Pool 22 (Bettis and Anderson 1990). The upper reach from St. Paul to about the Wisconsin River confluence tends to be a reach dominated by coarse-grained bedload. Within this upper reach, the vast quantities of dredged spoil sand are found along the channel margins. Native soils often appear below the relatively thin cap of historical deposits. At some locations, multiple buried late Holocene-aged soils were found, as shown in Photo 7-6. Natural levee building has occurred along the main channel during the late Holocene with the deposition of thin A-C or A-Bw-C sequence paleosols.

The Mississippi River System from the Wisconsin River to about the Des Moines River confluence is a mixed-load reach. Most of the Holocene-aged surfaces are found beneath thicker deposits of historical silt and sand. The most significant erosion and a relatively thin surface deposit of historical alluvium can be found in the upper pool reaches just below the locks and dams, as shown in Photo 7-7. The upper portions of the pools often contain multiple buried soils and multiple-aged Holocene and late Wisconsinan surfaces. The lower pool reaches contain thicker fine-grained historical deposits, and most of the Holocene surfaces are either deeply buried or are inundated at normal pool elevations. Generally, only alluvial fans, colluvial slopes, and late Wisconsinan terraces can be found at these lower pool locations.

Below the confluence with the Des Moines River, the Mississippi River is more of a suspended-load system. Dominant sediment type is silt and very fine sand. Upper reaches of the pools contain Holocene-aged surfaces buried by increasing thicknesses of historical alluvium. More or less continuous constructed levees below the Des Moines River concentrate cut-and-fill activities near the channel margin. Most of these near-channel surfaces are historic in age; however, some older deeply buried Holocene surfaces are expected.

Below the confluences with the Illinois and Missouri Rivers, Holocene-aged surfaces along the channel margin all but disappear and are replaced by thick-bedded historical alluvium, as shown in Photo 7-8. With the exception of a few areas, a continuous levee occurs along the open river below St. Louis. Massive, thick-bedded historical silt and very fine sand are being reworked actively below St. Louis. Major floods, such as the Great Flood of '93, have produced extremely thick vertical accretion of sand deposits along the channel margin. Major channel margin scour of historical silt, with scarps of 20 ft to 30 ft, is common in this reach, as shown in Photos 7-9 and 7-10. However, where the main channel abuts the valley wall, levees are absent and truncation of small depositional fans and colluvial deposits occur. Generally, these valley-wall deposits are the only remaining Holocene and older aged surfaces being impacted by main channel erosion below St. Louis.

Photo 7-6 Buried native soil below historical alluvium observed at Site 4, RM 751.1 (the lighter colored upper unit is the historical deposit)

Photo 7-7 Severe bank erosion at barge mooring area observed at Site 15, RM 576.0

Photo 7-8 Thick historical alluvium overlying the native soil observed at Observation Site, RM 194.0 (the bottom of stadia rod indicates the native soil surface)

Photo 7-9 Observation Site, RM 134.1 -- looking north upstream -- (this photo shows study team members standing on CCC-placed riprap (ca. 1930s) About 150 ft of bank erosion has occurred westward to the left since riprap placement)

Photo 7-10 Bank face showing a profile composed entirely of recent historical alluvium at Site 39, RM 112.4

Field Methods

The field study required accessing the sites by boat. Bank exposure observations, and advancement of 1.25-in. ID sampling tube cores were conducted during the investigations. Subsurface investigations consisted of obtaining 70 sample tube cores at 61 locations. The detailed soil profile descriptions can be found in Appendix H.

Places chosen for coring were generally midpoints within the erosion study site. Cores were advanced to provide an overall picture of the thickness of historical alluvium and underlying native soils (if present). The soil descriptions included color, texture, structure, consistency, sorting, special features (roots, peds – individual aggregates of soil particles, voids, mottling, gleying, concretions – round or sub-rounded clasts of secondary minerals, organics, clay skins – clay coatings on soil peds or grains that result from pedogenic process), effervescence and/or pH, and horizon boundary. Colors of the deposits were determined with a Munsell color chart. Soil reaction was determined through application of a weak 14% hydrochloric acid solution, and soil field pH was determined through the use of a Hellige-Truog soil pH kit. Vegetation, depth to the water table, and total core depth were recorded at each location, as included in Appendix H. The profiles were described according to the Unified Soil Classification System (USCS) and according to USDA soil taxonomy. Horizon depths were listed in both feet and centimeters.

For each site, a summary description of the geological soil characteristics is included in the second paragraph. The following terms are used therein to describe the geological ages of the Mississippi River site soils:

- Late Wisconsinan 20,000 to 9,500 years old
- Early Holocene 9,500 to 7,500 years old
- Middle (mid) Holocene 7,500 to 5,000 years old
- Late Holocene 5,000 to present
  Very Late Holocene Less than 1,000 years old
  Historic Since ca. AD1830 (Euro-American Settlement)

General Site Characteristics

1. Site 1 at RM 825.5 RDB (Pool 2)

This right-bank site shown in figure 7-6 is located along the outer bank of a sharp river bend, and is very close to the thalweg sailing line. Side and upstream views of the site are shown in Photos 7-11 and 7-12, respectively. As can be seen in figure 7-7, the active steeply failing bank slope, approximately 90 ft high, consists primarily of glacial deposits.

Each site map similar to figure 7-6 was prepared by the COE-RID using the geographic information system (GIS)-based navigation-chart data superimposed by the global positioning system (GPS) data acquired during the field study. It should be noted that the land coverage shown in each site map is based on the COE's 1984 aerial survey and the water's edge is drawn for a river stage of 90% frequency occurrence. Each bold line shown over the river channel is drawn between the starting and ending points of the GPS data, indicating the location of the site and the orientation of the river cross section taken. Each bold broken line shown for some of the site location maps in this chapter is drawn over the eroded-bank reach determined by the GPS. No GPS data on the eroded-bank length were collected at Site 1; therefore, only a bold line was drawn in figure 7-6. Similarly, no eroded-bank length was determined at Sites 1, 7, 13, 21, 23, 25, 27, 30, 31, 36, 37, 39, 41, 42, 43, and 44; therefore, only the river cross-section lines are shown in their site maps.

All the bank sections and river cross sections shown in this chapter are drawn looking downstream, and there is no distortion in both horizontal and vertical scales. Although detailed river cross-section data are included in Appendix G, the available river cross section for each site was plotted together with the bank section for readers' convenience. Each subaerial and subaqueous soil types and soil-core map are shown in each bank-section plot at locations where the samples were taken. Detailed soil particle-size distributions are given in Appendix F. A bench slope was determined for each site in such a way that a straight-line bench was first sought by the naked eye in the bank-section plot around the water's edge and a linear regression line was then drawn on the bank section. The bench slope was then determined using a regression method. The bench slope thus determined is shown in each figure. Determination of the bench slope for each site was not straightforward; engineering judgments were required in some cases for selecting proper bank-section points to define the bench.

The surficial soil near the water's edge at this site is fine to coarse sands (FS and CS, see table 7-3 for soil-gradation scales), and the tube soil sample taken at the top of the bank was classified as poorly-graded gravelly sands (SP, see table 7-4 for definition). The bank soils also include very coarse sands, gravels, cobbles, and boulders. The bench slope was estimated to be 0.200, as shown in figure 7-7. A regression line, shown by a thick solid line in each bank-section plot and noted as Regression Line in the legend, shows the bench. The river cross section shown in this figure does not indicate a typical profile for the concave bank in which flow depth and velocity are much larger along the outer bank.

The site is located at the base of a Late Wisconsinan outwash terrace. A bouldery lag deposit has accumulated at base of the steep terrace scarp and mantles the channel margin.

Primary causes of bank retreat at this site study include gravitational fall of the loose material, flood erosion and oversteepening, and current and wave wash. The loose bank soils close to the sailing line are susceptible to impacts of high-stage flood flows and subsequent wave erosion. As can be seen in Photos 7-11 and 7-12, failed fine soil and recently deposited sediment had been washed out and only large gravel or boulder lag remain near the water's edge. This erosion site is classified as bank Type F (see figure 7-4). The principal information for this site and every other site is summarized in tables 7-5a, 7-5b, and 7-5c.

2. Site 2 at RM 791.7 RDB (Pool 4)

Three sections were established on the outside of a bend, as shown in figure 7-8. Photos 7-13 and 7-14 show upstream and downstream views of the site, respectively. Figures 7-9, 7-10, and 7-11 show the bank sections obtained at the upstream point, midpoint, and downstream point, respectively. As at Site 1, the river cross section at the upstream point did not exhibit a deep channel along the right bank. However, the midpoint river cross section shows a shape typical for a mildly curved channel. As can be seen in these three figures, the bank soils are predominantly sands varying from fine

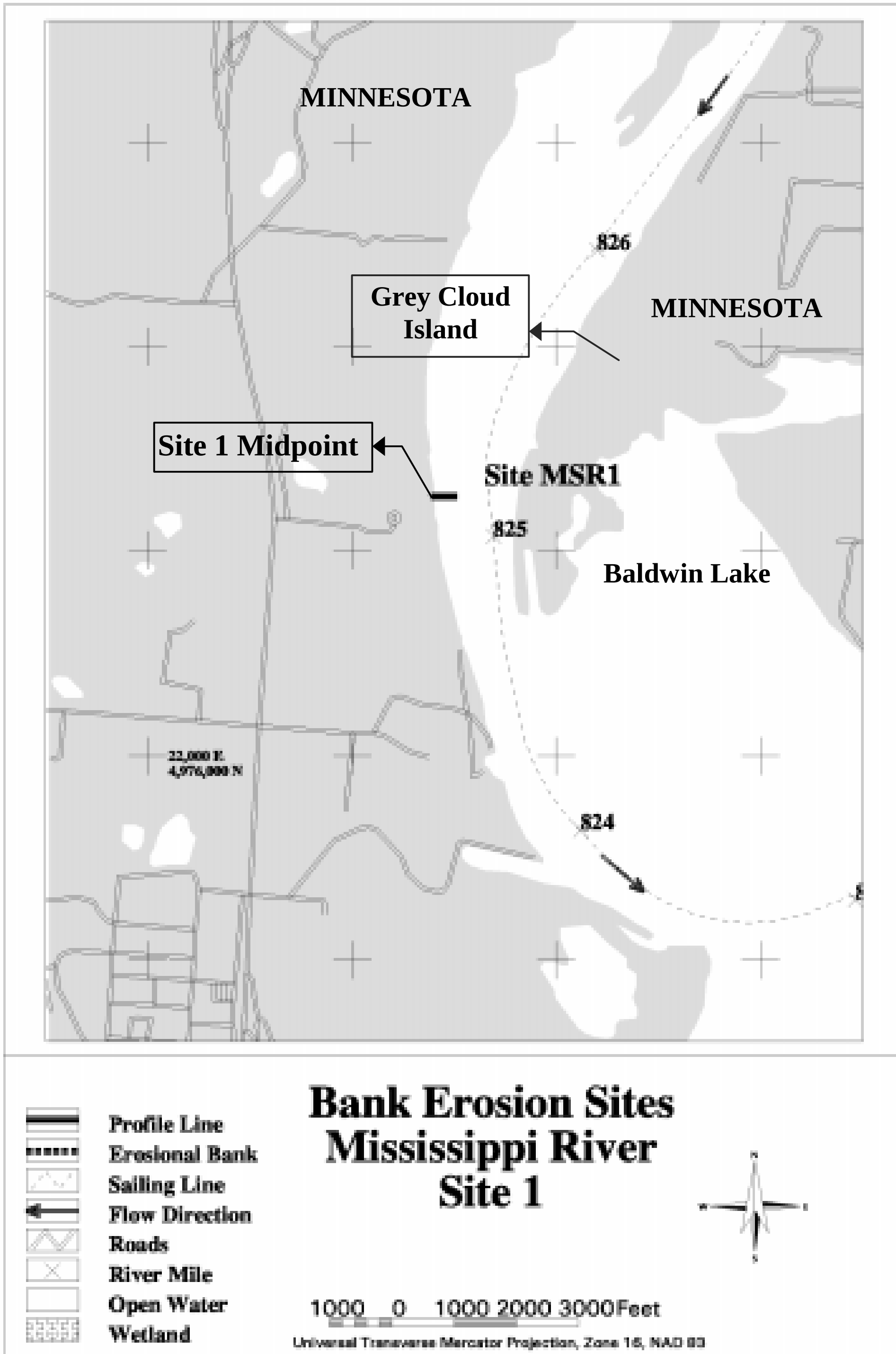


Figure 7-6 A map showing Mississippi River Site 1

Photo 7-11 A side view of Site 1 midpoint

Photo 7-12 An upstream view of Site 1 midpoint

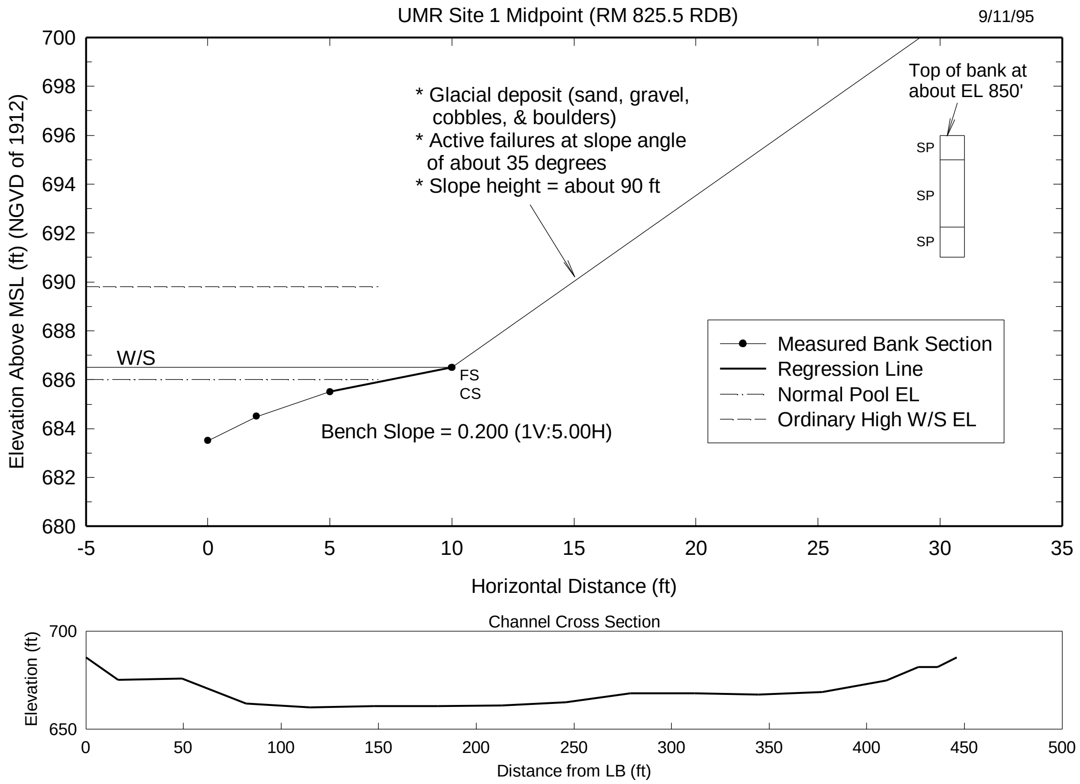


Figure 7-7 Bank section and channel cross section measured at Site 1 midpoint

Table 7-3 Sediment grade scale

Size Range (mm)	Class Name	Class Name Abbreviation
64-32	Very Coarse Gravel	**VCG**
32-16	Coarse Gravel	**CG**
16-8	Medium Gravel	**MG**
8-4	Fine Gravel	**FG**
4-2	Very Fine Gravel	**VFG**
2.000-1.000	Very Coarse Sand	**VCS**
1.000-0.500	Coarse Sand	**CS**
0.500-0.250	Medium Sand	**MS**
0.250-0.125	Fine Sand	**FS**
0.125-0.062	Very Fine Sand	**VFS**
0.062-0.031	Coarse Silt	**CST**
0.031-0.016	Medium Silt	**MST**
0.016-0.008	Fine Silt	**FST**
0.008-0.004	Very Fine Silt	**VFST**
0.004-0.002	Coarse Clay	**CC**
0.0020-0.0010	Medium Clay	**MC**
0.0010-0.0005	Fine Clay	**FC**
0.0005-0.00024	Very Fine Clay	**VFC**

Table 7-4 Unified soil classification system adopted from PLATE 5 Appendix G - Demonstration projects on other streams, nationwide, Vol. 2 of 2, U.S. Army Corps of Engineers, December 1981

Major Divisions			Group Symbols	Typical Names
COARSE GRAINED SOILS - 50% or more retained on the No. 200 sieve	GRAVELS - More than half of coarse fraction retained on the No. 4 sieve	Clean sands	**GW**	Well-graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines	**GM**	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS - More than half of coarse fraction passing the No. 4 sieve	Clean sands	**SW**	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sands, little or no fines
		Sands with fines	**SM**	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS - More than 50% passing the No. 200 sieve	SILTS AND CLAYS	Liquid limit below 50%	**ML**	Inorganic silts and very fine sands, rock flour, silty fine sands or silts - plastically below "A" line
			CL	Inorganic clays, gravelly clays, sandy clays, lean clays - plastically above "A" line
			OL	Organic silts and organic clays - plastically below "A" line
		Liquid limit 50% and above	**MH**	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts - plastically below "A" line
			CH	Inorganic fat clays - plastically above "A" line
			OH	Organic clays or organic silts - plastically below "A" line
Highly organic soils			**PT**	Peat, organic content greater than 60%

Table 7-5a A summary of bank-erosion study sites and their characteristics

No.	Site No.	Date	RM (mi)	Pool No.	Location Identification	Site Characteristics (Close to Sailing Line?: Y/N)	W/S EL (ft)	Bench Slope	OHWL (ft)	NPL (ft)	Erosion Type
1	1	9/11/95	825.5R	2	Midpt	Outside Bend/Glacial Deposit/(Y)	686.5	0.200	689.8	686.0	F
2	2	9/11/95	791.7R	4	U/S Pt		669.5	0.222	671.3	666.6	E
3	2	9/11/95	791.7R	4	Midpt	Outside Bend/Displaced Riprap/(N)	669.5	0.130	671.3	666.6	E
4	2	9/11/95	791.5R	4	D/S Pt		669.5	0.150	671.2	666.6	E
5	3	9/12/95	763.4L	4	U/S Pt		667.5	0.127	668.2	665.3	E & F
6	3	9/12/95	763.4L	4	Midpt	Straight/D.S. of Chippewa/Dredge/(N)	667.5	0.100	668.2	665.3	F
7	3	9/12/95	763.4L	4	D/S Pt		667.5	0.153	668.2	665.3	E & F
8	4	9/12/95	751.1L	5	U/S Pt	Less than 2 miles downstream from L&D 4	660.8	0.217	661.8	658.7	E
9	4	9/12/95	751.1L	5	Midpt	Outside Bend/Mooring Facilities/(Y)	660.8	0.200	661.8	658.7	E
10	4	9/12/95	751.1L	5	D/S Pt		660.8	0.106	661.8	658.7	E
11	5	9/13/95	746.5L	5	U/S Pt		660.4	0.313	661.1	658.5	F
12	5	9/13/95	746.4L	5	Midpt	Outside Bend/Island/Dredge/(Y)	660.4	0.183	661.1	658.5	F
13	5	9/13/95	746.3L	5	D/S Pt		660.4	0.139	661.1	658.5	F
14	6	9/13/95	727.4R	6	U/S Pt	Only 1 mile downstream from L&D 5A	646.4	0.164	647.8	643.8	E
15	6	9/13/95	727.4R	6	Mid Pt	Outside Bend/Island/(Y)	646.4	0.196	647.8	643.8	E
16	6	9/13/95	727.4R	6	D/S Pt		646.4	0.132	647.8	643.8	E
17	7	9/13/95	727.4L	6	Midpt	Inside Bend/Island/1 mile D.S. from L&D 5A/(N)	646.4	0.136	647.8	643.8	E
18	8	9/14/95	677.7R	9	U/S Pt	Only 1.7 mi downstream of L&D 8	622.6	0.204	625.1	619.9	C
19	8	9/14/95	677.5R	9	Midpt	Outside Bend/Channel Erosion/(Y)	622.6	0.161	625.1	619.9	C
20	8	9/14/95	677.5R	9	D/S Pt		622.6	0.176	625.0	619.9	C
21	9	9/14/95	677.5L	9	Midpt	Inside Bend/Island/1.7 mile D.S. of L&D 8/(N)	622.6	0.161	625.0	619.9	E & F
22	10	9/15/95	669.5R	9	U/S Pt		622.0	0.081	623.7	619.5	D & E
23	10	9/15/95	669.5R	9	Midpt	Outside Bend/Dredge Spoil/(Y)	622.0	0.111	623.6	619.5	D & E
24	10	9/15/95	669.5R	9	D/S Pt		622.0	0.122	623.6	619.5	D & E
25	11	9/16/95	620.5L	10	U/S Pt	5.5 mi upstream from L&D 10	610.2	0.081	612.3	609.1	D & E
26	11	9/16/95	620.5L	10	Midpt	Crossover/Island/U.S. of Wing Dam/(N)	610.2	0.148	612.3	609.1	D & E
27	11	9/16/95	620.5L	10	D/S Pt		610.2	0.078	612.3	609.1	D & E
28	12	9/16/95	613.6L	11	U/S Pt	Only 1.5 mi downstream from L&D 10	605.8	0.012	608.0	602.7	E & F
29	12	9/16/95	613.6L	11	Midpt	Outside Bank/Island/Dredge/(Y)	605.8	0.033	608.0	602.7	E & F
30	12	9/16/95	613.4L	11	D/S Pt	D.S. of Ackerman's Cut	605.8	0.131	608.0	602.7	E & F
31	13	9/16/95	613.6R	11	Midpt	Inside Bend/Island/Wing-Dam Field/(N)	605.8	0.125	608.0	602.7	E
32	14	9/16/95	607.5R	11	U/S Pt		604.8	0.109	606.8	602.5	A & B

Table 7-5b A summary of bank-erosion study sites and their characteristics

No.	Site No.	Date	RM (mi)	Pool No.	Location Identification	Site Characteristics (Close to Sailing Line?: Y/N)	W/S EL (ft)	Bench Slope	OHWL (ft)	NPL (ft)	Erosion Type
33	14	9/16/95	607.5R	11	Midpt	Inside Bend/Fleeting Area/(N)	604.8	0.145	606.8	602.5	**A & B**
34	14	9/16/95	607.5R	11	D/S Pt		604.8	0.075	606.8	602.5	**A & B**
35	15	9/17/95	576.0L	12	U/S Pt		593.7	0.086	595.5	590.5	**C**
36	15	9/17/95	576.0L	12	Midpt	Inside Bend/Island/Fleeting/Riprap Protection/(N)	593.7	0.160	595.5	590.5	**C**
37	15	9/17/95	576.0L	12	D/S Pt		593.7	0.059	595.5	590.5	**C**
38	16	9/17/95	551.9L	13	U/S Pt		585.5	0.286	588.0	582.9	**C**
39	16	9/17/95	551.9L	13	Midpt	Inside Bend/Island/Channel Erosion/(Y)	585.5	0.358	588.0	582.9	**C**
40	16	9/17/95	551.9L	13	D/S Pt		585.5	0.096	588.0	582.9	**C**
41	17	9/18/95	512.7L	14	U/S Limit		573.2	0.105	575.9	571.3	**D**
42	17	9/18/95	512.7L	14	U/S 1/4 Pt		573.2	0.056	575.9	571.3	**D**
43	17	9/18/95	512.7L	14	Back Chan U/S 1/3 Pt		573.2	0.145	575.9	571.3	**D & E**
44	17	9/18/95	512.7L	14	Midpt	Straight/Island/Wing-Dam Field/(N)	573.2	0.059	575.9	571.3	**D & E**
45	17	9/18/95	512.7L	14	D/S 1/4 Pt		573.2	0.188	575.9	571.3	**E**
46	17	9/18/95	512.7L	14	Back Chan D/S 1/3 Pt		573.2	0.066	575.9	571.3	**E**
47	17	9/18/95	512.7L	14	D/S Limit		573.2	0.054	575.9	571.3	**E**
48	18	9/18/95	509.2R	14	U/S Pt		572.6	0.182	574.5	571.0	**D, E, & F**
49	18	9/18/95	509.2R	14	Midpt	Straight/Island/Channel Erosion/(Y)	572.6	0.133	574.5	571.0	**D, E, & F**
50	18	9/18/95	509.2R	14	D/S Pt		572.6	0.117	574.5	571.0	**D, E, & F**
51	19	9/18/95	509.2L	14	Midpt	Straight/Glacial Deposit/(N)	572.6	0.134	574.5	571.0	**F**
52	19	9/18/95	509.2L	14	D/S Pt		572.6	0.174	574.5	571.0	**F**
53	21	10/2/95	466.9L	16	U/S Tip of Island		545.8	0.295	546.8	541.8	**C & D**
54	21	10/2/95	466.7L	16	U/S Pt		545.8	0.090	546.8	541.8	**D**
55	21	10/2/95	466.8L	16	Back Chan U/S 1/3 Pt		545.8	0.069	546.8	541.8	**D**
56	21	10/2/95	466.7L	16	Midpt	Straight/Island/(Y)	545.8	0.051	546.8	541.8	**C**
57	21	10/2/95	466.5L	16	D/S 1/4 Pt		545.8	0.068	546.8	541.8	**C**
58	21	10/2/95	466.7L	16	Back Chan D/S 1/3 Pt		545.8	0.094	546.8	541.8	**C**
59	21	10/3/95	466.3L	16	D/S Toe of Island		545.8	0.077	546.8	541.8	**C**
60	22	10/3/95	436.4L	18	U/S Limit		531.0	0.116	535.4	527.0	**C**
61	22	10/3/95	436.4L	18	U/S 1/4 Pt		531.0	0.146	535.4	527.0	**C**
62	22	10/3/95	436.4L	18	Midpt	Straight/D.S. of L&D 17/(Y)	531.0	0.106	535.4	527.0	**C**
63	22	10/3/95	436.4L	18	D/S 1/4 Pt		531.0	0.417	535.4	527.0	**C**
64	22	10/3/95	436.4L	18	D/S Limit		531.0	0.207	535.4	527.0	**C**

Table 7-5c A summary of bank-erosion study sites and their characteristics

No.	Site No.	Date	RM (mi)	Pool No.	Location Identification	Site Characteristics (Close to Sailing Line?: Y/N)	W/S EL (ft)	Bench Slope	OHWL (ft)	NPL (ft)	Erosion Type
65	23	10/3/95	436.4R	18	U/S Pt	Straight/Island/Failed Riprap/(N)	531.0	0.068	535.4	527.0	C
66	23	10/3/95	436.4R	18	D/S pt		531.0	0.145	535.4	527.0	C
67	24	10/3/95	432.3L	18	U/S Pt		530.0	0.159	535.4	527.0	F
68	24	10/3/95	432.3L	18	Midpt	Outside Bank/(Y)	530.0	0.151	535.4	527.0	F
69	24	10/3/95	432.3L	18	D/S Pt		530.0	0.192	535.4	527.0	F
70	25	10/3/95	432.3R	18	Midpt	Inside Bank/Island/Channel Erosion/(N)	530.0	0.336	535.4	527.0	C & D
71	26	10/3/95	420.0R	18	U/S Pt		528.5	0.130	530.7	526.6	E & F
72	26	10/3/95	420.0R	18	Midpt	Straight/Island/Wing-Dam Field/(Y)	528.5	0.105	530.7	526.6	E & F
73	26	10/3/95	420.0R	18	D/S Pt		528.5	0.200	530.7	526.6	E & F
74	27	10/4/95	360.0R	20	Midpt	Straight/Wing Dams/D.S. of Des Moines Conf./(N)	481.5	0.119	485.0	478.0	A
75	28	10/4/95	357.6R	20	Midpt	Crossover/Island/(Y)	481.2	0.168	484.5	477.7	A
76	29	10/5/95	339.4L	21	U/S Pt		471.8	0.143	475.2	469.5	A, B, & C
77	29	10/5/95	339.3L	21	Midpt	Straight/Island/Wing Dams/(N)	471.8	0.136	475.2	469.5	A, B, & C
78	29	10/5/95	339.3L	21	D/S Pt		471.8	0.073	475.2	469.5	A, B, & C
79	30	10/5/95	339.3R	21	Midpt	Straight/(Y)	471.8	0.106	475.2	469.5	C
80	31	10/6/95	293.0L	24	Midpt	Inside Bend/Island/Wing Dams/(N)	450.8	0.092	459.0	449.8	D & E
81	32	10/11/95	275.3R	24	Midpt	Inside Bend/U.S. of L&D 24/Mooring Site/(Y)	449.0	0.159	452.0	449.0	A
82	33	10/12/95	266.5L	25	Midpt	Crossover/Island/(N)	436.6	0.144	447.5	435.6	A
83	34	10/13/95	232.2R	26	Midpt	Straight/Chute Outlet/(Y)	421.0	0.113	432.0	420.3	A
84	35	10/13/95	222.1R	26	U/S Pt		419.4	0.129	428.5	419.9	A
85	35	10/13/95	222.1R	26	Midpt	Straight/Island/(Y)	419.4	0.119	428.5	419.9	A
86	35	10/13/95	222.1R	26	D/S Pt		419.4	0.097	428.5	419.9	A
87	36	10/13/95	217.5R	26	Midpt	Straight/Confluence of ILWW/(N)	419.4	0.076	427.5	419.4	C
88	37	10/14/95	197.6R	27	Midpt	Inside Bank/U.S. of Missouri River/Mooring/(N)	403.6	0.115	423.0	401.1	C
89	38	10/14/95	175.2L	Open	Midpt	Straight/Fleeting Area/(Y)	389.6	0.141	390.6	386.8	A, B, & C
90	39	10/15/95	112.4L	Open	Midpt	Inside Bend/Island/Wing-Dam Field/(N)	352.9	0.172	359.7	355.9	A, B, & C
91	40	10/16/95	94.2R	Open	U/S Pt	Outside Bank/Wing-Dam Field/(Y)	347.6	0.488	349.6	345.9	C
92	40	10/16/95	94.1R	Open	D/S Pt		347.6	0.068	349.6	345.8	C
93	41	10/16/95	77.2R	Open	Midpt	Outside Bank/Pleistocene Terracette Failure/(Y)	338.2	0.172	340.1	336.5	E & F
94	42	10/17/95	53.2L	Open	U/S Pt		321.8	0.135	326.3	322.7	A
95	42	10/17/95	53.2L	Open	Midpt	Outside Bend/Riprap Failure/(Y)	321.8	0.092	326.3	322.7	A
96	42	10/17/95	53.2L	Open	D/S Pt		321.8	0.170	326.3	322.7	A
97	43	10/17/95	45.3L	Open	Midpt	Straight/Shale Rock Beach/(Y)	317.4	0.186	322.3	318.8	A
98	44	10/17/95	26.0R	Open	Midpt	Inside Bank/Island/Wing Dams/(Y)	306.9	0.132	311.5	308.1	B

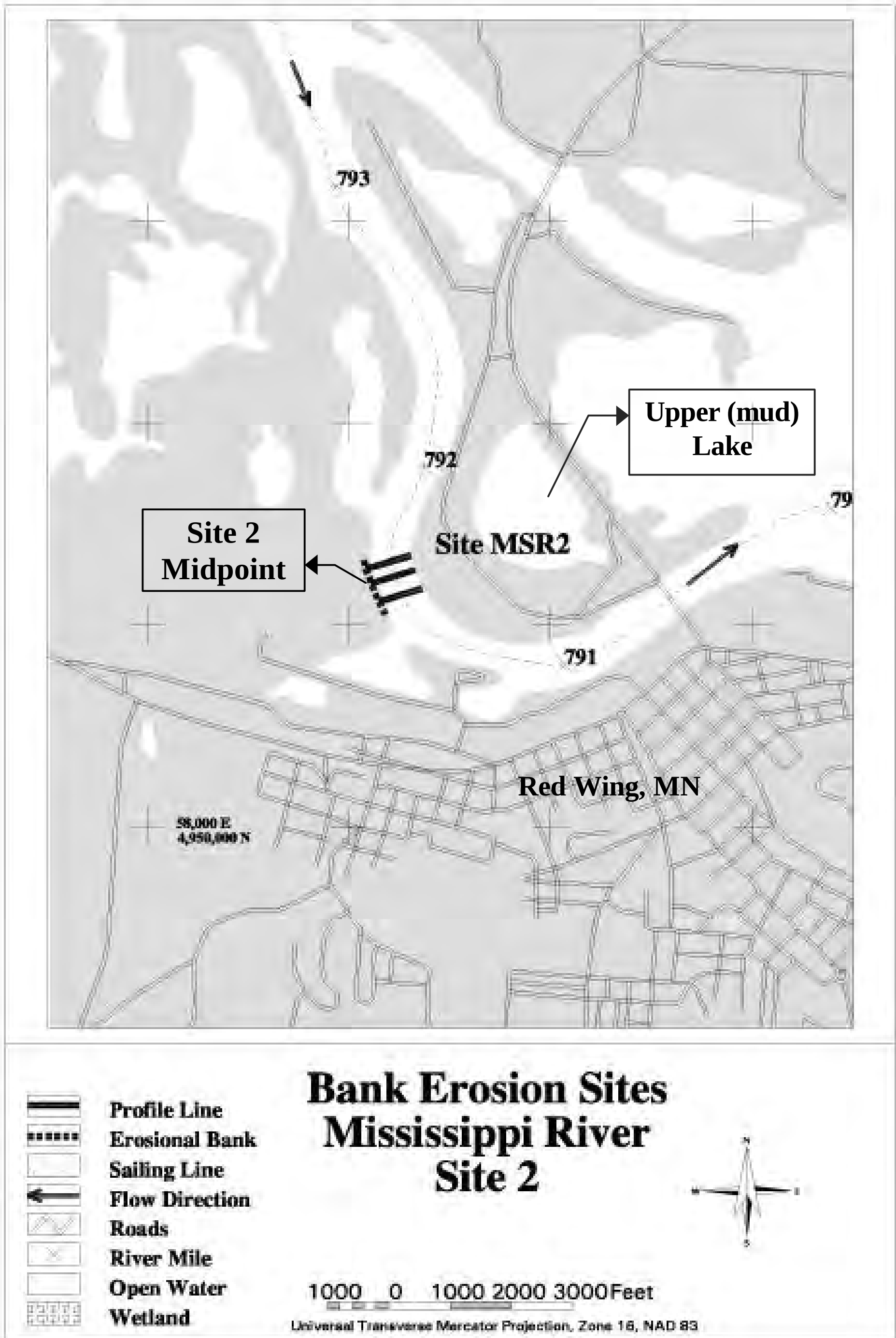


Figure 7-8 A map showing Mississippi River Site 2

Photo 7-13 An upstream view of Site 2 midpoint

Photo 7-14 A downstream view of Site 2 midpoint

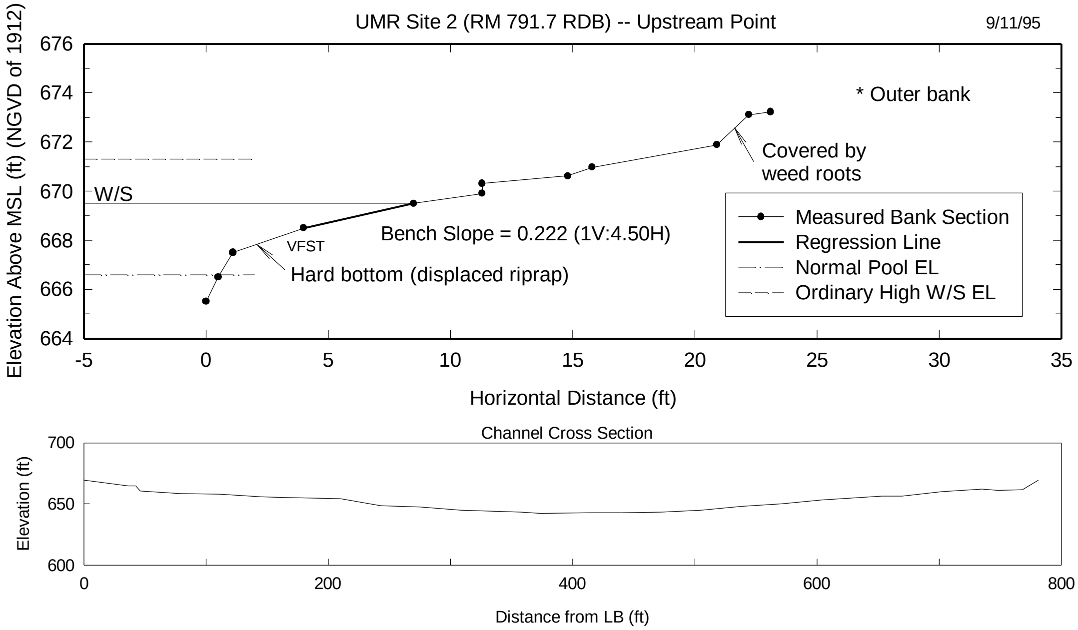


Figure 7-9 Bank section and channel cross section measured at Site 2 upstream point

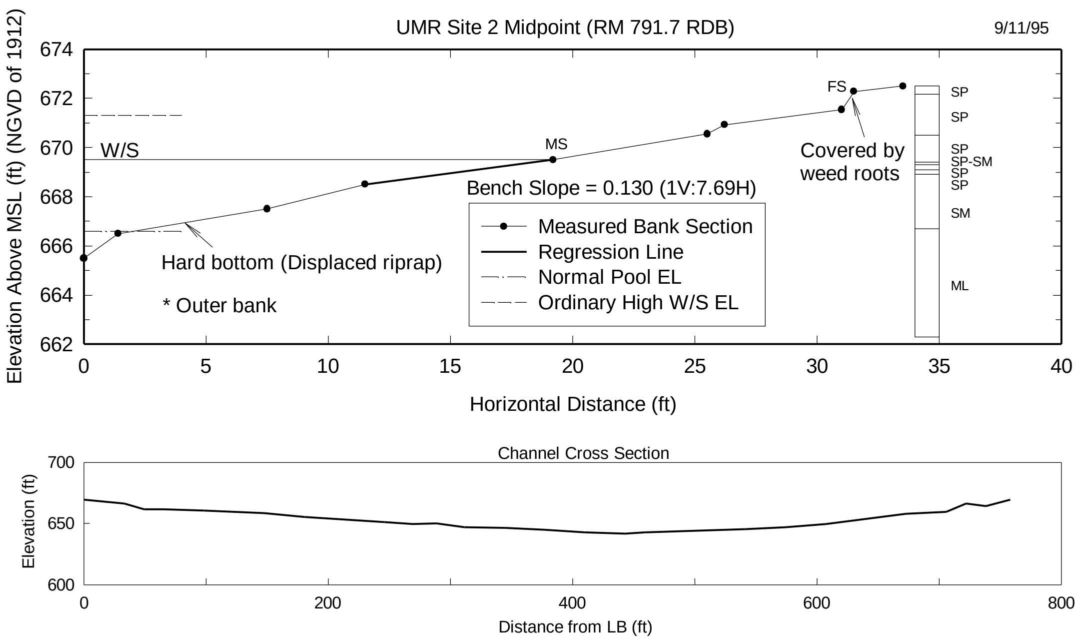


Figure 7-10 Bank section and channel cross section measured at Site 2 midpoint

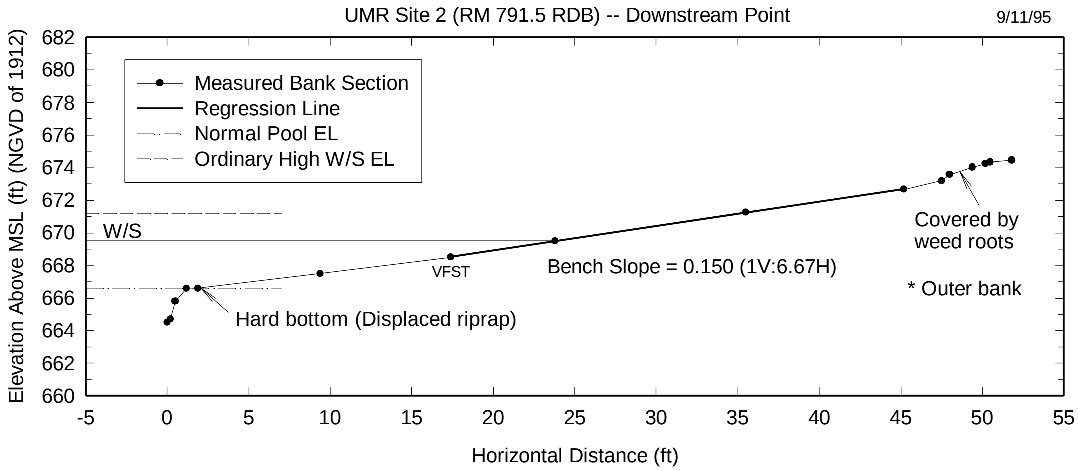


Figure 7-11 Bank section measured at Site 2 downstream point

sand (FS) to medium sand (MS); the stone slope-protection revetment apparently had failed. Subaqueous soil is very fine silt (VFST). Figure 7-9 exhibits a typical rework-transport bank-section pattern which is illustrated in figure 7-5. Several subaerial parallel benches seen in figures 7-9 and 7-10 are considered to be formed at different river stages within a range of stage between NPL and OHWL. Those parallel benches formed at different bank elevations were observed at many other sites investigated.

The tube-core samples showed that the thickness of recent historical alluvial deposits varies greatly at this site, ranging from 0.3 ft to greater than 5.0 ft. Young and very late Holocene deposits lie below historical soils. A weak, thin buried AC horizon is recorded at about 3.1 ft below the surface. Below that horizon are calcareous flood laminae containing partially decomposed gastropod shells and charcoal.

Causative factors for bank retreat at this site include wave and rework-transport of failed soil, and flood-period failure and erosion. Sandy sediment mantles the bench. This site can be classified as Type E.

3. Site 3 at RM 763.4 LDB (Pool 4)

This straight-channel dredged-material disposal site, shown in figure 7-12, is immediately downstream from the mouth of the Chippewa River. A downstream view of the site is shown in Photo 7-15 and dredged-material layers are shown in Photo 7-16. Three bank sections obtained here are shown in figures 7-13 through 7-15. The river water depth along the left bank is extremely shallow, only 2 to 3 ft deep, and the main

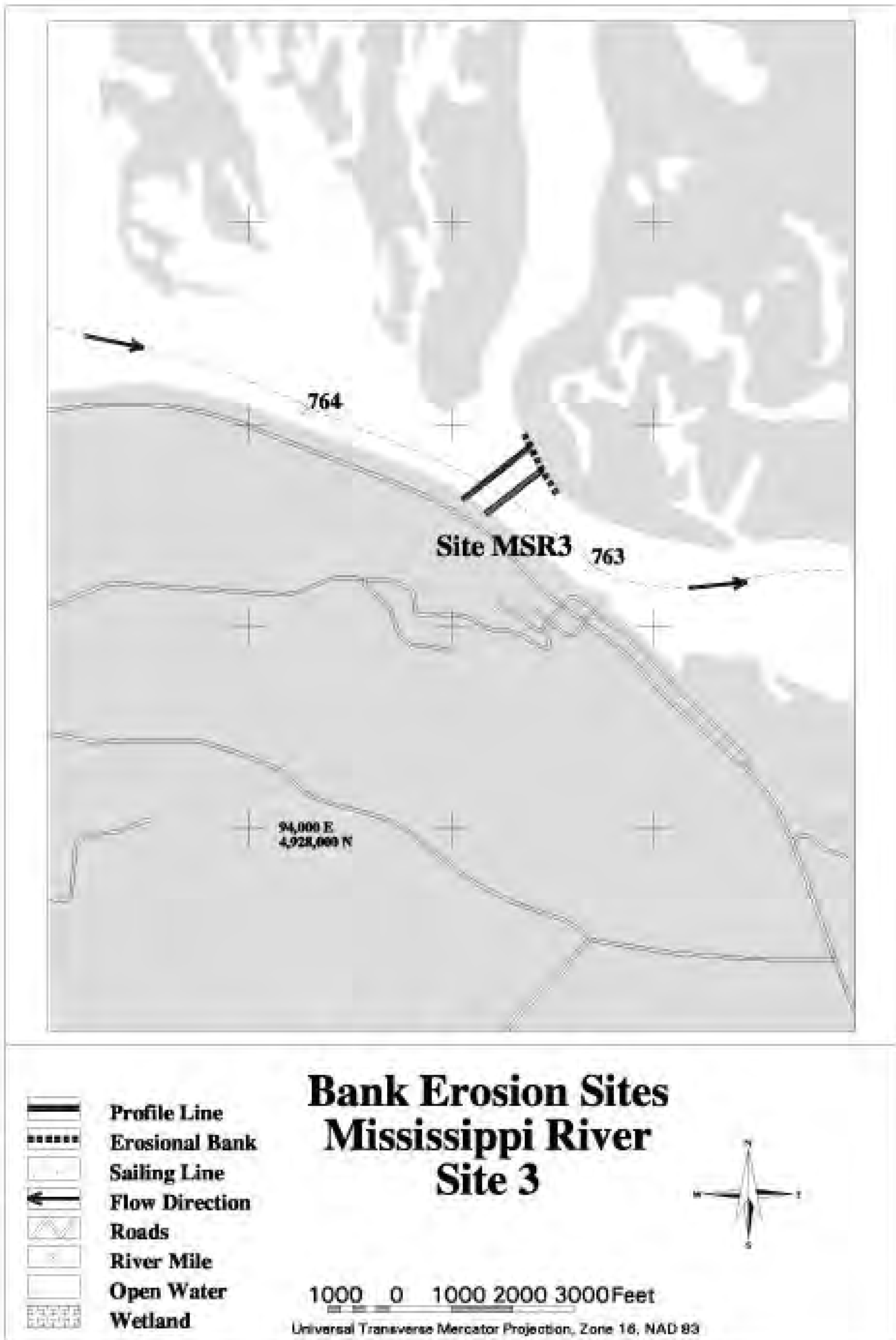


Figure 7-12 A map showing Mississippi River Site 3

channel is located about 600 ft to 800 ft away from the left bank. The dredged bank material consists primarily of medium sand (MS). Subaqueous soil is sand (MS-CS). At the midpoint section, the bank slope was found to be approximately 32°, typical of the angle of shearing resistance of medium dense sand.

Site 3 is located at the distal end of the historical portion of a Chippewa alluvial fan complex. Numerous abandoned tributary channels (former fan outlets) were observed. Two sampling tube cores, taken at this site, indicate that sandy dredged material caps recent historical flood laminae. The native pre-settlement (before ca. 1830) soil was not encountered.

Because there is no erosion protection at this site, dredged material was reworked and transported to the river. The bank-section bench area can be seen clearly in figure 7-14 at the midpoint section. Dredged material at this site is prone to current and wave erosion. The bank sections at the upstream and downstream points are classified as a combination of bank Type E and Type F, and the midpoint section as Type F.

Photo 7-15 A downstream view of Site 3 midpoint

Photo 7-16 Detailed bank-soil structure of Site 3 midpoint

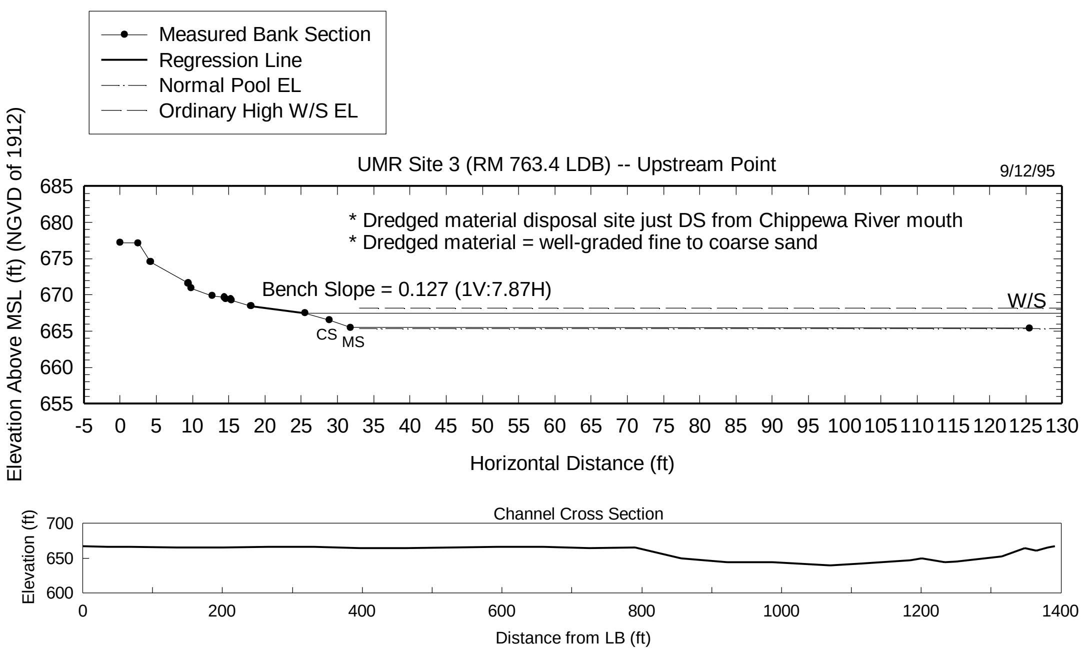


Figure 7-13 Bank section and channel cross section measured at Site 3 upstream point

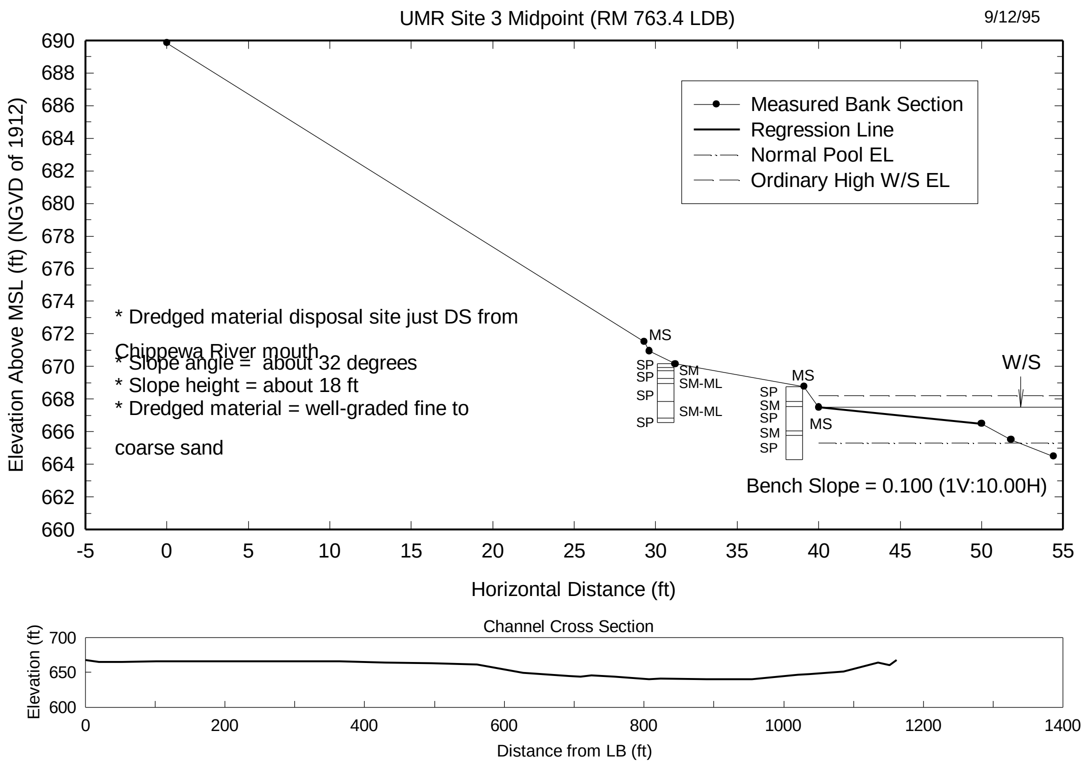


Figure 7-14 Bank section and channel cross section measured at Site 3 midpoint

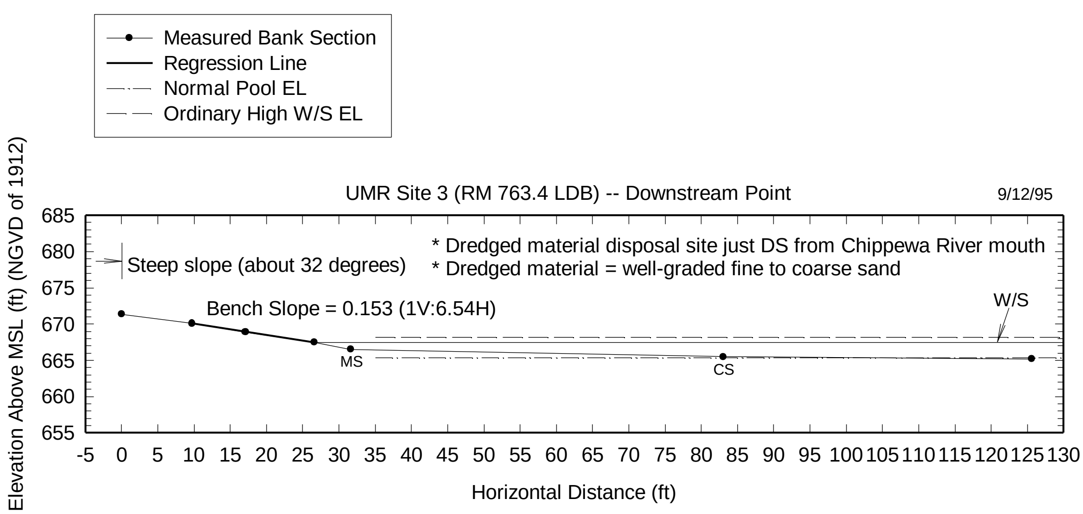


Figure 7-15 Bank section measured at Site 3 downstream point

4. Site 4 at RM 751.1 LDB (Pool 5)

This left-bank site, shown in figure 7-16, is located only about 2 miles downstream from Lock & Dam No. 4, and is adjacent to mooring facilities used by two nearby power plants. A downstream view of the site is shown in Photo 7-17. As shown in figures 7-17 through 7-19, very steep subaqueous slopes exist at this site, which is indicative of in-channel erosion. At the downstream section, evidence of failed revetment was found near the water's edge (see figure 7-19). The bank soils are primarily FS. The soil core sample, taken at the bank and shown in figure 7-18, show multiple layers of SP-ML (see table 7-4) which are judged to be historical deposits due to a series of flood events.

A narrow Holocene meander belt occurs along this reach of the UMR. A deflated outwash terrace and paleochannel system was observed along the western portion of the valley. The Mississippi River Holocene meander belt lies along the eastern portion of the valley where this site is located. Western lateral stream migration has produced a ridge and swale topography from the study site east to the valley wall. Apparent channel stability for several thousand years has produced natural levee deposits at this site. The core sample showed multiple paleosols of late Holocene age. At least six paleosols were recognized below a thin surficial unit of historical alluvium, ranging in age from very late Holocene/early historic, to middle or early late Holocene. Because Archaeological site 47BF160 is nearby at RM 753.0, and because of the existence of multiple paleosols, a high potential exists for buried archaeological material at this study site.

Causative factors for bank retreat at this site include flood erosion and rapid recessional loading and failure, and wave and rework-transport of failed soil and recently deposited sediments. Because of the closeness to the thalweg sailing line and mooring activities, this bench area cover is eroded by waves. All three bank sections are classified as bank Type E.

5. Site 5 at RM 746.4 LDB (Pool 5)

This left-bank, outside-of-bend island site, shown in figure 7-20, is an old dredged material disposal site located about 8 miles upstream from Lock & Dam No. 5. Upstream and downstream views of the site are shown in Photos 7-18 and 7-19, respectively. Three bank sections are plotted in figures 7-21 through 7-23. The subaerial bank as well as the

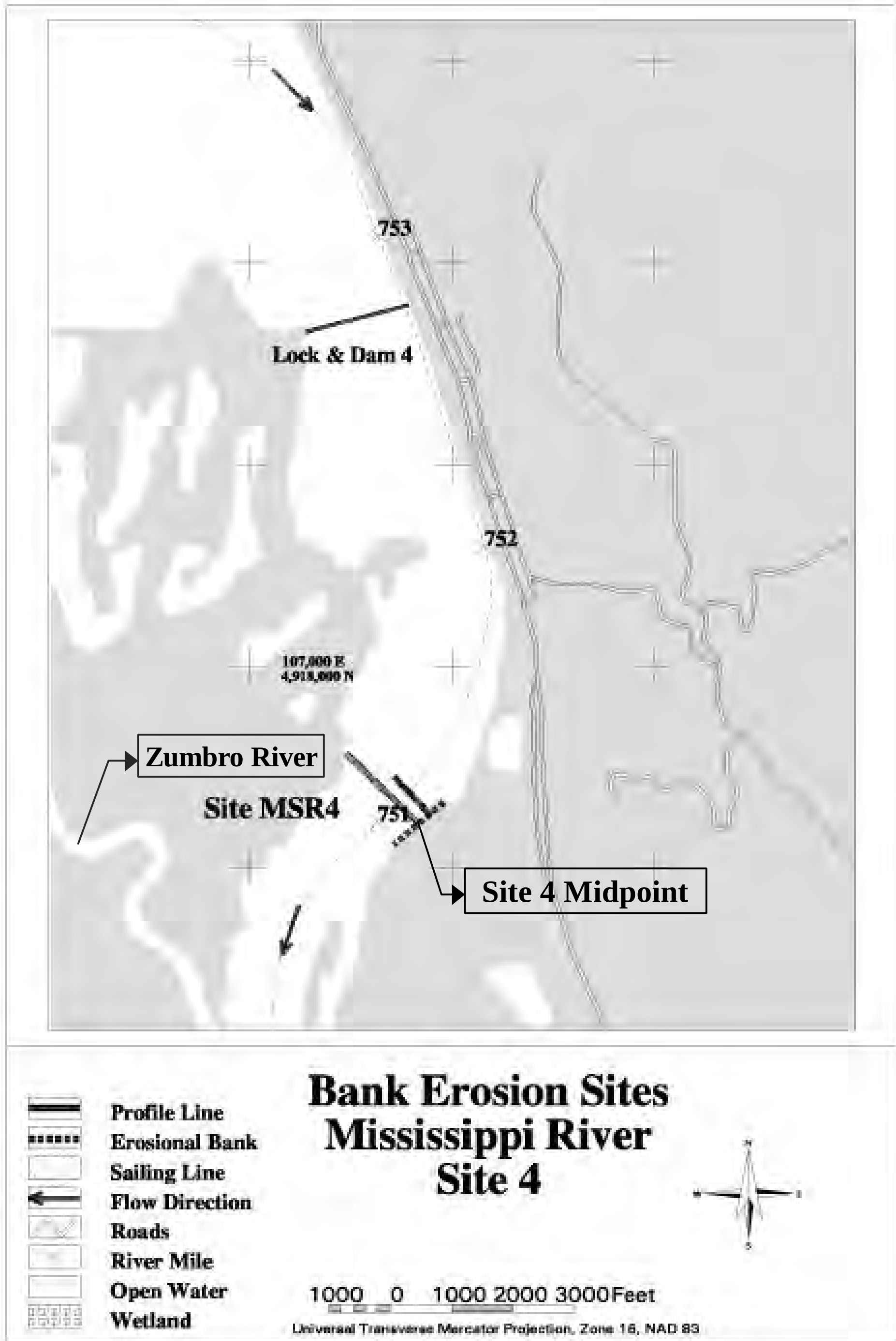


Figure 7-16 A map showing Mississippi River Site 4

Photo 7-17 A downstream view of Site 4 midpoint

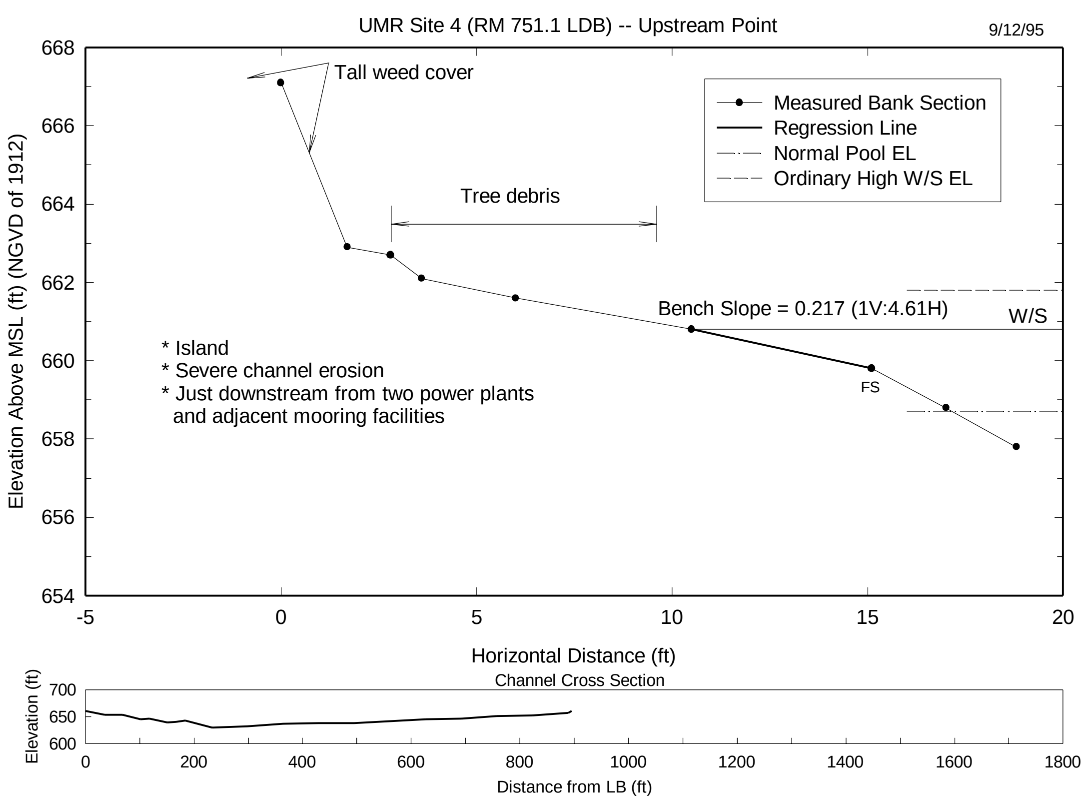
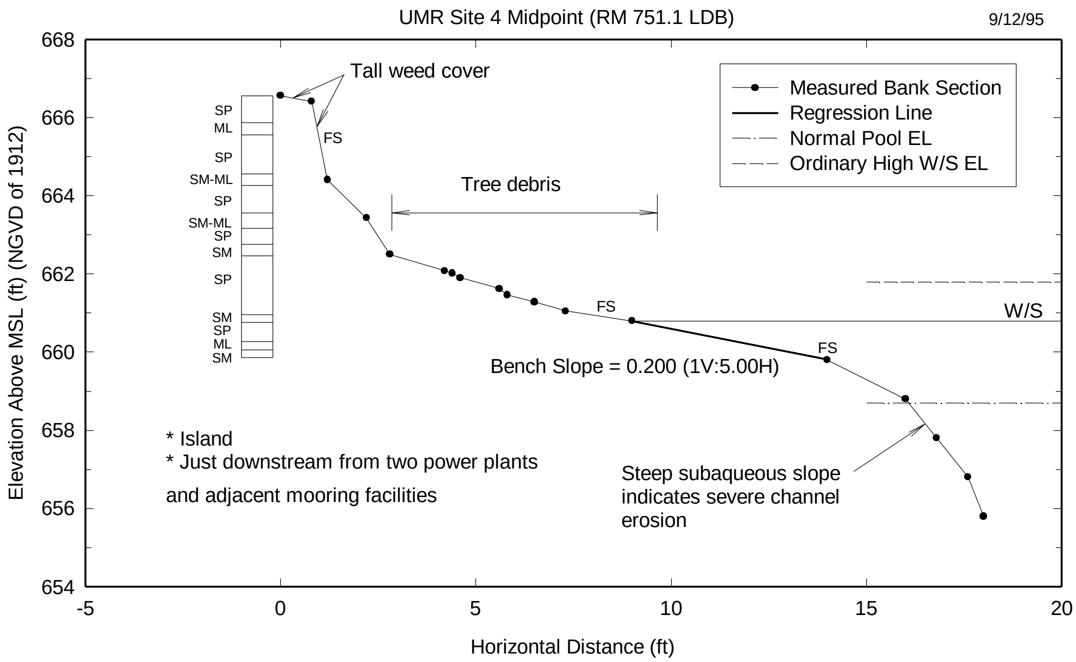


Figure 7-17 Bank section and channel cross section measured at Site 4 upstream point



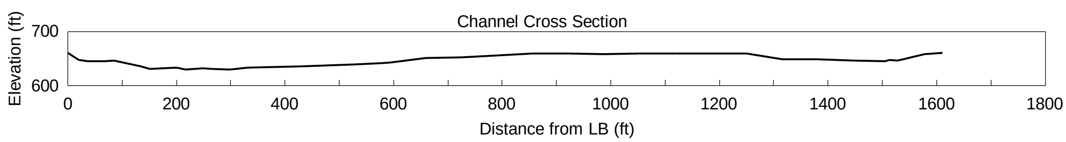


Figure 7-18 Bank section and channel cross section measured at Site 4 midpoint

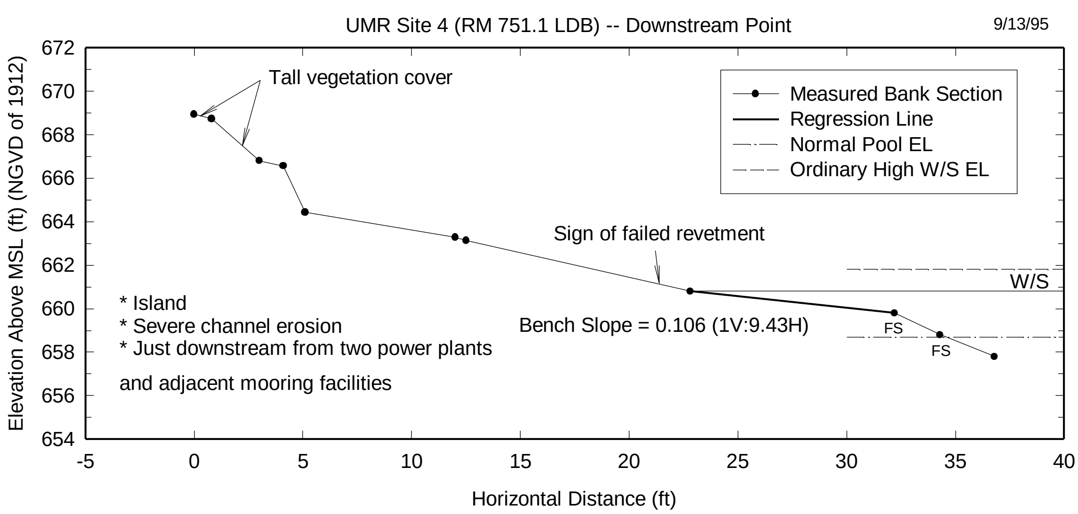


Figure 7-19 Bank section measured at Site 4 downstream point

near-bank subaqueous area are covered by FS, and the site is very close to the thalweg sailing line. As indicated in these figures, bed elevation drops off sharply toward the

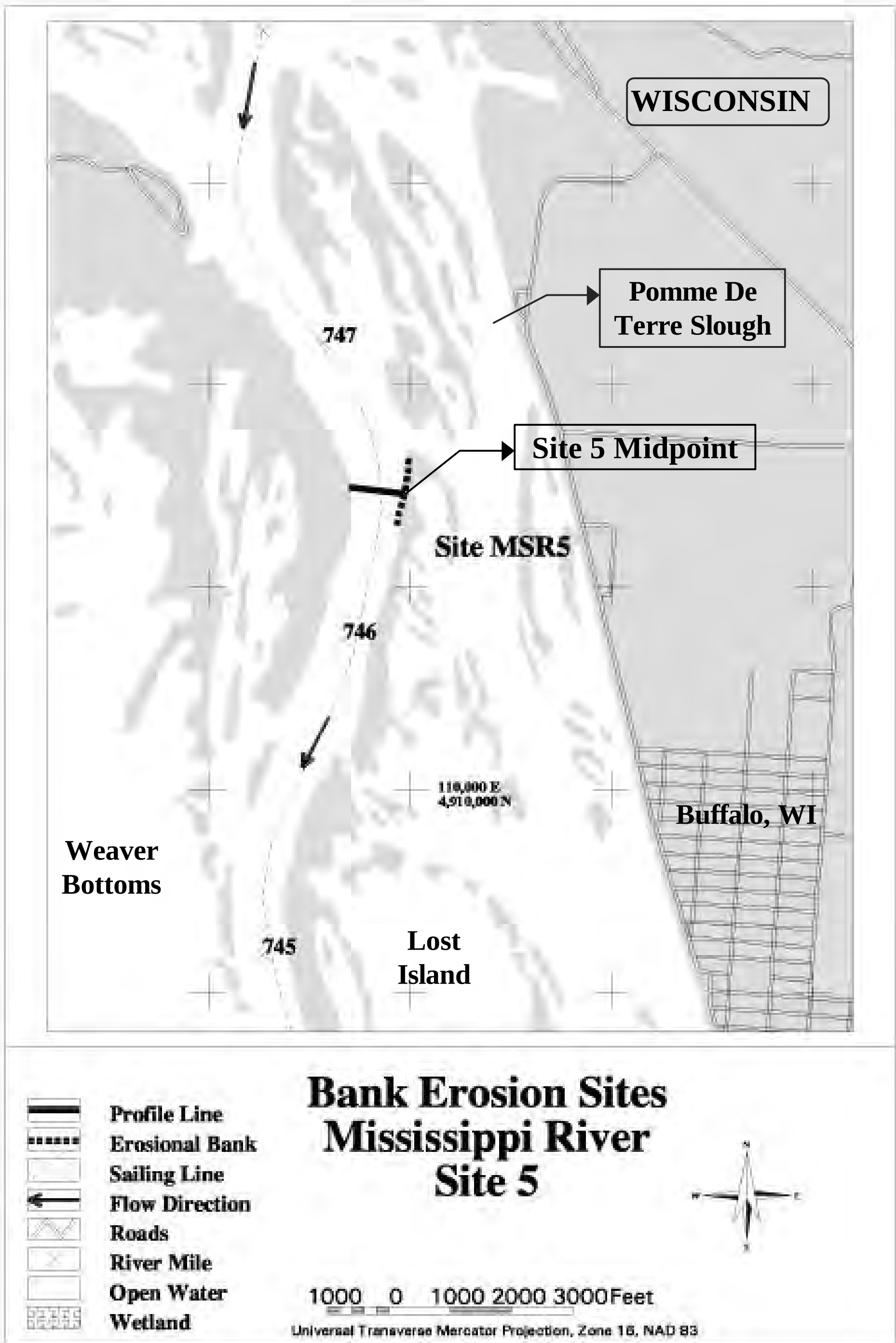


Figure 7-20 A map showing Mississippi River Site 5

Photo 7-18 An upstream view of Site 5 upstream point (see in-channel erosion)

Photo 7-19 A downstream view of Site 5 midpoint

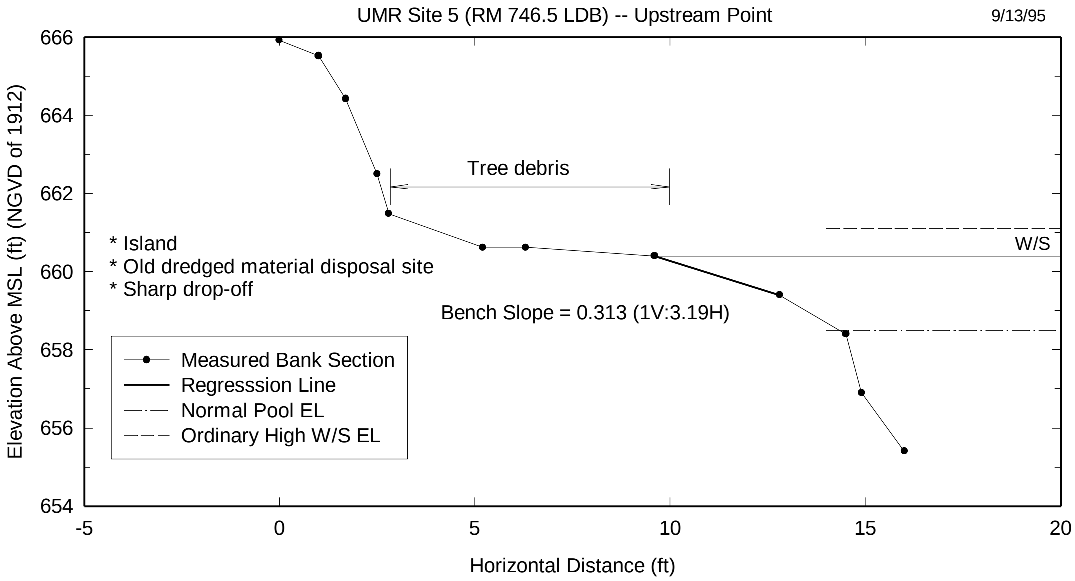


Figure 7-21 Bank section measured at Site 5 upstream point

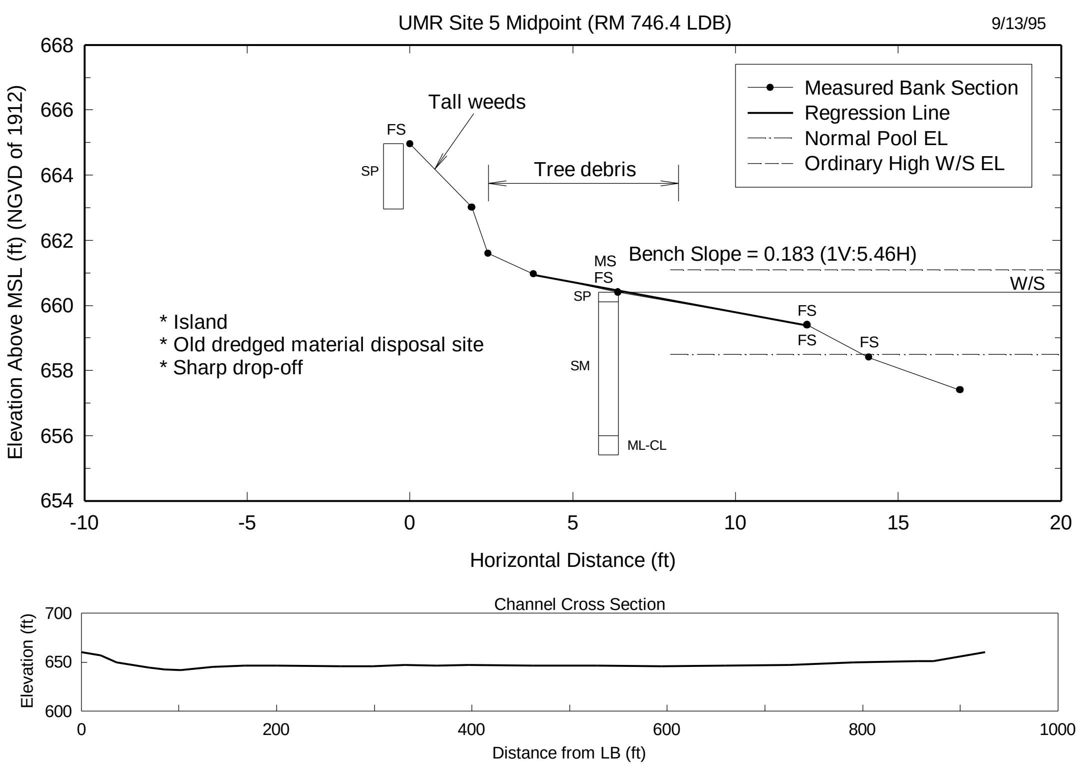


Figure 7-22 Bank section and channel cross section measured at Site 5 midpoint

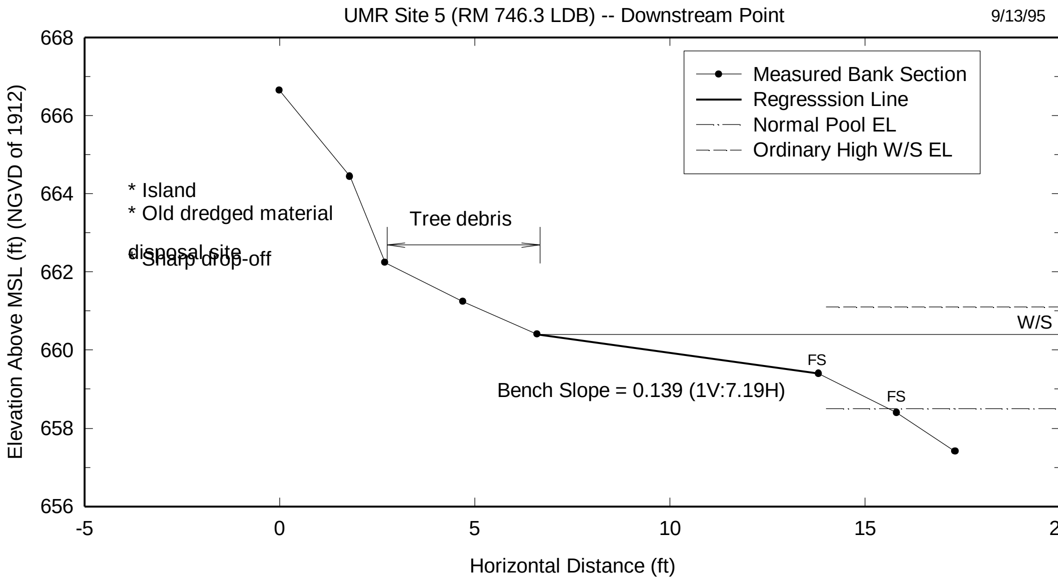


Figure 7-23 Bank section measured at Site 5 downstream point

channel. The bench slope gradually decreased from 0.313 at the upstream point to 0.183 at the midpoint, and to 0.139 at the downstream point along the island. These eroded island banks exhibit steep bench topography near the tip of the island and the bench slope decreases toward the toe of the island. These morphological characteristics were observed at other island sites.

Most of the Holocene surfaces are inundated. An approximately 4.4-ft deep dredge-spoil layer was found in the core sample. The core sample also showed historical alluvium overlying a very poorly drained late Holocene to historical soil.

Causative factors for bank retreat at this site include wave and rework-transport of failed soil and recently deposited sediments and flood erosion. Wave erosion within berm and bench areas appear to be significant at this site. The bank section for this site is classified as Type F.

6. Site 6 at RM 727.4 RDB (Pool 6)

This site was on the right outer bank of a minor river bend, shown in figure 7-24, only about 1 mile downstream from Lock & Dam No. 5A, and the bank is close to the thalweg sailing line. Photos 7-20 and 7-21 show a downstream view and scarp at this site, respectively. The three bank sections obtained at this site are depicted in figures 7-25 through 7-27. The river cross section in figure 7-26 shows the thalweg near the right

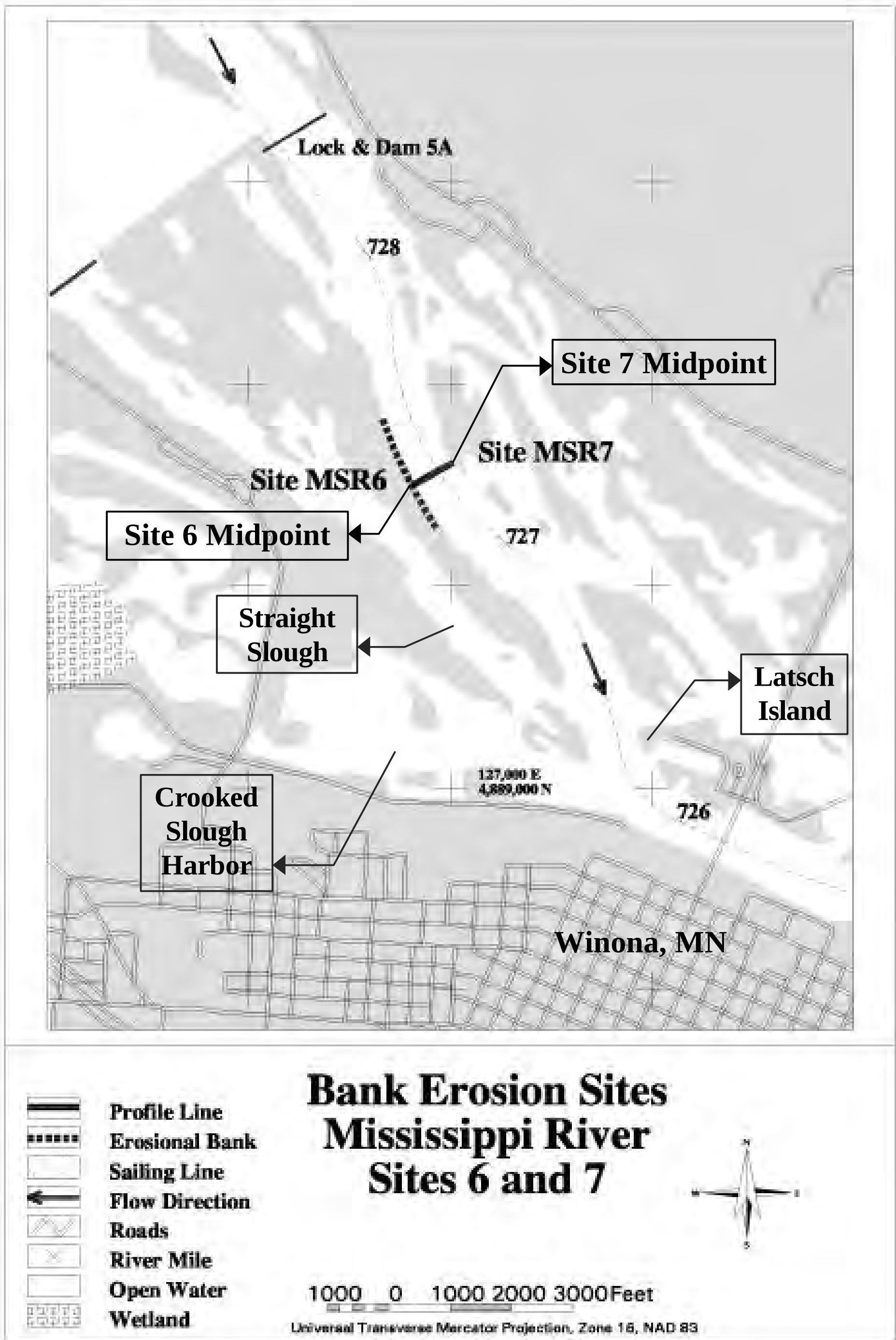


Figure 7-24 A map showing Mississippi River Sites 6 and 7

bank. The bank soil is primarily sand (VFS-MS) and subaqueous sediment is sand (FS-MS). The scarp was covered by grass roots and tree debris.

Photo 7-20 A downstream view of Site 6 midpoint

Photo 7-21 A close-up view of scarp at Site 6 midpoint

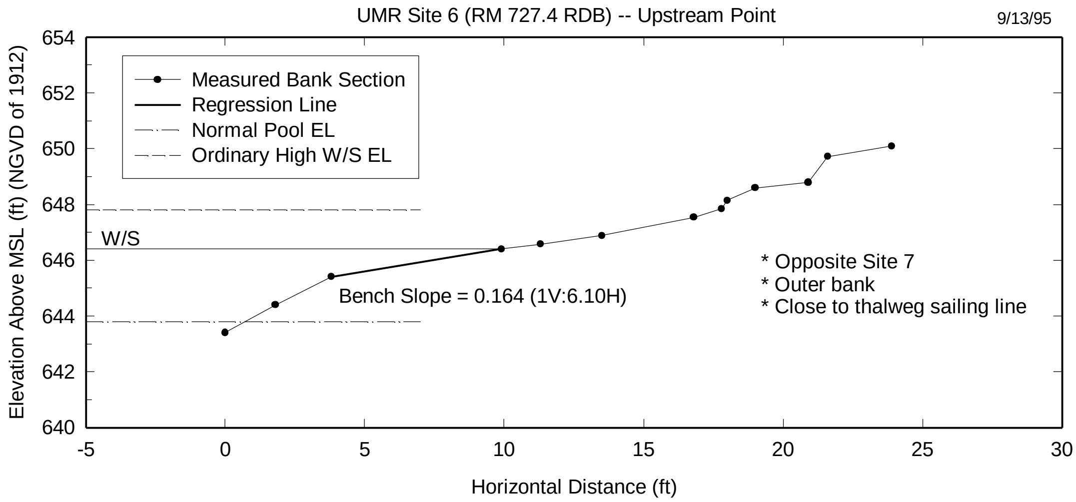


Figure 7-25 Bank section measured at Site 6 upstream point

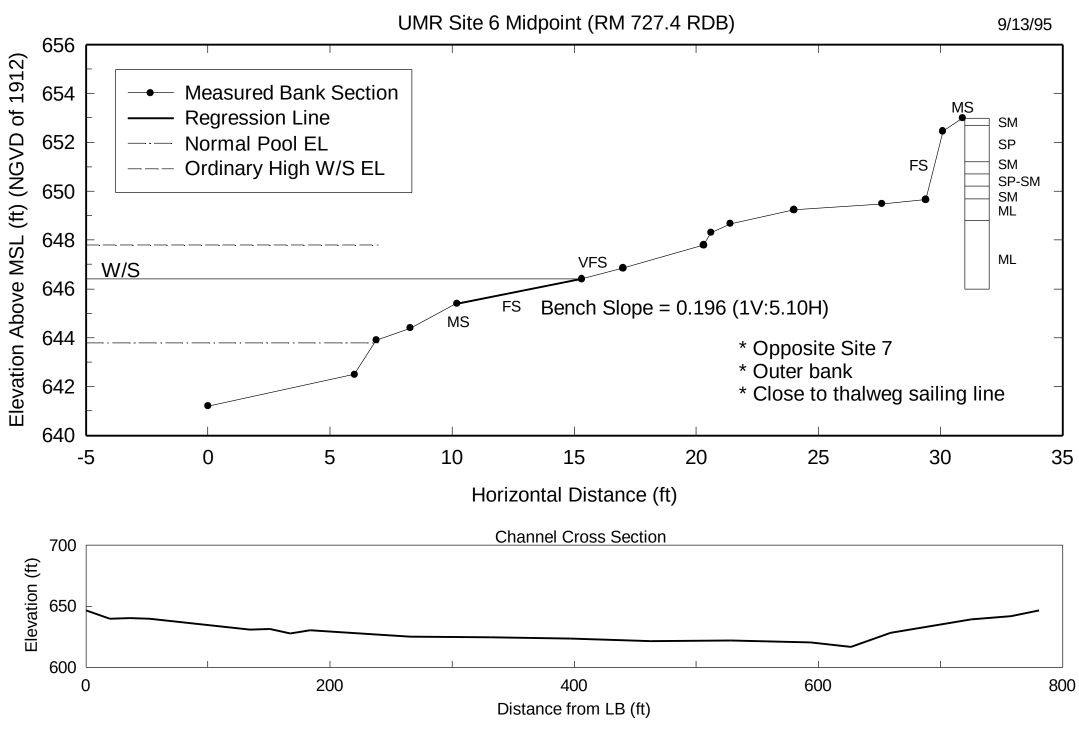


Figure 7-26 Bank section and channel cross section measured at Site 6 midpoint

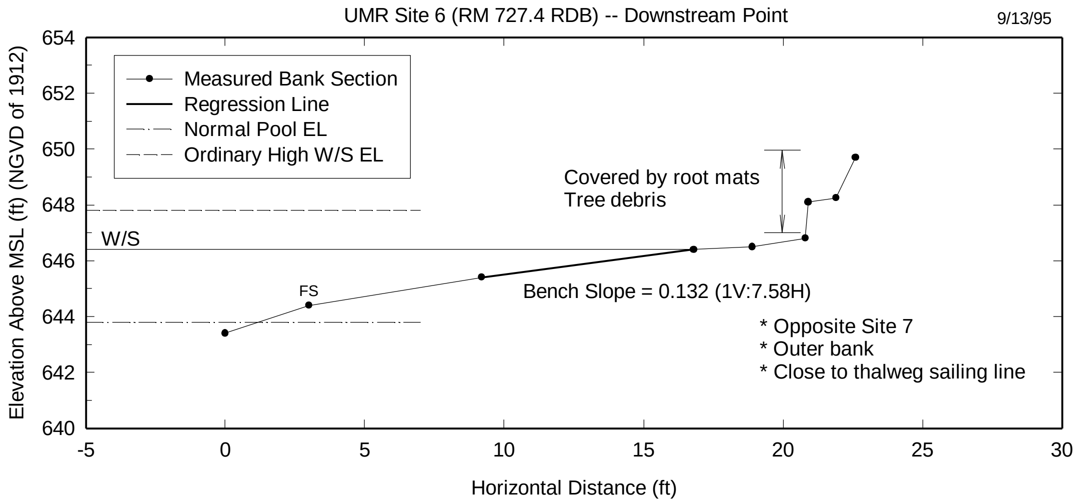


Figure 7-27 Bank section measured at Site 6 downstream point

Observations indicate lateral bank erosion with minor surface erosion. No historical deposits were found in the core sample. Three paleosols were observed in the profile, developed in levee deposits, and they appear to be of late Holocene age. It should be noted that the buried soils occur in a MR natural levee deposit. Because of the buried soils and location in the upper pool, there is potential for buried archaeological material although there are no recorded archaeological sites nearby.

Primary causative factors for bank retreat at this site include flood-flow erosion and rapid recessional loading and failure, wave and rework-transport of failed soils and recently deposited sediments, and minor piping. Wave erosion of sand cover occurs within bench areas at this site. This site is classified as Type E.

7. Site 7 at RM 727.4 LDB (Pool 6)

This site on the left bank of a minor bend, located on island opposite Site 6, is only about 1 mile downstream from Lock & Dam No. 5A (see figure 7-24). The site includes a wing-dam field. Upstream and downstream views of the site are shown in Photos 7-22 and 7-23, respectively. The measured bank section is shown in figure 7-28. The scarp was covered by a grass-root mat. Both the subaerial bank and the subaqueous bench consisted primarily of sand (FS-CS). When the mat was lifted, sand ran freely from the scarp. At the water's edge a 6-in. thick layer of CS was found to lie on top of coarse silt (CST).

The core sample showed historical deposits and a very poorly drained very late Holocene soil profile. The island surface appears to be a late to very late Holocene surface, much younger than the deposits observed across the channel at Site 6. Major historical vertical sediment accretion has occurred at the site along the eastern channel margin.

Primary causative factors for bank retreat at this site include flood erosion, wave and rework-transport within bench and berm areas, and minor piping. Because bench cover is primarily sand, erosion by traffic-induced waves was observed. This site is classified as bank Type E.

Photo 7-22 An upstream view of Site 7 midpoint

Photo 7-23 A down stream view of Site 7 midpoint

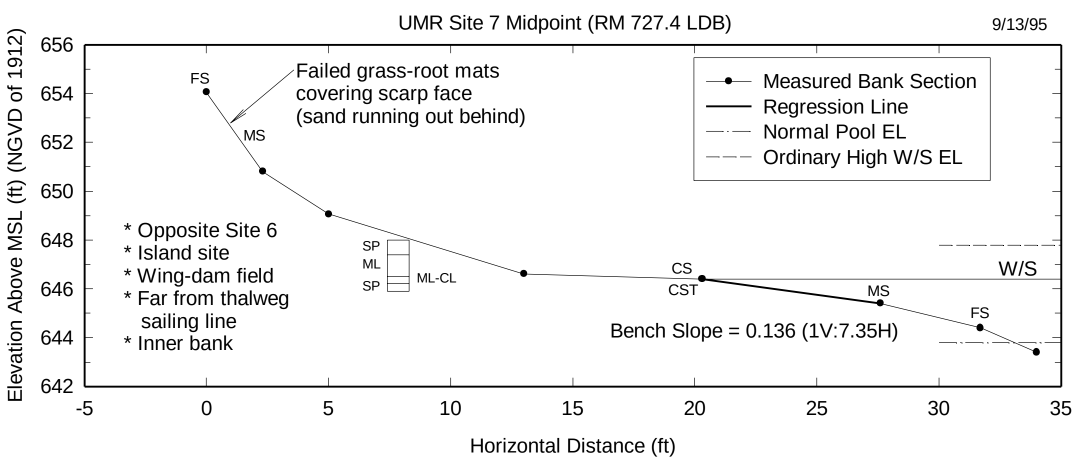


Figure 7-28 Bank section measured at Site 7 midpoint

8. Site 8 at RM 677.5 RDB (Pool 9)

This right-bank site on the outside of a slight bend, shown in figure 7-29, is located only about 1.7 miles downstream from Lock & Dam No. 8. A downstream view of the site is shown in Photo 7-24. Three bank sections obtained at this site are plotted in figures 7-30 through 7-32. The bank soils are predominantly coarse silt (CST defined in table 7-3), and piping features were observed within the entire bank face. The river cross section shown in figure 7-31 is typical for a river bend. Bed level at this site drops off sharply, and the thalweg sailing line is very close to the site. As shown in figure 7-29,

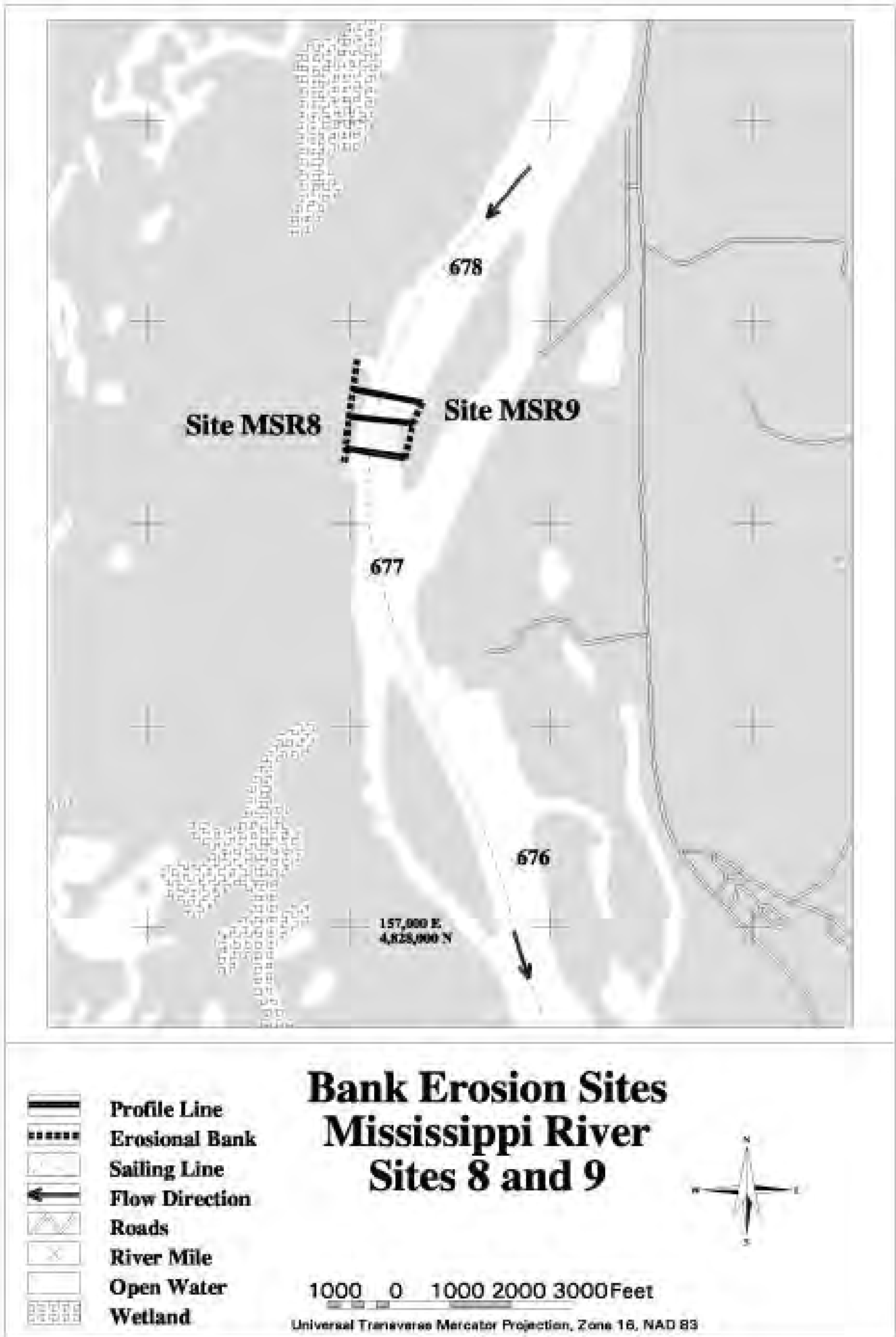


Figure 7-29 A map showing Mississippi River Sites 8 and 9

Photo 7-24 A downstream view of Site 8 midpoint

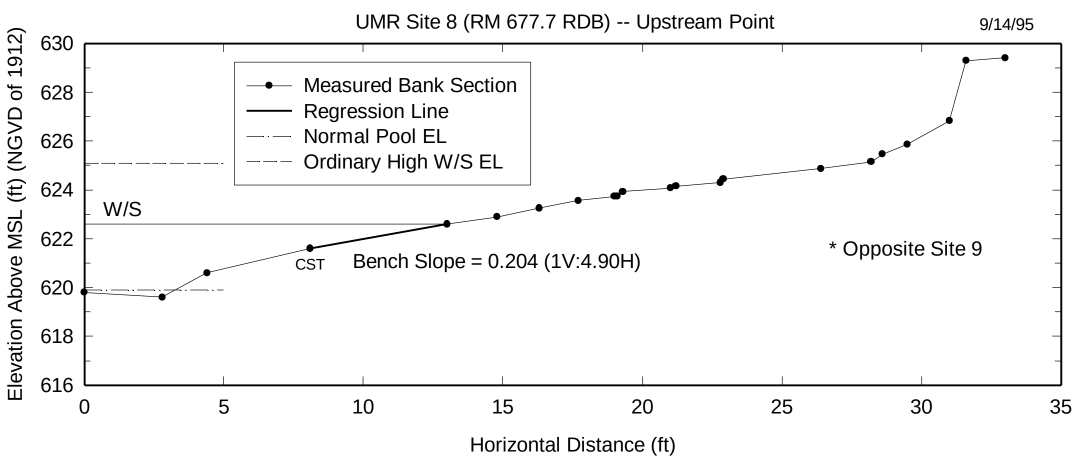


Figure 7-30 Bank section measured at Site 8 upstream point

the bank line at this site had retreated considerably in comparison with that in 1984.

Historical alluvium was encountered from the surface to a depth of 4.3 ft, as shown in figure 7-31. Below the alluvium are late Holocene levee deposits with two buried soils. Multiple-age Holocene surfaces are encountered in this part of Pool 9. The

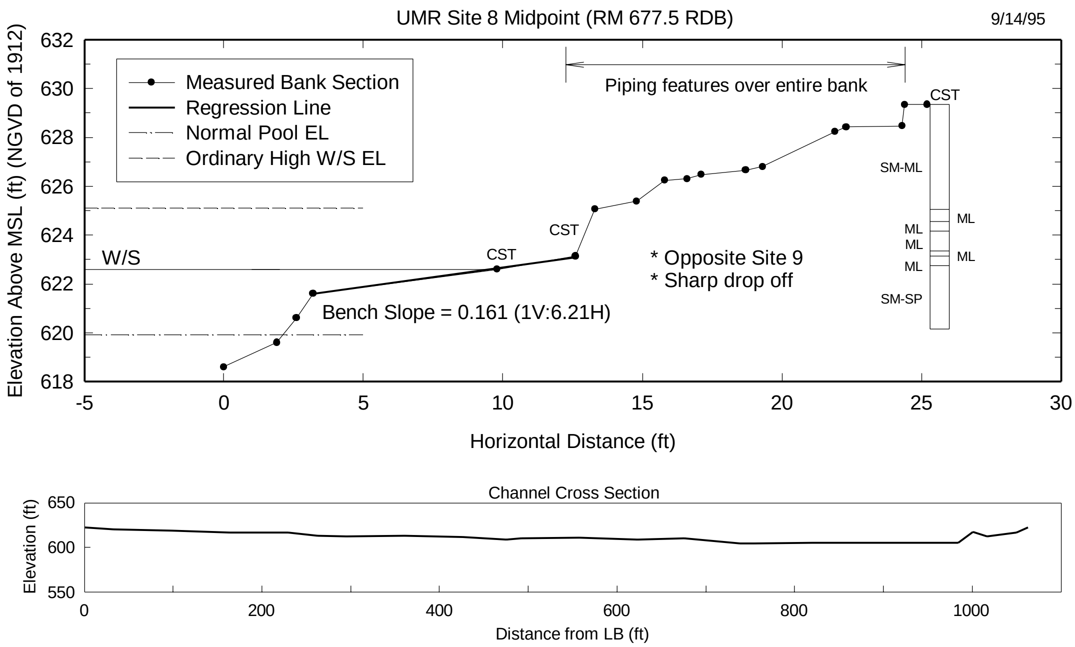


Figure 7-31 Bank section and channel cross section measured at Site 8 midpoint

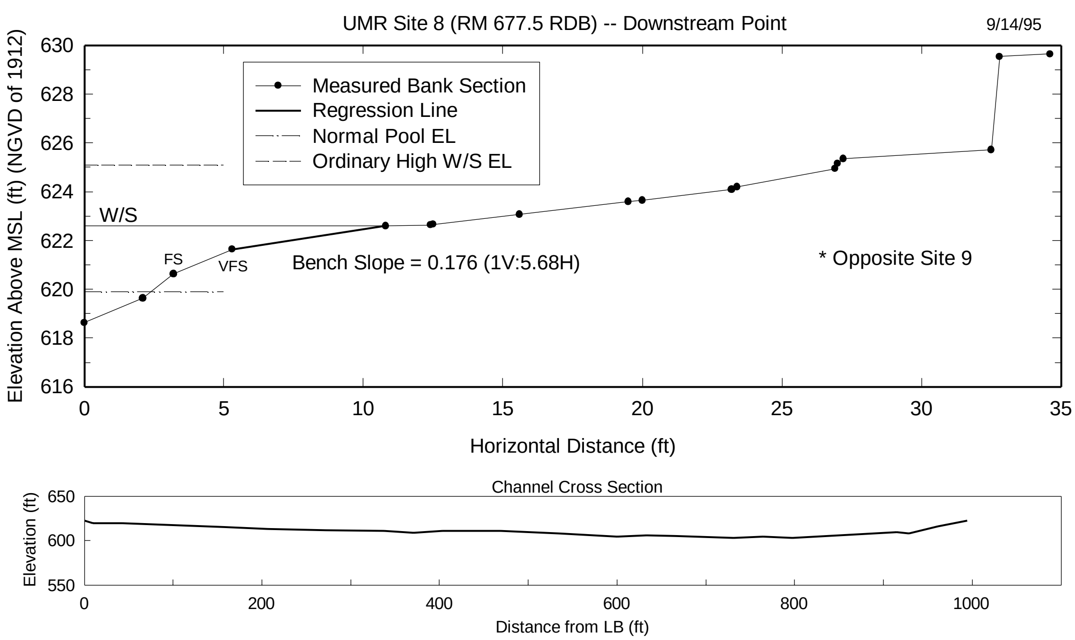


Figure 7-32 Bank section and channel cross section measured at Site 8 downstream point

Holocene surfaces have been buried by a variable thickness of historical alluvium. This site is located on a very late Holocene to historic surface.

Causative factors for bank retreat at this site include flood-flow erosion, wave-flow related rework-transport of failed soils and recently deposited sediments, and piping. Potential for wave erosion of bench areas is significant. This site is classified as Type C.

9. Site 9 at RM 677.5 LDB (Pool 9)

This left-bank site on the inside of a slight bend, shown in figure 7-29, is located opposite Site 8. An upstream view of the site is shown in Photo 7-25. On the other side of this island is Thief Slough. Site 9 is located within a wing-dam field. Bank retreat at this site since 1984 is apparent in figure 7-29. The bank section is shown in figure 7-33, and the bank soils are old dredged material (VFS-MS). A small scarp was covered by a layer of failed grass-root mat.

Photo 7-25 An upstream view of Site 9 midpoint

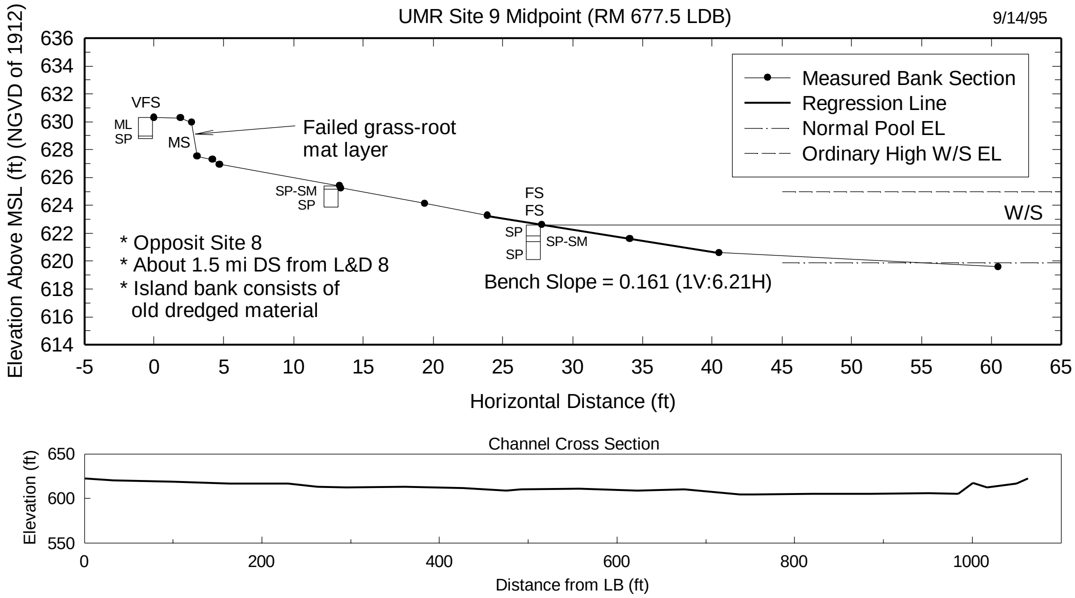


Figure 7-33 Bank section and channel cross section measured at Site 9 midpoint

All three core samples showed dredged material. The deepest core was advanced to 2.5 ft. This island is probably of late to very late Holocene age. The older Holocene surfaces lie on the east and west sides of the island.

The site is far from the thalweg sailing line. Causative factors for bank retreat at this site include wave and rework-transport of failed soils and recently deposited sediments in berm and bench areas, and flood and secondary current erosion. Because of the nature of sandy bench cover, there is potential for wave erosion in bench areas. This site is characterized by a combination of bank Type E and Type F.

10. Site 10 at RM 669.5 RDB (Pool 9)

This right-bank site on the outside of a mild bend, shown in figure 7-34, is located only about 1.5 miles downstream from the mouth of the Upper Iowa River. The bank is covered by fine silt (FST) and sand (VFS-MS), and subaqueous soil is silt (FST-CST). A downstream view of the site is shown in Photo 7-26, and a close-up view of the scarp is shown in Photo 7-27. Three bank sections are shown in figures 7-35 through 7-37. Numerous fresh, fallen silty soil blocks, 6 in. to 2 ft high, were found along the sand bench, which indicates that Site 10 is an active bank failure and erosion location. At the upstream section, a rocky bottom was observed about 30 ft from the water's edge (see figure 7-35).

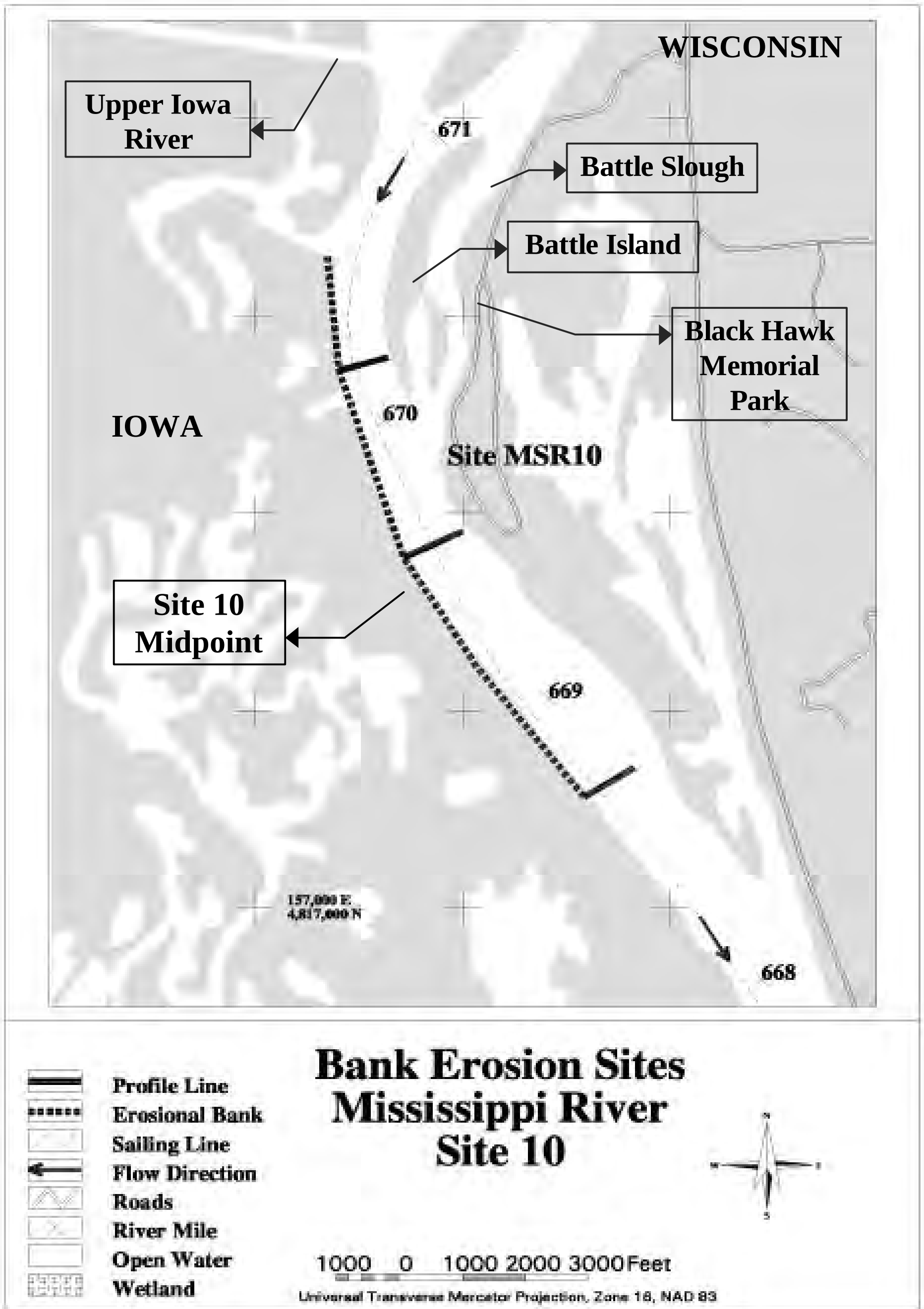


Figure 7-34 A site map showing Mississippi River Site 10

Photo 7-26 A downstream view of Site 10 midpoint

Photo 7-27 A close-up view of scarp at Site 10 midpoint

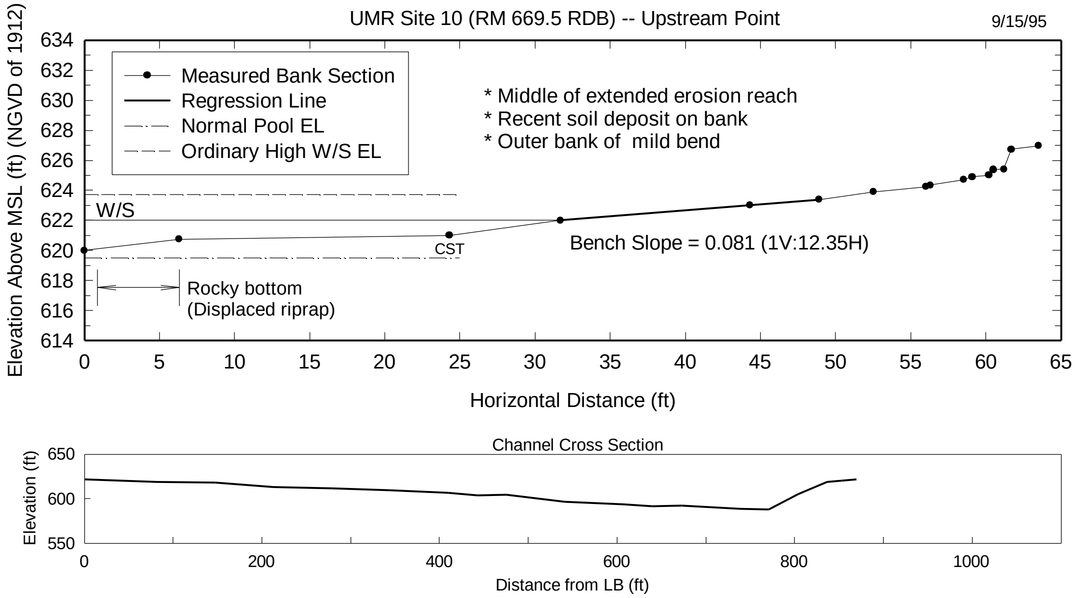


Figure 7-35 Bank section and channel cross section measured at Site 10 upstream point

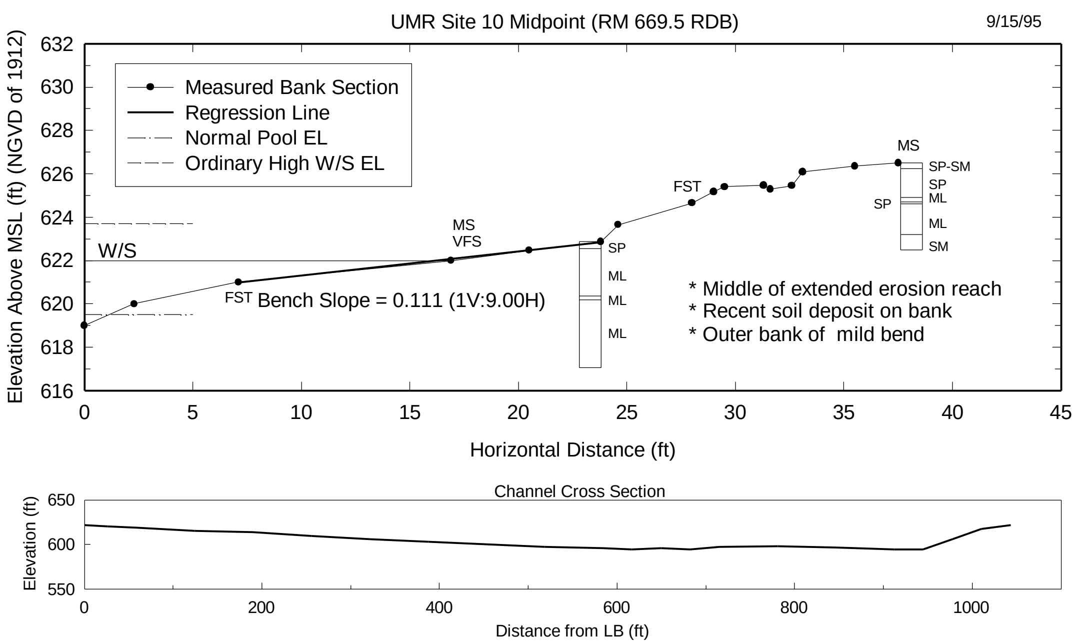


Figure 7-36 Bank section and channel cross section measured at Site 10 midpoint

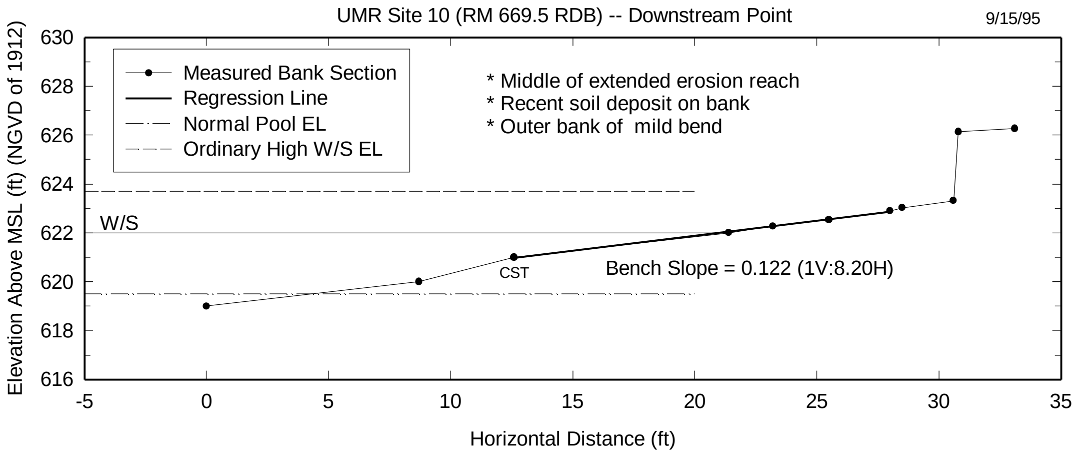


Figure 7-37 Bank section measured at Site 10 downstream point

Five sampling tube cores and an excavated soil pit were examined at four locations across Site 10. The cores showed a highly variable thickness of historical alluvium and dredged material, ranging from about 0.3 ft to 4.0 ft thick. Below the historical deposit is a fine-grained, poorly drained, very late Holocene wetland soil. Older Holocene surfaces are expected to lie west of the site and away from the channel. The Upper Iowa River alluvial fan enters the Mississippi River Valley immediately upstream from the site.

Causative factors for bank retreat at this site include flood-flow erosion, secondary currents, overland flow, wave and rework-transport of failed soils and recently deposited sediments, and piping. There is potential for wave erosion in bench areas. The bank section at this site is classified as a combination of bank Type D and Type E.

11. Site 11 at RM 620.5 LDB (Pool 10)

This island site, shown in figure 7-38, is located within a relatively narrow section of the valley, about 5.5 miles upstream from Lock & Dam No. 10, in the crossover reach between two mild bends. Upstream and downstream views of this site are shown by Photos 7-28 (see undercutting) and 7-29, respectively. Three bank sections are shown in figures 7-39 through 41. There are two wing dams, the upstream wing dam extends about 700 ft, and the downstream wing dam extends approximately 1,000 ft from the island. The midpoint section is just upstream from the longer downstream wing dam. The river cross section in figure 7-40 seems to indicate that the thalweg developed along this left bank. It appears that the shorter upstream wing dam is not able to direct river flow

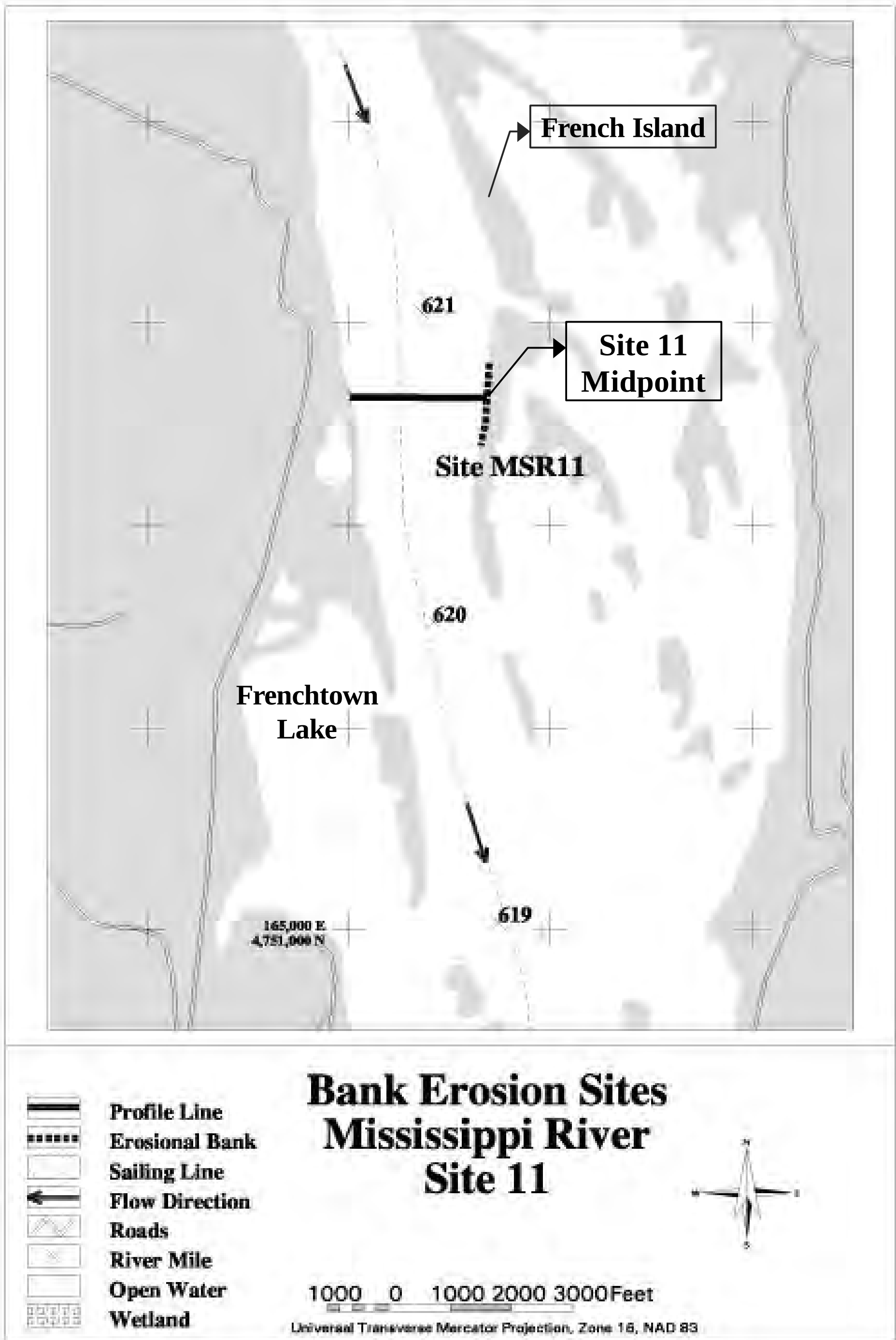


Figure 7-38 A site map showing Mississippi River Site 11

Photo 7-28 An upstream view of Site 11 midpoint

Photo 7-29 A downstream view of Site 11 midpoint

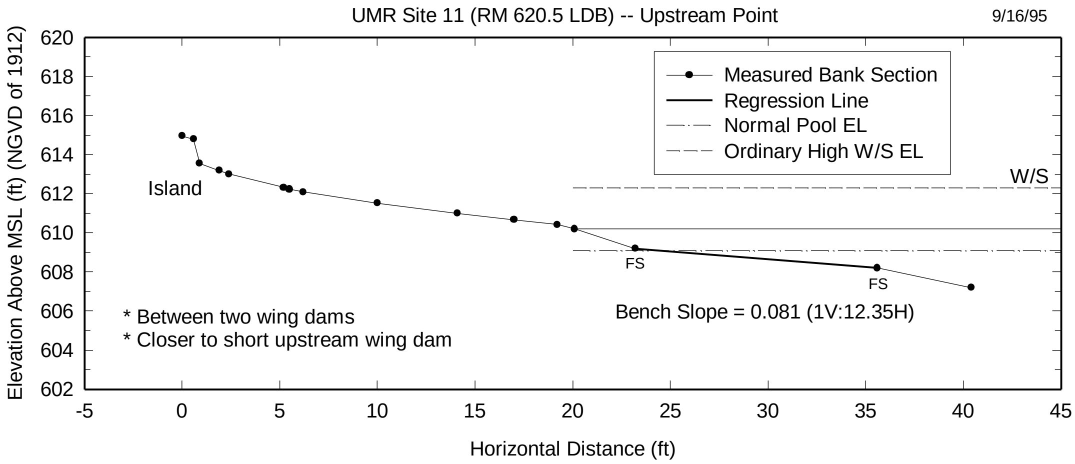


Figure 7-39 Bank section measured at Site 11 upstream point

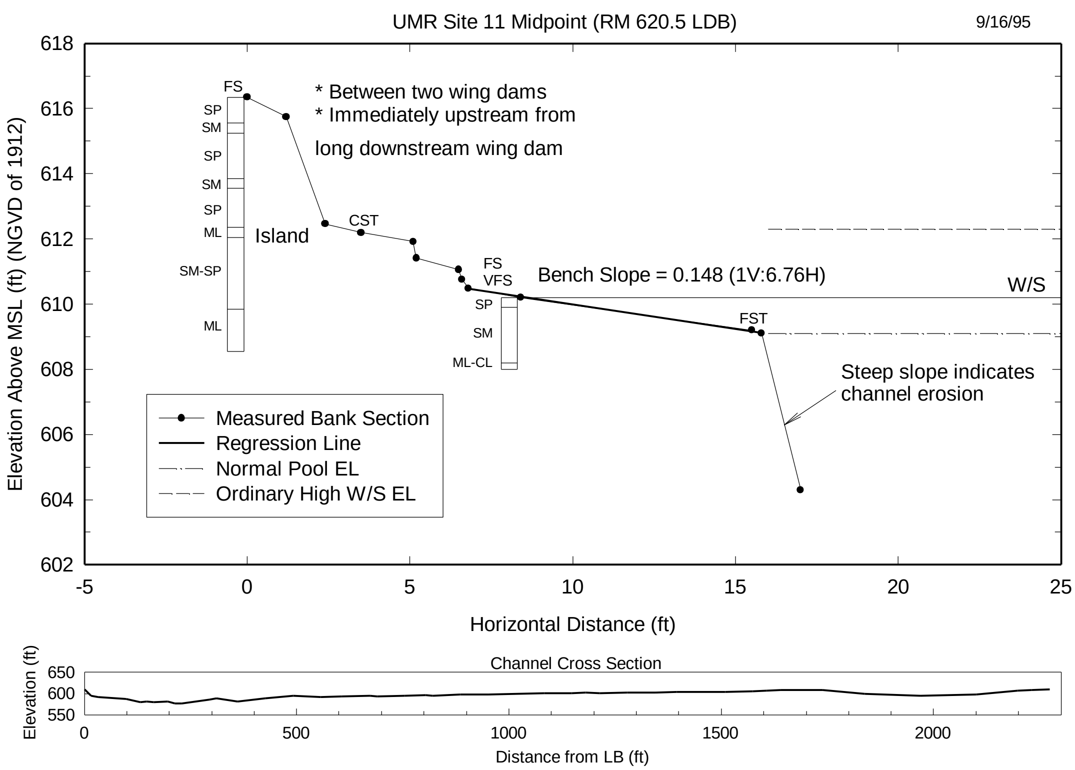


Figure 7-40 Bank section and channel cross section measured at Site 11 midpoint

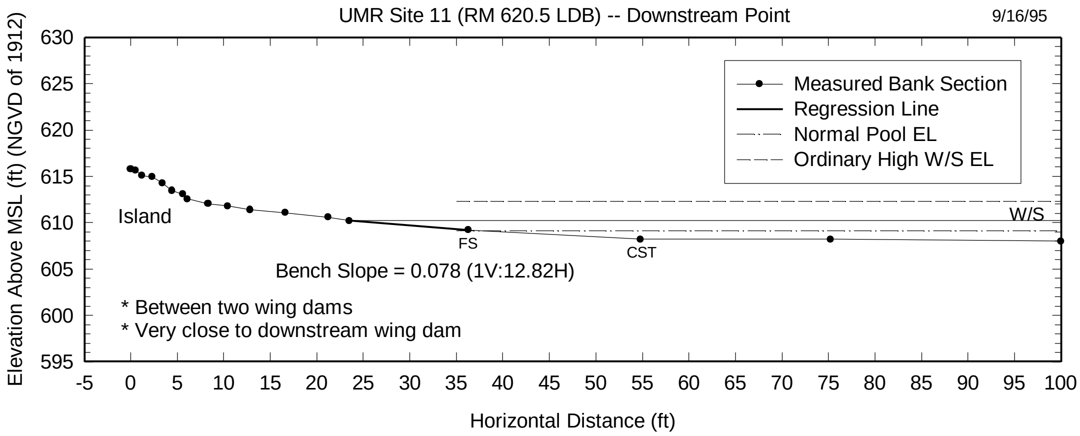


Figure 7-41 Bank section measured at Site 11 downstream point

toward the main channel, which resulted in strong currents impinging on the longer downstream wing dam, eroding the subaqueous bank at the midpoint section. The bank section in figure 7-40 shows a sharp drop of the bed near the bank. At both the upstream and downstream sections, near-bank water depth was small. The bank soils consist primarily of coarse silt (CST) and sand (VFS-FS).

Two sampling tube cores were advanced on the very late Holocene island. The cores generally showed thick historical alluvium overlying a very poorly drained very late Holocene soil. At another island just upstream, a soil core showed a very late Holocene soil below thick historical alluvium. It is estimated that the historical alluvium near the main channel ranges from about 5 ft to 7 ft thick in this portion of Pool 10.

Causative factors for bank retreat at this site include flood-flow erosion, rework-transport of failed soils and recently deposited sediments within bench areas, undercutting, and piping. Because this site is located away from the sailing line along the right bank, impacts of traffic-induced waves on erosion of bench areas is minor. This eroded bank is classified as a combination of bank Type D and Type E.

12. Site 12 at RM 613.6 LDB (Pool 11)

This left-bank island site on the outside of a slight bend, shown in figure 7-42, is located only 1.5 miles downstream from Lock & Dam No. 10, and 0.25 mile downstream from Ackerman's Cut. Upstream and downstream views of the site are shown in Photos 7-30 and 7-31, respectively. Three bank sections obtained at this site are shown in figures

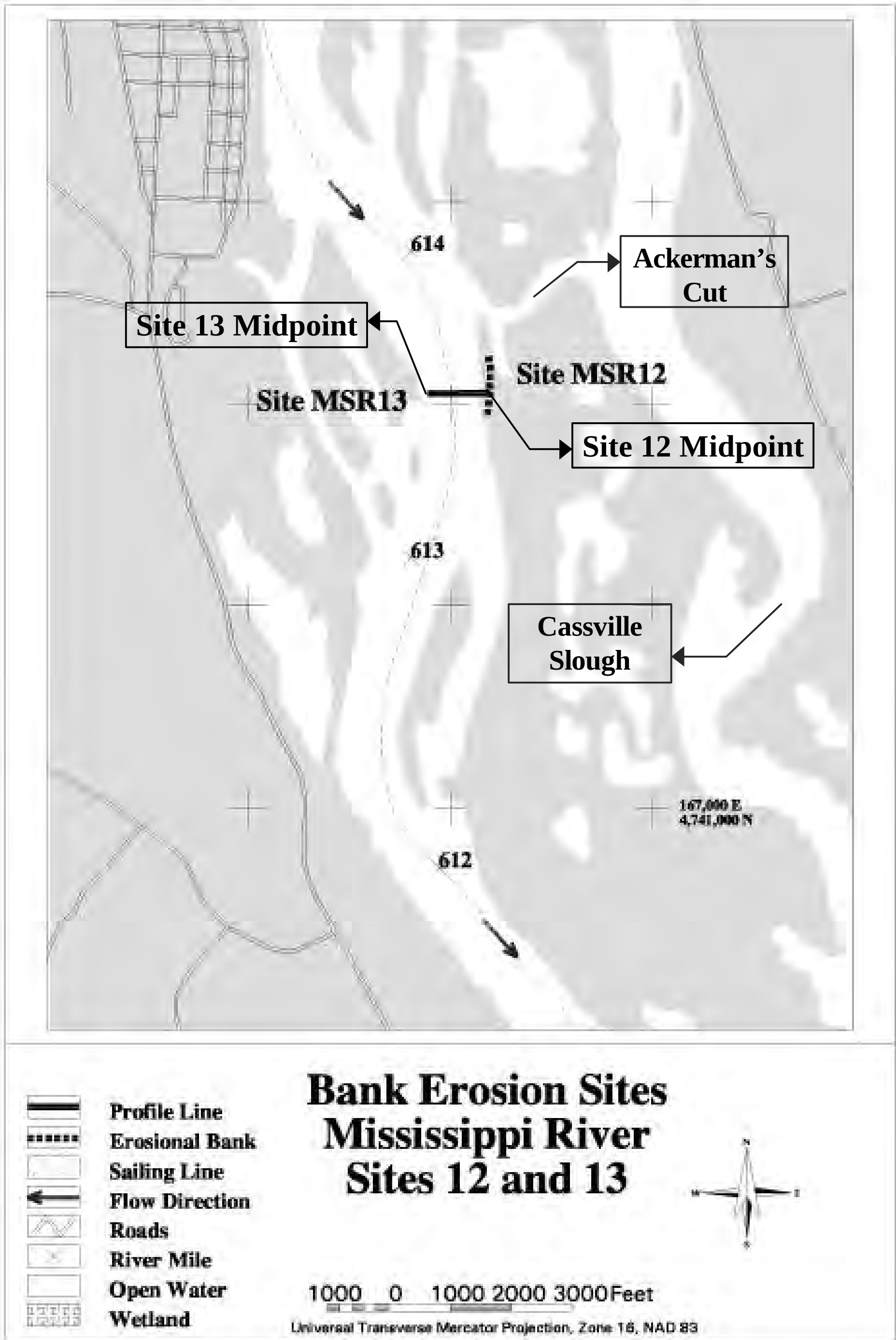


Figure 7-42 A map showing Mississippi River Sites 12 and 13

Photo 7-30 An upstream view of Site 12 midpoint

Photo 7-31 A downstream view of Site 12 midpoint

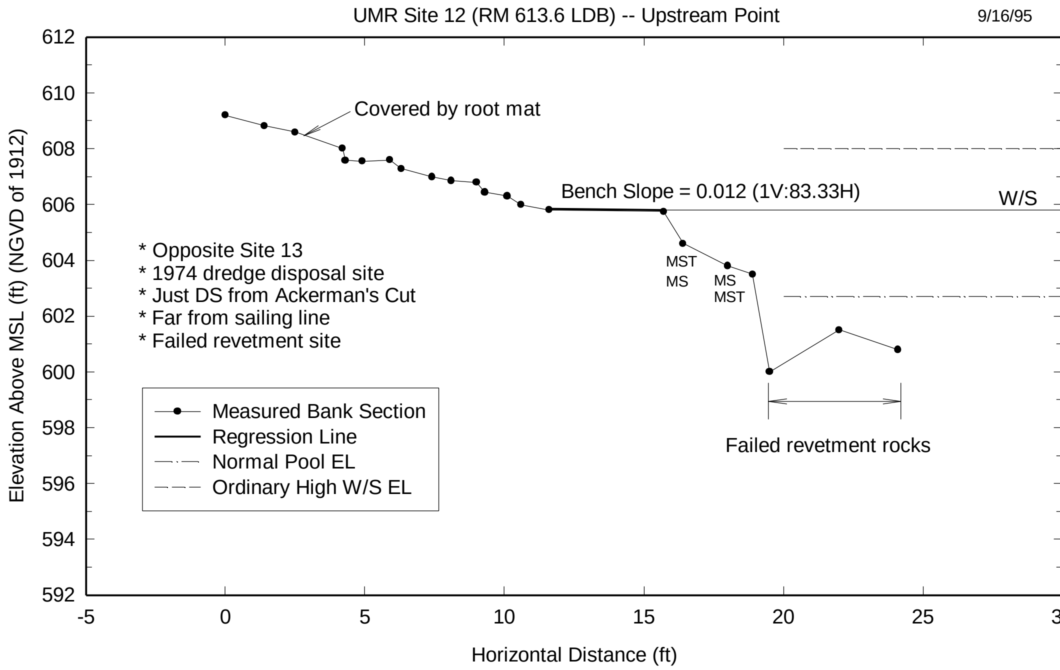


Figure 7-43 Bank section measured at Site 12 upstream point

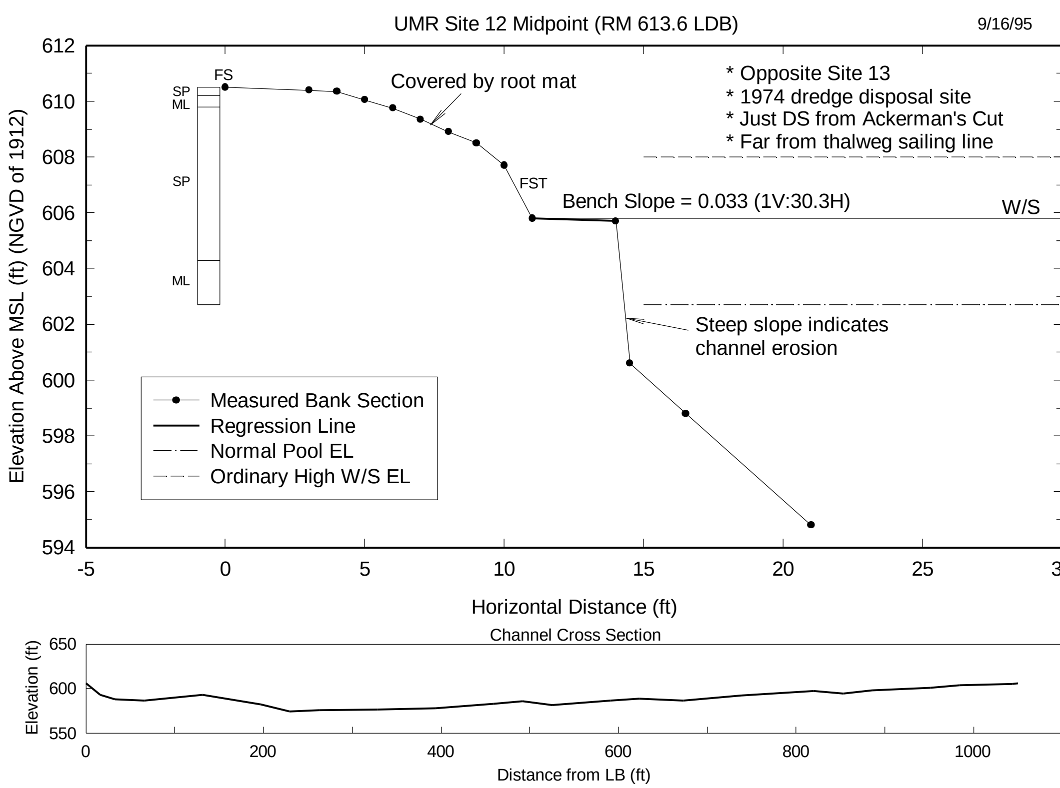


Figure 7-44 Bank section and channel cross section measured at Site 12 midpoint

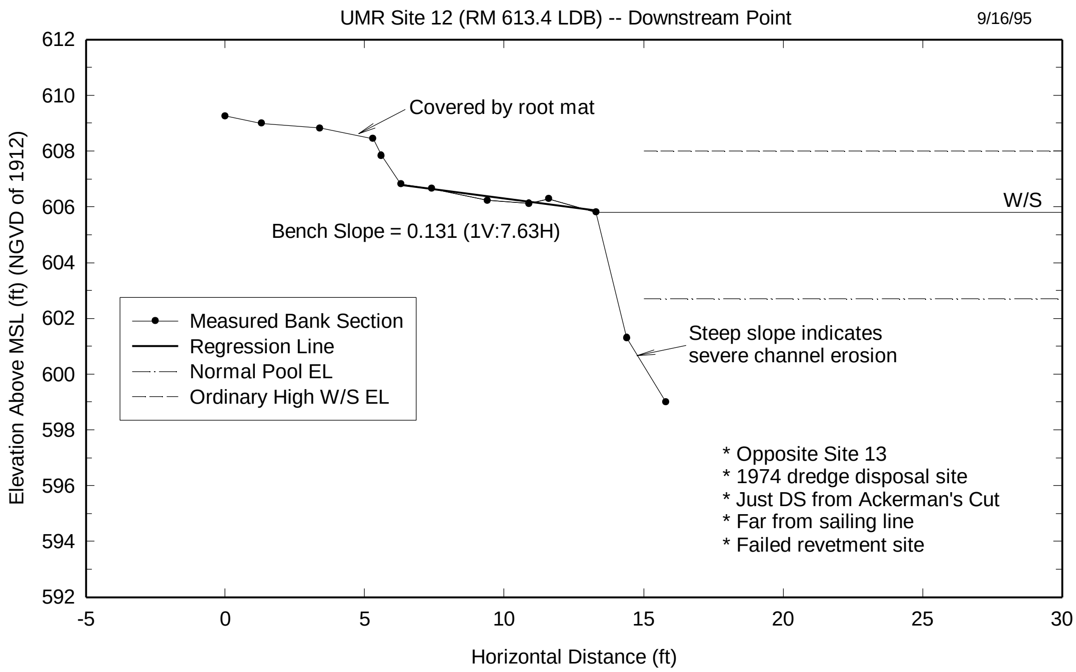


Figure 7-45 Bank section measured at Site 12 downstream point

7-43 through 7-45. Bank retreat at Site 12 since 1984 is apparent in figure 7-42. As can be seen in figure 7-44, the thalweg is very close to this left bank, and evidence of severe channel erosion was observed at the site. This site was a dredged material disposal site. At the upstream section, failed revetment rocks were found adjacent to the water’s edge (see figure 7-43). Since the upper end of Cassville Slough (eastern limb of the MR) was closed when Lock & Dam No. 10 was completed in 1938, the new MR channel flow, downstream from the dam spillways located on the west side of the river, had a tendency to return to the old channel slough, resulting in Ackerman's Cut. According to Nakato (1983), as much as 28 percent of the river flow was passing through Ackerman's Cut, causing reduction of sediment-transport capacity of the main channel and transport of sediment into the slough. In order to protect the fishery resources of Cassville Slough and to reduce dredging requirements in the downstream navigation channel, the COE-RID constructed partial closure structures in Ackerman's Cut in 1985. A post-construction study was conducted in 1986 and it was found that the flow diversion rate was reduced to 18 percent from the previous 28 percent (Toda and Nakato 1987). The bank was covered by a root mat. The top of the bank consists of old dredged spoil material (FS) and the scarp material is silt (FST). Subaqueous soil consists of silt (MST) and sand (MS).

The sampling tube core advanced at the midpoint section showed historical alluvium throughout the 7.8 ft deep profile. The early to mid-Holocene surface probably lies further inland (east) from this near-channel location. Earlier work conducted near Ackerman's Cut in 1984 identified buried late Holocene soils and Woodland pottery in a bank exposure. However, no archaeological site number has been assigned.

Causative factors for bank retreat at this site include flood damage which includes erosional oversteepening and rapid recessional loading and failure, wave and rework-transport of failed soils and recently deposited sediments within berm and bench areas, cleft pressures and block displacement, and minor piping. There is potential for traffic-generated wave erosion at this site. This bank section is classified as a combination of bank Type E and Type F.

13. Site 13 at RM 613.6 RDB (Pool 11)

This right-bank island site is located on the inside of the bend opposite Site 12, as shown in figure 42. Upstream and downstream views of the site are shown in Photos 7-

Photo 7-32 An upstream view of Site 13 midpoint

Photo 7-33 A downstream view of Site 13 midpoint

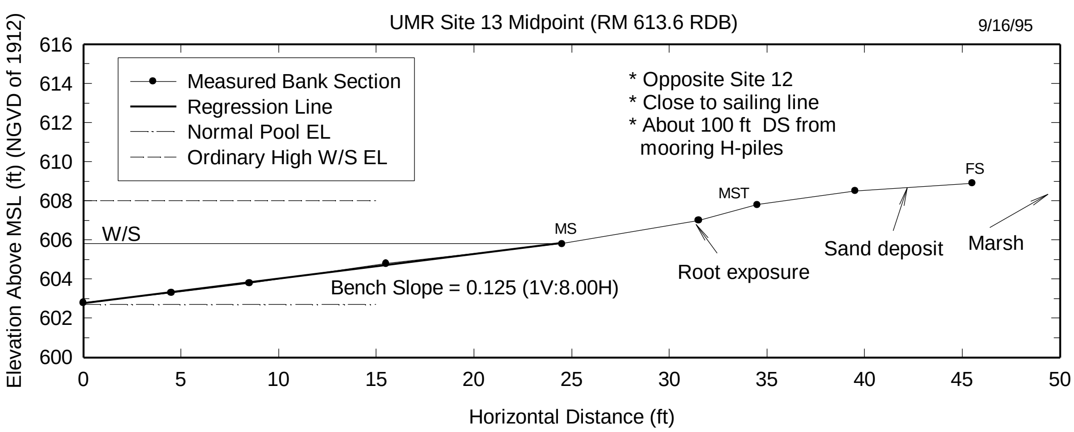


Figure 7-46 Bank section measured at Site 13 midpoint

32 and 7-33, respectively. The bank section is shown in figure 7-46. The site is located within a wing-dam field and the low-lying island is connected to a marsh area. There is a barge-mooring facility located about 100 ft upstream from this site. The bank bench and berm area cover consists of recent silt (MST) and sand (FS-MS) deposits left by floods.

Causative factors for bank retreat at this site include piping failure, and wave and flow rework-transport of recently deposited sediments in bench areas. This site is classified as bank Type E.

14. Site 14 at RM 607.5 RDB (Pool 11)

This right-bank, barge-fleeting site, shown in figure 7-47, is inside of a slight bend, and about 7.5 miles downstream from Lock & Dam No. 10 and 1 mile upstream from

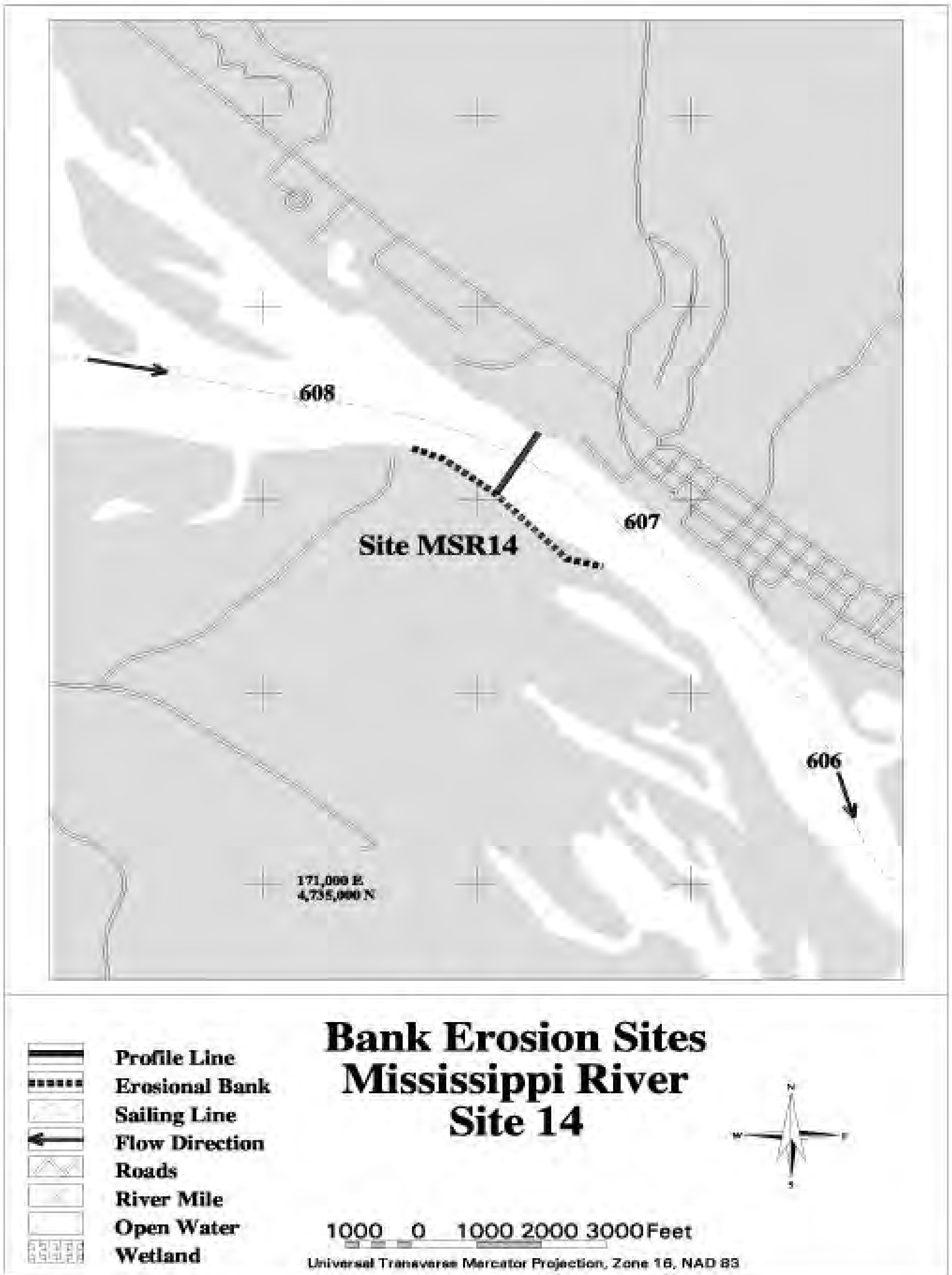


Figure 7-47 A site map showing Mississippi River Site 14

Photo 7-34 An upstream view of Site 14 midpoint

Photo 7-35 A downstream view of Site 14 midpoint

Cassville, Wisconsin. The Turkey River confluence is only 0.5 mile upstream from the site. Upstream and downstream views of the site are shown in Photos 7-34 and 7-35, respectively. Three bank sections taken at this site are plotted in figures 7-48 through 7-

50. The bank soils consist of fine silt (FST) to coarse silt (CST). Fallen soil blocks were observed at the base of the scarp, and piping features were observed within the bank scarp as well as at minor scarps within the berm and bench rework-transport zones. As can be seen in figure 7-49, the surveyed river cross section is atypical for a river bend because the site is located near the upstream end of the bend.

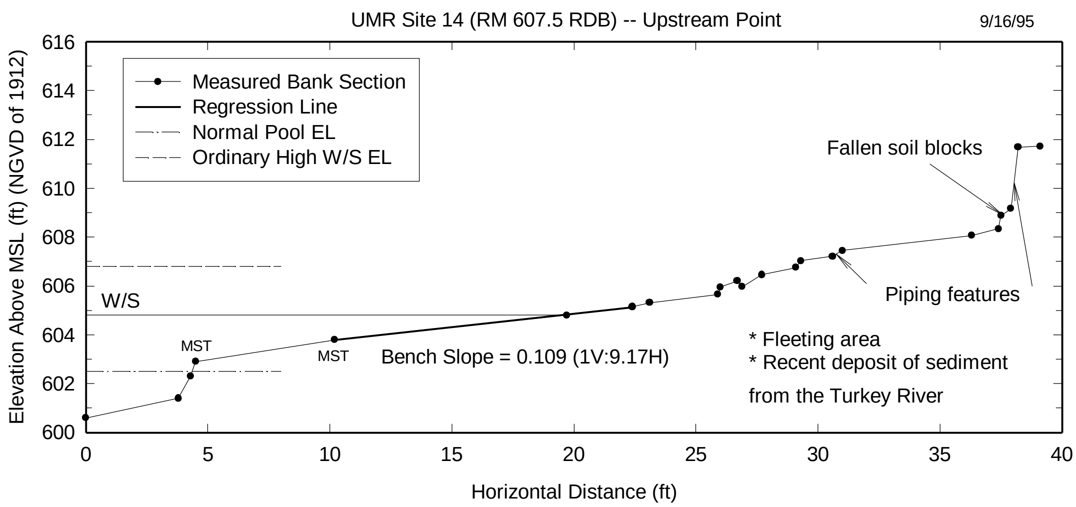


Figure 7-48 Bank section measured at Site 14 upstream point

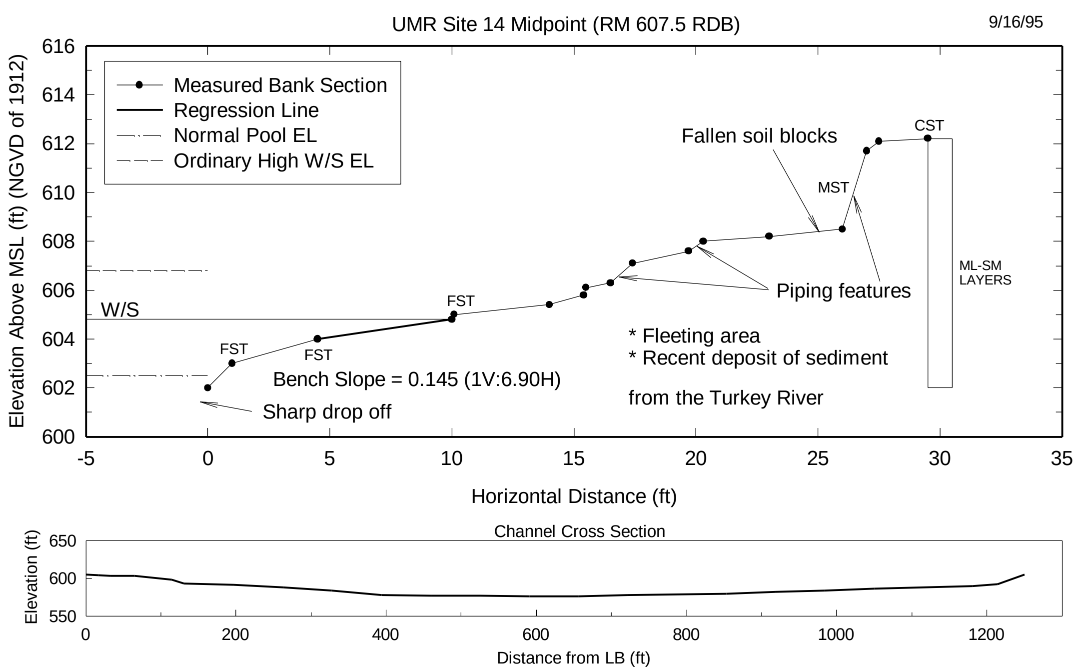


Figure 7-49 Bank section and channel cross section measured at Site 14 midpoint

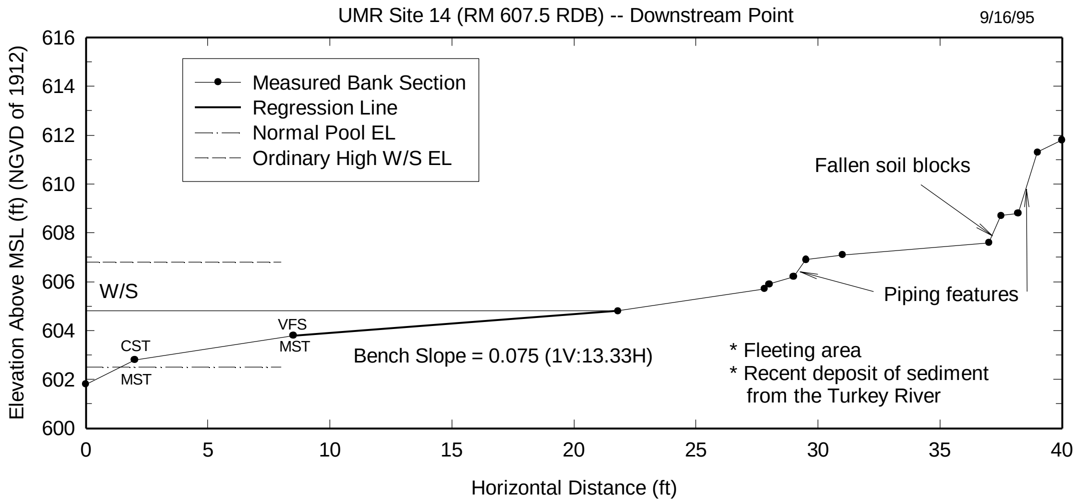


Figure 7-50 Bank section measured at Site 14 downstream point

Thick historical (ML-SM) deposits were observed in the sampling tube core throughout the entire 10.2 ft profile. Scarp exposures further confirm the thick deposits which represent historical alluvium from both the MR and the Turkey River. The Turkey River fan is progressing into the main valley. Landform and depositional contacts near

Photo 7-36 Piping feature of Site 14 midpoint

Photo 7-37 A close-up of bench of Site 14 midpoint

the tributary include an alluvial fan and the early to mid-Holocene surfaces. Earlier work conducted by Overstreet and Anderson further indicates that this site contains thick historical alluvium (Overstreet 1985a, Anderson 1991).

Causative factors for bank retreat at this site include flood-flow oversteepening and rapid recession slumping, wave and rework-transport of deposited sediments within berm and bench areas, and piping-related cantilever and block failures (see Photo 7-36). The thalweg sailing line is remote from this site; however, heavy fleeting activities surrounding this site generate significant waves (see Photo 7-37 for evidence of wave erosion). A combination of Type A and Type B characterizes Site 14.

15. Site 15 at RM 576.0 LDB (Pool 12)

This left-bank island site in a fleeting area, shown in figure 7-51, is located about 7 miles downstream from Lock & Dam No. 12, along the inside bank of a minor bend. An upstream view of the site is shown in Photo 7-38. Three bank sections measured in the field are shown in figures 7-52 through 7-54. The bank soils are primarily MST to CST and the soil near the water's edge is FS. Subaqueous sediments are sand (VFS-FS). Failed revetment stone was observed along the bench, as indicated in figure 7-53.

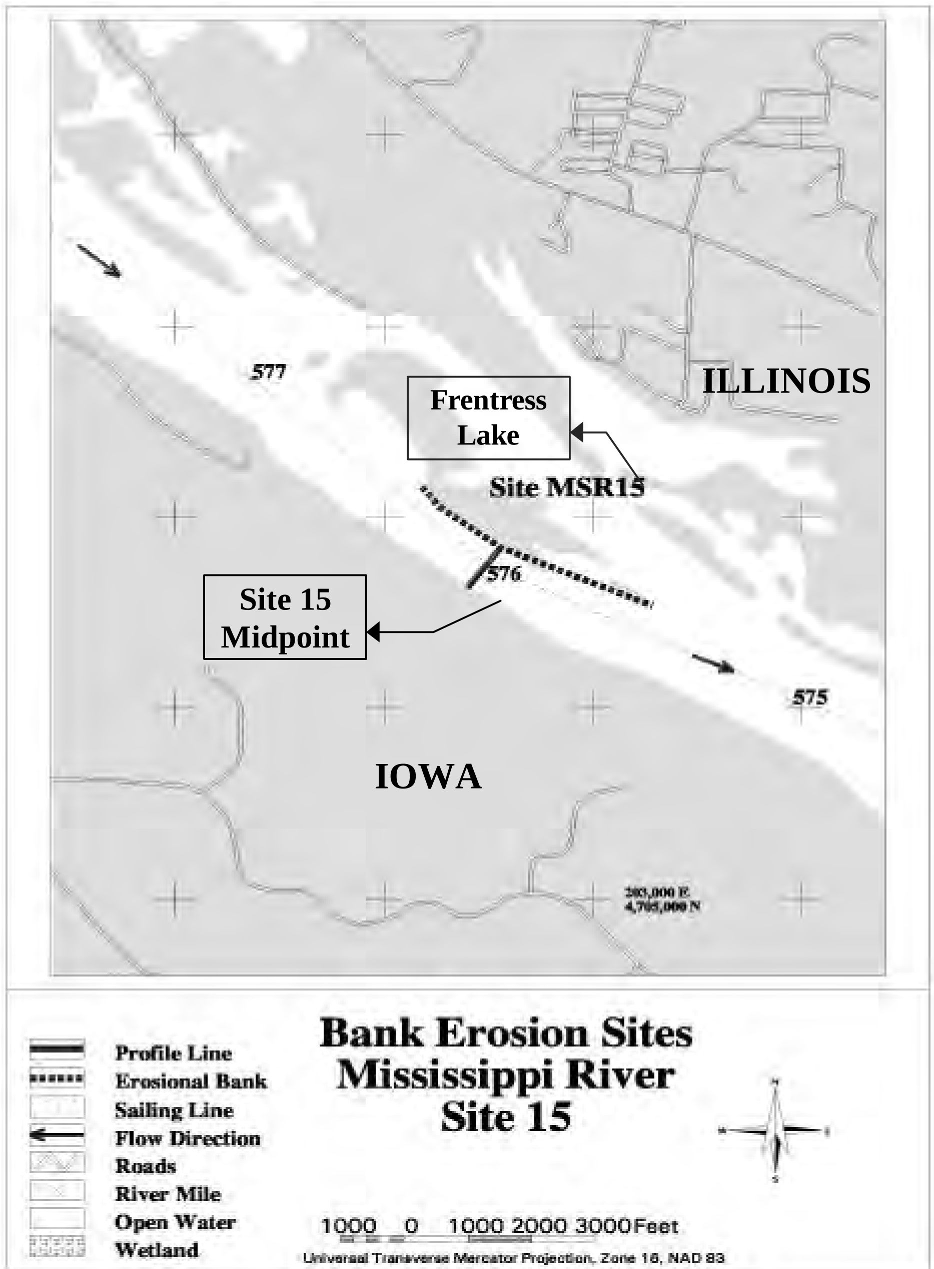


Figure 7-51 A site map showing Mississippi River Site 15

Photo 7-38 An upstream view of Site 15 midpoint

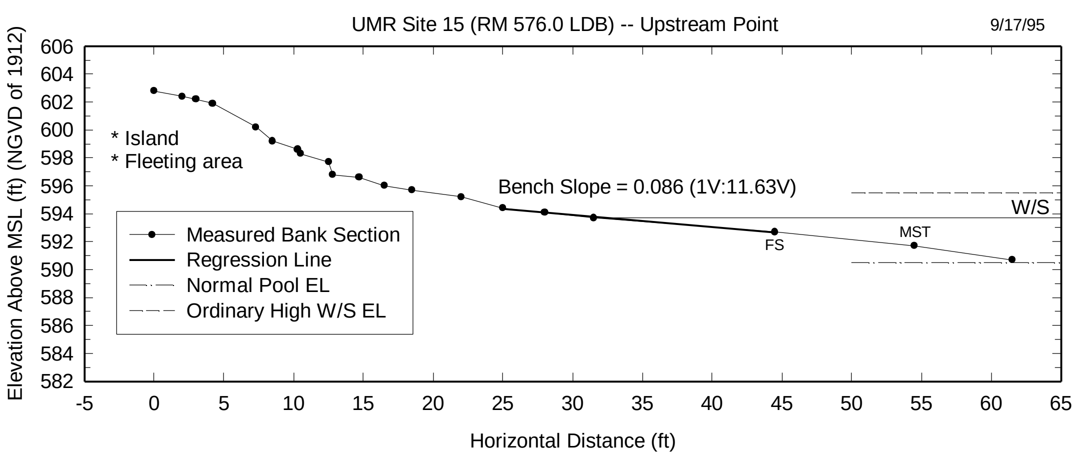


Figure 7-52 Bank section measured at Site 15 upstream point

The site is on a late Holocene island, and two sampling tube cores advanced at the site showed thick historical alluvium to at least 10 ft, as shown in figure 7-53. Archaeological site 11JD124 is located approximately 1 mile upstream from the erosion site, and site 11JD126 is about 1 mile downstream.

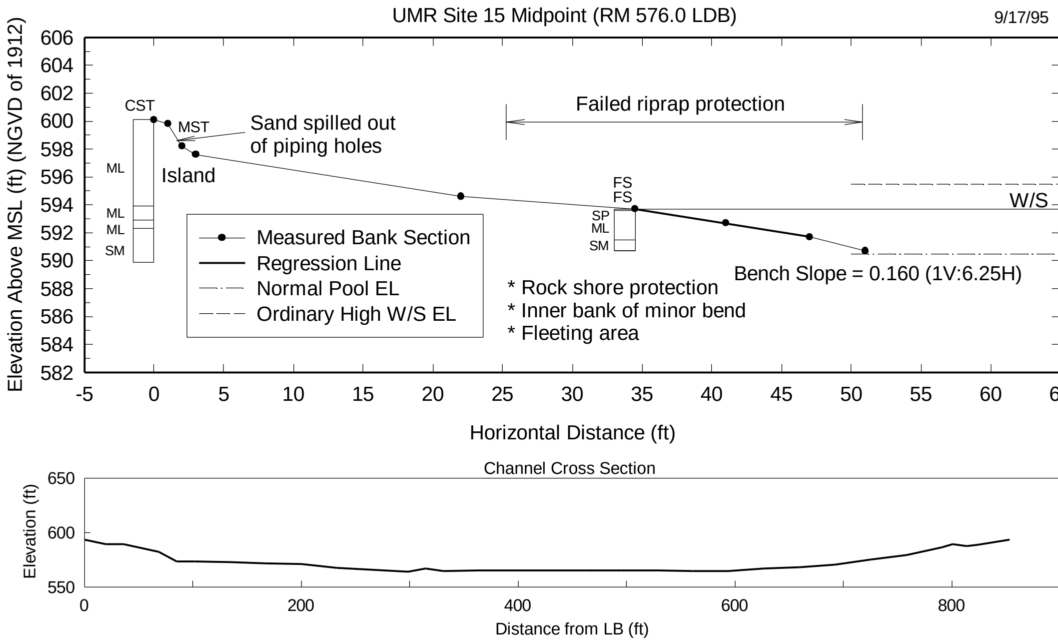


Figure 7-53 Bank section and channel cross section measured at Site 15 midpoint

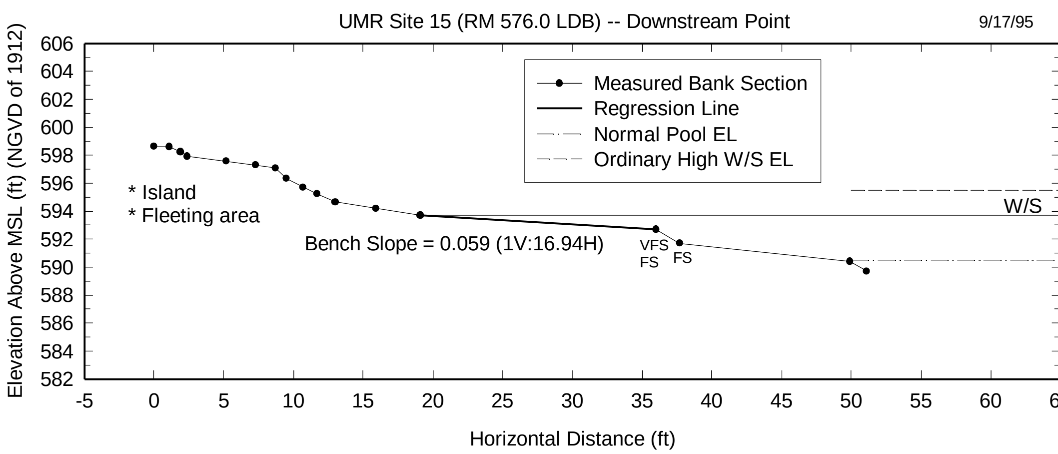


Figure 7-54 Bank section measured at Site 15 downstream point

Evidence of severe erosion was observed where barges were moored. Heavy infestation of zebra mussels was observed on riprap materials as well as on moored barges. Photo 7-39 shows the bankline disturbed by mooring activities. There were some piping features within the scarp, and fine sand at the midpoint section was being displaced by piping (see Photo 7-40). Causative factors for bank retreat at this site include wave erosion and rework-transport of failed soils and recently deposited sediments, piping-related failures. This site has been subject to barge run-up and beaching. The site can be classified as Type C.

Photo 7-39 Disturbed bankline of Site 15 midpoint

Photo 7-40 Hidden piping feature of Site 15 midpoint

16. Site 16 at RM 551.9 LDB (Pool 13)

This left-bank island site on the inside of a bend, shown in figure 7-55, is located 4.8 miles downstream from Lock & Dam No. 13. Side, upstream, and downstream views

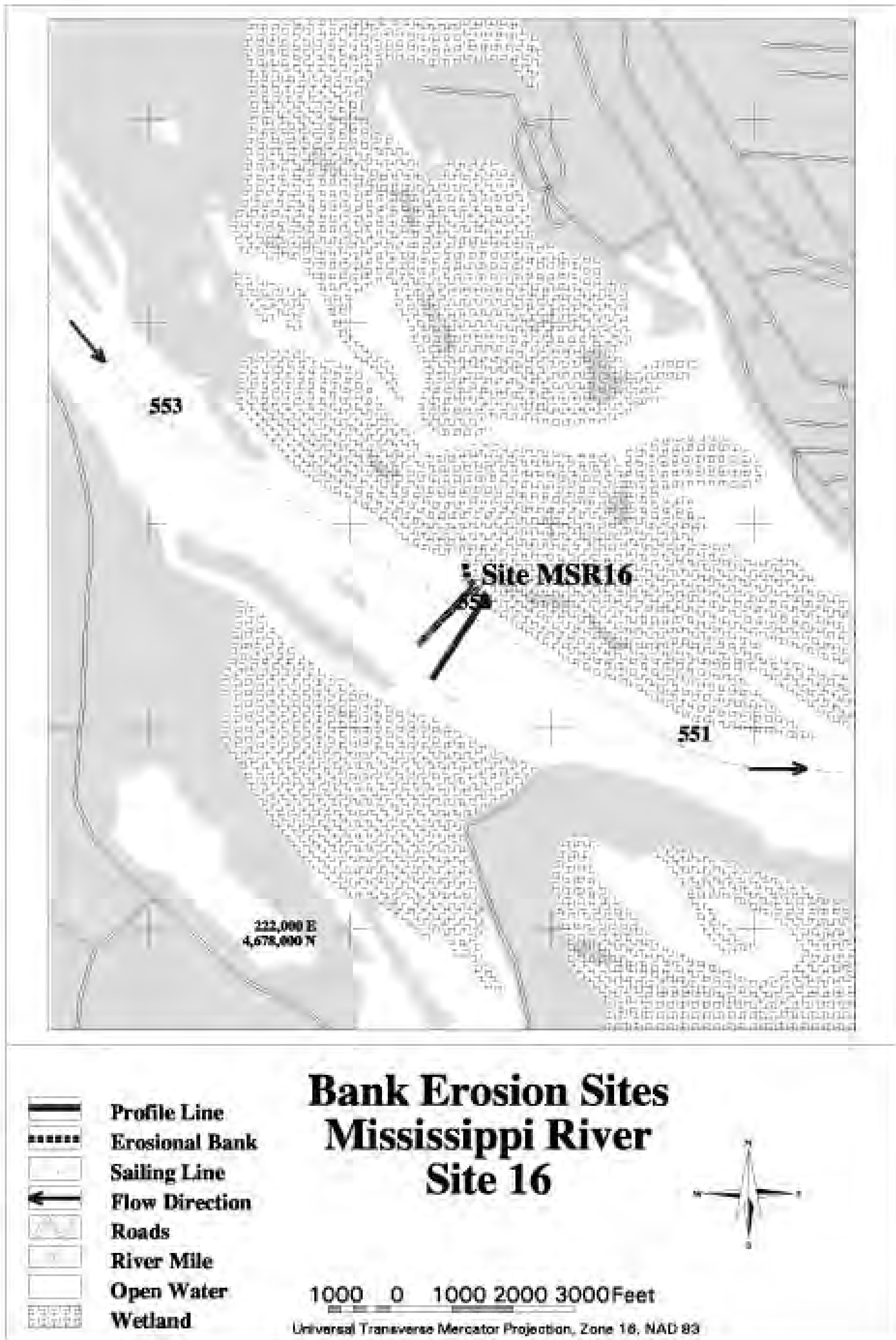


Figure 7-55 A site map showing Mississippi River Site 16

of this site are shown in Photos 7-41, 7-42, and 7-43, respectively. Photo 7-44 shows a close-up view of the scarp. Three bank sections were taken at this erosion site and are shown in figures 7-56 through 7-58. The bank soils consist primarily of silt (FST-MST)

Photo 7-41 A side view of Site 16 midpoint

Photo 7-42 An upstream view of Site 16 midpoint

Photo 7-43 A downstream view of Site 16 midpoint

Photo 7-44 A close-up view of Site 16 midpoint

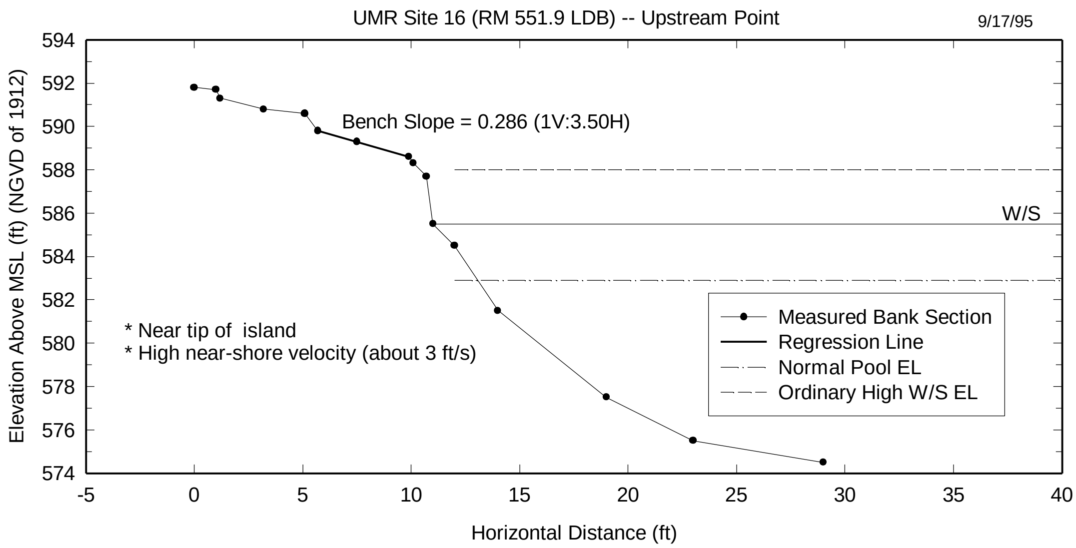


Figure 7-56 Bank section measured at Site 16 upstream point

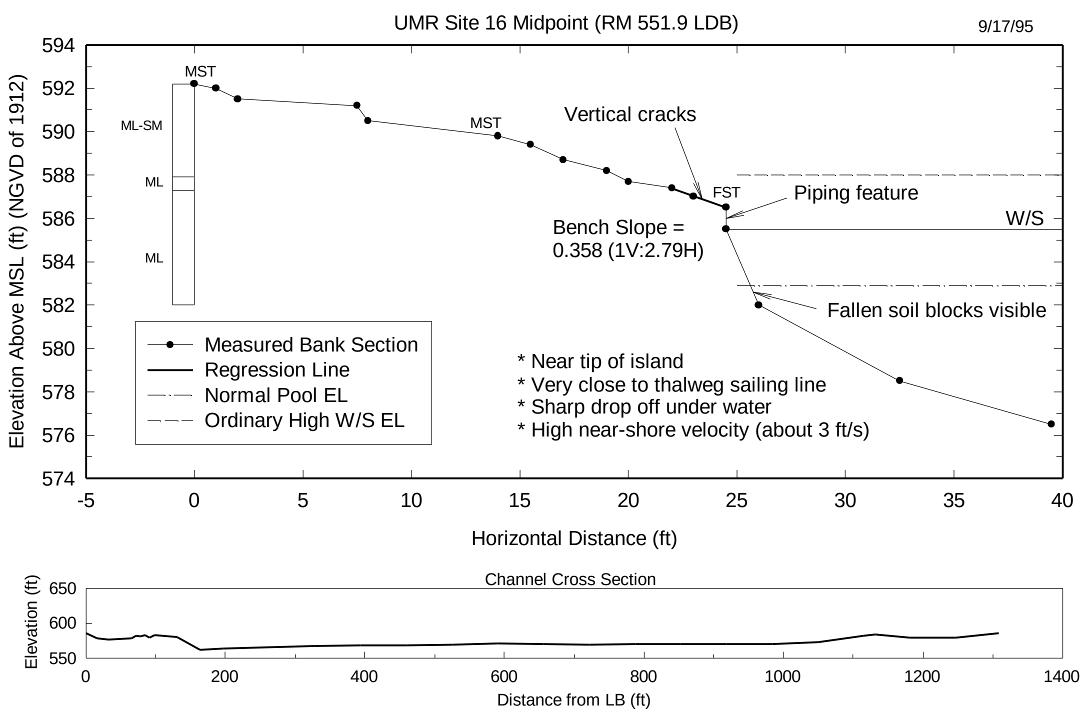


Figure 7-57 Bank section and channel cross section measured at Site 16 midpoint

and subaqueous sediments are silt (VFST-MST). The site is very close to the thalweg and evidence of severe flood-related channel erosion was visible. The near-bank flow velocity was estimated to be about 3 ft/s, at the time of the field study. At the downstream point, a rock pile was found, about 60 ft off the water's edge.

The core sample indicated historical alluvium at least 3 ft thick, overlying a poorly drained very late Holocene surface. Older Holocene surfaces and late Wisconsinan outwash terraces occur closer to both east and west valley walls. A well developed paleosol is buried by late Holocene eolian sand on a nearby late Wisconsinan outwash terrace at the Savana Army Depot at RM 549.6. Within the channel, flood flows appear to have eroded the outwash terrace, and destabilized the terrace slope. Destabilization appears to have occurred from the 1993 flood event because earlier work found the outwash terrace slope to be apparently stable (Benn et al. 1989).

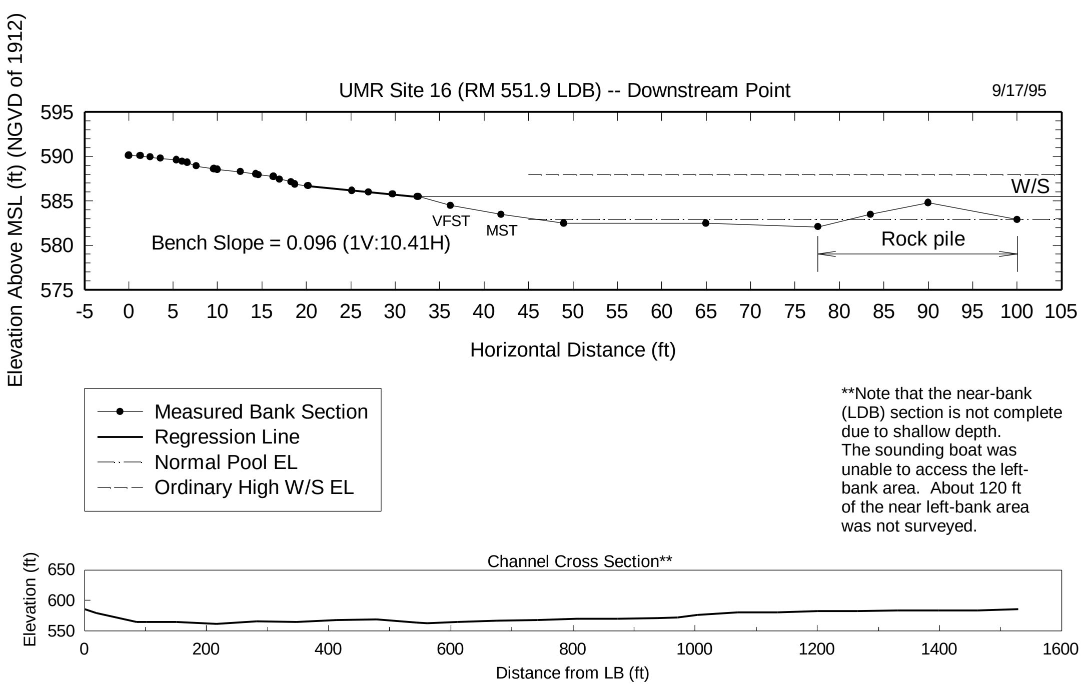


Figure 7-58 Bank section and channel cross section measured at Site 16 downstream point

Both at the upstream section and the midpoint section, the scarp contained piping features, and fallen soil blocks were found in the water. Causative factors for bank retreat at this site include flood-flow related oversteepening and recessional slumping, lower-bank piping-related cantilever and block failures, wave and flow rework-transport actions, and secondary currrents. Type C characterizes Site 16.

17. Site 17 at RM 512.7 LDB (Pool 14)

This site is a mid-channel island site in a rather straight river reach, 9.8 miles downstream from Lock & Dam No. 14, as shown in figure 7-59. Upstream and downstream views of the midpoint site are shown in Photos 7-45 and 7-46, respectively. Photo 7-47 shows an upstream view of the toe of the island, and Photo 7-48 shows wave removal of sand from the bench cover near the toe of the island. Substantial downstream accretion of the island since 1984 can be seen in figure 7-59. In order to investigate bank erosion characteristics on the island, five bank sections were taken along the channel side and two sections were taken along the back channel (see figures 7-60 through 7-66). The bench area cover is primarily sand with recently deposited silt. Subaqueous sediments are medium sand (MS) at the upstream limit, coarse silt (CST) at the midpoint section, and CST on top of FS at the downstream limit, indicating the reduction in bed-material particle size along the island. The island is located within two large wing dams which extend toward the main channel from the left bank approximately 1,700 ft, and immediately downstream from Beaver Slough along the right bank. Beaver Slough is heavily used by barge traffic, and the area across from this island site is a busy fleeting site. The upstream tip of this island is eroded and the toe of the island appears to be extending downstream, indicating that the island is shifting downstream.

This island is apparently late to very late Holocene age. Three sampling tube cores showed the historical alluvium thickness varying from about 4.0 ft to 6.0 ft. Below the historical deposits, a weakly developed very late Holocene soil was found. The sampling tube core taken at the midpoint section showed a second buried organic enriched surface (Acg horizon) at about 9.2 ft below the surface.

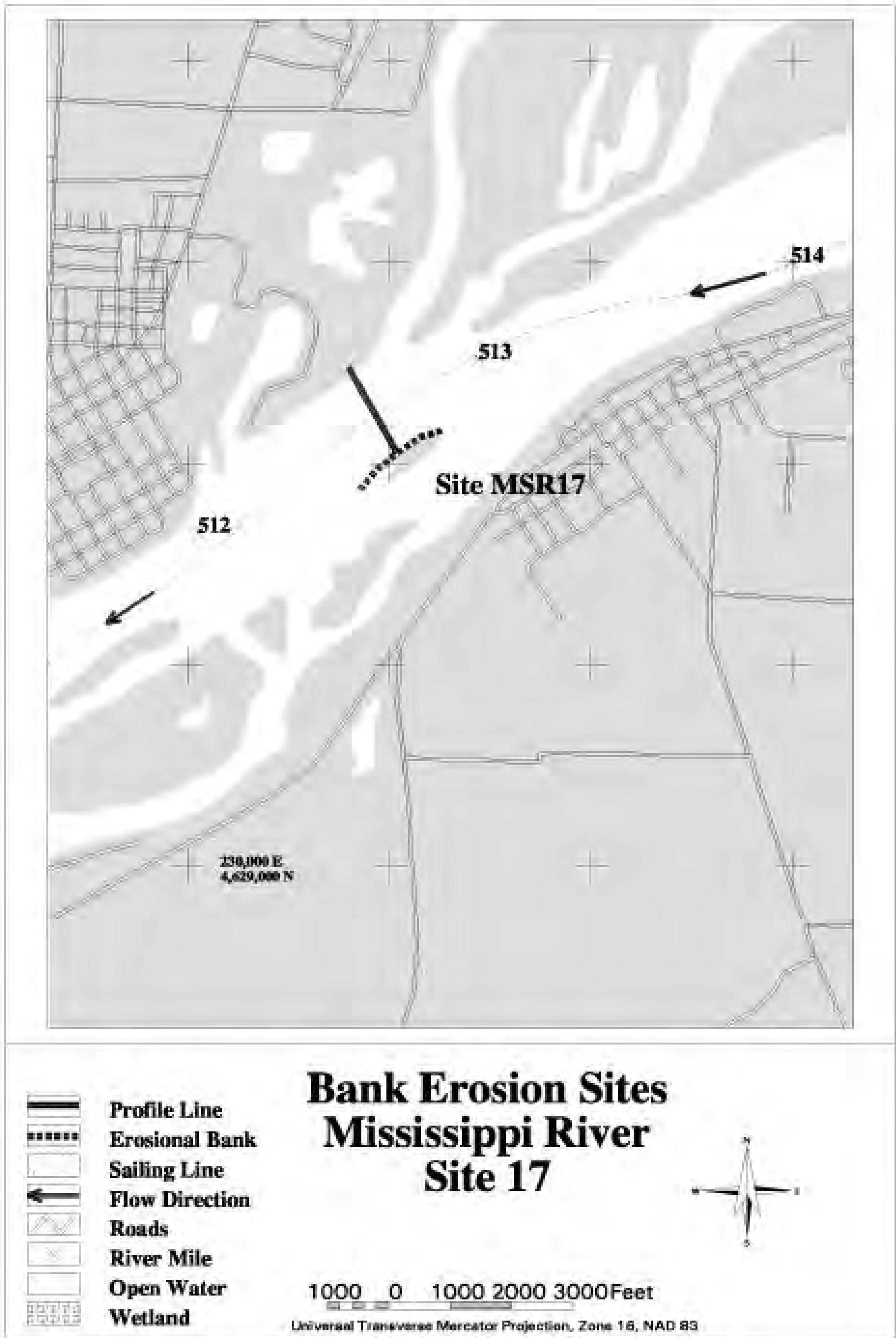


Figure 7-59 A site map showing Mississippi River Site 17

Photo 7-45 An upstream view of Site 17 midpoint

Photo 7-46 A downstream view of Site 17 midpoint

Photo 7-47 An upstream view of toe of island of Site 17

Photo 7-48 Sand removal near toe of island of Site 17

Causative factors for bank retreat at this site include flood erosion, wave and flow rework-transport actions, and piping-related collapse. Because the site is remote from the thalweg sailing line, erosion potential due to traffic-generated waves appears to be minor. Eroded bank types for these seven sections are characterized by Type D and Type E, as listed in table 7-5b.

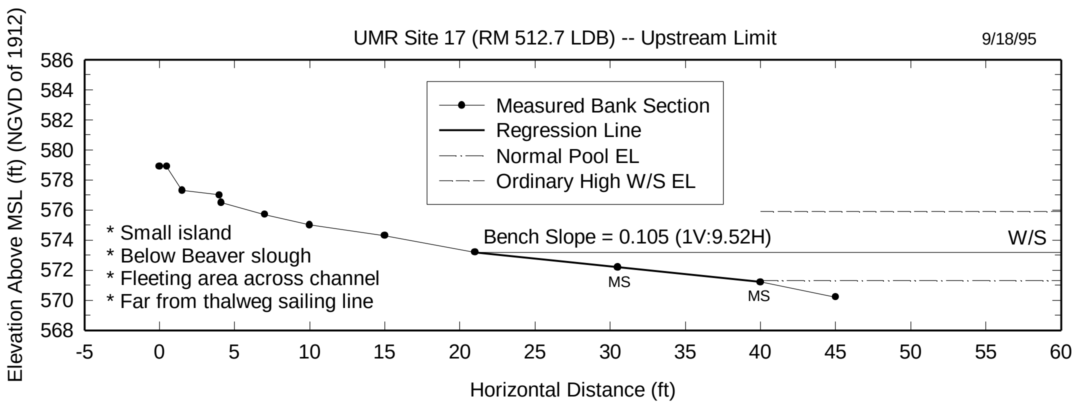


Figure 7-60 Bank section measured at Site 17 upstream limit

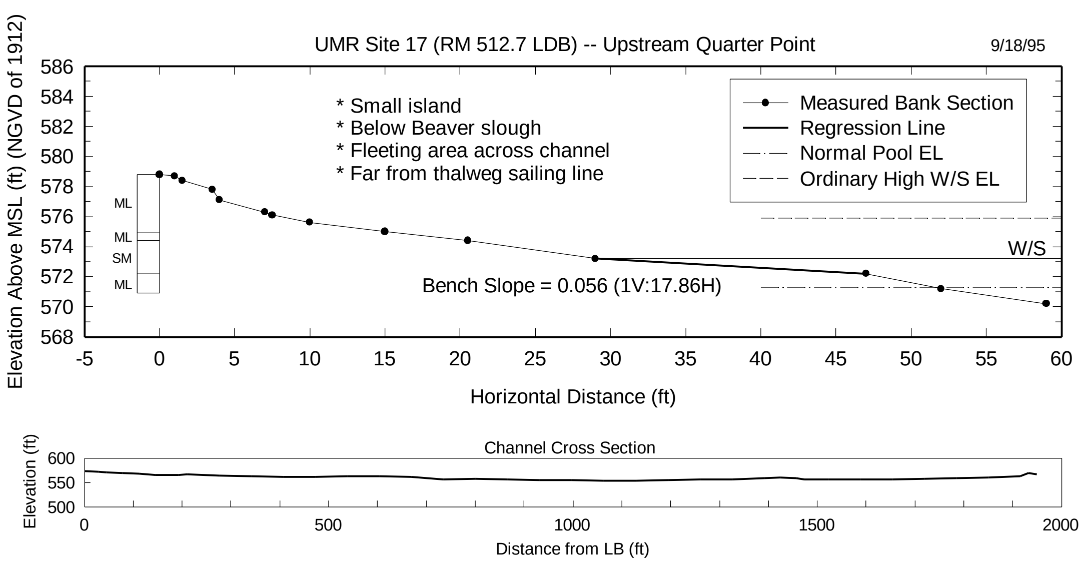


Figure 7-61 Bank section and channel cross section measured

at Site 17 upstream quarter point

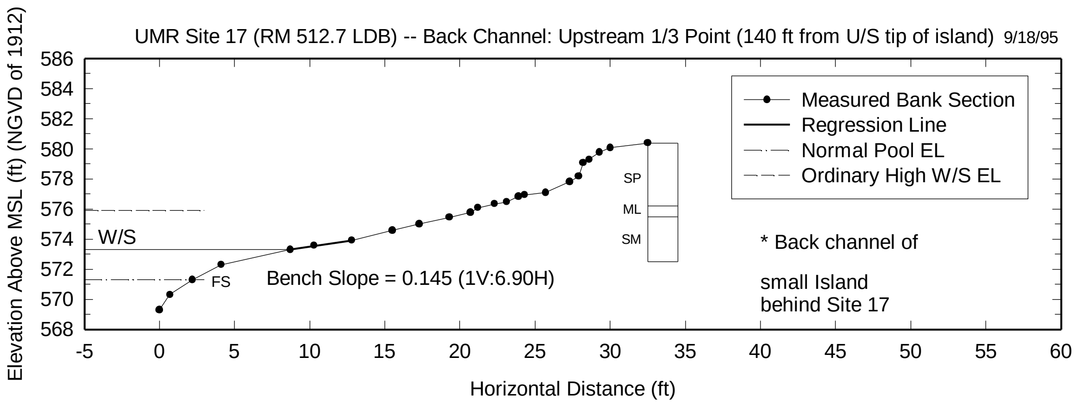


Figure 7-62 Bank section measured at Site 17 back channel upstream 1/3 point

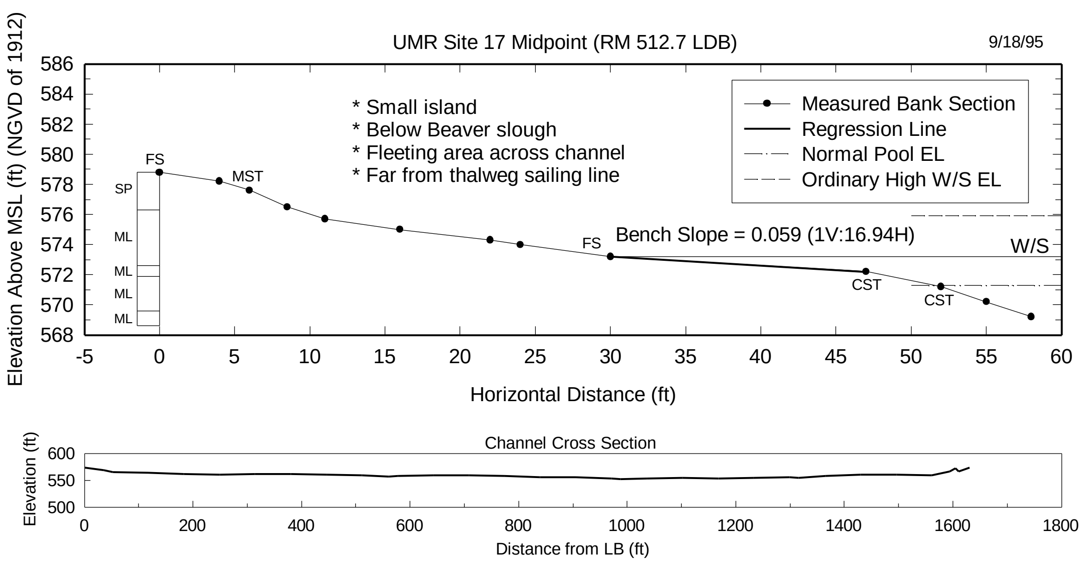


Figure 7-63 Bank section and channel cross section measured at Site 17 midpoint

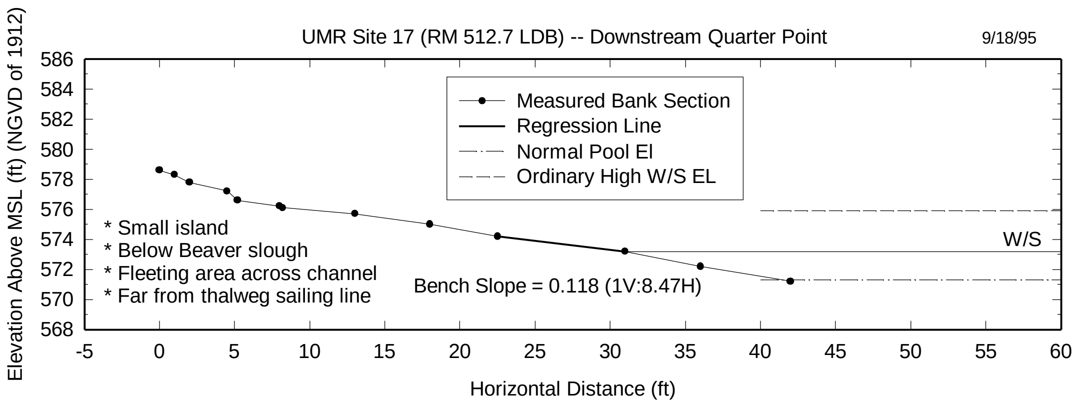


Figure 7-64 Bank section measured at Site 17 downstream quarter point

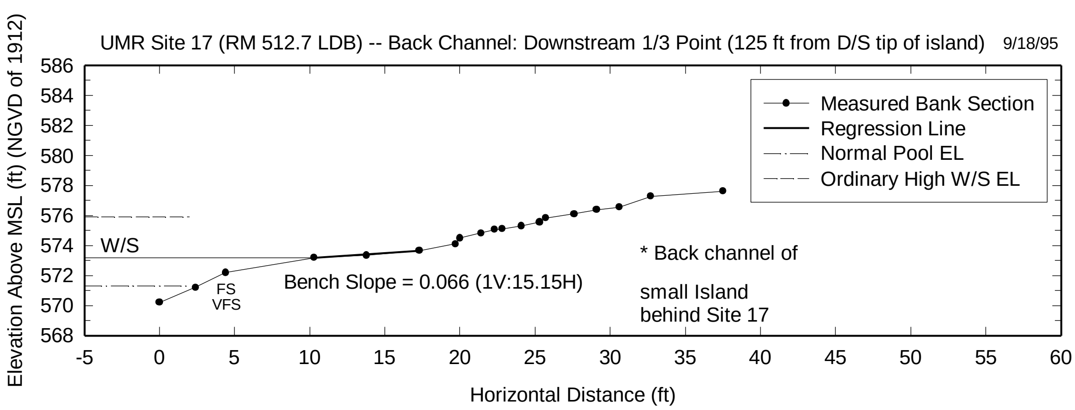


Figure 7-65 Bank section measured at Site 17 back channel downstream 1/3 point

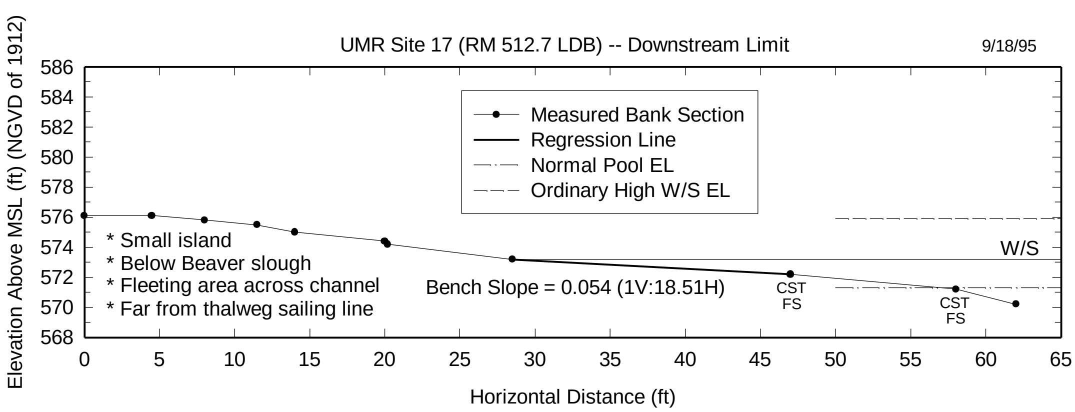


Figure 7-66 Bank section measured at Site 17 downstream limit

18. Site 18 at RM 509.2 RDB (Pool 14)

This right-bank island site, shown in figure 7-67, is located on Camanche Island in a straight reach of the MR. The island is covered by dredged material. Photo 7-49 shows

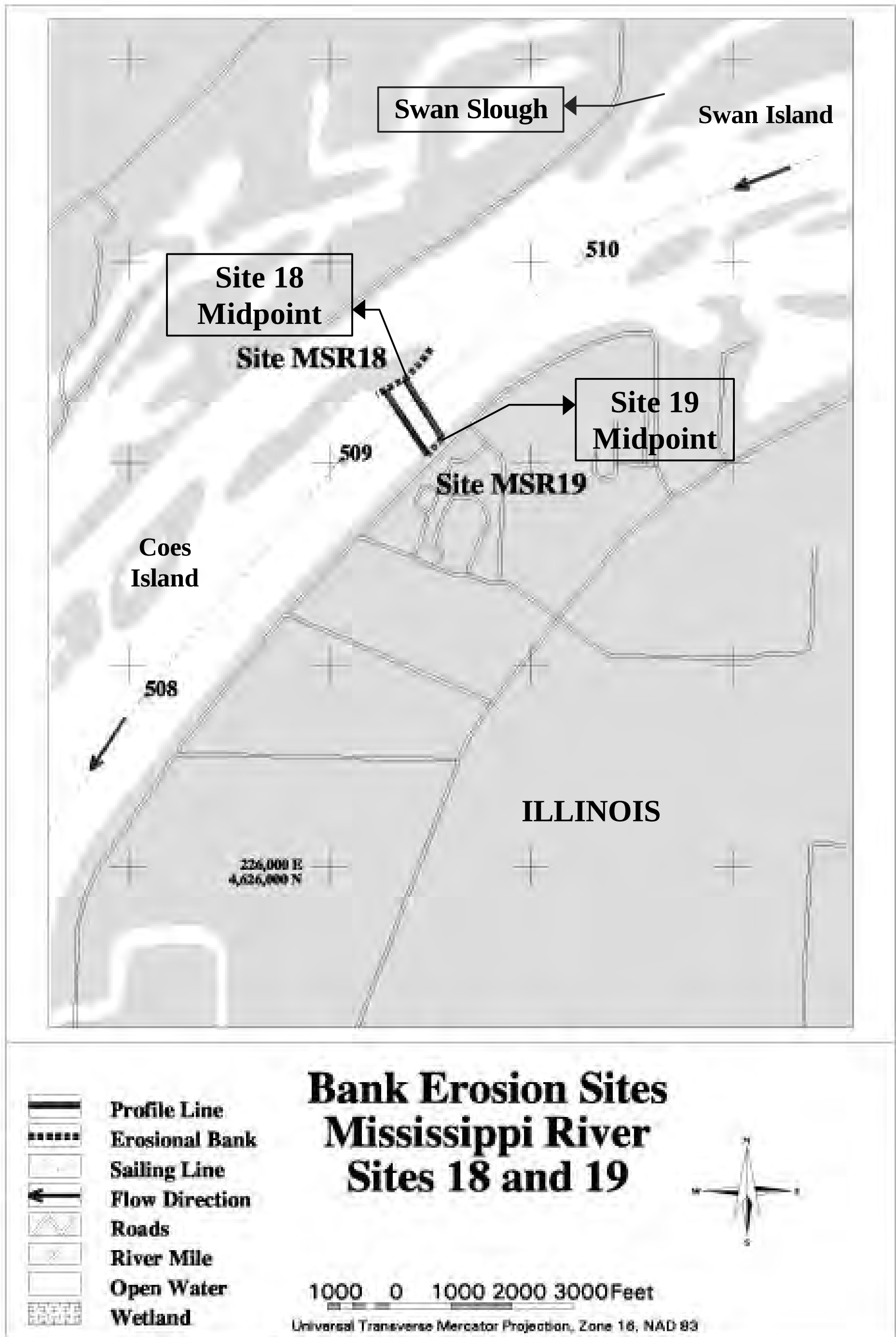


Figure 7-67 A map showing Mississippi River Sites 18 and 19

Photo 7-49 An upstream view of Site 18 midpoint

Photo 7-50 A close-up view of Site 18 midpoint

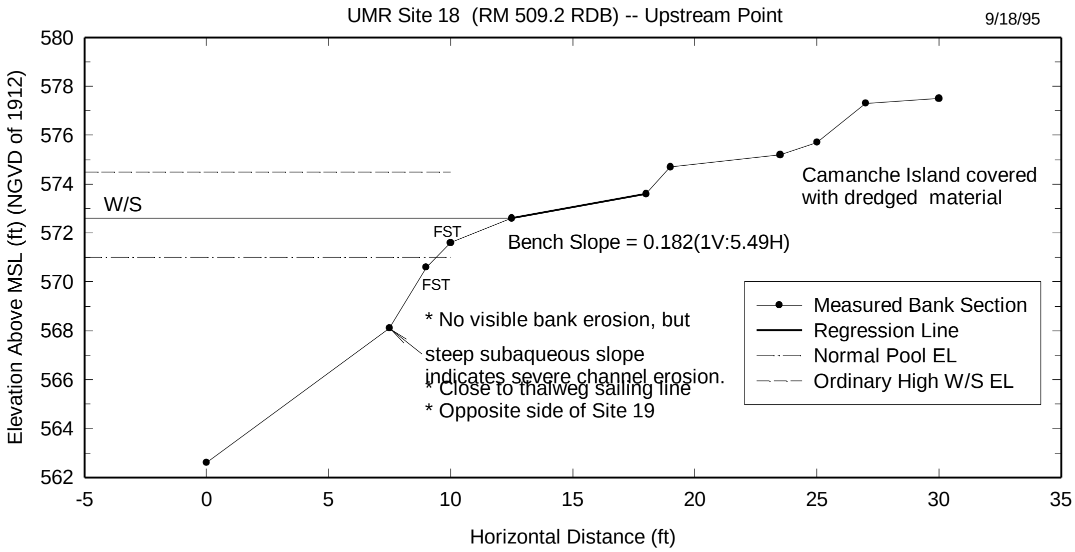


Figure 7-68 Bank section measured at Site 18 upstream point

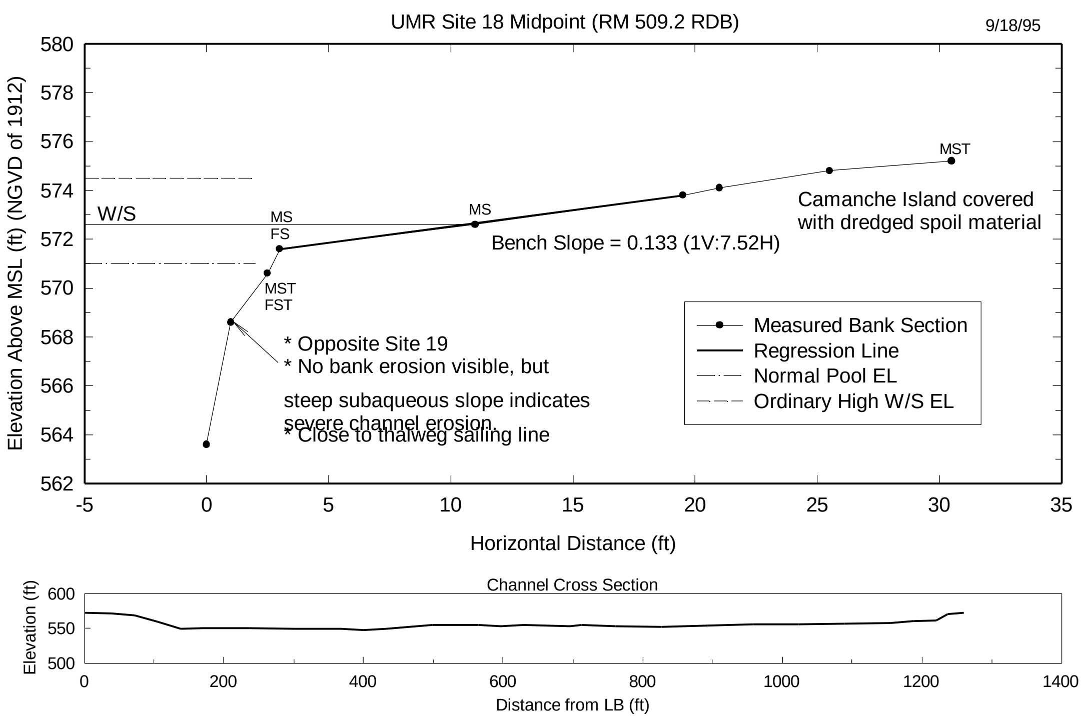


Figure 7-69 Bank section and channel cross section measured at Site 18 midpoint

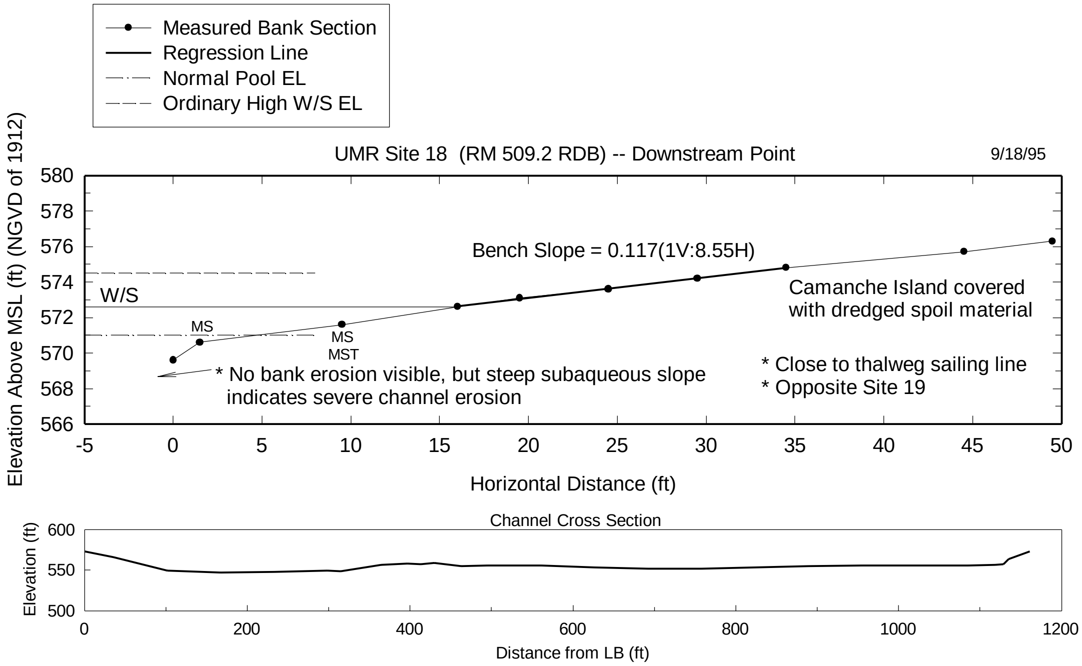


Figure 7-70 Bank section and channel cross section measured at Site 18 downstream point

an upstream view of the site, and Photo 7-50 shows a close-up view of the bankline. Three bank sections were taken at this site and they are shown in figure 7-68 through 7-70. No bank erosion was visible; however, very steep subaqueous bed slopes indicate severe channel erosion at this site.

As can be seen in figure 7-69, the scarp of the subaqueous bank is practically vertical at the midpoint section. Causative factors for bank retreat at this site include primarily undercutting by currents, and wave and rework-transport of recently deposited sediments within berm and bench areas. Because of the closeness of the channel thalweg to this site, potential for further in-channel flood-flow erosion exists at this site. This site is characterized by a combination of Types D, E, and F.

19. Site 19 at RM 509.2 LDB (Pool 14)

This site is located opposite Site 18 across the straight reach of the MR channel. The site is located along a Wisconsinan outwash terrace which is occupied by factories.

Photo 7-51 shows an upstream view of the site. The bank face was covered by tall weeds and shrubs, as can be seen in Photo 7-52. Two bank sections were taken at this site and

Photo 7-51 An upstream view of Site 19 midpoint

Photo 7-52 A perpendicular view of Site 19 midpoint

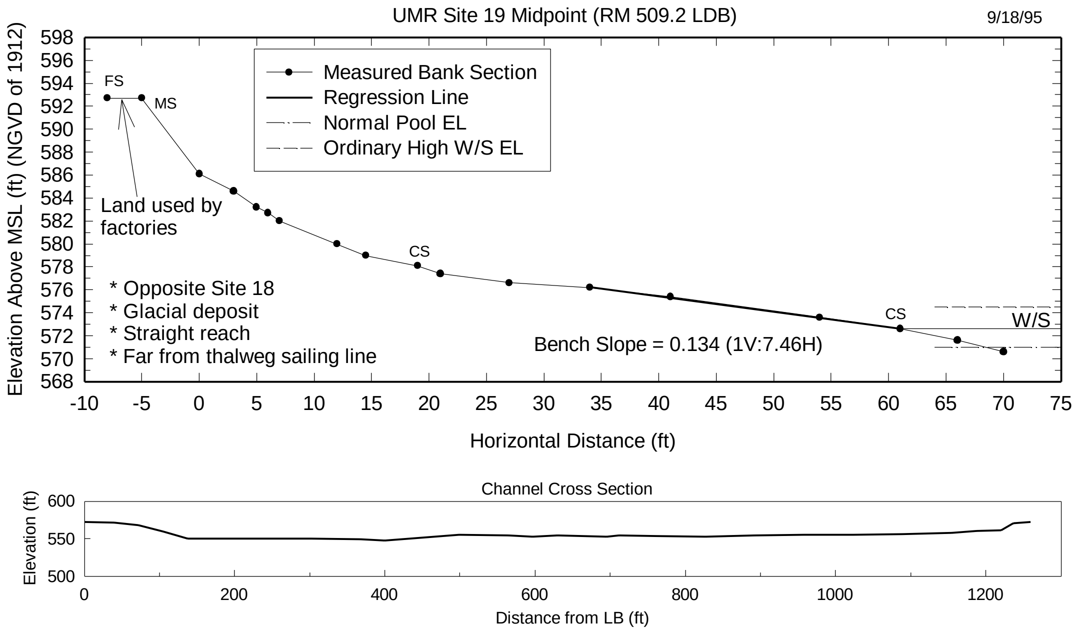


Figure 7-71 Bank section and channel cross section measured at Site 19 midpoint

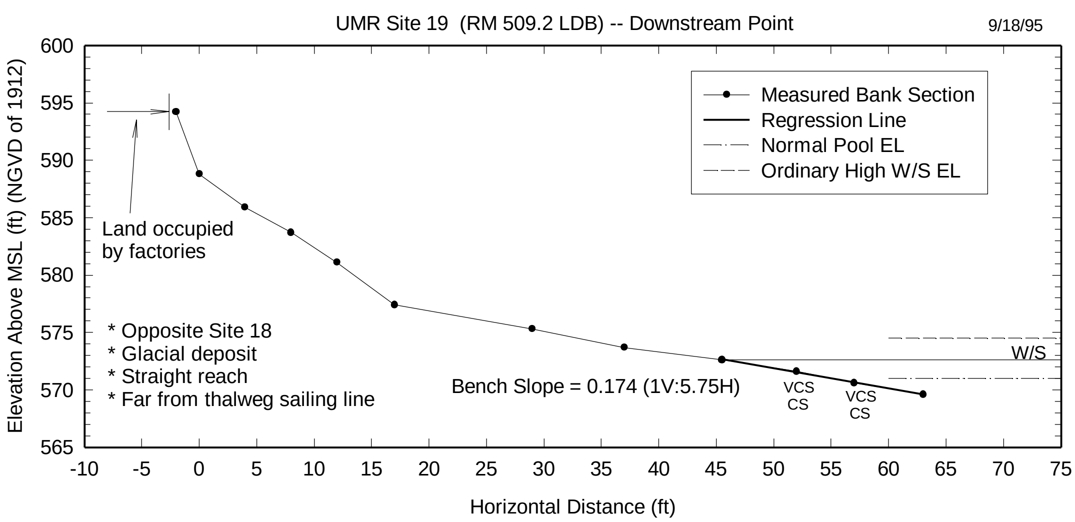


Figure 7-72 Bank section measured at Site 19 downstream point

are shown in figures 7-71 and 7-72. The bank soils are primarily sand, ranging from FS to CS.

As shown in figure 7-72, subaqueous bed sediments (CS and VCS) are much coarser than the bank soil, indicating high fine-sediment transport along this site. Causative factors for bank retreat at this site include flood-flow undercutting followed by cantilever and slab failures, debris slides, piping, and wave and flow rework-transport actions within bench-area sand cover. Type F characterizes Site 19.

Note that there is no Site 20.

21. Site 21 at RM 466.7 LDB (Pool 16)

This left-bank island site, shown in figure 7-73, is located in a straight reach, 9.8 miles upstream from Lock & Dam No. 16 and 16.2 miles downstream from Lock & Dam No. 15. This small, mid-channel island lies in the Andalusia Gorge across from Andalusia Island which extends approximately 9 miles from RM 464.0 to RM 473.0 along the left bank. A side view of the midpoint section is shown in Photo 7-53. As at Site 17, seven detailed bank sections were taken around the island at this site and they are shown in figures 7-74 through 7-80. The bank soil is silt (MST-CST) with sandy silt lenses. Subaqueous soil consists of layers of silt (FST-CST) and sand (VFS-FS). There are some piping features at the upstream tip of the island, as shown in figure 7-74, and the bench slope there is 0.295. The bench slope appears to decrease in the downstream direction, as was the case for Site 17. At the downstream end of the island, flow depth was extremely small; depth was only 3 ft even 570 ft riverward from the water's edge. It appears that this island is moving downstream. There are a series of wing dams along the right river bank opposite this site, and the river cross section near the right bank is quite complex, as can be seen in figure 7-77 for the midpoint section.

The site is located on a small late Holocene island. Small areas of older Holocene and late Wisconsinan surfaces occur abutting the narrow valley. Core samples showed historical alluvium thicknesses ranging from about 4.3 ft to 4.6 ft. Below the historical deposits, a weakly developed, poorly drained, late to very late Holocene soil was found.

Causative factors for bank retreat at this site include flood erosion, piping and collapse, wave and flow rework-transport of failed soils and recently deposited sediments, and piping failure. This island site is very close to the thalweg sailing line, and there is potential for wave erosion of failed soils and recently deposited sediments which mantle the benches. Bank types for these seven sections can be classified as Type C or Type D, as listed in table 7-5b.

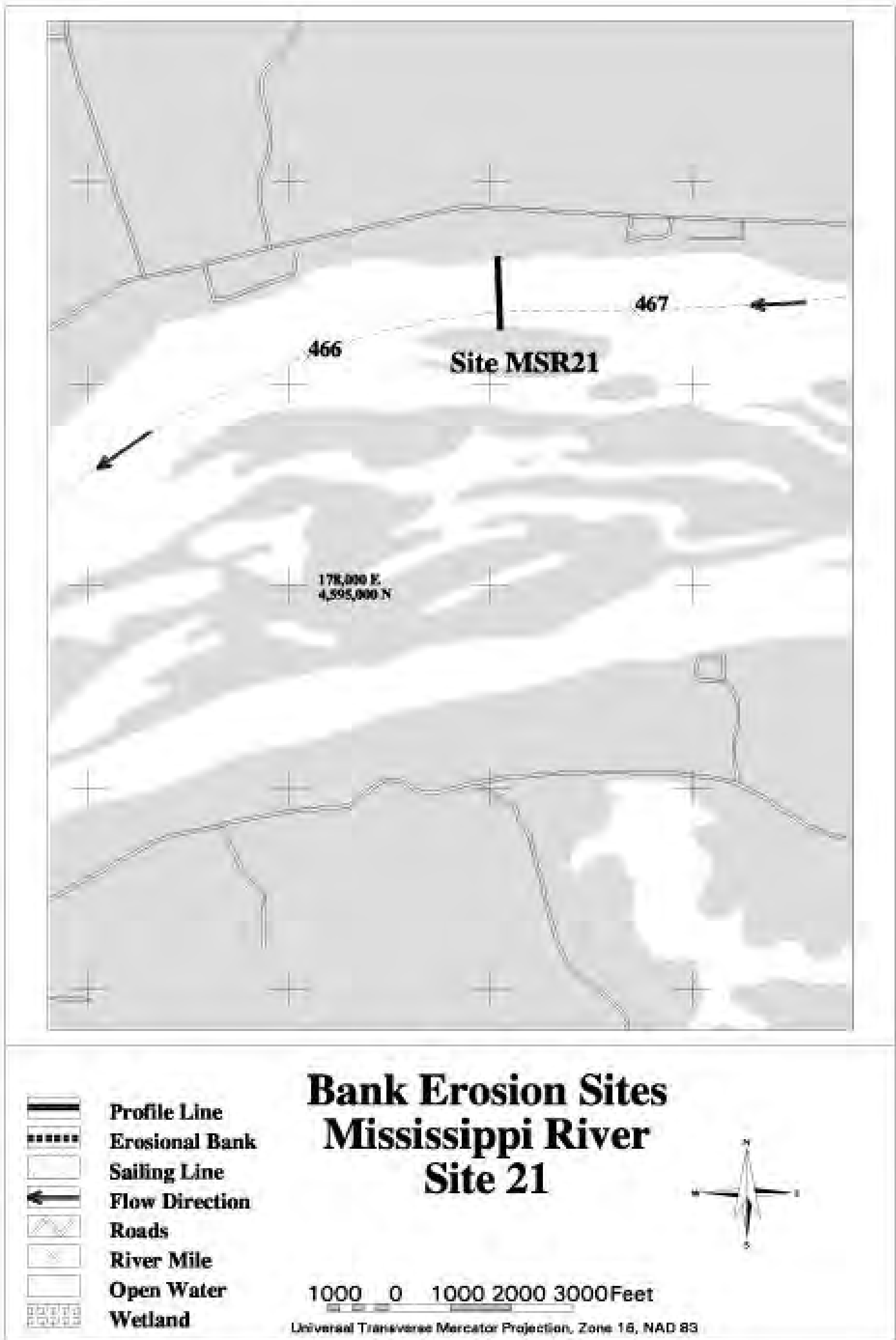


Figure 7-73 A site map showing Mississippi River Site 21

Photo 7-53 A side view of Site 21 midpoint

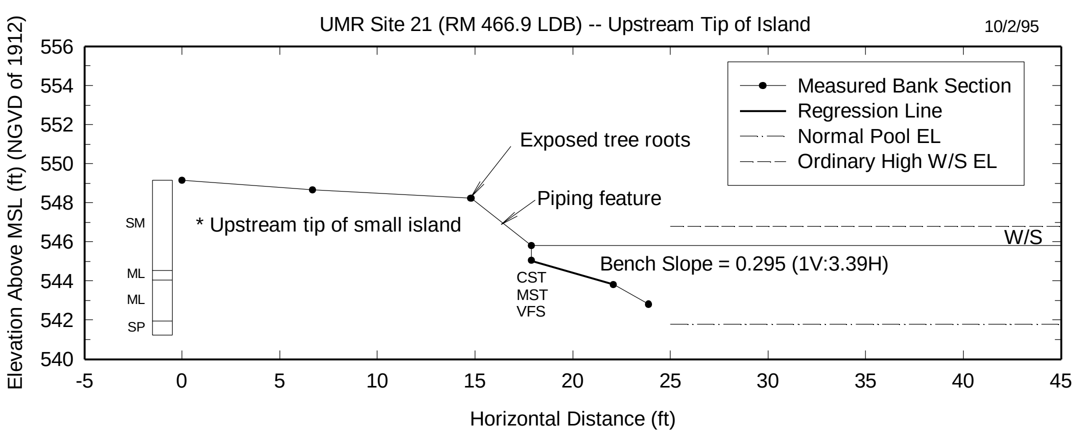


Figure 7-74 Bank section measured at Site 21 upstream tip of island

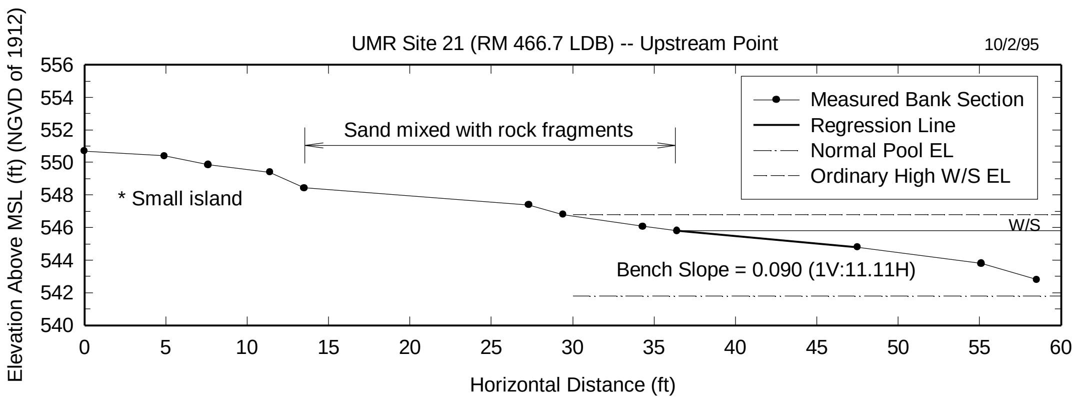


Figure 7-75 Bank section measured at Site 21 upstream point

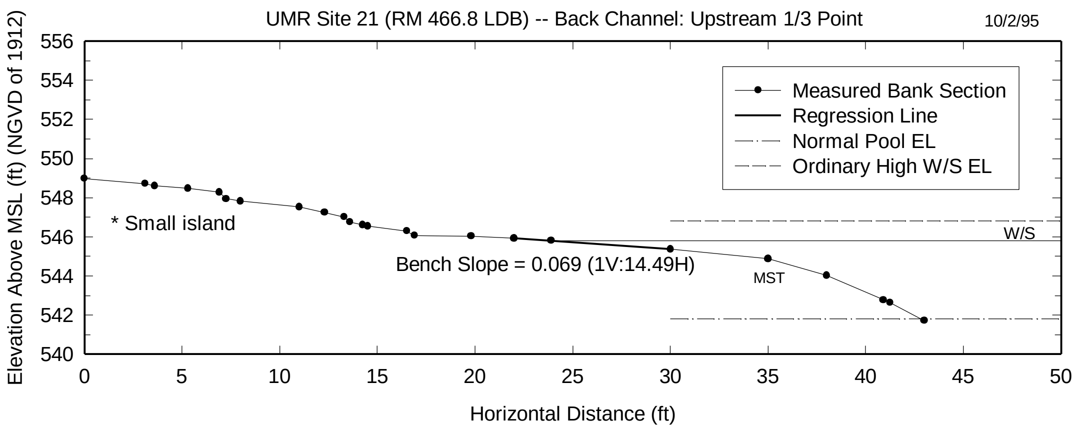


Figure 7-76 Bank section measured at Site 21 back channel upstream 1/3 point

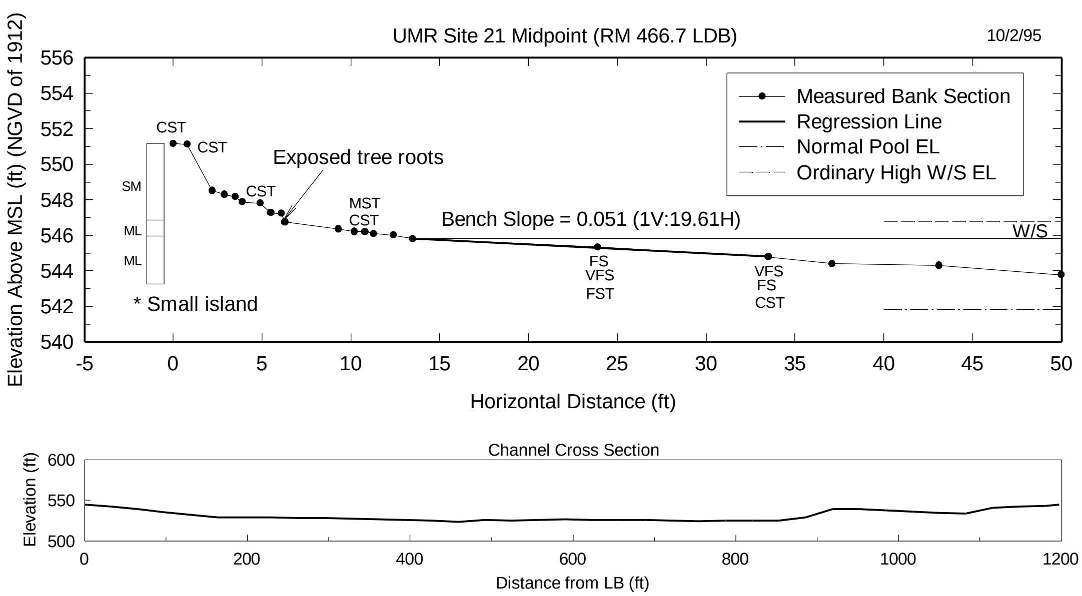


Figure 7-77 Bank section and channel cross section measured at Site 21 midpoint

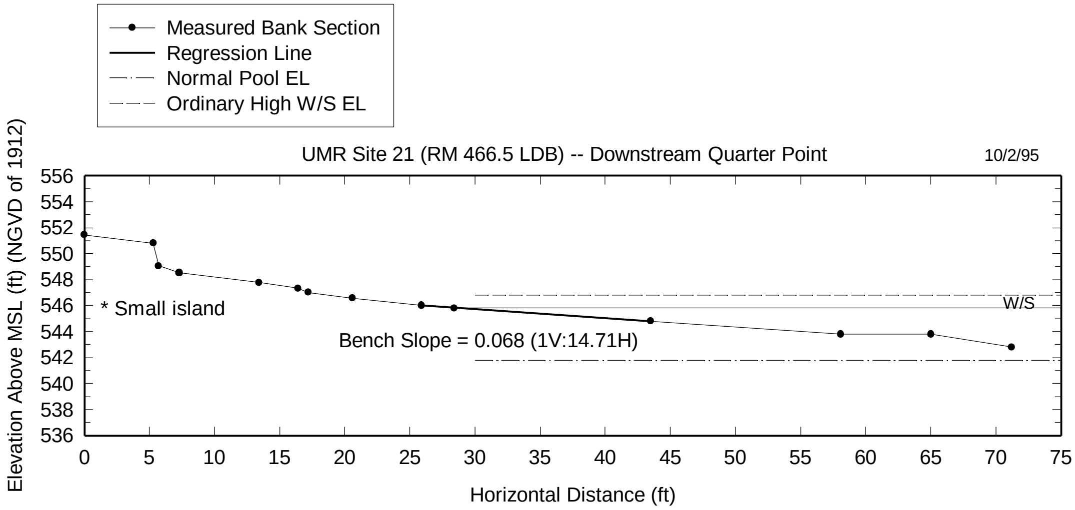


Figure 7-78 Bank section measured at Site 21 downstream quarter point

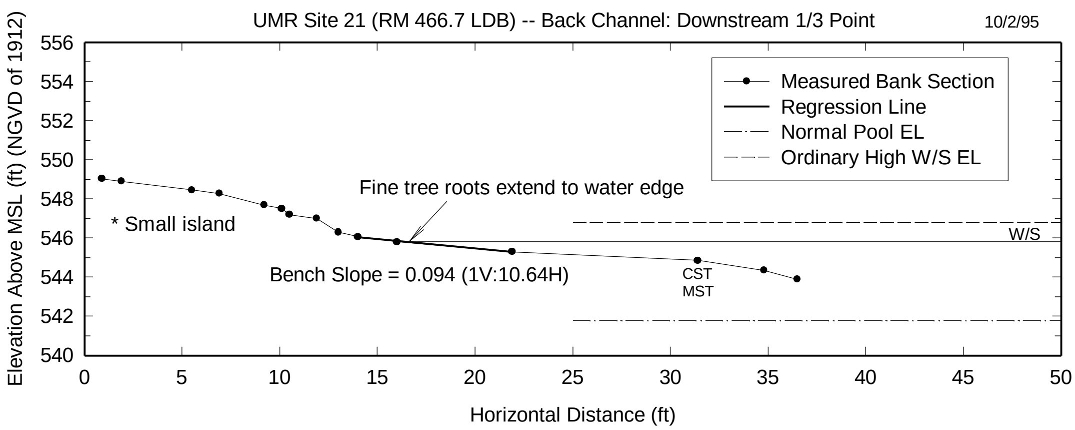


Figure 7-79 Bank section measured at Site 21 back channel downstream 1/3 point

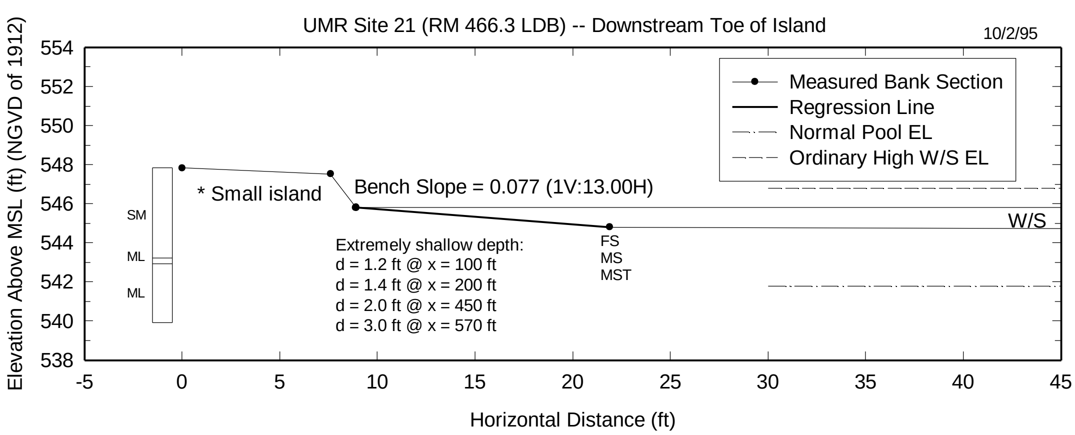


Figure 7-80 Bank section measured at Site 21 downstream toe of island

22. Site 22 at RM 436.4 LDB (Pool 18)

This left-bank erosion site, shown in figure 7-81, is located along a narrow straight river reach opposite Keg Island, only 0.7 mile downstream from Lock & Dam No. 17.

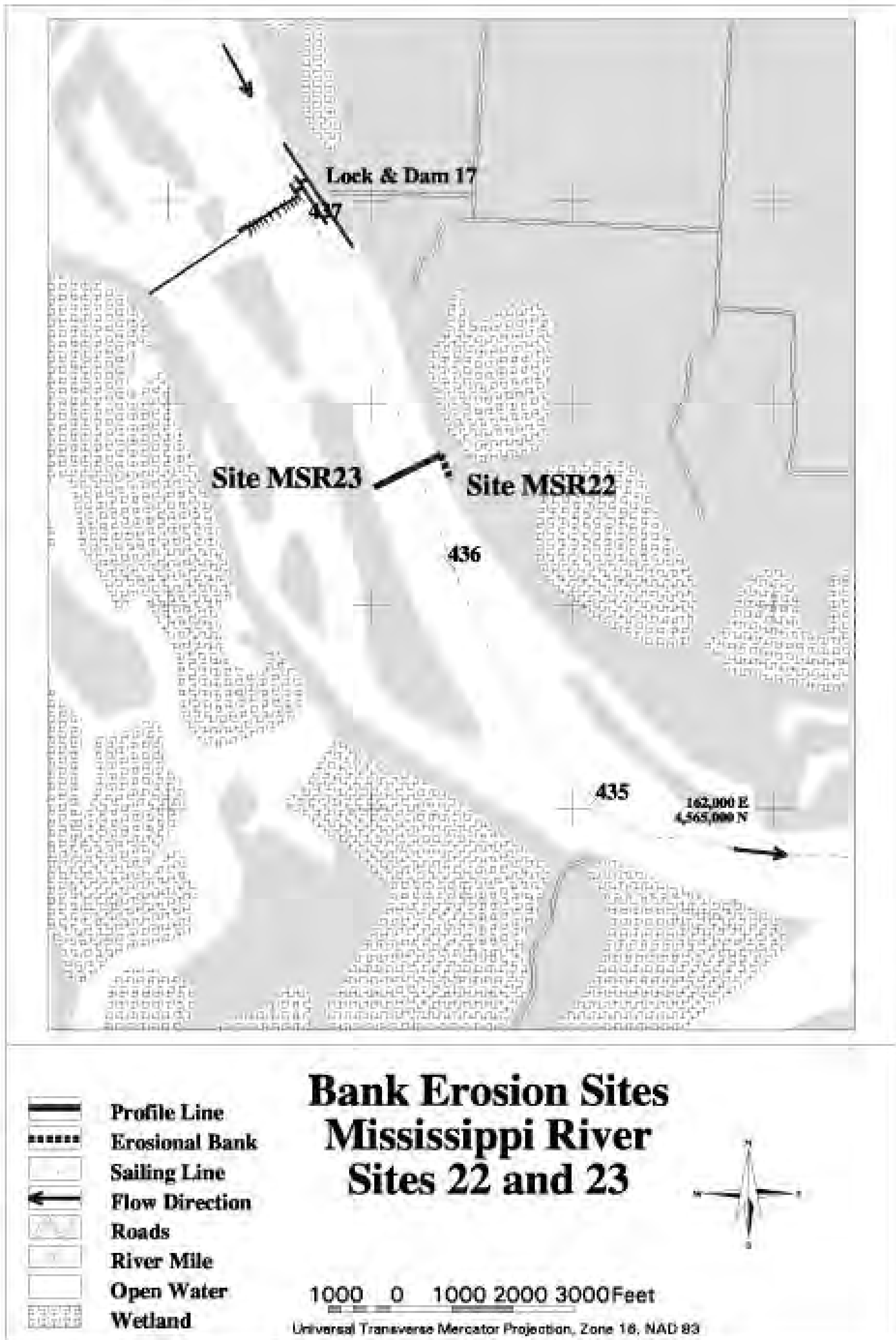


Figure 7-81 A site map showing Mississippi River Sites 22 and 23

Photo 7-54 An upstream view of Site 22 midpoint

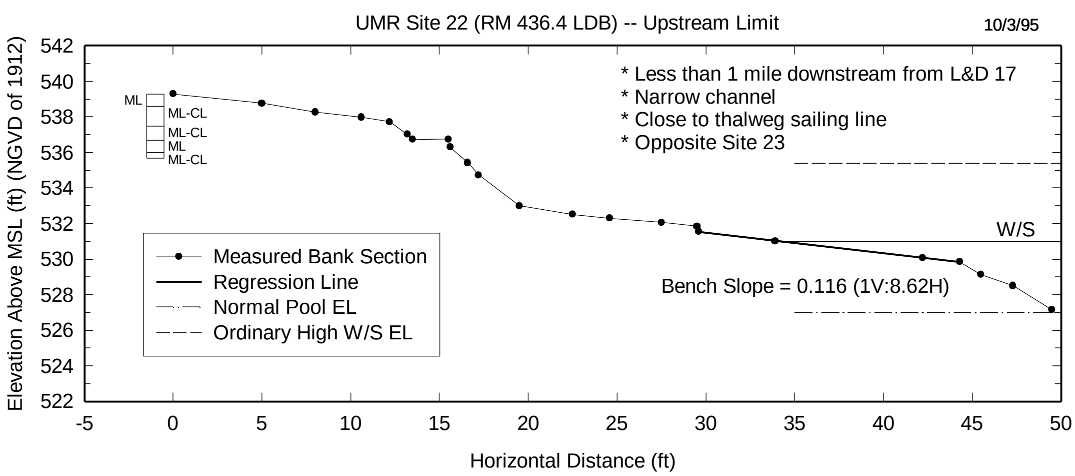


Figure 7-82 Bank section measured at Site 22 upstream limit

An upstream view of the midpoint section is shown in Photo 7-54. Five bank sections were taken at the erosion site: at the upstream limit; the upstream quarter point; the midpoint; the downstream quarter point; and the downstream point. The sections are depicted in figures 7-82 through 7-86. As can be seen in figure 7-84, the channel cross section is a typical parabolic shape common to straight channels. The bank soils consist of silt (FST-MST) with moderate piping features and subaqueous sediments are silt (MST-CST) and sand (VFS). Site 22 is very close to the thalweg sailing line. Steep subaqueous bank slopes observed along the bank downstream from the midpoint section indicate that this reach is subject to strong currents and vessel-induced prop-wash.

Three sampling tube cores were advanced at this location. One core advanced near the channel margin showed 6.2 ft of historical alluvium over an early to mid-Holocene soil. Two more cores advanced to the east of the constructed levee showed no historical deposits on the surface. The profile showed a late Holocene soil to about 2.6 ft, underlaid by early to mid-Holocene paleosol.

Two additional cores were advanced in the Lock & Dam No. 17 area in September 1996 during an environmental study. These cores showed a profile similar to that at Site 22 with a late Holocene soil burying an older early to mid-Holocene soil. In addition, the investigations during the erosion study recovered pre-historic pottery along the channel margin. Site 22 is located very close to that archaeological site. The older Holocene soils and archaeological site 11MC124 have been eroded.

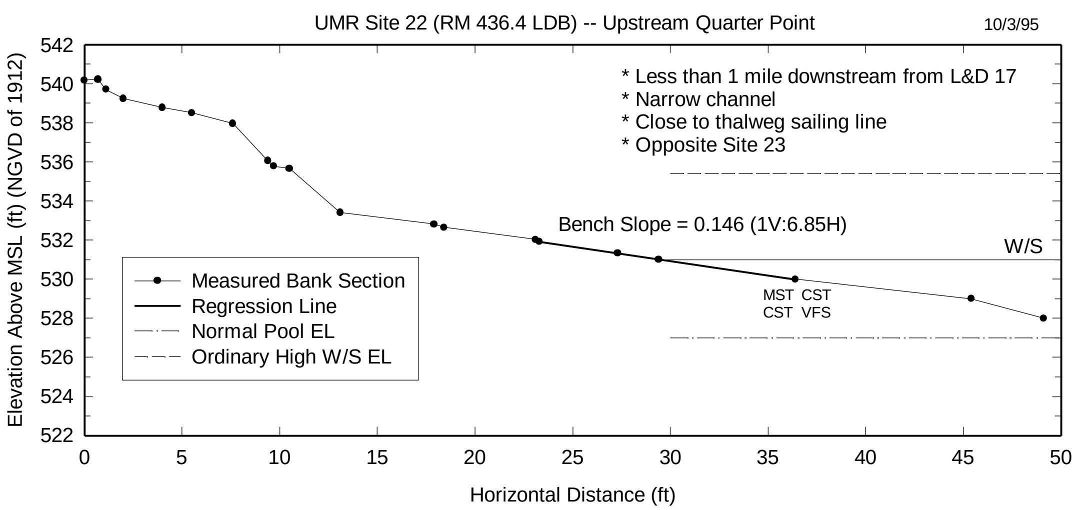


Figure 7-83 Bank section measured at Site 22 upstream quarter point

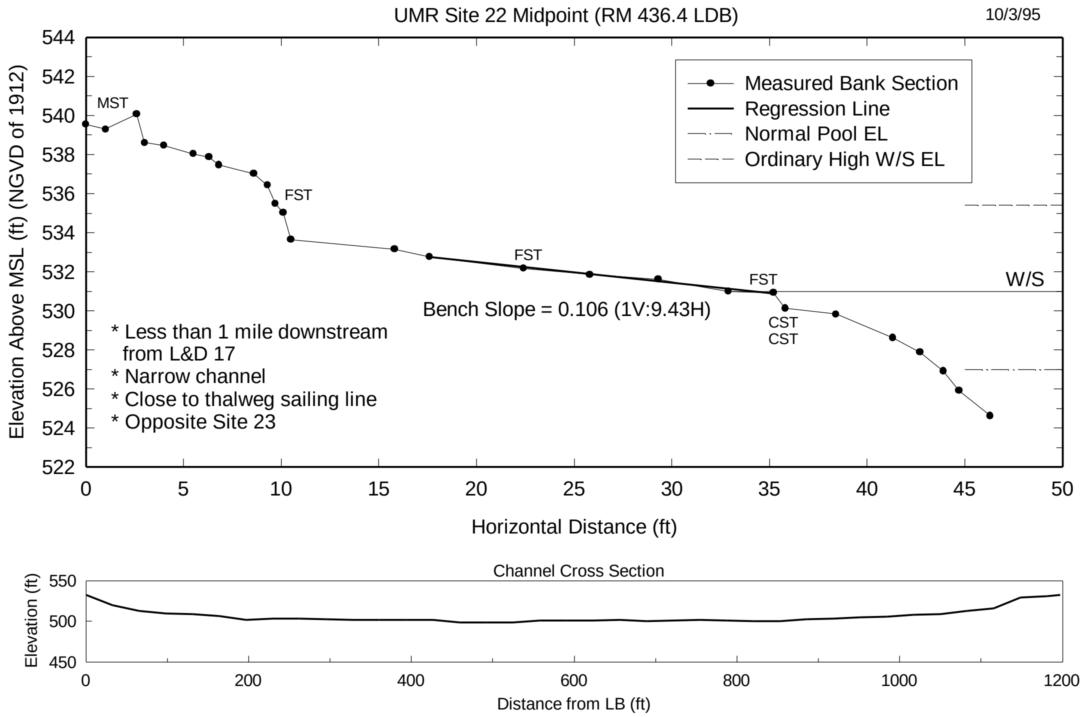


Figure 7-84 Bank section and channel cross section measured at Site 22 midpoint

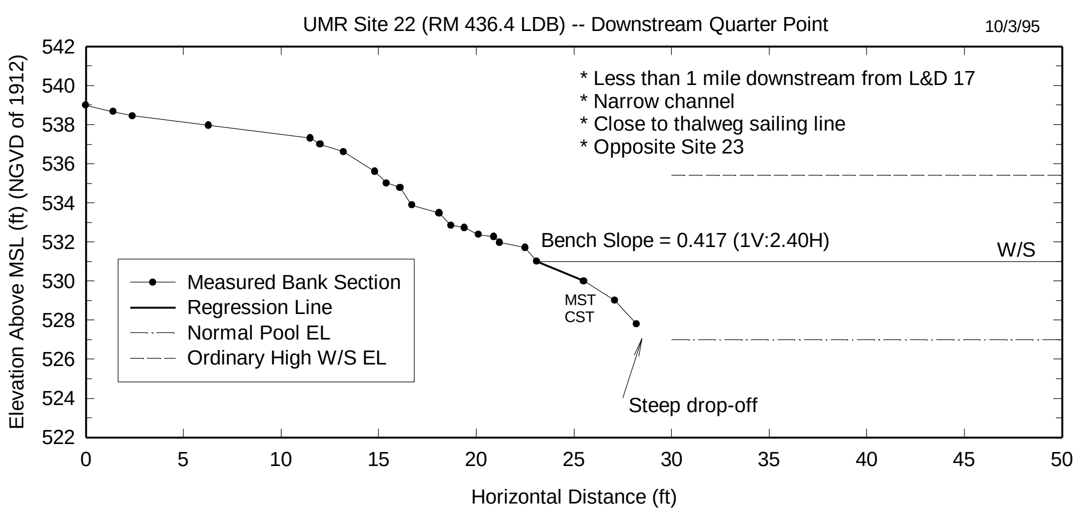


Figure 7-85 Bank section measured at Site 22 downstream quarter point

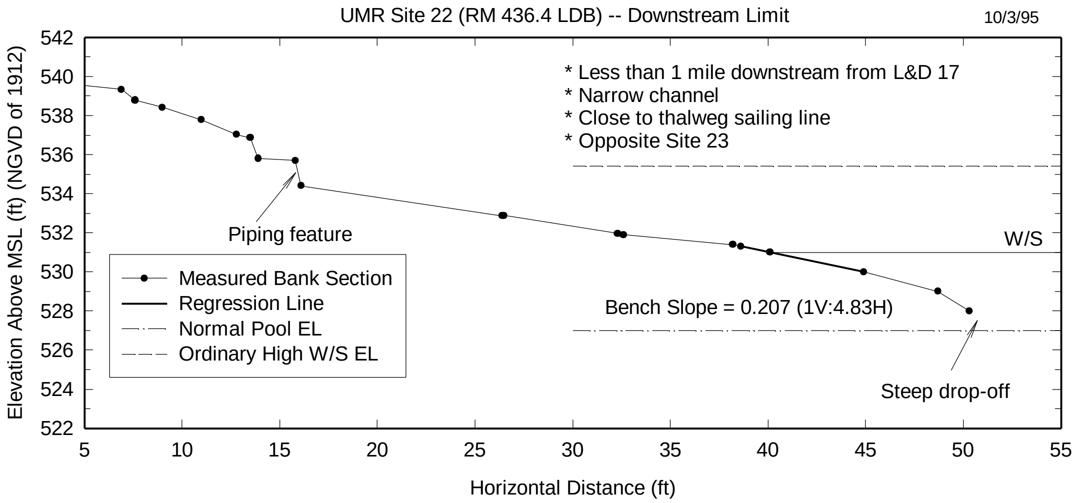


Figure 7-86 Bank section measured at Site 22 downstream limit

Causative factors for bank retreat at this site include flood-flow erosion and slumping during the rapid recession period, wave and flow rework-transport of failed soils and recently deposited sediments, and moderate piping failures. Because of the closeness to the thalweg sailing line, potential exists for wave erosion of failed soils and recently deposited sediments. Type C characterizes Site 22.

23. Site 23 at RM 436.4 RDB (Pool 18)

This right-bank site is located on the upper portion of Keg Island across the channel from Site 22 (see figure 7-81). A downstream view of the upstream site is shown in Photo 7-55. Two bank sections were taken at upstream and downstream points, and they are shown in figures 7-87 and 7-88. No midpoint section was established. The site is located far from the thalweg sailing line. As can be seen in figure 7-87 and Photo 7-55, stone slope-protection failure was observed at the upstream section. The bank soils consist of lensing silt (FST-CST) and some sand (FS) was found on the surface along the water's edge. Subaqueous sediments are silt (MST-CST) at the upstream section, and are silt (MST-CST) and sand (MS) at the downstream section.

The site is a late Holocene island whose surface is capped by historical alluvium. One sampling tube core advanced at the site showed historical alluvium to a depth of 4.9

ft, then contacting native soil. The native soil continued to 5.9 ft in depth, and a second buried soil was found deeper.

Causative factors for bank retreat at this site include flood-flow erosion and recessional piping failures, and wave and flow rework-transport of bench-area failed soils and recently deposited sediments. Site 23 is classified as bank Type C.

Photo 7-55 A downstream view of Site 23 upstream point

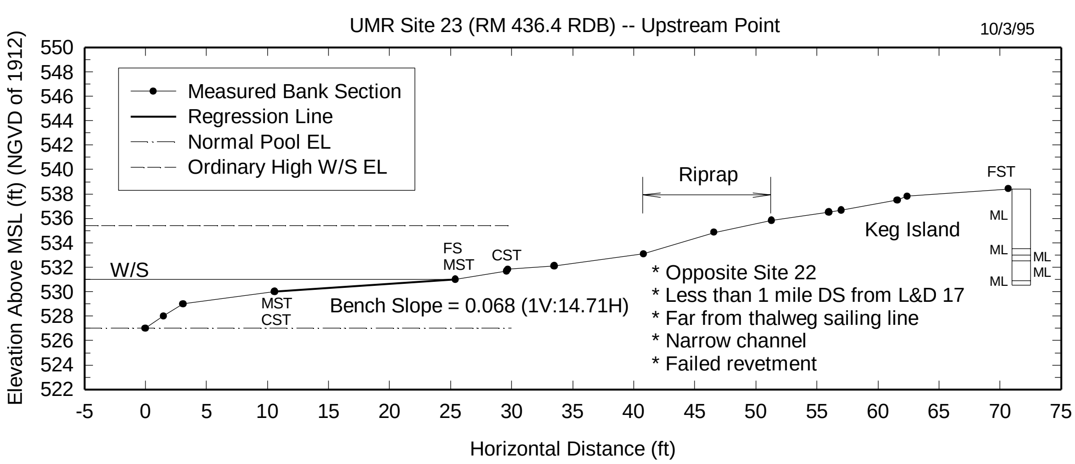


Figure 7-87 Bank section measured at Site 23 upstream point

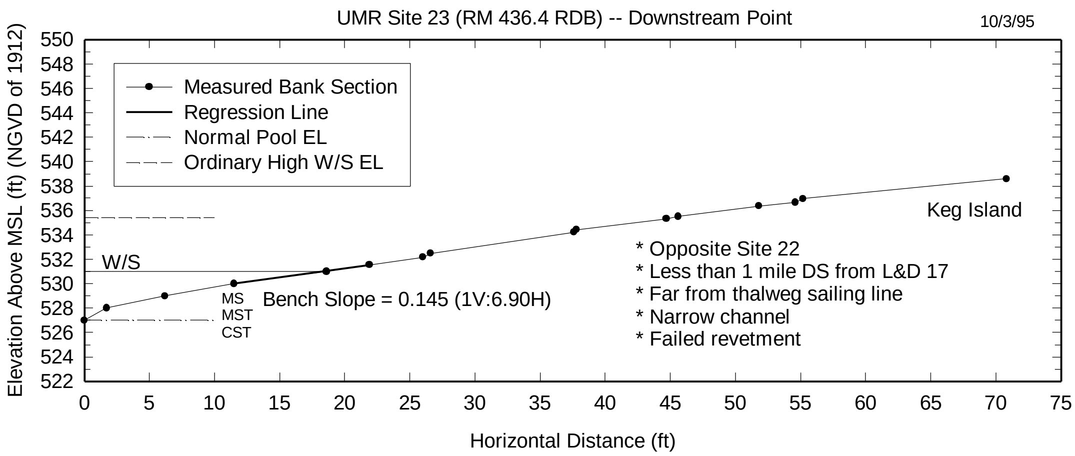


Figure 7-88 Bank section measured at Site 23 downstream point

24. Site 24 at RM 432.2 LDB (Pool 18)

This left-bank site, shown in figure 7-89, is located along the outside of the downstream extent of a sharp bend, only 1.7 miles downstream from the mouth of the Iowa River (RM 434). The site is 4.8 miles downstream from Lock & Dam No. 17, and is close to the thalweg sailing line. An upstream view of this site is shown in Photo 7-56. Three bank sections taken at this site are shown in figures 7-90 through 92. The bank soils consist of sand (FS-CS), and a steep sandy slope rises approximately 40 ft above the berm. This feature is shown in the bank sections.

This erosion site is located along a Wisconsinan outwash terrace. Although no cores were advanced at this site, observations indicate that the main channel is shifting laterally into the outwash terrace.

Causative processes for bank retreat at this site include flood erosion and recessional failures, and wave and flow rework-transport of bench-area failed soils and recently deposited sediments. Because the bank soils are primarily fine sand, wave erosion is extensive. This site is characterized by bank Type F.

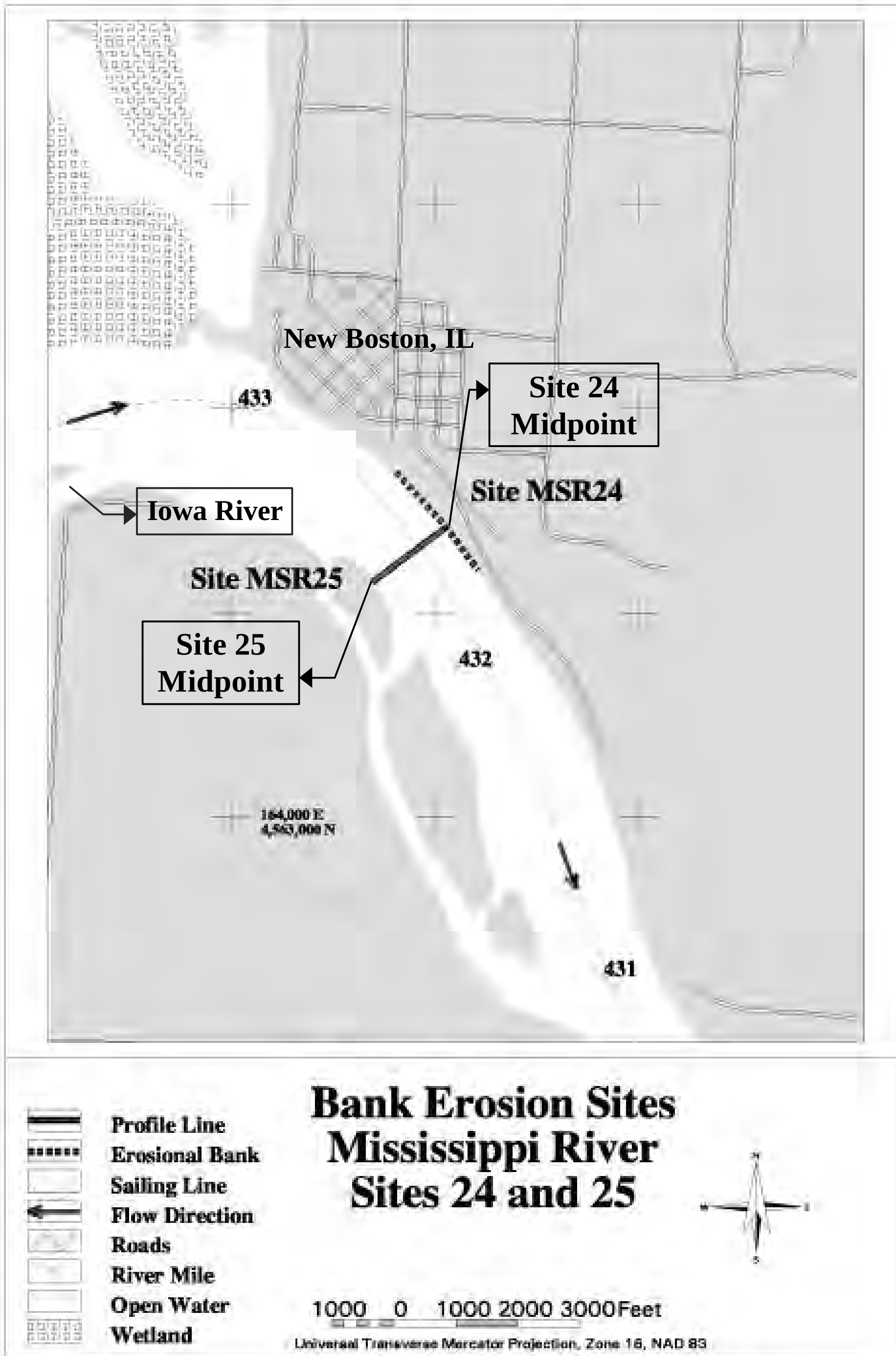


Figure 7-89 A site map for Mississippi River Sites 24 and 25

Photo 7-56 An upstream view of Site 24 midpoint

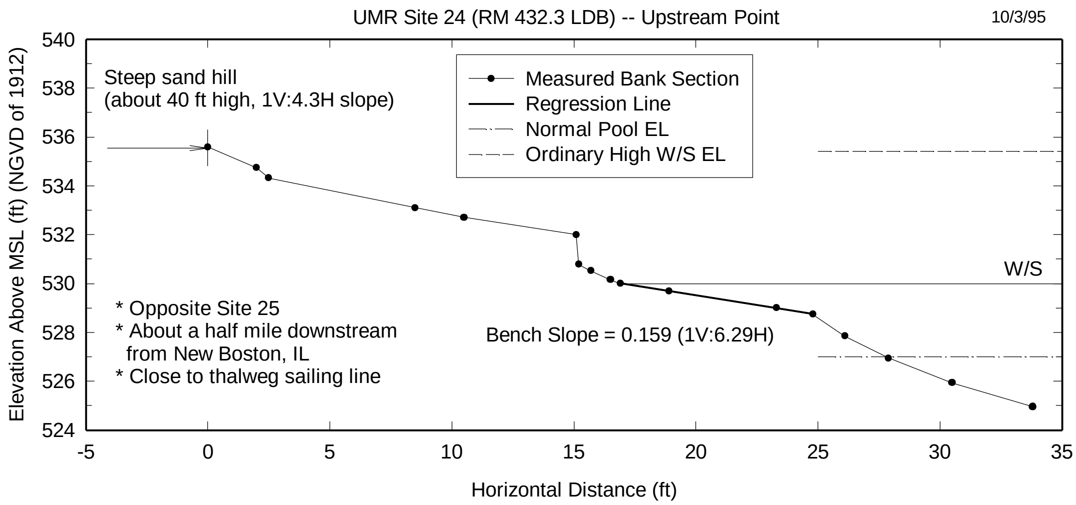


Figure 7-90 Bank section measured at Site 24 upstream point

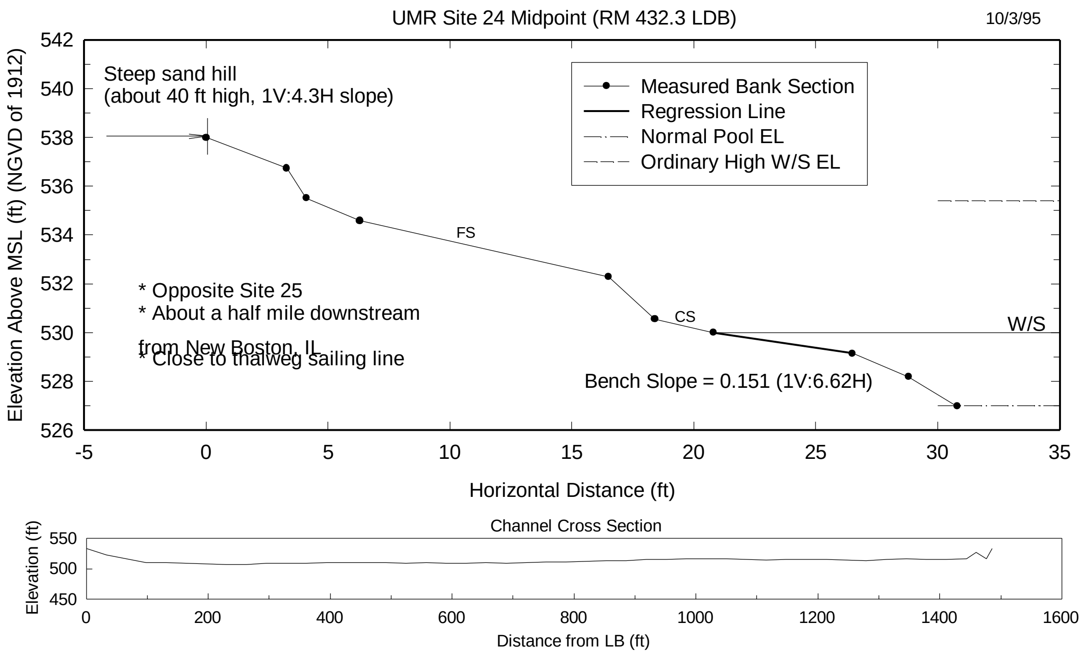


Figure 7-91 Bank section and channel cross section measured at Site 24 midpoint

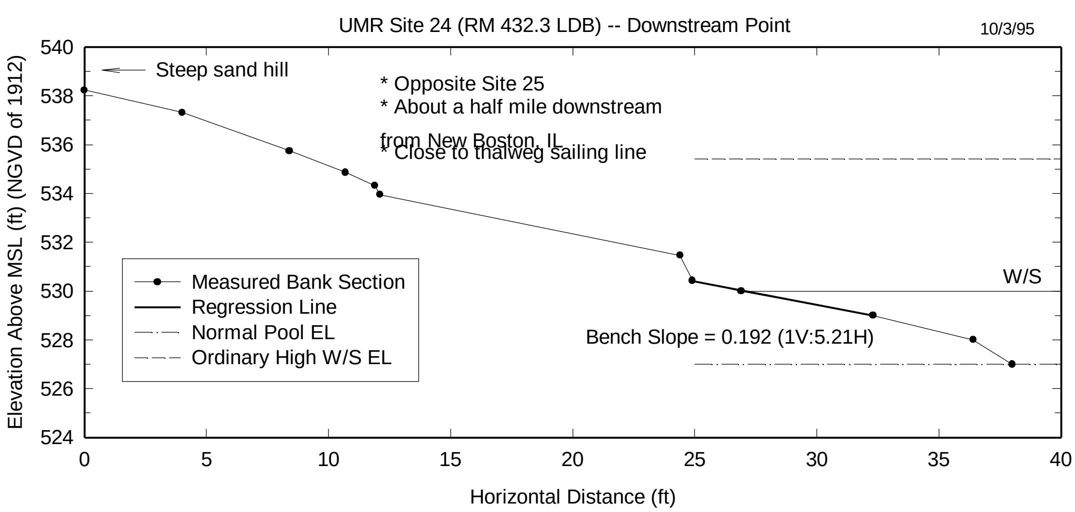


Figure 7-92 Bank section measured at Site 24 downstream point

25. Site 25 at RM 432.2 RDB (Pool 18)

This right-bank island site is located opposite Site 24. An oblique view of this site is shown in Photo 7-57. One bank section taken is shown in figure 7-93. The bank soils are primarily silt (VFST-MST), and subaqueous soil is silt (MST) and sand (FS).

One sampling tube advanced at the site showed thickly bedded historical alluvium throughout the 8.0 ft depth of advance. Erosion at this site is removing stored historical deposits.

The island is covered by a recent sand deposit, about 3 ft deep, apparently from the Great Flood of '93. Causative factors for bank retreat at this site include flood-flow bank oversteepening and rapid recessional slumping and seepage, piping collapse, and wave and flow rework-transport of failed soils and recently deposited sediment cover within bench areas. The steep subaqueous drop-off is a strong indication of channel erosion at this site, as referenced in figure 7-93. Eroded bank type is a combination of Type C and Type D.

Photo 7-57 A side view of Site 25 midpoint

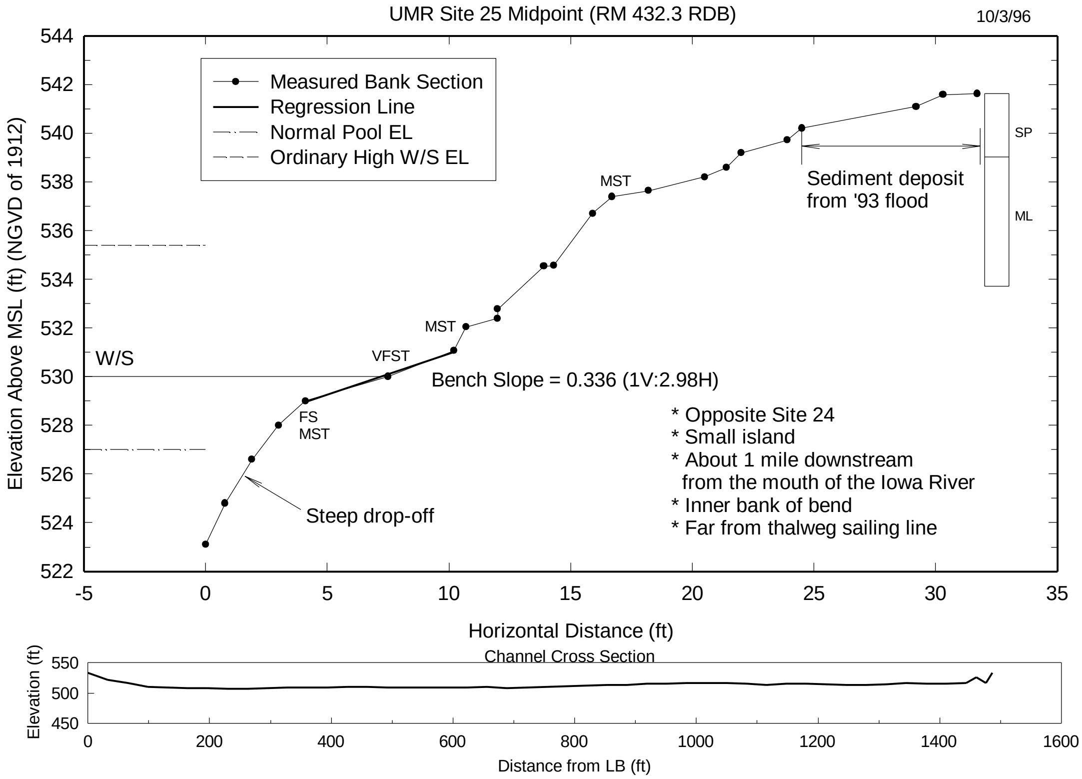


Figure 7-93 Bank section and channel cross section measured at Site 25 midpoint

26. Site 26 at RM 420.0 RDB (Pool 18)

This right-bank site, shown in figure 7-94, is located on Camp Island along a straight channel reach. The site is about 9.5 miles upstream from Lock & Dam No. 18. Camp Island is one of numerous islands formed downstream from the confluence of the Mississippi River and the Iowa River. An upstream view of this site is shown in Photo 7-58. Three bank sections taken at this site are shown in figures 7-95 through 7-97. The bank soils are mainly silt (FST) and sand (MS-CS), and subaqueous bench soil is silt (VFST-MST). As can be seen in the river cross section (figure 7-96), the thalweg is developing along this island. Severe in-channel erosional bank oversteepening is indicated by the steep subaqueous bank slope.

Two sampling tube cores taken at the midpoint section showed that the island is capped by historical alluvium and then dredged spoil up to 8 ft thick. A wetland filled with historical alluvium was found near the center of the island. Erosion at this site is removing the stored historical deposits.

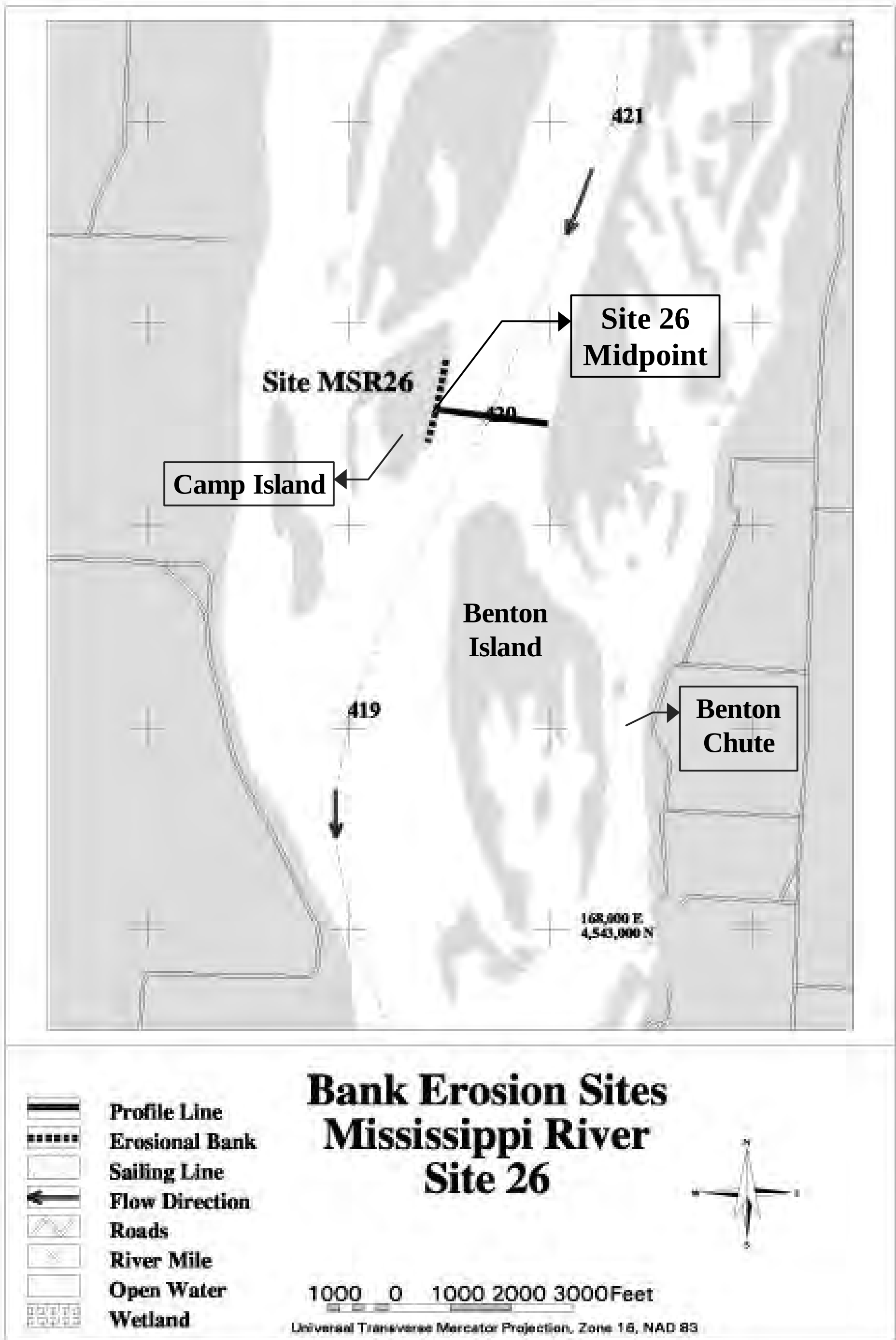


Figure 7-94 A site map showing Mississippi River Site 26

Photo 7-58 An upstream view of Site 26 midpoint

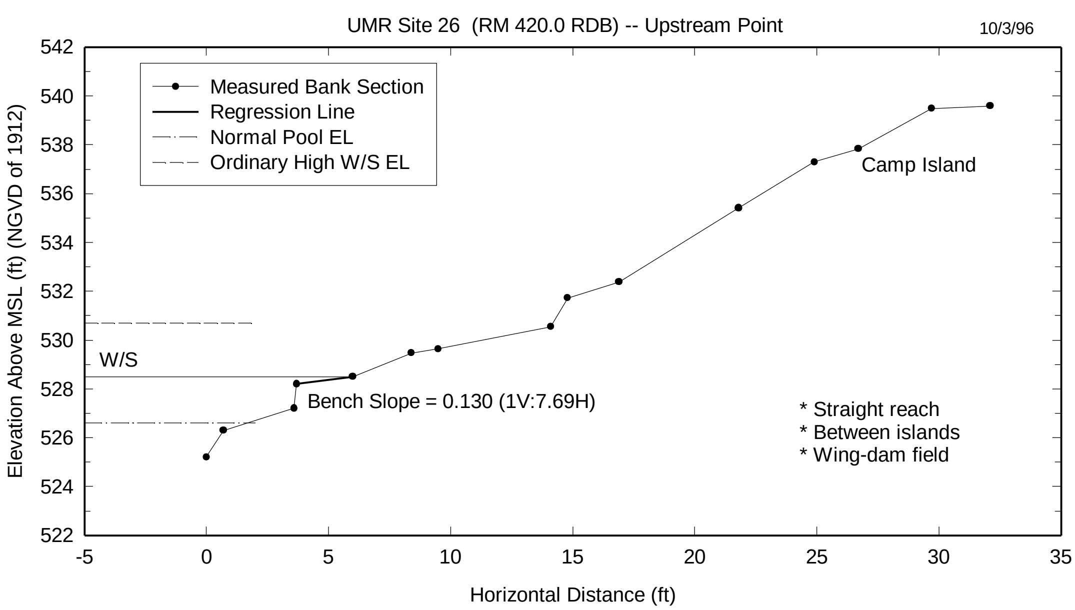


Figure 7-95 Bank section measured at Site 26 upstream point

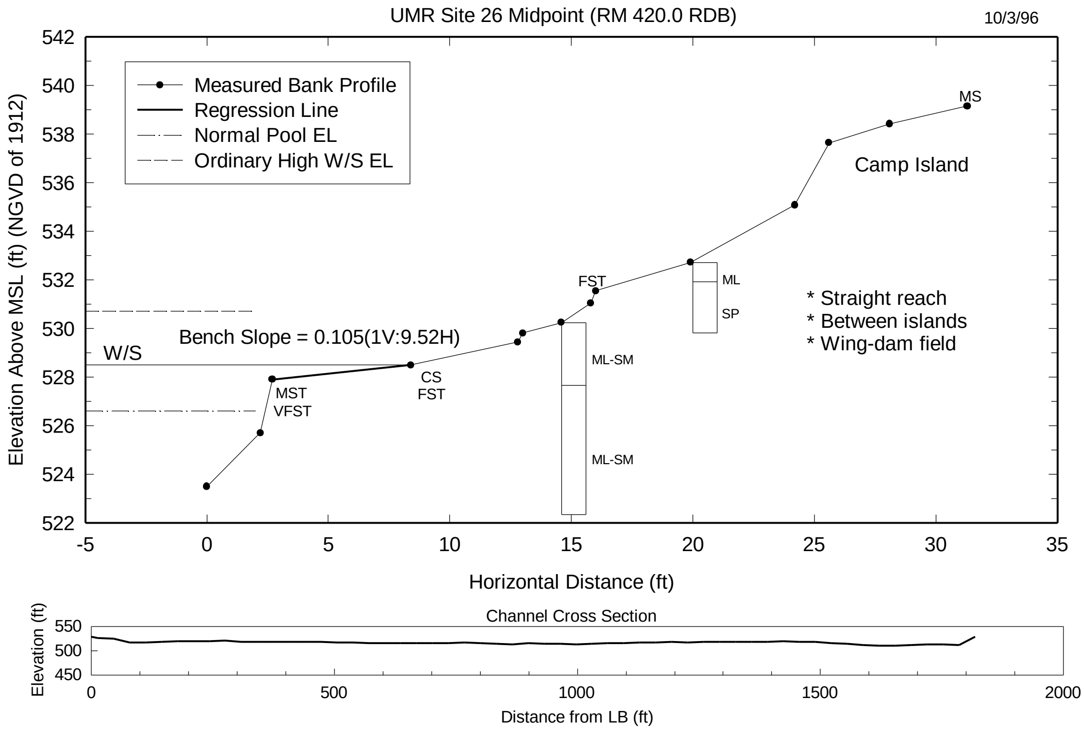


Figure 7-96 Bank section and channel cross section s measured at Site 26 midpoint

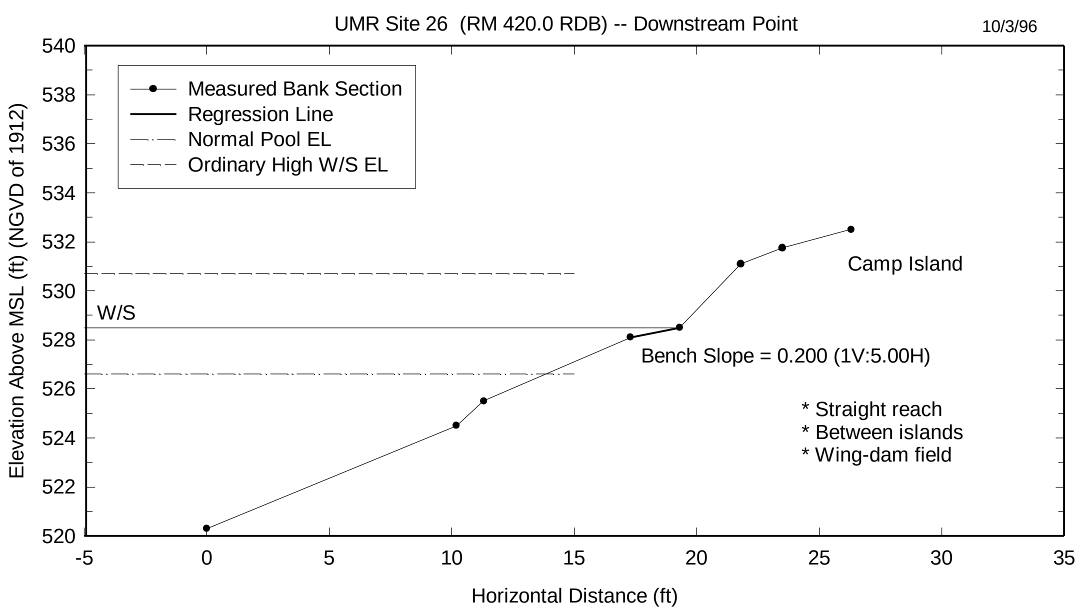


Figure 7-97 Bank section measured at Site 26 downstream point

Causative factors for bank retreat at this site include flood-flow erosion and recessional slumping of oversteepened banks and piping-related collapse with seepage, and wave erosion within bench areas affecting rework-transport of failed bank soils and recently deposited sediments. Because of the closeness to the thalweg and silty bank soils, wave erosion is more extensive at this site. A combination of bank Type E and Type F characterizes this site.

27. Site 27 at RM 360.0 RDB (Pool 20)

This right-bank site, shown in figure 7-98, is located directly across from Warsaw, Missouri, 4.2 miles downstream from Lock & Dam No. 20 and 1.6 miles downstream from the mouth of the Des Moines River. This site is within a rather straight segment within a wing-dam field. Bank retreat since 1984 can be seen in figure 7-98. An upstream view of this site is shown in Photo 7-59 and a close-up view of the scarp is shown in Photo 7-60. Only a midpoint bank section was taken, as shown in figure 7-99. The bank consists of layered silty clay and clayey silt, ranging from coarse clay (CC) to MST. Extensive piping features were observed at the scarp. The thalweg sailing line is remote from the erosion site. The ordinary high-water (25% occurrence frequency) elevation coincides closely with the top elevation of the head scarp. This erosion site includes examples of typical rework-transport bench zones depicted by figure 7-5. A run-out condition affected by blockage from fifteen loaded downstream-bound barges was measured to be about 0.1 ft at the midpoint site.

This erosion site had been mapped as a late Holocene surface; however, the site is characterized by thickly bedded historical alluvium. One sampling tube core showed silty to very fine sandy historical deposits to a depth of at least 8.2 ft. The site included desiccated blocks of failed historical alluvium bank soils at the toe of the scarp and within the bench area.. Desiccated vertical cracks formed deep into the soil profile during the summer of 1995. The cracks result from contraction or shrinkage of smectite expandable silts/clays. As moisture is removed, this creates dry soil conditions. The smectite silts/clays swell during moist periods and close the vertical cracks, which adds the cohesiveness to the medium to fine-grained soils. During the late dry summer of 1995, river stage levels were lower compared to periods earlier in the year. Soil blocks were observed to be calving and slumping into the river's channel margin. The instability of the banks, indicated by the slumping soil blocks, may be caused by several factors,

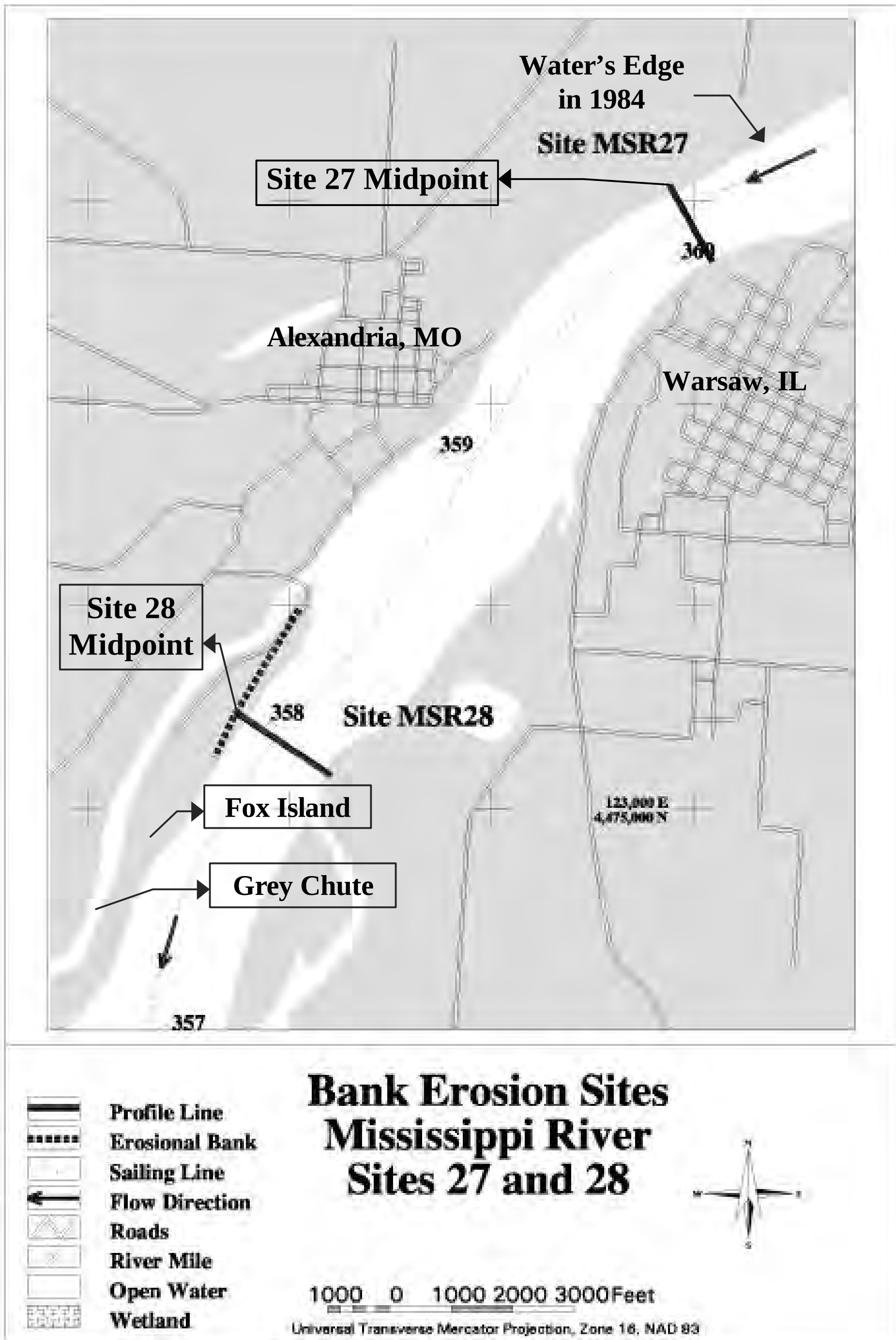


Figure 7-98 A site map showing Mississippi River Sites 27 and 28

Photo 7-59 An upstream view of Site 27 midpoint

Photo 7-60 A close-up view of scarp at Site 27 midpoint

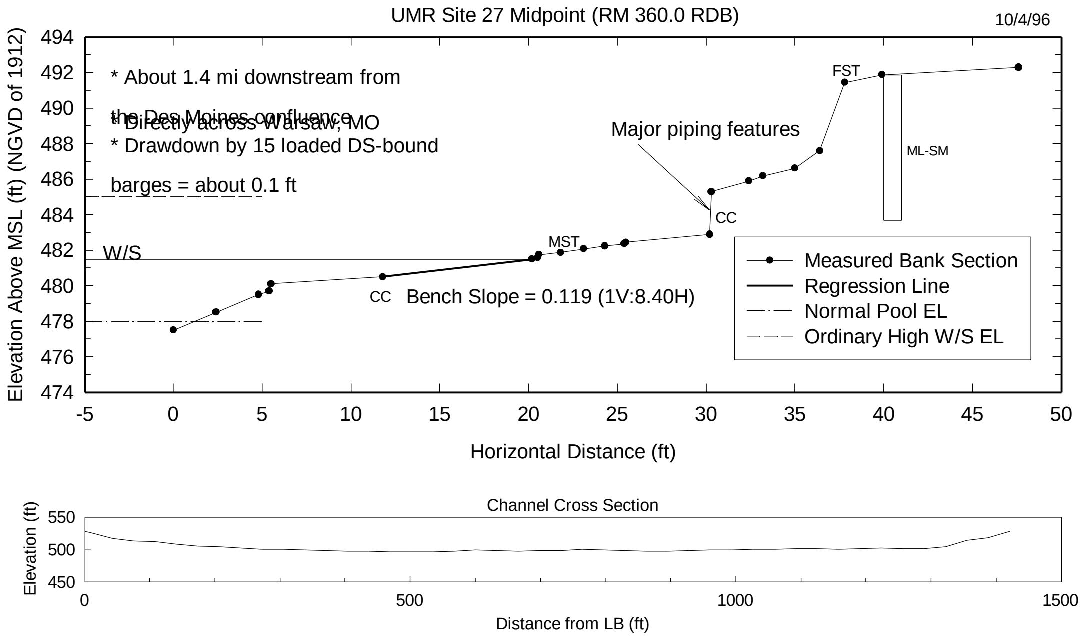


Figure 7-99 Bank section and channel cross section measured at Site 27 midpoint

including (1) weakening of the soil body from vertical fracturing; (2) a lower river stage which caused a steepening of the bank slope; (3) wave actions undermining fine sands along the bank interbedded by silt/fine sand alluvial sequence; (4) head differences between the water table and river level, causing groundwater flow along weaker fine sand seams; and finally, (5) less hydraulic bank support during low water dry periods. Moist conditions and higher river stages, higher water table elevations, and improved soil moisture would tend to provide hydraulic support of the soil body.

Causative factors for bank retreat at this site include flood-flow erosion and recession and piping-initiated slumping, slaking, seepage, and wave and flow rework-transport of failed and slaked bank soils and recently deposited sediments within bench areas. Site 27 is classified as Type A.

28. Site 28 at RM 357.6 RDB (Pool 20)

This right-bank site, shown in figure 7-98, is located on Fox Island in a crossover reach with chronic dredging problems, approximately 6.6 miles downstream from Lock & Dam No. 19. Significant bank retreat since 1984 is evident in figure 7-98. Photo 7-61

Photo 7-61 An upstream view of Site 28 midpoint

Photo 7-62 A close-up view of scarp at Site 28 midpoint

Photo 7-63 Vertical cracks and massive block failures at Site 28 midpoint

Photo 7-64 Piping features and vertical cracks seen at Site 28 midpoint

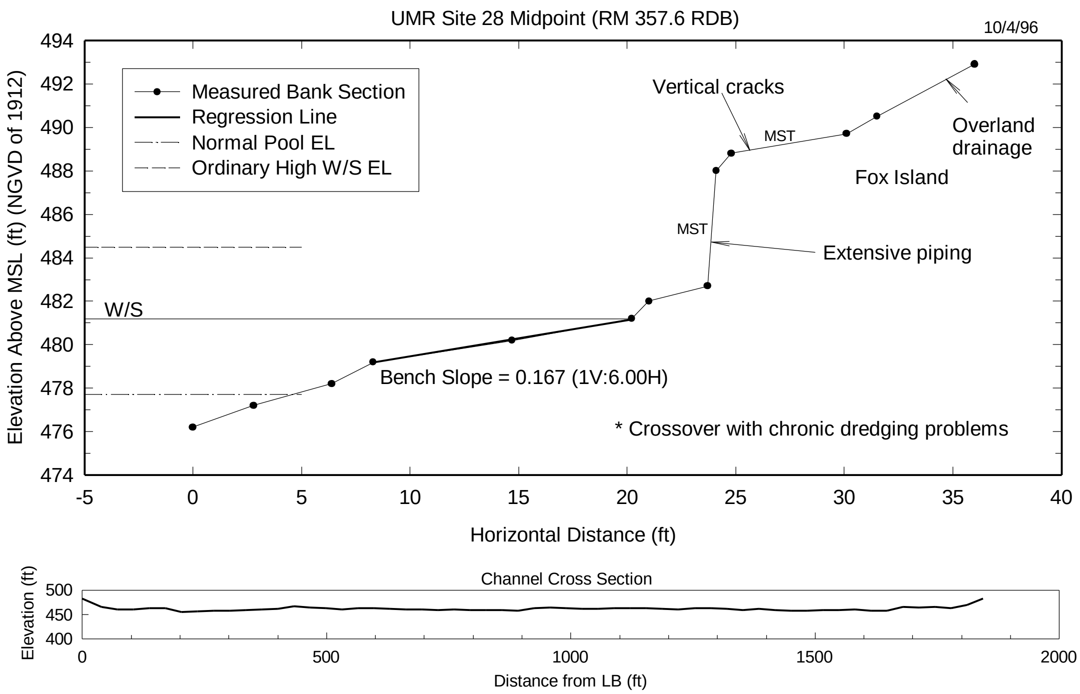


Figure 7-100 Bank section and channel cross section measured at Site 28 midpoint

shows an upstream view of the site and Photo 7-62 is a close-up of the scarp. Photo 7-63 shows extensive vertical cracks associated with block failures along the bank face, and Photo 7-64 shows piping features and vertical cracks. Shown in figure 7-100 is the bank section obtained at this erosion site. The river cross section shown in figure 7-100 has a typical shape for a crossover reach characterized by a nearly constant depth across the width. The scarp, about 7 ft high, is nearly vertical, and the bank soils are predominantly MST.

A MR reach (RM 355 - RM 356) along Fox Island Bar just downstream from Site 28 and a downstream reach around Buzzard Island (RM 349 - RM350) were investigated by Iowa Institute of Hydraulic Research (IIHR), The University of Iowa, in 1976 and 1978. Those studies focused on sediment-transport characteristics around crossovers by both field studies and numerical methods. These reaches required extensive channel dredging. The studies identified significant reduction in the main-channel sediment transport capacity by bifurcations surrounding the study sites (Nakato & Kennedy 1977, Nakato et al. 1979, Nakato & Vadnal 1981).

Extensive piping features were present within the scarp. Surface erosion due to overland drainage was visible at the site. Causative factors for bank retreat at this site include displacement of slabs, slaking, piping and flood erosion and rapid recession-related slumping, slab and block failures, cleft pressure, and overland drainage. A defined rill formation of failed soils and recently deposited sediments is evident within bench areas. Because the site is close to the thalweg sailing line, wave erosion exists here. Type A is the best description of this site.

29. Site 29 at RM 339.3 LDB (Pool 21)

This left-bank site, shown in figure 7-101, is located between two wing dams on a small island, detached from Long Island situated along the left bank of a straight stretch of the MR. It is 3.9 miles downstream from Lock & Dam No. 20. Bank retreat since 1984 is visible in figure 7-101. Photos 7-65 and 7-66 show an upstream view and a perpendicular view of the site. Three bank sections are shown in figures 7-102 through 104. The bank soils are layered silt (MST) and sand (FS-MS). Subaqueous soil is FS. Piping features and related block failures were observed at this site. There were multiple scarps within the bank. The thalweg sailing line is located in the mid-channel. Drawdown by fifteen upstream-bound empty barges, as measured at this site, was about 0.2 ft.

Several years prior to this study, Long Island was investigated by Anderson who found that the island Holocene soil is at least 3,200 years old, based on radiocarbon chronology (Anderson et al. 1988). Another conclusion, derived in that investigation, was that recent historical deposits became considerably thicker along the channel margin. The section taken in this study showed thickly and thinly bedded historical alluvium and medium calcareous sand to the base of the 10.7 ft profile. Erosion at this site has been limited to stored historical alluvium.

Causative factors for bank retreat at this site include piping, flood-flow erosional oversteepening and rapid recession and piping-initiated failures, block failures, and wave and flow rework-transport of failed soils and recently deposited sediments within bench areas. This site is characterized by a combination of Types A, B, and C.

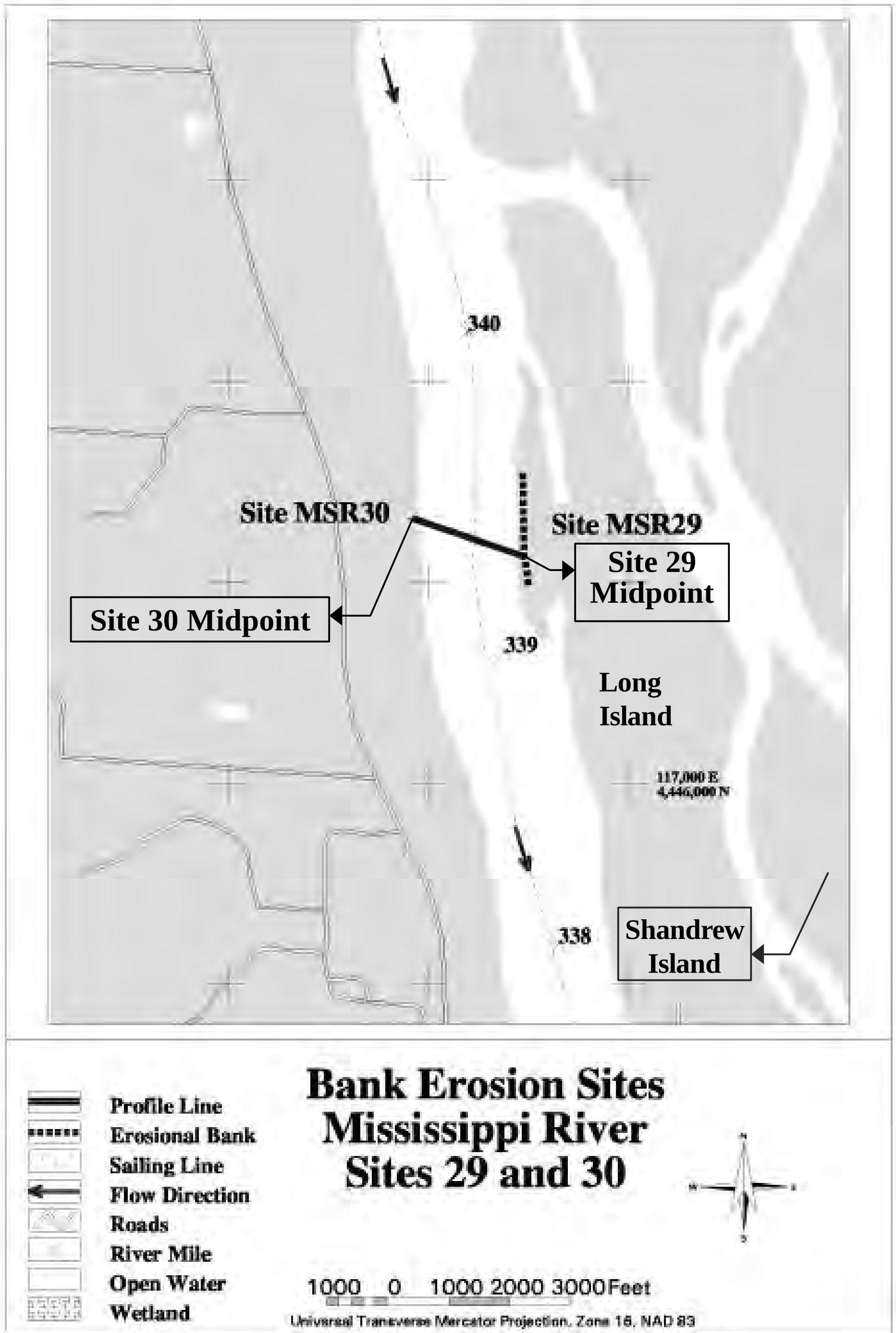


Figure 7-101 A site map showing Mississippi River Sites 29 and 30

Photo 7-65 An upstream view of Site 29 midpoint

Photo 7-66 A perpendicular view of Site 29 midpoint

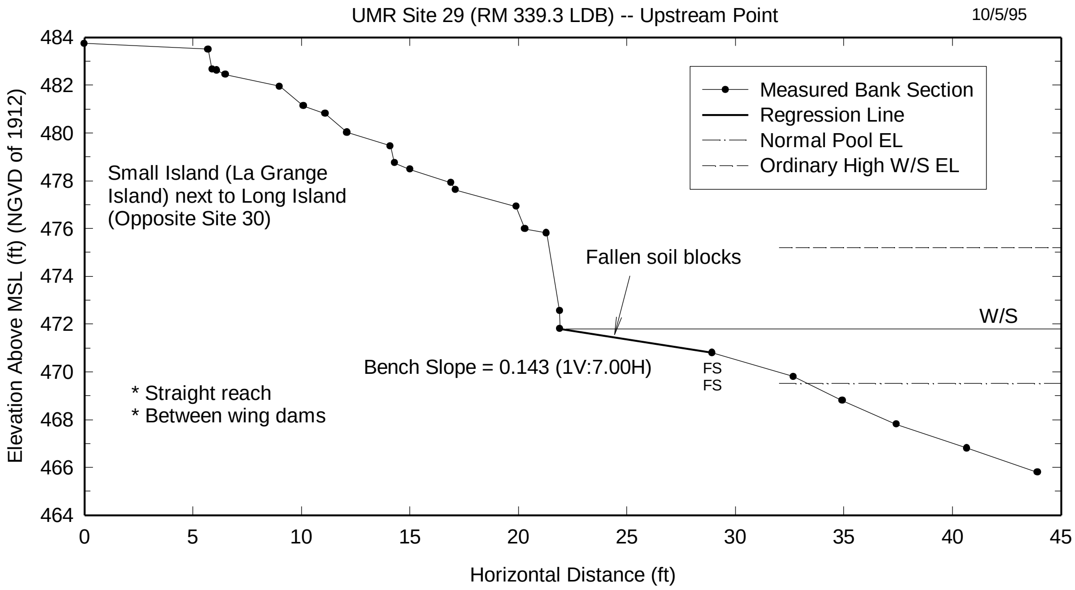


Figure 7-102 Bank section measured at Site 29 upstream point

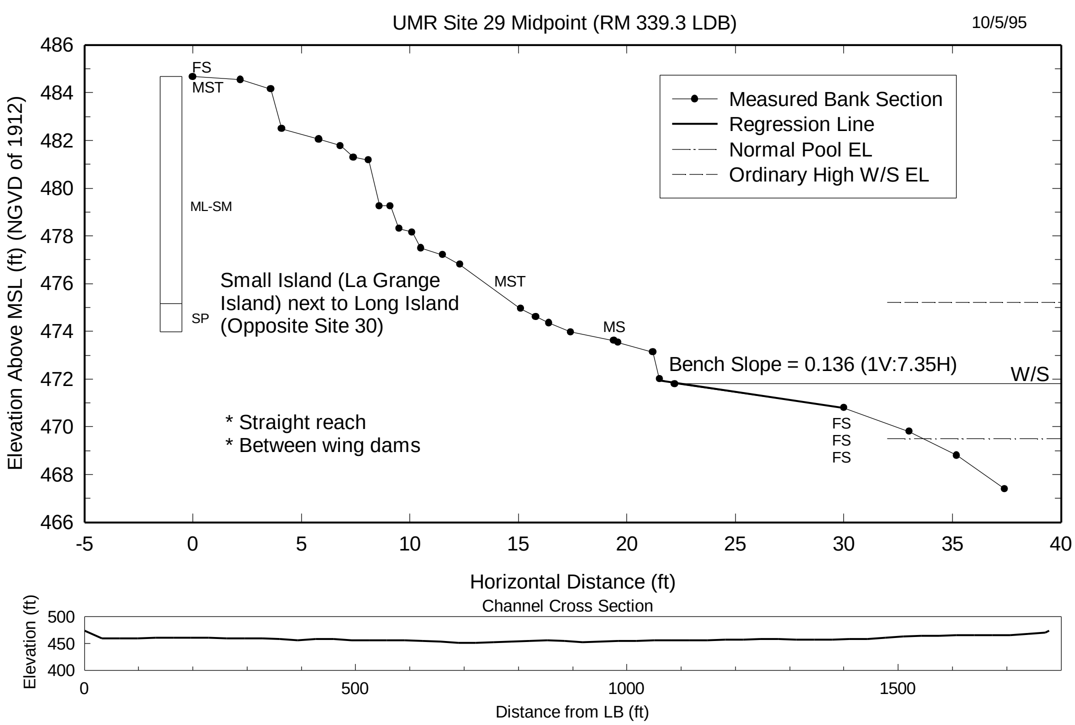


Figure 7-103 Bank section and channel cross section measured at Site 29 midpoint

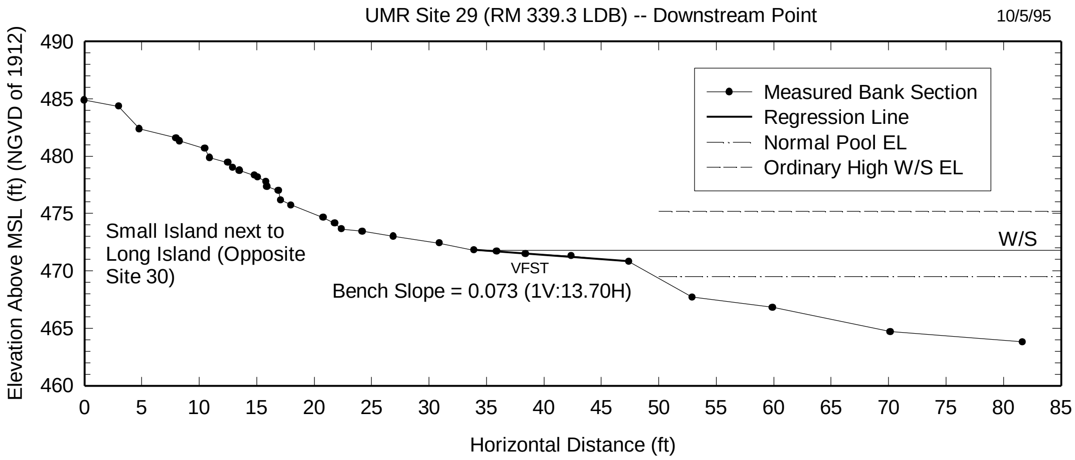


Figure 7-104 Bank section measured at Site 29 downstream point

30. Site 30 at RM 339.3 RDB (Pool 21)

This right-bank site is located opposite Site 29. Photos 7-67 and 7-68 show upstream and downstream views of the site. Only one bank section was taken at this site, as shown in figure 7-105. The scarp is almost 6 ft high. The bank soils are silts (VFST-MST) and subaqueous soil is CST.

Photo 7-67 An upstream view of Site 30 midpoint

Photo 7-68 A downstream view of Site 30 midpoint

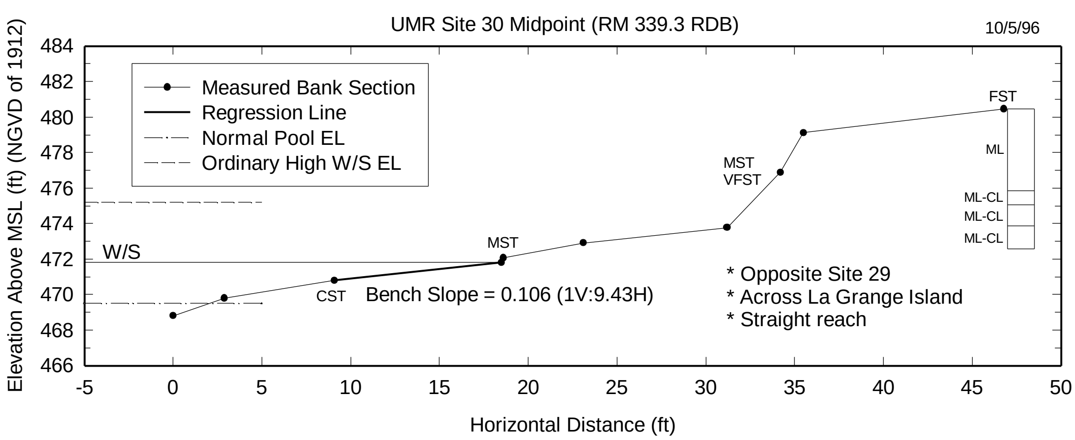


Figure 7-105 Bank section measured at Site 30 midpoint

One sampling tube core was advanced at this location. The soil profile showed historical alluvium to about 4.6 ft, below which an early to mid-Holocene, poorly drained wetland soil was observed. Erosion of historical and older Holocene deposits are occurring at the site.

Causative factors for bank retreat at this site include flood-flow erosional oversteepening and rapid recession and piping-initiated failures, and wave and rework-transport of failed soils and recently deposited sediments within bench areas. Secondary wave erosion occurs within berm and bench areas. The bank is classified as Type C.

30a. Observation Site at RM 322.9 RDB (Pool 22)

This right bank observation site, located about 2 miles downstream from Lock & Dam No. 21, had several interesting topographic features, including direct impacts on river banks of barge mooring (tows wait for up-bound locking procedures), piping cavities, and large block failures. Photos 7-69 shows a trace of bank-surface scraping by a barge during higher river stages, and Photos 7-70 and 7-71 show the barge-impact smearing within the bench. Numerous piping holes were observed at this site. Photos 7-72 through 7-74 show close-up views of piping cavities. The piping feature shown in Photo 7-74 was about 3 ft wide and 4 ft high, and extended about 6 ft horizontally at that size. Photos 7-75 and 7-76 show vertical slabbing failures within bank upslope from

Photo 7-69 Bank soil scraped by a barge - Observation Site at RM 322.9 RDB

Photo 7-70 Bench smeared by a barge - Observation Site at RM 322.9 RDB

Photo 7-71 Close-up of smeared bench - Observation Site at RM 322.9 RDB

Photo 7-72 Piping features - Observation Site at RM 322.9 RDB

Photo 7-73 Close-up of piping features - Observation Site at RM 322.9 RDB

Photo 7-74 Further close-up of piping features - Observation Site at RM 322.9 RDB

Photo 7-75 Vertical bank failure - Observation Site at RM 322.9 RDB

Photo 7-76 Vertical failure of lower bank - Observation Site at RM 322.9 RDB

piping features. Neither bank sections nor soil samples were taken at this observation site. However, visual observations indicated that the upper scarp consisted of ML (see table 7-4) and the lower scarp consisted of two layers of soils (CH on top of SM).

Causative factors for bank retreat at this site include flood-flow erosion, rapid recession and piping-initiated block failures, barge-mooring impacts, and wave and flow rework-transport of failed soils and recently deposited sediments which cover bench areas. Type A characteristics describe this observation site.

31. Site 31 at RM 293.0 LDB (Pool 24)

This left island site, shown in figure 7-106, is located on the inside of a bend in a wing-dam field along the upper portion of Denmark Island, about 8.2 miles downstream from Lock & Dam No. 22. ***It should be noted that there is no Lock & Dam No. 23***. An upstream view of the site is shown in Photo 7-77, and sand deposits on Denmark Island are shown in Photo 7-78. The bank section taken at the midpoint is shown in figure 7-107. The river cross section, shown in figure 7-107, is typical for a river bend, with a larger flow depth along the concave bank. The bank soils are primarily sand (VFS-FS) with some medium silt (MST). Denmark Island is covered with sand deposit from the Great Flood of '93. No geomorphic soil core samples were taken at Site 31.

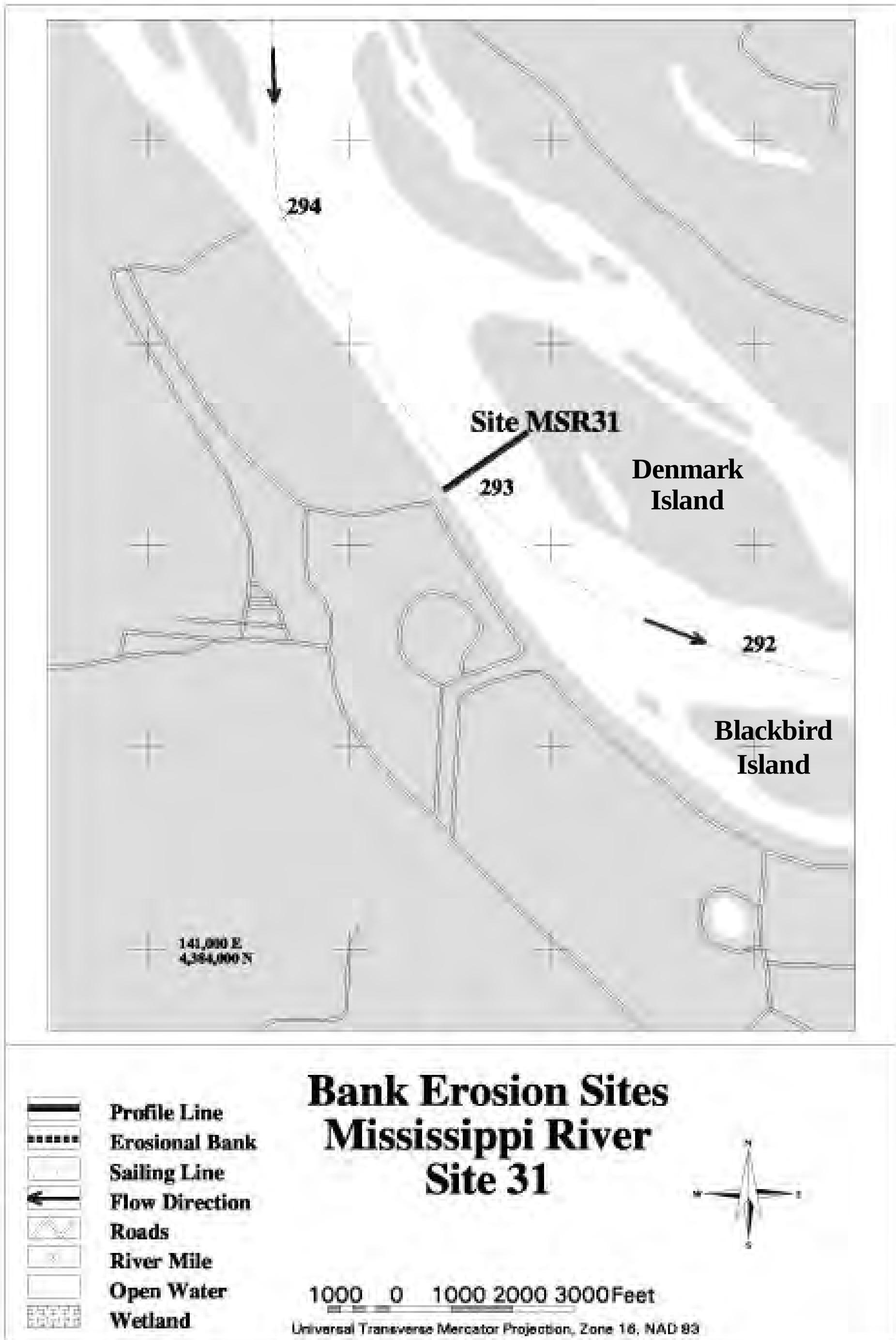


Figure 7-106 A site map showing Mississippi River Site 31

Photo 7-77 An upstream view of Site 31 midpoint

Photo 7-78 Sand deposits on Denmark Island of Site 31 midpoint

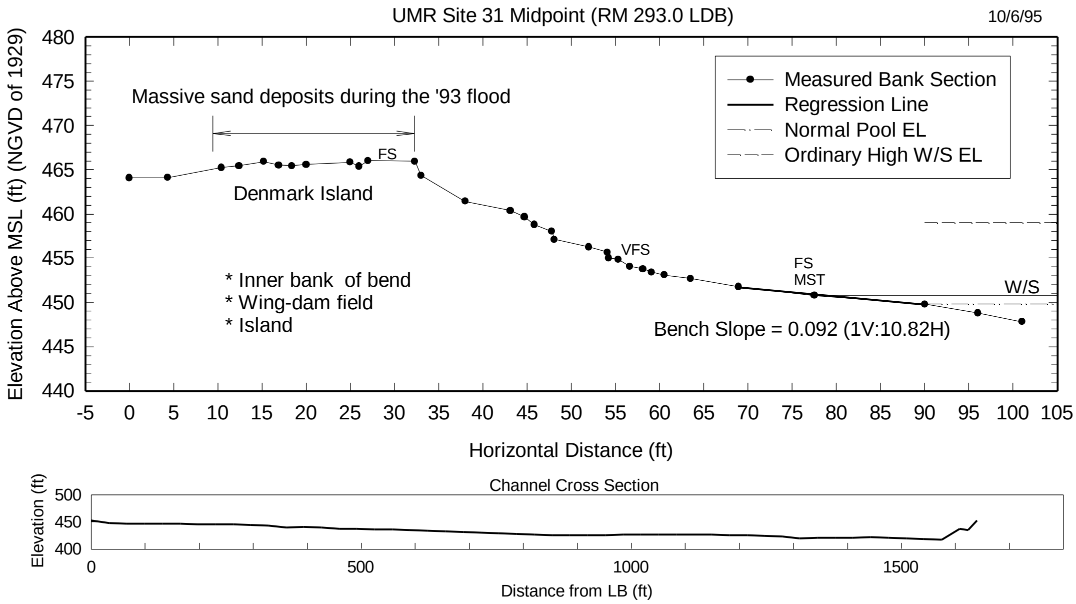


Figure 7-107 Bank section and channel cross section measured at Site 31 midpoint

Causative factors for bank retreat at this site include flood-flow erosion, piping-related collapse, and wave and flow rework-transport of failed soils and recently deposited silty sand which covers bench areas. A combination of Types D and E characterizes this site.

32. Site 32 at RM 275.3 RDB (Pool 24)

This right-bank inside-bend site, shown in figure 7-108, is located in a mooring zone, only 2 miles upstream from Lock & Dam No. 24. Photo 7-79 shows a downstream view of the site, and Photo 7-80 shows a close-up view of the bank disturbed by mooring activities. Note the sign on the tree shown in Photo 7-79. Only one bank section was taken at this site, which is shown in figure 7-109. The bank material is silt (CLT-MST). Subaqueous soil is primarily silt (VFST-FST). This site is used heavily as a barge-mooring site where tow boats wait for downstream locking at Lock & Dam No. 24. Although this erosion site is located along the inner bank, the river cross section in figures 7-109 indicates that the thalweg is developing along the right bank. Evidence of severe in-channel flood-flow erosional oversteepening is visible in the bank-section defined topographic features.

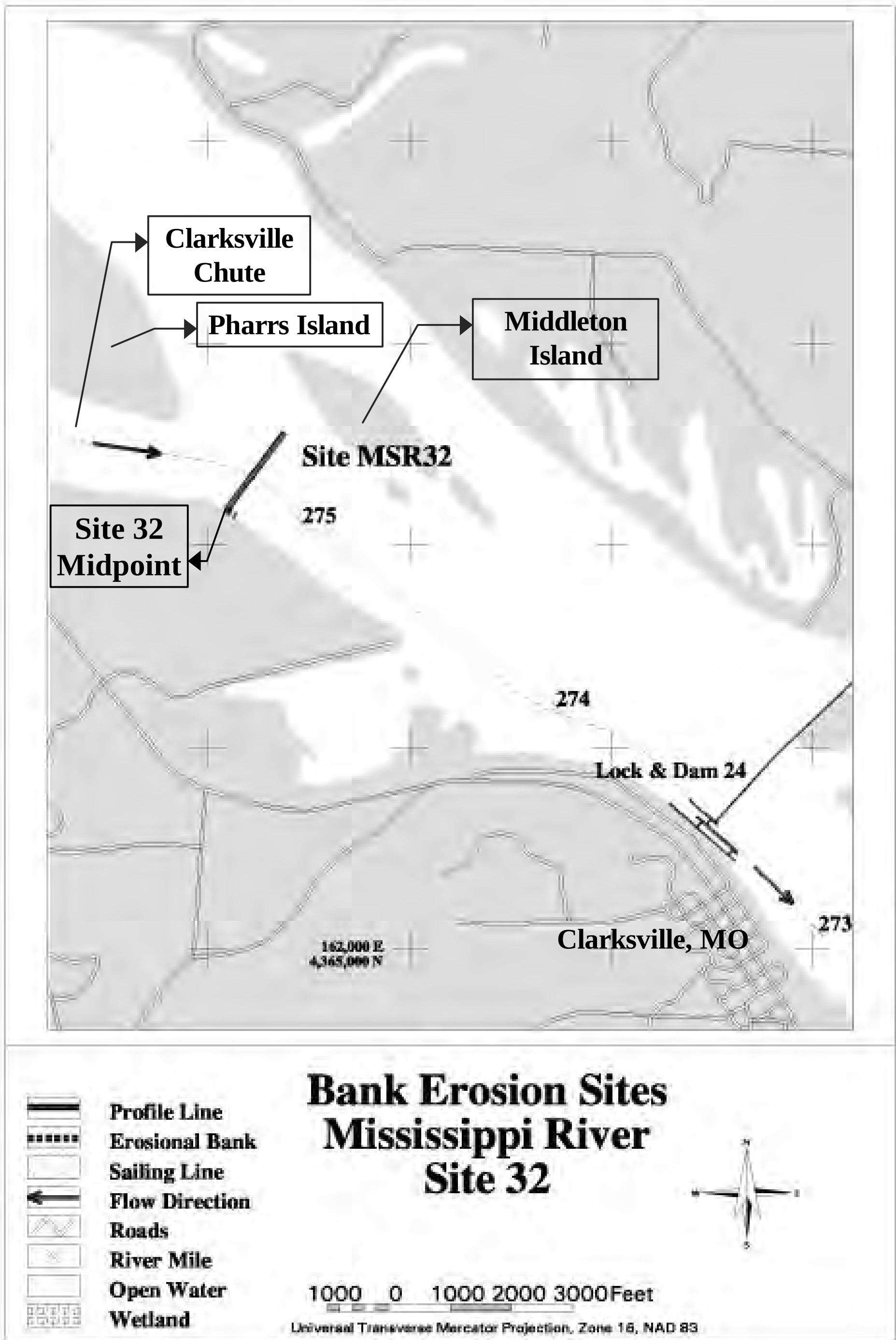


Figure 7-108 A map showing Mississippi River Site 32

Photo 7-79 A downstream view of Site 32 midpoint

Photo 7-80 A close-up view of mooring activities at Site 32 midpoint

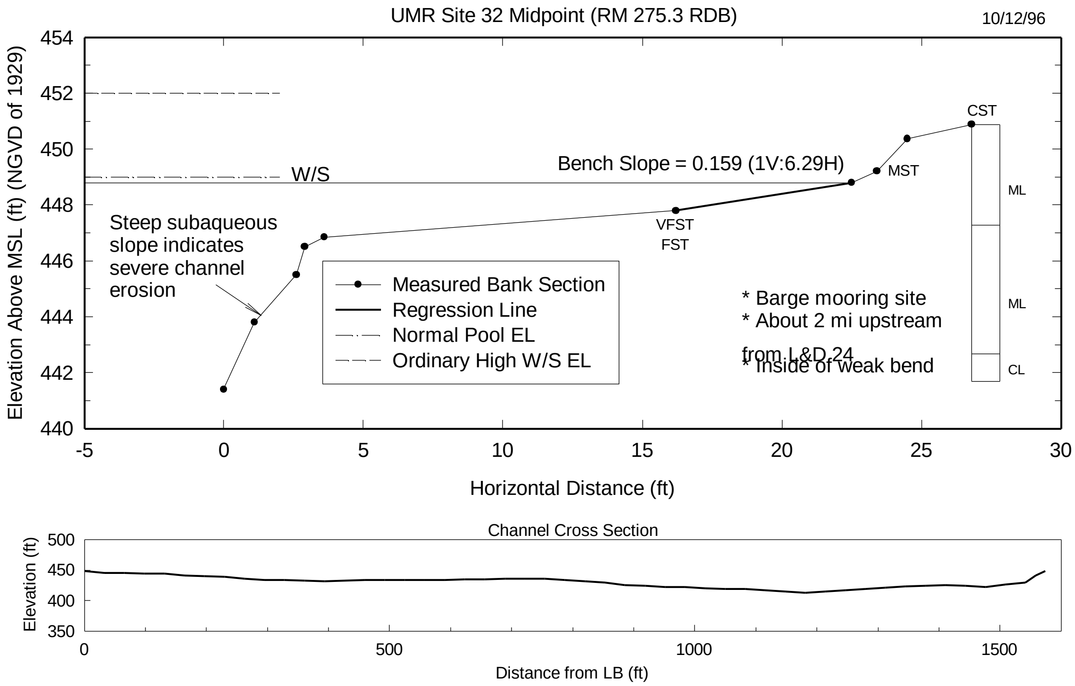


Figure 7-109 Bank section and channel cross section measured at Site 32 midpoint

Site 32 is located within a late Holocene surface. Two sampling tube cores showed thick historical deposits to at least 4.0 ft over a late to very late Holocene soil. The underlying native soil is below the water table. This soil is poorly drained and weakly developed.

Causative factors for bank retreat at this site include flood-flow erosional oversteepening and subsequent failures, bench-area rework-transport of failed soils and recently deposited sediments by waves, and barge-mooring activities. Evidence of erosion due to traffic-generated waves and turbulence, and barge mooring exists at this site. Type A is the most representative classification for Site 32.

33. Site 33 at RM 266.5 LDB (Pool 25)

This left-bank island site, shown in figure 7-110, is located in a crossover on the lower part of Coon Island. The site is located 6.9 miles downstream from Lock & Dam No. 24. The MR main channel is maintained between Coon Island and Slim Island near this eroded-bank site. Upstream views of the site are shown in Photos 7-81 and 7-82.

One bank section taken at the midpoint is shown in figure 7-111. The bank soils are primarily silt (VFST-CST). The scarp is almost vertical and contains numerous piping features. Failed soil blocks had accumulated at the toe of the scarp.

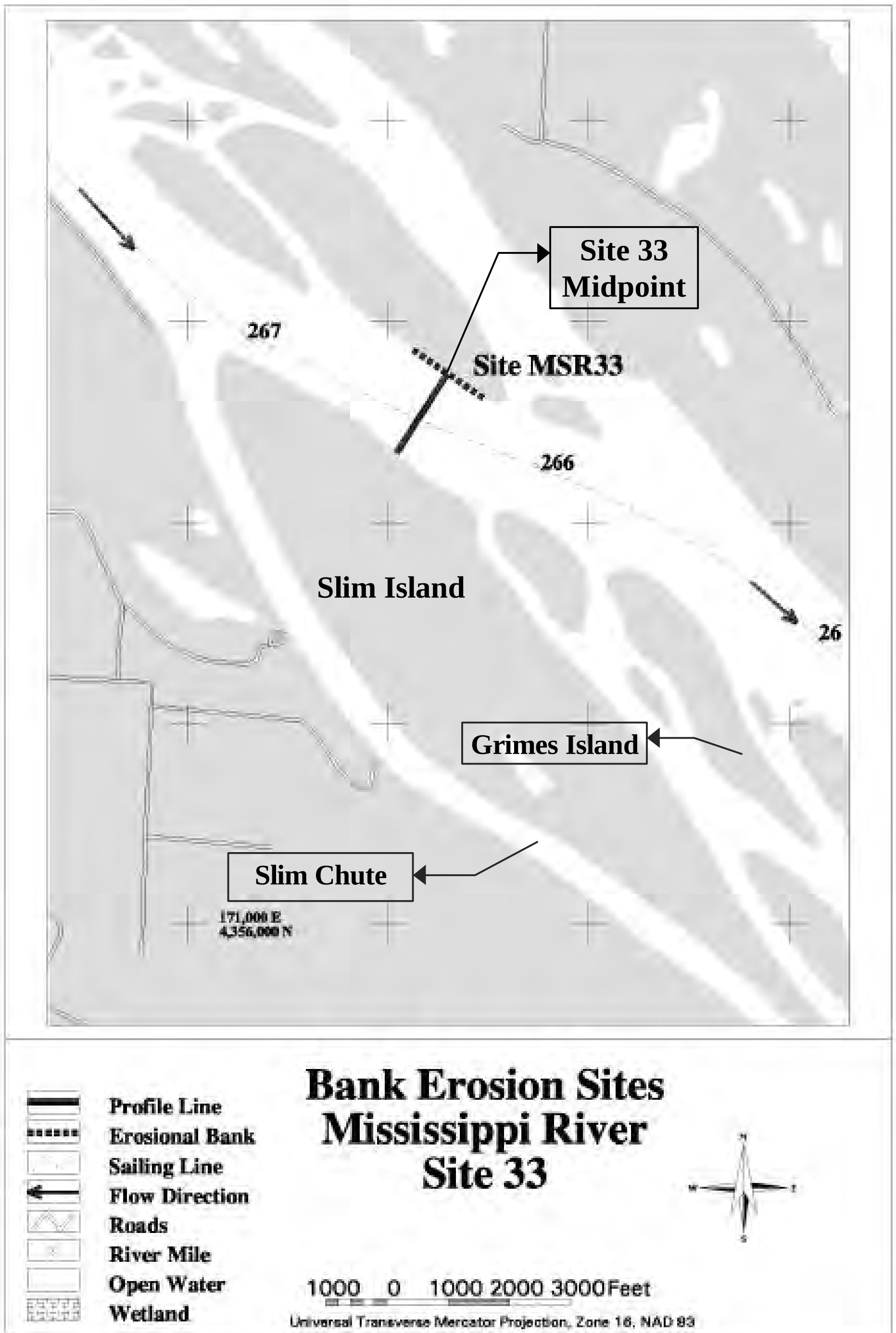


Figure 7-110 A map showing Mississippi River Site 33

Photo 7-81 An upstream view of Site 33 midpoint

Photo 7-82 A close-up view of Site 33 midpoint

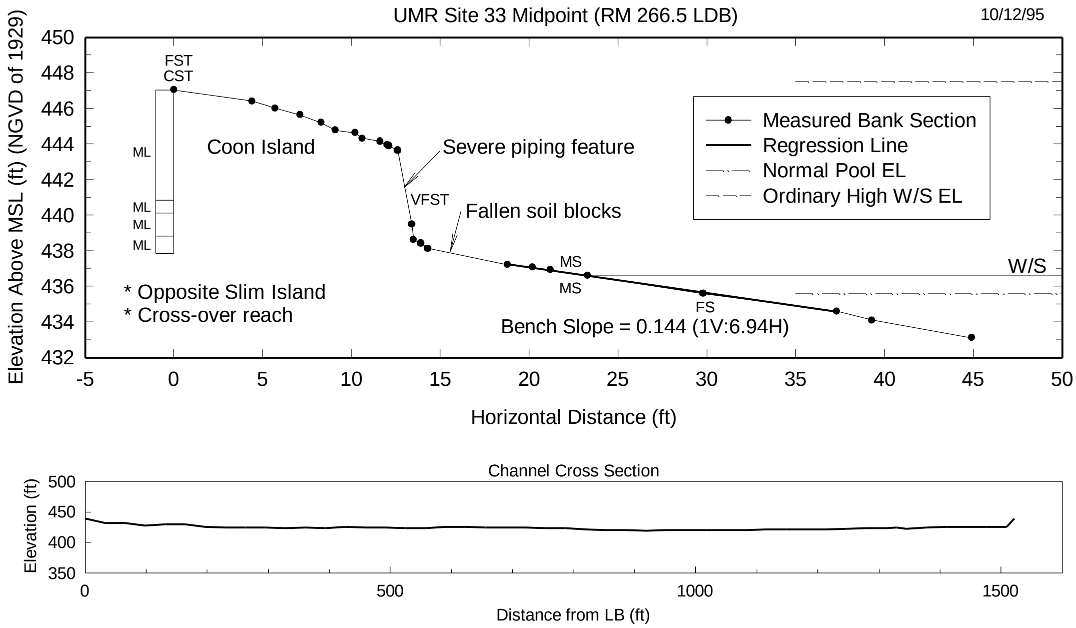


Figure 7-111 Bank section and channel cross section measured at Site 33 midpoint

One sampling tube core showed a thickly bedded, historical deposit about 6.2 ft thick. Below the recent alluvium, two buried late Holocene soils were observed. A very late Holocene to early historic soil occurs from 6.2 ft to 6.9 ft. A second buried soil encountered at about 6.9 ft showed a well-developed buried A horizon. Erosion at this location has exposed both the stored historical deposits and late Holocene soils.

Causative factors for bank retreat at this site include piping and flood-flow related erosion and block failures, and wave and rework-transport of failed soils and recently deposited sediments from bench and berm areas. Type A characterizes this erosion site.

34. Site 34 at RM 232.2 RDB (Pool 26)

This right-bank site, shown in figure 7-112, is located 15.3 miles downstream from Lock & Dam No. 25 and 29.3 miles upstream from Lock & Dam No. 26. This erosion site is immediately downstream from Cuivre Slough outlet behind Island No. 508. Photos 7-83 and 7-84 show upstream and downstream views of this site, respectively. The bank section taken at this site is shown in figure 7-113. The bank soil is primarily VFST and FST. Subaqueous soil sample taken at 1 ft depth is VFST. The severely eroded bank face with minor piping, about 8 ft high, indicates that erosional oversteepening and collapse occurred during the Great Flood of '93 and the floods of

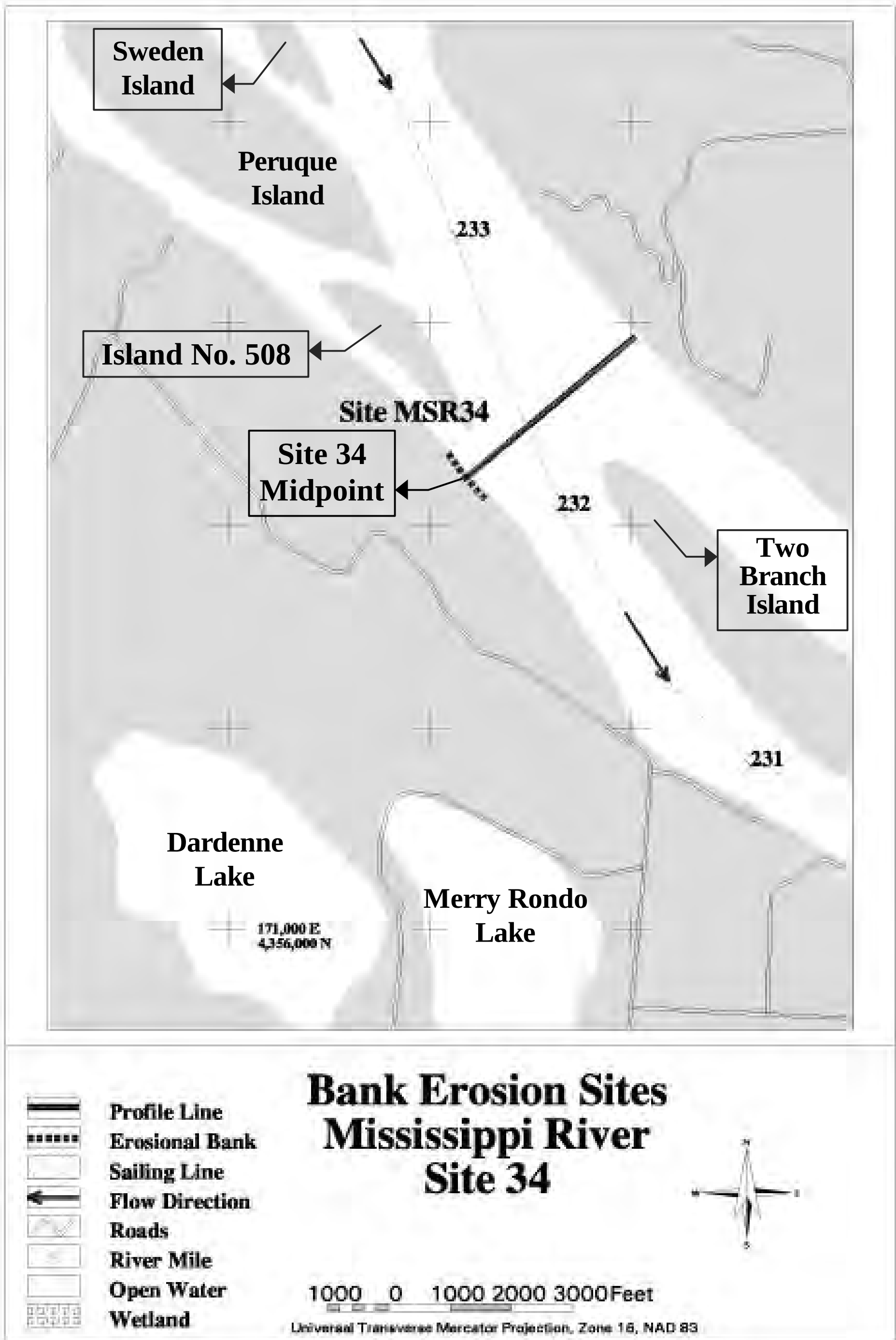


Figure 7-112 A map showing Mississippi River Site 34

Photo 7-83 An upstream view of Site 34 midpoint

Photo 7-84 A downstream view of Site 34 midpoint

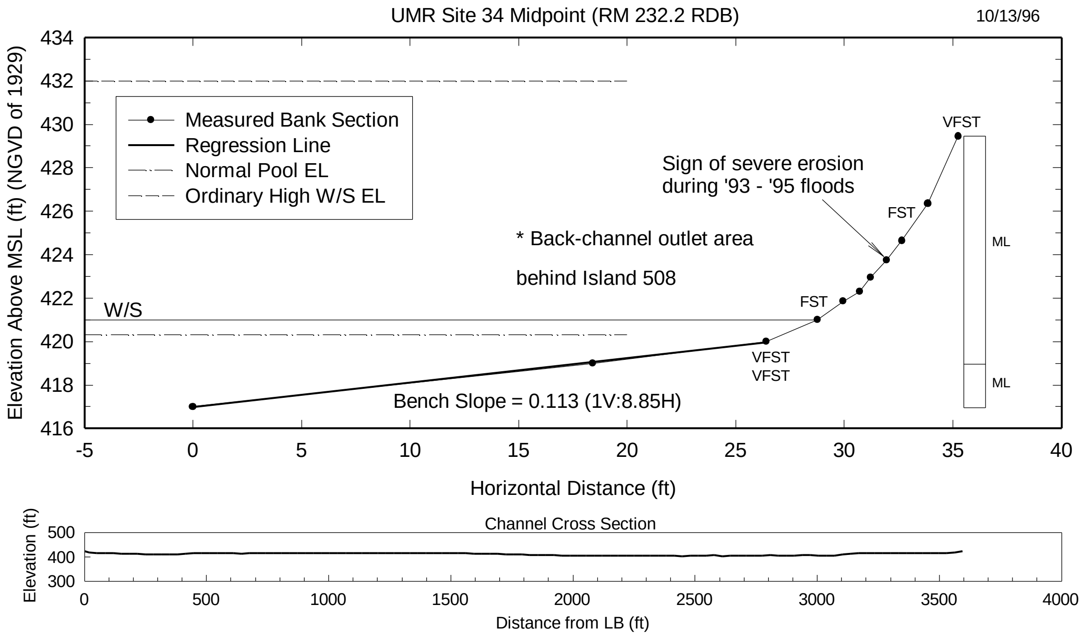


Figure 7-113 Bank section and channel cross section measured at Site 34 midpoint

1994 and 1995. Drawdown generated by the transiting of 16 loaded upstream-bound barges was measured as about 0.25 ft.

Numerous abandoned channels from both the MR and Cuivre River systems were observed. The site is along the distal end of the Cuivre River alluvial fan. One sampling tube core showed very late Holocene deposits capped by greater than 10 ft of historical alluvium. The historical deposit consisted of alternating thickly and thinly bedded silt, clayey silt, and very fine sand. The underlying native soil is a very poorly drained, fine grained, late to very late Holocene soil. Erosion at this site includes stored historical deposit.

Causative factors for bank retreat at this site include flood-flow erosion and rapid recession failures, and minor piping and collapse. There is potential for wave erosion of failed soil and recently deposited sediments which cover bench and berm areas. Type A is the best bank type for this site.

35. Site 35 at RM 222.1 RDB (Pool 26)

This right-bank island site, shown in figure 7-114, is located in a straight reach on Island No. 521, 25.4 miles downstream from Lock & Dam No. 25 and 4.7 miles upstream

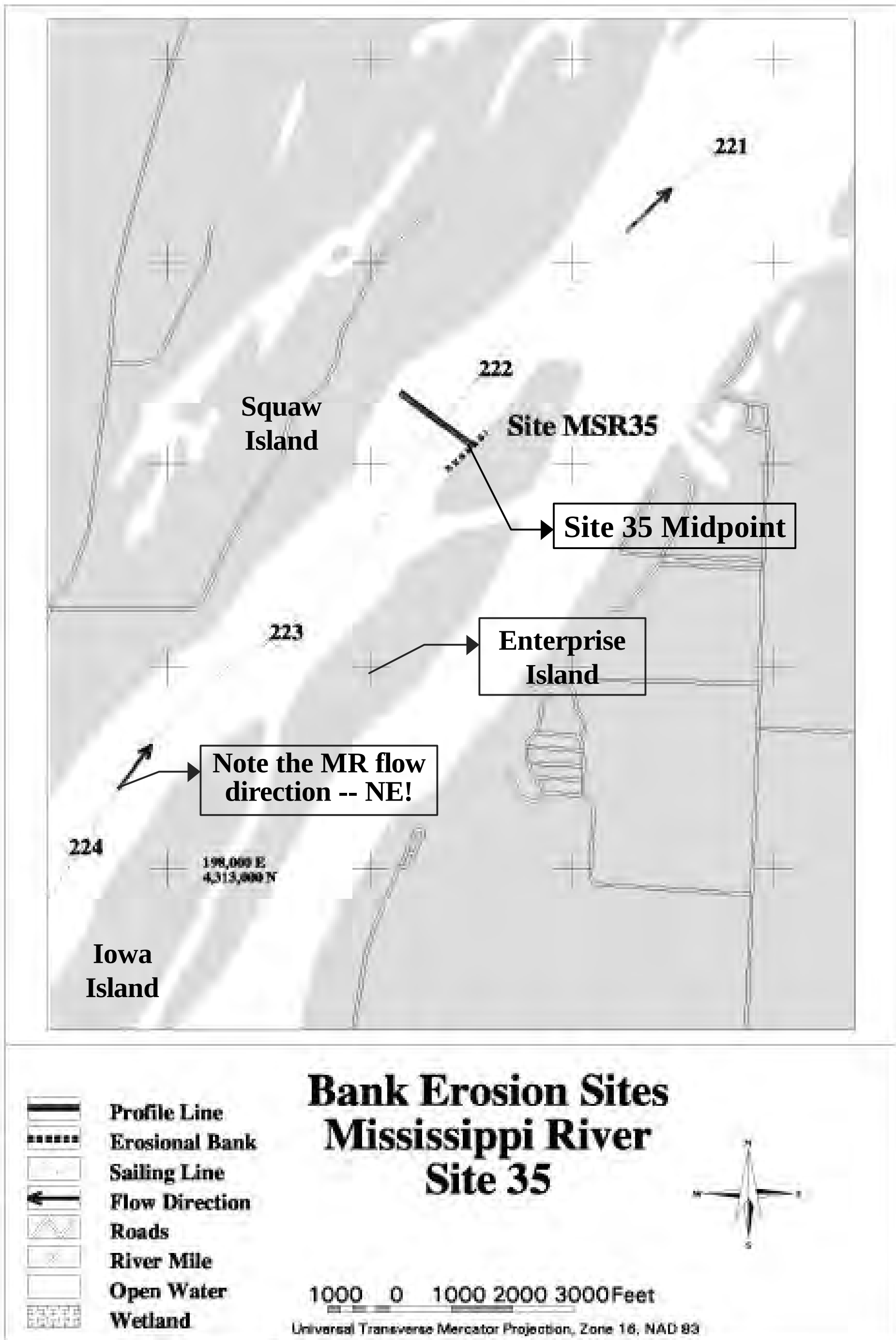


Figure 7-114 A map showing Mississippi River Site 35

Photo 7-85 A downstream view of Site 35 midpoint

Photo 7-86 Inspection of tree roots at Site 35 midpoint

from the confluence of the Illinois River. Photo 7-85 shows an upstream view of this site, and Photo 7-86 shows exposed tree roots. Three bank sections taken are shown in figures 7-115 through 7-117. The bank soils are fine silt (FST) to coarse clay (CC).

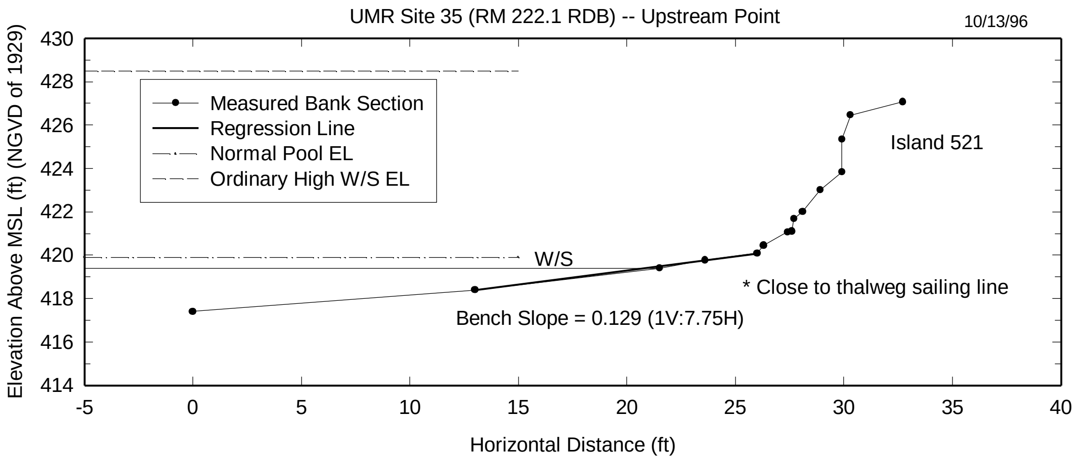


Figure 7-115 Bank section measured at Site 35 upstream point

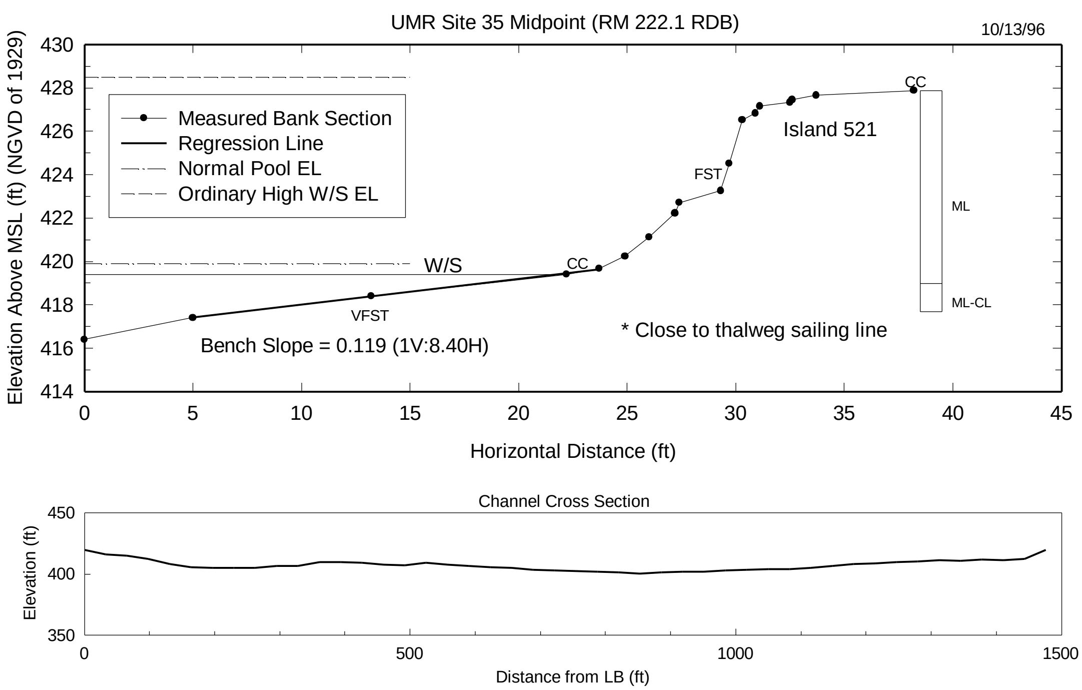


Figure 7-116 Bank section and channel cross section measured at Site 35 midpoint

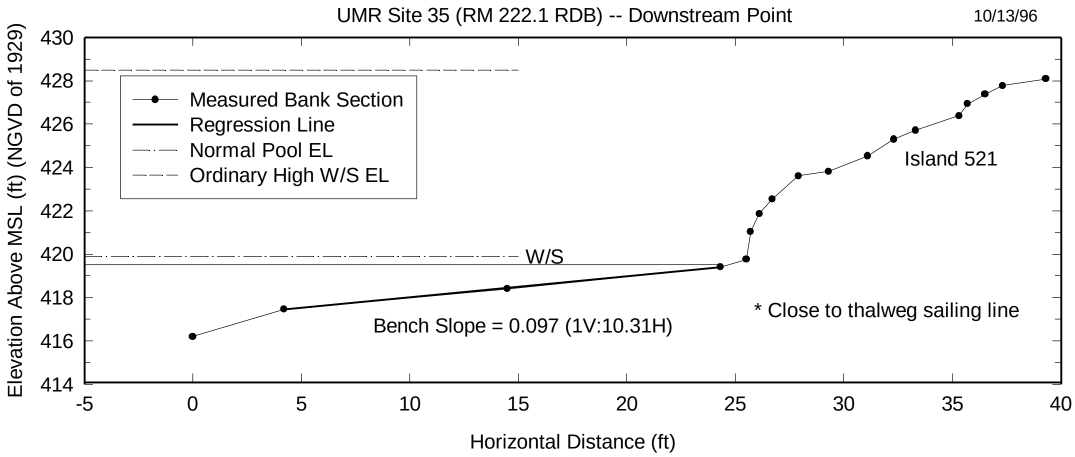


Figure 7-117 Bank section measured at Site 35 downstream point

The soil profile from one sampling tube core showed at least 9 ft of historical deposits. A poorly drained, fine grained, very late Holocene to historic surface lies below the recent historical sediment layers.

Causative factors for bank retreat at this site include flood-flow erosion and rapid recessional slumping, minor piping and collapse, and wave and rework-transport of failed soils and recently deposited sediments within bench areas. Because the site is very close to the thalweg sailing line, wave erosion within bench areas is more significant. Site 35 can be classified as Type A.

36. Site 36 at RM 217.5 RDB (Pool 26)

This right-bank site, shown in figure 7-118, is located along a rather straight reach, just 0.5 mile downstream from the confluence of the Illinois River, 14.6 miles upstream from Lock & Dam No. 26. Photo 7-87 shows a downstream view of the site, and Photo 7-88 shows a close-up view of the scarp. The bank section taken is shown in figure 7-119. The river cross section indicates that the site is located in the convex bank of a minor bend. At the top of the bank is a farm field, and some segments of a local road were found to be collapsing due to bank retreat. The bank soils consist of fine to medium silt (FST-MST) and fine sand (FS). Subaqueous sediments are fine sand (FS).

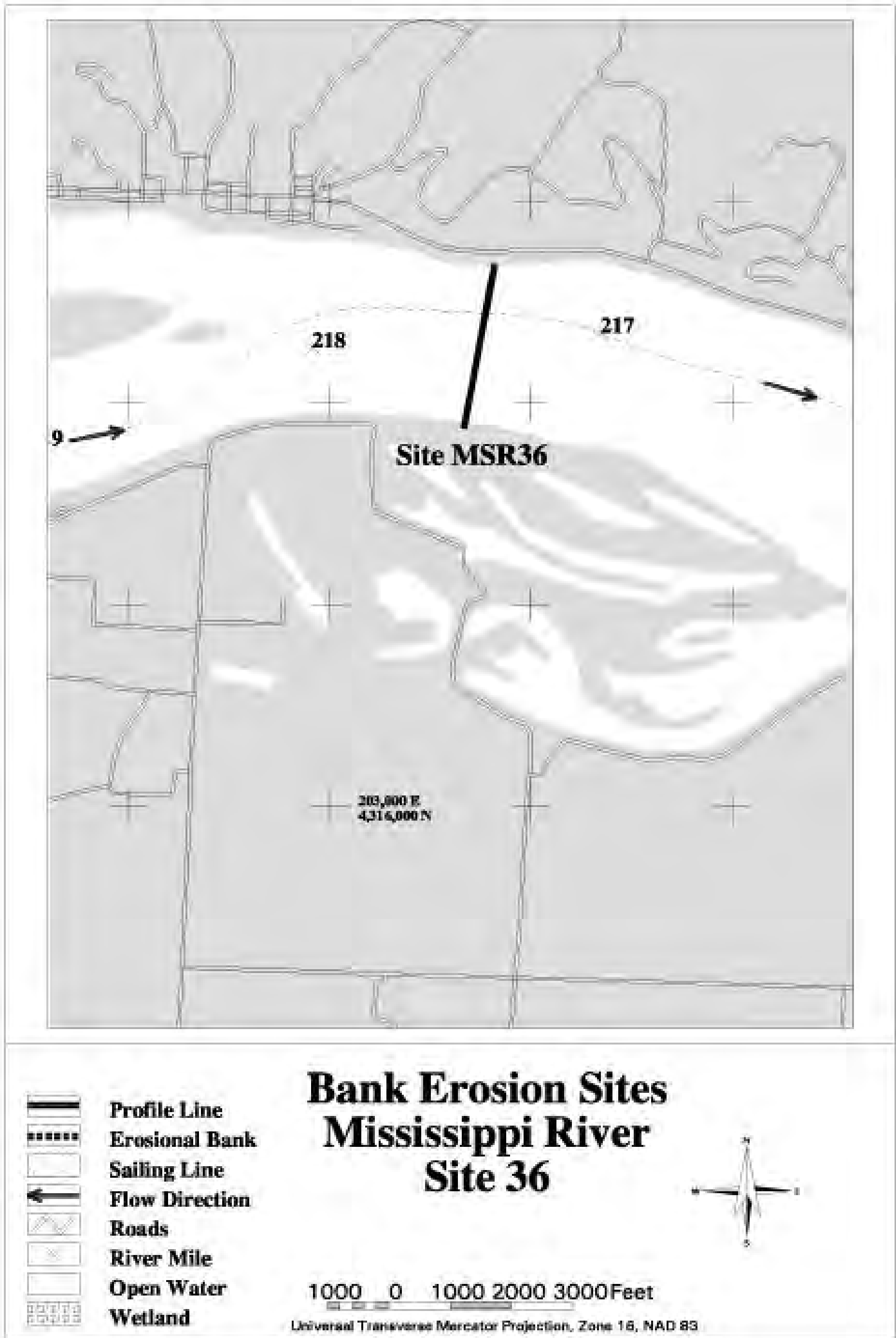


Figure 7-118 A map showing Mississippi River Site 36

Photo 7-87 A downstream view of Site 36 midpoint

Photo 7-88 A close-up view of scarp of Site 36 midpoint

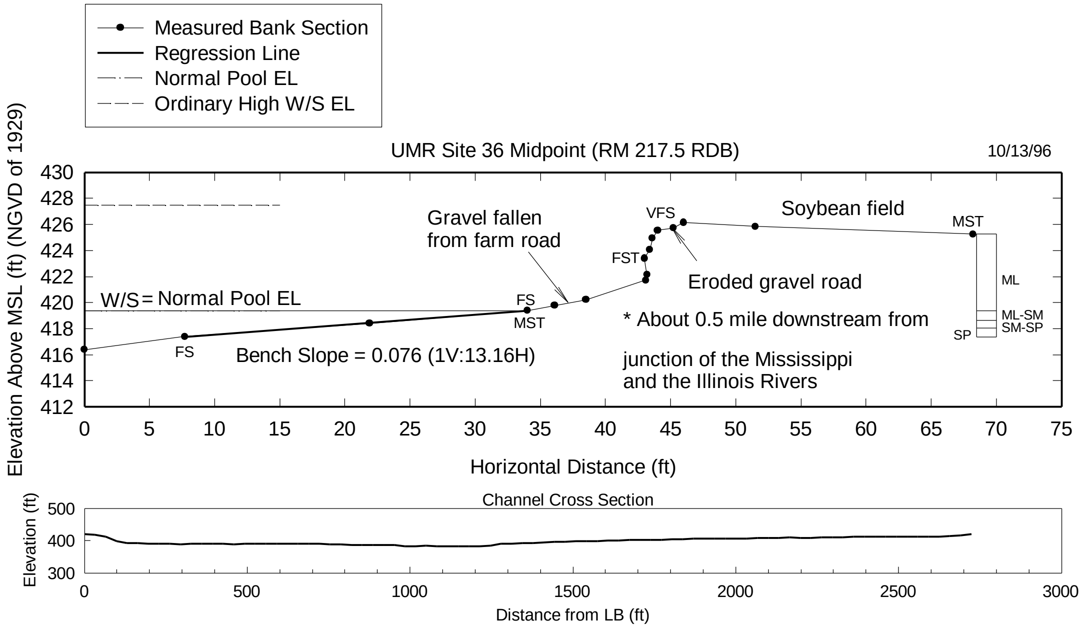


Figure 7-119 Bank section and channel cross section measured at Site 36 midpoint

Several minor overflow channels were found in the vicinity of the site. The relative ages of the landscape assemblages are probably late Holocene. Recent work conducted by Anderson at a nearby location showed Mississippi River alluvium, estimated to be 4,000 years old, buried by younger Illinois River alluvium (Titus et al. 1996). However, the one sampling tube core advanced at Site 36 encountered historical alluvium. The recent deposits are thickly and thinly bedded silt, clayey silt, and very fine sand, and they extend to at least 8 ft below the surface. Erosion at this site has removed historical alluvium.

Causative factors for bank retreat at this site include flood-flow erosion and recessional block failures, piping and collapse, slaking, overland drainage, and wave and seepage rework and transport of failed and slaked soils and recently deposited sediments within bench areas. Because the thalweg sailing line is far from the site, traffic-generated wave erosion appear to be minor. Type C can best describe Site 36.

36a. Observation Site at RM 200.2 RDB (Pool 27)

This observation site is near the tip of Maple Island, 2.7 miles downstream from Lock & Dam No. 26, and exhibits evidence of typical bank retreat caused by overland

Photo 7-89 A side view of Observation Site at RM 200.2 RDB

Photo 7-90 A close-up view of Observation Site at RM 200.2 RDB

drainage. Bank-line incisions (gullies) cut by overland drainage and seepage can be seen in Photo 7-89. Photo 7-90 shows a close-up view of the scarp, which exhibits many features, including slaking, gully formation, vertical cracking, flood-flow related erosional oversteepening and recessional slumping, and piping and collapse. The bank soil was primarily silt and clay.

37. Site 37 at RM 197.6 RDB (Pool 27)

This right-bank site on the inside of a sharp bend, shown in figure 7-120, is located less than 3 miles upstream from the Missouri River confluence at RM 195. Bank retreat since 1984 is evident in figure 7-120. Photos 7-91 and 7-92 show upstream and close-up views of the site, respectively. The bank section taken is shown in figure 7-121. The river cross section in figure 7-121 shows topography representative of the sharp bend along the site. The bank soils are primarily silt. The site is far from the thalweg sailing line. There is a barge-mooring site immediately downstream from the erosion site. There are several scarps within the bank. The levee along Mobile Island was overtopped during the Great Flood of '93, and this site is located where a breached portion of the levee was being repaired.

Soils in the area probably developed in the late Holocene. Missouri River alluvial fan deposits probably interfingered with Missouri River alluvium. The one sampling tube core advanced at the site showed a 6.0 ft profile composed entirely of thickly bedded historical alluvium and fill material.

As at Site 36, causative factors for bank retreat at this site include flood-flow erosion and recessional failures, piping and collapse, slaking, overland flows, and wave and rework transport of failed soils and recently deposited sediments in bench areas. Due to nearby fleeting activities, more extensive wave erosion occurs at this site. Type C best characterizes Site 37.

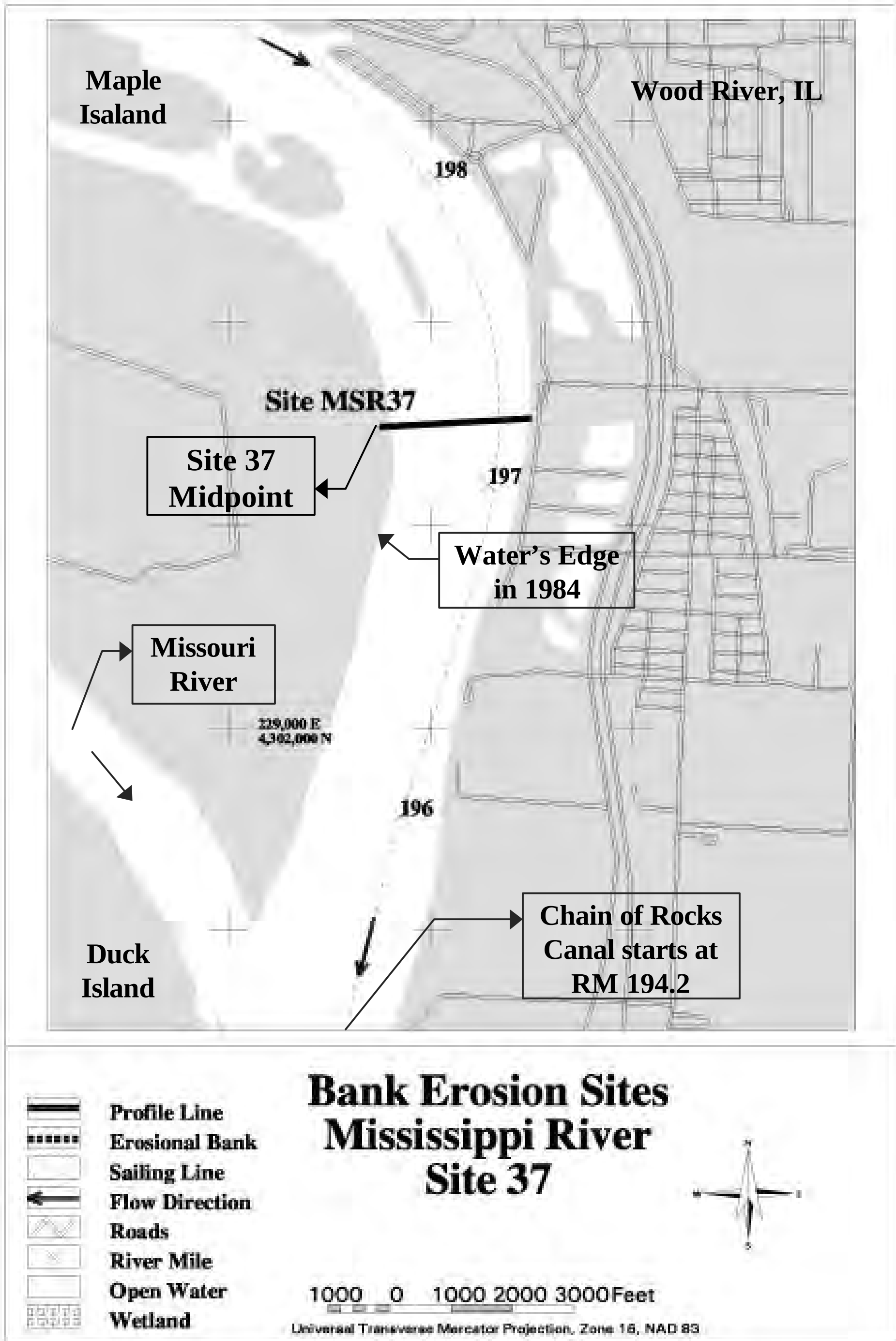


Figure 7-120 A map showing Mississippi River Site 37

Photo 7-91 An upstream view of Site 37 midpoint

Photo 7-92 A close-up view of Site 37 midpoint

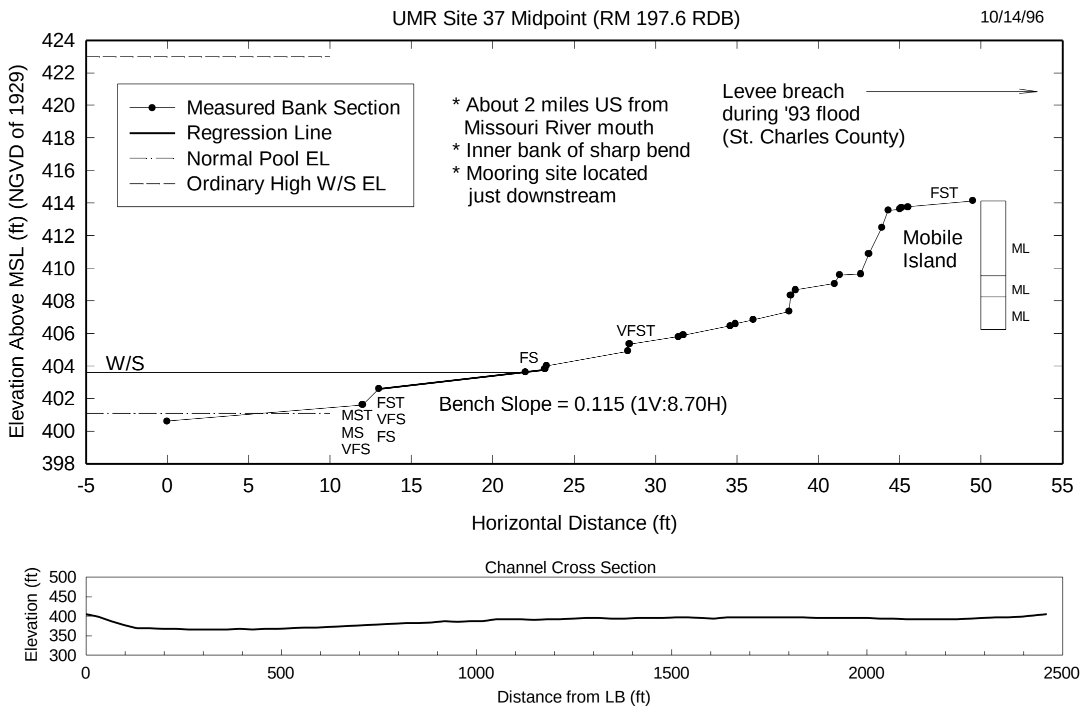


Figure 7-121 Bank section and channel cross section measured at Site 37 midpoint

37a. Observation Site at RM 195.1 LDB (Pool 27)

This left-bank observation site is located immediately upstream from the mouth of the Oahokia Creek diversion channel, and directly opposite the confluence of the Missouri River. The scarp exposes silty clay and clayey silt layers and is about 4 ft to 6 ft high. Historical deposits can be seen clearly in Photos 7-93 and 7-94. A dark-color native soil at the bottom of the scarp, as well as vertical cracks and fallen soil blocks, can be seen in these photos. At this site, a simple field experiment was conducted to demonstrate how fast a block of failed bank soil would disintegrate in water. A block of soil, about 4 in. high, 4 in. wide, and 8 in. long, was carefully placed in water, as shown in Photo 7-95. Only the bottom portion, about 1 in., was wet initially; however, the block disintegrated as soon as it was wetted. The process of this block disintegration is illustrated by Photos 7-96 through 7-98. Within 3 minutes, the entire block disintegrated. These photos are extremely important in describing the unique characteristics of failed soil blocks and peds which cannot resist wetting and slaking. Wetting destroys capillary

Photo 7-93 An upstream view of Observation Site at RM 195.1 LDB

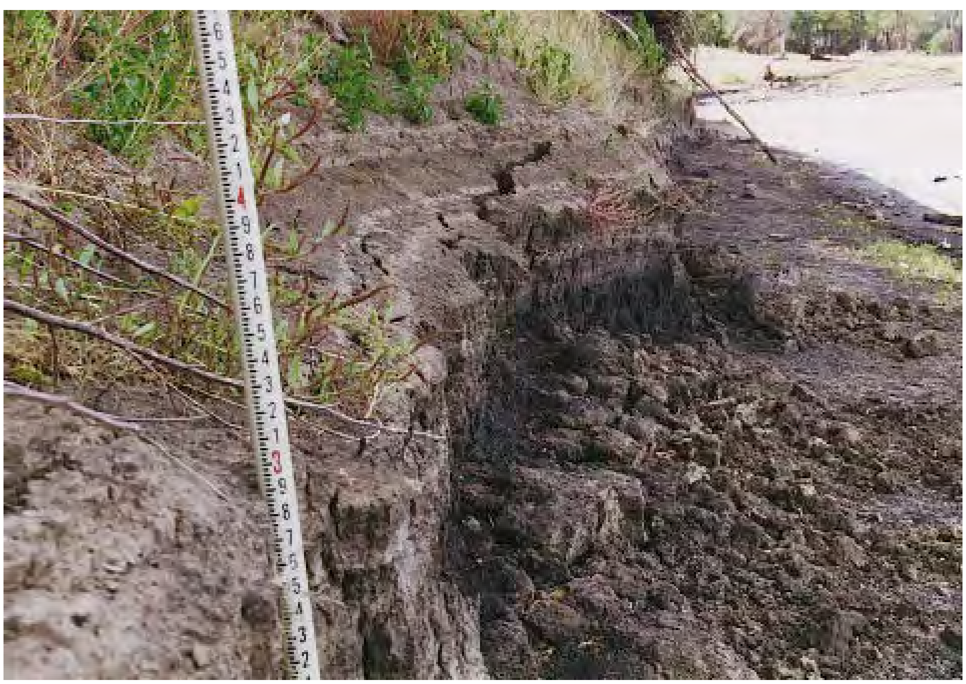


Photo 7-94 A downstream view of Observation Site at RM 195.1 LDB

Photo 7-95 A block of failed bank soil placed in water (t = 0) -- Observation Site at RM 195.1 LDB

Photo 7-96 A block of failed bank soil placed in water (t = 1 min.) -- Observation Site at RM 195.1 LDB

Photo 7-97 A block of failed bank soil placed in water (t = 2 min.) -- Observation Site at RM 195.1 LDB

Photo 7-98 A block of failed bank soil placed in water (t = 3 min.) -- Observation Site at RM 195.1 LDB

action in fissures between peds, and the block disintegrates into individual fissure-defined pieces (peds). Any banks composed of unsaturated soils would be susceptible to wet/dry slaking. This observation site was eroded severely during the Great Flood of ’93 and possibly during the flood of 1994 and the flood of 1995. The site demonstrates typical characteristics of bench area rework and transport described earlier. This erosion site can be classified as Type A.

This Observation Site at RM 195.1 LDB was the last study site within the lock and dam system of the Mississippi River. Other sites described below (Site 38 - Site 44) were located in the open-water river reach.

38. Site 38 at RM 175.2 LDB (Open Water)

There are no “***Normal Pool Elevations***” or “***Ordinary High Water-Surface Elevations***” defined for the open-water reach within the COE-St. Louis District. Comparable levels for the open-water study reach are represented by water-surface elevations which correspond to those for the mean discharge and for a discharge that is 125 percent of the mean discharge, respectively.

This left-bank site, shown in figure 7-122, is located within a busy fleeting area along a straight reach near St. Louis, Missouri. As can be seen in figure 7-122, the bank appears to have retreated considerably since the current navigation chart, based on the 1984 COE aerial survey, was published in 1989. Photos 7-99 and 7-100 show upstream and close-up views of the site, respectively. Photo 7-101 shows an upstream view of the bench, and Photo 7-102 shows a close-up view of wave attack on the lower bank which consists of recently deposited sand. Only one bank section was taken at this severely eroded bank site, which is shown in figure 7-123. The bank soils are primarily MST and FS. There were three distinct scarps with extensive piping features, as shown in figure 7-123. At the top of the bank is a farm field covered by two large sand dunes, 2 to 3 ft high and about 200 ft wide. The first row of dunes was located along the edge of the bank, and the second was located about 1,000 ft from the bank line. Both dunes were oriented parallel to the bank line. This silty sand deposition and dune formation is believed to have been produced by the Great Flood of '93 and subsequent floods of 1994 and/or 1995. Fine sand was observed blown by strong winds. Numerous failed soil blocks were observed on the bank below the head scarp, as indicated in figure 7-123.

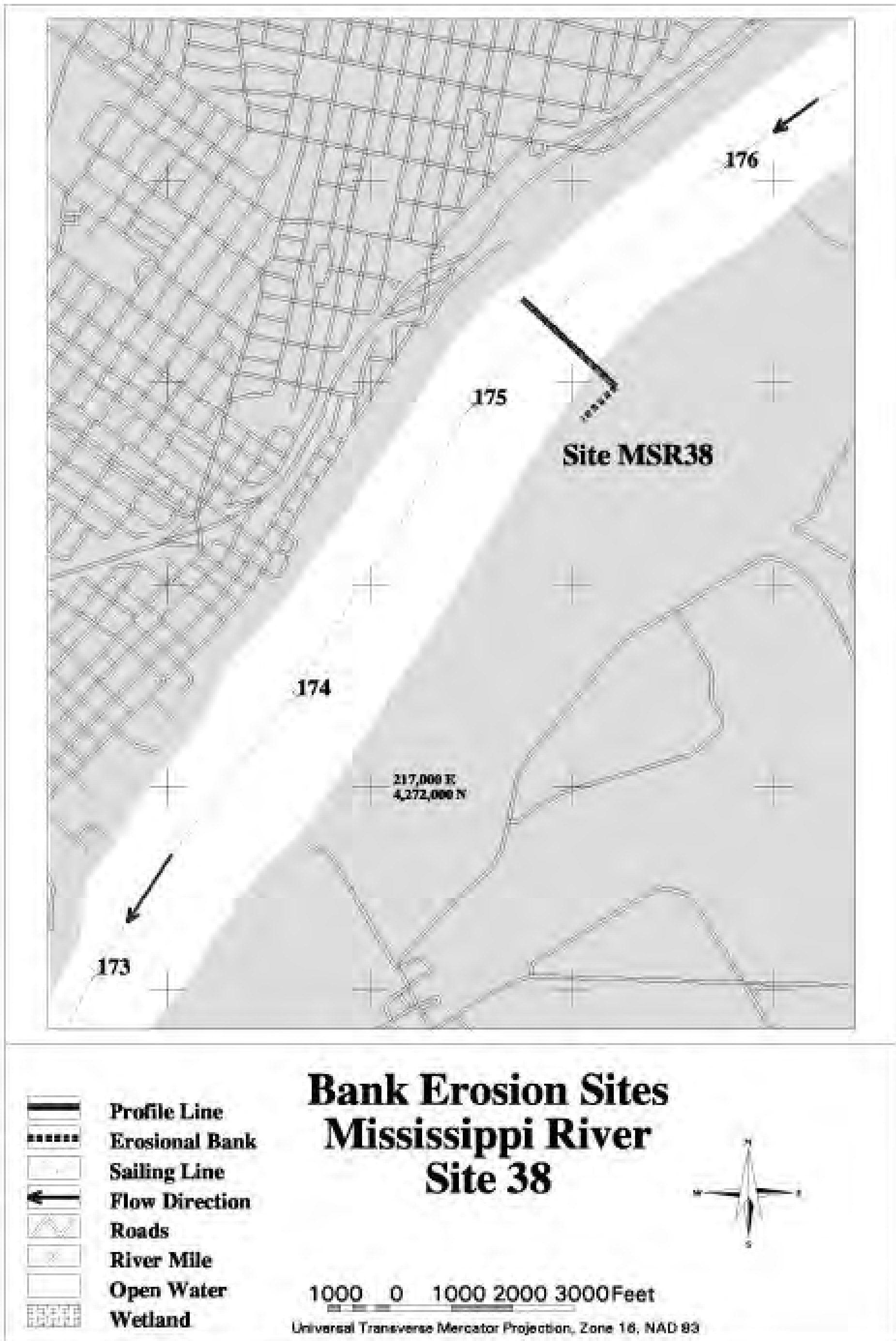


Figure 7-122 A map showing Mississippi River Site 38

Photo 7-99 An upstream view of Site 38 midpoint

Photo 7-100 A close-up view of Site 38 midpoint

Photo 7-101 An upstream view of bench of Site 38 midpoint

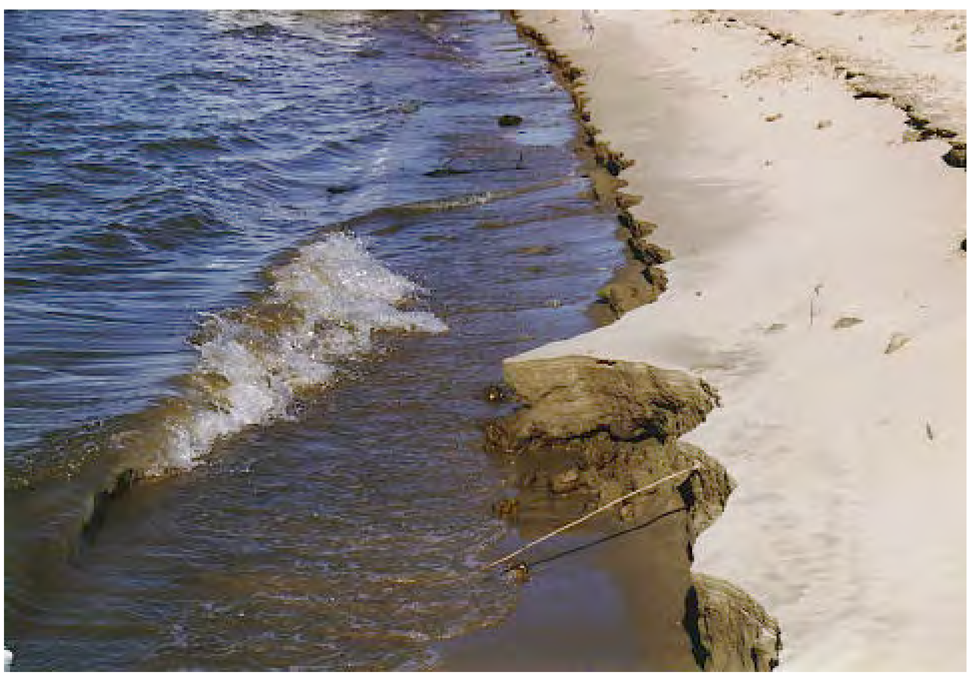


Photo 7-102 A close-up view of wave erosion at Site 38 midpoint

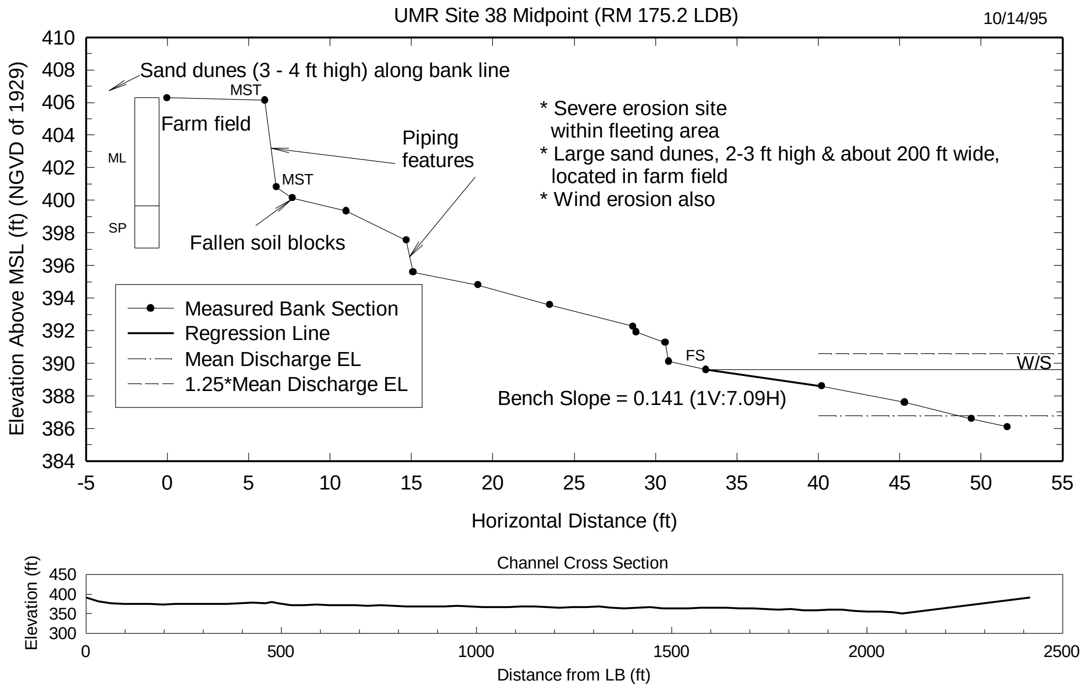


Figure 7-123 Bank section and channel cross section measured at Site 38 midpoint

Site 38 is located on what may be a deeply buried late Holocene surface. Recent historical deposits are extremely thick at this site and native soils were not observed. The thickly bedded historical silt and very fine sand laminae extend to about 6.6 ft, below which lies well-sorted, fine to medium sand which may be dredged spoil. Other observations at this location show what appears to be a recent (1993, 1994, and/or 1995) coarse-grained flood deposit which contained buried leaf litter.

Causative factors for bank retreat at this site include flood-flow erosion and recession and piping failures, slaking, wave and rework-transport of failed soil peds and recently deposited silty fine sand, and aeolian deflation. Barge fleeting-related wave erosion occurs within the bench area at this site. A combination of bank Types A, B, and C describes Site 38.

38a. Observation Site at RM 168.5 LDB (Open Water)

This left-bank observation site is located about 0.1 mile downstream from the Jefferson Barracks Highway Bridge. These banks, containing two vertical scarps, approximately 6 ft high, are located immediately downstream from an L-shaped rock-

Photo 7-103 An upstream view of Observation Site at RM 168.5 LDB

Photo 7-104 A downstream view of Observation Site at RM 168.5 LDB

Photo 7-105 A close-up view of Observation Site at RM 168.5 LDB

Photo 7-106 Sand lens found at terrace of Observation Site at RM 168.5 LDB

filled flow-training structure. As shown in Photos 7-103 through 7-105, multiple layers of historical deposits consisting of silty clay and clayey silt are exposed within each scarp. There was a sand lens, about 3-in. thick at the bottom of each scarp. These lenses are shown in Photo 7-106. This site is characterized by Type B. It should be noted that many bank-erosion sites within the open-water reach were located immediately downstream from rock-filled flow-training structures.

39. Site 39 at RM 112.4 LDB (Open Water)

This left-bank site, shown in figure 7-124, is located inside a bend on a small island. Photos 7-107 and 7-108 show upstream and downstream views of the site, respectively. Photo 7-109 shows eroded bank near the tip of the island and Photo 7-110 shows a close-up view of eroded bench. Although the site map does not show this bank to be on an island, erosion along the left bank at about RM 112.5 had formed a small island. The back channel of this island meets the MR at around RM 111.6. There are several large wing dams, and this erosion site is located between two wing dams. Around the upstream tip of the island, flow velocities toward the back channel were estimated to be about 8 ft/s. These flows are eroding the island. This erosion along the concave bank was initiated by the Great Flood of '93. The back channel apparently was eroded deeply during the flood, creating a large differential head between the main MR channel and the slough.

A wing dam and a large sand bar, located just upstream from the island tip, exacerbates island erosion by creating additional differential head where it diverts the MR flow toward the slough. The sand bar upstream of the island appeared to act as a dam to produce differential head. As shown in figure 7-125, multiple scarps with piping features were present with failed soil blocks. The total height of scarps was almost equal to the bank height, about 20 ft, and the bank soils are primarily medium silt (MST) and fine sand (FS). Subaqueous bed sediments consist of fine sand (FS).

Site 39 is located on an erosional bank composed of historical alluvium. A sampling tube core and bank exposure were examined. The native soil was not observed, but it is of Holocene age. A "Purex" brand plastic bottle was recovered from a steep scarp exposure about 20.5 ft below the top of bank. The plastic bottle indicates that historical deposits are much greater than 20 ft thick at this location.

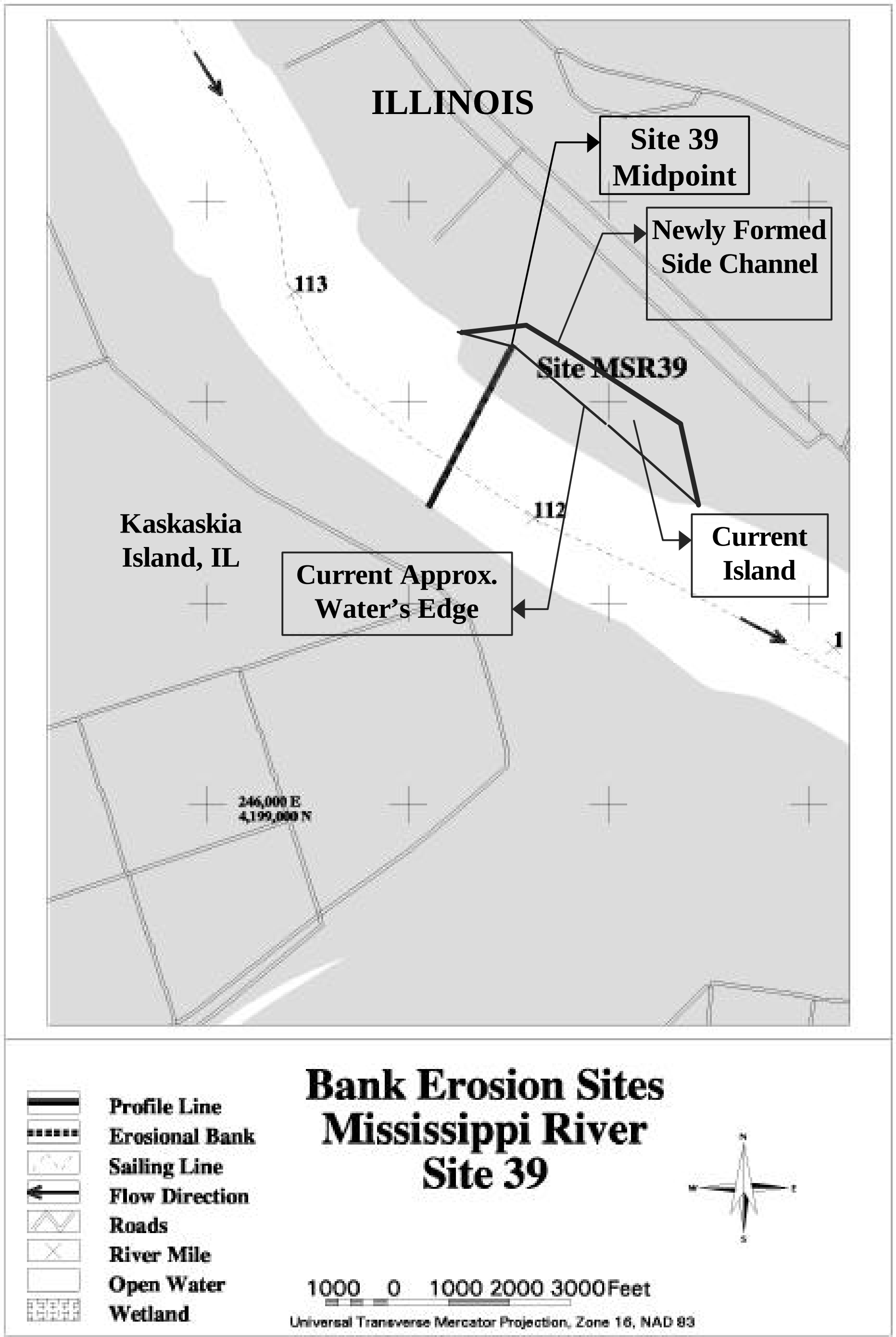


Figure 7-124 A map showing Mississippi River Site 39

Photo 7-107 An upstream view of Site 39 midpoint

Photo 7-108 A downstream view of Site 39 midpoint

Photo 7-109 An upstream view of the tip of island at Site 39

Photo 7-110 A close-up view of eroded bench at Site 39 midpoint

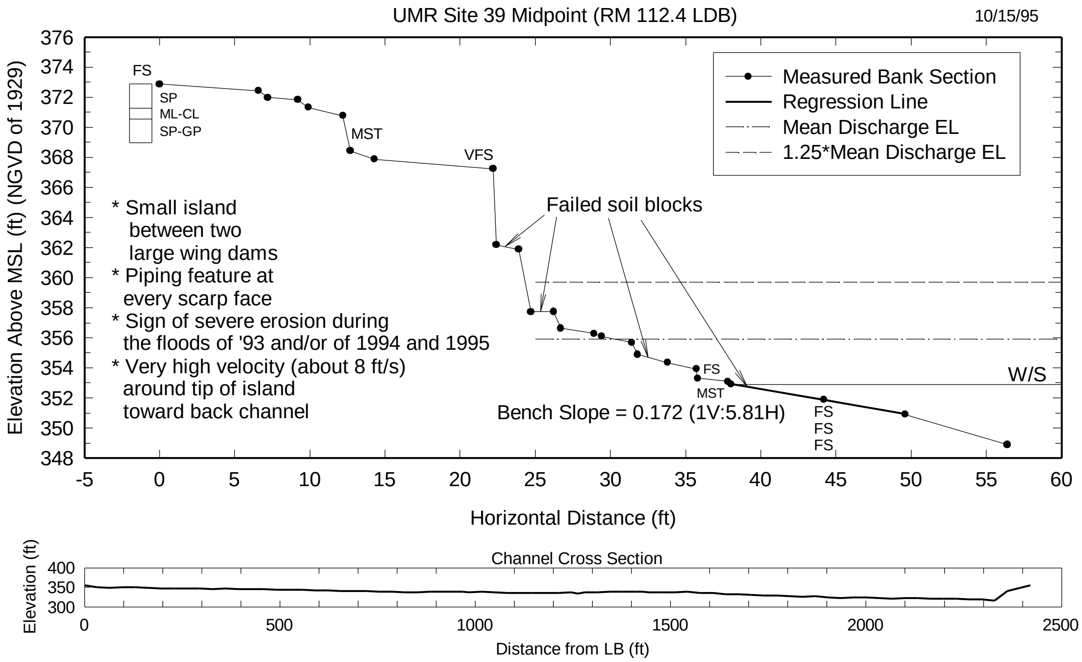


Figure 7-125 Bank section and channel cross section measured at Site 39 midpoint

Causative factors for bank retreat at this site include flood-flow erosion, impacts by flow-control structures, piping and failures, and wave and rework-transport of failed soils and recently deposited sediments within berm and bench areas. Although the thalweg sailing line is far from this site, silty sand deposits are eroded by waves. A combination of Types A, B, and C characterizes Site 39.

40. Site 40 at RM 94.1 RDB (Open Water)

This right-bank site on the outside of a sharp bend, shown in figure 7-126, is located immediately downstream from a small tributary outlet. Figure 7-126 shows that bank retreat had occurred since 1984 when the land coverage data for the current navigation chart were obtained. Photos 7-111 and 7-112 show upstream and downstream views of the site, respectively. Photo 7-113 shows a close-up view of eroded bench. Two bank sections were taken at this site, as shown in figures 7-127 and 7-128. There was no midpoint section at this site. Because the upstream section was located immediately downstream from a wing dam which is just upstream from the tributary outlet, strong reverse currents were observed. The bank soils are primarily FST and MST. Piping cavities and overland drainage rills were observed at Site 40.

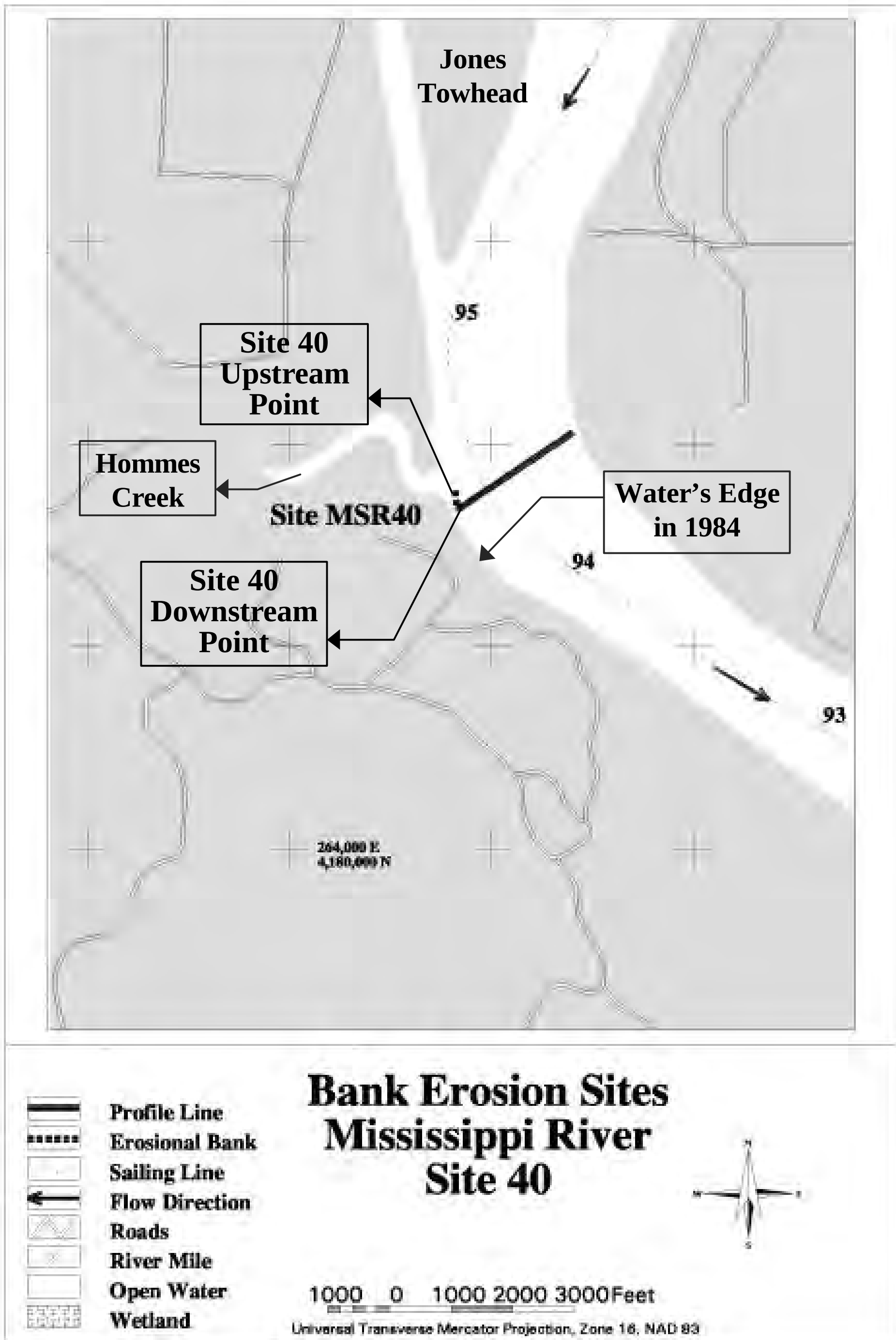


Figure 7-126 A map showing Mississippi River Site 40

Photo 7-111 An upstream view of Site 40 downstream point

Photo 7-112 A downstream view of Site 40 downstream point

Photo 7-113 A close-up view of eroded bench at Site 40 downstream point

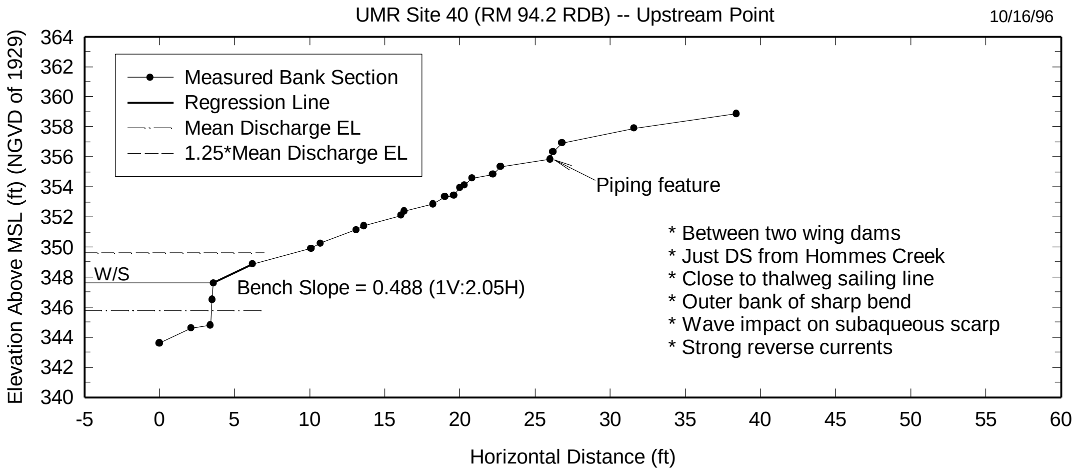


Figure 7-127 Bank section measured at Site 40 upstream point

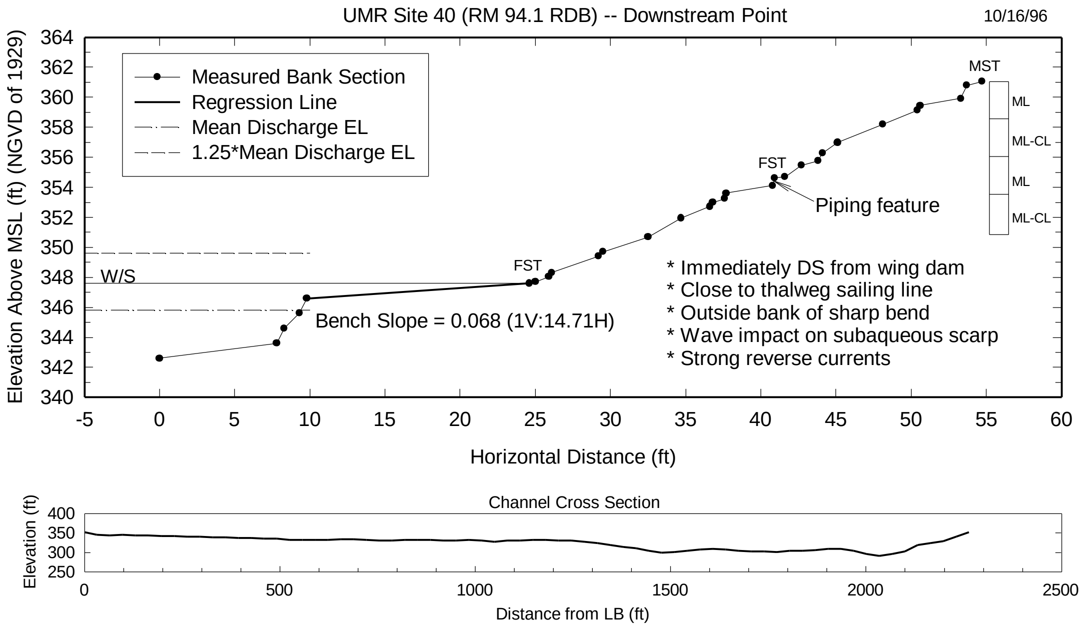


Figure 7-128 Bank section and channel cross section measured at Site 40 downstream point

This erosion site appears to lie on a surface composed entirely of historical alluvium. One sampling tube core showed extremely thick historical deposits. From a bank exposure and from the sampling tube core, it appears that the historical alluvium is in excess of 26 ft thick. The pronounced Mississippi River ridge with swale topography in the nearby areas is protected by a constructed levee. Multiple orientations of the ridges and swales indicate possible older Holocene surfaces in the valley.

Causative factors for bank retreat at this site include flood-flow erosion and recessional failures, piping and collapse, seepage and overland-flow surface erosion, wave and rework-transport of failed soils and recently deposited sediments within berm and bench areas, and impacts due to flow-training structures. Type C describes this site.

41. Site 41 at RM 77.2 RDB (Open Water)

This right bank erosion site, shown in figure 129, is located on the outside of a mild bend across from Grand Tower Island, less than 0.5 mile downstream from a mid-channel island. Upstream and downstream views of the site are shown in Photos 7-114 and 7-115, respectively. One bank section was obtained, as shown in figure 7-130. The upper bank soil is primarily post-glacial Pleistocene and consists of coarse sand and gravel,

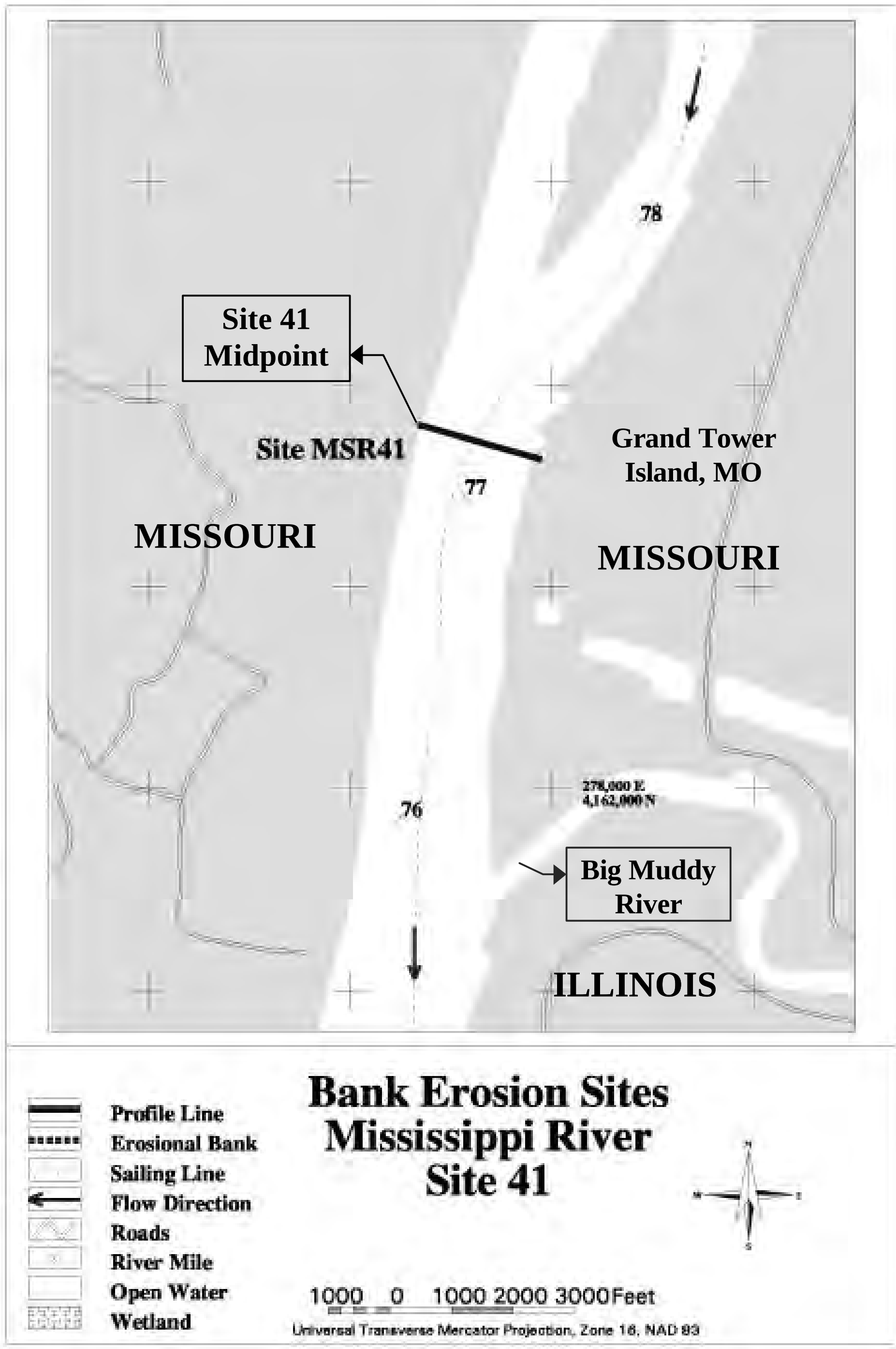


Figure 7-129 A map showing Mississippi River Site 41

Photo 7-114 An upstream view of Site 41 midpoint

Photo 7-115 A downstream view of Site 41 midpoint

Photo 7-116 Piping features of Site 41 midpoint

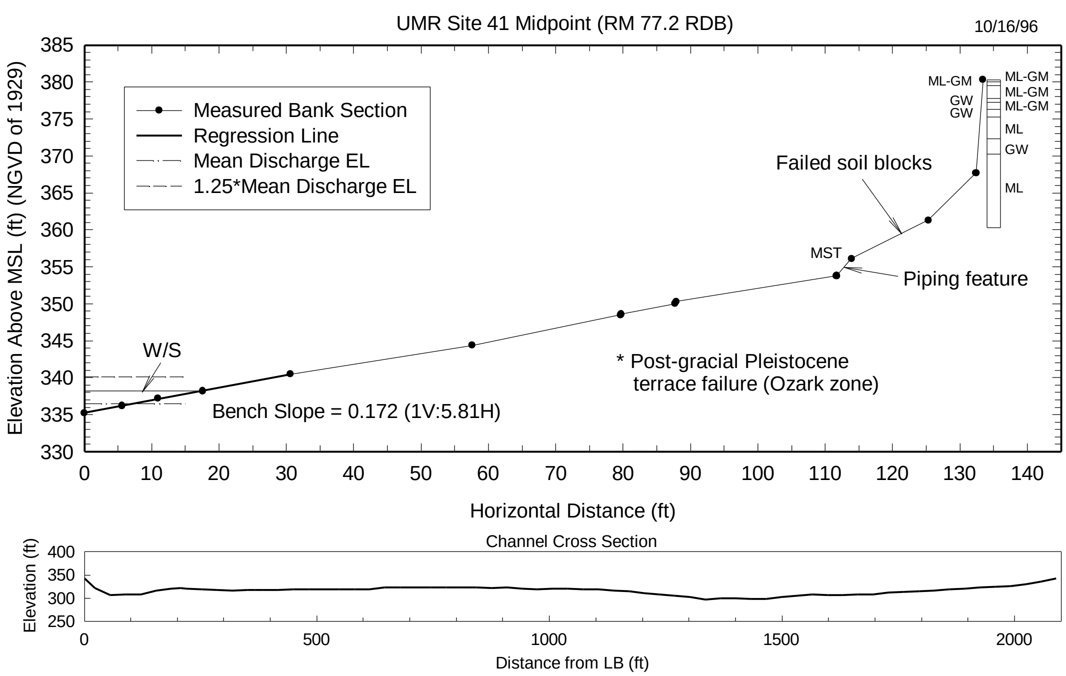


Figure 7-130 Bank section and channel cross section measured at Site 41 midpoint

forming layers and lenses. These deposits are over 25 ft thick. At the base of the scarp, where piping cavities were observed, deposits are silty. Photo 7-117 shows piping cavities.

Site 41 lies along the west valley margin where erosion has formed alluvial fans. Colluvial slopes indicate active failures. A scarp about 25 ft to 30 ft high exposes the fan and toe of slope deposits. A sampling tube core and erosional features examined at the site indicate that a late Wisconsinan to early Holocene colluvial slope is now undergoing active erosion. No paleosols or historical alluvium were observed in the profile. Barge smears at flood stage were observed about 20 ft to 25 ft above the water surface which was at EL 338.2 above MSL (NGVD of 1929).

Causative factors for bank retreat at this site include flood-flow erosion and rapid recessional failures, piping and collapse, overland drainage erosion, and wave actions which erode failed soils and recently deposited sediments within berm and bench areas. A combination of Type E and Type F describes Site 41.

42. Site 42 at RM 53.2 LDB (Open Water)

This left-bank erosion site, shown in figure 7-131, is located along the outside of a bend in the MR at Cape Girardeau. The river channel at this site is about 1,800 ft wide. Photo 7-117 shows an upstream view of the site and Photo 7-118 shows a close-up view of a revetment failure. Photo 7-119 shows a downstream view of the site. Photo 7-120 shows bank failure which was taking place. Undercut blocks fell onto the sandy lower bank. Three bank sections are shown in figures 7-132 through 7-134. The bank soils are primarily MST, FS, and VFS. This site is located within a failure of a hand-placed revetment. Piping features and failed soil blocks were observed at this site. Apparently, bank undercutting occurred and the toe of revetment was truncated, resulting in upslope launching of revetment stone. Once the revetment base, consisting of limestone gravel, is launched, waves or high water flows would erode the slope, resulting in further launching of upper revetment stone.

Site 42 lies on a surface composed entirely of historical alluvium. From a bank exposure and from the sampling tube core, the historical alluvium is considerably greater than 10 ft, and as much as 30 ft, thick. As at most locations south of St. Louis, considerable storage and removal of historical deposits typically occur channel-ward from the levee.

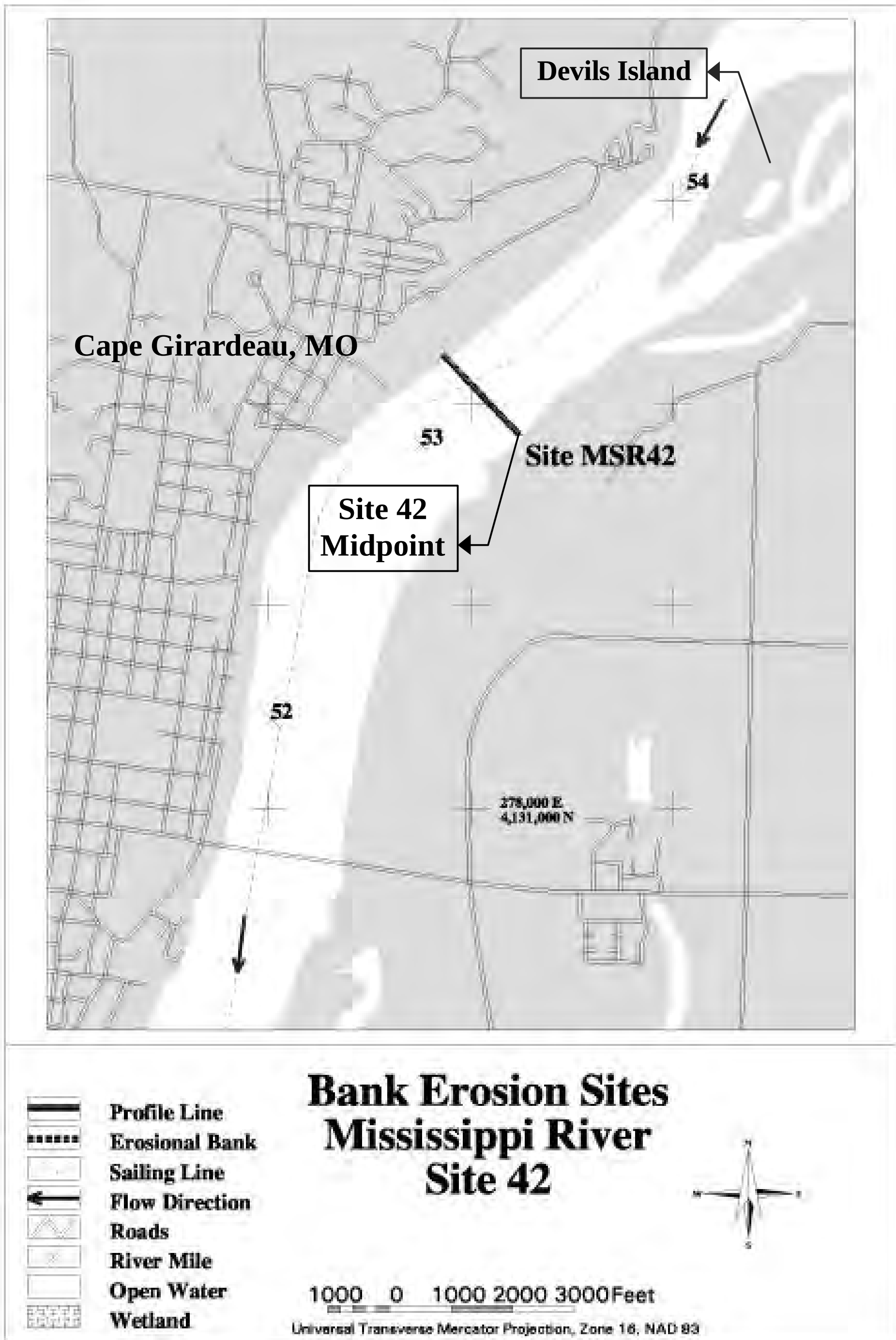


Figure 7-131 A map showing Mississippi River Site 42

Photo 7-117 An upstream view of Site 42 midpoint

Photo 7-118 A close-up view of revetment failure at Site 42 midpoint

Photo 7-119 A downstream view of Site 42 midpoint

Photo 7-120 A close-up view of bank failure of Site 42 midpoint

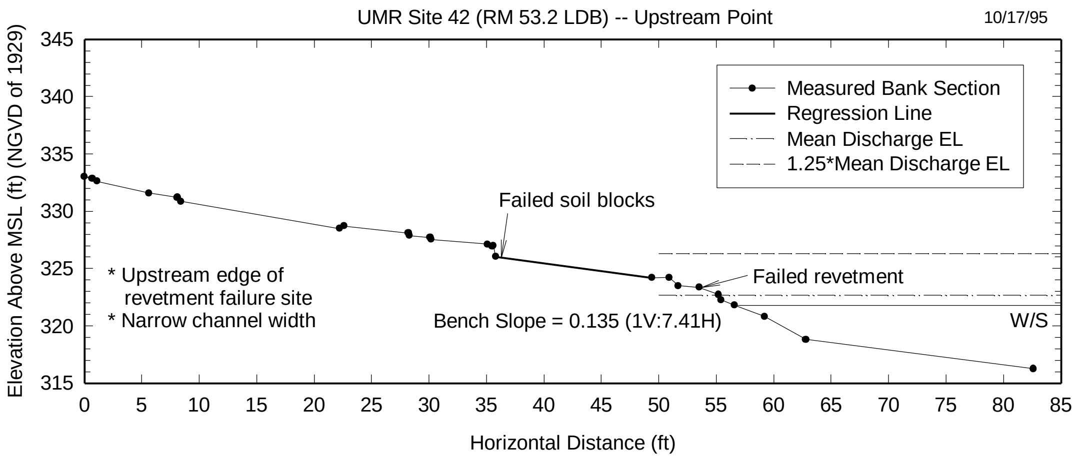


Figure 7-132 Bank section measured at Site 42 upstream point

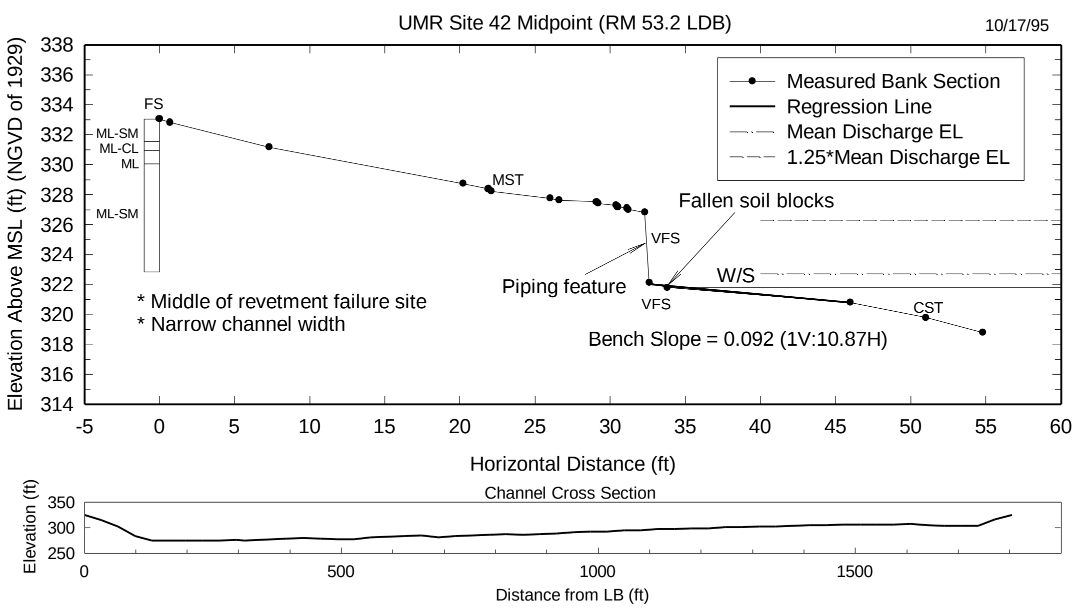


Figure 7-133 Bank section and channel cross section measured at Site 42 midpoint

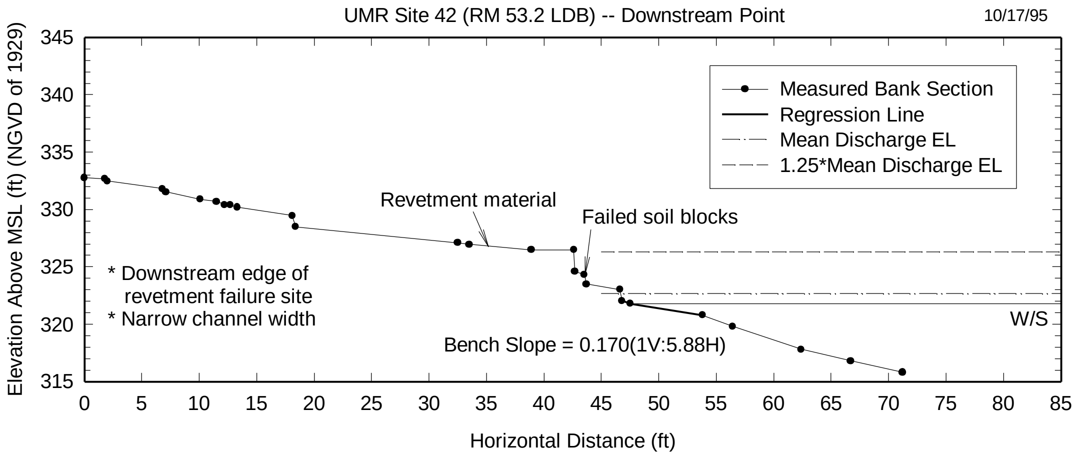


Figure 7-134 Bank section measured at Site 42 downstream point

Causative factors for bank retreat at this site include flood-flow erosion and oversteepening, recession and piping collapse, stone launching, and wave and rework-transport of failed soils and recently deposited sediments within berm and bench areas. Type A conditions best describe Site 42.

43. Site 43 at RM 45.3 LDB (Open Water)

This left-bank site, shown in figure 7-135, is located in a narrow straight reach, immediately downstream from a sharp bend. The bank lies on a shaley siltstone, as depicted in Photo 7-121 and figure 7-136. Photo 7-122 shows a close-up view of the scarp which exposes medium silt (MST) and coarse clay (CC). Photo 7-123 shows the reddish brown bank soil when it was placed in water. The river cross section at Site 43 has a very peculiar shape, practically triangular, indicating a rather steep-slope bedrock-defined channel, with active erosion.

Site 43 is located in a very narrow valley reach, Thebe's Gap. An alluvial fan has entered the MR valley and is being eroded actively. The erosional features and a sampling tube core were used to describe an approximately 26.5 ft profile. The fan appears to be of late Wisconsinan to early Holocene age and lies over other deposits, possibly older than Wisconsinan age. Six paleosols are developed in the fan, and underlying loess and alluvium. A highly oxidized reddish brown loessal deposit (Loveland Loess-Sangamon) overlies shaley siltstone which outcrops at the toe of slope.

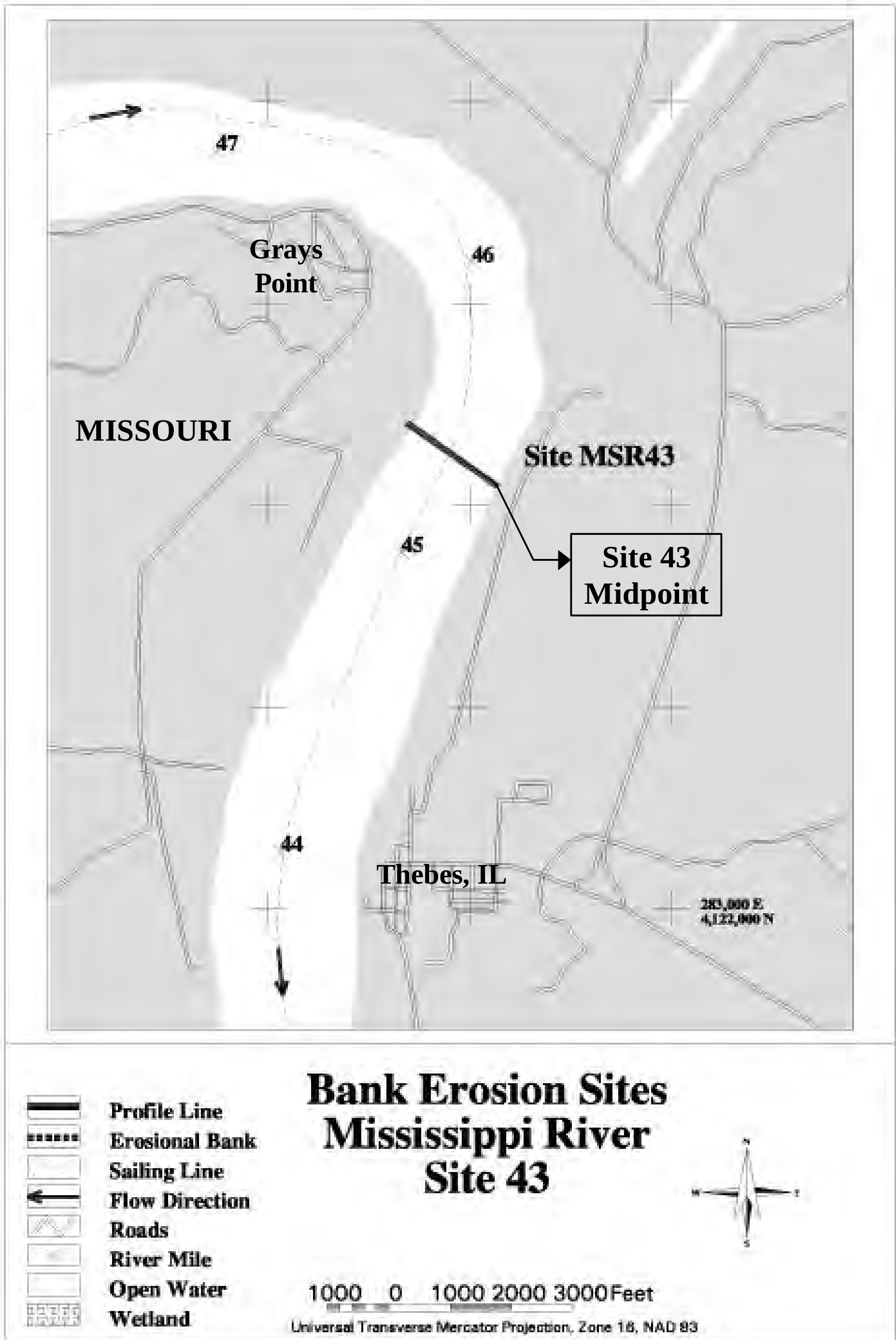


Figure 7-135 A map showing Mississippi River Site 43

Photo 7-121 An upstream side view of Site 43 midpoint

Photo 7-122 A close-up of scarp face of Site 43 midpoint

Photo 7-123 Reddish brown color of soil block in water at Site 43 midpoint

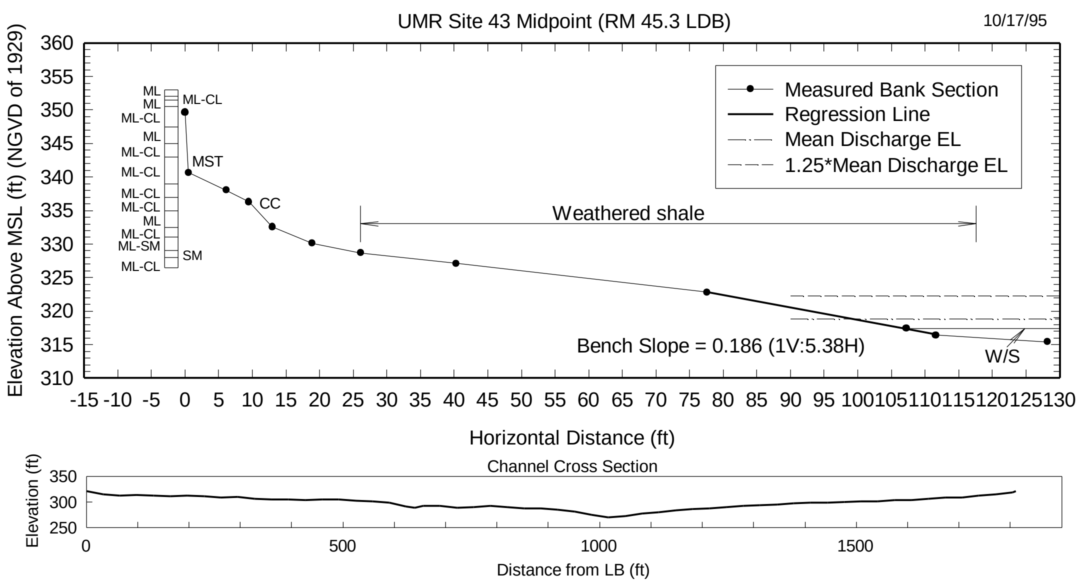


Figure 7-136 Bank section and channel cross section measured at Site 43 midpoint

Causative factors for bank retreat at this site include flood-flow erosion, recession and piping related failures and slaking, overland drainage, and wave and flow rework and transport of failed and slaked soils within bench areas. Type A characterizes Site 43.

44. Site 44 at RM 26.0 RDB (Open Water)

This right-bank site, shown in figure 7-137, is located on an island along the inside bank of a mild bend, which is located about 4 miles upstream from Dogtooth Bend at RM 22.0. Site 44 is located near the entry point into an S bend. As shown in figure 7-137,

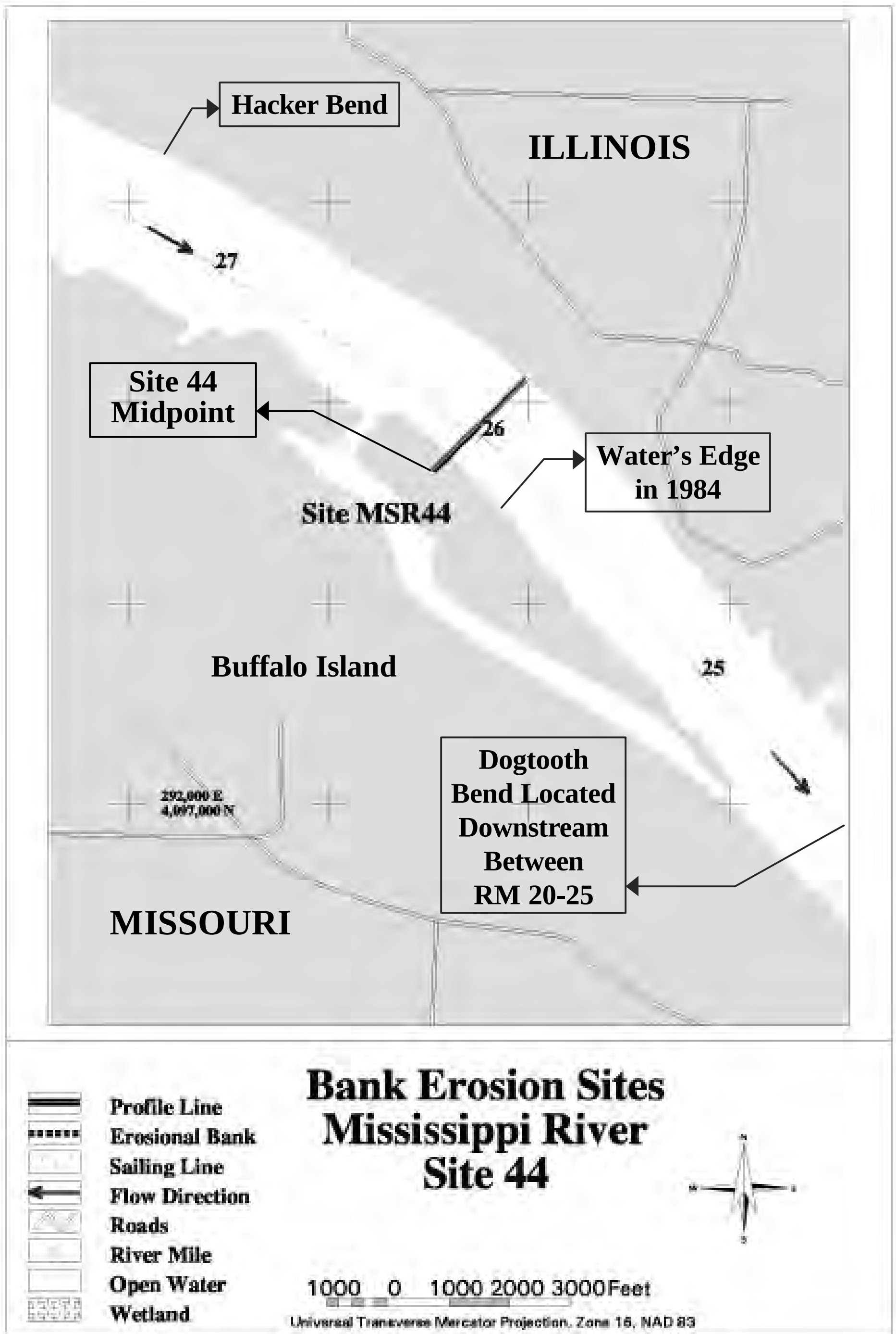


Figure 7-137 A map showing Mississippi River Site 44

Photo 7-124 An upstream view of Site 44 midpoint

Photo 7-125 A downstream view of Site 44 midpoint

Photo 7-126 A close-up view of buried plastic sheet at Site 44 midpoint (see Photo 7-124 for its relative location)

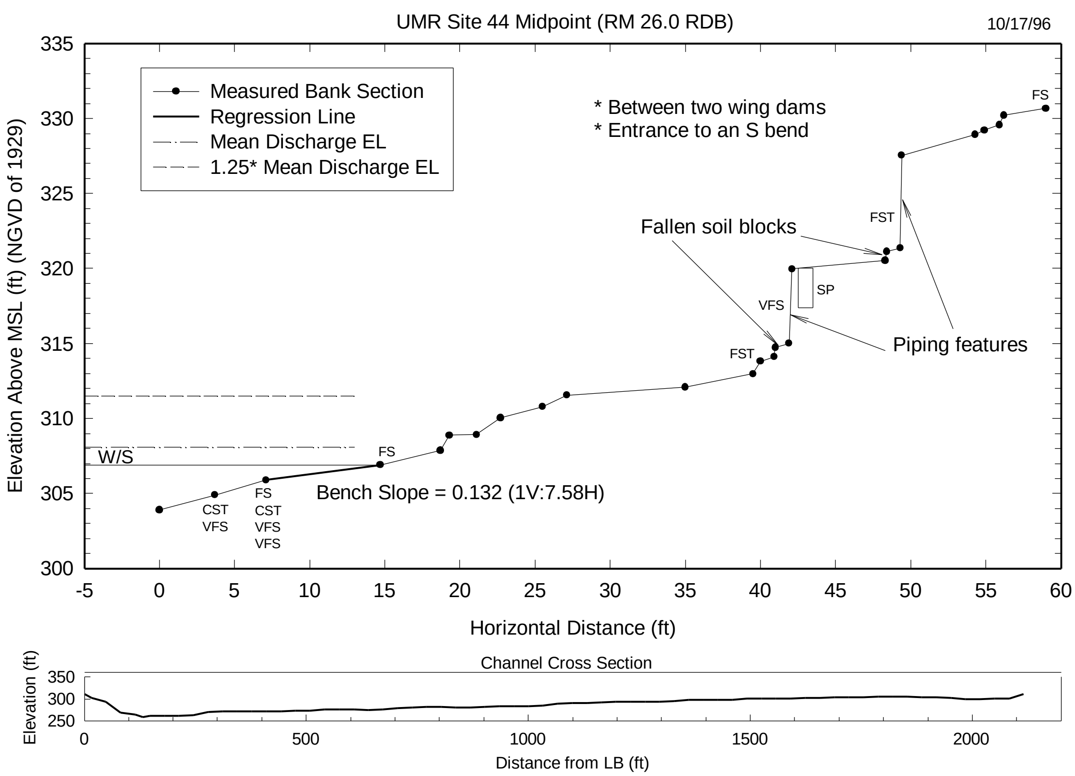


Figure 7-138 Bank section and channel cross section measured at Site 44 midpoint

the Global Positioning System (GPS)-determined river's cross-section end point of Site 44 is located farther into the island, indicating that severe bank retreat took place since 1984. Photos 7-124 and 7-125 show upstream and downstream views of the site, respectively. Photo 7-126 shows a close-up view of a piece of plastic sheet buried in the bank. The bank section taken is shown in figure 7-138. There are several scarps and failed soil blocks at piping cavities. Bank erosion at Site 44 appeared to have been exacerbated by the wing dams surrounding the site. The top of the bank is covered by FS, and soils within scarps consist of FST and FS. Subaqueous sediments consist of silt and sand ranging from CST to VFS.

Site 44 is composed of thick historical alluvium. Two sampling tube cores and a bank retreat showed extremely thickly bedded silt and very fine sand. The core and the bank exposure indicate that the historical deposits are at least 22 ft thick.

Causative factors for bank retreat at this site include flood-flow erosion, recession and piping failures, slaking, and wave and rework-transport of failed soils and recently deposited sediment within berm and bench areas. Type B Characterizes Site 44.

Additional Site Characteristics and Navigation Data

For Sites 1 through 37 (no Site 20) located in Mississippi River pools, relative locations within each pool were identified as being in "upper quarter pool (U1)," "upper middle quarter pool (U2)," "lower middle quarter pool (D3)," and "lower quarter pool (D4)," as shown in table 7-6. The percent of pool length from the downstream Lock and Dam for each site also was calculated, and shown in the table. Table 7-6 also includes fifty-four observation sites (OB-1 through OB-54); thirty-nine observation sites were located in pools and fifteen were in open water. Among the seventy-five sites in pools, thirty-two sites were located in U1(42.7% of the total), twenty in U2 (26.7% of the total), twelve in D3 (16.0% of the total), and eleven in D4 (14.7% of the total). As much as 69.4 percent of the total number of the major and observation sites were located in the upper halves of the pools. Severe bank erosion appears to be occurring more or less in the upper halves of the pools in the Mississippi River, where the main channel width is generally smaller than in the downstream halves, and flow depths are generally smaller,

Table 7-6 Relative location of each site within pool, including the major and observation sites, and locations of other observation sites in open-water reach

Site No.	River Mile (mile) Above Ohio River Mouth	Pool No.	Relative Location Within Pool (see definition sketch below)
1	825.5R	2	D3* (0.32)**
2	791.7R	4	U1 (0.88)
3	763.4L	4	D4 (0.24)
4	751.1L	5	U1 (0.88)
5	746.4L	5	U2 (0.56)
6	727.4R	6	U1 (0.96)
7	727.4L	6	U1 (0.96)
OB-1* **	715.0L	6	D4 (0.06)
8	677.5R	9	U1 (0.95)
9	677.5L	9	U1 (0.95)
OB-2	677.1L	9	U1 (0.94)
10	669.5R	9	U2 (0.69)
OB-3	658.8R	9	D3 (0.35)
OB-4	636.0L	10	U2 (0.64)
11	620.5L	10	D4 (0.16)
OB-5	617.7L	10	D4 (0.08)
12	613.6L	11	U1 (0.95)
13	613.6R	11	U1 (0.95)
14	607.5R	11	U1 (0.76)
OB-6	604.5R	11	U2 (0.67)
15	576.0L	12	U2 (0.73)

* Relative pool locations (U1, U2, D3, and D4) are defined in the sketch shown below.
** Values shown in parentheses indicates percent of pool length from downstream Lock & Dam
*** The prefix "**OB**" denotes "**Ob**servation Site"

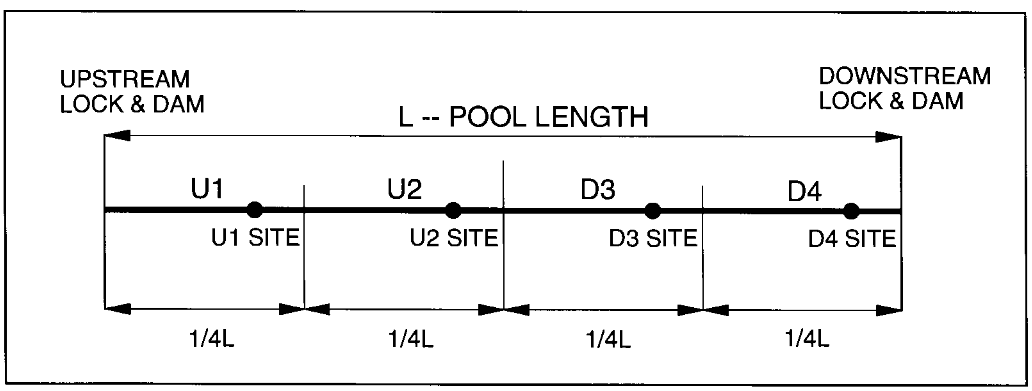


Table 7-6 continued

Site No.	River Mile (mile) Above Ohio River Mouth	Pool No.	Relative Location Within Pool (see definition sketch below)
OB-7	554.2R	13	U1 (0.93)
16	551.9L	13	U1 (0.86)
OB-8	549.5L	13	U1 (0.79)
OB-9	518.0L	14	U1 (0.85)
OB-10	517.2L	14	U1 (0.82)
OB-11	514.0R	14	U2 (0.71)
17	512.7L	14	U2 (0.66)
18	509.2R	14	U2 (0.54)
19	509.2L	14	U2 (0.54)
OB-12	505.4R	14	D3 (0.41)
OB-13	499.0R	14	D4 (0.20)
OB-14	470.9L	16	U2 (0.53)
21	466.7L	16	D3 (0.37)
OB-15	454.0L	17	U1 (0.84)
OB-16	436.9L	18	U1 (0.99)
22	436.4L	18	U1 (0.97)
23	436.4R	18	U1 (0.97)
24	432.3L	18	U1 (0.82)
25	432.3R	18	U1 (0.82)
OB-17	425.0R	18	U2 (0.55)
26	420.0R	18	D3 (0.36)
OB-18	405.0R	19	U1 (0.88)
OB-19	370.2L	19	D4 (0.13)
OB-20	361.5L	20	D3 (0.48)
27	360.0R	20	U1 (0.80)
28	357.6R	20	U2 (0.69)
29	339.3L	21	U1 (0.79)
30	339.3R	21	U1 (0.79)
OB-21	339.2R	21	U1 (0.79)
OB-22	322.8R	22	U1 (0.91)
OB-23	310.8L	22	D3 (0.41)
OB-24	308.6L	22	D3 (0.31)
0B-25	308.3L	22	D3 (0.31)
31	293.0L	24	U2 (0.70)
OB-26	276.2L	24	D4 (0.10)
32	275.3R	24	D4 (0.07)
OB-27	272.8L	25	U1 (0.98)
OB-28	266.8L	25	U2 (0.75)
33	266.5L	25	U2 (0.73)
OB-29	261.0L	25	U2 (0.52)
OB-30	252.7L	25	D4 (0.20)

Table 7-6 continued

Site No.	**River Mile (mile) Above Ohio River Mouth**	**Pool No.**	**Relative Location Within Pool (see definition sketch below)**
OB-31	249.1L	25	D4 (0.06)
OB-32	241.5L	26	U1 (0.87)
OB-33	238.0R	26	U1 (0.79)
OB-34	233.4R	26	U2 (0.69)
34	232.2R	26	U2 (0.66)
35	222.1R	26	D3 (0.41)
OB-35	221.6L	26	D3 (0.42)
36	217.5R	26	D3 (0.33)
OB-36	210.6R	26	D4 (0.17)
OB-37	203.3L	26	D4 (0.01)
OB-38	200.2R	27	U1 (0.85)
37	197.6R	27	U2 (0.71)
OB-39	195.3L	27	U2 (0.59)
OB-40	168.5L	OPEN	N/A*
OB-41	140.7R	OPEN	N/A
OB-42	140.7L	OPEN	N/A
OB-43	134.1R	OPEN	N/A
OB-44	125.6L	OPEN	N/A
OB-45	99.2R	OPEN	N/A
OB-46	87.0L	OPEN	N/A
OB-47	84.6L	OPEN	N/A
OB-48	82.6R	OPEN	N/A
OB-49	53.1L	OPEN	N/A
OB-50	42.6R	OPEN	N/A
OB-51	38.7L	OPEN	N/A
OB-52	22.2L	OPEN	N/A
OB-53	16.0R	OPEN	N/A
OB-54	9.1L	OPEN	N/A

* N/A: Not Applicable

causing much higher flow velocities. Stage recession after floods is greater in the upper ends of pools, and gradients and exposed bank heights for emergent seepage are larger in upper ends of pools, also.

Additional information on the length of eroded bank determined by means of the GPS for each site is tabulated in table 7-7. At sixteen sites, including Sites 1, 7, 13, 21,

Table 7-7 Summary of erosion length identified during the field study

Site No.	1	2	3	4	5	6	7	8	9	10
Erosion Length (ft)	---	984	1,132	1,079	1,138	1,988	---	1,699	945	10,085
Site No.	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**21**
Erosion Length (ft)	1,352	948	---	3,638	4,229	804	1,680	1,181	361	---
Site No.	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Erosion Length (ft)	443	---	2,057	---	1,378	---	2,759	1,870	---	---
Site No.	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**
Erosion Length (ft)	184	1,417	981	899	---	---	761	---	312	---
Site No.	**42**	**43**	**44**							
Erosion Length (ft)	---	---	---							

Note that "---" indicates that the erosion length was not determined.

23, 25, 27, 30, 31, 36, 37, 39, 41, 42, 43, and 44, erosion limits were not established. A total of 46,306 ft of eroded bank was identified from twenty-seven sites, indicating an average length per site of about 1,715 ft. Since forty-three major sites and fifty-four observation sites were identified for the Mississippi River in the present study, a total length of eroded bank could be assumed to be about 31.5 miles [= (43+54)x1,715 = 166,355 ft = 31.5 miles], if it is assumed that the average length of eroded bank were 1,715 ft. This mileage is about 2 percent of the total length of the MR banks upstream from the Ohio River confluence, roughly 1,695 miles (note that Lock & Dam No. 1 is located at RM 847.6). An independent estimate on eroded-bank length conducted by the study team using visual field observations and marking eroded bank on the navigation chart is about 246 miles (about 14 percent of the total river bank). Therefore, the field crew happened to have picked approximately one out of seven potential erosion sites during the study.

Historical records of barge traffic for 1980-1995 along the Upper Mississippi River have been compiled by the three COE Districts. The annual records for upbound and downbound barge traffic are listed in tables 7-8 and 7-9, respectively. On the basis of the records, mean annual barge traffic through each Lock and Dam was computed for both the upbound and downbound barges, as shown in figures 7-139 and 7-140, respectively.

Table 7-8 Historical records of total (both empty and loaded) upbound barge traffic along the Upper Mississippi River

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total	Mean
L&D 1A	1099	617	457	753	740	726	689	513	483	431	788	950	1186	856	995	998	12281	768
L&D 1B	1707	1065	943	1261	1273	1134	1378	997	861	825	1004	957	1207	857	995	994	17458	1091
L&D 1	1762	1112	1021	1273	1271	1127	1299	993	863	847	1015	956	1210	857	1011	995	17612	1101
L&D 2	7827	8257	7736	10476	9151	7439	6010	5567	6414	6299	7708	6182	6879	3644	4577	4555	100894	6306
L&D 3	6792	7415	6948	9595	8536	6401	5714	5562	6377	6274	7703	6210	6865	3628	4573	4547	103140	6446
L&D 4	7194	7887	7321	9982	8792	6612	6042	5901	6638	6543	7990	6552	7275	3803	4803	5012	108347	6772
L&D 5	7095	7936	6968	9966	8733	6510	5888	5862	6543	6489	7929	6523	7135	3823	4954	5032	107386	6712
L&D 5A	7092	7840	7192	9948	8753	6548	5949	5850	6585	6501	7909	6575	7227	3865	4940	5078	107852	6741
L&D 6	7979	8544	7379	10824	9469	6903	6347	6590	7567	7578	9129	7691	8351	4327	5675	6539	120892	7556
L&D 7	7968	8624	7564	10820	9467	6929	6324	6615	7608	7529	9146	7760	7966	4192	5623	6461	120596	7537
L&D 8	8215	8778	6848	11053	9709	7075	6570	6781	7741	7725	9332	7919	8602	4597	5785	6809	123539	7721
L&D 9	8500	9038	7787	11283	9543	6976	6552	6720	7642	7518	9101	7918	8681	5025	6064	7497	125845	7865
L&D 10	9724	10397	8738	12730	10472	7455	7013	7683	9114	8972	10790	9497	10192	5867	7015	9452	145111	9069
L&D 11	9765	10494	9106	12749	10378	7427	6246	7708	9060	8927	10562	9502	10422	6216	7483	9909	145954	9122
L&D 12	10416	11270	9852	14074	11379	8141	7097	9735	10921	11023	12839	11277	12372	6730	7637	10742	165505	10344
L&D 13	10290	11263	9903	14095	11476	8149	7106	9807	11110	11379	13258	11665	12647	6923	7801	11098	167970	10498
L&D 14	12400	13937	12260	17371	13859	10001	9029	13176	14721	14987	17373	15162	16198	9312	10742	14986	215514	13470
L&D 15	12094	13735	12431	17150	13957	9902	9132	13269	14699	14543	16950	14862	15766	9137	10296	14731	212654	13291
L&D 16	12931	15170	13579	18491	15299	10613	10037	14290	15842	15481	17983	15519	16411	9593	10703	15588	227530	14221
L&D 17	14281	15918	14452	19461	15546	11206	10495	15284	16913	16472	19107	16375	17020	9850	10916	15935	239231	14952
L&D 18	13960	16484	15047	19961	15977	11437	10808	15791	17517	16945	19499	16844	17492	10215	11347	16539	245863	15366
L&D 19	15730	17369	15612	20687	17128	12040	11597	16780	18742	17954	20530	17987	18889	11368	12320	17508	262241	16390
L&D 20	16306	17898	15966	21081	17386	12299	11901	17224	19214	18406	20935	18465	19457	11826	12829	18184	269377	16836
L&D 21	17084	18341	16517	21415	18042	12697	12669	17994	19861	18786	21455	19002	20007	12606	13453	18681	278610	17413
L&D 22	17412	18315	16817	21662	18374	12979	13053	18439	20135	19043	21771	19130	20164	12740	13647	18863	282544	17659
L&D 24	18112	19348	17561	22373	19216	13699	13829	19136	20749	19764	21915	19836	20953	13674	14458	19586	294209	18388
L&D 25	18147	19318	17577	22389	19192	13719	13840	19145	20750	19761	21957	19811	20983	13682	14411	19595	294277	18392
L&D 26	36925	38349	34553	41899	36897	29853	31018	36812	37869	36351	38173	37435	38580	31316	32713	38975	577718	36107
L&D 27	41987	42817	42134	46186	39960	33901	34761	41001	42209	40258	40829	40881	41614	34299	35797	42249	640883	40055

Table 7-9 Historical records of total (both empty and loaded) downbound barge traffic along the Upper Mississippi River

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total	Mean
L&D 1A	1093	602	459	759	741	722	674	517	475	446	795	934	1195	859	993	995	12259	766
L&D 1B	1708	1064	962	1256	1256	1125	1371	999	856	832	1009	951	1205	862	999	998	17453	1091
L&D 1	1748	1117	1004	1268	1246	1124	1409	1005	849	806	1010	945	1205	875	998	1011	17620	1101
L&D 2	7871	8315	7769	10502	9072	7360	5997	5800	6461	6254	7733	6193	6790	3665	4562	4521	108865	6804
L&D 3	6909	7527	6959	9586	8390	6342	5762	5740	6425	6257	7712	6175	6904	3656	4540	4539	103423	6464
L&D 4	7326	7985	7352	9994	8733	6571	6056	5982	6741	6513	7984	6609	7163	3834	4866	5038	108747	6797
L&D 5	7238	7993	7029	9890	8653	6433	6113	5924	6580	6495	7887	6452	7132	3881	4972	5100	107772	6736
L&D 5A	7216	7931	7237	9912	8651	6439	6116	5983	6607	6497	7955	6445	7049	3878	4976	5089	107981	6749
L&D 6	8146	8653	7365	10829	9367	6814	6503	6687	7591	7546	9228	7849	8218	4411	5661	6533	121401	7588
L&D 7	8120	8718	7586	10821	9379	6796	6534	6707	7596	7553	9198	7821	7725	4269	5708	6522	121053	7566
L&D 8	8344	8849	6877	11025	9605	6865	6791	6900	7823	7702	9342	7970	8684	4519	5783	6785	123864	7742
L&D 9	8533	9190	7849	11297	9472	6779	6794	6813	7689	7488	9215	7891	8580	5030	6062	7470	126152	7885
L&D 10	9876	10577	8717	12797	10340	7249	7181	7854	9176	9008	10786	9584	10061	5854	6965	9385	145410	9088
L&D 11	9863	10574	9123	12661	10302	7269	6397	7881	9081	8896	10554	9442	10302	6208	7484	9849	145886	9118
L&D 12	10490	11552	9900	13981	11361	7929	7259	9903	10916	10983	12828	11211	12300	6745	7633	10713	165704	10357
L&D 13	10467	11640	9933	14041	11371	7921	7294	9994	11023	11341	13198	11599	12616	6982	7842	10986	168248	10516
L&D 14	12444	14177	12314	17128	13723	9719	9324	13355	14793	14924	17318	15098	16183	9314	10712	14922	215448	13466
L&D 15	12156	13842	12299	16971	13754	9597	9361	13397	14756	14531	16933	14766	15643	9113	10390	14733	212242	13265
L&D 16	13150	15418	13629	18268	15208	10282	10369	14492	15891	15478	17959	15390	16324	9561	10732	15547	227698	14231
L&D 17	14496	16063	14616	19295	15557	10736	10852	15537	17081	16651	19106	16209	16952	9772	10925	15771	239619	14976
L&D 18	14762	16676	15095	19769	16113	11014	11181	15978	17529	16925	19463	16777	17396	10252	11358	16444	246732	15421
L&D 19	16006	17632	15543	19955	17660	11587	11958	16992	18760	17939	20489	17892	18796	11374	12387	17403	262373	16398
L&D 20	16405	17868	15984	20206	18074	11821	12334	17413	19290	18346	20923	18392	19271	11768	12907	18133	269135	16821
L&D 21	17050	18480	16491	20619	18710	12241	13057	18182	20053	18716	21486	18943	19855	12538	13569	18613	278603	17413
L&D 22	17294	18678	16873	20746	19065	12506	13395	18678	20343	18996	21742	19245	20105	12723	13790	18912	283091	17693
L&D 24	18239	19353	17562	21493	19809	13185	14255	19322	20969	19643	21449	19912	20910	13660	14601	19658	294020	18376
L&D 25	18160	19327	17532	21499	19904	13212	14261	19325	20950	19658	21435	19986	20812	13700	14620	19653	294034	18377
L&D 26	36816	37888	34751	41282	37919	44775	31222	37148	38216	35951	38563	37858	38636	30956	32685	38945	593611	37101
L&D 27	41925	42132	41945	45573	41065	33392	34704	41663	42277	39613	41211	41271	41848	33888	35764	41925	640196	40012

As can be seen in these figures, the mean annual traffic, in terms of either upbound or downbound traffics, at Lock & Dam No. 1 is about 1,100 passages, compared to about 6,300 passages at Lock & Dam No. 2. The mean one-way annual traffic increases very slightly downstream, from about 6,300 passages at Lock and Dam No. 2 to 10,300 passages at Lock & Dam No. 12, but it increases rather sharply between Lock & Dam No. 12 and Lock and Dam No. 25 (from about 10,300 passages to 18,400 passages). The mean one-way annual barge traffic doubles to about 36,000 passages suddenly at Lock & Dam No. 26. The mean one-way traffic at Lock & Dam No. 27 is about 40,000 passages per year. This pool-by-pool information on barge traffic is very important relative to traffic impacts on bank erosion.

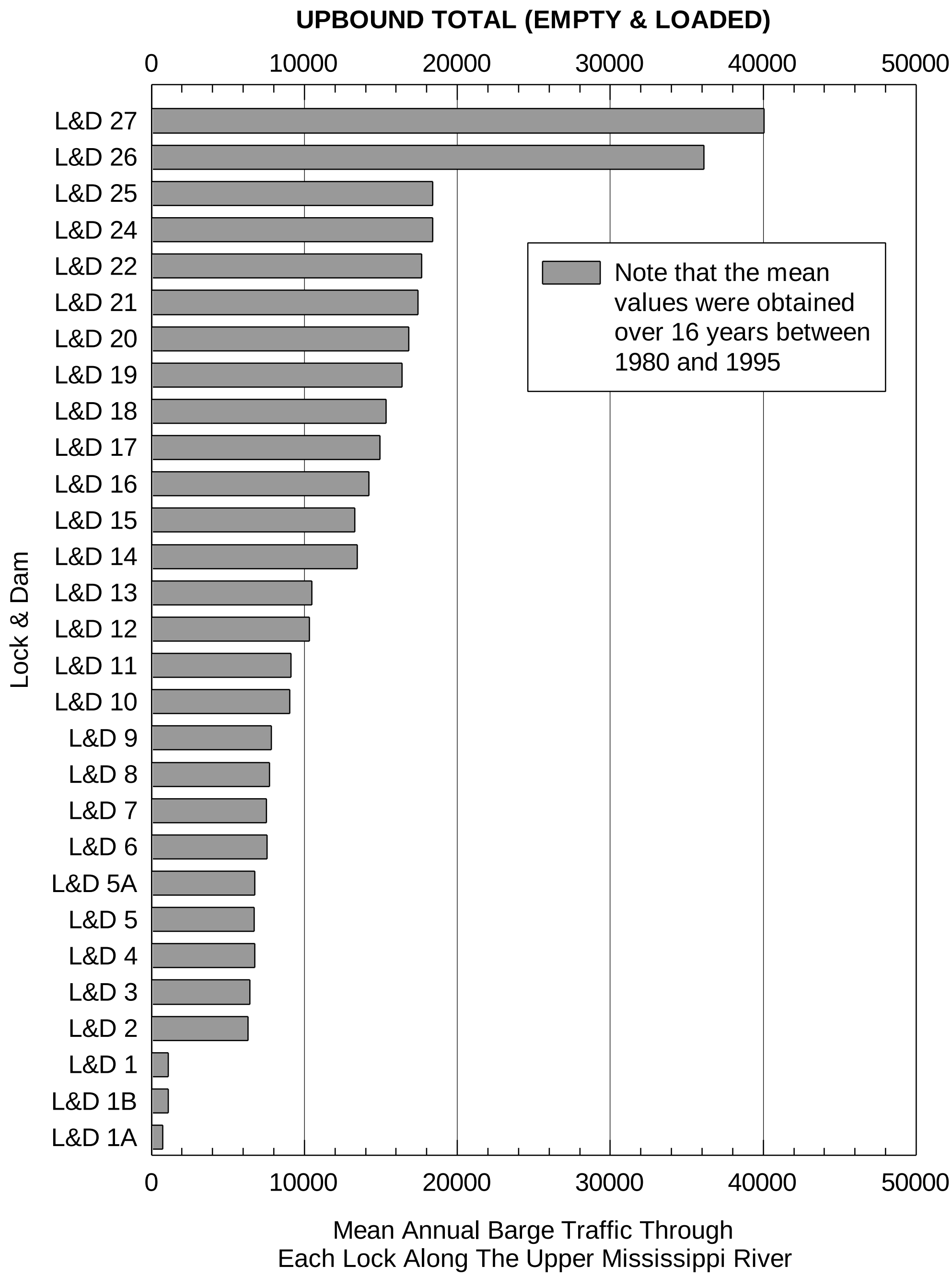


Figure 7-139 Variations in average annual upbound barge traffic Mississippi River locks

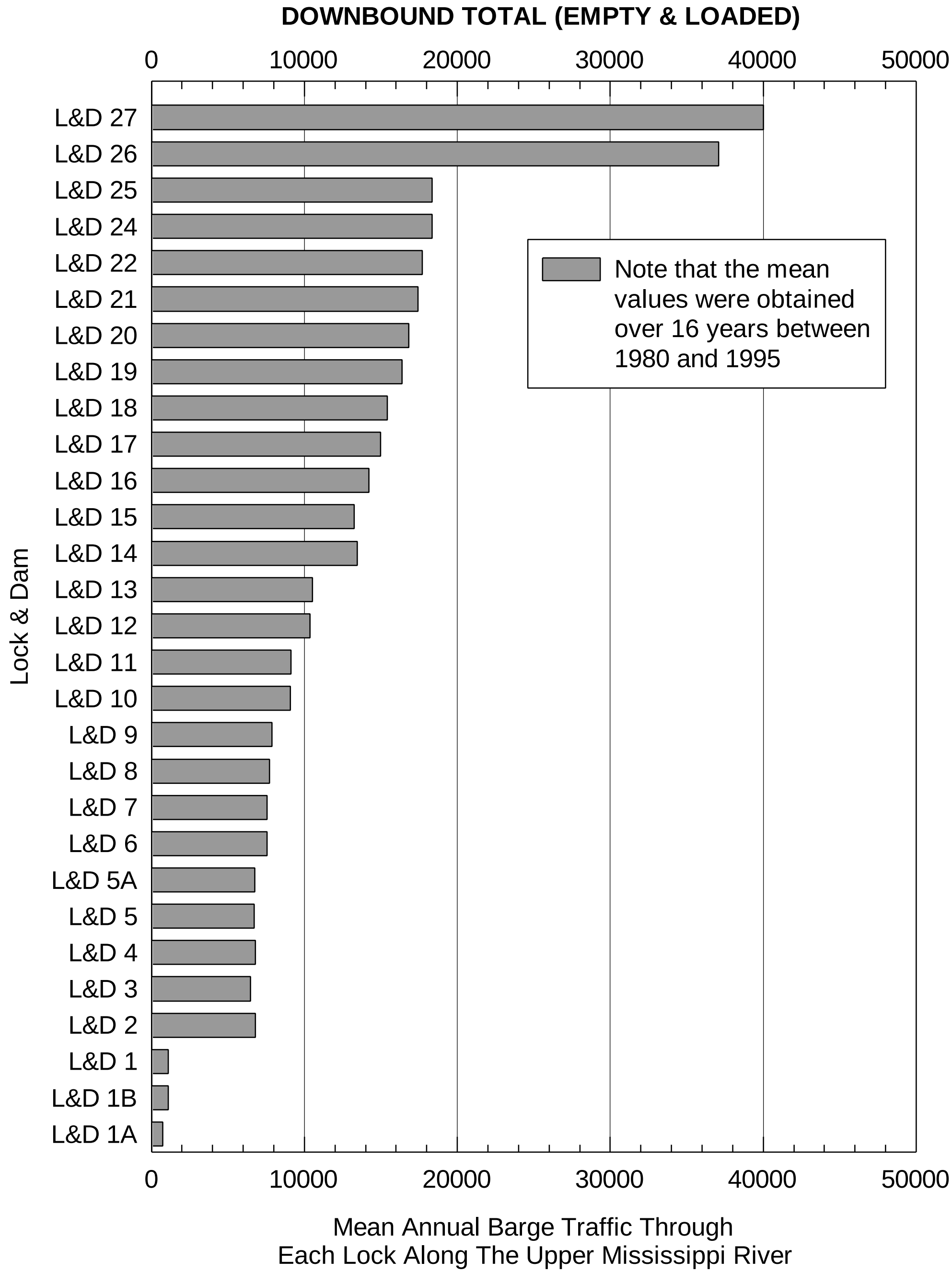


Figure 7-140 Variations in average annual downbound barge traffic through Mississippi River locks

Summary of Conclusions

Conclusions obtained from the present field study can be summarized as follows:

1. Eroded bank sections along the Mississippi River study reach (RM 0.0 at the Ohio River confluence to RM 847.6 at Lock & Dam No. 1) can be classified into six distinct types (Type A through Type F), as defined in table 7-2 and sketched in figure 7-4.
2. The majority of the eroded bank sections investigated in the COE-St. Paul District (Site 1 through Site 11) appear to belong to Type E and Type F, as shown in table 7-5a. Those in the COE-Rock Island District (Site 12 through Site 30) appear to be Type C, Type D, and Type E (see tables 7-5a through 7-5c). Those in the COE-St. Louis District (Site 31 through Site 44) were primarily Type A, Type B, and Type C (see table 7-5c). Surficial bank soils along the upper study reach consist primarily of sand and gravel; silty and sandy deposits were more frequent along the middle study reach; and clayey and silty deposits dominated the lower study reach.
3. Much of the bank erosion in the St. Paul District was found at dredged material placement locations and along Holocene-aged landscapes. Deposits in this portion of the valley are generally coarser compared to those downstream, and historical alluviation is less there compared to downstream reaches.
4. Historical deposits are thicker along the channel margin in the Rock Island District. Erosion of Holocene surfaces is most severe in the upper portion of the pools. The lower pool reaches contain progressively thicker historical deposits which cover most Holocene surfaces. The more or less continuously-constructed protective levee system has greatly focused erosional and depositional events between the levee and channel margins. Generally thickly-bedded historical silt and very fine sand laminae dominate the near-channel alluvial sequences downstream from the Des Moines River.
5. Below St. Louis, the continuous levee and open river systems reveal even more significant historical reworking along the channel margins. Scarps more than 20 ft high, showing historical alluvial sequences, are common. In addition, the relatively small areas where the channel abuts the valley wall, which contains late Wisconsinan and Holocene hillslope and tributary deposits, have been eroded.

6. Because of the Great Flood of ’93, most of the bank-erosion sites investigated, in particular along the middle and lower study reaches, showed such vividly apparent flood impacts that it was extremely difficult to identify any wave-induced rework and transport except at a few fleeting and mooring sites. The lower study reach downstream from the Missouri River confluence also indicated apparent flood impacts of the floods of 1994 and 1995. Major floods had occurred along the study reach at an approximate interval of 5 to 10 years; for example, the flood of 1952, the flood of 1965, the flood of 1969, the flood of 1973, the flood of 1986, and the Great Flood of ’93. Flood effects appear to be much more significant than other erosion mechanisms.
7. Based on the individual geomorphological and hydraulic site characteristics, erosion potential of traffic-induced waves was estimated for each major study site. However, there is no means to estimate bank retreat due to waves from this field reconnaissance study. As stated above, the Great Flood of ’93, the flood of 1994, and the flood of 1995 had left extensive erosion scours and encompassed most of the secondary failure and erosion features due to other causes.
8. Among the seventy-five sites within the MR pools, including the observation sites, approximately 43 percent of them were located in the upper quarter pool; approximately 27 percent in the upper middle quarter pool; approximately 16 percent in the lower middle quarter pool; and approximately 14 percent were located in the lower quarter pool. This means that approximately 70 percent of the study sites (including the observation sites) within the MR pools were located in the upper halves of the pools where the channel is narrower and the river stage varies more frequently than in the lower portion of the pool. Stage recession after floods is also greater in the upper ends of pools, and gradients and exposed bank heights for emergent seepage are larger in upper ends of pools.
9. On the basis of the present field study, approximately 14 percent of the Mississippi River banks are estimated to be actively eroded as of 1995.

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Chapter 8. Summary and Conclusions

Summary

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer districts of Rock Island, St. Louis, and St. Paul under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing and, in consideration of existing system lock constraints, will result in traffic delays which will continue to grow into the future. The system navigation study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from 2000 through 2050. The final product of the System Navigation Study is a Feasibility Report which is the decision document for processing to Congress.

As part of the UMR-IWW System Navigation Study, a field investigation of the current state of bank erosion on the Upper Mississippi River (UMR) and Illinois Waterway (IWW) was conducted by a team of scientists from the Illinois State Water Survey, University of Iowa, and Rock Island and Huntington District Offices of the U.S. Army Corps of Engineers in July, August, and September of 1995. The team surveyed the UMR reach from Cairo, Illinois, to the navigation head water above St. Paul, Minneapolis for a total of 857 miles. The IWW reach was surveyed from Grafton, Illinois to Brandon Road Lock and Dam at Joliet, Illinois, a total of 286 miles.

Six tasks were identified in the Initial Project Management Plan (IPMP) for this effort with a decision point after Task 3. Task 1 was to conduct a literature search to identify applicable and available references for use in decision making in the other tasks. Task 2 was to conduct a system-wide inspection of the Upper Mississippi River/Illinois Waterway systems with a multi-disciplinary team to determine the current state of bank erosion and to attempt to discern the probable causes of the observed erosion. Based on the pertinent literature and the field inspections, Task 3 involves qualitatively assessing the relative significance of commercial navigation on existing bank erosion. If navigation effects on bank erosion could not be discerned from other causative factors, or if navigation effects were not considered significant, the bank erosion study would terminate. Otherwise, Tasks 4 and 5 would require some type of "modeling" effort to establish future conditions with and without project, based on projections of future navigation traffic growth; and

Task 6 would be a final report. This Field Survey Report addresses Tasks 2 and 3 and makes a recommendation regarding Tasks 4 and 5.

Data on bank erosion severity, location of erosion areas, and bank materials samples were gathered during the field trips. Information gathered from these selected sites was used to develop a classification system for the observed bank erosion and to identify the potential causes of erosion on these sites. Team members also agreed on the possible causes of erosion for the selected sites. During the field trip, the following tasks were completed:

- A total of 29 sites and 3 observation sites on the IWW, and a total of 43 sites and 54 observation sites on the UMR were selected and detailed field data were collected.
- Both the banklines for IWW and UMR have been mapped on navigation charts for conditions such as: severely eroded, moderately eroded, alternate erosion and stable bank, or stable banks. Information was also gathered on the presence of riprap, bank protection work, rocks, or vegetation and the location of dredge disposal material placement sites.
- At each of the selected sites, data such as bank sections, bank and core samples, land use and vegetation cover of the bank, surrounding features related to erosion, and at least one river cross section at the midpoint were collected.

The study team adapted a near-shore rework and transport model for classification utilizing three bank features: scarp, berm, and bench. Further analysis included the classification of the selected banks into more descriptive types. All the measured bank sections were divided into six erosion types for both the IWW and UMR, although different criteria were used for each river.

Analysis and presentation of data for the selected sites have been separated for the two rivers.

Illinois Waterway Summary

Information obtained from the field survey study for the IWW can be summarized as follows:

- The river widths varied from 529 to 919 feet, and the thalweg depths varied from 12 to 21 feet.

- The scarp slopes varied from about 1V:3H to 1V:.037H, berm slopes varied from 1V: 8.06H to 1V: .83H, and the bench slopes varied from 1V: 83H to 1V:1H. Scarp and bench slopes showed little variation whereas berm slopes were highly variable.
- A total of 174 bank and nearshore bed material samples were analyzed. Of the 174 samples, 93 samples were collected from the riverbanks and 81 samples were collected from core samples. Bank soils consisted of fine sand and silt within the upper portion of the waterway and become silty and clayey within the lower reach of the waterway. Almost all the bank soil samples appeared to be well graded.
- Site lengths varied from a minimum of 0.09 mile to a maximum of 0.95 miles.
- Seventeen of the sites were located on the Right Descending Bank (RDB), and 12 on the Left Descending Bank (LDB). Thirteen were located on the straight reaches of the river, 11 on the outside bank, 3 on the inside bank, and 2 on the crossover reaches. All the selected erosion sites had natural land covers. The dominant land cover on the failure face was grass or weeds. The dominant land cover on the bank crest was woody vegetation followed by agricultural crops.
- Most of the sites from the uppermost and lowermost portions of the waterway are located within the straight portion of the river. Sites selected from the outside bank are evenly distributed throughout the waterway.

Although large floods could be the most significant cause of erosion on natural rivers, this study found 27% of the selected bank sections (80 of them in 29 sites), evidenced erosion which could have occurred only at high stages. At many sites erosion features were located within the range of stage fluctuation between the Ordinary High Water and Normal Pool stages, which cannot completely be attributed to high stages. Among these bank sections causes of erosion can be described as follows. Note that multiple causes of erosion were identified for each bank profile.

- 74% of the bank sections had evidence of seepage or piping. About 26% of these banks sections had piping holes or springs; the remaining 48% had wet subaerial benches, which likely resulted from poor drainage.
- 28% of the bank sections had small scarps on the bench that could be induced by waves, piping, seepage, or a combination of these causes.
- 24% of the bank sections showed evidence of traffic-induced disturbance. These include physical damages due to direct impact by barges and undercut banklines in fleeting areas and lock approaches.
- 10% of the selected bank sections can be associated with eddy/disturbed flow induced by riparian trees or gravel.
- 11% of the bank sections showed presence of surface drainage.

- Only about 4% of the bank sections showed erosion associated with weathering of surficial soils, which could be caused by freeze/thaw processes.

The eroded bank sections were classified into six types. Their distribution is discussed in Chapter 6. A measurement of the length of "severely eroded reaches", as marked on the navigation charts (Appendix J), shows that approximately 117 miles of the IWW bankline is severely eroded. This corresponds to approximately 20% of the total bank length (both banks) of the IWW. This percentage is very similar to the percentage represented by Types 1 and 2 in the analysis.

For the flat pool reaches including Peoria, La Grange, and Alton, Types 5 or 6 banks are generally found on the upper pool (free flowing reach) where normal stage fluctuations are high. The erosion Types then gradually change to Types 3 or 4 in the middle pool (transition reach), and to either Types 3 or 4 or Types 1 or 2 in the lower reach (pooled reach) where the stage fluctuations are minimal.

Upper Mississippi River Summary

Information obtained from the field survey study for the UMR can be summarized as follows:

1. Eroded bank sections along the Mississippi River study reach (RM 0.0 at the Ohio River confluence to RM 847.6 at Lock & Dam No. 1) can be classified into six distinct types.
2. Surficial bank soils along the upper study reach consist primarily of sand and gravel; silty and sandy deposits were more frequent along the middle study reach; and clayey and silty deposits dominated the lower study reach.
3. Much of the bank erosion in the St. Paul District was found at dredged material placement locations and along Holocene-aged landscapes. Deposits in this portion of the valley are generally coarser compared to those downstream, and historical alluviation is less there compared to downstream reaches.
4. Historical deposits are thicker along the channel margin in the Rock Island District. Erosion of Holocene surfaces is most severe in the upper portion of the pools. The lower pool reaches contain progressively thicker historical deposits which cover most Holocene surfaces. The more or less continuously-constructed protective levee system has greatly focused erosional

and depositional events between the levee and channel margins. Generally thickly-bedded historical silt and very fine sand laminae dominate the near-channel alluvial sequences downstream of the Des Moines River.

5. Below St. Louis, the continuous levee and open river systems reveal even more significant historical reworking along the channel margins. Scarps more than 20 ft high, showing historical alluvial sequences, are common. In addition, the relatively small areas where the channel abuts the valley wall, which contains late Wisconsinan and Holocene hill-slope and tributary deposits, have been eroded.
6. Because of the Great Flood of 1993, most of the bank-erosion sites investigated, in particular along the middle and lower study reaches, showed such vividly apparent flood impacts that it was extremely difficult to identify any wave-induced rework and transport except at a few fleeting and mooring sites. The lower study reach downstream from the Missouri River confluence also indicated apparent flood impacts of the floods of 1994 and 1995. Major floods have occurred along the study reach at an approximate interval of 5 to 10 years; for example, the flood of 1952, the flood of 1965, the flood of 1969, the flood of 1973, the flood of 1986, and the Great Flood of 1993. Flood effects appear to be much more significant than other erosion mechanisms.
7. Based on the individual geomorphological and hydraulic site characteristics, erosion potential of traffic-induced waves was estimated for each major study site. However, there is no means to estimate the exact rate of bank erosion due to waves from this field study. As stated above, the Great Flood of '93, the flood of 1994, and the flood of 1995 had left extensive erosion scours and smeared most of the erosion evidence due to other causes.
8. Among the seventy-five sites within the UMR pools, including the observation sites, thirty-one sites were located in the upper quarter pool; twenty sites in the upper middle quarter pool; twelve sites in the lower middle quarter pool; and twelve sites were located in the lower quarter pool. This means that fifty-one of the study sites (including the observation sites) within the UMR pools were located in the upper halves of the pools where the channel is narrower and the river stage varies more frequently than in the lower portion of the pool. Stage recession after floods is also greater in the upper ends of pools, and gradients and exposed bank heights for emergent seepage are larger in upper ends of pools.

9. On the basis of the present field study, approximately 14 percent of the Mississippi River banks are estimated to be actively eroded as of 1995.

Conclusions

The site evaluations presented in Chapters 6 and 7 provide estimates as to the relative significance of navigation use effects in the context of bank erosion processes on the UMR and the IWW. Physical forces generated by navigation traffic, such as drawdown, waves, return flow, propeller jets, and disturbed local flows could also cause erosion. These forces and their effect on bank erosion may be separated from other causative processes. The study team has determined that the bank erosion caused by navigation could be significant in mooring and fleeting areas, some lock approach and waiting areas, and in some very narrow channel reaches. Since in some study sites it has been proposed that the impacts of navigation traffic may be separated from other causative factors, and in locations the navigation induced bank erosion could be identified to be significant, the study team recommends proceeding to tasks 4 and 5.

Tasks 4 and 5 of the IPMP discuss development of regression equations which will be used to predict navigation induced erosion for the with- and without- project conditions. Usefulness of such equations has been debated among the study team members. However the team agreed that the development of a generalized equation or a set of equations that can be applied to the whole UMR and IWW would not be possible considering the time constraints and the costs associated with the field experimentation at the present time. Results from this study indicate that it may be possible to conduct field experiments at individual sites which would result in an equation or set of equations which could be applied to that individual site or at an identical site to estimate the rate of erosion caused by passing navigation traffic. Development of a set of equations which could be systematically applied to the entire UMR and IWW would require field experiments to be conducted at several representative sites so that the wide variety of bank conditions which exist on these two rivers are represented in the equations.

A correlative approach, in lieu of the regression equations discussed in Task 4 and 5 of the IPMP, as described below is suggested.

Bank Erosion Impact Assessment Study for the Upper Mississippi River/Illinois Waterway

Scope of Work

1. General. The scope of work to be accomplished consists of developing a model to assess the risk of bank erosion based on site specific field data for existing conditions and future conditions for the Mississippi River and Illinois Waterway system.

2. Available Data. The following data is available: Aquatic Areas Classification, Mapping, available data on bank erosion field survey, environmental and cultural resources, and GIS mapping/ database.

3. Develop correlations between apparent navigation induced erosion and physical parameters such as proximity to narrow channel reaches, locks, and mooring/fleeting activities, soil and sediment characteristics, land uses, etc. These correlations will be developed from data collected at the 72 detailed study sites during the 1995 bank erosion field study. In order to accomplish this task, the study team will develop a database for relevant physical parameters that were collected during the 1995 field study for both the Illinois Waterway and the Upper Mississippi River. This database is partially available in an EXCEL spreadsheet format with the remainder being in ARCINFO-GIS format. The study team will combine these two databases using Microsoft ACCESS so that any correlations between individual variables can be easily sought in a systematic manner. The study team will seek, beyond 72 detailed sites, additional data from the observation sites, the Navigation Chart Mapping, aerial video descriptions that could help increase the accuracy of the field data. Attributes to be considered for river banks and navigation traffic would include (but are not limited to) the following:

River Attributes

1. Geomorphic characteristics (inside bend/outside bend/cross over/island) – radius of curvature of bend
2. Channel width
3. Relative location of thalweg sailing line
4. Fetch length and average wind direction within fetch length/river-bank orientation
5. Closeness to flow-control structures
6. Nature of bank (natural/revetment/dredge material/etc.)
7. Bench width
8. Bench slope
9. Bench soil characteristics
10. Subaqueous lateral bed slope
11. Width of vegetation coverage on bench

12. Relative location of water edge on bench at predominant river stage
13. Relative location of erosion site with respect to Lock & Dam
14. Scarp height
15. Scarp slope
16. Bank soil characteristics
17. Bank face coverage (tree roots/vegetation/etc.)
18. Land use (farms/woods/industrial/etc.) and soil characteristics
19. Background features (closeness to lakes/wetlands/etc.)

Traffic Attributes

1. Locate major industries related to barge traffic (power plant/oil refinery/etc.)
2. Barge/leisure boats traffic records along rivers
3. Mooring activities
4. Traffic during high stages (connect with Item 10 above)
5. Tow/barge size (vary along river reach)
6. Drawdown, waves, return flow, propeller jets, and altered local shear stresses

This risk assessment study team, consisting of selected members of the Field Survey study team supplemented with experts in the ecological risk assessment field, will develop models to assess the risk of bank erosion, which is directly related to the increase in commercial navigation and recreation traffic. The study team will determine — based upon the data correlations for the Illinois and Mississippi rivers — if the river systems should be modeled separately or together. This model will be used to model the existing conditions (1992 commercial navigation traffic), the baseline conditions, and the future conditions without project.

The risk assessment study team using these correlations along with 1995 erosion mapping of both rivers, the Aquatic Areas Classification Mapping and existing resource mapping, will attempt to predict areas of adverse impacts where a measurable increase in navigation induced erosion will likely occur with increases in navigation traffic levels. Bank reaches will be classified as low, medium, and high risk areas for navigation induced erosion. The study team will identify and characterize the key assumptions and uncertainties associated with the development of the bank erosion model. Considering these assumptions and uncertainties, the study team will develop the model in a manner consistent with the fundamental concepts and methods of probabilistic risk estimation and assessment.

GLOSSARY

Accretion - The process of building by accumulation.

Alluvium - The general name for all sediments deposited on the and surface by streams.

Anthropic - A diagnostic surface layer of soil, about one foot in thickness, in which the content of soluble P_2O_5 is greater than 250 ppm. It develops due to long periods of cultivation and fertilization.

Aquatic - Those organisms (plant and animal) that live in the water.

Aquifer - Stream or zone below the surface of the earth capable of producing water.

Archaeology - Relates to occupation sites, work areas, evidence of farming or hunting and gathering, burial sites, artifacts, and structures of all types, usually dating from prehistoric or aboriginal periods, or from historic periods and non-aboriginal activities for which only vestiges remain.

Bank - Topographic feature which, together with the bed, defines the stream channel and may include scarp, berm, and bench areas indicative of failure and erosion processes.

Bank Erosion - Erosion in which the ground bordering a stream and serving to confine the water to the natural channel during normal course of flow is removed.

Bed - A stratum one centimeter or more thick. Also, the floor of a stream channel.

Bedrock - Continuous solid rock that underlies weathered rock in soil everywhere and in a particular spot forms the consolidated portion of the earth's surface.

Bench - The relatively mild slope that occurs riverward of the scarp and berm. This mildly sloping area generally is visible at normal pool levels and in many areas extends a considerable distance riverward of the land-water contact at normal pool. The visible portion of the bench is termed "subaerial bench" and the underwater portion is termed the "subaqueous bench".

Berm - Failed soils that accumulate at the base of the scarp at a failed or eroded bank, generally resulting in a wedge shaped failed soil deposit.

Calcareous - Soils or water containing calcium carbonate ($CaCO_3$).

Canopy - The uppermost leafy cover in a forest.

Channel Erosion - Erosion in which material is removed by water flowing in well-defined channels; erosion caused by channel flow.

Chute Cutoff - A new channel cut across a point bar, producing the abandonment of part of a meander.

Clay - As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay skins - A modification of the texture, structure, or fabric of a soil material consisting of a coating of clay minerals on the surface of a ped or the wall of a void in a soil mineral.

Cleft Pressures - Pressures caused by a sudden cut, breach, or other sharp opening such as a wave-cut gully in a cliff.

Cohesion - In general, an electrostatic force of attraction among fine soil particles. In soil mechanics, the term "cohesion" refers to that portion of the resistance to shearing deformation possessed by a soil, which is not due to friction between particles or to the physical interference of one particle with another in resisting shearing movements.

Colluvium - Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposits at the base of steep slopes.

Concretion - A hard, compact rounded, normally subspherical mass or aggregate of mineral matter generally formed by orderly and localized precipitation from aqueous solution in the pores of a sedimentary or fragmental volcanic rock and usually of a composition widely different from that of the rock in which it is found and from which it is rather sharply separated. It represents a concentration of some minor constituent or of cementing material such as silica, calcite, dolomite, iron oxide, pyrite, or gypsum, and is characterized by concentric shells of slightly varying properties due to variation during growth.

Confluence - The place of meeting of two streams.

Consistence, Soil - The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:
Loose - Noncoherent; will not hold together in a mass.
Friable - When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm - When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic - When wet, readily deformed by moderate pressure, but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky - When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.
Hard - When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft - When dry, breaks into powder or individual grains under very slight pressure.
Cemented - Hard and brittle, little affected by moistening.

Creep - The imperceptibly slow downslope movement of weathered rock and soil materials. This term is interchangeable with solidification in general usage.

Cubic Feet per Second (cfs) - Commonly reported unit of measurement for the rate of flow of water in the U.S.

Cycle of Erosion - The sequence of landforms, essentially valleys and hills, through which a land mass is considered to evolve from the time it begins to be eroded until it is reduced to an equilibrium condition.

Datum - A reference element, such as a line or plane, in relation to which the position of other elements are determines. Also called the "reference plane" or "datum plane".

Debris Flow - The rapid downslope plastic flow of a mass of debris.

Discharge - The quantity of water passing a given point in a given unit if time.

Drawdown - The difference in elevation between the water surface elevation at a constriction and what the elevation would be if there were no constriction.

Dredge Materials - Sediments obtained from dredging.

Dredging Maintenance - Removal of material from the river channel, locks, and approaches to the locks.

Ecosystem - Any unit that includes all of the organisms (the community) in a given area interrelated with the physical environment.

Elevation - The vertical distance from the datum, usually mean sea level (msl), to a point or object on the earth's surface.

Eluviation - The downward movement of soluble or suspended material in a soil, from the A horizon to the B horizon, by groundwater percolation. The term refers especially, but not exclusively, to the movement of colloids, whereas the term leaching refers to the complete removal of soluble materials.

Environment - All the conditions, circumstances, and influences surrounding and affecting the development of an organism or group of organisms.

Eolian - Windblown transport of sediment.

Erosion - A general term that describes the physical breaking-down, chemical solution, and movement of rock fragments and soils from place to place on the surface of the earth.

Frost Heaving - The lifting of soil or rock materials by expansion of ice during freezing of water contained within the soil or rock mass.

Frost Wedging - The mechanism involving the pushing-up or apart of rock particles by the action of the ice.

Geologic Time Scale -

Era	Period	Approx. # of years ago
Cenozoic	Quarternary	1 Million
	Tertiary	60 Million
Mesozoic	Cretaceous	130 Million
	Jurassic	165 Million
	Triassic	195 Million
Paleozoic	Permian	220 Million
	Pennsylvanian	240 Million
	Mississippian	260 Million
	Devonian	320 Million
	Silurian	360 Million
	Ordovician	430 Million
	Cambrian	510 Million
Precambrian Eras		3 Billion

Geology - The science dealing with the structure if the earth's crust and the formation and development of its various layers. It includes the study of individual rock types and early forms of life found as fossils in rocks.

Glaciation - The alternation of a land surface movement of glacier ice.

Groundcover - The lowermost vegetational zone.

Groundwater - That water beneath the earth's surface which is contained in the pore spaces within the soil and bedrock. (In this connection, geologists frequently refer to water within the regolith, meaning that water contained within the bedrock and overlying weathered rock materials, but not the water contained within the uppermost soil layers which support plant growth.)

Habitat - A place where a given species lives, generally the kind of place rather than a geographic location.

Historical - References to features generally consisting of post European structures or sites which are relevant to an event, person, or period specifically commemorative to previous generations.

Holocene - An epoch of the Quaternary period, from the end of the Pleistocene (0.01 million years before present) to the present time: also, the corresponding series of rocks and deposits.

Horizon, Soil - A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Hydrograph - A graph showing, for a given point on a stream, the discharge, stage, velocity, or other property of water with respect to time.

Hydrology - A science dealing with the properties, distribution, and circulation of water on the surface of land, in the soil, and underlying rocks, and in the atmosphere.

Kansan, Pre Illinoian - Older studies suggested two early Pleistocene glacial advances, the Nebraskan and Kansan. More recent work by the Iowa Geological Survey suggests many more early glacial advances and retreats. They suggest using the term Pre-Illinoian for the early Pleistocene events. Generally referred to as about 500,000 year ago and older. Following the Pre-Illinois is the **Yarmouth interglacial**. At about 225,000 years ago is the **Illinoian glacial stage**. Following the Illinoian is the **Sangamon interglacial stage**. The Sangamon continues to about 60,000 years ago and is followed by the **Wisconsinan**.

Leaching - The removal in solution of the more soluble minerals by percolating waters.

Levee: Natural - A broad, low ridge of fine alluvium built along the side of a stream channel by water spreading out if the channel during floods.

Liquefaction - A term utilized in soil mechanics to describe the loss of shearing resistance in a cohesionless material caused by vibration or shock loading and the consequent decrease in friction and interference between individual particles within the mass of soil. In such an instance, the granular soil will flow like a viscous fluid.

Load: Bed - The coarse solid particles, within a body of flowing fluid, moving along or close above the bed.

Load: Suspended - The fine solid particles turbulently suspended within a body of flowing fluid.

Loess - A type of soil composed of finely graded, wind-blown, silt-sized angular particles which are frequently cemented. Loess soils are frequently deep and appear homogeneous for most of their depth.

Map, Topographic - A map showing correct horizontal and vertical positions of features represented.

Mass-Wasting The movement of rock debris downslope under the influence of gravity, without the aid of a flowing medium to assist transport (air at ordinary pressure, water, or glacial ice).

Meander - A loop like bend of a stream channel.

Mesozoic - See Geologic Time Scale.

Morphology, Soil - The physical constitution of the soil expressed in the kinds of horizons, their thickness and arrangement in the profile, and their color, texture, structure, consistence, and chemical and biological properties.

Mottling, Soil - Irregular spots or patches of different colors, usually indicating poor aeration and lack of drainage. The pattern of mottles is described as to abundance, size, and contrast. Descriptive terms are as follows:

Abundance - few, common, and many.
Size - fine, medium, and coarse.
Contrast - faint, distinct, and prominent.
The size measurements are these:
Fine - less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension
Medium - 5 to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension;
Coarse - more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Native soils - Soils or group of soils that are restricted to a particular region or environment.

Natural Drainage - Refers to the condition that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation, but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural drainage are recognized.

- *Excessively drained soils* are commonly very porous and rapidly permeable and have a low water-holding capacity.
- *Somewhat excessively drained soils* are also very permeable and are free from mottling throughout their profile.
- *Well-drained soils* are nearly free from mottling and are commonly of intermediate texture.
- *Moderately well drained soils* commonly have a slowly permeable layer in or immediately beneath the solemn. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.
- *Imperfectly or somewhat poorly drained soils* are wet for significant periods, but not all the time, podzolic soils that are somewhat poorly drained commonly have mottling in the lower part of the A horizon and in the B and C horizons (at a depth below 6 to 16 inches).
- *Poorly drained soils* are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly absent in some.
- Very poorly drained soils are wet nearly all the time. They have a dark gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Ordinary High Water - That elevation on the river bank which defines river dominance.

Overburden - Materials of any nature, consolidated or unconsolidated, that overlie inplace rock or a deposit of ores, or coal, especially those deposits that are mined from the surface by open cuts.

Paleosol - A buried soil horizon of the geologic past. When uncovered, it is said to be exhumed.

Parent Material (Soil) - The horizon of weathered rock or partly weathered soil material from which soil has formed; C horizon in the soil profile.

Pastureland - Land covered with grass or herbage suitable for grazing livestock.

Ped - A naturally formed unit of soil structure, e.g. granule, block, crumb, aggregrate.

Pedogenic - Pertaining to soil formation.

Pennsylvanian - The sixth system and period of the Paleozoic era; contains units younger than Mississippian, older than Permian.

Period - Unit of geologic time.

Piping - That mode of failure in soil masses which is produced by the removal of a grain of soil at the surface of the soil mass by water flowing from within the mass, with a progressive removal of other particles to form a conduit or pipe into the interior of the soil mass, with subsequent collapse of the mass after creation of this conduit or pipe.

Plant Community - The association of all the plants which are found living together in specific environmental situations.

Pleistocene - The earlier of the two epochs of the Quarternary period, also called Glacial epoch and formerly called Ice Age. The Ice Age occurred during the Pleistocene epoch which began about 1,000,000 years ago.

Point Bar - A crescent-shaped bar built out from each convex (inside) bank of a stream channel.

Profile, Soil - A vertical section of a soil through all of its horizons and extending into the parent material.

Relief - The elevations or inequalities of the land surface, considered collectively.

Rework and Transport_- Removal and displacement of material by natural agents from its place of origin. Carried by flowing water and redeposited in another locality.

Riparian - Relating to, or living on, the bank of a river.

Runoff - Term referring to that rainwater which actually reaches a stream after losses from infiltration, transpiration, and evaporation.

Sailing Line - The line actually navigated - not necessarily the center of channel.

Sample, Disturbed - A soil sample containing all the constituents of a particular stratum, but the original soil sample has been altered.

Sample, Undisturbed - As above, but the original soil structure has been maintained.

Sand - As a soil separate, individual rock or mineral fragments from .05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand may be of any mineral composition. As a textural class, soil material that is 85 percent or more sand and not more than 10 percent clay.

Scarp - The generally steeply sloping, and many times near vertical portion of an eroding or failed bank which is located landward of the bench and berm, extending to the top of the bank.

Sediment - Rock or soil material that has been transported and deposited by water, air, or ice.

Sedimentation - The settling of solids, such as soil particles, by gravity.

Silt - As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil material that is 80 percent or more silt and less than 12 percent clay.

Siltation - The deposition of finely divided soil particles.

Slaking - The crumbling and disintegration of the earth materials upon exposure to air or moisture: specifically the breaking up of dried clay or indurated soil when saturated with or immersed in water.

Slip and Failure - Actual relative movement of a material that has been stressed beyond its ultimate strength.

Soil - A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.

Spoil - See 'Dredge Materials'.

Stage, River - The height of water surface of a stream above some referenced datum.

Stratum - A definite layer of rock or soil consisting of material that has been out upon the surface of the earth.

Stream Terrace - A bench along the side of a valley, the upper surface of which was formerly the alluvial floor of the valley.

Stress - Force per unit area.

Stress: Shearing - A stress causing parts of a solid to slip past one another, like playing cards in a pack.

Structure, Soil - The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an angel mass of unaggregated and have properties unlike those of an equal mass of unaggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principle forms of soil structure are: Platy (laminated); Prismatic (vertical axis of aggregates longer than horizontal); Columnar (prisms with rounded tops); Blocky (angular or subangular); and Granular. Structureless soils are (1) single grain (each grain by itself, as in dune sand) or (2) Massive (the particles adhering without any regular cleavage, as in many claypans and hardpans).

Subaerial - Occurring beneath the atmosphere or in the open air; especially said of conditions and processes that exist or operate on or immediately adjacent to the land surface, or of features and materials that are formed or situated on the land surface.

Subsoil - Technically, the B horizon; commonly, that part of the profile below plow depth.

Substrate - The material which makes up the bottom of a stream or the surface to which living organisms attach themselves.

Substratum - Any larger beneath the solum, or true soil; applied to both parent material and other layers unlike the parent material below the B horizon.

Surcharge - An additional excessive burden: overload.

Surface Runoff - The water that flows off the land surface.

Surface Layer - The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness.

Swash - A narrow sound or secondary channel of water lying within a sandbank or between a sandbank and the shore.

Terrace - An embankment or ridge constructed across sloping soils on the contour or at a slight angle to the contour. A terrace intercepts surface runoff so that it will soak into the soil or flow slowly to a prepared outlet without harm.

Terrace (Geological) - An old alluvial plain, usually flat or undulating, bordering a stream; frequently called a second bottom, as contrasted to a first bottom or flood plain; seldom subject to overflow.

Terrestrial - Those organisms (plants and animals) that live on land.

Thalweg - the line joining the deepest points of a stream channel.

Topsoil - A presumed fertile soil or soil material, generally rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Turbidity - A measure of the clouded or muddy appearance of water. (See JTU).

UTM - Universal Transverse Meridian. The grid system in which the earth is mapped and divided into coordinates.

Water Table - The upper surface of the zone of water saturation in soil or rock masses.

Weathering - The chemical alteration and mechanical breakdown of rock materials during exposure to air, moisture, and organic matter, as well as changing temperatures.

Wisconsinan - The uppermost Pleistocene stage in Illinois and Wisconsin. Pertaining to the last glacial stage of the Pleistocene Epoch in North America, following the Sangamon interglacial stage. It began about 85,000+/- 15,000 years ago and ended about 7,000 years ago.

Appendix A.

Upper Mississippi River System Navigation/Sedimentation Study -- Report 1 Bank Erosion Literature Study (A separate report; WES Technical Report HL-96-10, available at Rock Island District, U.S. Army Corps of Engineers)

Technical Report HL-96-10
August 1996

Upper Mississippi River System Navigation/Sedimentation Study

Report 1
Bank Erosion Literature Study

by Stephen T. Maynord, Sandra K. Martin

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Report 1 of a series

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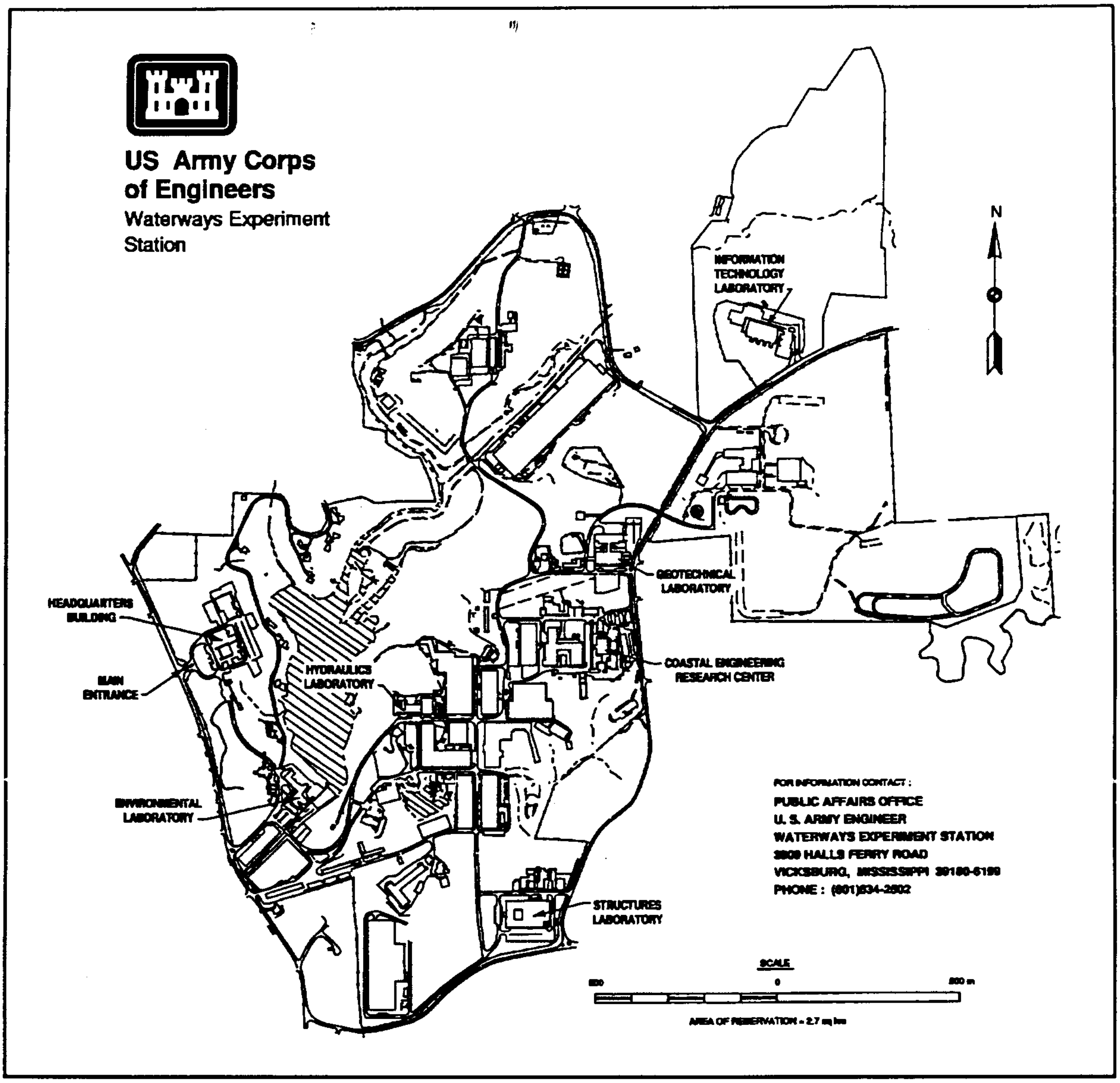

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Contents

Preface

The work described in this report was sponsored by the U.S. Army Engineer Districts of Rock Island, St. Louis, and St. Paul as part of the Environmental Plan of the Upper Mississippi River-Illinois Waterway System Navigation Feasibility Study.

The work was performed by personnel of the Hydraulics Laboratory (HL), U.S. Army Engineer Waterways Experiment Station (WES), during the period 1994-1995. The study was accomplished under the direction of Mr. Frank A. Herrmann, Jr., Director, HL; Mr. Richard A. Sager, Assistant Director, HL; and Dr. Larry L. Daggett, Acting Chief of the Navigation Division (HN), HL. The study was conducted by Dr. Stephen T. Maynord and Ms. Sandra K. Martin, both of the Navigation Effects Group, HN. This report was written by Dr. Maynord and Ms. Martin.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

1 Introduction

Historical Perspective

Many of the geomorphic and ecological changes in the Upper Mississippi River System (UMRS) parallel the history of navigation developments. The UMRS includes the main stem Mississippi River above Cairo, IL, and the Illinois River (Figure 1). The navigability of the river has attracted settlers and development since the 1700's. By the late 1800's the U.S. Army Corps of Engineers had conducted sufficient channel improvement measures to encourage the regular navigation of the system by steamboats. Coupled with these activities, agricultural practices and lumbering activities (which peaked in the late 1800's) greatly affected the watershed erosion. According to Fremling and Claflin (1993) these activities can be "shown to have serious detrimental effects on the river system 100-yr later." Man's influences on the ecology of the river were observed as early as 1870 when fisheries resources rapidly declined (Fremling and Claflin 1993).

The Rivers and Harbors Acts of 1878 funded and authorized the Corps to maintain a 1.4-m (4.5-ft) channel, and in 1907 this authorization increased to 1.8 m (6 ft). This was accomplished by channel improvements including wing dams, dredging, channel alignment, closure of side channels and backwaters, and channel revetments. Many of these features are still evident today. During the depression of the 1930's the 2.7-m (9-ft) channel was authorized, and thus the lock and dam system was born. By 1940 the Upper Mississippi had 26 locks in place while the Illinois River had 7 locks.

While the actual ecological benefits or disadvantages from this navigation system, particularly the impoundments, are widely debated (and not the subject of this report), it is important to discuss at least some features of the system considered by some resource agencies to have detrimental effects on the ecology of the river. The first regards the operation of the system to maintain water levels as constant as possible to facilitate navigation, particularly during low-flow periods. This change in the regime could reduce the potential for bank erosion in areas where the energy potential has been lowered (for instance in the pools). On the other hand, the removal of the stage change during low to moderate discharge periods not only changes the river's hydraulic regime,

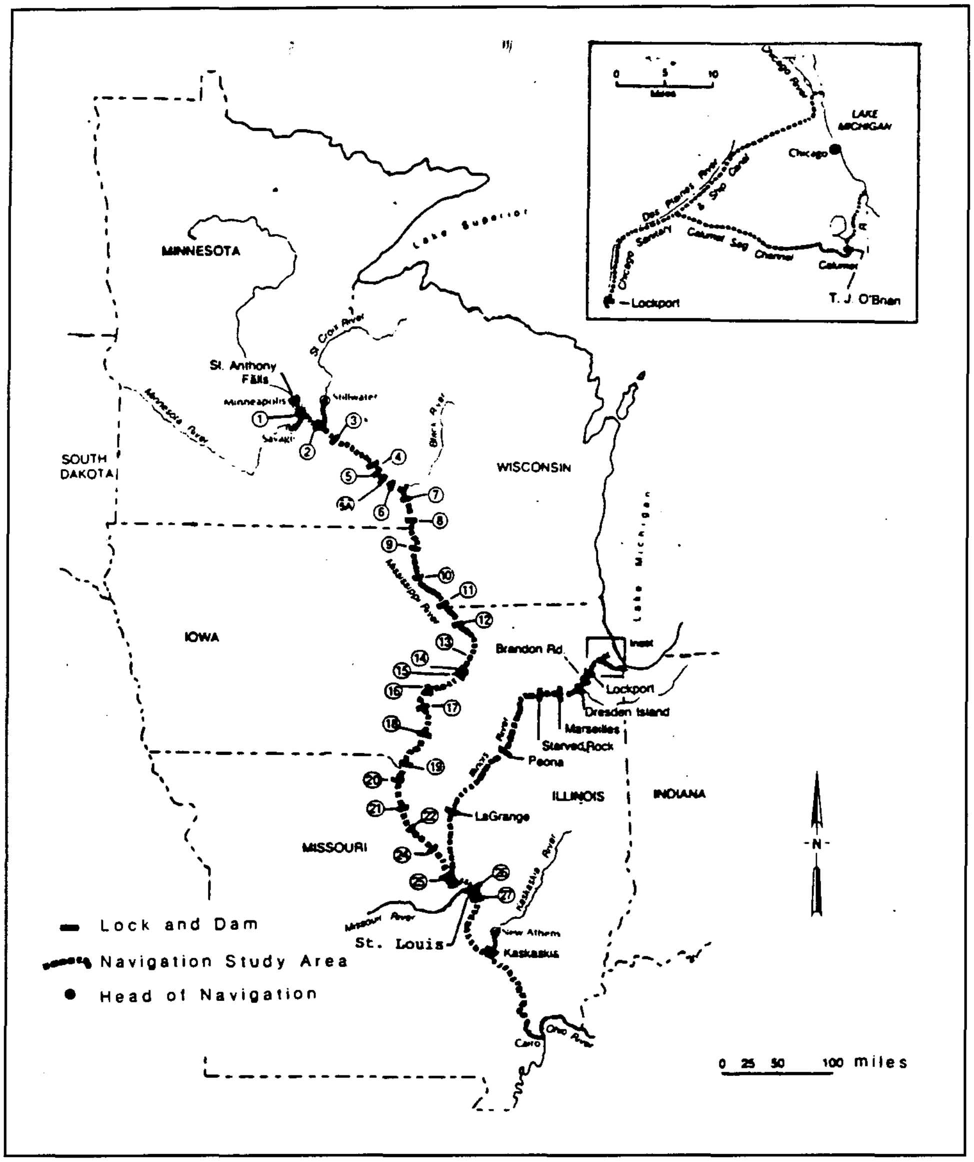

Figure 1. Location map of the UMRS

but also changes the ecological health of the system by reducing organic and nutrient cycling, reducing rate of oxidation in sediments, increasing rates of eutrophication, and permanently inundating areas that ultimately evolve through sedimentation to terrestrial habitats (Lubinski 1993; Fremling and Claflin 1993).

Even though the hydraulic energy may be lower during some hydrologic events, the actual length of shoreline exposed to periodic wetting and drying has increased as a result of permanent inundation of areas in the floodplain. From a habitat standpoint, an increase in shoreline is generally positive. However, a potential impact of this inundation could be the exposure of cultural (archeological or historical) resource sites to frequent hydraulic forces such as wind waves that had previously had only infrequent exposure to flooding.

Another attribute of the impounded system is the accumulation of sediments in ecologically sensitive aquatic areas. The original impoundment by itself would account for the greatest portion of the accretions due to the lower velocities and higher trap efficiencies of the dams. **Continued** accumulation of sediments in certain areas of the system would imply that materials must be generated from one of two basic sources: either they are introduced in the system through tributaries and upland erosion (sources outside the floodplain), or they are generated from bed sediments and bank materials (sources within the floodplain). Therefore, identification of bank erosion processes and their probable contribution to the system as a source of sediments are important to quantify.

Increasing levels of traffic and predictions of further increases have caused evaluation of upgrades to the existing system through repair, rehabilitation, or replacement of certain features. Studies considering lock rehabilitation or replacement alternatives require accurate projection of the size and power of future tows and traffic, and give careful consideration to the environment from both a local and system level (Armstrong et al. 1985) The Melvin Price replacement lock and dam was the first project completed on this system. The new lock and dam structure upgraded the existing lock capacity at Lock and Dam 26 from 182.9- and 109.7-m (600- and 360-ft) chambers to 365.8- and 182.9-m (1,200- and 600-ft) chambers. Use of the UMRS by recreational vessels has also increased significantly. The impacts of existing and projected levels of commercial and recreational traffic on bank erosion in the UMRS are important to determine.

Impacts of Bank Erosion

Bank erosion leads to the loss of cropland, forest, pasture, residential and municipal areas, wetlands, and riparian zones. The land that is lost may be replaced by land that will have value as habitat for a variety of organisms but may not be suitable for the aforementioned human uses for some time. Suspended sediment from bank erosion and other sources can increase water treatment costs and adversely affect the operating life of machinery, shellfish quality, recreational use, and aesthetic qualities (U.S. Army Corps of Engineers (USACE) 1981a, 1981b). Dredging is often necessary to remove accumulated sediment to maintain adequate harbor and waterway depths. Deposited sediment reduces fish habitat and depletes reservoir storage. Chemical compounds residing in banks may adversely affect water quality once entrained by bank erosion. Bank erosion undermines trees and brush, which can clog channels and adversely affect navigation, hydropower, and other hydraulic structures in the river environment. Boszhardt and Overstreet (1981) report on a workshop whose participants concluded that of the various navigational factors impacting on the cultural resources on the UMRS, bank erosion was the most serious. Sing (1986) used a sediment budget on the Sacramento River and determined that "bank eroded material contributes 60 percent, or 7.5 million tons per year, of the total sediment inflow of 12.7 million tons per year into the river system. Much of this eroded material is carried down through the river system and deposits into the flood control bypasses and downstream navigation channels."

The positive side of bank erosion lies in a natural system being able to meander freely across its floodplain through the processes of bank erosion and deposition. Meandering produces new habitats, marshes, and backwaters. If bank erosion is halted, no new marshes, habitats, or backwaters are created. On the UMRS, the channelization and dam construction of the 1900's-1930's has significantly reduced the rate of production of new habitats and the old marshes, habitats, and backwaters are being lost to sedimentation.

UMRS Bank Erosion Scope of Work

As a part of the environmental effort of the Upper Mississippi-Illinois Waterway Navigation Feasibility Study, the scope of a bank erosion study was described in the Initial Project Management Plan. It was determined that changes in the shoreline as a result of bank erosion could impact the riparian habitat of fish and wildlife and cultural resources along the shoreline. It is also important to understand these processes as they relate to the potential loss of land and its effect on property ownership, structural integrity, etc. Therefore, the study proposes an investigation into the extent of existing bank erosion, the probable processes that cause bank erosion, and the potential for further bank erosion, particularly as related to navigation traffic.

Basically six tasks were identified for this effort with a decision point after Task 3. Task 1, to which this report is devoted, was to conduct a literature search with the goal of identifying applicable and available references for use in decision making in the other tasks. Task 2 would conduct a systemwide inspection of the UMRS with a multidisciplinary team not only to quantify the present amount of bank erosion, but also to attempt to discern the probable cause of the erosion. Based on the pertinent literature and the field inspections, Task 3 involves qualitatively assessing the relative significance of commercial navigation on existing bank erosion. At this point, if navigation effects on bank erosion cannot be discerned from other causes, or navigation effects are not considered significant, the bank erosion study would terminate. Otherwise, Tasks 4 and 5 would require some type of "modeling" effort to establish with- and without-project future conditions; and Task 6 would be a final report.

Objective of This Study

The U.S. Army Engineer Waterways Experiment Station (WES) was asked to participate in Task 1, the literature search. The scope of work is as follows: "Obtain available pertinent data, research, and opinions regarding the process of bank erosion along the Upper Mississippi River and Illinois Waterway. Since erosion is a function of flow velocity, flow quantity, secondary currents, bank materials and covers, as well as wave energy from wind and navigation, all of these factors will be included in the literature search. Differentiation will be made between recreational and commercial navigation impacts. Reference material will be obtained with the goal of establishing the relative significance of each factor in the process of bank erosion."

Chapter 2 describes of all pertinent erosion mechanisms and causes expected to occur on the UMRS other than those related to navigation. No attempt was made to obtain every reference on the non-navigation processes, but every reference pertaining to non-navigation processes on the UMRS was documented. In Chapter 3, references pertinent to the extent of existing erosion on the UMRS were summarized. Chapter 4 includes a summary of each reference relevant to navigation processes. Of particular emphasis were studies on similar large alluvial rivers having navigation. Chapter 5 presents available bank erosion models which are also needed by the Recreational Boating Study, which is part of the UMRS Feasibility Study environmental plan. Chapter 6 identifies the dominant mechanisms and causes on the UMRS.

This report addresses bank erosion on only the main stem Illinois and Upper Mississippi Rivers.

2 Bank Erosion Mechanisms and Causes

Bank erosion is defined as loss of bank material from both fluvial processes in the channel as well as internal failure processes that occur within the bank. Lawson (1985) makes a useful distinction between erosion and recession. Erosion is a mass concept involving removal of a certain volume of material. Recession (or retreat in other references) is a geometric concept that involves the landward displacement of the waterline.

In this investigation, bank erosion mechanisms are different from bank erosion causes. Mechanisms are the processes by which bank material is lost. Bank erosion causes are the immediate action or event that led to the occurrence of the bank erosion mechanism. For example, the mechanism of piping loss of bank material could be caused by poor overbank drainage, overbank ponds or lakes, or water level variation due to flood flows. The mechanism of tractive force loss of bank material can be caused by a variety of events such as floods, propeller jets, flow concentration caused by failed vegetation, or breakup of an ice jam.

In USACE (1981a, 1981b) and Allen and Tingle (1993), erosion is classified as either natural or accelerated. Natural erosion occurs as a result of time-dependent climatic or geologic factors. Stream meandering and piping erosion resulting from recharge of the bank by flood flows are examples of natural erosion. Accelerated erosion occurs as a result of human actions or possibly atypical natural occurrences. Erosion resulting from increased discharge after urbanization of a watershed and piping erosion resulting from recharge of the bank by septic tanks or man-made overbank ponds are examples of accelerated erosion. The distinction can be quite important because landowners have filed claims against other parties alleging causation of accelerated erosion (U.S. Army Engineer Division, Ohio River, 1977).

The UMRS has been significantly altered by man, and any evaluation of bank erosion causes and mechanisms must consider the impact of these changes. At low flow, the UMRS is a series of impoundments separated by river reaches. The UMRS impoundments differ from typical reservoirs because the UMRS impoundments are shallow, limiting wave heights and reducing their ability to trap sediments. As flows increase, most of the navigation dams have less and less effect on the flow profiles and the system begins to look like a river over most of its length. Therefore, this chapter addresses both bank erosion causes and mechanisms in river environments as well as in impoundments. Simons and Li (1982) categorized erosion forces as

a. Those which have their major impact at the water surface.

b. Those which act with greatest intensity near the base of the submerged bank.

Impoundments generally follow the first category whereas river environments generally have both categories.

Lawler (1992) discussed the possibility that bank erosion is a supply-limited rather than a transport-limited process. Walling and Webb (1981) discussed a suspended sediment exhaustion effect. They presented a suspended sediment and streamflow hydrograph showing a double peak storm runoff with a corresponding single peak in sediment concentration. One possibility to be drawn from this is that previous floods not only decrease bank strength by factors such as saturation, but also increase the sediment scouring potential of subsequent floods by depleting the available supply of sediment.

Bank Soil Type and Stratigraphy

As reported in Hagerty, Sharifounnasab, and Spoor (1983), "The severity of erosional loss appeared to depend principally on the bank materials; sandy banks retreated farthest in the study." Banks that are predominantly cohesive can often resist surface erosion from intense attack by waves or currents. However, they can easily be failed by internal mechanisms (discussed in the following section) related to the layering of the bank soils. Layered streambanks are common in alluvial channels like the UMRS.

Geologic and Geomorphic Considerations

Schumm and Thorne (1989) stated that "[the Mississippi River drains] from areas that were subjected to continental glaciation and the valley alluvium will contain glacial outwash sediments that can be very different from the modern alluvium. The fine sands, silts, and clays deposited by the modern Mississippi River overlies [sic] coarse sand and gravel. The less cohesive older alluvium is more readily eroded, where exposed in bed and banks. However the older alluvium contains cobbles and boulders that can armor the channel thereby preventing the bed scour which is associated with bank erosion....[The] geologic history can have a significant effect on modern bank erosion." Nielsen, Rada, and Smart (1984) provided a geomorphic description of the UMRS basin and observed that "it has become apparent that many of the sedimentation problems of the Mississippi River are linked to the inability of the River to effectively remove all the sediment supplied by its tributaries. The main channel has adapted to an oversupply of sediment by becoming wider and more shallow." Overloading of coarse-grained sediments from tributaries is the cause of the island braided pattern of the UMRS. Nielsen, Rada, and Smart (1984) referenced Lane (1957), who suggested that the Mississippi River has not yet reached grade and is still responding to postglacial conditions, thus causing the overloading. According to Lubinski (1993), while the UMRS was aggrading during presettlement times, "land use changes, stream channelization designed to transport water rapidly off the basin, and the construction of dams have greatly accelerated the aggradation rate. The Illinois River has been impacted more by sedimentation than the Mississippi River because of its shallower gradient." A detailed description of the geologic history of the UMRS is provided in Fremling, Gray, and Nielsen (1973) and Church (1984).

Lubinski (1993) described a classification of the UMRS that may be useful in explaining or understanding the relative occurrence of bank erosion. On the UMRS three reaches are described as follows:

a. From Minneapolis, MN, to Clinton, IA, encompassing Pools 1-13. This reach is characterized by large areas of off-channel water, large acreages of aquatic vegetation, and few agricultural levees.

b. From Clinton, IA, to Missouri River encompassing Pools 14-26. This reach is characterized by a high proportion of water in channels, limited aquatic vegetation, and a moderate amount of land in agricultural levees.

c. From the Missouri River to Ohio River, an open river reach. This reach is characterized by a high proportion of water in channels, almost no aquatic vegetation, and extensive levees.

Lubinski divides the Illinois River into the following two reaches:

a. The confluence of Kankakee and Des Plaines Rivers to Hennepin, IL. It passes through a young geologic valley and has a relatively high gradient, narrow floodplain, and three navigation dams.

b. From Hennepin, IL, to Mississippi River. It is geologically older and wider than the upper reach. It was used by the Mississippi River before recent glacial activity redirected the Mississippi westward. It has a very shallow gradient, extensive levees, and two navigation dams.

Bank Erosion Mechanisms

Bank erosion mechanisms were classified in USACE (1981a, 1981b) as follows:

a. Mechanisms that cause displacement of soil particles from the bank surface.

b. Mechanisms that destabilize the internal structure of the bank and fail blocks or entire segments of the bank.

c. Mechanisms that transport the displaced soil particles or failed soil blocks away from the bank. Unless the stream is capable of removing the displaced soil particles or the failed soil blocks, the bank will tend toward a stable or aggrading condition. This concept is called basal end point control and is presented in Thorne, Reed, and Doornkamp[1] and discussed subsequently.

Tables 1, 2, and 3 describe individual mechanisms under these three categories based on USACE (1981a, 1981b).

An alternate classification system presented by Thorne, Reed, and Doornkamp[1] is as follows:

a. Erosion processes, which detach, entrain, and transport individual particles or assemblages of particles away from the bank. This category includes fluvial entrainment, waves, surface erosion, piping, and freeze/thaw.

b. Failure mechanisms, which lead to collapse of all or part of a bank. This category includes soil fall, shallow slide, rotational slip, slab type failure, cantilever failure, dry granular flow, and liquefaction.

c. Weakening processes, which operate on and within the bank to increase its erodibility and to reduce its geotechnical stability. This category includes leaching, trampling, destruction of vegetation, mechanical damage, positive pore-water pressures, and desiccation.

Reid (1993) categorizes factors controlling bank recession as either activating or passive. Activating factors are those that trigger erosion such as waves, runoff, groundwater discharge, and freeze-thaw, etc. Passive factors are properties of the bank material or bank geometry that cause the bank to be relatively susceptible to activating factors. Passive factors exist all or most of the time

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[1] Colin R. Thorne, Sue Reed, and John C. Doornkamp. (1993). "Bank erosion on navigable waterways," Draft R&D Report 336/1/T, National Rivers Authority, Almondsbury, Bristol.

Table 1
Soil Particle Displacement Mechanisms

Mechanism	Description
Abrasion by ice and debris	Ice and debris carried by flowing water dislodge surface soil particles.
Biological	Bank surface destruction by animal movement and overgrazing. Tree falls or vegetation patterns that concentrate streamflow attack.
Chemical	Water chemistry affects cohesive and other types of particle-to-particle bonding.
Flow velocity or tractive forces	Soil displacement by tractive forces is a major cause of soil particle displacement. Many factors affect rate of displacement including magnitude of tractive force, turbulence level, bank soil characteristics, etc.
Freeze-thaw	Cyclic temperature changes cause fracture due to excessive contraction and expansion and spalling due to successive freezing and thawing of moisture within the bank.
Gravity	The stable slope of a cohesionless bank corresponds to gravitational stability; for steeper slopes, surface particles roll downslope.
Human actions	Many human actions are classified herein as causes and include farming/ranching operations, structures built in the stream, mining operations, and vessel-induced motions. Most of these fit under the heading of causes.
Precipitation	Surficial destruction occurs due to impact by rain or hail.
Waves	Waves due to wind or vessel traffic can cause displacement of soil particles along the bank surface.
Wet-dry	Alternate wetting and drying cause stress and chemical effects that result in surface soil loosening.

and include bank composition and stratigraphy, moisture content, bank height and slope, and vegetation, etc.

While these three methods have similarities, it is obvious that bank erosion can be categorized in different ways.

Table 2
Internal Failure Mechanisms

Mechanism	Description
Slope instability	On banks experiencing surface soil displacement, the displacement will often take place at different rates over the bank height depending on the erodibility of the bank material or the variation of bank attack intensity. This often results in upper portions of the bank being placed in a geotechnically unstable geometry by removal of material on lower portions of the bank. Groundwater levels have a significant effect on slope stability.
Piping	Piping results in the removal of soil layers having relatively high permeability. Water concentrates in these layers and flows out after periods of flooding, significant precipitation, or other change in groundwater flow. Water flowing out of these layers causes these materials to be removed and results in failure of overlying layers of more cohesive materials.
Liquefaction or flow failures	Relates to fine-grained and loosely structured materials subject to a rapid increase in pore pressure (such as occurs during a rapid drawdown or earthquake) and results in a large segment of bank material flowing downslope as a fluidlike mixture.
Tension cracks	Deep tension cracks due to excessive drying of a cohesive soil may cause the streambank to weaken and become unstable when operating in conjunction with other mechanisms.
Swelling and shrinking	Swelling and shrinking during wetting and drying affect the stability of clay soils.
Overburden	Structures or material placed along the top of bank may cause an otherwise stable bank to become unstable.
Pore pressure	The shear strength of clay soils is highly dependent on pore-water pressure. Cohesive layers can be rendered unstable by water pressures in thin sand layers resulting in landslides.

Table 3
Mechanisms of Transport of Displaced and Failed Soil Away From Bank

Mechanism	Description
Gravity	Gravity is an intermediate means of transport because either materials are removed from the site by other mechanisms or transport ceases due to accumulation.
Human action	Examples are dredging or mining activities.
Water flow	Transport by flowing water is the most significant transport mechanism as far as streambank erosion is concerned. Streamflow is the most common transport mechanism; but vessel-induced water motions are capable of moving displaced and failed soil away from the bank, and overbank flows are capable of transport down the bank.

Bank Erosion Causes

As stated previously, bank erosion causes are the actions or events that result in the occurrence of a bank erosion mechanism. Bank erosion can occasionally be traced to a specific cause, but multiple causes are more frequently the case. The following paragraphs present specific bank erosion causes, the resulting mechanisms, and references documenting their occurrence. All navigation-related causes are discussed in Chapter 4.

Meandering

Meandering may be more the result of erosion than a cause, but it is treated herein as a cause. Rivers have a natural tendency to meander or move across and down their floodplains by eroding one bank and building their opposite bank through deposition. Fisk (1944) surveyed courses of the Mississippi River below Cairo, IL, and demonstrated that a great amount of channel migration has occurred over the last 200 years. Crickmay (1960) reported that the Mississippi River below Cairo, IL, showed an average annual migration on bends of 13.4 m (44 ft) based on surveys dating back to 1765. Hooke (1979) reported that maximum erosion rates are directly related to stream size but the composition and resistance of the banks and the channel slope are significant in determining variation in rates. Simons et al. (1979) stated that "in rivers of this [Connecticut River] type, geomorphologists and engineers have documented that the outside banks will annually erode landward a distance about equal to the depth of flow." Biedenharn et al. (1989) found channel migration depends on planform geometry as described by the ratio of radius R to width W. An R/W of 5 separated sites having low and high erosion rates on the Red River in Louisiana. Hickin (1974) found a critical value of channel curvature which "exerts considerable control over subsequent direction and rate of lateral migration." Meandering as a cause is often indistinguishable from high flows, described in the next section, and could also fit under a previous section, "Geologic and Geomorphic Considerations."

High flow

Hooke (1979) and Simons et al. (1979) have evaluated erosion causes on specific rivers and concluded that most erosion occurred as a result of high flows. Simons et al. (1979) stated that "in most instances when considering the instability of alluvial rivers, it can be shown that approximately 90 percent of all river changes occur during 5 to 10 percent of the time when large flows occur." Everitt (1968) used corings from cottonwood trees to demonstrate that erosion on the Little Missouri River is related to episodic events, namely high flows. While flood flows are generally greater than bank-full stage, erosion can be significant for lesser events. Thorne and Tovey (1981) observed significant undercutting and movement of failed soil blocks in the River Severn at a stage corresponding to one-third of bank-full stage. Hughes (1977) found minimal erosion for flows occurring 10 to 12 times per year and major erosion for flows that have a return interval of 1.5 years or greater. However, extreme events are not always effective in producing bank erosion; as Schumm (1973) reported, large events did not significantly affect the Connecticut River. According to Hooke (1980), "The lack of effectiveness of large floods is also reinforced by the lack of field or documentary evidence of large amounts of erosion associated with events such as the 1960 Exe River floods when a peak flow of 457 cumecs, recurrence interval 264 years, was reached."

High flows cause bank erosion through the following mechanisms:

a. High flows create tractive forces (Lane 1955) great enough to displace inplace soil and/or transport failed soil from the bank. Secondary flows, which depend on channel curvature, cause higher tractive forces to occur along the outer bank of channel bends where erosion is prevalent (Bathurst, Thorne, and Hey 1979). Krinitzsky (1965) reported that the processes of bank failure on the Lower Mississippi River were as follows: "(a) seasonal deepening of the scour pool in bendways occurs during high river stage, (b) oversteepening at the toe of the bank slope causes subaqueous bank failure, and (c) subaqueous failure may induce failure in the remainder of the bank." Thorne and Tovey (1981) and Okagbue and Abam (1986) observed that for rivers with a flow through alluvial deposits of cohesive soils over sand and gravel materials, bank erosion occurs by fluvial entrainment of material from the lower cohesionless bank at a much higher rate than occurs in the material in the upper, cohesive bank. Thorne and Tovey found "field investigations show that unless the surface of a cohesive bank is loosened or weakened by such processes as frost heave or thorough wetting, fluvial entrainment alone is not particularly effective in causing erosion." Fluvial entrainment of the lower cohesionless bank leads to undermining that produces cantilevers of cohesive bank materials. According to Hickin and Nanson (1984), bank migration is largely governed by the size of material at the toe of the bank. Based on Thorne, Reed, and Doornkamp,[1] the concept of basal end point control states that the rate of bank retreat depends primarily on the rate of tractive force scour at the toe. The three states of basal end point control are as follows:

(1) *Basal scour.* Sediment removal exceeds supply; therefore, toe scour and undercutting occur. Decreased bank stability due to toe scour increases rate of bank retreat, tending toward the second state.

(2) *Dynamic equilibrium.* Rates of sediment removal by the flow and supply from bank erosion are matched; therefore, the bank

[1] Thorne, Reed, and Doornkamp, op. cit.

maintains its profile and undergoes parallel retreat at a rate determined by the rate of fluvial scour.

(3) *Berm and beach building*. The sediment supply exceeds removal; therefore, sediment accumulates at the toe. The increased bank stability due to toe accumulation reduces the rate of supply, tending toward the second state.

b. High flows cause high-water levels, which infiltrate the bank to a degree that depends on the characteristics of the flood hydrograph and of the bank. Leopold (1994) stated, "It is generally assumed that erosion of a riverbank occurs during peak discharge from the shear caused by high-velocity flow against the banks, but in many types of rivers this factor is not important. Rather, bank material is softened, crumbled, granulated, or slumped by other processes which prepare a supply of debris for movement by the high flow." In fact, Browne (1980) concluded that velocity-induced shear failure is not a major cause of bank erosion on the Ohio River. Studies by the U.S. Army Engineer Division, Ohio River (1977), and Hagerty (1991a, 1991b) documented that during the recession of the hydrograph, the falling water levels result in seepage and piping of the groundwater back to the stream through noncohesive layers typically found in the fluvial system. The piping mechanism results from the seepage flow and is the transport of the noncohesive layer by the groundwater flow. Loss of this layer destabilizes upper cohesive layers, which fail in blocks or segments of the bank. Tension cracks contribute to the bank instability. The failed cohesive soils, resistant to erosion while in place, are often easily eroded by subsequent flood flows. Piping is the formation of tubular conduits whereas seepage erosion occurs over a broad areal extent (Keller, Kondolf, and Hagerty 1990). Ullrich, Hagerty, and Holmberg (1986) reported that "the most important factors governing piping were permeability and capillarity suction in sand seams, slope of sand seams, and water in tension cracks behind the bank face. Flood hydrograph parameters... were less important, though significant." According to Hamel (1983), high flows and high precipitation often occur jointly and both increase groundwater flow. Also bank instability is "fundamentally a geotechnical phenomenon working outward from bank soils rather than inward from the water in the channel." Clough (1966) presented data showing the time lag between the water level in the river and in the bank. Duration of discharge, affecting the amount of recharge of a bank, is an important factor in bank erosion. Simons et al. (1979) constructed a physical model of a bank with a layered soil configuration and demonstrated the piping mechanism leading to failure of the overlying cohesive layers. They also reported that wave activity can cause piping to occur. Erosion due to piping has also been reported by Twidale (1964), Bell (1968), Camfield, Ray, and Eckert (1980), and Odgaard, Jain, and Luzbetak (1989). Hagerty (1991a, 1991b) documented other examples. Budhu and Gobin (1994) reported seepage-induced erosion is extensive below Glen Canyon Dam on the Colorado River. The dam is operated to satisfy peak power demands resulting in a daily stage variation downstream of the dam of 1-4 m. Leopold, Wolman, and Miller (1964) discuss the importance of piping on the movement of headcuts in gully formation. Laboratory studies by Burgi and Karaki (1971) showed that seepage caused by a high water table in the bank reduces the stability of sand. Negative seepage (out of the channel) was reported by Harrison and Clayton (1970) to increase bank stability due to the formation of a silt seal caused by movement of suspended sediment into the bank or bed.

c. High water levels associated with high flows also cause bank erosion through saturation of the bank. Thomas and Watt (1913) observed that the bank breaks off piece by piece and that "this breaking is most severe after wet weather, or when a flood has saturated the earth and has receded quickly, leaving a weight of water in the bank, which was scarcely able to support its particles even under ordinary conditions." Thorne and Tovey (1981) analyzed the stability of cantilevered banks using static equilibrium and beam theory.

d. High water levels associated with high flows saturate bank material, which decreases the shear strength of cohesive soils (American Society of Civil Engineers Task Committee on Cohesive Materials 1966) and results in greater rates of particle entrainment. High water levels also create high uplift pressures along highly permeable noncohesive layers that can result in slumping of overlying cohesive layers.

e. Changing water levels associated with high flows have resulted in various types of bank failures including flow failures on the Mississippi River on areas of sand overlain by overburden (Turnbull, Krinitzsky, and Weaver 1966) termed retrogressive flow failures by Torrey, Dunbar, and Peterson (1988).

Antecedent moisture

Although not a cause by itself, antecedent moisture was found by Hooke (1979) on streams in England as a statistically important parameter in relation to mean erosion on the banks and the proportion of the bank exhibiting some erosion at a given study site. Hill (1973) observed that major rises in stream level during the summer when the banks were in a dry, hard state did not result in large amounts of erosion, in comparison to similar floods in the winter. Hughes (1977) attributed lack of bank erosion during a summer flood to a dry, hard bank as opposed to significant erosion during two winter floods having similar magnitude but preceded by a pattern of minor floods. Hagerty, Sharifounnasab, and Spoor (1983) found greater amounts of bank erosion on the Ohio River when banks were wetted by antecedent precipitation before flood events.

Back of bank water sources

Uncontrolled overbank drainage can lead to sheet and rill erosion of streambanks. Poor overbank drainage patterns and man-made or natural lakes behind bank lines provide groundwater sources that move toward the stream and cause piping-related failures. Twidale (1964) observed water emerging from the bank and subsequent failures when overbank depressions were filled with water on a river in Australia. Hagerty (1983) reported that much greater than average precipitation from the late 1960's through the 1970's resulted in increased groundwater elevations for several areas within the Ohio River basin. Higher groundwater resulted in increased flow out of riverbanks, increasing piping failures.

Wind waves

Lawson (1985) stated, "Net erosion by wind waves depends primarily upon the following factors: wind velocity, duration, and effective fetch; near shore and offshore bathymetry; shoreline configuration (plan view); water level; and beach and bluff composition." Lawson discussed shoreline and erosion processes relative to the two main parts of the shore zone—the beach and the bluff. The distinction between the beach and bluff areas is not nearly as apparent in river environments having significant stage fluctuation as it is in impoundments having relatively constant water level. Similar to the river environment where flood flows are often reported to be dominant, Lawson singles out storms because of "their potential importance as events that can cause rapid and extensive modification of the shore zone over short time intervals."

Walker and Morgan (1964) described bank erosion on the Colville River in Alaska where wind waves cause erosion in summer months when banks thaw from their frozen winter condition. Wave erosion undercuts the bank resulting in soil blocks falling into the river. The greatest activity occurs when persistent winds coincide with high rainfall. Ouellet and Baird (1978) concluded that wind waves are the primary cause of erosion on relatively wide sections of the St. Lawrence River while erosion on narrow sections is attributed to both wind- and vessel-induced waves. Markle (1983) conducted a demonstration model of sand bank erosion under wave and drawdown conditions. His model used wave heights comparable to wave heights in the UMRS, but no erosion rates were measured in this study.

Wind wave erosion at Lake Orwell is the dominant cause of erosion producing an average annual retreat of 0.36 m based on analysis of 13 erosion stations (Reid 1984). Reid, Sandberg, and Millsop (1988) found shoreline erosion on Lake Sakakawea a function of different variables in summer versus winter. In summer, the primary factors affecting recession rate were bank angle relative to dominant wind, offshore slope angle, beach width, bank height, effective fetch, and percent of coarse beach clasts. In the winter, bank height and bank orientation relative to the sun were the dominant factors. Reid (1993), in his description of the mechanics of shoreline erosion, stated that the most significant factor in bank erosion is waves, whether wind-induced or boat-induced. Reid, Sandberg, and Millsop (1988) reported that in Lake Sakakawea, most bank failures occur through mass movements rather than from surface erosion processes, but most movements are the result of undercutting by waves. He cites two references for determining the rate of bank erosion due to waves: Quigley and Gelinas (1976) and Sunamura (1984). Benn (1994) reported on bank erosion on the Hog Hollow archaeological site due to wind waves in pool 12 of the UMRS. Nairn (1992) discussed wind wave shoreline erosion of cohesive soils and how the erosion processes differ from that in noncohesive materials. Nairn stated that the controlling process of wind wave erosion of cohesive soils is downcutting of the cohesive foreshore slope.

Sunamura (1984) presents an excellent summary of wind wave erosion of cliffs and an extensive list of references. His fundamental relation of cliff erosion by waves is as follows:

$$X = \phi(f_w, f_r, t) \tag{1}$$

where

X = eroded distance

f_w = force exerted by waves

f_r = resisting force of the cliff

t = time

Sunamura noted that there is no suitable physical or quantitative index for f_w and resorted to wave height like most other investigators. Sunamura presents a diagram for waves which is comparable to the previously discussed basal end point control. Sunamura presents an equation for bluff recession

$$R = K\left(C + Ln \frac{\rho g H}{S_c}\right) \tag{2}$$

where

R = recession rate

K = constant having dimensions of length/time

C = a nondimensional constant

ρ = water density

g = gravitational constant

H = wave height

S_c = compressive strength of the bluff forming material

Kamphuis (1987) stated that in the wind wave environment, "the erosional debris from the cohesive till bluff normally disappears rapidly as suspended load. It forms virtually no protection and hence the height of the bluff does not exert much influence on the recession rate." He presented plots showing that cohesive foreshores under wind wave attack have profiles similar to noncohesive foreshore profiles. Kamphuis also emphasized that recession rate ultimately depends on the ability of the wave to downcut the foreshore slope. He developed the following expression that the recession rate of a till bluff R should be proportional to the incident wave height H:

$$R = AH^{3.5} \tag{3}$$

or the incident wave power P_b as

$$R = BP_b^{1.4} \tag{4}$$

The coefficients A and B are calibrated to reflect different geotechnical properties. This formulation assumes that the wave height or power is much greater than the difficult-to-determine critical wave height or power, which is the condition required to initiate erosion. The exponents in these equations vary for breaking versus nonbreaking wave zones. Wave power per unit length of shoreline is defined as

$$P_b = \frac{\rho g^{3/2} H^{5/2}}{8\lambda^{1/2}} \cos \alpha \tag{5}$$

where

λ = breaker index = H/d

d = depth of water at breaking

α = angle of wave breaking

Observed recession rates from wind waves at several sites on Lake Erie resulted in

$$R = 1.06P^{1.37} \tag{6}$$

where

R = long-term recession rate, meters/year

P = long-term average wave power, kilowatts/meter, arriving at the shoreline

Bishop, Skafel, and Nairn (1992) presented results of laboratory wave erosion tests on undisturbed cohesive soils under wave heights of 0.3 m. Downcutting of the cohesive profile is attributed to shear stress at the bed caused by orbital velocities (for unbroken waves) and wave energy dissipation in the surf zone (for broken waves).

Effect of structures, including UMRS navigation dams

Nielsen, Rada, and Smart (1984) report that the lower one-third of Pool 4 on the UMRS has aggraded 0.4 m, whereas the upper third has degraded 0.7 m since lock and dam construction. The degradation is attributed to clear water discharges from the dam that result from sediment trapping in the upstream pool areas. Streambed degradation can lead to bank erosion because the degradation causes banks to be placed in a geotechnically unstable condition and slope failures occur. In Great River Environmental Action Team (GREAT) (1980b), dredging quantities and sediment inflow and outflow are examined and their impact on downstream bed degradation is discussed.

Stage fluctuations due to reservoir operations such as lock surges and hydropower can result in rapid drawdown, leading to piping failures (Budhu and Gobin 1994), slope stability failures of saturated banks, and instability due to excess pore-water pressures. Linder and Wei (1986) reported that bank erosion from hydropower releases below Harry S. Truman Dam was not a significant problem after evaluation of prototype experience. Simons et al. (1979) concluded that pool fluctuation due to structure operation was the second leading cause of bank erosion on the Connecticut River; however, magnitude was small compared to the primary cause of tractive force erosion during high flows. Boszhardt and Overstreet (1981) concluded that boat wakes and natural erosion are increasing the rate of shoreline erosion in Pool 12 of the UMRS primarily through vegetation loss. According to Boszhardt and Overstreet, "Pool maintenance has apparently created a situation where the water levels change to such intense degrees and at such irregular intervals, that floral species are unable to adapt, and die off leaving exposed soil." Another potential source of erosion due to structures is the large pool created upstream of navigation dams on the UMRS which could increase the occurrence of wind wave erosion. Simons et al.[1] evaluated change in surface area, surface width, bed elevation, and discharge/ stage as a result of dike and navigation dam construction on the UMRS. Surface area, width, and bed elevation increased upstream of navigation dams and decreased downstream.

Browne (1980) concluded that "bank erosion is not caused by or related to the construction and operation of navigation dams" on the Ohio River. Browne further concludes that navigation structures have reduced the natural fluctuations of river stage, therefore, reduced the drawdown failures. Hagerty, Linker, and Beatty (1989) surveyed bank erosion before and up to 4 years after construction of the Smithland Dam Pool. The authors found no indication that the pool raise caused any increase in bank erosion. Hagerty, Spoor, and Parola (1995) report: "It has not been proven conclusively whether maintenance of a navigation pool accelerates, decelerates, or does not affect the rate of retreat above the regulated stage." They also state: "It is also possible that the bank near the navigation pool elevation is subject to persistent conditions which previously did not exist, and that retention of a navigation pool has accelerated bank retreat above the maintained stage level." Neill and Yaremko (1989) reported obstructions at bridge structures accelerate and concentrate flow forces. Bridge abutments often create back eddies that can erode large embayments into the bank. Richardson and Stevens (1986) reported on another structural form, levees. The Lower Citanduy River in Indonesia remained stable after 23 cutoffs reduced the channel length from 98.7 to 78.6 km. The subsequent addition of levees to this river resulted in increased bank erosion. Volker (1986) also reported that embanking (levees) may increase bank erosion.

Flow impingement

Flow impingement occurs when channel bed forms, structures, debris, or vessel propeller jets direct flow against a bank at a large acute angle. It can occur at a wide range of flows and causes large tractive forces. Flow impingement frequently results in bank erosion in braided streams having multiple channels that often experience rapid shifts in alignment. Woody debris and ice jams also cause flow impingement that can result in bank erosion. Wallerstein and Thorne (1994) observed that the presence of organic debris increases channel width in certain stream sizes.

[1] D.B. Simons et al. (1981). "Investigation of effects of navigation development and maintenance activities on hydrologic, hydraulic, and geomorphic characteristics," Working Paper 1 for Task D, submitted to Upper Mississippi River Basin Commission, Minneapolis, MN.

Winter effects

On a stream evaluated by Hill (1973), precipitation and frost action together resulted in bank soil being loosened first by frost action and then swept away easily by flood flows. Added precipitation after the flood increased the subsequent frost action effects. On the significance of frost action, Leopold (1994) reported: "Erosion in Watts Branch is concentrated in the winter months and rarely occurs in the summer. Maximum flows are most likely from summer thunderstorms, at which time the stream banks are dry and resistant to erosion. There was practically no erosion during the high flow in July, 1956." Twidale (1964) considered frost action to assist other mechanisms by loosening soil and soil blocks on the face of the bank. Lawler (1987) studied channel bank erosion in Wales and concluded that groundwater movement to locations of freezing and frost action prepared riverbank materials for erosion. Erosion was lacking without such preparation. Reid (1984) reported that thaw failure at Lake Orwell was the second most effective erosion process. According to Reid, "Thaw failure begins with slab slips along joints in the insitu till that have been enlarged by frost action, and mud and earthflows then occur when thaw has progressed." Gatto (1982b) stated: "When ice covers a river, lake, or reservoir from shore to shore, it dampens waves and protects the banks from normal wave erosion processes. Erosion restarts at breakup when the ice becomes mobile; the ice scrapes, shoves, and scours the shore or bank, and transports sediment away." Wuebben[1] reports that ship and wind waves on the St. Marys River were "undetectable for periods with ice cover." Gatto (1982b) discussed various ice erosion processes and provided references on ice erosion. As reported by the *Shore Protection Manual* (1984), the net effects of ice on shoreline stability are largely beneficial.

Land use/basin/channel changes

Since the size (width, cross-sectional area) of a stream is largely a function of the flows that have occurred historically in that basin, changes in flow (rate, timing, duration) from land use changes will almost certainly result in a change in the channel size. Hammer (1972) studied 78 watersheds in Pennsylvania and demonstrated increased stream size as a result of urbanization. The study showed that effects decreased after about 30 years and that the effect of urbanization decreases for larger watersheds. Land use changes such as the clearing of riparian vegetation can result in bank and channel instability (Oswalt and Strauser 1983). The contribution of riparian vegetation to bank stability tends to decrease with increase in size of the system (Keller, Kondolf, and Hagerty 1990). Smaller systems have lesser erosive forces and vegetation increases stability unless the bank is high in relation to the depth of rooting (Neill and

[1] James L. Wuebben. "Environmental effects of extended season navigation on the Great Lakes - St. Lawrence Seaway System," draft report, Cold Regions Research Engineering Laboratory, Hanover, HN.

Yaremko 1989). Keller, Kondolf, and Hagerty (1990) documented cases of increased bank erosion following loss of suitable riparian vegetation. Loss of riparian vegetation resulted from either rising or falling groundwater levels brought on by either pumping of aquifers or stream aggradation resulting from timber harvesting. Gravel mining is another basin change that is a possible source of channel instability (Lagasse, Winkley, and Simons 1980). Browne (1980), in a study of the Ohio River, concluded that "changes in land use tend to increase infiltration rates and piping losses."

Bank erosion can also be caused by aggradation of the channel brought on by increased sediment load in a river. Smith and Patrick (1979) reported that bank erosion in the Eel River in California is caused by high sediment production resulting from both natural environmental conditions and man's land use activities. According to Sparks et al. (1990), basin changes on the Illinois River that included intense agriculture and barge traffic resulted in increased turbidity that killed submerged plants. Loss of vegetation allowed larger waves to occur, which uprooted even more plants and further increased turbidity. This cycle continued allowing wave attack to erode banks adding to the turbidity. As Neill and Yaremko (1989) reported, channelization or straightening often initiates a long sequence of response that can include incision or degradation, slope undercutting, and a tendency to develop new meanders.

Relative Significance of Bank Erosion Mechanisms and Causes

Studies have been conducted to define the major mechanisms and causes of bank erosion that have occurred historically over a specific area. Simons et al. (1979) evaluated erosion causes on the Connecticut River and concluded that shear stress and velocity were by far the dominant causes of bank erosion. Pool fluctuations caused by structures was a distant second followed by boat waves, gravitational forces, and seepage forces. Reid (1984) found wind wave erosion in Orwell Lake, Minnesota, accounted for 76 percent of the total erosion in 1981-1982 and 88 percent in 1982-1983. The second most significant mechanism, thaw failure, accounted for 20 and 10 percent of the erosion following 1982 and 1983, respectively. USACE (1981a) studies on the Ohio River concluded that the major causes of erosion are rapid drawdown and stage fluctuation triggering slumpages, and removal of bank soil by water seepage through zones of low resistance with slabbing and caving of overlying soils. Ofuya (1970) presented a method for evaluating the relative significance of wind- versus boat-generated waves based on comparison of the total energy of waves striking the bank. Bhowmik and Schicht (1980) evaluated bank erosion sites along the Illinois River and concluded that wind and vessel waves were responsible for most bank erosion. Spoor and Hagerty (1989) concluded that most bank erosion on the Illinois River was the result of piping.

Erosion of Islands

Lagasse, Winkley, and Simons (1980) reported that the upstream ends of islands are areas where gravel armor layers form. These areas are subject to scour after gravel mining by dredging. Weigel and Hagerty (1983) reported on riverbank change at Sixmile Island in the Ohio River. Erosion resulted from exit of bank recharge after flood recession. Wind and vessel waves "were of little significance in causing bank failure." Tractive forces and wave action "were effective only in removing soft sediments or loose debris from upper bank failures. Sediments deposited by spring floods, if allowed to dry for two to three months, strongly resisted subsequent wave attack." Boszhardt and Overstreet (1981) reported that in Pool 12 of the UMRS "islands surrounded by the main channel and side channels exhibit both sedimentation and erosion. The upper ends of these insular units, in most cases, are being severely eroded, illustrated by high vertical banks......The lower ends of islands typically consist of recent sand bar formations." Boszhardt (1990) reported that after inundation by construction of Lock and Dam No. 8, the highest landforms in the lower end of Pool 8 remained above water as low islands. These islands were then subjected to accelerated erosion due to wind wave action. Boszhardt reported that little remains of these islands after 50 years.

Cohesive Soil Erosion

The state of the art of the investigation of cohesive soil erosion is one of the factors preventing reliable prediction of erosion rates. Investigators of the initiation and rate of cohesive soil erosion have found a large and complex number of factors to affect this process (Paaswell 1974) for both wave erosion and tractive force erosion. Kamphuis (1990) reported that understanding cohesive bed erosion is greatly simplified by the finding that the noncohesive material carried by the eroding stream plays a significant role in the cohesive soils erosion. Clear water erosion of cohesive soils is much less than erosion with flows containing a small amount of sand. In his bridge crossing example, the critical shear stress determined experimentally for the cohesive soil was the same critical shear stress from the Shields diagram for the sand carried by the flow. Kamphuis stated: "If any sand or gravel is presented in the eroding stream or overlying the cohesive formation in a discontinuous layer, the design should be based on the sediment transport characteristics of the granular material. The complex geotechnical properties of the cohesive formation are only of secondary importance in that they modify the erosion rate resulting from abrasion and protection by the granular material." Relegating geotechnical parameters to secondary importance has not been widely accepted as indicated by the listing of 32 important cohesive sediment parameters in Boyt (1992).

Bank Erosion Monitoring

Thorne (1981), Gatto and Doe (1987), Reid (1993), and Lawler (1993) review methods for monitoring bank erosion rates. Lawler (1993) explains that these methods are not automatic or quasi-continuous, which is needed to quantify the erosion or deposition impact of a given event. Lawler developed a Photo Electronic Erosion Pin System providing a continuous monitor of the bank position.

3 Extent of Existing Bank Erosion on the UMRS

Potential Sources of Data

There are several sources of data and field observations that cover many areas within the UMRS and could assist in establishing the baseline bank erosion conditions: aerial photographs, questionnaire results, field studies by the Corps and other agencies, and hydrographic surveys, etc. These data could be pertinent to determining geomorphic changes in the bankline, identifying reaches with moderate to severe erosion, and providing supplementary data to sites where detailed investigations are warranted.

A recent survey queried the Corps offices in the UMRS, the Illinois State Water Survey, and the Environmental Management Technical Center attempting to locate and compile sources of existing hydrodynamic and sediment data. Various levels of details for bathymetric and hydraulic data exist in either hard copy or digital format. In a Water Operation Technical Support Program questionnaire conducted in February 1990, all Corps Districts were surveyed for reservoir shoreline erosion problems. The St. Paul District reported they had less than 160 km (100 miles) of erosion, and St. Louis and Rock Island Districts had from 160 to 320 km (100 to 199 miles) of eroded shoreline (Allen and Tingle 1993). Both these surveys may have details pertinent to this study.

The Environmental Management Technical Center, Onalaska, WI, is responsible for storing data on the UMRS as part of the Long Term Resource Monitoring Program. They are building and maintaining a Geographic Information System for the UMRS that includes historical land coverages from as far back as 1890 to detailed coverages in more recent years (*River Almanac* 1994).

Several studies that were completed on UMRS bank erosion whose data may be accessible are described in detail in the following sections.

Extent of Illinois River Bank Erosion

According to Schumm (1971), the Illinois River has such a low gradient that meandering is inhibited. The Ouachita River in Louisiana is similar and was reported by Biedenharn, Raphelt, and Montague (1983) to be relatively stable with intermittent areas of bank erosion. Stability on the Ouachita was also attributed to cohesive bank material, heavily vegetated banks, and low sediment loads. Bhowmik and Schicht (1980) evaluated erosion at 20 sites on the Illinois River and reported erosion ranging from negligible to severe. Warren (1987) monitored five prehistoric archaeological sites on the lower Illinois River over a 4- to 6-month period and determined that the mean horizontal erosion rate was about 1 mm per day. Warren concluded that bank erosion is an important problem on the lower Illinois River and it poses a widespread and often severe threat to significant cultural and natural resources near the river's edge. He stated: "The pattern observed in this study is consistent with the hypothesis that a substantial amount of bank erosion along the lower Illinois River is caused by wave action, much of which is an artificial consequence of vessel traffic on the river." Based on a 1988 evaluation by Spoor and Hagerty (1989), severe erosion on the Illinois Waterway was very limited. They also observed that undercutting of banks by waves and currents was not encountered. Areas experiencing bank erosion were caused by piping-induced erosion. Good (1993) reported that shoreline erosion on Illinois lakes and reservoirs is caused by "fluctuating water levels, easily erodible shoreline soil types, steep shoreline slopes, heavy visitor usage, lack or disturbance of nearshore aquatic vegetation and/or rock barriers, deep nearshore water depths, boat and wind induced waves, and ice damage." Also the average percentage of eroded shoreline was 15 percent for lakes larger than 202.3 ha (500 acres).

Extent of Mississippi River Bank Erosion

Through the more recent history of navigation on the UMRS, numerous studies have been conducted by several agencies regarding some aspect of bank erosion. One study, begun in 1974, was conducted by a multidiscipline, multi-agency team established through a partnership between the Corps and the U.S. Fish and Wildlife Service. Their mission was a long-range management strategy for the Upper Mississippi River (UMR). The team, known as GREAT, was a consortium of interests authorized by Congress in Section 117 of the Water Resources Development Act of 1976. The first team, GREAT I, established in 1974 was responsible for studying the river from Minneapolis/St. Paul, MN, to Lock and Dam 10 (all within St. Paul District) (GREAT 1980a). The second team, GREAT II, began in 1976, and picked up the river from Guttenberg, IA, to Saverton, MO (Rock Island District). And finally, GREAT III, organized in 1977, continued from Saverton to the mouth of the Ohio River (St. Louis District).

Work groups addressed the following problem areas: commercial transportation, dredged material uses, dredging requirements, fish and wildlife management, floodplain management, material and equipment needs, public participation and information, sediment and erosion, side channel, water quality, and plan formulation. The sedimentation and erosion work group had multiple tasks including identification of sources of sediments and their fate. One task was to "monitor rates of sedimentation and erosion within the river corridor." Technical results of the sediment and erosion work groups are found in separate appendices (GREAT 1980b, 1980c).

GREAT (1980b) stated that "shoreline protection has benefitted the environment by preventing tow propwash and flood flows from eroding channel banks." GREAT I also developed an inventory of areas needing shoreline protection, but did not discuss the extent of erosion. From the GREAT II study (GREAT 1980c), 15 percent of the 5,934 bank miles of main stem rivers were experiencing erosion. No figures were given for the UMR alone. From the GREAT III study (Morris 1982), bank erosion was determined from mappings of the UMR from Saverton, MO, to Cairo, IL. "The results of the mapping of the high bankline indicate there have been only small changes over the 22 years studied." Above St. Louis no changes were found, which was attributed to the many locks and dams. The GREAT III study further concluded that bank erosion is not a significant factor in the total sediment budget of the river. This report also stated that the Corps of Engineers revetment program has resulted in the high bank being in virtual equilibrium.

1993 Flood

Specific attention is focused on bank erosion resulting from the 1993 flood on the UMRS and Missouri River. The U.S. Army Engineer District, Rock Island (1994), evaluated channel changes resulting from the 1993 flood based on 26 cross sections compared from 1992 and 1993. Thirteen of the twenty-six cross sections showed deposition, and only four showed degradation across the entire channel. The remaining nine had equal amounts of aggradation and deposition. According to this report, "Due to the torrential downpours which occurred during this period and the resultant swelling of rivers and streams, both sheet and bank erosion were tremendous." The report does not delineate which rivers within the District experienced tremendous erosion. In a short helicopter overflight of parts of the UMR in the Rock Island District in October of 1993, the authors of the present report observed relatively stable banks and little evidence of bank erosion. Benn (1994) documents several Mississippi River archaeological sites that experienced erosion during the 1993 flood. Benn reported that the erosion signature of fluctuating water levels is "treads and risers" or stepwise lines of erosion on the bank. He reported that of 33 selected sites, 42 percent had some degree of damage and 21 percent had "flood damage [that] either accelerated the rate of erosion or started new erosion to the extent that the cultural deposit is considered adversely affected...." Benn goes on to say that "the rate of flood effects among all sites in the valley is much lower, probably less than five percent." A potential long-term effect of the 1993 flood is the bank instability resulting from die-off of vegetation as a result of the long inundation by the flood. U.S. Army Engineer District, Omaha (1994), documents that streambank erosion was either the sole cause or a partial cause of levee failure at 9 out of 29 Omaha District levees damaged in the 1993 flood. U.S. Army Engineer District, Kansas City (1994), documents 56 locations of significant (several hundred feet) bankline blowouts and 14 locations of major (305 to 610 m (1,000 to 2,000 ft or more)) blowouts between river miles 486.8 and 25.0 on the Missouri River as a result of the 1993 flood.

4 Summary of Navigation-Related Processes and Bank Erosion Studies

A number of bank erosion studies have been conducted specifically related to navigation for either navigation channels or in reservoirs. These efforts range from multiple-effort large-scale projects such as those on the Great Lakes connecting channels in the late 1970's and early 1980's to smaller efforts by individual researchers. Some studies were site specific and involved detailed field investigations, while others were broad in scope involving perhaps only a literature review. In some cases the research was cumulative over years of field data, multiple scientists, and laboratory efforts (see section, "Dutch studies," later in this chapter). However, it became apparent that much of the research covered navigation effects and bank protection. Research containing actual relationships between navigation processes (or any processes for that matter) and bank erosion were rare and often unverified in the field. Only two articles presented a shoreline retreat model related to boat energy, Grigor'eva (1987) and Nanson et al. (1993). This lack of applicable models and need for further research are expressed in many articles, for example the article by Pilarczyk et al. (1989), which stated, "The mechanics of bank erosion and the stability of protective structures subject to hydraulic loading are complex problems. The understanding of erosion processes and failure mechanisms of structures is still in a rudimentary stage, and it is not yet possible to describe many important phenomena and their interactions by theory."

After the difference between commercial and recreational vessels is discussed, summaries and conclusions from references pertaining to navigation and bank erosion are presented.

Commercial Versus Recreational Vessels

Commercial and recreational vessels, each having the potential to cause bank erosion, differ in the forces they generate and where they are able to navigate. To understand the difference in forces, the vessels can be classified as either confined or unconfined. Commercial tows on the UMRS are classified as confined because their submerged cross-sectional area takes up a significant part (greater than 2 to 5 percent) of the cross-sectional area of the waterway. The ratio of channel cross-sectional area to submerged vessel cross sectional area is called the blockage ratio. Recreational vessels are unconfined because they do not take up a significant part of the waterway. The water motions created by confined vessels (commercial tows) that can attack banks are return currents, water level drawdown, transverse stern wave (significant only for small blockage ratios and high vessel speeds), propeller wash, and if vessel speeds are high enough, short-period waves. The water motions created by unconfined vessels (recreational vessels or workboats) are primarily short-period (1 to 3 sec) waves, which are larger than short-period waves from commercial vessels because of the higher speeds for recreational vessels. Johnson (1994) reported maximum wave heights of 30.5 and 61.0 cm (12 and 24 in.) from commercial and recreational vessels, respectively. Regarding the differences in where they navigate, commercial vessels are generally confined to a narrow portion of the channel that is removed from the shoreline except in bendways. With some dependence on size, recreational vessels have few restrictions on where they operate.

Commercial and recreational vessels also differ in frequency of occurrence. Bhowmik et al. (1992) reported that up to 704 recreational vessels passed a highly used area on the UMR in one day whereas commercial tows on the UMR are presently about 35 tows per day in the lower pooled reaches. Commercial and recreational vessels also differ in their location of maximum frequency of occurrence. Frequency of vessel passage for recreational vessels is often closely related to proximity to metropolitan areas whereas commercial vessel traffic on the UMRS decreases as one proceeds upstream from St. Louis.

St. Lawrence Seaway Studies (Connecting Waterways)

The connecting channels of the Great Lakes-St. Lawrence Seaway are the main topic of several studies:

Ofuya

Ofuya (1970) investigated wind, ship, and cruiser waves in the St. Clair, Detroit, and St. Lawrence Rivers to determine their relative contribution to shore erosion. Ofuya assumed the quantity of sediments dislodged from the riverbank is proportional to the work done by the waves and is calculated as the wave energy propagated to the shoreline by

$$W_t = \frac{20}{S_{max}} H_{max}^2 \, T_{max} \, Q_s \tag{7}$$

where

W_t = wave energy at shoreline in ft-lb/hr/ft of shoreline

S_{max} = slope of the average maximum power versus energy curve

H_{max} = maximum wave height

T_{max} = period of maximum wave

Q_s = number of ships per hour

For ships $S_{max} = 0.11 - (0.87)(10)^{-5}X$ and for cruisers $S_{max} = 0.19 - (2.56)(10)^{-5}X$ where X = distance from shoreline to sailing line in feet and is limited to 0 to 1,524 m (5,000 ft). Ofuya also provides equations for wind wave energy and examples comparing the relative contribution of wind, ships, and cruisers.

Ouellet and Baird

Ouellet and Baird (1978) investigated shoreline erosion along the St. Lawrence Seaway between Quebec and Montreal. Using a total energy approach to compare processes, they concluded that the relative contribution of each process can be calculated. Their equations for evaluating energy due to wind and boat waves that consider duration tie the number of vessel passages to total potential energy. The authors repeatedly characterize ship waves as ones that "pound" the shoreline. According to Ouellet and Baird, the majority of bank erosion along this section of the river was caused by wind waves, followed by ship passage. The least damaging process was the effects of ice. Also since the costs of monitoring were prohibitive due to long-term nature of active bank erosion sites, the processes were not specifically linked to rates of bank erosion.

Gatto

Gatto (1982a) conducted a study of shoreline damages to determine increases in bank erosion resulting from winter navigation. Regarding ship effects, he referenced Wuebben (1978) in the introduction stating "the rapid water level changes associated with ship passage can occur faster than the pore water pressure in river bottom sediments can adjust. This imbalance can create explosive liquefaction, in which a mass of bottom sediment is rapidly resuspended.... When the offshore slope is altered by this ship-induced resuspension, a readjustment at the shoreline can eventually result." A potential winter problem caused by ship motion regards not only the direct contact of ice when shoved against the bank, but also the disruption of ice formations allowing wave and prop action to cause damages. This study summarized other studies conducted in the Great Lakes area and gave conclusions from each regarding their contributions to bank erosion resulting from navigation. Surveys, field observations, historical maps and records were used in the analysis. The author concluded that 24.2 km (15.1 miles) of eroding banks on the four rivers (70.2 percent) could **not** be attributed to **winter** navigation, and hydraulic changes due to ships are important in narrow reaches or where the ships sail close to the shoreline. However, the author also concluded "that the contribution of winter or summer navigation to bank erosion is minor."

Wuebben (1983)

Wuebben (1983) investigated increased erosion due to **increased vessel sizes** whereas Gatto dealt with potential increased erosion due to **winter navigation**. Both studies were conducted for the Detroit District on the Great Lakes connecting rivers. The largest existing ship on the Great Lakes channels is 305 m (1,000 ft) long by 32 m (105 ft) wide with a draft of 7.8 m (25.5 ft). The proposed ship size is 366 m (1,200 ft) in length with a 40-m (130-ft) beam and a maximum 9.3-m (30.5-ft) draft. Wuebben's study identified areas where an increase in ship size might affect the hydraulics. The author stated in the introduction, "The analysis cannot predict the occurrence or magnitude of damage at those sites because of the interdependence of the effect of vessel size with uncontrolled factors such as water levels and vessel speeds. The result of the study is an estimate of shore areas that could be affected by an increase in vessel size."

It is important to reiterate that the analysis was conducted for incremental increases in damages due to changes in vessel size. Vessel-induced damages based on existing conditions were not considered.

Based on energy and continuity, the author compared idealized channels and increasing drafts. It is assumed the effects are negligible since the channel depth is also increased with ship draft. Based on a family of curves for various channel depth to ship draft ratios, the author states: "Even at a relatively high speed of 17 fps, where the drawdown would be an unacceptable 2 feet, the difference in drawdown between existing conditions and the maximum proposed draft would be less than that due to a change in vessel speed of only 1 fps."

To evaluate effects of different channel geometries and how increases in draft affect them, the author described a channel shape factor S_f between 0.2 and 1.0. A triangle has a shape of 0.5, a parabola, 0.67, and a rectangle, 1.0. It is important to note, based on the author's calculations, the tremendous effect channel shape has on the magnitude of the drawdown for a given vessel speed. This is not surprising since the author fixed the channel depth and top width but did not keep the cross-sectional area when calculating the shape factor. As the author investigated beam width of the ship, he concluded that it **does** have a significant impact on drawdown.

Regarding sediment resuspension and the potential for shoreline damage, Wuebben described the vessel passage mechanism that changes bed load or ripple migration direction, how saltation occurs due to increased velocities, and the explosive liquefaction of bottom sediments caused by a rapid change in the pore-water pressure gradient resulting from vessel-induced drawdown. He stated, "If the decrease in water pressure on the riverbed during the passage of the moving trough occurs faster than the change in soil pore pressure, a net uplift force on the soil near the surface will occur. After the trough passes and the water level rises, the process reverses and there is a net downward force on the riverbed sediment. As the ship passage cycle is repeated, this mechanism, in conjunction with gravity acting downslope, encourages a net offshore migration of sediment that is in addition to any transport due to water velocities alone."

To evaluate **potential** damage to shorelines from increased vessel size, Wuebben "defined" ship-induced effects that are unacceptable and then determined the effects of a larger vessel. The criterion adopted, based on the author's observations nearshore, was that drawdowns greater than 0.3 m (1 ft) and current changes of 0.6 m/sec (2 ft/sec) caused unacceptable sediment movement. Study areas were excluded if drawdown was calculated as less than about 0.3 m (1 ft) for a 366- by 39.6- by 9.3-m (1,200- by 130- by 30.5-ft) upbound ship traveling at the speed limit.

Wuebben then examined reach by reach the areas where increased vessel sizes exceeded the criteria. Although he admits that pilots often exceed existing speed limits, he recommended for areas of potential increases in erosion that the speed limit be lowered except in severe cases where bank protection may be warranted.

Hochstein and Adams

Hochstein and Adams (1989) applied analytical solutions on the St. Marys River (connecting river of the Great Lakes) to quantify environmental effects of ship passage in open and ice-covered waters. The authors describe and present equations for predicting return current, drawdown, propeller jet velocity, diverging waves, horsepower in ice, bed-load transport, and suspended load transport. Kinetic energy was calculated as a function of the combined total velocity (ambient, return current and prop velocity) squared. Field measurements (approximately 84) were used to verify and adjust models for vessel motion hydrodynamics. Sediment predictive techniques were not verified. Only erosion of the bed, not banks, was considered in this study.

Wuebben (1993)

Wuebben (1993)[1] is a compilation of writings on literature and studies on the extended season navigation for the St. Lawrence Seaway. It covers a multitude of topics including sediment transport, shoreline erosion, shore structure damage, oil and hazardous substance spills, biological effects, ship-induced vibrations, bubbler systems, ice booms, and ice control at locks.

Chapter 2, "The effects of extended season navigation on sediment transport, shoreline erosion, and shore structure damage," written by Wuebben, basically reiterates conclusions from his 1983 report. He refers to models by Hodek and Algers and Hochstein and Adams. He concluded that the major vessel effects during periods of ice are propeller wash, drawdown, and surge and that ship-generated waves are dampened by the ice.

Nearshore turbidity was observed by Hodek et al. (1986) due to ship passage. Sediment studies by these researchers indicated that upbound vessels caused more net sediment transport than downbound and drawdowns of less than 152 mm (6 in.) resulted in minimal disturbances. A criterion was set assuming that nearshore wave heights (not drawdown) of 152 mm (0.5 ft) result in the onset of sediment motion in sand bed systems.

Studies by the Detroit District concluded that on the St. Marys River, erosion of the shorelines occurs during the traditional navigation season and is minor during the extended season. The District concluded that high-water levels were the cause of this erosion, while a follow-up study by a consultant concluded that erosion was due to all causes. Furthermore, waves due to wind and small boats were more significant than ship waves. Their recommendation was bank protection against these other causes rather than a reduction of ship speeds since in their conclusion, these forces were insignificant. Following these two studies in the mid 1970's, the U.S. Army Engineer Cold Regions Research Engineering Laboratory (CRREL) began a series of studies.

The author summarized: "Although various analyses of vessel effects have concluded that there is a potential for shoreline erosion, field surveys and reviews of historical records have not supported that conclusion. For the most part erosion rates due to any cause have been minor, and a comparison of erosion rates during years with and without winter navigation show no appreciable difference."

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[1] James L. Wuebben. (1993). "A review of the environmental effects of extended season navigation on the Great Lakes-St. Lawrence seaway system," Cold Regions Research Engineering Laboratory, Hanover, NH.

European Studies

Dutch studies

Jansen and Schijf (1953). They elaborated on Dutch studies evaluating vessel forces. The authors reintroduced, from a 1949 study, the concepts of limiting velocity criteria, evaluating the vessel drawdown and return current based on the energy principle. As ship size increased and Dutch navigable waterways did not, it became necessary to reevaluate revetment practices. Alternatives to revetment could include speed restrictions.

Bouwmeester et al. (1977). The physical forces produced by a pushtow and the processes contributing to bank erosion are described. This study correlates to information described in Bekendam et al. (1988). When pushtows were introduced in the Rhine waterways, these studies were conducted to determine the effects on the existing waterway. The authors stated: "The increasing dimensions and engine power of ships result in more violent movements of the water (currents and waves) and consequently in more serious erosion of the bottom and banks of rivers and canals. "

This paper studied these forces and the bank protection required for pushtows. A 1:25-scale model was used with a free-running pushtow unit with two, four, and six barges to measure waves and currents in a straight reach and bendway both with and without ambient currents. It describes the mechanics of sailing ships that cause bank erosion. In fact, the authors stated: "The banks and beds of navigable waterways are mainly attacked by the water motion set up by the passage of ships, though tidal movements, swell, wind-generated waves and other currents may also affect the structure." No method of predicting bank erosion was given. It was apparently assumed that these forces will cause erosion.

Blaauw and van de Kaa (1978). They gave equations for predicting the jet velocity and turbulence intensity of a propeller jet. They provided equations for designing graded stone for bottom protection and gave some rules of thumb regarding the scouring depth of unprotected bottoms.

Verhey (1983). This report presented propeller velocity predictive equations. The author used shear stress to evaluate stability. A formula is presented for predicting scour depth.

Blaauw et al. (1984). As in many Dutch reports, they described very well the physical forces of vessel motion. They presented a method for design of bank protection but did not deal with bank erosion.

van der Knaap (1986)[1]. He summarized Dutch methods for predicting vessel forces and designing bank protection.

Bekendam et al. (1988). They reported a major study effort on the Rhine River addressing increasing pushtow traffic from four barges to six on portions of the river system in The Netherlands. As a result, numerous studies were conducted including analytical studies, physical model studies, and prototype studies. Determining navigability was the main objective, particularly bendway widths and maneuvering situations in various flow conditions and the associated economics. This report also presented conclusions of studies related to navigation effects and their relationship to bank erosion, sedimentation, and ecological factors.

A summary of data obtained from the comparisons of aerial photographs shows that in reaches with pushtow traffic on the Dutch section of the Rhine system, about half the system has bank protection and the other half is unprotected. Of the unprotected banks, approximately 14 percent have erosion rates of greater than 1 m/year and 70 percent have erosion rates of 0 to 1 m/year. Due to the complexity of the phenomena, the Dutch authors stated that differentiation between cause and effect was difficult. Therefore, they took the approach of studying the physical forces from the pushtows instead of measuring the erosion itself.

Previous studies concluded "pushtows induce large currents and indicated that the impact on river banks without groynes is the same for six-barge pushtows as four-barge pushtows" assuming vessel speeds are the same. The tests described in this paper focused on sediment movement within groyne fields (unsubmerged dikes). Field tests were conducted in two river reaches (a bend and a straight reach) with groyne fields where velocities, waves, and suspended sediment were measured **without** the presence of tows. These data were used to calibrate a 1:25 physical model with groynes in which hydrodynamic data were collected and tracer tests with polystyrene were conducted in the presence of pushtows.

The following conclusions were reported regarding sedimentation and erosion:

a. Four- and six-barge tows increased sediment transport downstream of the groyne head.

b. Net transport of tracer materials in the small-scale model out of the groyne field was 1.5 to 2 times higher with the bigger barge train.

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[1] F. C. M. van der Knaap. (1986). "Load and strength aspects of bank and bottom protection in ship canals," Lecture, Postdoctoral course on bank and bottom protection, Delft University of Technology, The Netherlands.

c. Pushtows cause erosion in groyne fields.

d. Erosion downstream of the groyne field can ultimately lead to bank collapse.

And finally, "the rate of bank erosion due to pushtows cannot yet be predicted and more information is required about the recovery capability and local sediment transport." The authors suggested bank protection, as they would for four-barge tows.

It is interesting to note some of the comments on the ecological aspects of the Rhine system as presented by the same authors. In fact this section spells out concerns that have been raised on the UMRS, except that the Dutch waited too late. Many of the viable habitat areas and ecological factors necessary to maintain biotic diversity are already gone. The river channel that formerly meandered through the floodplain is now fixed. Small islands and sand banks have disappeared. Riverbank maintenance has flattened natural levees and disconnected contiguous side channels and back waters. Annual hydrographs have moderate fluctuations.

According to the authors, "The loss of natural environment has been considerable, continuing still because of the severe water pollution originating from large industrial zones and densely populated areas. The direct influence of navigation on the natural environment of the river banks causes the loss of bank and channel edge vegetation. The banks are exposed to intense water movement as ships pass. Introduction of larger scale nautical units such as six-barge pushtows may increase the influences already exerted on the natural environment of the river banks."

And in the conclusions, "A substantial loss of plant and animal habitat has taken place, due to river bank erosion, enforced wave action on unprotected beaches and artificial bank protection constructions that suppress natural processes.... Apart from nautical restrictions, methods not contrary to the natural river regime must be developed."

Pilarczyk et al. (1989). This report presented the general philosophies and experiences of the Dutch in protecting their navigable rivers from erosion caused both by natural processes and navigation effects. It reiterated the study conducted to determine the effect of increasing pushtow units to six barges from four and provided summaries of both field and laboratory studies in groyne fields. See Bekendam et al. (1988) for further conclusions.

Verhey and Bogaerts (1989). The authors used available data, physical models, and field investigations to develop predictive equations for secondary waves produced by ships. A modification of the wave height prediction included coefficients for various ship types and wave characteristics developed from a relationship by Havelock that included the independent variables of ship speed, water depth, and sailing line. The authors then developed bank protection criteria of riprap and blocks against secondary waves using small-scale physical model testing. An equation was also given for the extent of bank protection required based on wave runup. Profile data were collected on the transport of the stone slope protection. No information was given on bank erosion of natural soils.

USSR studies

Balanin et al. (1977). They defined variables of ship motion in USSR canals. They discussed the impact of navigation increases on the system with respect to design of the canal, bank stabilization, and navigability. Other than stating that increases in navigation are expected to increase bed and bank erosion, the paper does not deal with bank erosion. There are other references providing better estimation techniques for determination of navigation-induced forces.

Grigor'eva (1987). He used a method developed by the State Hydrological Institute for predicting reservoir banks reforming due to wind waves. The author applied the method to small canals (less than 30 m wide and 2 m deep) where small ships navigate and produce wakes. The method was adapted by converting time to number of ship passages. This exercise was purely mathematical and did not involve verification in the field. A volumetric displacement of materials was calculated based on the wave energy produced and a coefficient of resistance for four different soil types. The conclusions were as follows: small ships rework the channel banks, bank reworking is highly dependent upon ship wave height, the banks change by increasing the top width of the canal while simultaneously narrowing the deeper sections, since bank deformation is directly attributed to the number of vessel passages, and in areas of concern the traffic should be limited.

German studies

Fuehrer and Romisch (1977). They presented study results on calculations of return current, squat, and critical speed of a vessel. The paper gave a description of the propeller jet and methods for calculating the jet velocity. The paper stated that erosion near hydraulic structures is often due to the propeller jet velocities and turbulence, and gave a formula based on a steady jet load for evaluating scour.

Fuehrer, Romisch, and Engelke (1981). They conducted physical model tests in a trapezoidal channel for two types of vessels. They used sand on the banks and determined the erosion potential due to vessel passage. In general, they determined that propeller jets had more influence on stability during maneuvers and waves dominated bank erosion for ships underway. Furthermore, ships maneuvering bends can scour both banks due to drift angle. They gave methods for calculating stable bank protective layers for straight and curved reaches.

Oebius (1984). He presented formulas for predicting the velocity distributions in a propeller jet. He also provided equations for estimating the shear stresses on the bed or embankment caused by loads induced by parallel jets, inclined jets, and impinging jets. Since scour depth is a function of reaction time, the author stated: "It can be seen that about 50% of final erosion depth is reached within half an hour, a relatively long time compared with the reaction time. This means that the risk of damages in regions of low density of traffic is low, but extremely high in areas which are very near to the propulsion system or where the sequence of individual events is very short thus provoking long term effects."

Swedish studies

Bergh (1981) and Bergh and Cederwall (1981). They described research conducted in Sweden on the scouring action of propellers in harbor areas. The researchers presented propeller jet predictive equations and suggested the use of critical bottom velocity to determine the initiation of motion or scour potential. A simple equation was presented for critical velocity that can be used to estimate the risk of erosion.

British studies

Prosser (1986). This report gave methods for predicting propeller jet velocities. Shields' criteria were applied to determine if materials are erodible and, if so, an equation was given for predicting maximum scour depth. An example shows how these methods can compare different operational constraints such as reduced jet velocities, increased underkeel clearance, vessel position, etc.

Garrad and Hey (1988). As stated in the summary, "Since 1945 the width of the Broadland rivers has increased dramatically. This is shown to be mainly due to wave attack by boat traffic aggravated by a decline in bankside vegetation. Management options to reduce bank erosion include curbs on boat speed and bank protection."

Studying historical surveys since 1883, the authors stated that bank retreat on lower reaches of the Bure River in eastern England has dramatically increased during the period 1946-1976. Further investigations using aerial photographs showed even steeper increases at some sites after approximately 1970.

Due to the naturally low intensity energy of the system as calculated by the authors and the relatively high intensity energy from passing boats, the authors concluded that boats are indeed causing the banks to retreat.

This study provided interesting conclusions to more detailed investigations not presented in the paper. It discussed such things as emerged macrophytes and their ability to dampen wave energy up to a threshold in which the mat fails, and the erosional resistance of the bank materials which in this case were silts, clays, and organic peat. Although the rivers studied were much smaller than the Upper Mississippi (on the order of 46 m (150 ft) wide), the research presented warrants further attention.

Hamill (1988). He used two different scale model propellers and four different uniform grain sizes. The author conducted laboratory experiments varying the distance to the bed and propeller speeds to determine the scour characteristics associated with the propeller jet. The author presented an equation for the development of the rate of scour due to a propeller jet for use on sands in the medium to coarse range.

Thorne, Reed, and Doornkamp[1]. They developed guidance on bank erosion studies and solutions for the National Rivers Authority in England. One of the many processes they described is boat wash. By their definition, boat wash includes vessel-generated waves, water level changes and currents, and propeller wash. The authors stated: "Boat wash can be a primary cause of bank erosion and retreat. Its severity increases non-linearly with boat speed, but is also affected by vessel design, waterway size and geometry, and the proximity of the sailing line to the bank." No equations or relationships were given to predict the rate of erosion due to boat wash.

Australian Study of Gordon River, Tasmania

Nanson et al. (1993) focused on correlating boat wave characteristics to erosion rates. They made the following statement (as the authors of this report have also found): "The American studies tend to fall into two groups: those that investigated the waves produced by river vessels and those that dealt with the extent and processes of bank erosion. Few studies examined both the magnitude of wave attack and the amount of bank erosion, and none have attempted to establish a relationship between these variables."

In their literature review the authors cited many references also used in this report (Camfield, Ray, and Eckert (1980); Garrad and Hey (1988); Bhowmik and Demissie (1983); Oswalt and Strauser (1983), etc.). One reference, by Limerinos and Smith (1975), compared wind waves, boat traffic, and flood

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[1] Thorne, Reed, and Doornkamp, op. cit.

flows in two narrow navigation channels on the Sacramento-San Joaquin River Delta, California. In that study, the channel dominated by flood flows attributed 20 percent of the annual energy expended on the banks to boat waves (twice as much as wind waves), and on the other channel 80 percent of the energy was attributed to boat waves.

In this study, the authors measured bank retreat, basal swash load, upper swash load, and wave trains for three recreational craft passing approximately 31 m offshore. The boats were the "wave generators." Each wave train was analyzed for wave periods, wave lengths, wave heights, and wave steepness, etc. Mean wave power per unit crest length was calculated from Komar (1976) as

$$\bar{P} = \frac{1}{8}\rho g H^2 C n \tag{8}$$

where

$\overline{P}$ = mean wave power

ρ = water density

g = gravity

H = wave height

C = wave speed

n = fraction of wave power that travels forward with the wave group

For waves in deep water, $n = 0.5$. Wave power was calculated for both the maximum wave height and the significant wave height. The wave power for the significant wave height was multiplied by one-third the total number of wave crests in the wave train to give a comparative measure of the total wave power in each wave train. A correlation matrix was made between wave characteristics and erosion characteristics.

The highest correlations were found between significant wave power and erosion. Also there was a good correlation between significant wave height and erosion. ("Significant" is defined as the average height of the highest one-third of waves in each wave train.) The analysis also showed erosion increases with wave length, but does not correlate to wave steepness.

The authors pointed out some inherent problems with the measurements, but still found reasonable correlations to the variables. They concluded that even though the correlations to erosion are slightly less for maximum wave height than significant wave height and other parameters, maximum wave height should be used due to the ease in measuring that parameter. Therefore, the threshold for noncohesive alluvial sand is a maximum wave height of 30 cm. Based upon their analysis of the swash loads, they stated that erosion processes can be accelerated by destabilizing the base of the bank and moving unconsolidated materials from the bank to the channel at wave heights of 5 to 10 cm. The controlled tests resulted in relatively large rates of recession because the waves were breaking at the base of a 2-m-high sandy bluff.

In the study of pre- and post-speed limit restrictions in the 45- to 55-km/hr area and 17 km/hr, respectively, erosion rates decreased from about 1 m/year to 0.3 m/year.

Nile River Study

El-Moattassem and Hassan (1991) investigated the River Nile fleet effects on bank erosion and river evolution. The authors assumed that the major hydrodynamic effects on the bank are river current and ship waves. The authors concluded that drawdown and return velocity are negligible in regard to bank erosion effects. Other factors were not considered in this study.

The authors studied several existing equations for wave height predictions including Balanin and Bykov (1965), Hochstein (U.S. Army Engineer District, Huntington, 1980), Bhowmik and Demissie (1982), and Sorensen and Weggel (1984). Sorensen's deepwater ship wave equations were assumed applicable and were applied with new coefficients for hull types. The predictions were found to be valid in the deep section near the channel thalweg but not as accurate in the shallows where refraction can occur.

The authors concluded the following: (a) upbound ships produce higher waves than downbound ships (Note: it is not clear if boat speed is relative to earth or water); (b) when a ship travels in the thalweg close to a bank, the diverging ship waves result in significant erosion (no data or erosion rates are given to support this theory); and (c) sediment transport in the shallows was significant due to ship motion.

Ohio River Studies

Hagerty, Spoor, and others have conducted studies and authored numerous papers about bank erosion. In particular, Hagerty has studied in detail both the Ohio and Illinois Rivers (see also section, "UMRS Navigation Erosion Studies"). There were numerous other papers by Hagerty and colleagues describing the Ohio River studies and the mechanisms of piping and sapping. Some of these studies were Hagerty, Spoor, and Kennedy (1986), Hagerty, Spoor and Parola (1995), Ullrich, Hagerty, and Holmberg (1986), and Springer, Ullrich, and Hagerty (1985). Several studies are discussed in the following paragraphs.

WES field efforts on the Ohio River and the Gallipolis General Design Memorandum

In January 1978, a scope of work was prepared for field studies on the Ohio River to identify and evaluate the physical effects of tow traffic on the river environment in the Gallipolis and Greenup pools. The data were collected in May and August of 1978. Data from these studies were given to the Huntington District in support of litigation regarding claims against the Corps and for replacement studies for the Gallipolis lock.[1] Results of this field effort are also referenced in Hagerty, Spoor, and Ullrich (1981). The maximum wave height for trip 1 was 1.0 m (3.3 ft) and 0.43 m (1.4 ft) for trip 2. The field trip analysis in summary stated that wave heights decreased with distance from the sailing line, increased with vessel speed, were smaller over a sloping bottom, and smaller for upbound vessels.

U.S. Army Engineer District, Huntington (1980)

This appendix to the Gallipolis General Design Memorandum entitled, "Environmental and Social Impact Analysis," contains data and results of field tests conducted by WES in 1978. This part of the planning study developed the Environmental Impact Statement for the lock replacement at Gallipolis on the Ohio River. The scope of the study was similar, if not identical, in nature to the UMRS environmental studies in that both the physical and environmental effects of tow traffic were to be addressed. The introduction stated: "An attempt was made to identify impacts of navigation as they related to the physical and biological environment in and along all navigable inland waterways." The investigation included bank stability.

The environmental study objectives were accomplished through field investigations of primarily physical forces and biological indicators, such as chlorophyll and plankton samples, at five field sites in the Gallipolis and Greenup pools. Criteria for site selection were established by an interdisciplinary team and included areas of active bank caving, reaches where tows navigated near the bank, temporary mooring areas in shallow waters, and areas downstream of tributaries.

Based on the study of historical photographs, maps, and aerial photography, the report stated there are and have been many locations of moderate to severe

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[1] Personal communication, 9 October 1979, Tim Fagerburg, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

bank erosion along the Ohio and its tributaries. Regarding bank failure and erosion the report said, "Erosion, sediment transport, and deposition processes are at dynamic near-equilibrium within the Ohio River Drainage basin. Significant bank erosion and bank and slope failures occur during and immediately after storms and floods...Lack of understanding of causative mechanisms has resulted in misassignments of these significant increments of bank failure and erosion to effects of navigation use and establishment of navigation pools; however, bank and slope failures and erosion have occurred through time."

A reconnaissance study was undertaken to map the location of existing bank erosion and "place causative mechanisms in perspective." The conclusions stated that the Ohio River is a relatively stable large river with bed and bank failures and erosion, primarily as a result of flood flows or natural mechanisms. Less than 5 percent of the total physical and biological impacts were navigation related.

Regarding the field studies for tow passage, three general categories described data collections: bank studies, shallow-water studies, and channel studies (both water column and river bottom). The bank and shallow-water studies assessed wave impacts, and the channel studies evaluated return currents and propeller jets. The data collection appeared very intensive using many instruments and collecting as much information as was physically and technically possible at the time. Over 200 tow events were recorded at the five field sites during two trips (high and low water).

Measurements of velocities and wave heights at an embayment near the main channel were taken during tow passages. Ambient velocities were essentially zero until tow passage. Flow reversals were noted at a maximum 0.85-m/sec (2.8-fps) velocity. Wave heights (maximum recorded, 10.2 cm (4 in.)) were smaller than corresponding wave heights in the main channel. This was attributed to waves dissipating in the shoaled area.

To determine impacts of increased navigation on the Ohio River, worst-case conditions were selected. An upbound, fully loaded fleet of tows 354 m (1,160 ft) long, 5,600 hp was used. An analysis of tows navigating along the sailing line and 46 m (150 ft) from shore for several riverflow conditions was made. The frequency of proposed traffic was assumed to be 24 tows per day. The most critical effects were assumed at minimum depths of 3.7 m (12 ft) in the upper reaches of the pools. Twelve representative cross sections were selected and analytical equations were applied to predict wave heights, return currents, propeller jets, etc., for the different scenarios.

For large blockage ratios such as those on the Ohio River, diverging waves, not drawdown, dominated the wave spectrum except when the tow was traveling within 30.5 m (100 ft) of the shore. The study concluded that since tows within 100 ft of the shore are a rare occurrence for this condition, effects of drawdown on the bank are insignificant. Since eroding potential increased when sailing lines were within 46 m (150 ft), the study suggested avoiding this condition. The report stated that "as far as wave energy generated by a tow is concerned, calculations indicate that it takes approximately 50 tows to deliver as much energy as would a four hour storm, with wind velocities of about 40 fps."

Hagerty, Spoor, and Ullrich (1981)

In response to complaints that increasing traffic and vessel draft were responsible for bank erosion on the Ohio River, the authors conducted a study for the Corps. They reference studies conducted for the Huntington District in which waves from more than 200 commercial tows were recorded. The maximum wave height recorded was 1 m. The authors stated: "The wave data and observations made during numerous reconnaissance trips indicate that wave-related erosion is not significant in comparison to storm- and flood-related bank failures and erosion. On the other hand, it was noted that prop wash and direct impact from motor vessels (e.g., temporary moorings) can significantly alter bank areas. Also, in the Ohio River system, islands were found on which banks near the designated channel areas (thus potentially most subject to vessel waves) were vegetated and apparently stable, while the opposite banks of these islands (remote from potential traffic effects) were bare and apparently failed and eroded."

Hagerty (1983)

The author stated in the conclusions (as found in his other papers as well) that neither wave attack (whether wind or tow-generated) nor propeller turbulence (whether commercial or recreational craft) contributed significantly to bank failure or erosion on the Ohio River.

Hagerty and Hagerty (1989)

After first conducting an extensive bank erosion study on the Ohio River from 1976 to 1983, the authors were asked to reevaluate the situation in 1986. Louisville District requested this reevaluation to settle the controversy surrounding alleged erosive effects of commercial navigation traffic. The authors went back to 150 sites on the Ohio and reevaluated them with the same criteria as before. They also evaluated the relative increases and decreases in commercial traffic over this time frame and concluded there was no correlation between commercial traffic effects and bank erosion. In fact, the authors reported major increases in bank stability in 1986 compared to the original survey in spite of increases in commercial traffic between the two surveys.

Hagerty, Linker, and Beatty (1989)

A short-term investigation of bank erosion was conducted before and after construction of Smithland Lock and Dam on the Ohio River. The study was designed to evaluate bank appearance before and after the pool was raised. Efforts were made to isolate the effects of stage and seasonal vegetation coverage. According to the authors, "The changes in the appearances of the river banks which had taken place from one inspection trip to the next were attributable to permanent inundation, to differences in river stage, and to differences in seasonal vegetative cover at the times of the inspections."

Hagerty and Hamel (1989)

Regarding cross sections analyzed on the Ohio River and the Illinois River in 1988, the authors stated, "These cross-sections indicated that undercutting by waves or by currents during floods is not an important cause of bank failure on these alluvial stream banks. The topography seen on the banks indicated conclusively that bank failure and erosion occurred almost exclusively above the minimum navigation pool level."

Hagerty and Spoor (1989)

This report reviewed the bank erosion studies on the Ohio, Kanawha and Illinois Rivers conducted by the authors. On the Ohio, two-thirds of severely eroding sites in 1977 through 1983 were found stable in 1986. Since all sites were exposed to similar navigation effects, since traffic had increased as much as 49 percent between 1977 and 1986, and as a result of site-specific investigations, the authors concluded: "Waves and turbulence from commercial traffic in the stream channel do not initiate significant bank erosion along the Ohio River. However, fleeting activities and maneuvering near the bank could cause localized impacts." They also eliminated in-channel forces (secondary currents and turbulence) as causal mechanisms on the Ohio River. Failures were attributed to piping.

UMRS Navigation Erosion Studies

There are several studies on the influence of vessel-generated forces on bank erosion in the UMRS. The following authors conducted studies by measuring either the wave heights from commercial and recreation craft, changes in velocity, sediment resuspension, and/or bank line retreat on reaches of the Upper Mississippi and Illinois River now under consideration in the navigation study.

Bhowmik (1976)

A field data collection program was conducted in Lake Carlyle on the Kaskaskia River, a tributary to the Mississippi between the Illinois and Ohio Rivers. Wind data, wind wave data, and boat-generated wave data were collected, and existing stone protection around the lake was evaluated. The author offered a design procedure for riprap protection on banks due to wave action. To validate this design equation, he compared the computed stone sizes to his field observations.

Regarding boat-generated waves, he stated: "It is reasonable to expect that the lake shore must dissipate a major amount of wave energy in a shorter period of time whenever the boat is running close to the shore. Therefore, it might be advisable to ban any high-speed motor boat, say within 100 ft of the shore line."

In his conclusions he stated: "Extensive lake shore erosion caused by wind-generated waves is present in Illinois." He also showed a picture of an eroded bank that presumably failed as a result of wind waves. No criteria relating wave height to bank erosion, measurements of bank recession, or method for analysis was given to substantiate these conclusions.

Bhowmik and Schicht (1980)

The Corps employed the Illinois State Water Survey to conduct a 5-year demonstration program on the effects of increased Lake Michigan diversion on the bank stability of the Illinois River. The main objectives of the study were to "1) document present bank erosion areas, 2) develop present plan views of severely eroded banks at about 20 selected reaches, 3) make bank stability analyses for each reach, 4) attempt to assess the effect of the increase in the Lake Michigan diversion on bank erosion, 5) propose a monitoring system to document any future changes in bank conditions, 6) suggest future research areas that should be undertaken to better identify the causes of the bank erosion of the Illinois River."

Twenty-four reaches of severely eroded riverbank were charted during a 5-day field inspection trip. Suspended sediment and soil samples were collected at these sites. Based on evaluation of the sites considering proximity to sailing line, wind fetch, riverine hydraulics, etc., the report hypothesized the causes of the erosion.

The stability analyses techniques were Lane's critical tractive force method, permissible velocity for bank material sizes, and Shields' criteria. For waves, the authors calculated the significant wind wave height and used a riprap stability equation to determine a stable rock size. The authors did not give a minimum wave in which no protection is required. In fact, they stated that banks subjected to waves without protection will erode.

The conclusions stated the following: "On the basis of present and anticipated flow conditions and of measured and estimated hydraulic parameters, bank stability analyses at each study reach were made following different accepted procedures. Stability analyses indicate that as far as the flow hydraulics are concerned, bank erosion along the Illinois River will not be affected by the proposed increase in diversion. In all probability, the main cause of the bank erosion of the Illinois River is the wave action caused by the wind and/or waterway traffic."

Environmental Science and Engineering (1981)

This report documented the results of two 1-week field collection studies. During this study two-directional velocities and water quality data were collected during tow passage. Although no data were gathered regarding sediments or bank erosion, the authors postulated conclusions regarding potential impacts to sedimentation.

Boszhardt and Overstreet (1981)

This study was conducted under contract for the Rock Island District to survey cultural resources in Pool 12 of the UMR. The authors stated that all 15 archaeological sites, of which 12 are located on main or side channels and 3 in backwaters in Pool 12, are being destroyed by erosion associated with maintenance of the 2.74-m (9-ft) channel and the lock and dam system. The authors stated: "All individuals consulted agree that navigation improvements and navigation practices contribute to erosion of landforms within the pool."

In the study the authors, citing Gramann (1981) and others, stated that waves, both boat-induced and natural, are causing increases in erosion rates exacerbated by losses of vegetation along the shorelines due to pool operations. Since the information collected at each of the sites included only geologic attributes, cultural artifacts, and condition of banks, the authors used the opinions of other researchers to form general conclusions regarding the causal effects of erosion at the sites.

The authors, estimating that the annual losses of shoreline are 1-2 m per year in Pool 12, expect total destruction of some sites within a few years if no action is taken.

Bhowmik, Demissie, and Osakada (1981)

The authors stated that along some reaches of the Illinois River, 75 percent of the banks are eroded by wind- and traffic-generated waves, citing a 1980 study. In this study, the authors conducted six field studies at two sites on the

Illinois River and two sites on the Mississippi River. They measured waves from passing tows and collected data for a total of 59 events. The maximum wave height measured was 0.33 m (1.08 ft) and the maximum drawdown 0.21 m (0.69 ft). The relative significance of tow-generated waves versus wind waves could not be ascertained from this study.

Bhowmik and Demissie (1982)

They present an empirical equation developed from field studies on the Illinois and Mississippi Rivers for maximum wave height as a function of vessel Froude number (based on tow draft).

Bhowmik and Demissie (1983)

This article summarized some of Bhowmik's work to date. The authors described the processes of erosion due to wind- and boat-generated waves. Specific information was not given, and the authors referred to studies described in more detail in this literature review. They concluded with the following specific information regarding the Illinois and Mississippi Rivers, "River traffic generated waves in most parts are less than 1 ft in height. For a 2-year, 6-hour duration wind, the significant wave heights can reach up to 0.9 ft on the Illinois River and 1.3 ft on the Mississippi River. For a 50-year, 6-hour duration wind, the significant wave heights can be as much as 1.6 ft on the Illinois River and 2.4 ft on the Mississippi River. A thorough analysis of wind-generated waves and river traffic generated waves over a certain period of time is needed before the relative importance of these two types of waves on the bank erosion potential of any river can be estimated."

Oswalt and Strauser (1983)

The authors stated that navigation effects differ according to whether the system is open river, a confined waterway, or a maneuvering area. Only small changes in the bankline were observed by the Erosion and Sediment Work Group of the GREAT III study on the UMR, St. Louis District. Furthermore, the authors stated: "The total bank erosion experienced in today's improved waterway is less than that experienced by the river in its natural state. Of the bank erosion that is experienced, the portion attributable to navigation is presently difficult to quantify. Some types of bank erosion are erroneously attributed to navigation when, in fact, other more subtle causes are responsible." The authors suggested when blockage ratios are less than 10, problems could occur.

Warren (1987)

Based on historical observations, the author found the Illinois River geologically stable until the early 20th century. He summarized the findings of previous studies, citing many of Bhowmik's papers on the Illinois River. The summary stated: "Although it is difficult to judge the amount of bank erosion that occurred along the Illinois River under natural conditions, there is little question that erosion rates are much higher today. The modern channel is still straight, but a variety of artificial changes in the regimen of the Illinois have both reinforced old causes and introduced new causes of erosion... some of the more important of these changes include the heightened water-surface elevation of the river; the increased frequency and magnitude of flooding along the river; the increase in wave action generated by vessel traffic and, perhaps, by wind; the introduction of drawdown as a new erosive force; and probably also the feedback between these various factors and the modern characteristics of cutbanks along the river. Together, these man-made causes and conditions have helped to create a severe erosion problem along many stretches of the Illinois River."

A field study was conducted at five archaeologically important sites on the Illinois River. Rates of erosion were measured both horizontally and vertically over a period of approximately 6 months. At all but one site, banks were generally eroding. A statistical analysis using multiregression of 14 variables related to site characteristics and erosion measurements was conducted. (None of the variables related to processes such as wind energy, or vessel waves, etc.) The average horizontal erosion rate at the five sites was 1 mm/day, with a high of 2.5 mm/day at one site and a low of -1 mm/day at another. Extrapolation of these rates indicates a 35-cm loss of bank deposits per year along the lower Illinois River. The author concluded that since erosion occurred on both sides of the river in both convex and concave channel areas, natural phenomena could not have caused the erosion; therefore, much of the erosion must be due to vessel traffic.

Spoor and Hagerty (1989)

The authors conducted a detailed bank erosion study on the Illinois River. They investigated 31 sites, 20 where previous erosion had been observed by Bhowmik and Schicht (1980) and 11 considered more typical of those found on the waterway. Their study objectives were to observe existing bank conditions, to determine the erosion or failure mechanisms involved, and to describe the relative significance of each.

The study area was first observed by a helicopter overflight, followed by a boat trip where detailed information was obtained. Navigation charts were color coded to indicate bank conditions.

According to the authors, wave action from winds or vessels was not a significant cause of bank erosion; this conclusion differed from that of studies by Bhowmik. Their conclusions were based on the lack of eroding banks near areas where the banks were protected by sunken barges. The failures were attributed primarily to seepage mechanisms.

In conclusion the authors stated: "Investigations conducted in 1988 along the Illinois Waterway indicated that bank failure and erosion are initiated by the flow of water out of the banks and removal of soil particles by piping/sapping.... Wave swash did not appear to be a significant mechanism for removal of inplace soils, although levee notching indicated erosion by a combination of waves and tractive forces during floods. Propeller turbulence was a cause of only very localized bed/bench scour.... Waterway bank erosion was not severe or widespread; even within the pools where erosion was most extensive, only 6 percent of the total bank length was severely eroded."

Karaki and van Hoften (1975) studied the resuspension of bed sediments by tows and wave effects from tows and recreational vessels on the UMRS. The authors report that "the effects of increase in waves on river banks will depend on bank stability, and river bank form. Most sections of the river system have had wave wash from winds and boats for many years and are quite stable. Additional waves of the same heights generated by increased traffic are not likely to cause any significant increased rates of bank erosion where none is presently evident. Also, any river bank area that is being eroded by waves will continue to be affected, at an accelerated rate....The effects of fast moving boats are more destructive to river banks than waves from slower moving towboats."

Bhowmik, Soong, Reichelt, and Bogner (1990)

Recreational boat wave data were collected at an Illinois River site near Havanna, IL, and a Mississippi River site near Red Wing, MN. The data consisted of controlled boat runs and waves generated by recreational vessels during a busy Labor day weekend.

Statistical analysis of data from the controlled runs showed that the maximum duration of waves by individual crafts is about 42 sec with an average of 22 sec and within each wave train there could be a maximum of 30 waves and an average of 12 sec. Frequency analysis indicated the waves were predominantly 0.14 m with a maximum of 0.58 m.

In the uncontrolled data from the Red Wing site, a significant hourly wave height was determined. The significant wave height was defined as the wave height where one-third of the waves are larger. Maximum significant wave heights at this site were 0.4 to 0.5 m.

Bhowmik, Reichelt, Seddik, and Soong (1992)

Wave height data were collected and analyzed from recreational craft at a site on the Illinois River near Havana, IL, and a site on the Mississippi River near Red Wing, MN. Wave data were collected for over 240 controlled runs with 12 different boats. A regression equation was developed from these data and presented in this paper. Data were also collected on uncontrolled boating events on the Mississippi River. Over 700 boats passed one site in one day with a peak of 120 boats in 1 hour. Bed material samples were collected at both sites and suspended samples were collected at Red Wing. Other data collected were ambient velocity information, field site characterization data, and wind data.

Johnson (1994)

A study was conducted by the Minnesota Department of Natural Resources in cooperation with the U.S. Fish and Wildlife Service Environmental Management Technical Center to evaluate the recreational boating impacts on bank erosion in Pool 4 of the UMR. The study reach is upstream of Lake Pepin adjacent to Red Wing, MN. Three sites on the main channel and two control sites on the Wisconsin side channel were selected for monitoring. The main channel and side channel have similar geologic and hydrologic characteristics. Therefore, it was assumed that influences in the main channel could be attributed to vessel influences, particularly since all commercial traffic and most recreational traffic is in the main channel, and only limited recreational use of shallow-draft boats occurs in the side channel. An analysis of wind data and fetch suggested that wind waves were not responsible for the observed erosion.

Transects of the five sites have been surveyed approximately 15 times since 1989 including two surveys in the fall of 1993 and 1994, not included in the publication. The transects in the side channel remained stable over the study period, while the main channel transects showed shoreline recession of 3.0 to 4.3 m (10 to 14 ft) over this time frame.

Erosion rates were calculated in terms of area lost per day and normalized to a baseline selected during the winter months. A figure in the report shows the relative erosion rates over the survey period and indicates the recreational boating season. During the study, commercial traffic remained steady or slightly declined, whereas recreational boating increased. The relative erosion rates indicated increases in erosion during the recreational boating season in the main channel.

Turbidity data were collected in the main and side channels along with data on recreational boating activities. There was a strong diurnal flux in the turbidity levels in the main channel with peaks occurring on weekend afternoons during peak boating activities. Turbidities during boating activities when compared to no-wake zones were much higher. The author concluded, "From the results of the field investigations, it can be concluded that recreational boating on the Mississippi River Main Channel is the contributing influence most responsible for the documented high rate of shoreline erosion. Recreational boating is also directly responsible for elevated turbidity levels in the littoral zone during peak boating times."

It may be significant to note that Johnson observed that the main channel contains significant sand on top of the cohesive banks from dredged material placement whereas the cohesive banks in the side channel are exposed. Observations by Kamphuis (1990) suggest that the presence of sand in the main channel could have a significant effect on erosion rate. Studies are being conducted at WES to determine if beach nourishment sand is actually having a negative effect on shoreline stability.

Other Navigation-Related Studies in the United States

This section discusses several studies on bank erosion in other areas of the United States.

Das and Johnson

This study was conducted for the U.S. Army Coastal Engineering Research Center by the University of California (Das and Johnson 1970). Wave characteristics and total energy were obtained in towing tank tests of two vessel types, a mariner class cargo ship and a pleasure cruiser. The energy density was the mean square height of the waves, which varies with distance from the sailing line and ship speed. There was no information about the relationship between this energy and bank erosion, but the authors concluded that small boats can induce more serious wave conditions than can a large ship.

Anderson

Anderson (1974) conducted a field study measuring the suspended load in a tidal flat as several boats passed at specified testing conditions. His main study purpose was to determine the quantity of sediment resuspended by boat waves and track its fate or transport potential. If the resuspended matter is removed, one concern was that it could result in a potential erosion problem. If it is deposited elsewhere, it can have detrimental effects on either dredging requirements or sensitive environmental habitats.

A matrix of 16 foot valves connected to onshore pumps collected suspended sediment samples. Half were placed at 15 cm and half at 30 cm above the sediment/water interface. The sampling frequency was not given. Other data collected were temperatures and wave heights.

Six different boat types, from a 4.0-m (13-ft) aluminum skiff to a 10.4-m (34-ft) fiberglass tri-hull with 300 hp, were used. It is not clear from the testing descriptions the distance and speed at which each boat operated as it passed the nearshore sampling matrix. On page 2, last paragraph, the author stated that **one** of the six boats ran 46 m (150 ft) from the sampling matrix twice in rapid succession. He later discusses results based on the "first wave," "second wave," etc. It appeared the tests were designed to collect suspended sediments before, during, and following a "test."

The author concluded that the smaller boats actually caused decreases in suspended sediment probably due to mixing. The largest waves observed (20 cm) were from a 10.4-m (34-ft) lobster boat. The author states that its "first boat wave caused considerable in situ resuspension." The author describes the processes affecting the measured suspended sediments as mixing of concentrations already there, resupension occurring within the testing matrix, and materials being transported by tidal currents into the matrix from wave-resuspended materials outside the matrix.

Although supporting data were not given, the author stated the following in his conclusions, "The largest boat examined (34 foot lobster boat) with a displacement type hull caused considerable sediment resuspension at even slow speeds (5 knots). In contrast, tri-hulled type vessels which planed on top of the water caused relatively minor resupension and only resuspended sediment when operated at speeds less than planing."

The author also concluded from his study that more sediments were resuspended as a result of boat waves during the flood cycle than the ebb. In general, resuspended sediments could have a net landward transport. This report may be more useful in the sediment or recreational boat wave studies.

Liou and Herbich

Liou and Herbich (1976) presented a math model for predicting propeller jet distributions and a Shields approach for predicting incipient motion of bed materials. This was not related to bank erosion, but may be considered in evaluating propeller jets in areas where tows maneuver close to the bank.

Simons, Andrew, Li, and Alawady

Simons et al. (1979) determined that one process causing erosion is boat waves. While they characterized the boat waves as quite different from wind waves, they described their erosional processes as similar. The authors subjectively rated the relative significance of various processes on bank erosion. This qualitative assessment gave the most significant rating to shear stresses acting on a noncohesive bank and the least significant to freeze-thaw processes. Boat waves ranked third behind pool fluctuations.

Camfield, Ray, and Eckert

This report is very closely related to the purpose of this literature review. Camfield, Ray, and Eckert (1980) conducted a literature survey for the U.S. Coast Guard to identify causes of bank erosion, and summarized available information on vessel-generated forces with possible connections to bank erosion. This report is significant to the bank erosion study since it describes erosional processes and existing techniques for predicting forces very well. The following abstract summarizes the report:

"The purpose of this report is to provide a summary of the knowledge available on vessel generated wake, and the possible impact of this vessel wake on bank erosion. A literature survey was conducted to identify the various causes of bank erosion along waterways. A summary of the various natural effects and possible vessel effects is provided.

"Recession of waterway banks involves a large number of effects. The physical and chemical nature of the channel's water, the materials forming the bank, and the groundwater may increase the soil's erodibility by formerly noneroding water currents, wind waves, or vessel wakes.

"No computational methods exist for linking a vessel with a chosen hull shape, traveling at a chosen speed in a channel of chosen depth and chosen cross-sectional area and shape with banks of chosen height and materials, to a predicted occurrence of erosion."

Zabawa and Ostrom

Zabawa and Ostrom (1980) included a summary brochure highlighting important findings. Their purpose was "to evaluate whether recreational motorboat traffic is detrimental to the ecology of small creeks and coves in Anne Arundel County, Maryland." The Maryland Department of Natural Resources conducted field studies on two tributaries of the Chesapeake Bay at five site-specific locations where recreational boating is popular. To address critical questions, the study was designed to compare energies from wind waves and boat wakes, to measure shoreline changes on a monthly basis, and to relate wave energies to boating conditions.

Of the five sites monitored, erosion at one was determined to be directly attributable to boat wake energies. Even though this site did not have the highest level of traffic, it had the highest wake energies. In the study, it was concluded this was due to a higher number of boats getting closer to the shore, caused partly by the fact that the site was located in a narrow cove. In fact, the critical distance to avoid high-wave intensities was determined as 61 m (200 ft). They also determined that wave energies decreased at higher speeds. That is, maximum wake occurred before the boats planed. According to the study, maximum energies occurred at 3.1 to 4.1 m/sec (6 to 8 knots) especially in shallow water.

The article stated: "The (boat) wakes which were measured far exceeded the heights of normal wind-generated waves." And later it stated: "Wind waves ranked behind the storm effects in causing shoreline changes over the year of observations, and in all cases boat wakes represented lower levels of wave energy." These two statements can be interpreted as follows: even though individual boat waves can be higher than wind waves, the total annual energy produced by wind waves was found to be higher than the annual energy produced by boat waves, which only occur for shorter periods.

According to the conclusions, "The type of shoreline most susceptible to erosion would have a combination of :

- exposed point of land in a narrow creek or cove;
- fastland consisting of easily-erodible material such as sand or gravel;
- steep nearshore gradient on the shoreline profile;
- location adjacent to a high rate of boating, with boat passes relatively close to the shoreline."

At Site C where erosional activity was influenced by boating, suspended sediment data were also collected. It was concluded that the near-shore short-term suspended materials increased by more than two orders of magnitude after repeated passes of a recreational craft passing at 10.8 m/sec (21 knots) at a distance of 61 m (200 ft) from the shore.

This study provides regression equations between wave energy and boating frequency. It parallels the objectives given for the UMRS recreational boat wave study. Simple "rules," analytical methods, and guidance for field studies could be obtained from this reference.

Oswalt, Mellema, and Perry

Oswalt, Mellema, and Perry (1981) summarized mechanisms and studies on several Corps projects. Other than verbal descriptions of tow motion, no real connections were made to bank erosion. The authors recommended offshore mooring and lower speed limits in areas that may be susceptible to navigation effects.

U.S. Army Corps of Engineers

As a part of the streambank program, 20 sites were evaluated nationwide (U.S. Army Corps of Engineers 1981b). At the Delaware Estuary, the noted cause of bank erosion was vessel-induced waves. Erosion was more severe at high tides due to the wave attack at the base of the bank. Observed wave heights were from 0.6-0.9 m (2-3 ft). The observed bank erosion rate was approximately 0.6 m (2 ft) per year.

Kuo

Kuo (1983) is a literature review much like this one. Kuo summarized the work of Camfield, Ray, and Eckert (1980), Gatto (1982a), Anderson (1974), and Liou and Herbich (1976). In summary he stated, "Boat generated waves are not seen as a major problem affecting the rate of shore erosion, except in inlets, restricted navigational channels and relatively calm sheltered coves."

Linder and Wei

Linder and Wei (1986) attempted to determine whether hydropower operations at the Harry S. Truman Dam and Reservoir were contributing to erosion in the Lake of the Ozarks. The authors found power operations had no impact on bank failures. They suggested, without any supporting data, boat wake waves "appears to be a major cause of bank erosion."

Sorensen

Sorensen (1986)[1] characterized vessel-generated waves and reviewed available literature on bank protection for vessel-generated waves. Regarding sloped embankment failure, the author stated: "It may fail by sliding under its own weight and irrespective of external waterway forces. An embankment

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[1] Robert M. Sorensen. (1986). "Bank protection for vessel generated waves," prepared by Lehigh University, Bethlehem, PA, for U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

along a water course may also fail because of hydraulic forces including those due to currents and waves, both of which have some similar effects....

"...When waves attack the embankment they will break on the slope, loosen and suspend soil, and carry some of the soil away from the embankment. A "notch" will form above the mean water level with an upper slope at about the soil's angle of repose, or possibly steeper to nearly vertical if the soil has cohesive properties. The submerged slope, which is similar to the beach face slope at an ocean beach, will typically be much flatter than the original embankment slope. The resulting submerged slope geometry will depend on the soil particle size and to some extent on the level of wave agitation.

"As the wave attack continues the notch will progress into the bank, increasing in size, until the steepened and possibly undercut slope collapses. The collapsed slope will leave a talus pile at the toe of the slope. The talus will then be removed by wave and current action so the bank recession process can continue again.

"Water level drawdown and return flow caused by a passing vessel will impact on this process primarily in two ways. Water flow down and back up, as well as horizontally, past the embankment will cause scour at the embankment toe. This will supplement the wave induced scour at the toe and talus removal from the toe. Also, the temporarily lowered water level during drawdown causes brief, but significant, outward hydraulic pressure gradients near the embankment face. These gradients and resulting seepage decrease bank structural stability which can lead to sliding, they can cause soil particle migration from the bank, and they can decrease the ability of surface particles to resist wave and current scour."

Davis

This study[1] investigated erosion along approximately 22 km (14 miles) of the Gulf Intracoastal Waterway (GIWW) near the Aransas National Wildlife Refuge.

Shoreline retreat rates determined from aerial photo comparisons were 0.6-0.9 m (2-3 ft) per year along certain reaches of the GIWW. (Note: Johnson (1994) reported a similar rate in high traffic areas on UMRS.) The eroded area along this segment of the waterway has been about 36.4 hectares (90 acres) since 1944. Erosion rates (shoreline retreat) were evaluated over segments of the study area for three different historic periods between 1950 and 1986.

Although no erosion data were collected relating to vessel passages, the

[1] Jack Davis. (1988). "Study of erosion along the GIWW in the Aransas National Wildlife Refuge" (unpublished), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

author concluded that traffic contributes to erosion since traffic occurs on both sides of the waterway and in areas protected from the wind. Since erosion on one bank is higher than on the other, the author stated that other mechanisms are also influencing erosion.

In the study, two types of erosional problems were identified, a gradual widening of the waterway and breaching into inland bays. The report indicated a loss of materials from the shallow bays. This observation was noted in some other studies as well. Some concepts were presented for stabilizing bank erosion.

Abbe and Eriksen

Abbe and Eriksen (1989) used energy as computed by Ofuya (1970) to examine onshore, offshore, and alongshore sediment movement along the banks of the Columbia River.

Knutson, Allen, and Webb

This study (Knutson, Allen, and Webb 1990) was funded by the Corps under the Dredging Operations Technical Support program. It classified dredged material shorelines, provided guidance for stabilization through vegetative techniques, and compared the energies from ship- and wind-generated waves.

The report stated that frequently sediment deposition occurs rather than erosion due to the energy dissipation of waves in vegetated marsh zones near the shoreline. In fact, one study referenced reported accretion of 15 to 30 cm of sediment in a 2-year period along a vegetated shoreline. Due to this aggradation, some shoreline marshes have advanced at rates of more than 10 m per year. Beaches of certain soil types and unprotected by marsh plants were more susceptible to erosion.

In describing the changes to beach geometry due to waves, the authors stated that generally steep waves move material offshore and long-period waves move material onshore. Also "when disposal areas are close to navigation channels, movement of sediment may be primarily offshore."

To determine the relative importance of wind versus boat waves, a sheltered dredged material island in North Carolina was studied. The study found the following: "The island is exposed to a fetch of only 0.5 km, but is located on the Atlantic Intracoastal Waterway where it is exposed to waves produced by the passing of approximately 25,000 boats per year at a distance of 100 to 200 m. The magnitude and frequency of wind and boat waves were studied at this site over a 2-year period. The study found that boats could produce waves equal to those produced by extreme wind conditions. However, in every category of waves, wind-generated waves were 10 times more frequent than were boat-generated waves. Boat waves are probably responsible for less than 5 percent of the wave energy impacting this site. Considering the limited fetch and the heavy vessel traffic of this example, it would appear that vessel traffic alone will seldom be the limiting factor in establishing coastal marshes for erosion control."

It does not say that boats do not contribute to erosion of the shoreline, but establishment of vegetation is a function of the wave energy environment. The report offers three methods of establishing vegetation based on the wave energy classifications of low, moderate, and high.

At the North Carolina site (with limited fetch and high vessel traffic), boat characteristic and wave data were collected. The majority of the motor-powered boats passing this site were in the 6- to 10-m length range. Each boat was assumed to produce 10 waves with a period of approximately 2 seconds. The majority of these waves were on the order of 15 cm (< 0.5 ft) and a rare maximum of 30 cm (< 1.0 ft). These boats classify as recreational craft and would not likely produce drawdown and return currents.

Way, Miller, Paine, and Wakely

Way et al. (1990) described a software report that summarizes technical information available on the physical effects of navigation. Many of the references discussed navigation-related processes and are included in more detail in this report on bank erosion.

Bottin, McCormick, and Chasten

This report was also prepared for the Maryland Department of Natural Resources by WES (Bottin, McCormick, and Chasten 1993) as a guide to aid in the design of marinas in the Chesapeake Bay against boat waves. It provides a series of graphs for estimating wave heights for eight typical vessels found in the bay.

Thorne

This study (Thorne 1993) was conducted for WES under the Flood Control Channels research program. Thorne presented evaluation forms for field stud- ies of bank erosion. Along with listing other mechanisms for bank erosion, he described the impact of vessel forces. According to Thorne, damages can occur as a result of vessel-produced surface waves that are similar to wind waves, drawdown and surges that can loosen and erode materials, propeller wash if the vessel is close to shore, and the mooring of vessels along the bank.

As Thorne stated, "Evidence includes: use of river for navigation; large vessels moving close to the bank; high speeds and observation of significant vessel-induced waves and surges; a wave-cut notch just above the normal low-water plane; a wave-cut platform or 'spending' beach around normal low-water plane." He also noted the potential for mistaking the notch and platform, produced by the mechanisms of piping and sapping as described by Hagerty, for those produced by vessels.

Zhang, Hershberger, Spell, Ting, and Yu

Zhang et al. (1993) did a field investigation along the same stretch of GIWW near the Aransas National Wildlife Refuge as did Davis.[1] Two sites were selected to measure navigation effects, wind, and erosion rates. The sites selected had already experienced high erosion rates and had some form of shoreline protection in place. No sites were selected as a control.

Wind waves, tidal currents, boat waves, and velocities were measured at these two sites. Wind wave data were compared to an analytical model, ACES, based on the Great Lakes fetch and wave data. The model tended to overpredict wave heights when wind was blowing along the channel and underpredict when the wind was blowing across the channel. Annual and seasonal energy flux were calculated.

Attempts to verify existing models for ship waves (secondary waves) with data gathered from different vessel types were unsuccessful. The authors stated that "ship waves are the main source of energy to cause bank erosion."

Using a modification to the Bouwmeester momentum approach that considers boundary layer development, the authors found a good correlation between barge-tug drawdown and return current calculations and field measurements. They calculated the energy associated with drawdown and return flow based on a form resistance formula. "The energy impact on a unit length of bank is assumed to be equal to the work done by a ship to overcome ship resistance." This energy is the sum of the energy from drawdown return velocity, and secondary waves.

The authors did not directly link energy to measured bank erosion. They stated, however, that ship-induced waves and surges dominate the erosion mechanisms in the confined areas of the GIWW.

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[1] Jack Davis. (1988). "Study of erosion along the GIWW in the Aransas National Wildlife Refuge" (unpublished), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

5 Bank Erosion Models

Literature on bank erosion modeling was reviewed to determine if a model exists or could be modified to assist the UMRS bank erosion study. The types of models related to navigation-induced mechanisms that may have bearing on the techniques selected for the UMRS bank erosion study fall into several categories. They are as follows:

a. Much research has been done in hydrodynamic models of ship motion (Jansen and Schijf 1953; Sorensen[1]; Pilarzcyk et al. 1989; Bouwmeester et al. 1977; Hochstein and Adams 1989, etc.). Many predictive formulas exist for quantification of vessel-induced forces including propeller jets, drawdown, secondary wave heights, and return currents. These formulas have in large part been verified in field and laboratory studies. Currently at WES, physical forces modeling is addressing the adaptation of these formulas to the specific characteristics of commercial navigation traffic and waterways on the UMRS. New techniques are being developed and verified using physical model testing, particularly with numerical solutions.

b. Another class of models or analysis techniques might be called relative importance models. The authors go beyond simply predicting vessel forces by calculating the energy produced by vessel forces and comparing it with energy from other mechanisms. The most common technique compares wind waves and boat waves (Ouellet and Baird 1978; Zabawa and Ostrom 1980; Knutson, Allen, and Webb 1990; Zhang et al. 1993). A few attempt to include other natural mechanisms such as river currents.

c. The most important, but least available, is erosion prediction models. The literature had several levels of sophistication regarding this modeling type. In many cases the "models" are based on threshold criteria such as Shields tractive force or critical velocities (for example, Bergh 1981). Darby and Thorne (1993, 1995) discussed various numerical models of

[1] Sorenson (1986), op. cit.

width adjustment in curved alluvial channels. The approaches described are limited to erosion initiated by flow-induced tractive force scour of the channel. Copeland and Thomas (1989) used a numerical model to evaluate bank erosion potential by determining the magnitude of bed degradation on the San Francisco River. River meander models have been developed by Ikeda, Parker, and Swai (1981), Kitanidis and Kennedy (1984), and Blondeaux and Seminara (1985). In a wave model, Hodek et al. (1986) set a wave height criterion of 0.15 m (0.5 ft) as a threshold for the onset of sediment motion. Hanson and Kraus (1989) presented a generalized model for simulating long-term shoreline changes as produced by longshore sand movement. Reservoirs with significant wind wave duration experience significant longshore transport, but vessel-generated waves are not of sufficient duration to allow application of this model. Larson and Kraus (1989) developed a two-dimensional numerical model, SBEACH, for simulating dune and beach erosion from wind waves. Nairn (1992) presented a summary of the complex wave-induced erosion processes of cohesive shorelines and presented results comparing his wind wave model to observed shoreline changes. Hagerty, Spoor, and Kennedy (1986) developed an analytical model for piping failure of streambanks.

d. Blaauw and van de Kaa (1978) presented a slightly more useful approach on rules of thumb for scour depths due to propeller jets, beyond initiation of motion criteria. Prosser (1986) also presented an equation for predicting maximum scour depth due to propellers.

e. Only two references, however, made an attempt to actually develop a model relating navigation causes to effect. One (Grigor'eva 1987) was unverified and showed a conceptual method for bank reworking due to wind waves only. The other reference is a study conducted on the Gordon River in Australia (Nanson et al. 1993). The authors actually measured erosion rates while boats passed a site. They found good correlations between wave power or wave height and erosion. In spite of these relationships, they ultimately reduced their relationships to "thresholds." In particular, the threshold for noncohesive alluvial sand is a maximum wave height of 30 cm. For removal of unconsolidated materials as swash loads, the threshold is 5 to 10 cm. Erosion rates were presented for pre- and post-boating speed limits.

In developing a boat wave erosion model, concepts from the wind wave erosion models similar to Kamphuis (1987) are a possible beginning point but need modification. Wave power appears a commonly used parameter, but existing wind wave models generally deal with large enough waves that the threshold wave power to initiate erosion can be ignored. This is not the case in boat waves, and a formulation similar to Kamphuis but including threshold wave power P_t, such as

$$R = A(P - P_t)^B \qquad (9)$$

where P is the long-term average wave power may be required. Coefficient A and exponent B will vary with the parameters (soil type and shoreline bathymetry). More sophisticated models like SBEACH for sandy banklines and Nairn's (1992) model for cohesive shorelines need modification for the lower wave heights and different wave characteristics of boat waves. Modification of these models may be beyond the resources of the UMRS bank erosion study.

Wind wave erosion literature focused on the importance of foreshore slope erosion. Consider the bank profile in Figure 2 where the minimum pool elevation intersects the low sloping portion of the bank, referred to as the beach. If bank recession is defined as the movement of the waterline at a constant elevation such as the minimum pool elevation, then bank recession will not occur unless the waves are capable of downcutting the foreshore slope. Even if temporary high-water levels cause wave activity to break against the bluff, the resulting erosion will eventually be limited if the waves are not capable of downcutting the foreshore slope. This is the reason Kamphuis related long-term wind wave erosion to the rate of foreshore movement. Use of measured bluff recession rates over short periods of time when water levels are temporarily high and causing waves to impact against the bluff can lead to overestimates of long-term recession rates.

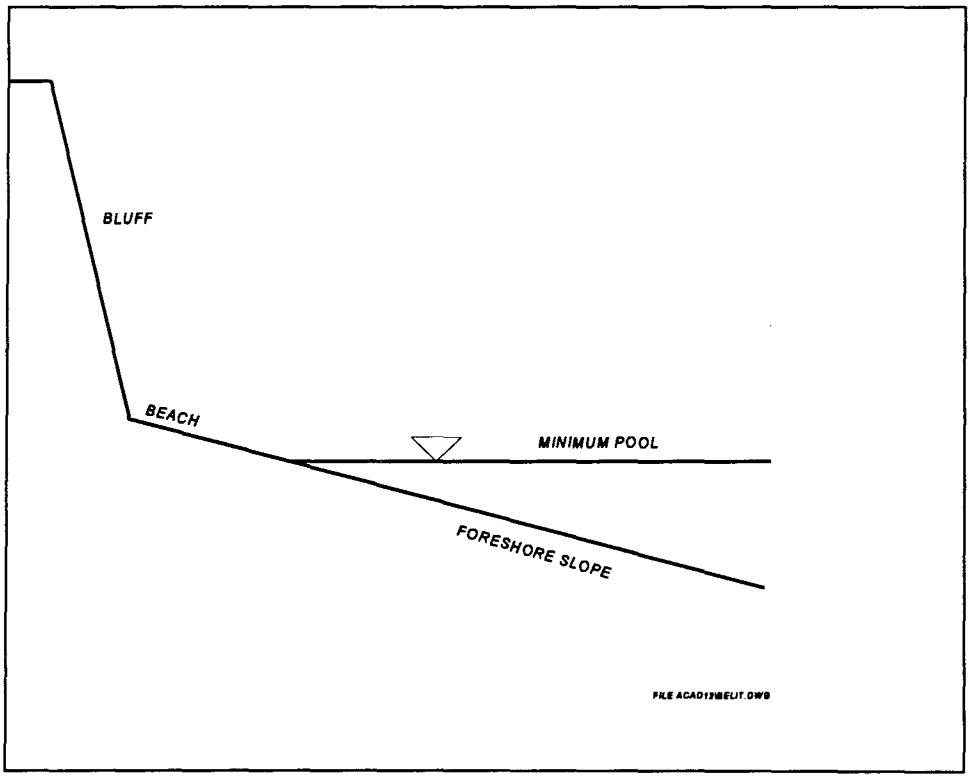

Figure 2. Schematic of shoreline

6 Dominant UMRS Bank Erosion Mechanisms and Their Identification

Dominant Mechanisms

Based on the cited UMRS reports, the experience of the authors of those reports, and the dominant mechanisms reported on similar streams, the dominant bank erosion mechanisms on the UMRS are listed in alphabetical order as follows:

a. Piping caused by flood recharge of banks and back of bank water sources. It is unknown if short-term drawdown from commercial vessels contributes significantly to piping-related failures. If true, piping caused by vessel drawdown would be limited to UMRS reaches having blockage ratios where drawdown magnitude is significant. Piping was classified as dominant because of the studies by Spoor and Hagerty (1989) on the Illinois River and the numerous studies by Hagerty and others on similar large, navigable, alluvial rivers.

b. Slope stability failures caused by undercutting due to waves, tractive force scour at high flows, piping, stage changes from flow variations and hydraulic structures, and moisture conditions in the bank. Bed degradation below UMRS dams can also contribute to slope instability. Again it is unknown if vessel-induced drawdown contributes significantly to slope failures. Slope stability failures are classified as dominant because their occurrence frequently follows the other four dominant mechanisms on the list.

c. Tractive force scour caused by high flows is generally accepted as a dominant mechanism on any alluvial stream like the UMRS. However, the literature did not reveal widespread occurrence of tractive force scour on the UMRS. Tractive force erosion is probably not extensive on the lower reach of the Illinois River (Lubinski 1993) (reach 2) because of the mild gradient. The 1993 Flood reports on the UMRS documented no significant bank erosion from an extremely large event both in magnitude and duration (USAED, Rock Island, 1994; USAED, Kansas City, 1994). It is likely that the numerous dikes and revetments on the UMRS partially explain the lack of tractive force scour. Tractive force scour at high flows was classified as dominant by the many authors who reported it as the major cause of erosion on alluvial rivers.

d. Wave erosion caused by vessels can be dominant in areas where traffic levels are high. Because of the lower amplitude and much less frequent occurrence from commercial tows, waves caused by vessels (short period) are predominantly caused by recreational vessels. Erosion from this mechanism would likely be greatest near metropolitan areas. Soil type plays a critical role in determining whether short-period waves are a dominant mechanism at a given site. Vessel waves (short period) were classified as dominant based on the studies by Bhowmik et al. (1992) and Johnson (1994) on the UMR.

e. Wave erosion caused by wind, primarily in the lower portion of UMRS pools, can be dominant where fetch distances are large. Wind waves were classified as dominant based on the many reservoirs experiencing wind wave erosion throughout the Corps in the presence of large impoundments on the lower portion of UMRS pools and the reports by Benn (1994) and Boszhardt (1990).

While these five mechanisms probably account for the majority of bank erosion on the UMRS, other less dominant or locally occurring mechanisms are present. The less dominant mechanisms are as follows (alphabetical order):

a. Freeze/thaw has been documented as an erosion mechanism on northern reservoirs.

b. Ice and debris have been documented as mechanisms of bank erosion.

c. Overbank drainage, when uncontrolled, can create local bank erosion.

d. Tractive force scour from propeller jets, primarily in bendways and bridge approaches, is a local cause of bank erosion and may be more prevalent in the upper reaches of the UMRS due to decreased channel widths.

Of unknown significance is the impact of sediment overloading from tributary streams that is widely reported on the UMRS. Geomorphic texts reported that sediment overloading will often result in channel widening by bank erosion. The impact of sediment overloading is somewhat offset by dredging as discussed in GREAT I (1980a). Also of unknown significance is the occurrence of transverse stern waves. These waves could occur in straight reaches of the upper UMRS, which has low blockage ratios.

Identification

How are various bank erosion mechanisms and causes recognized in the field? Keller, Kondolf, and Hagerty (1990) reported that piping type failures continue long after the flood event whereas failures of a saturated bank following a rapid drawdown tend to occur soon after the flood event. Hagerty (1991b) discussed the following factors in identification of piping-induced bank erosion:

a. Piping can be identified by active flow of soil and water from exfiltration zones, but such evidence is rarely found.

b. Strong indications of piping activity are furnished by features produced solely or principally by that mechanism such as piping cavities, blind gullies, and accumulations of piped-out soil particles.

c. Locations having soils stained a different color in exposed banks and shores are indirect evidence of piping activity, as are collapsed soil pipes at locations far from a bank or slope.

d. Other indirect evidence of piping activity includes features typical of certain localized failure modes associated with undercutting by piping (cracks, fallen blocks or slabs, and multiple scarps).

e. Piping ceases if soils displaced by piping are not removed by other transport mechanisms, but interaction with other mechanisms of erosion and sedimentation often obscures the evidence of piping and/or stops or retards piping activity.

Hagerty (1992) provided extensive photographs illustrating the piping mechanism. Hagerty, Spoor, and Parola (1995) observed that streams having a controlled stage and a gently sloping subaqueous bench at or just below minimum pool stage have been observed at hundreds of sites. "Bench formation is the result of bank failure and erosion processes including seepage induced erosion, localized failure of undermined layers, reworking of failed soils by waves, and erosion by current forces. Benches are prevalent along alluvial banks composed of layered soils." Location of benches was not related to planform; benches were found on the inside and outside of bendways.

Thorne (1993) developed bank erosion assessment sheets to aid in the field identification of channel stability, bank retreat, bank characteristics, erosive forces and processes, failure mechanisms, and extent of erosion. Pictures and descriptions of various erosion processes were provided.

Table 4 summarizes identification of the dominant bank erosion mechanisms using identification guidance by Hagerty (1991b) and Thorne (1993) and provides potential causes for their occurrence.

Table 4
Identification of Erosion Mechanisms on the UMRS

Mechanism	Primary Evidence	Potential Causes
Freeze/thaw	Periods of below-freezing temperatures; a loose crumbling surface layer of soil on the bank; loosened crumbs accumulated at the foot of the bank after a frost event; jumbled blocks of loose bank material	Climate
Ice and debris	Severe winters with rivers prone to ice over; rivers prone to heavy debris load; gouging and disruption of the bank line; toppling and cantilever failures of bank and attached ice masses during spring breakup	Climate, watershed characteristics
Overbank drainage (rilling and gullying)	Corrugated appearance of the bank surface due to closely spaced rills; larger gullied channels incised into the bank face; headward erosion of small tributary gullies into the floodplain surface; eroded material on lower bank	Uncontrolled surface runoff
Piping	Active flow of soil/water from exfiltration zones; piping cavities; blind gullies; accumulations of piped-out soil particles; stained zones; collapsed soil pipes away from bank	River stage variation, vessel drawdown, septic tanks, adjacent water bodies, poor overbank drainage, excess precipitation, land use change
Slope instability (various types of slope instability detailed in Thorne (1993))	Failure debris at base of slope; debris can be blocks, slabs, cantilevers, or loose depending on failure type and bank material	Stage fluctuation; rapid drawdown; undercutting and undermining by other mechanisms such as tractive force scour, waves, piping, bed degradation
Tractive force	High flow velocity near bank; near bank scouring of bed; undercutting of toe/lower bank relative to bank top;fresh ragged appearance to bank face	Meandering, high flow, flow impingement, structures, vessel currents, land use change such as removal of riparian vegetation
Waves	Large wind fetch; acute angle between eroding bank and direction of significant waves; high vessel traffic frequency and small distance from sailing line; wave cut notch just above normal low-water plane; wave cut platform or run up beach around normal low-water plane	Wind or vessels

7 Summary and Conclusions

Extent of Bank Erosion

Illinois River

Warren (1987) described the Illinois River as a river with a severe erosion problem; however, Spoor and Hagerty (1989) reported waterway bank erosion was not severe or widespread. The 1993 flood reports by USACE and others did not report the occurrence of significant bank erosion on the Illinois River.

Upper Mississippi River

GREAT II (1980c) (Lock and Dam 10 to Saverton, MO) reported that 15 percent of total bank miles for all main stem rivers were experiencing bank erosion. GREAT III (Morris 1982) (Saverton to mouth of Ohio River) reported small high bank line changes over the 22 years studied. The USACE 1993 flood reports did not mention relative occurrence of the UMR bank erosion. Benn (1994) reported that flood damage in the Rock Island District from the 1993 Flood occurred at less than 5 percent of all sites in the valley.

Dominant Bank Erosion Mechanisms and Causes

The following dominant erosion mechanisms on the UMRS and their potential causes are listed in alphabetical order:

a. Piping caused by flood recharge or back of bank water sources with the possible addition of drawdown from commercial vessels.

b. Slope stability failures caused by undercutting by waves, tractive force scour at high flow, or piping in conjunction with stage changes from flow variation or structure operation and vessel drawdown.

c. Tractive force scour caused by high flow.

d. Waves caused by vessels (short period).

e. Waves caused by wind.

Less dominant or locally occurring erosion mechanisms are freeze/thaw, ice and debris, uncontrolled overbank drainage, and tractive force scour from propeller jets.

Channel widening by tractive force scour is a geomorphic response to overloading of sediments reported on the UMR due to tributary inputs. It is not known whether this is a significant cause of erosion on the UMRS.

Bank Erosion Models

Little modeling effort relating boating activity to bank recession was found. It is likely that a wind wave bank recession model could be modified to address boat wave induced bank erosion. The ability of waves to downcut the foreshore slope must be considered in predicting long-term recession rates.

Significance of Commercial Navigation in Bank Erosion

Summary of navigation-related studies

The references cited on navigation-related bank erosion are broad in scope and content. The St. Lawrence studies and the studies on the Rhine River are important because their objective is similar to that of the UMRS navigation study. Those studies evaluated incremental effects of navigation (specifically increases in vessel size and a longer navigation season) on bank erosion. Studies on the UMRS and Illinois combined the previous and the current efforts to identify bank erosion and its potential causes. These studies provided diverse approaches and opinions regarding the nature of existing conditions and what has the most application for these conditions. Several studies may be important for follow-up. Although no bank erosion data were collected by Bhowmik et al. (1992) on the site near Red Wing, MN, this study could provide data for correlations to the Minnesota Department of Natural Resources (Johnson 1994) bank erosion study. Actual erosion rates on the UMRS could be determined by follow-up investigations at sites like those described in Boszhardt and Overstreet (1981) and Warren (1987).

Recurring throughout the references was the recommendation of bank protection in locations where there were active erosion sites, forces exceeded threshold criteria, and potential erosion might occur. In some cases, where the dominant cause was traffic, restrictions on vessel size, speed, or proximity to the shoreline might also be recommended.

Wuebben described a phenomenon he calls "explosive liquefaction." It states that during ship-induced drawdown, an imbalance is created in the pore pressures of bottom sediments, resulting in sediment resuspension followed by a net offshore migration of sediments.

Gatto stated that during ice, ships can disrupt the bank by directly shoving ice on the bank and by breaking up the ice near the shore that protects the bank from wave erosion. Gatto concluded from his studies that contributions to erosion from navigation are minor.

Wuebben, Pilarzyck, and others recognized that predicting the actual magnitude of damages at a site is not possible at this time. Wuebben attempted to estimate areas that **could** be affected by navigation.

The Detroit District concluded that wind waves and small boats had more significant impacts than ships on the St. Marys River. Reported erosion was attributed to high flows.

Summary of commercial navigation effects

Based on the cited reports, the following conclusions are drawn relative to bank erosion resulting from commercial navigation:

a. Short-period waves from commercial navigation may not be a significant cause of erosion on the UMRS because of the low wave height and infrequent occurrence when compared to recreational vessels.

b. The importance of tow drawdown causing slope failures or piping is unknown. Wuebben reported that vessel-induced drawdown can cause liquefaction of streambeds. Since drawdown magnitude is highly correlated with blockage ratio (channel area/vessel area), it is almost certain that if drawdown causes failures, these failures will be most frequent in the upper reaches of the UMRS where channel sizes are smallest.

c. It is possible that in straight reaches (where vessels can travel at high speed) of the UMRS upper reaches where blockage ratios are small, transverse stern waves form and cause significant attack of bank lines.

d. Propeller wash was assigned a less dominant role in causing erosion because the UMRS literature was relatively quiet on this issue. Propeller jet scour is generally limited to unprotected low-radius bendways or bridge crossings with difficult approaches. It is likely that in the upper reaches of the UMRS, the smaller channel sizes result in greater occurrence of propeller jet effects.

e. The pattern that emerges from these statements is that bank erosion from commercial navigation, if any, will be most prevalent in areas where channel sizes are smallest or in larger channels where navigation is close to erodible bank lines.

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9. (Concluded).

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13. ABSTRACT *(Maximum 200 words)*

This literature search was conducted to obtain pertinent data and research regarding the process of bank erosion along the Upper Mississippi River System (UMRS). References were identified pertaining to bank erosion resulting from flow velocity, flow quantity, secondary currents, bank materials and covers, wave energy from wind and navigation, and other forces resulting from navigation. References were from both studies on the Upper Mississippi River System and other similar alluvial rivers.

14. SUBJECT TERMS

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Illinois Waterway	Mississippi river
Literature review	Navigation

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Appendix B.

Scope of Work for Field Survey

Upper Mississippi River and Illinois Waterway
Streambank Erosion Study
Scope of Work

I. Objectives

The main objectives of this study will be to review information provided by the COE including oblique aerial video photography, conduct a field reconnaissance survey by boat, gather photos, identify bank erosion on navigation charts, obtain cross-section and soil data from the selected sites, and classify the bank erosion sites following a system of classification attributes. Opinions as to the relative significance of bank erosion due to various factors such as hydraulics of flow and waves generated by commercial and/or recreational traffic and wind will be provided. Finally, about five (5) sites will be selected for future field experimentation based on the field visit. All the data thus gathered and/or measured will be put into a data base. A final report is to be prepared incorporating all the work described here.

II. Scope

The scope of this work is to identify and describe reach of riverbank conditions and bank erosion sites on the entire Upper Mississippi River System including the Illinois Waterway. It is also designed to identify the major erosion areas, inventory those bank sites, provide opinions as to the erosion and failure mechanisms at each location, and identify the bank soils. The study reach for this work will consist of the Upper Mississippi River from the confluence of the Ohio River at Mile 0 to the Upper St. Anthony Falls Lock at Mile 854 and the Illinois Waterway from Mile 0 at Grafton, IL to Mile 286 at Joliet, IL.

The basic data collection will include but will not be limited to procedures outlined by Bhowmik et al. (1990). Other reference documents that will be used are those given by Bhowmik and Schicht (1980) and Hagerty (1988).

The contractor will be required to coordinate all work with a multi-disciplinary team of individuals to be selected jointly by the COE and the contractor to produce a report such that conclusions and recommendations are reached in a collaborative effort between the contractor and the multi-disciplinary team. This team of individuals will provide input throughout the study process including, but not limited to, the field reconnaissance and the report preparation. The contractor will serve as the focal point of this multi-disciplinary team and will be responsible for ensuring that the field reconnaissance and study results are inclusive of conclusions of both the contractor and the multi-disciplinary team.
The following section outline the work items and tasks for this contract.

III. Tasks

Task 1. Review of Literature: Review the bank erosion literature survey conducted by the Waterways Experiment Station (Maynord and Martin, 1995). Review the previous reports on the Illinois Waterway prepared by Bhowmik and Schicht (1980) and Hagerty (1988).

Task 2. Develop Classification System: All significant bank erosion sites and especially the 60 sites to be selected for detailed investigations will be classified based on the following parameters.

Site Location

- River
- Navigation Pool
- Right or left descending bank
- Upstream river mile
- Downstream river mile
- Upstream UTM coordinates
- Downstream UTM coordinates

Site Attributes (limited to selected erosion sites only)

- Anthropic character
  - Natural bank or revetted bank
  - Wing dam(s) present or absent
    - (from navigation charts)
  - *Archaeology sites present or absent
  - *Recreational or commercial traffic levels
  - Distance from center of navigation channel
    - (from navigation charts)
  - Land use on bank crest
    - Urban
    - Industrial
    - Agricultural
    - Wooded
    - Grasses and weeds
    - Levee
    - Railroad track

This portion of data should be developed from oblique video photography and river plan view information prior to boat reconnaissance.

*To be provided by the COE. See Item IV.

- Geomorphic character
  - Inside bend
  - Outside bend

Straight reach
Transition reach
Island

Erosion site attributes (limited to 60 sites selected for detailed investigations)

- Failure face height
- Failure face slope
- Basal berm height
- Basal berm width
- Failure face soil type
- Basal berm soil type
- Underwater slope
- Near-shore sediment type
- Vegetation at tope of failure face
  - Wooded
  - Grasses and weeds
  - Agricultural row crops

This portion of data base should be developed during and shortly after boat reconnaissance.

This list is not intended to exclude other parameters that may become important in the classification of banks. Other parameters may be added at a later date.

Task 3. Review of Video and Available Mapping: Review the video, photographs, etc. taken by the Rock Island District during the aerial overflight. A preliminary selection of at least 60 sites for detailed study and data collection will be made following review of the aerial overflight video. These sites will be marked on navigation charts for the boat reconnaissance survey. These sites should be representative of the system based on the above classification attributes. This preliminary selection will be subject to the recommendations of the COE and the multi-discipline bank erosion committee assembled by the COE.

Task 4. Boat Reconnaissance Survey: Conduct a field reconnaissance survey by boat for the Illinois Waterway and the Upper Mississippi River. This will consist of a trip from Joliet to Grafton on the Illinois Waterway and St. Anthony Falls to Cairo on the Mississippi River. The team members will participate in this trip will be determined jointly by the contractor and the COE. The following data and information will be collected during this trip.

A. *Illinois Waterway: Joliet to Grafton (RM 286 to 0)*

A-1. The trip on the Illinois Waterway will require 6 to 9 days to complete. It will commence in Joliet, IL and conclude in Grafton, IL.

A-2. All failure and erosion sites and reach conditions on both banks of the river will be identified on navigation charts. Identification of the 20 representative failure and erosion sites will also be recorded utilizing a portable GPS.

A-3. During this trip at least 20 bank failure and erosion sites representative of the river system will be identified and about six bank and near bank soil and sediment samples will be collected at each site. The location of these sites will be based on the results of the oblique aerial video review from task 3 and the expertise of the multi-disciplinary team during the field reconnaissance.

A-4. Referenced photographs representative of site conditions consisting of slides and prints will be taken.

A-5. Field notes will be made at the 20 representative sites to indicate site features and opinions as to the probable causes of bank failure and erosion, general characteristics of the back of bank areas, bank and near bank soils, presence or absence of vegetation, location of failure and with respect to the river plan form and channel, and other pertinent information. This information will be added to the site classification data base outlined in Task 2 and will be marked on navigation charts as appropriate.

A-6. Other related information including back of bank land use will also be added.

A-7. Bank slopes at three to five locations at each of the 20 sites will be measured.

A-8. One cross-sectional profile of the river at each of the 20 sites will also be measured utilizing automated sounding equipment.

A-9. A chase vehicle will accompany the boat for its entire trip.

B. *Upper Mississippi River: St. Paul to Cairo (RM 854 to 0)*

B-1. The trip on the Upper Mississippi River, is expected to take three to four weeks. The trip will commence in St. Paul, MN, and conclude in Cairo, IL.

B-2. All failure and erosion sites and reach conditions on both banks of the river will be identified on navigation charts. Identification of the location of the 40 representative failure and erosion sites will also be recorded by utilizing a portable GPS.

B-3. During this trip at least 40 bank failure and erosion sites representative of the river system will be identified and about six bank, and near bank soil and sediment samples will be collected at each site. the location of these sites will be based on the results of the oblique aerial video review from task 3 and the expertise of the multi-disciplinary team during the field reconnaissance.

B-4. Referenced photographs representative of site conditions consisting of slide and prints will be taken.

B-5. Field notes will be made at the 40 representative sites and indicate site features and the probable causes of bank failure and erosion, general characteristics of the back of bank area and banks and bank soils, presence of absence of vegetation, location of the failure and erosion with respect to the river plan form and channel, and other pertinent information. This information will be added to the site classification data base outlined in Task 2 and will be marked on navigation charts as appropriate.

B-6. Other related information including back of bank land use will also be added.

B-7. Bank slopes at three to five locations at each of the 40 sites will also be measured.

B-8. One cross-sectional profile of the river at each of the 40 sites will also be measured utilizing automated sounding equipment.

B-9. A chase vehicle will accompany the boat for its entire trip.

Task 5. Site Selection for the Detailed Traffic Impact Study: The contractor, with assistance from the COE and the multi-disciplinary team, will recommend at least five representative sites for detailed field data collection on the impacts of traffic on bank failure and erosion. Of these five sites, two will be from the Illinois Waterway and three from the Upper Mississippi River. These detailed experiments are not included in this scope of work.

Task 6. Meetings: The contractor will hold meetings with the COE on a regular basis to inform the COE on the progress of the project. these may include: One initial meeting with the entire reconnaissance team to plan the details of the reconnaissance trip; one meeting just prior to the reconnaissance trip to discuss the results of the oblique video review, initial data base development and sites selected for detailed site investigations; three meetings during the preparation of the report at 50 percent, 80 percent and 95 percent completion and; one final meeting for final project and report presentation.

Task 7. Submittals

1. Maps and Photographs: Five sets of selected photographs from each of 60 selected sites and five sets of color coded navigation charts showing bank erosion site locations and other pertinent information. This will also include the 5 sites selected for field experiments (Detailed Traffic Impact Study).

2. Data Base: An electronic data base file containing all bank erosion classification system attribute data outlined in Task 2 for the 60 sites selected for detailed studies will be submitted in a comma-delimited ASCII file to the COE.

3. Report: At the end of this project, a report will be prepared and submitted to the COE containing the following information.

- Review of historical and technical information.
- Review of oblique video photography and available mapping.
- A detailed description of the classification system and resulting attribute data base development.
- Report of reconnaissance by boat including a detailed description of each of the approximately 60 sites selected for detailed investigations.
- Opinions as to initiating bank failure and erosion mechanisms and processes.
- Description of the sites selected for detailed observation and evaluation including sites for detailed experiments, and reasons why those sites were selected.
- Opinions regarding the relative significance of bank failure and erosion mechanisms and navigation (both recreational and commercial) effects on bank erosion and failure.
- An appendix where all the relevant data are to be included.

The draft report will be subject to review and comment by the same multi-disciplinary bank erosion committee assembled by the COE and the contractor prior to final printing. Ten copies of the final report will be submitted to the COE.

IV. Hydraulic and Other Data:

The COE will provide the following information for all the selected sites as needed, and if available: stage hydrographs; discharge hydrographs; velocity measurements; stage-duration diagrams; discharge-duration diagrams; discharge rating curves; sediment rating curves; precipitation cumulative departure information; historical and recent waterway improvement and operational changes; navigation traffic statistics; typical tow sizes; towboat horsepower ranges; transitions; fleeting and mooring area references; data on all bank protection projects; recreational boating statistics; and archaeological sites. A set of Regulation Manuals for all of the locks and dams on both rivers will be provided to the contractor by the COE at the initiation of the contract. These manuals contain much of the above listed information. Eight sets of navigation charts for each river will be provided to the contractor.

V. Equipment and Support Materials to be Provided by the Contractor

The Contractor will provide necessary equipment for these reconnaissance and detailed site inspections. At a minimum this will include:

- A 35 to 40 foot field boat with large river data collection and storage facilities and one 18 to 20 foot field boat for collecting near-shore data.
- Boat crews and operators.
- A hand-held GPS, accurate in the range of 10 meters.
- Soil and sediment sampling equipment.
- Surveying Equipment (hand held levels, level rods, chains, tapes)
- Vehicles, drivers, etc.
- Cameras and film.
- Field supplies, equipment that will be needed to gather, store, and/or analyze the data and samples that will be collected during these reconnaissance and site inspections.

VI. Schedule

The timing of individual tasks will depend on the availability of the oblique aerial video photography to be taken by the COE. The reconnaissance trip schedule is also dependent on when the water level in the rivers is low enough to evaluate and record the bank failure and erosion sites. This portion of the project will be complete by the end of July, 1996.

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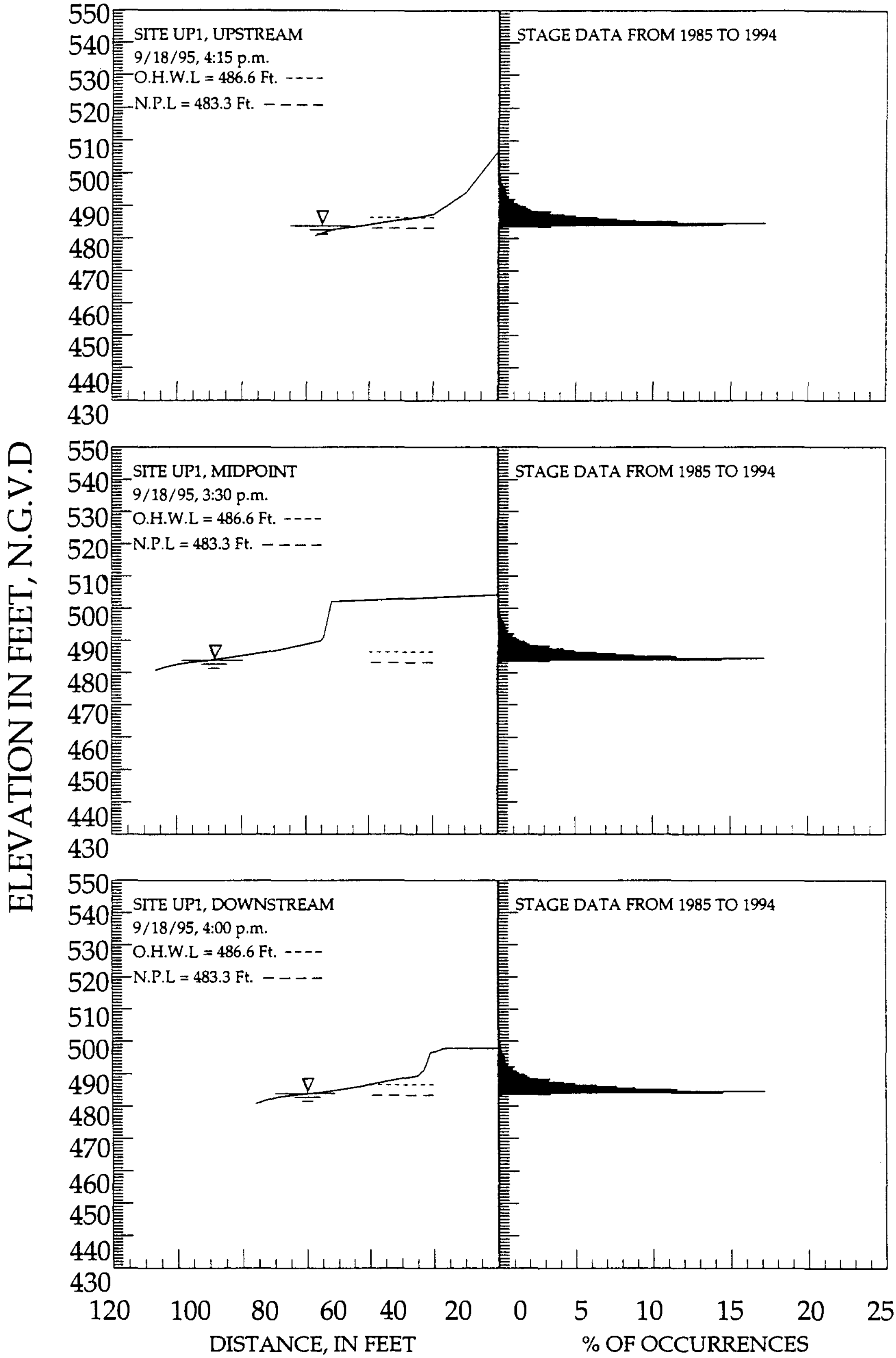
Appendix C.

Stage Histograms and Bank Profiles for the Erosion Sites Along the Illinois Waterway and Upper Mississippi River



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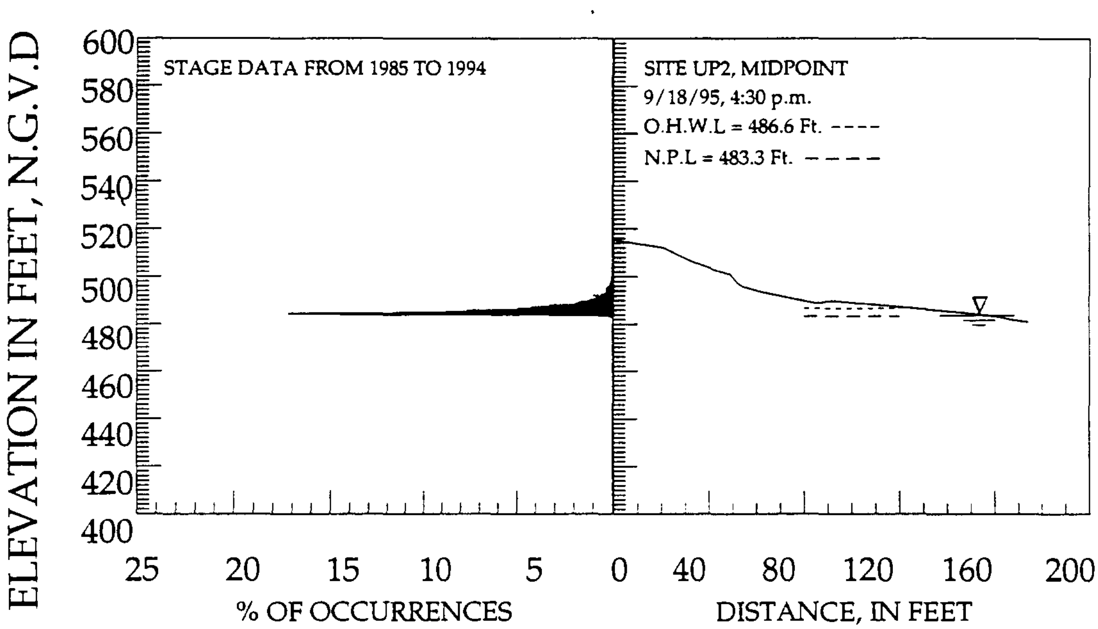

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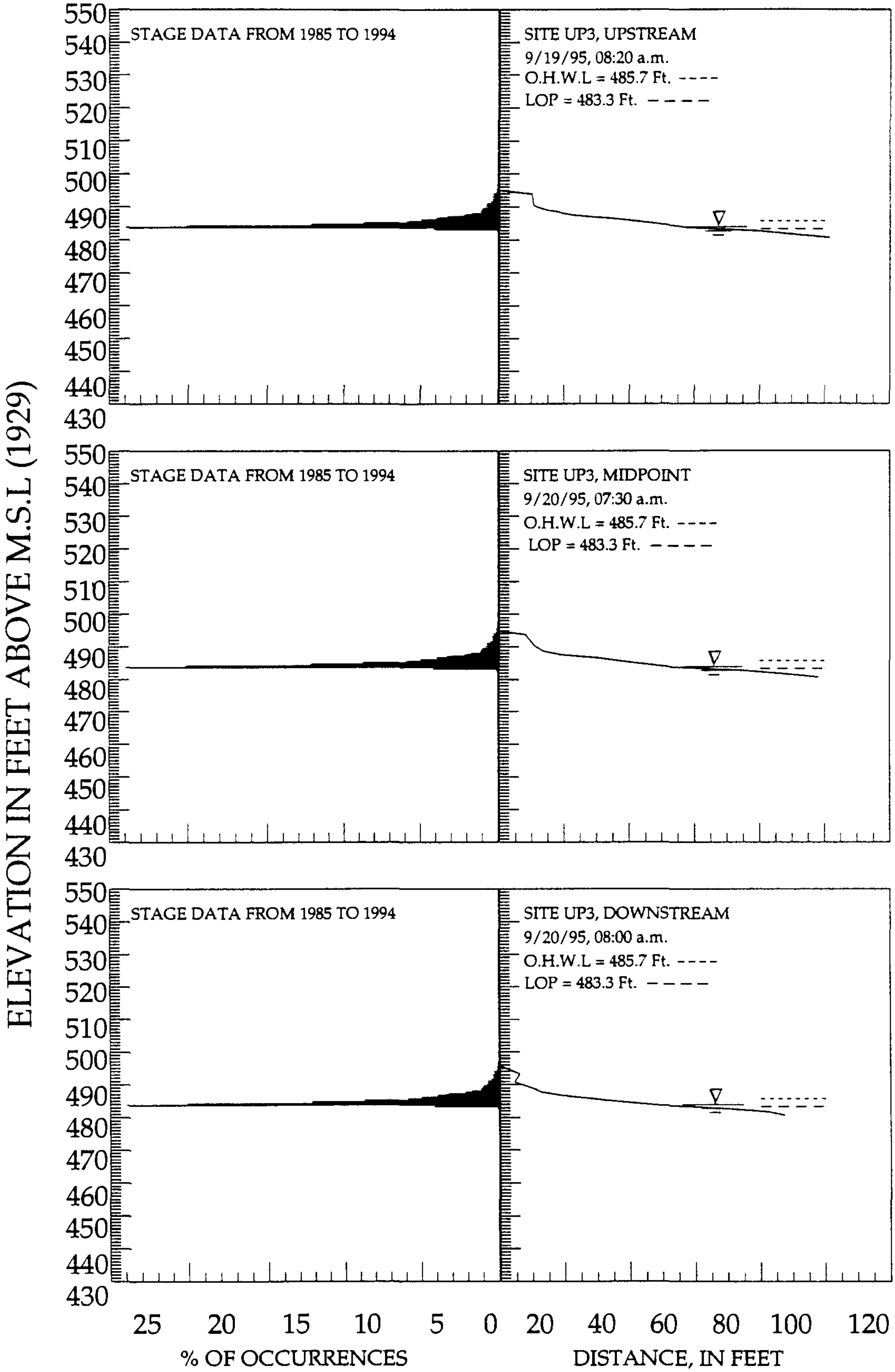

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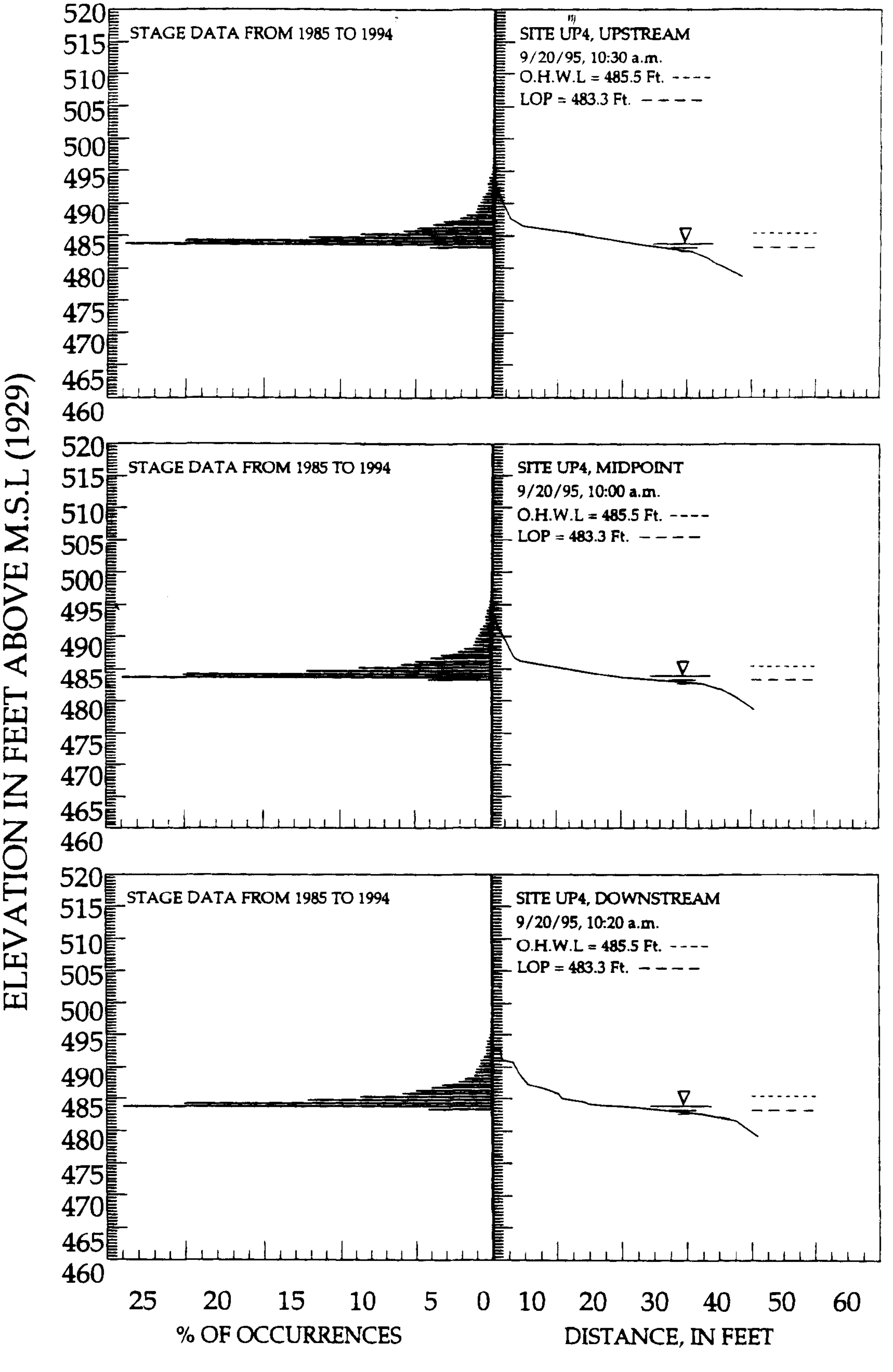

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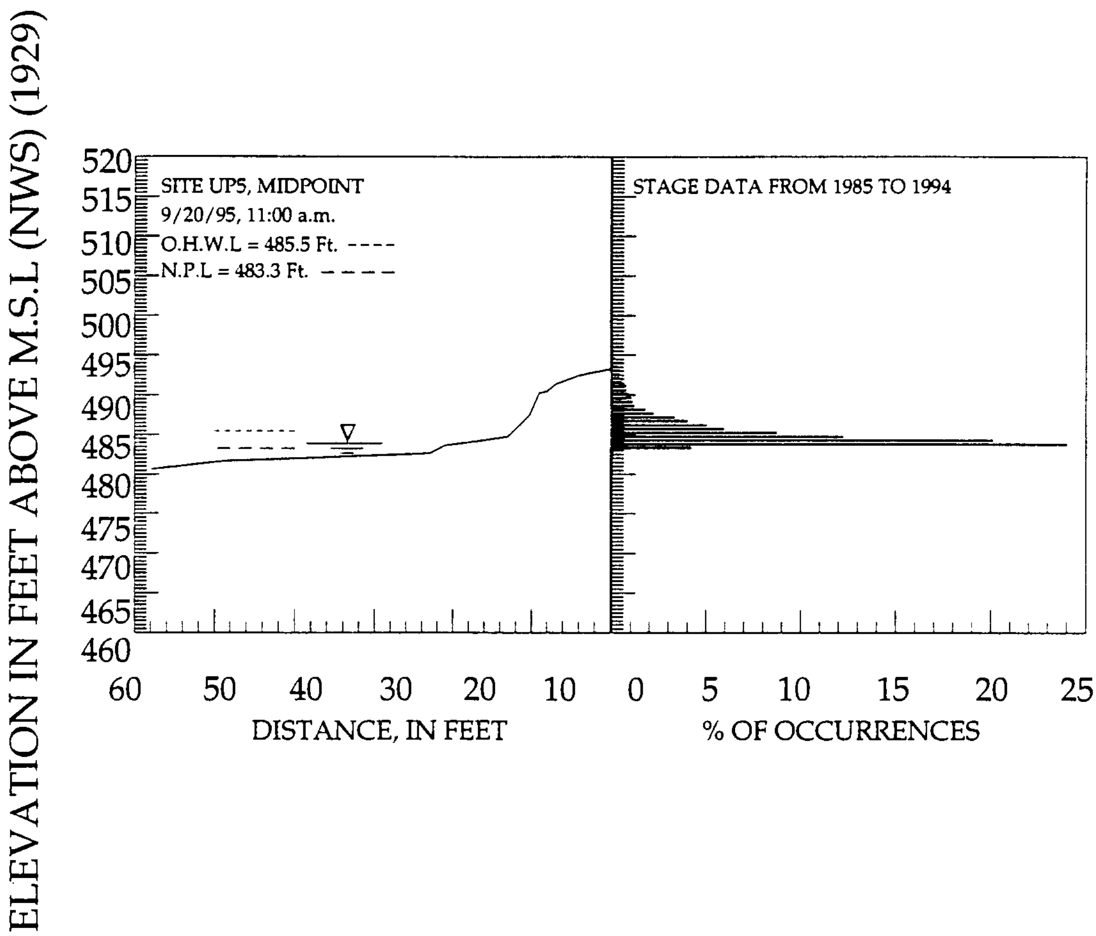

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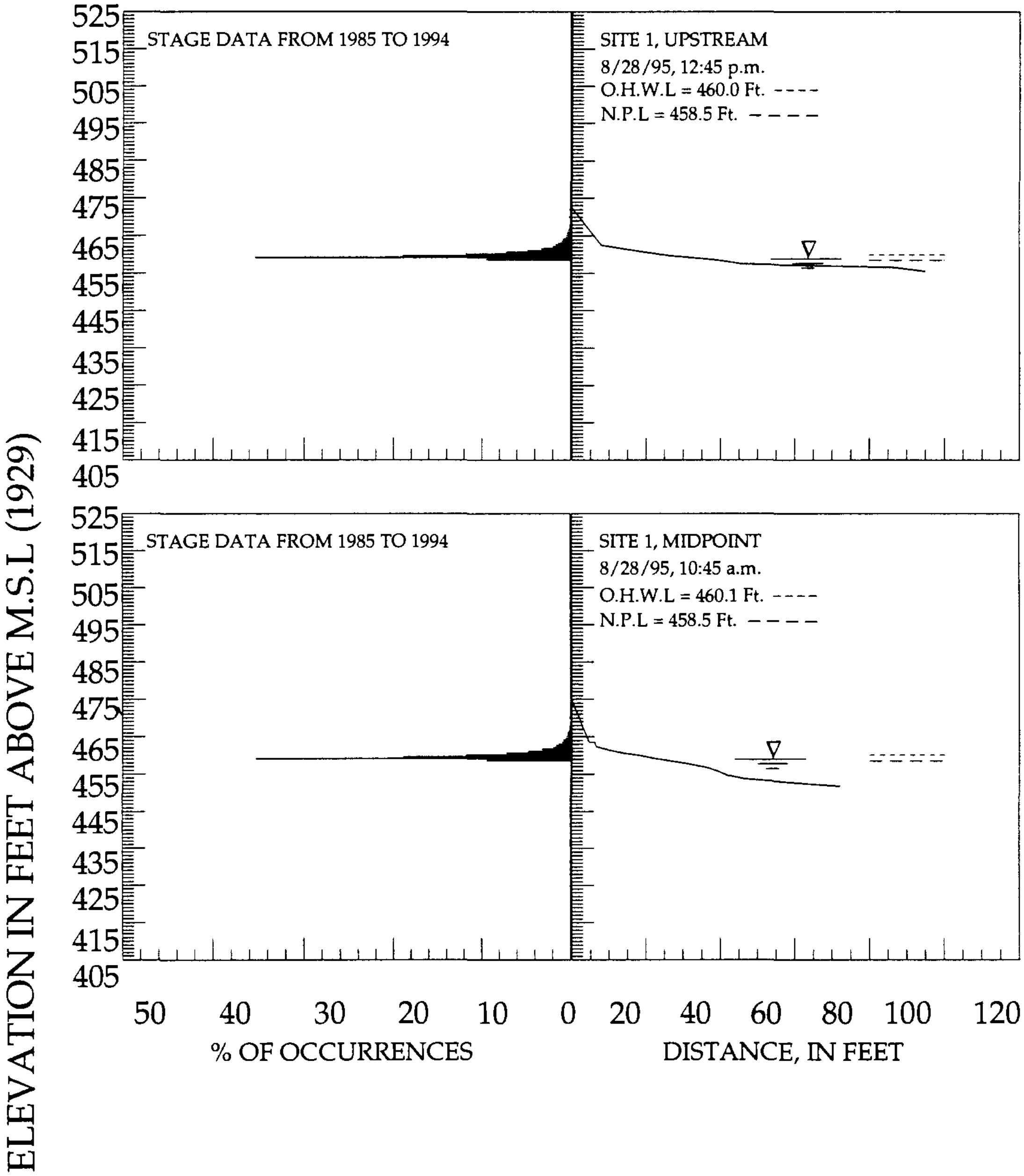

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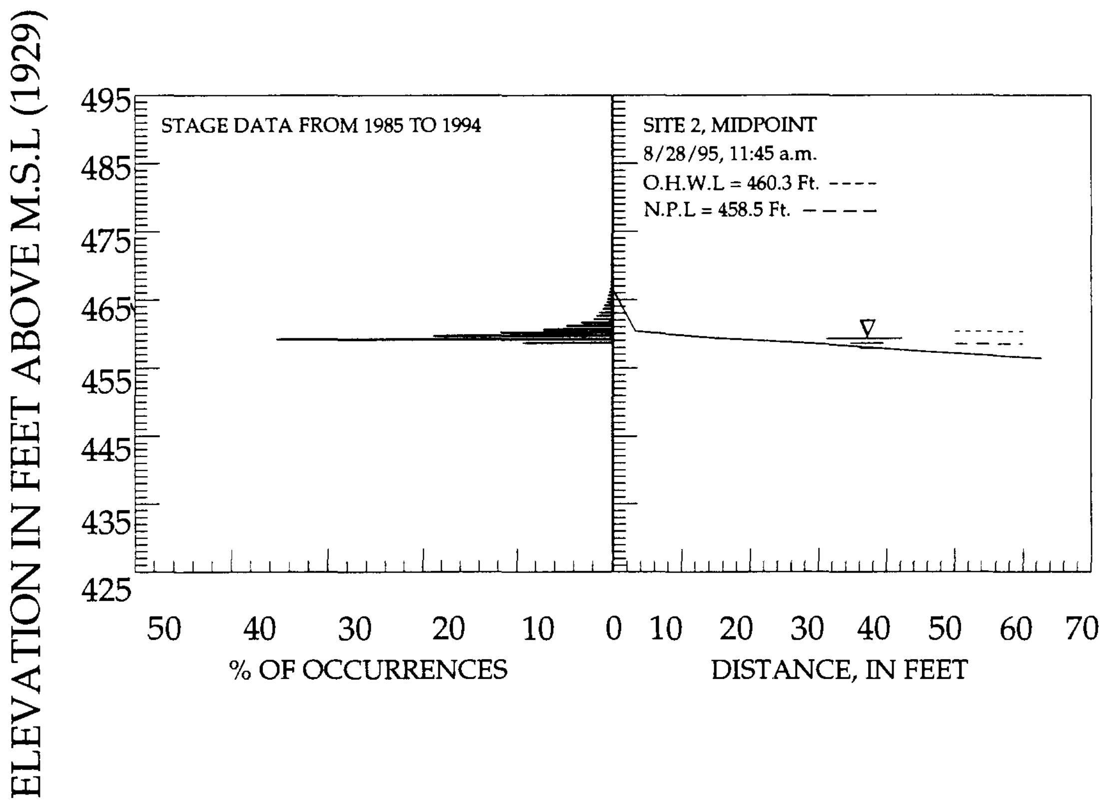

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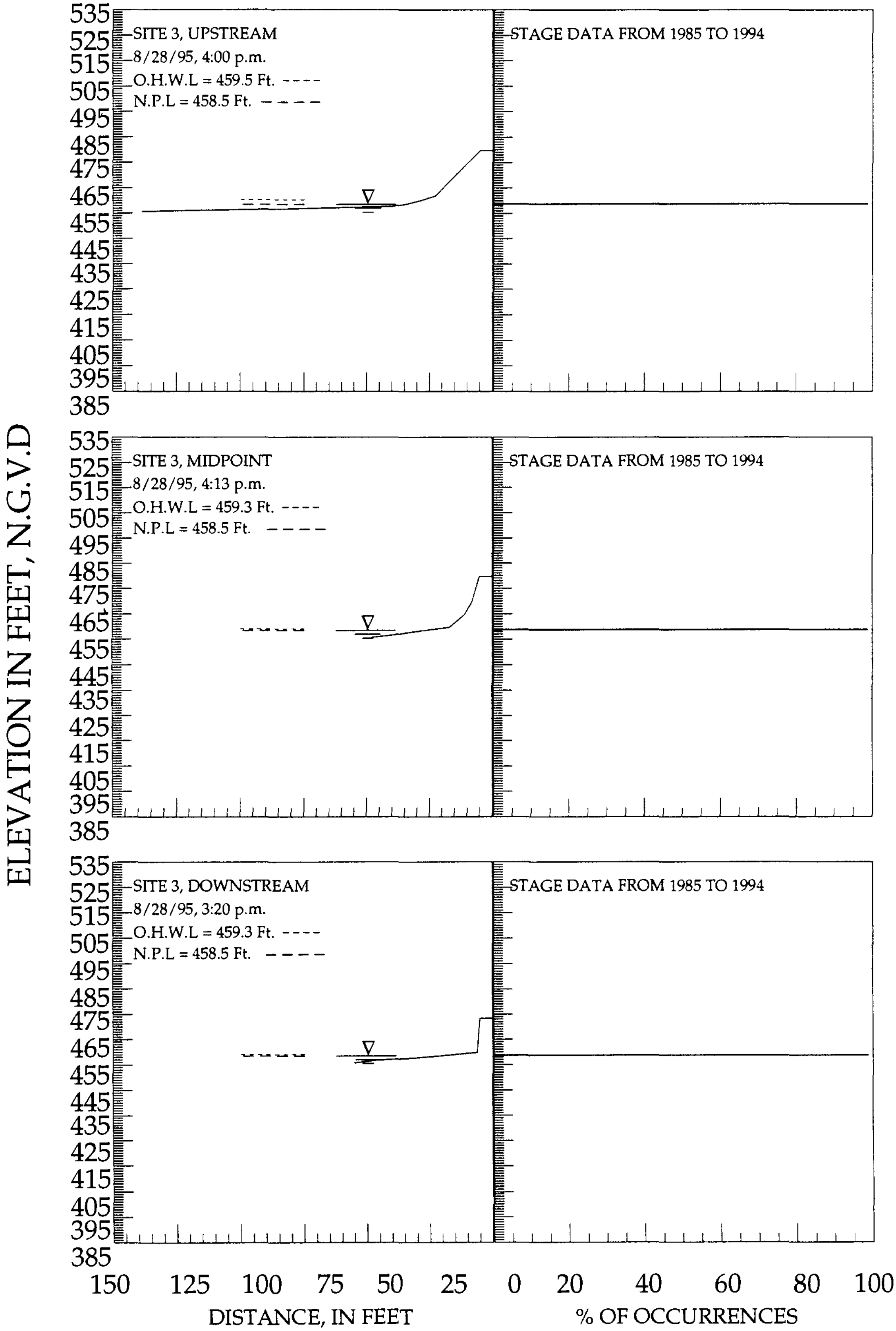

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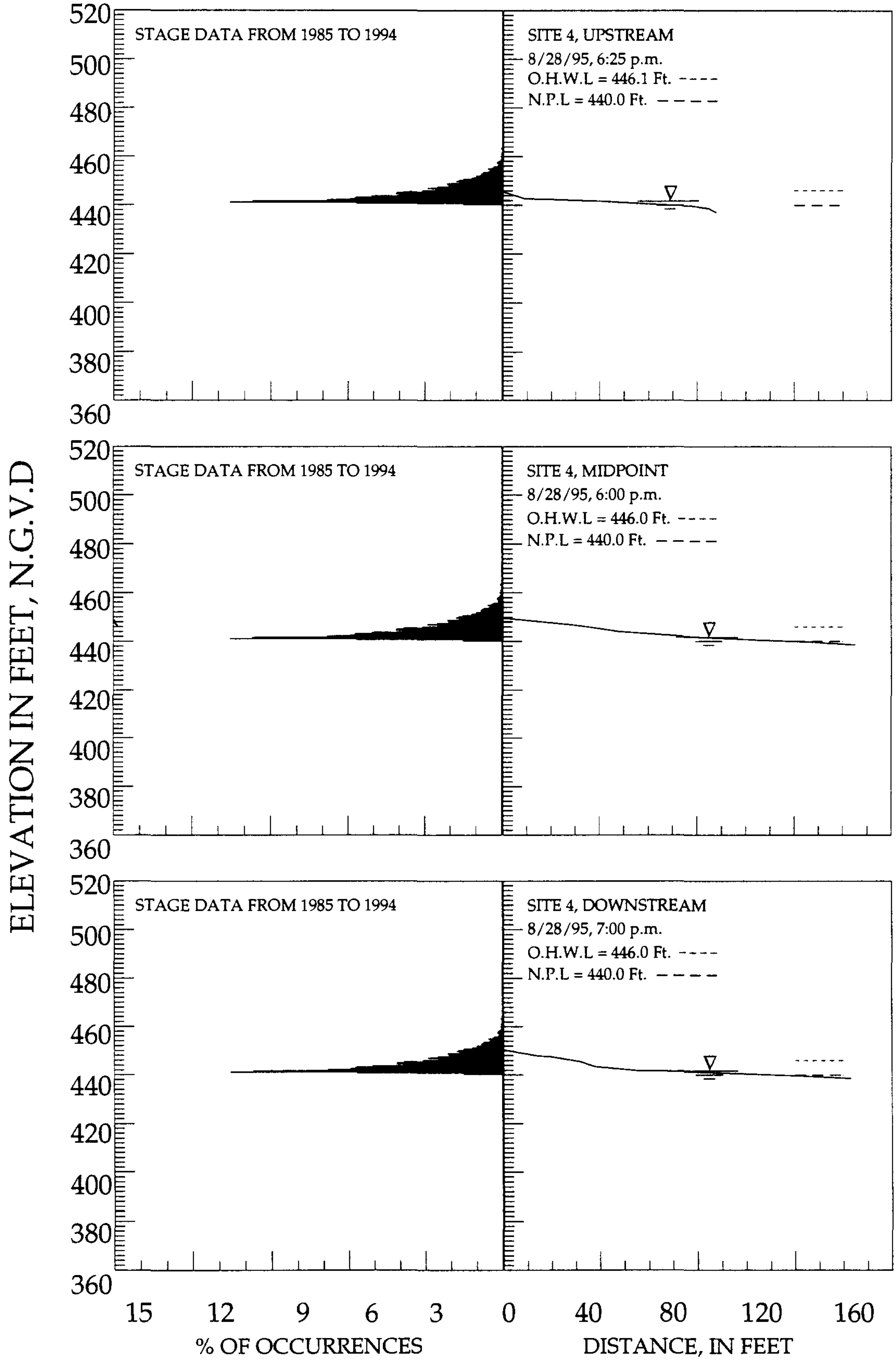

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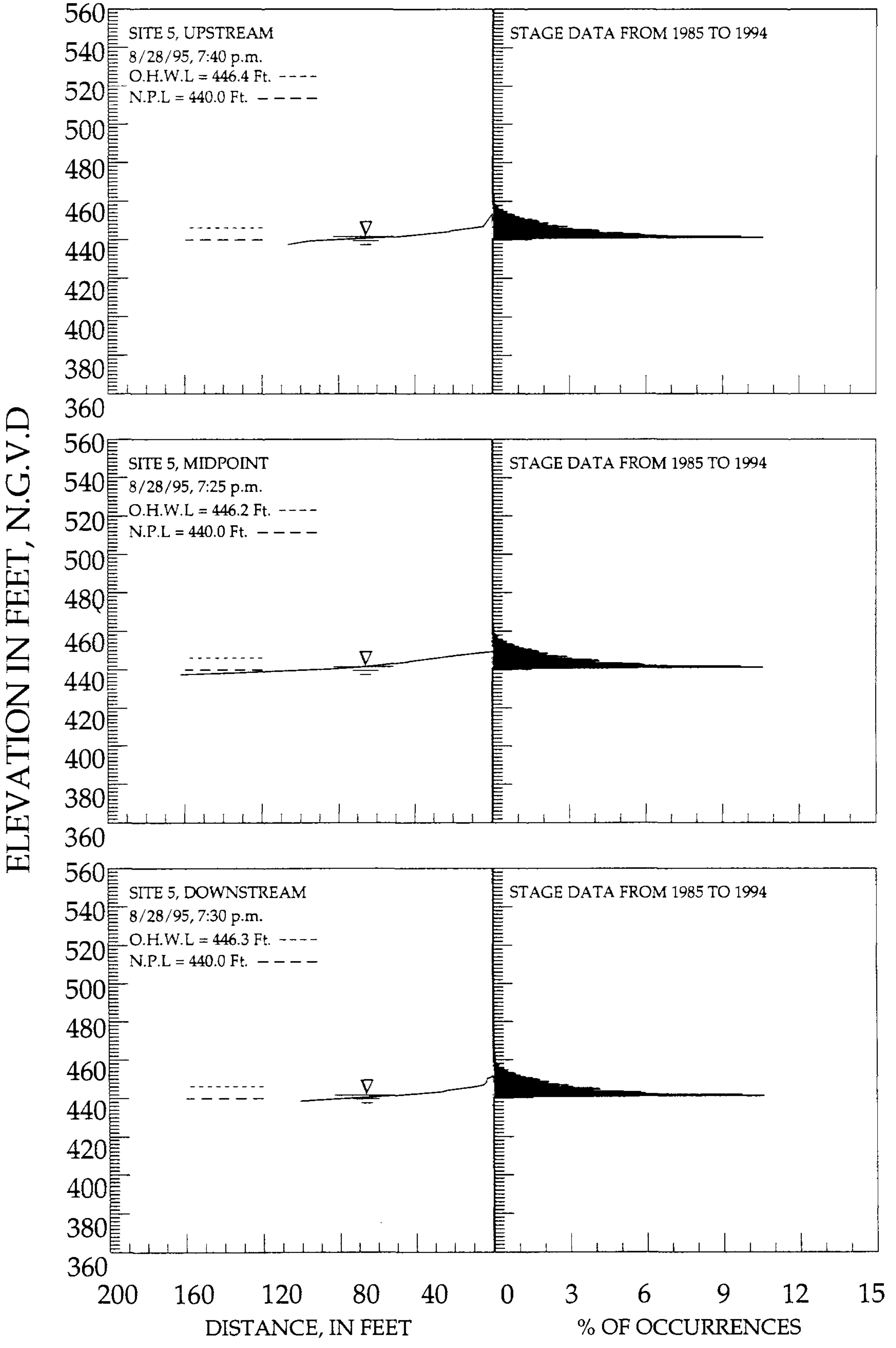

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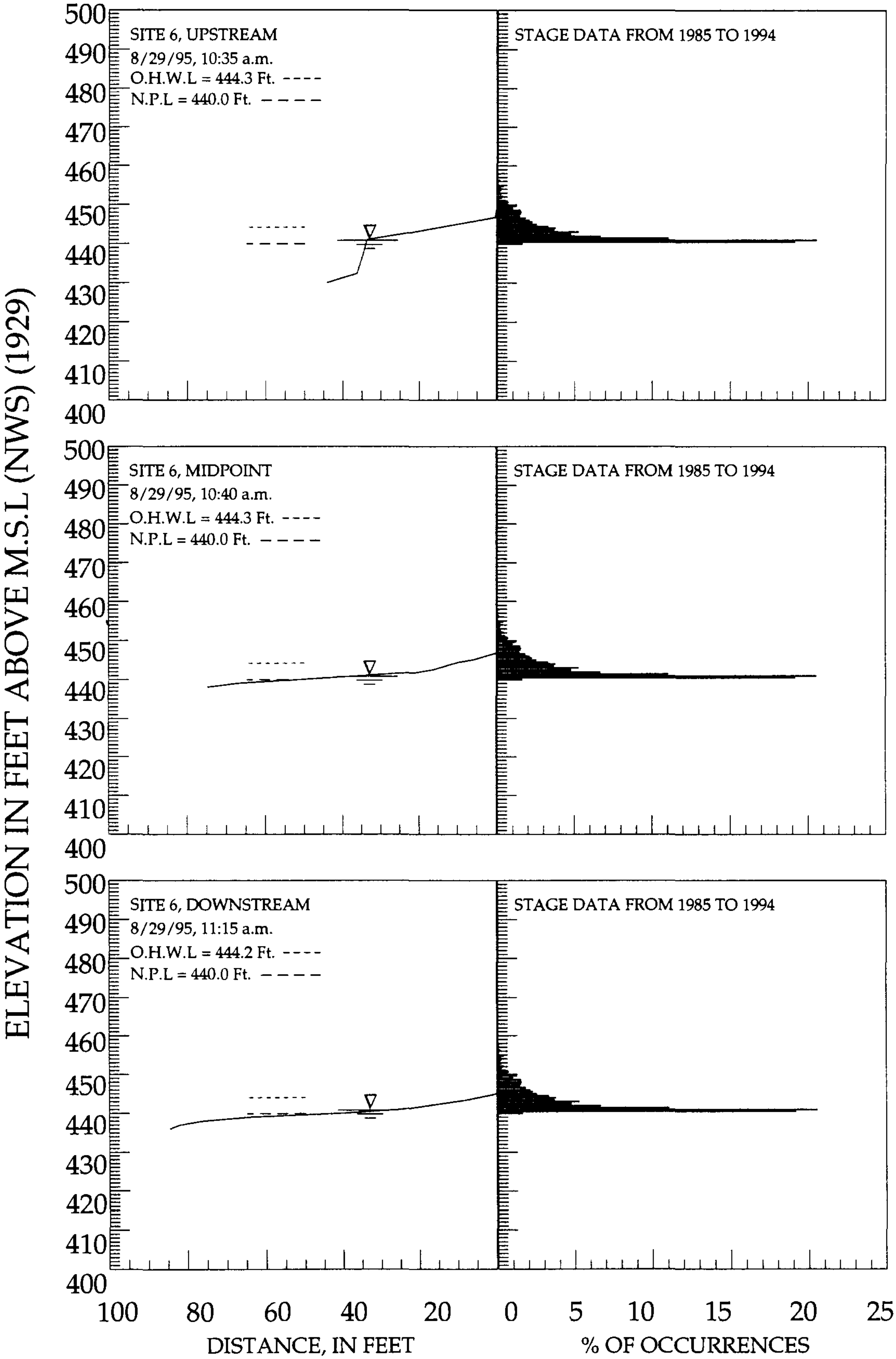

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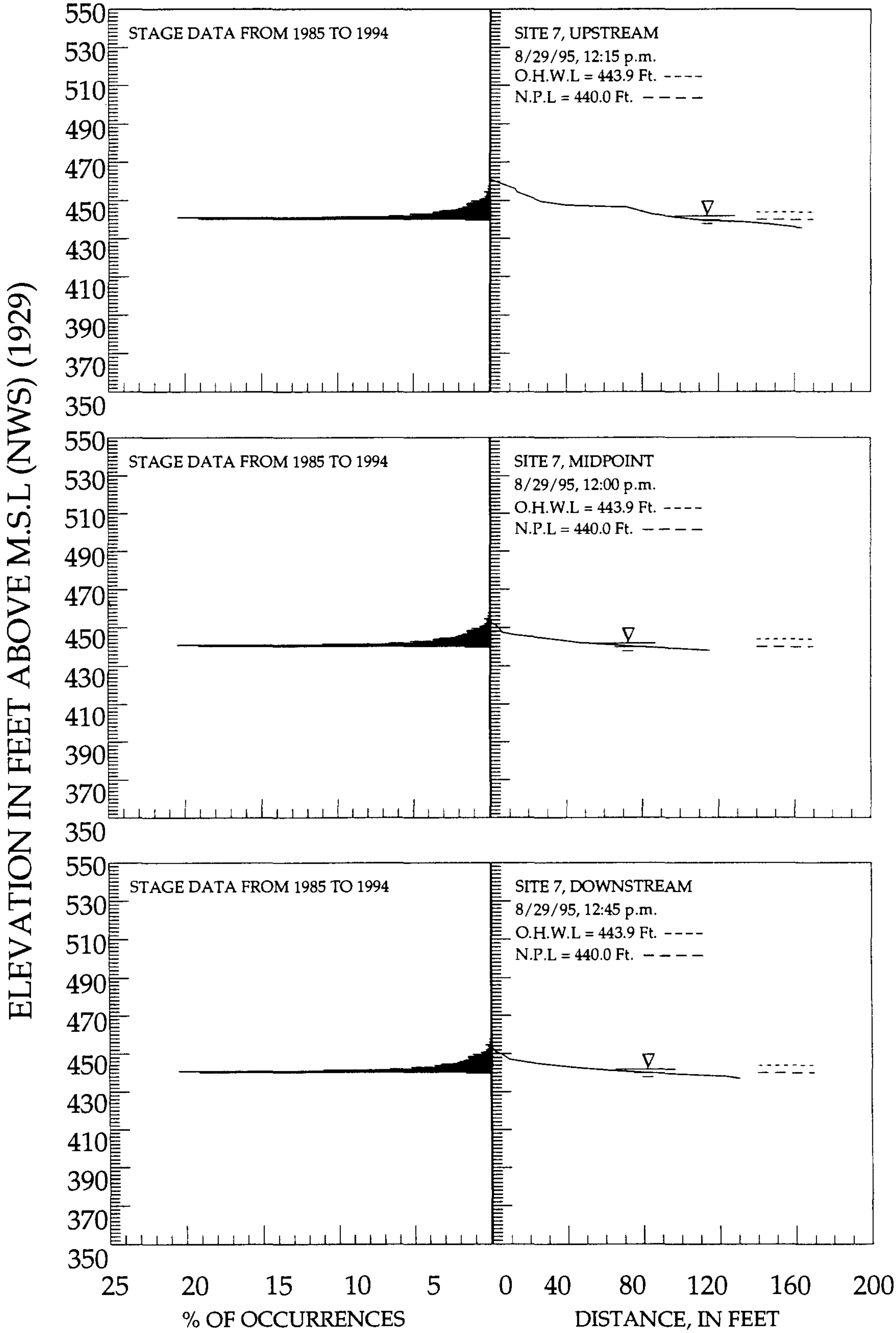

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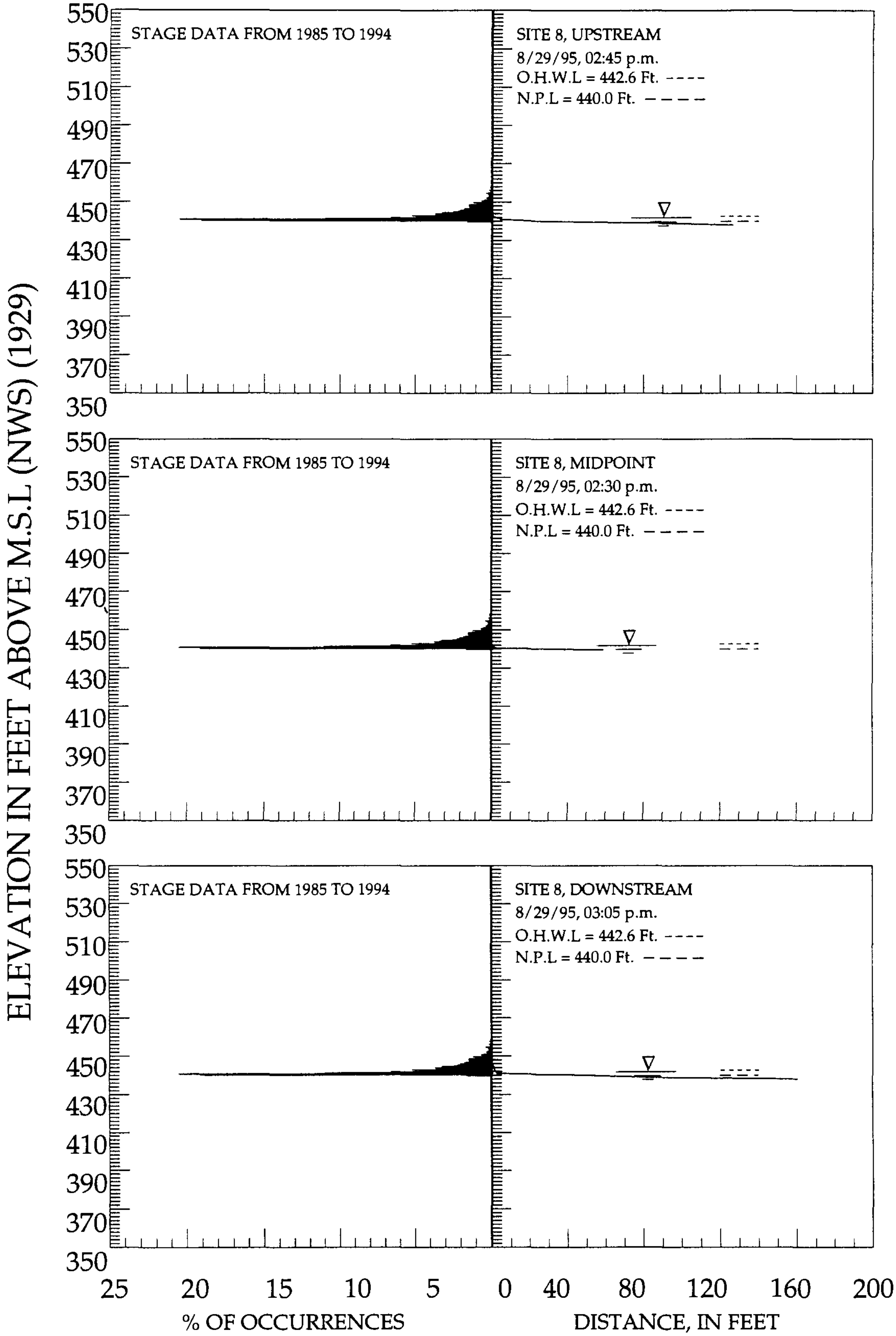

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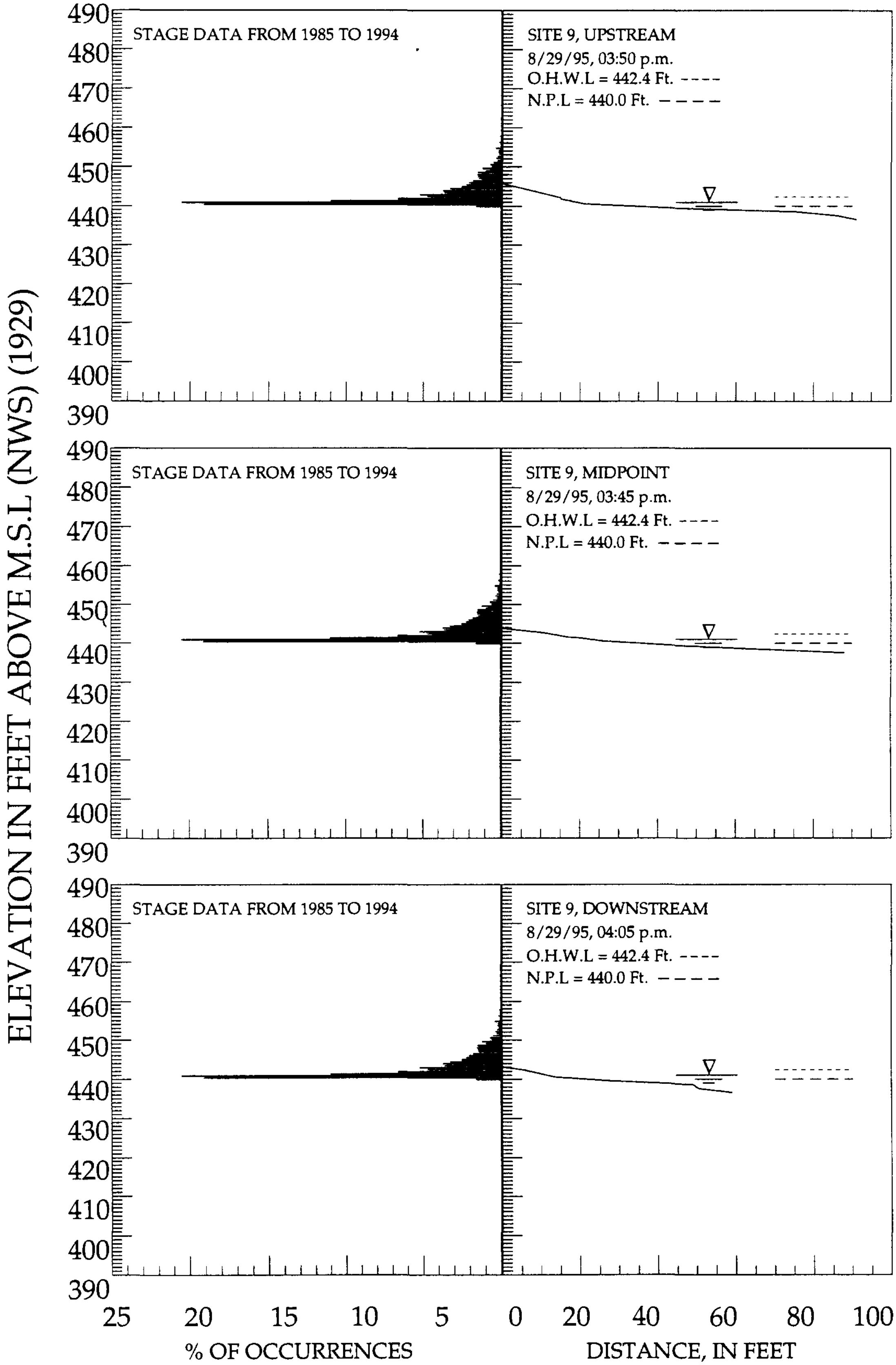

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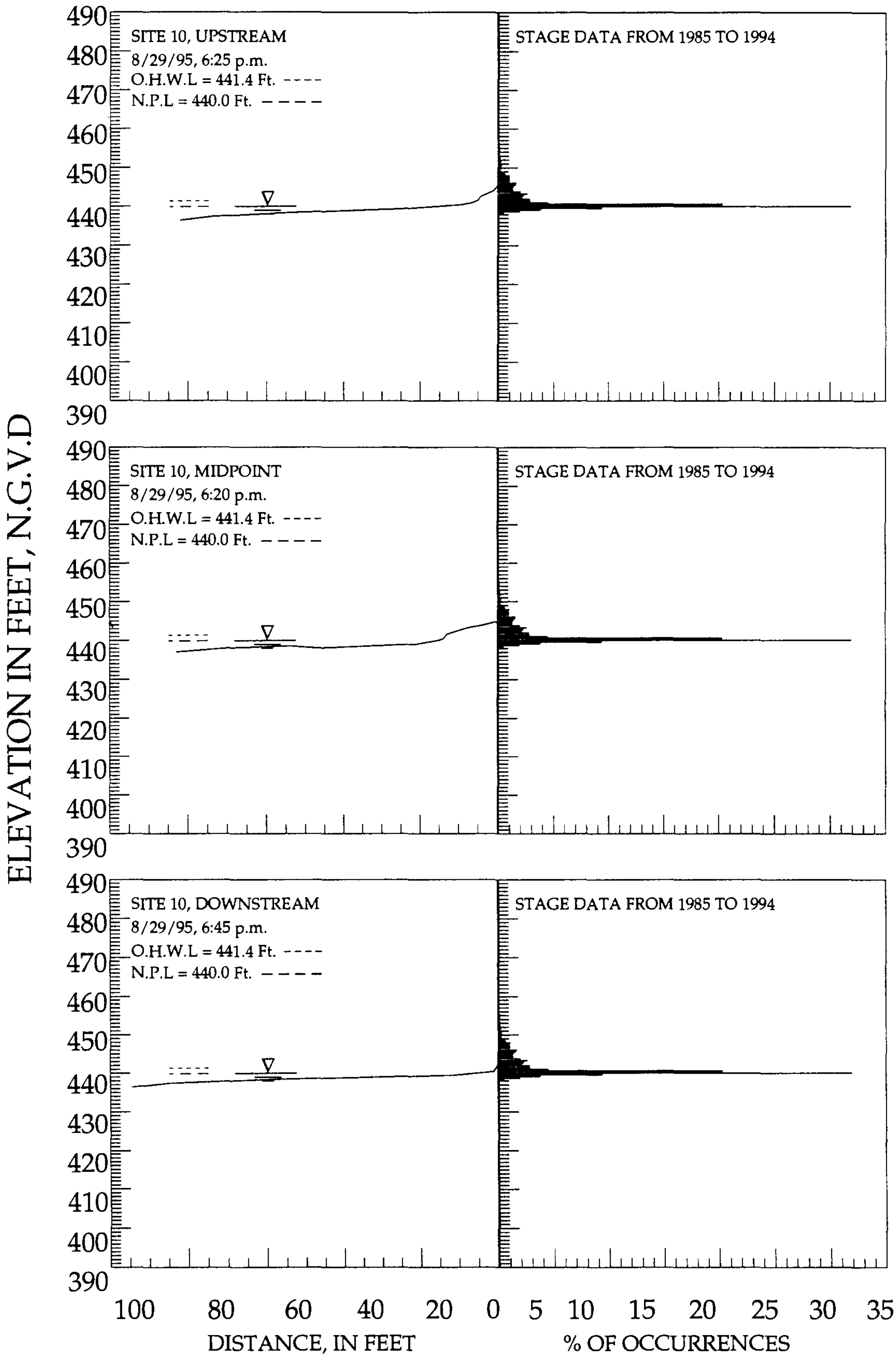

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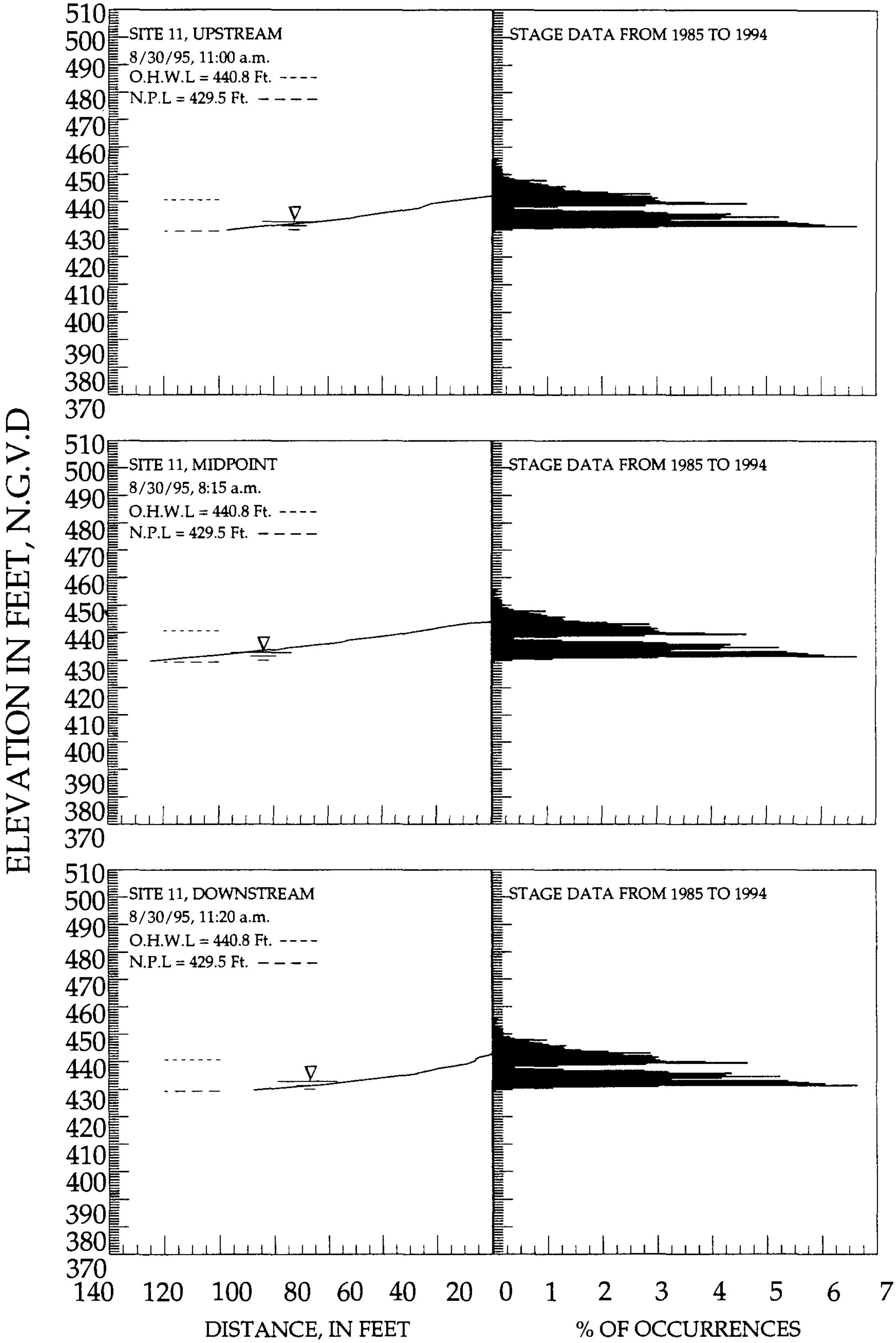

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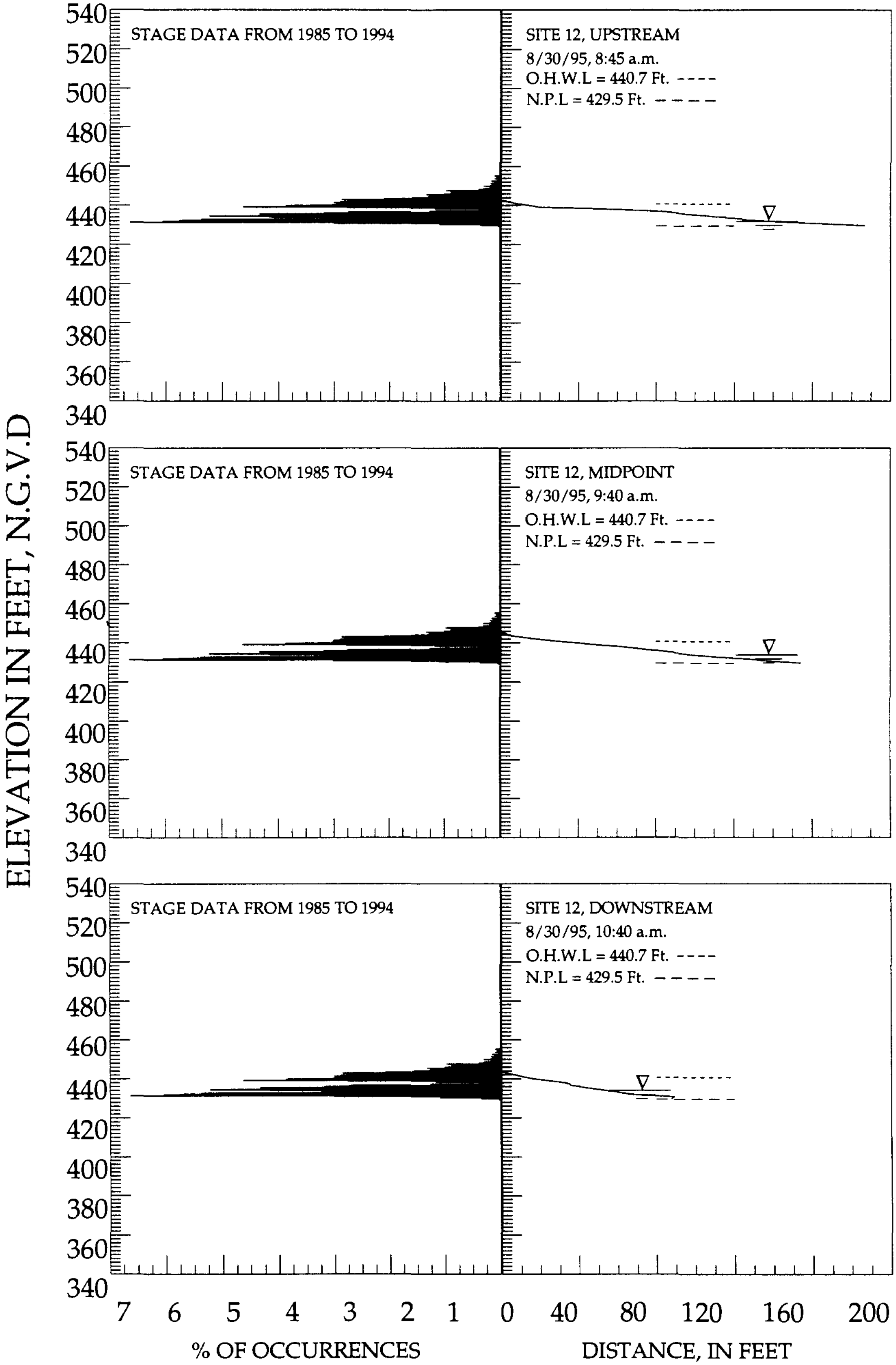

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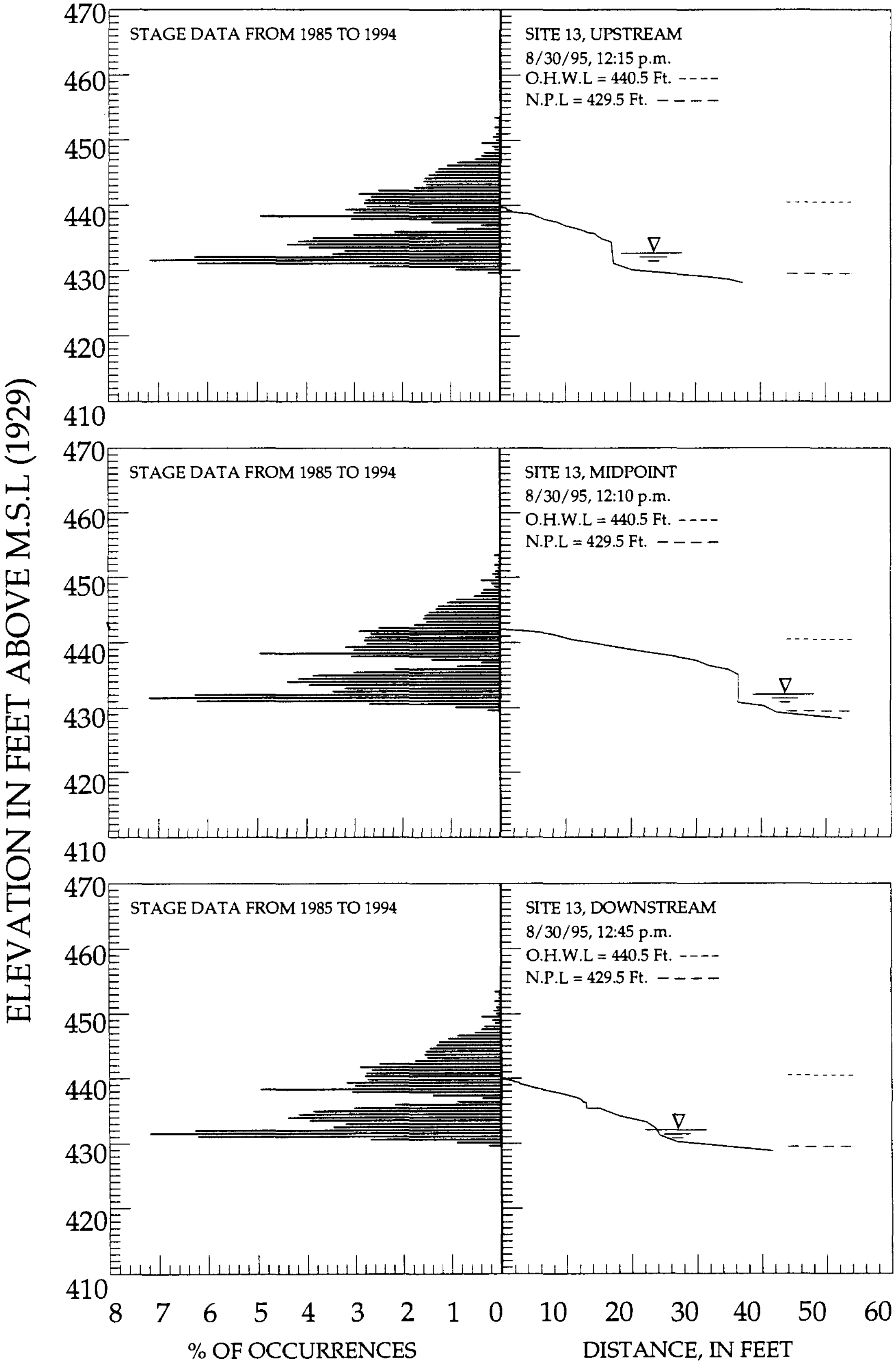

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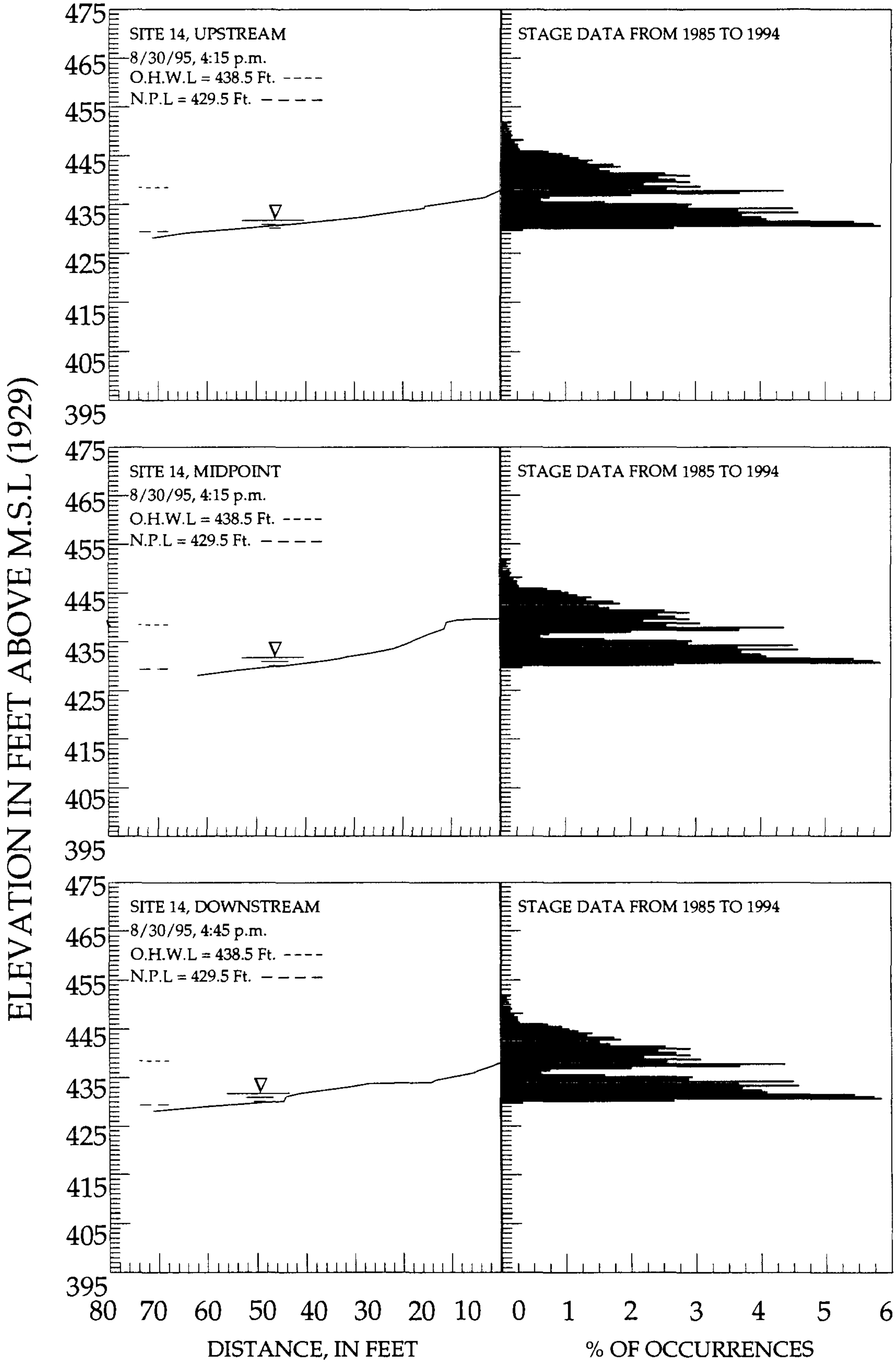
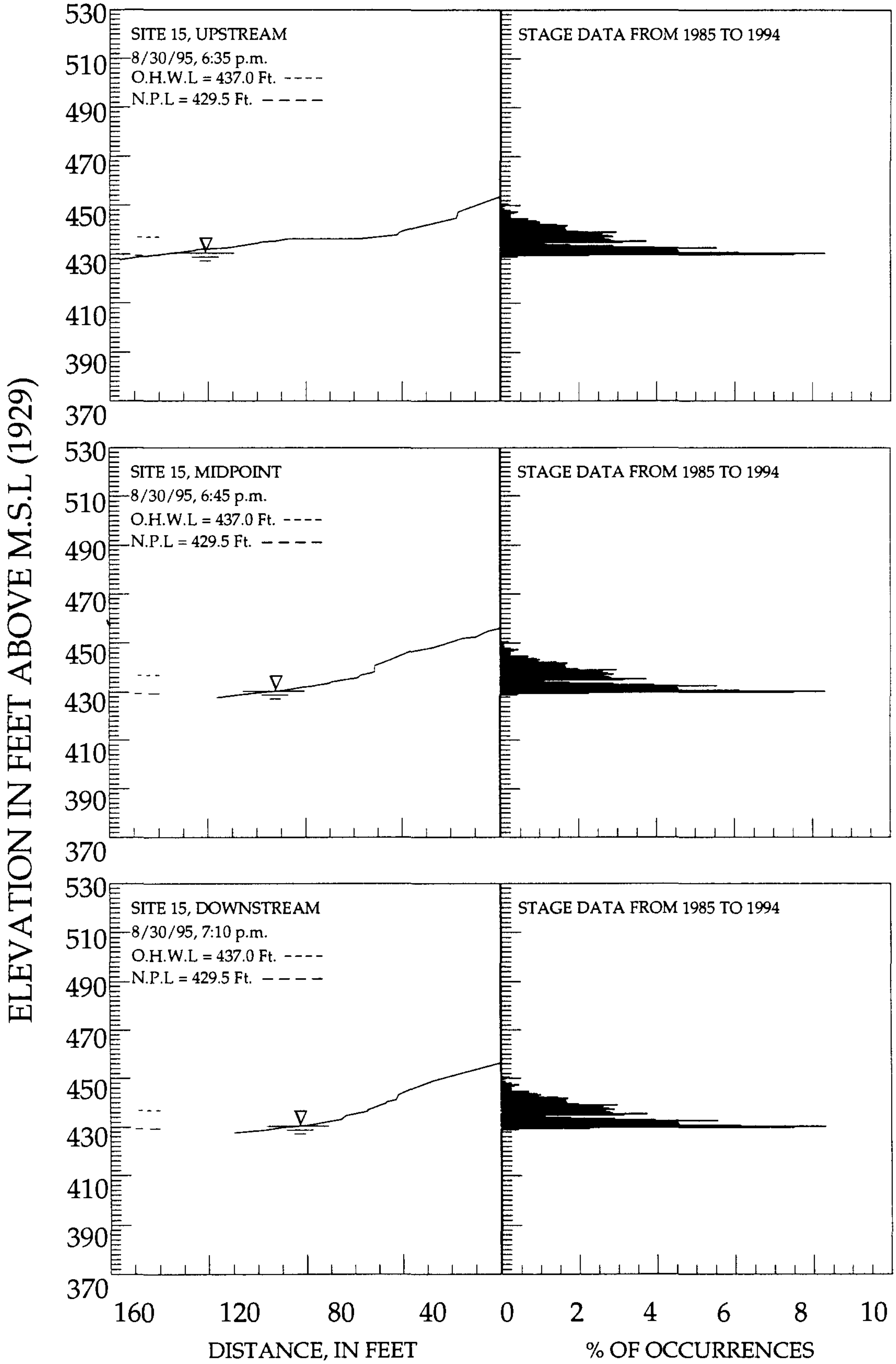
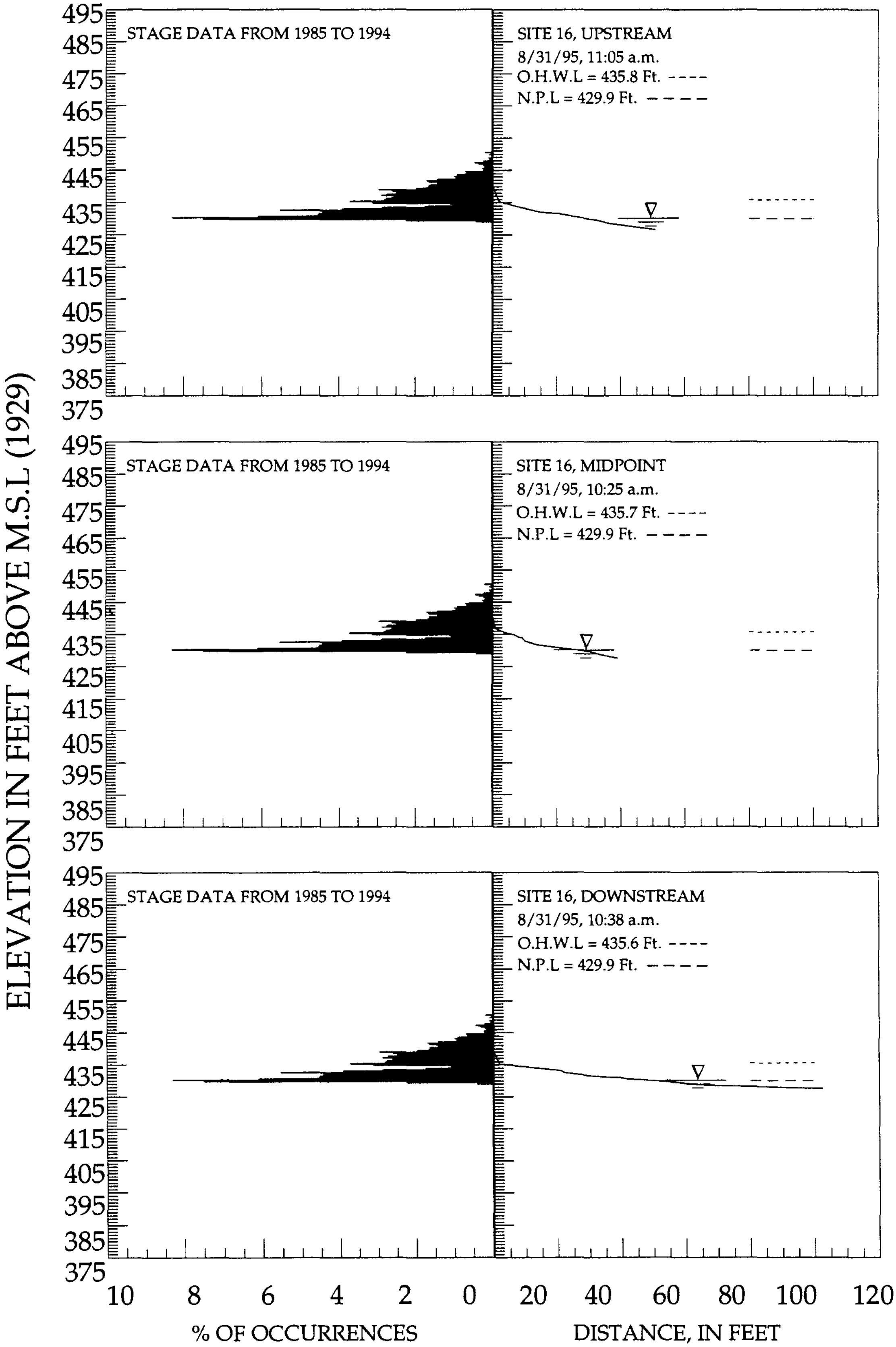
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER NEAR KINGSTON MINES,IL; RM 145.4



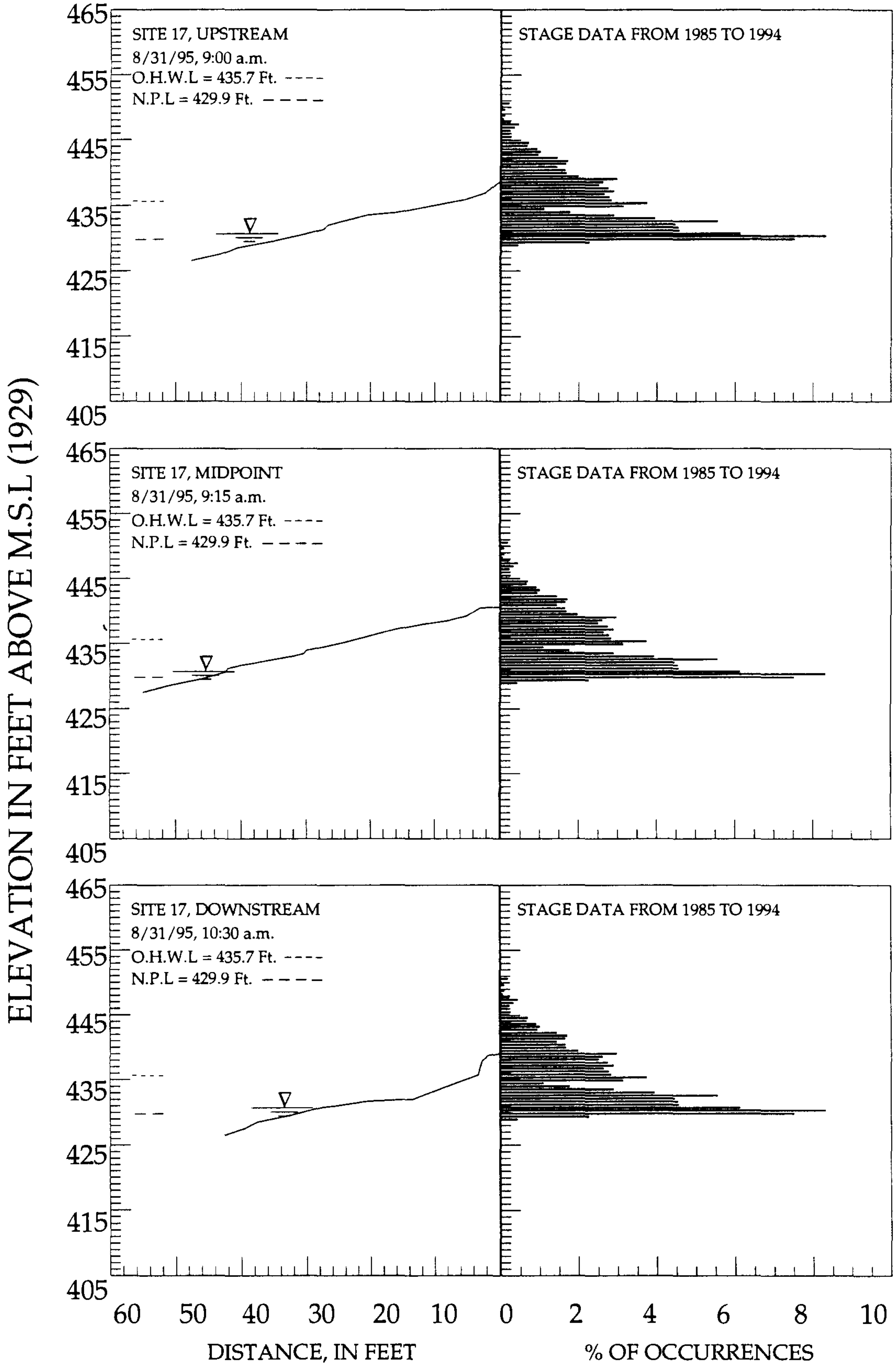
BANK PROFILE AT SITE 14 IN LAGRANGE POOL OF THE ILLINOIS RIVER; RM 129.3, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER NEAR COPPERAS CREEK,IL; RM 139.9



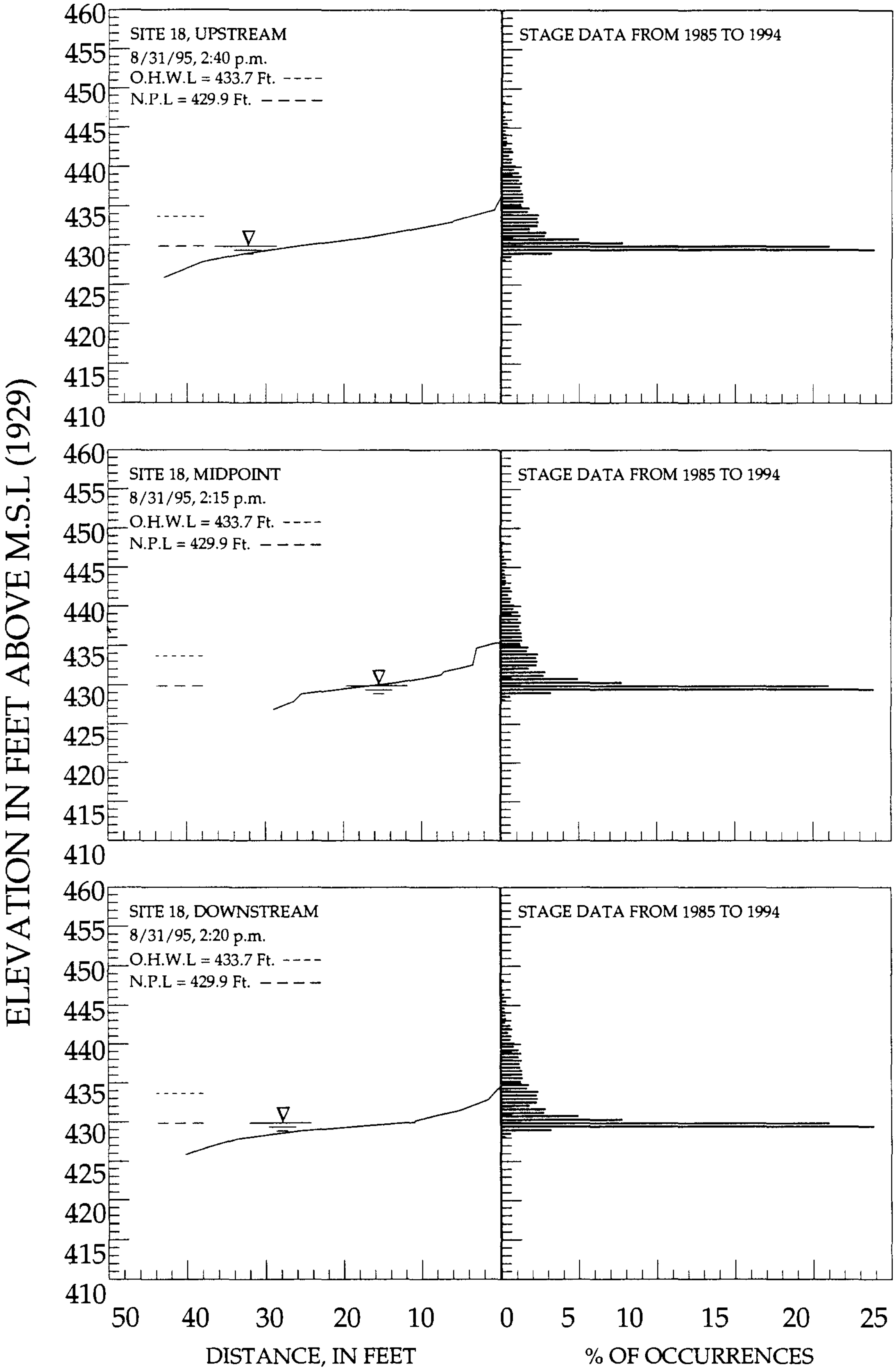
BANK PROFILE AT SITE 15 IN LAGRANGE POOL OF THE ILLINOIS RIVER; RM 116.5, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER NEAR HAVANA,IL; RM 119.6



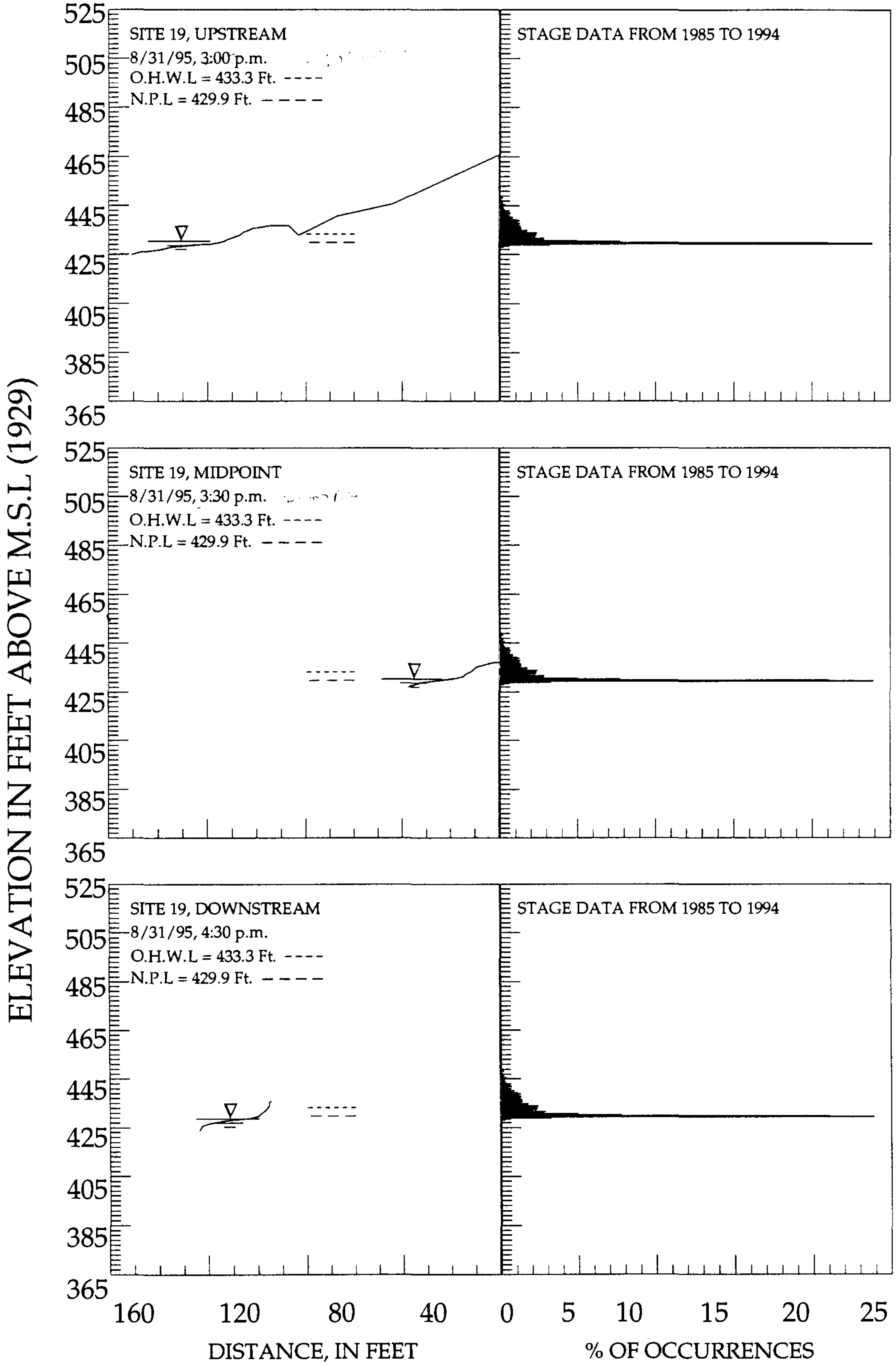
BANK PROFILE AT SITE 16 IN LAGRANGE POOL OF THE ILLINOIS RIVER; RM 109.5, LDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER NEAR HAVANA,IL; RM 119.6



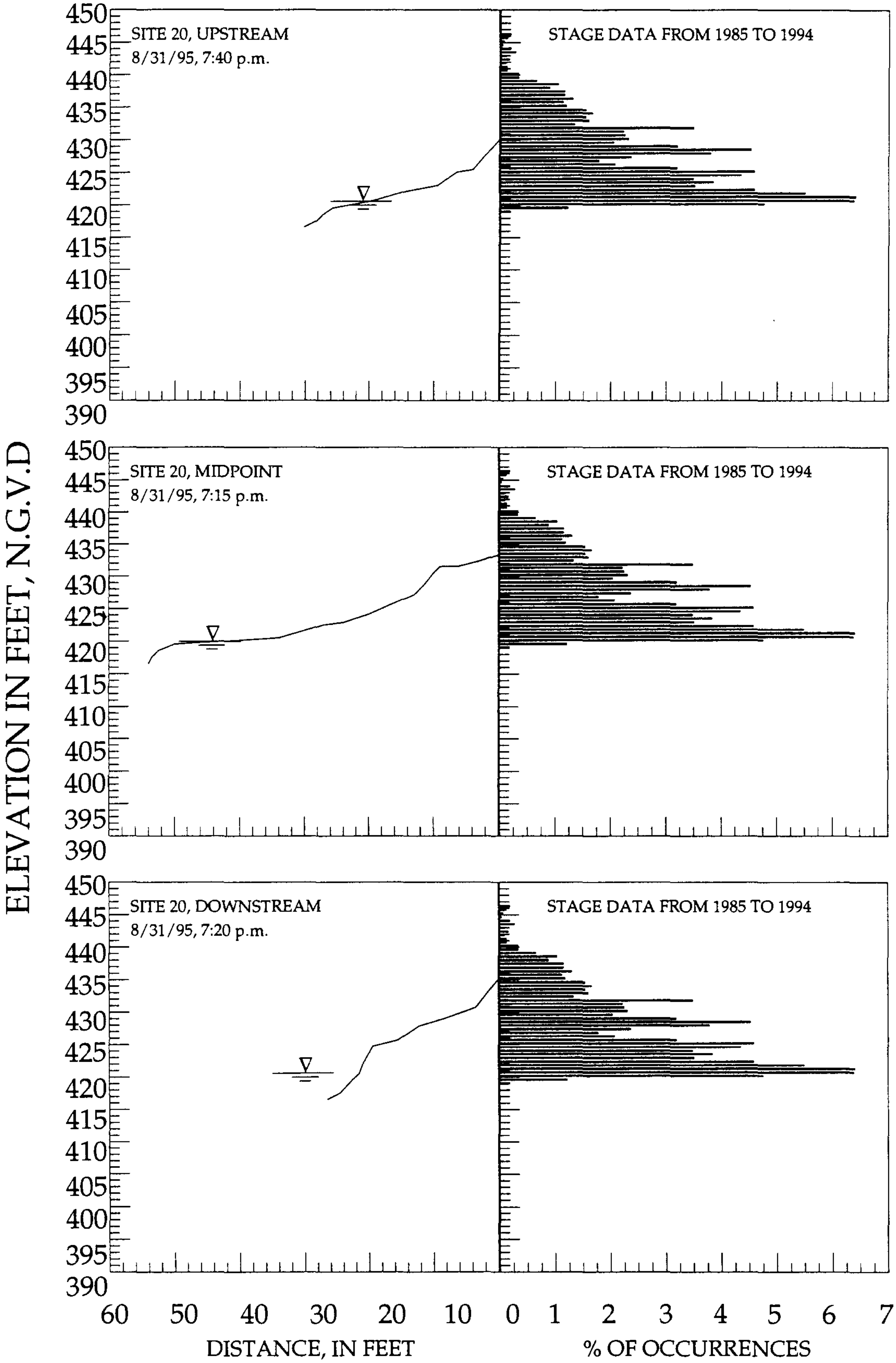
BANK PROFILE AT SITE 17 IN LAGRANGE POOL OF THE ILLINOIS RIVER; RM 109.5, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER NEAR HAVANA,IL; RM 119.6



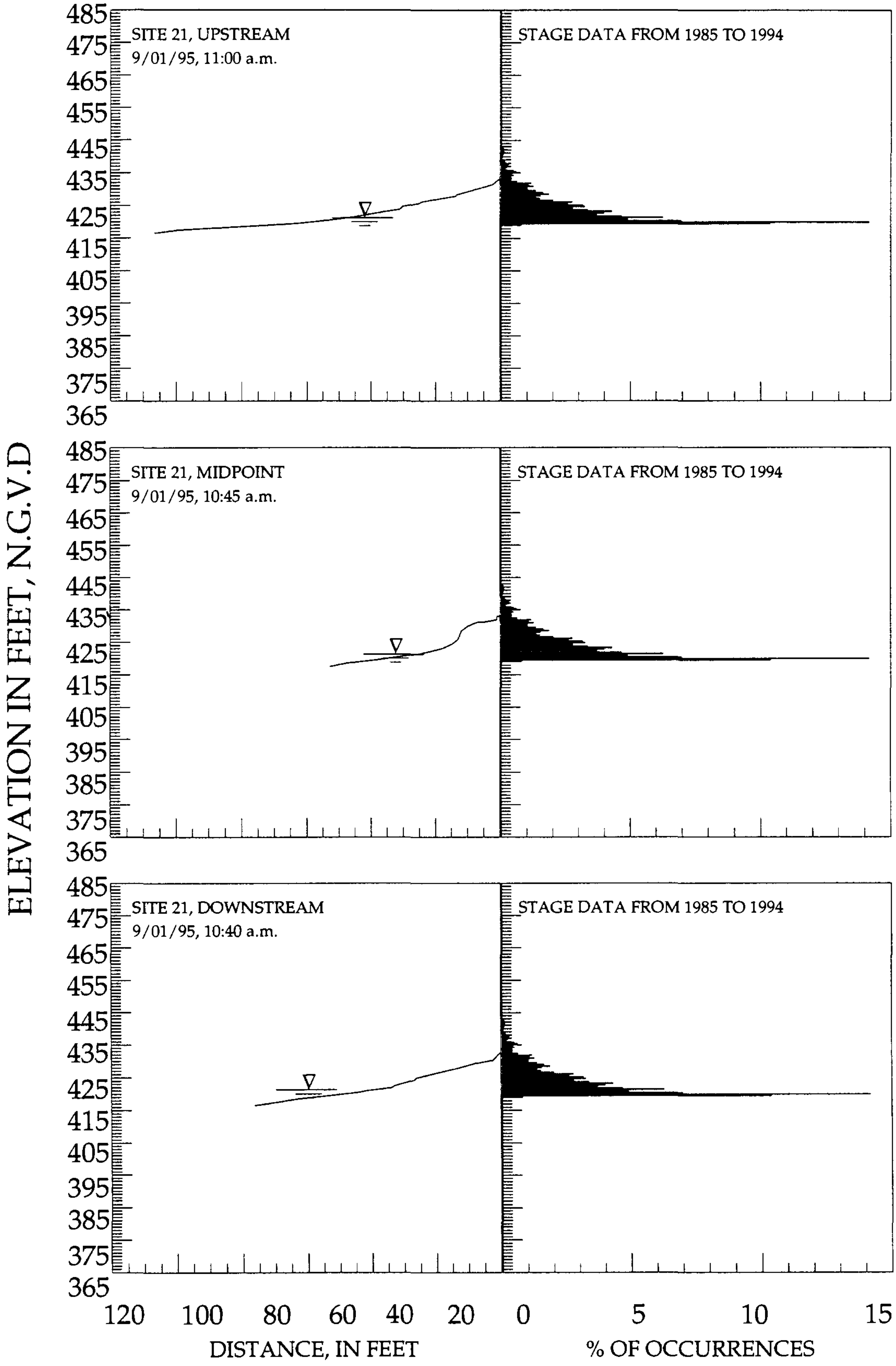
BANK PROFILE AT SITE 18 IN LAGRANGE POOL OF THE ILLINOIS RIVER; RM 94.2, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER AT BEARDSTOWN,IL; RM 88.3



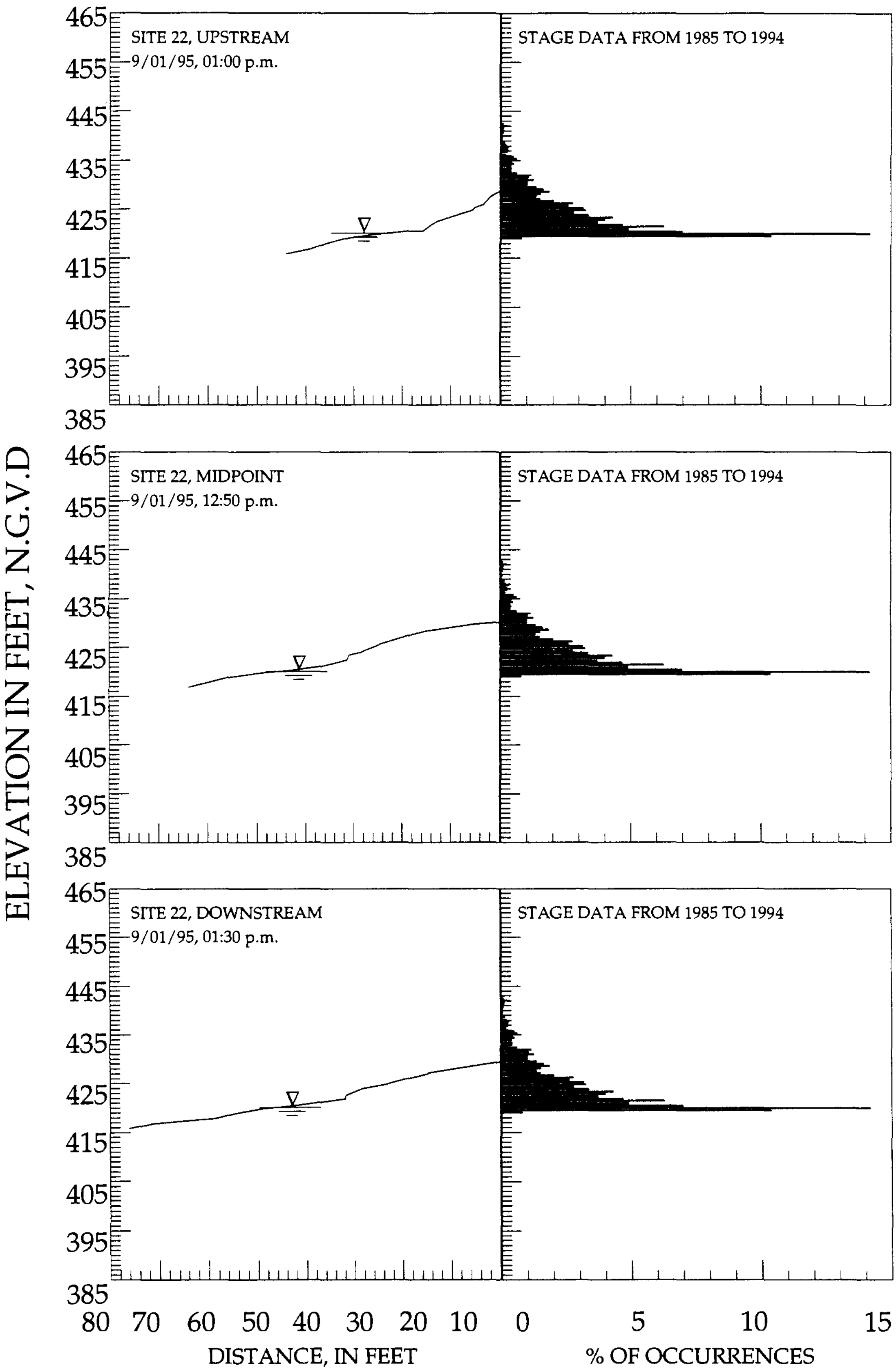
BANK PROFILE AT SITE 19 IN LAGRANGE POOL OF THE ILLINOIS RIVER; RM 91.2, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER AT BEARDSTOWN,IL; RM 88.3



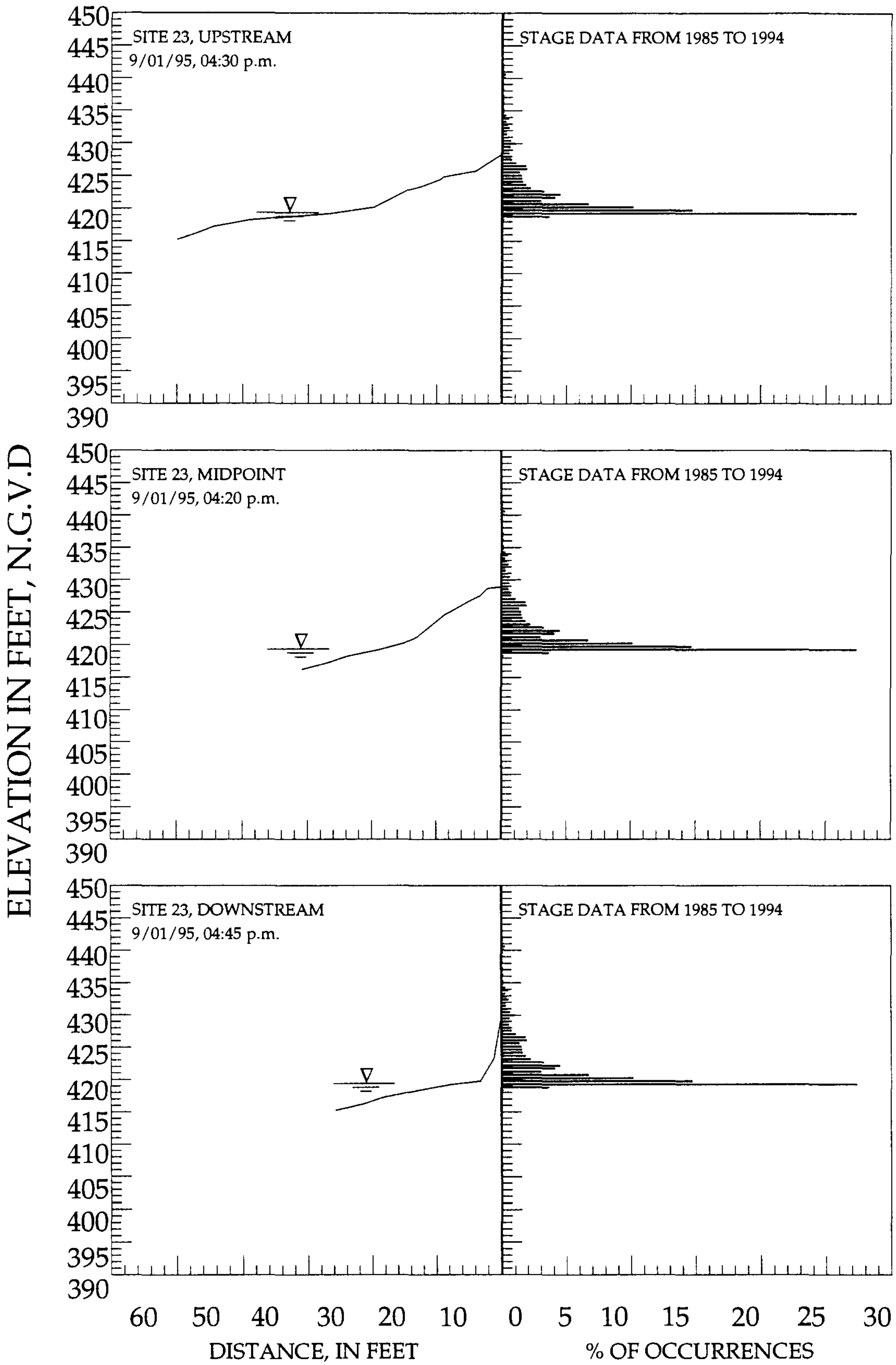
BANK PROFILE AT SITE 20 IN ALTON POOL OF THE ILLINOIS RIVER; RM 79.4, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF LAGRANGE POOL, RM 80.2



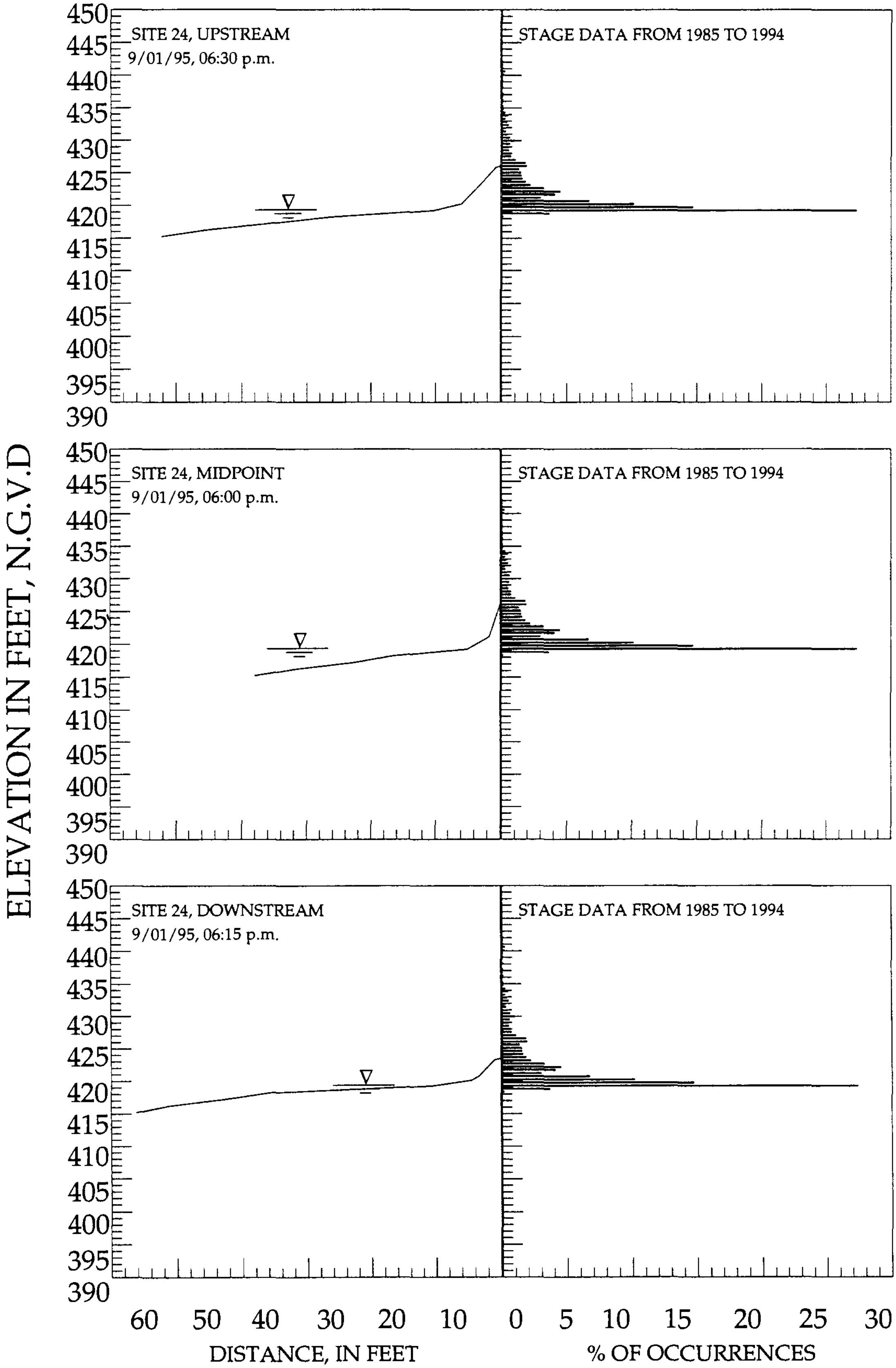
BANK PROFILE AT SITE 21 IN ALTON POOL OF THE ILLINOIS RIVER; RM 61.7, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER NEAR VALLEY CITY, IL; RM 61.3



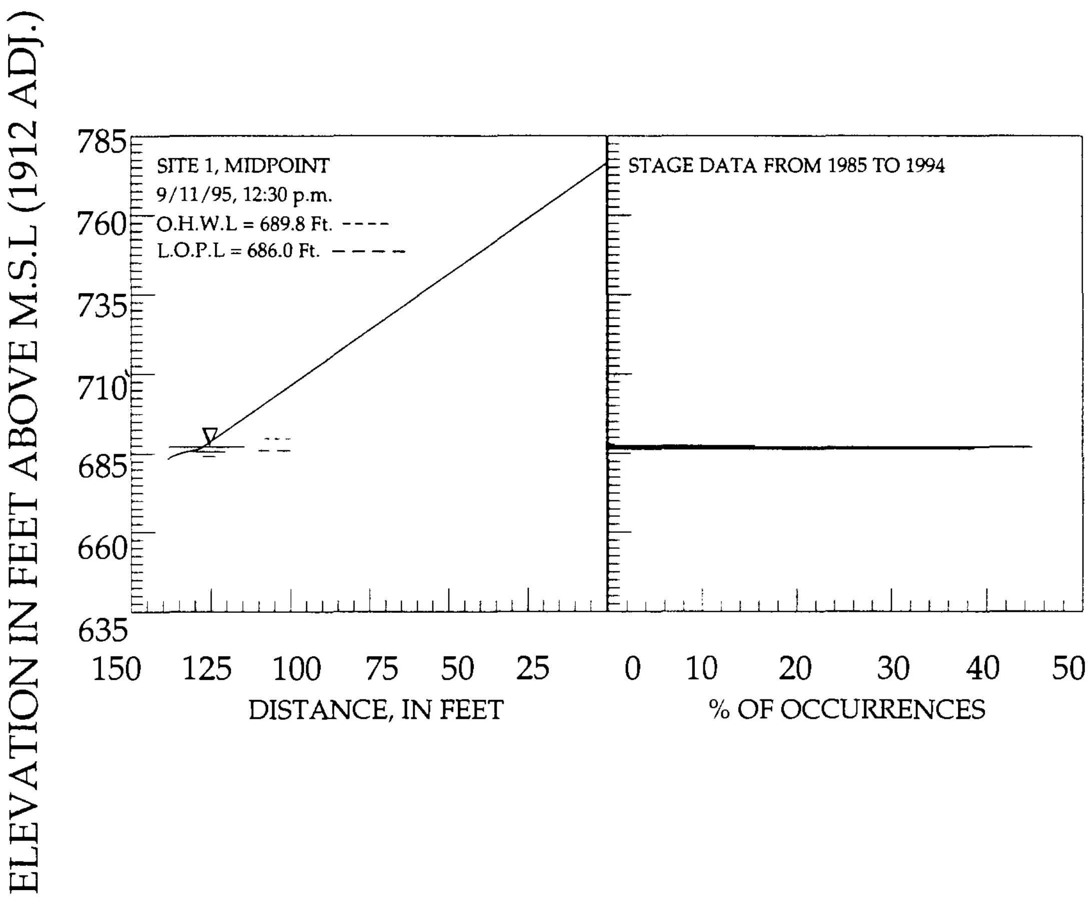
BANK PROFILE AT SITE 22 IN ALTON POOL OF THE ILLINOIS RIVER; RM 45.1, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER AT PEARL,IL; RM 43.2



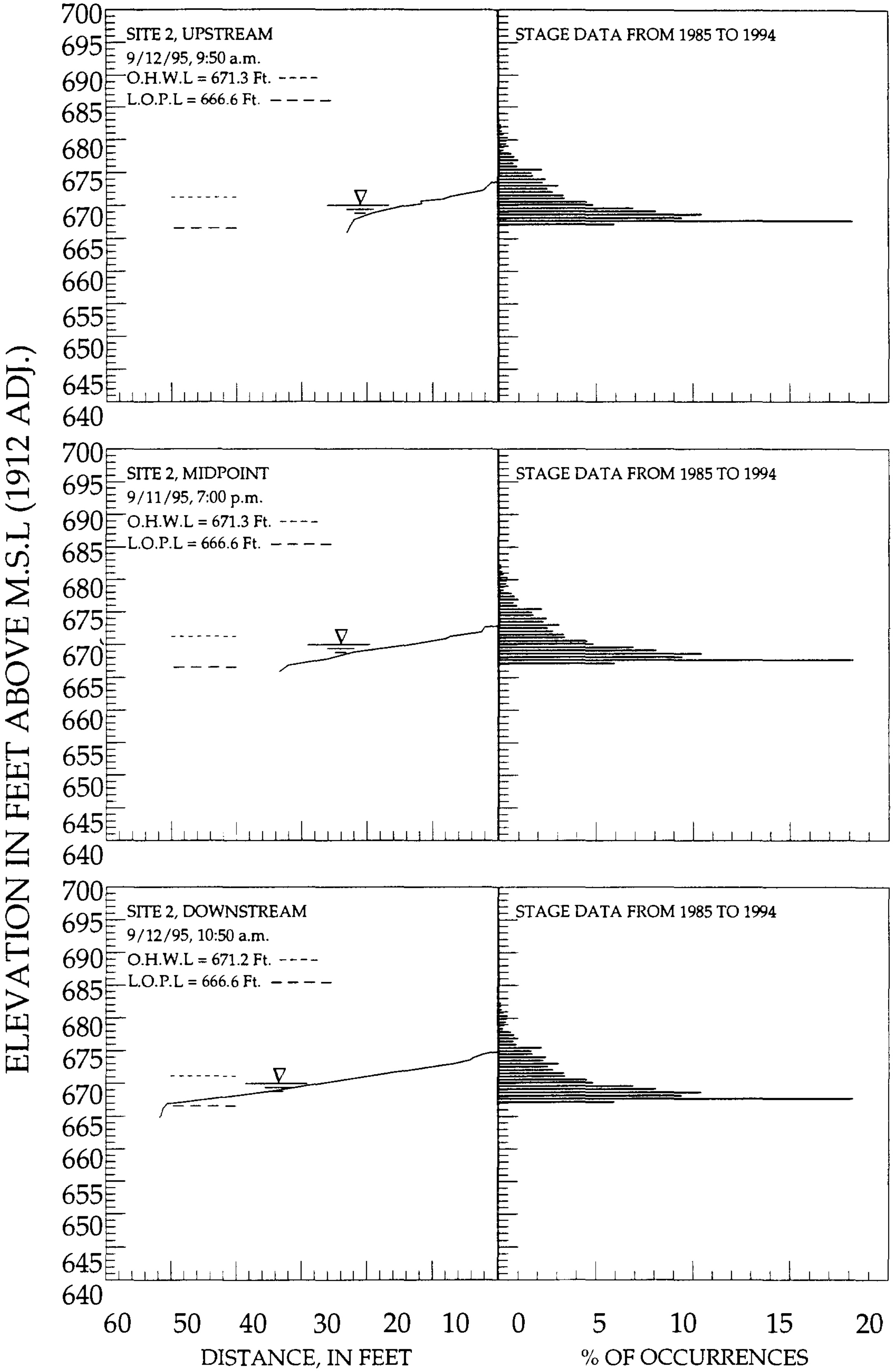
BANK PROFILE AT SITE 23 IN ALTON POOL OF THE ILLINOIS RIVER; RM 23.4, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER AT HARDIN,IL; RM 21.6



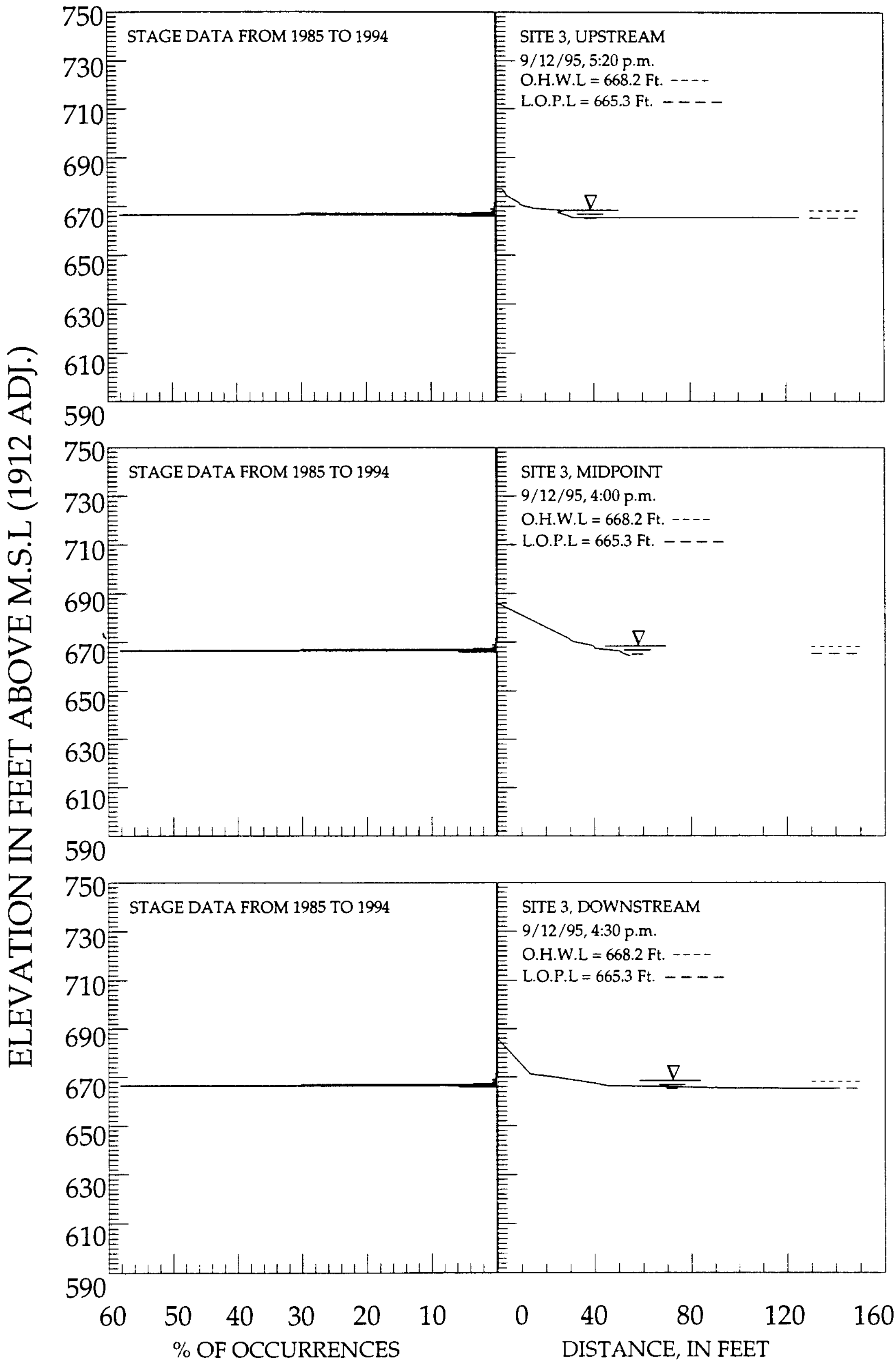
BANK PROFILE AT SITE 24 IN ALTON POOL OF THE ILLINOIS RIVER; RM 13.0, RDB
STAGE HISTOGRAM AT GAGE ON ILLINOIS RIVER AT HARDIN,IL; RM 21.6



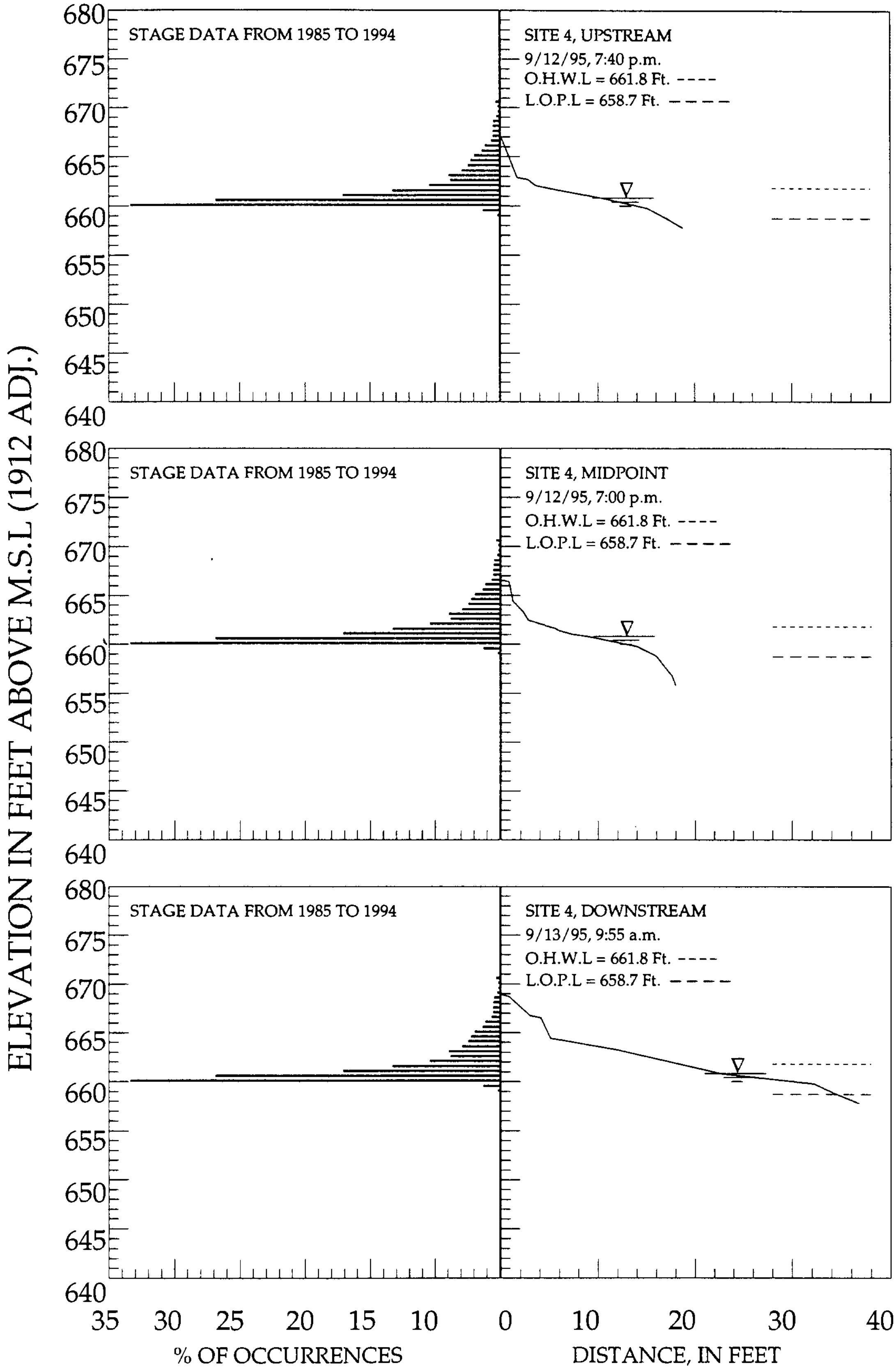
BANK PROFILE AT SITE 1 IN POOL 2 OF THE MISSISSIPPI RIVER; RM 825.5, RDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 2, RM 815.2



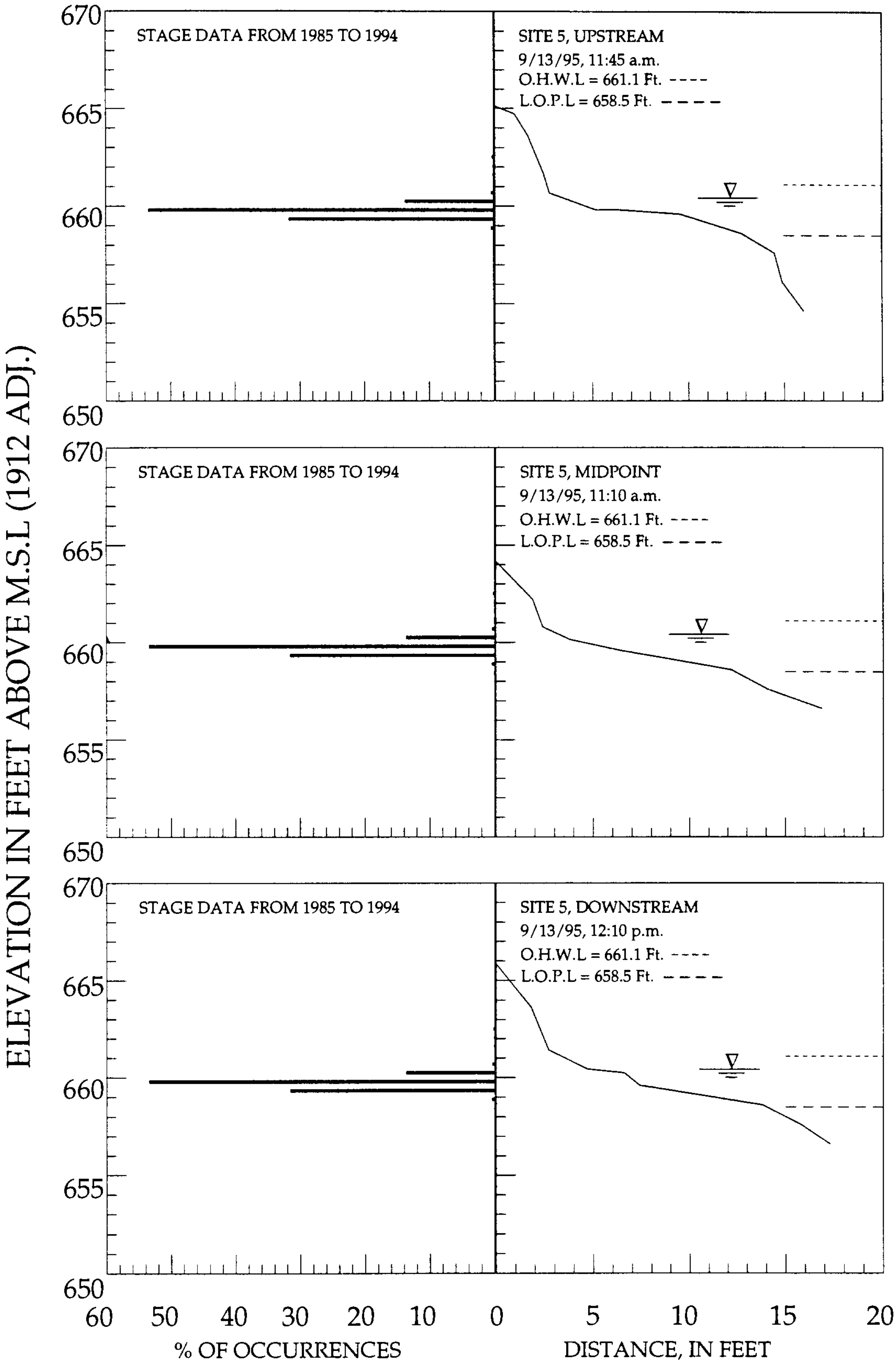
BANK PROFILE AT SITE 2 IN POOL 4 OF THE MISSISSIPPI RIVER; RM 791.7, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 3, RM 797.06



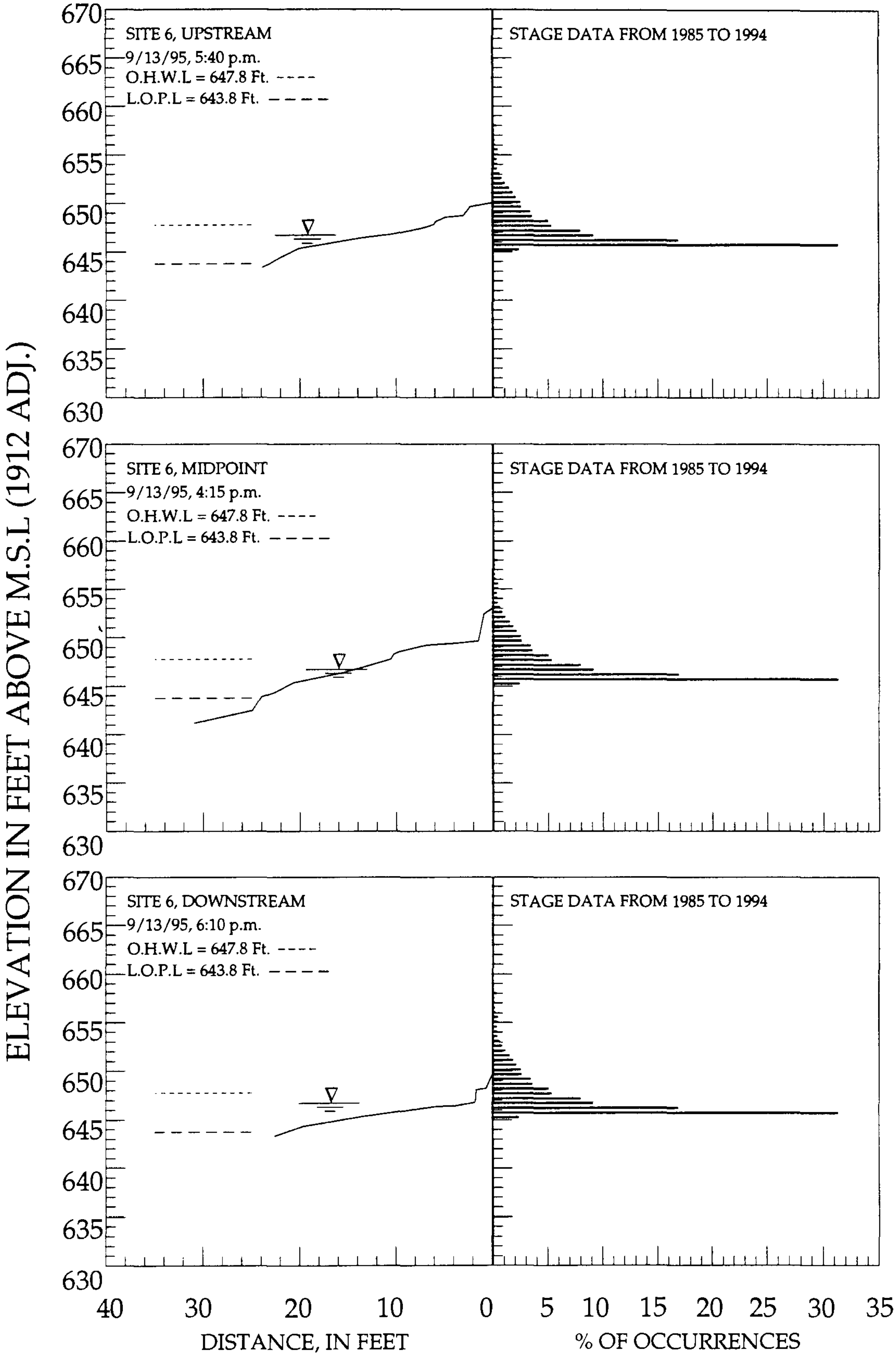
BANK PROFILE AT SITE 3 IN POOL 4 OF THE MISSISSIPPI RIVER; RM 763.4, LDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 4, RM 752.8



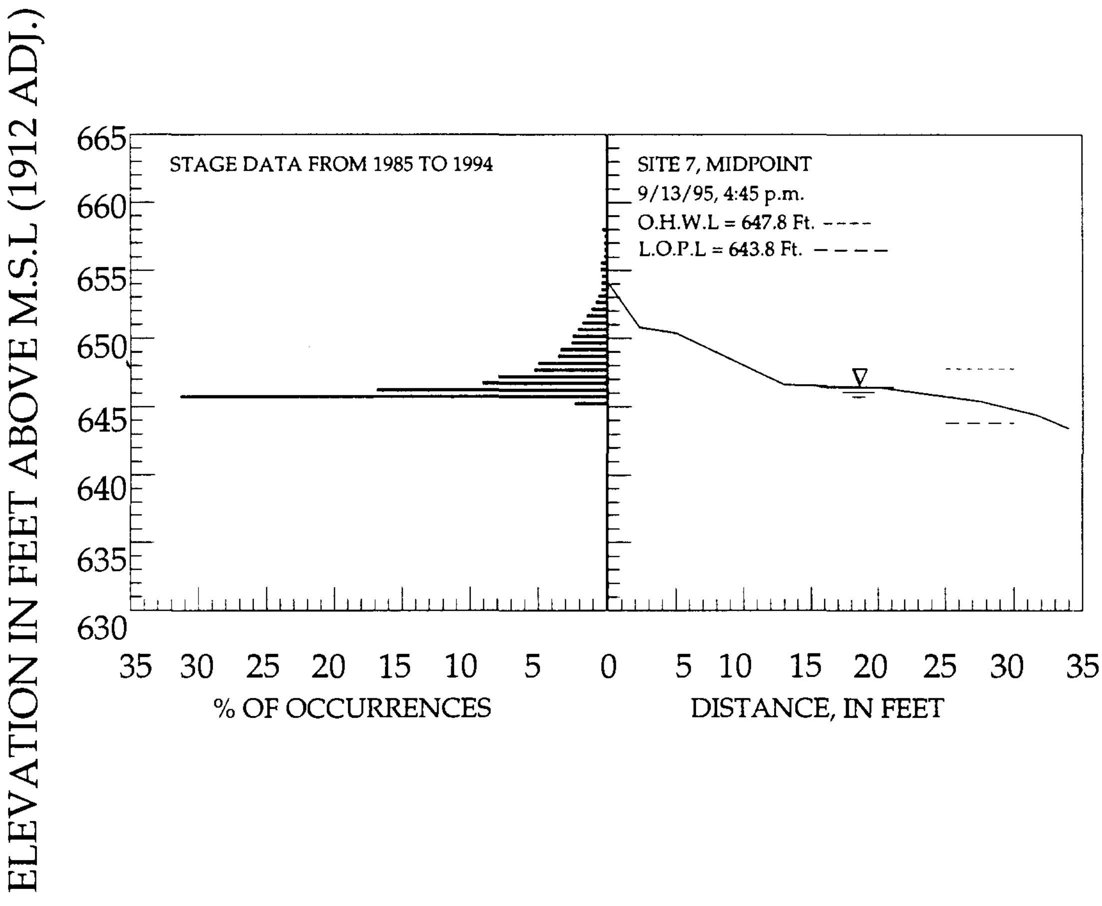
BANK PROFILE AT SITE 4 IN POOL 5 OF THE MISSISSIPPI RIVER; RM 751.1, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 4, RM 752.8



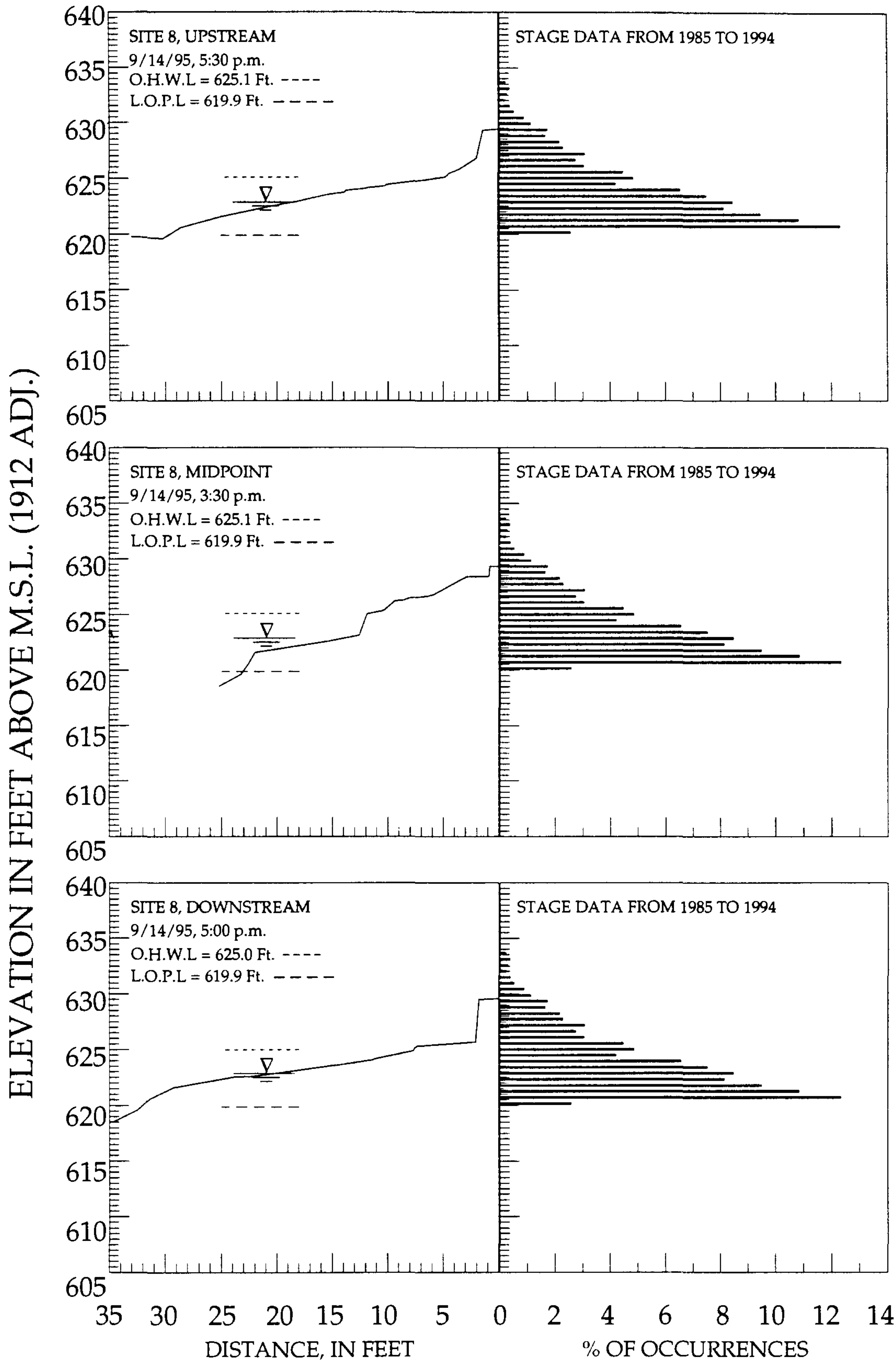
BANK PROFILE AT SITE 5 IN POOL 5 OF THE MISSISSIPPI RIVER; RM 746.4, LDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 5, RM 738.1



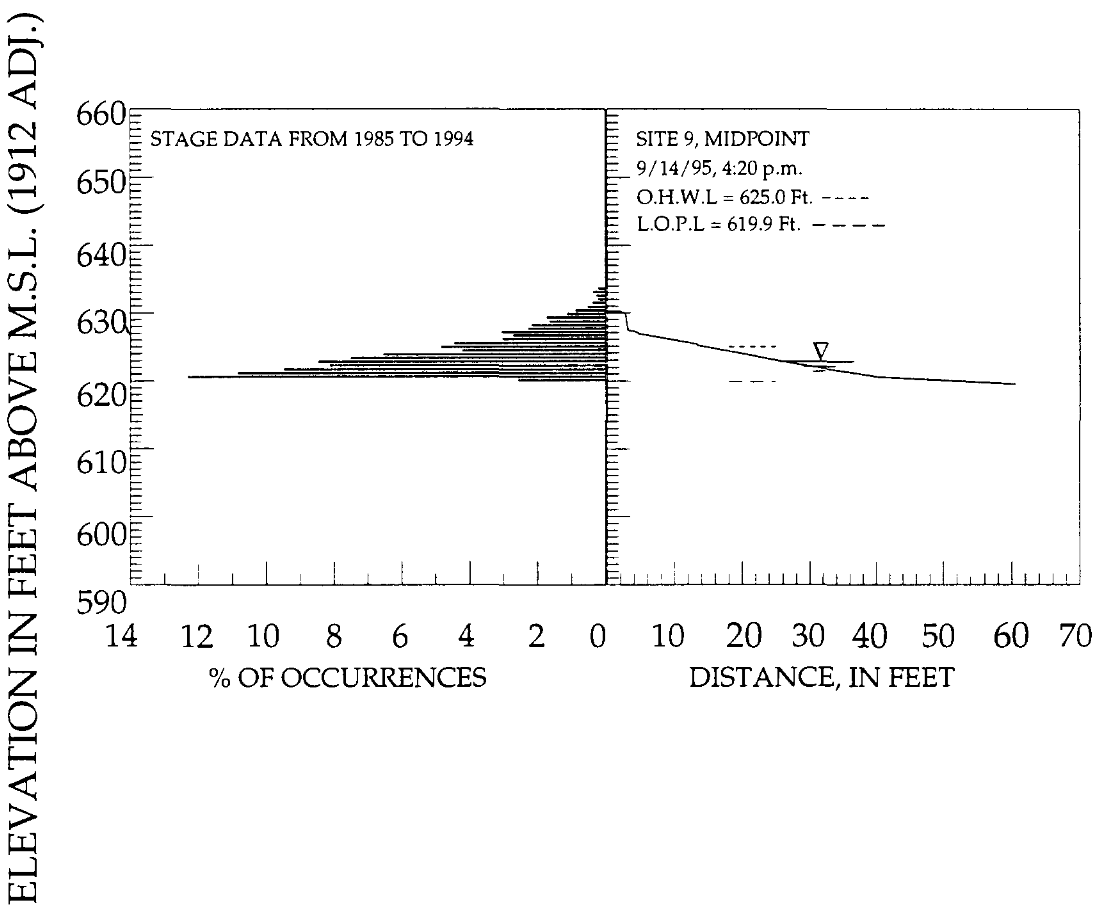
BANK PROFILE AT SITE 6 IN POOL 6 OF THE MISSISSIPPI RIVER; RM 727.4, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 5A, RM 728.5



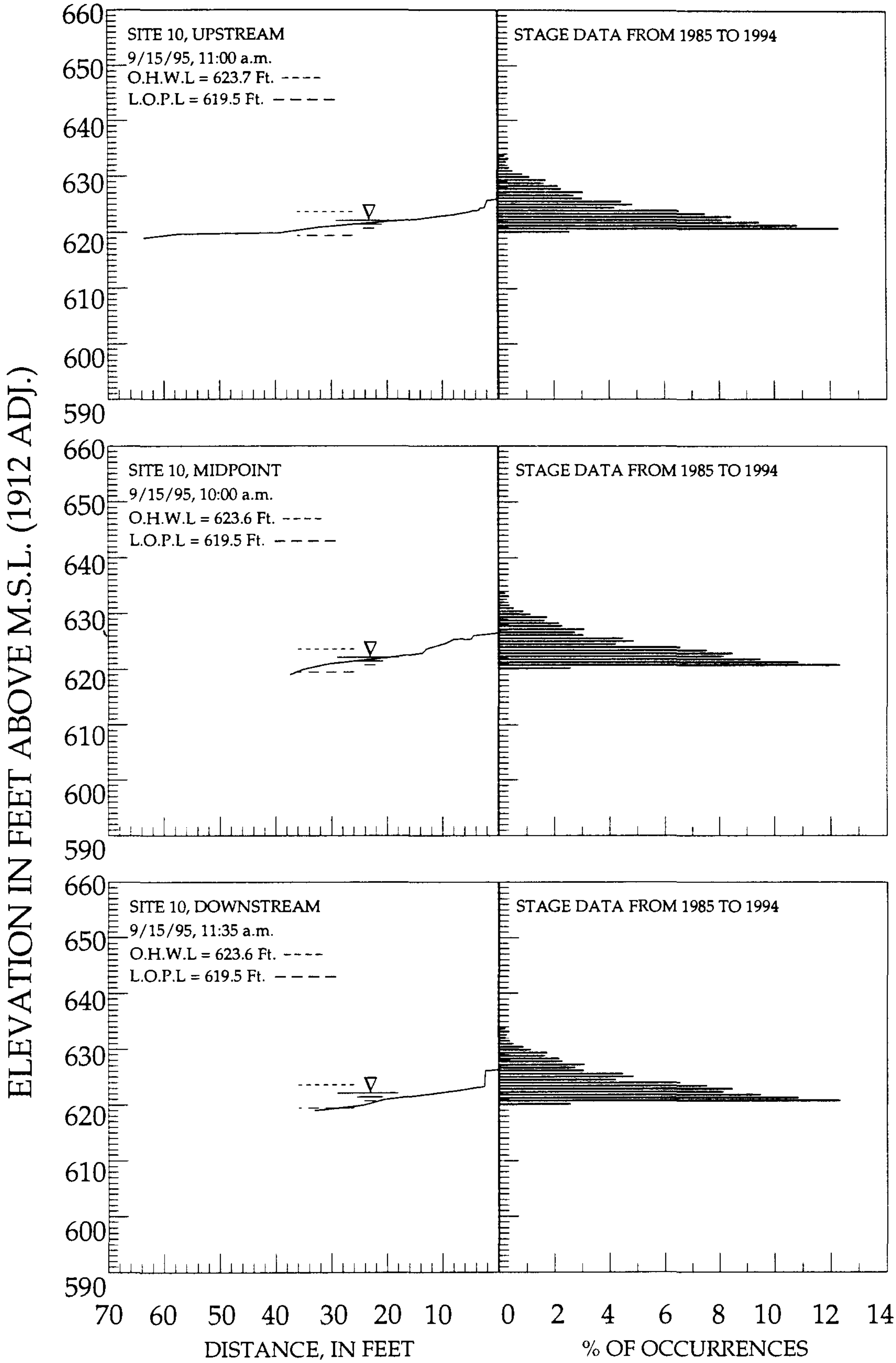
BANK PROFILE AT SITE 7 IN POOL 6 OF THE MISSISSIPPI RIVER; RM 727.4, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 5A, RM 728.5



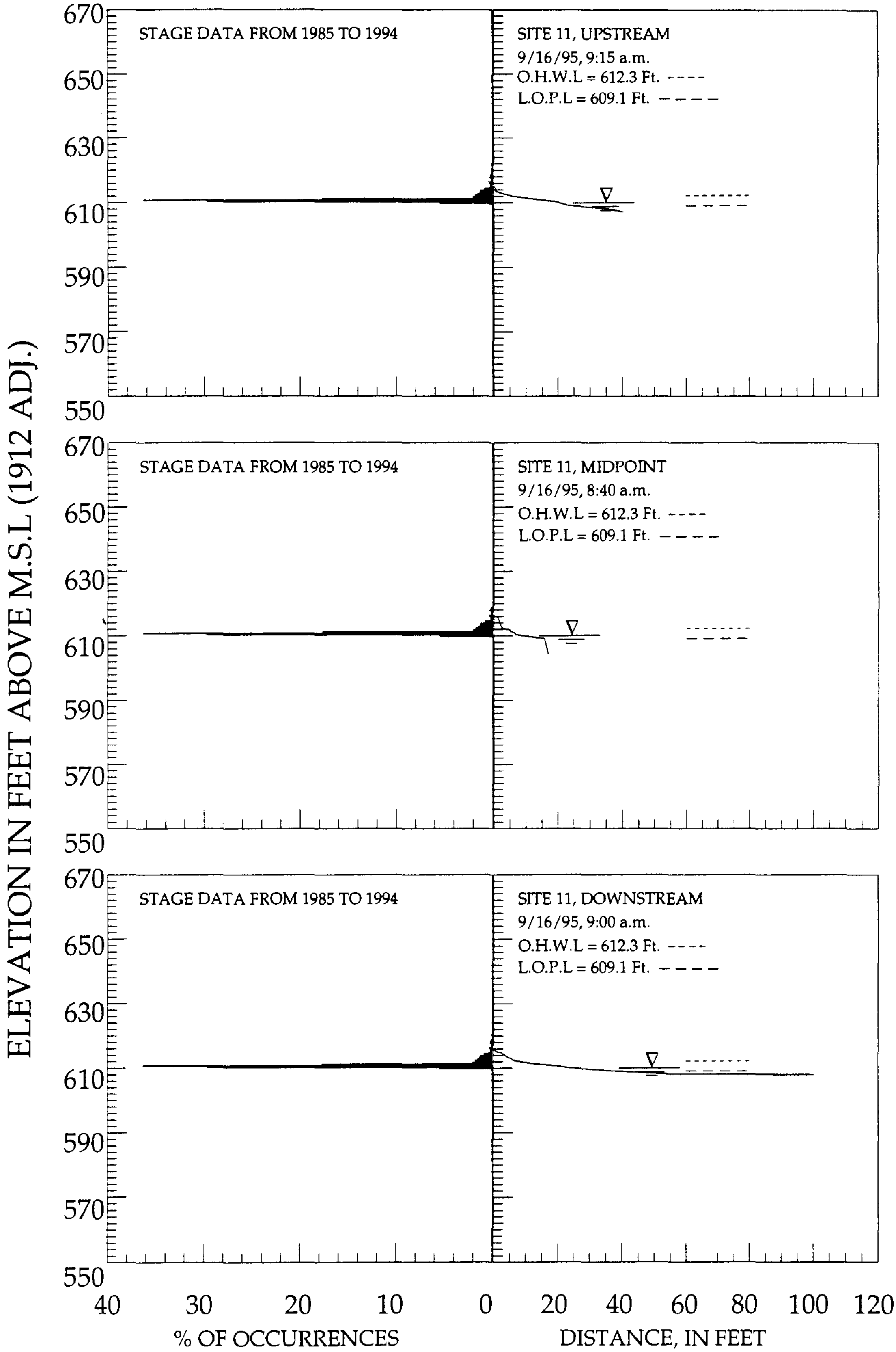
BANK PROFILE AT SITE 8 IN POOL 9 OF THE MISSISSIPPI RIVER; RM 677.7, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 8, RM 679.08



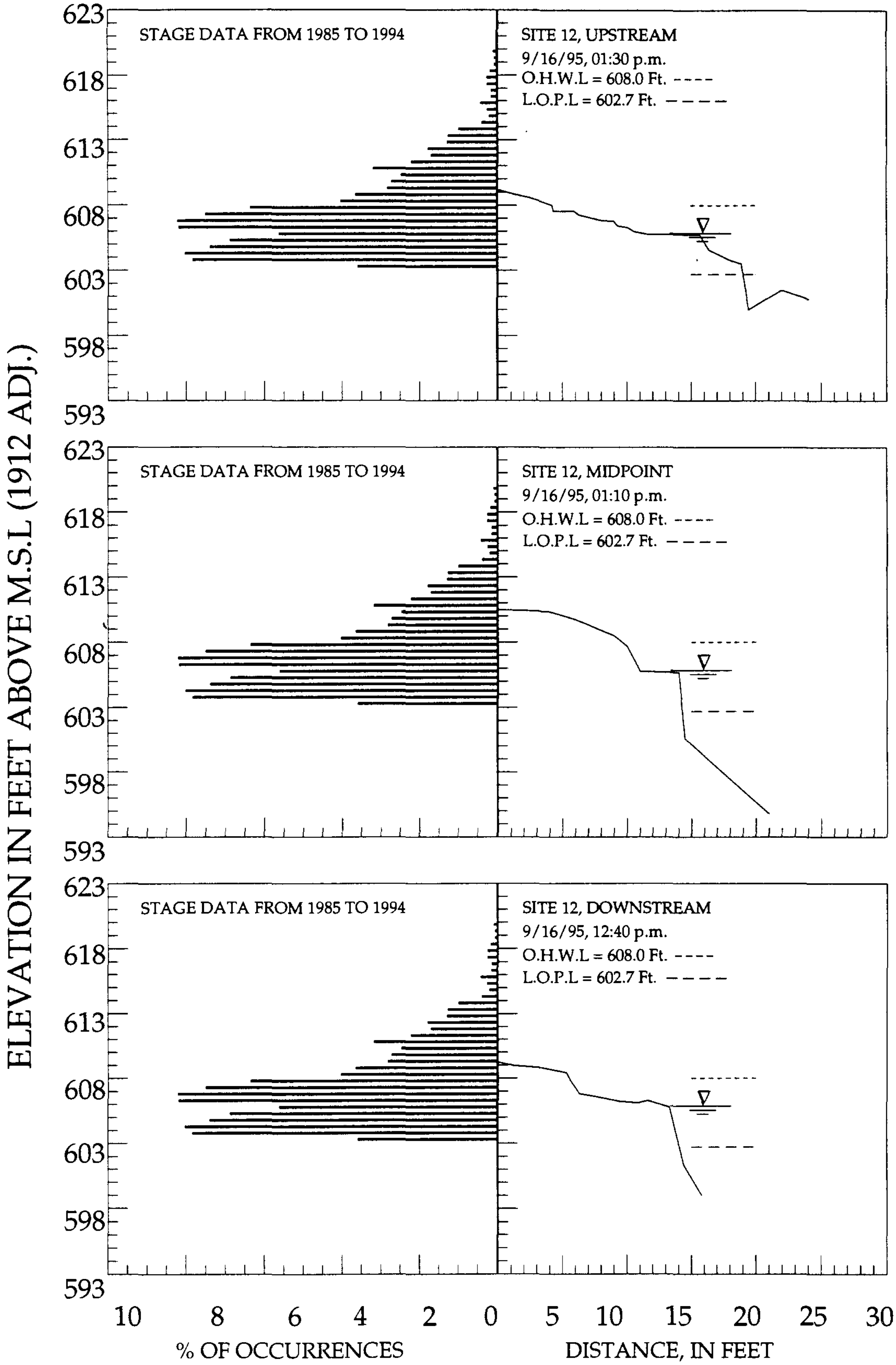
BANK PROFILE AT SITE 9 IN POOL 9 OF THE MISSISSIPPI RIVER; RM 677.5, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 8, RM 679.08



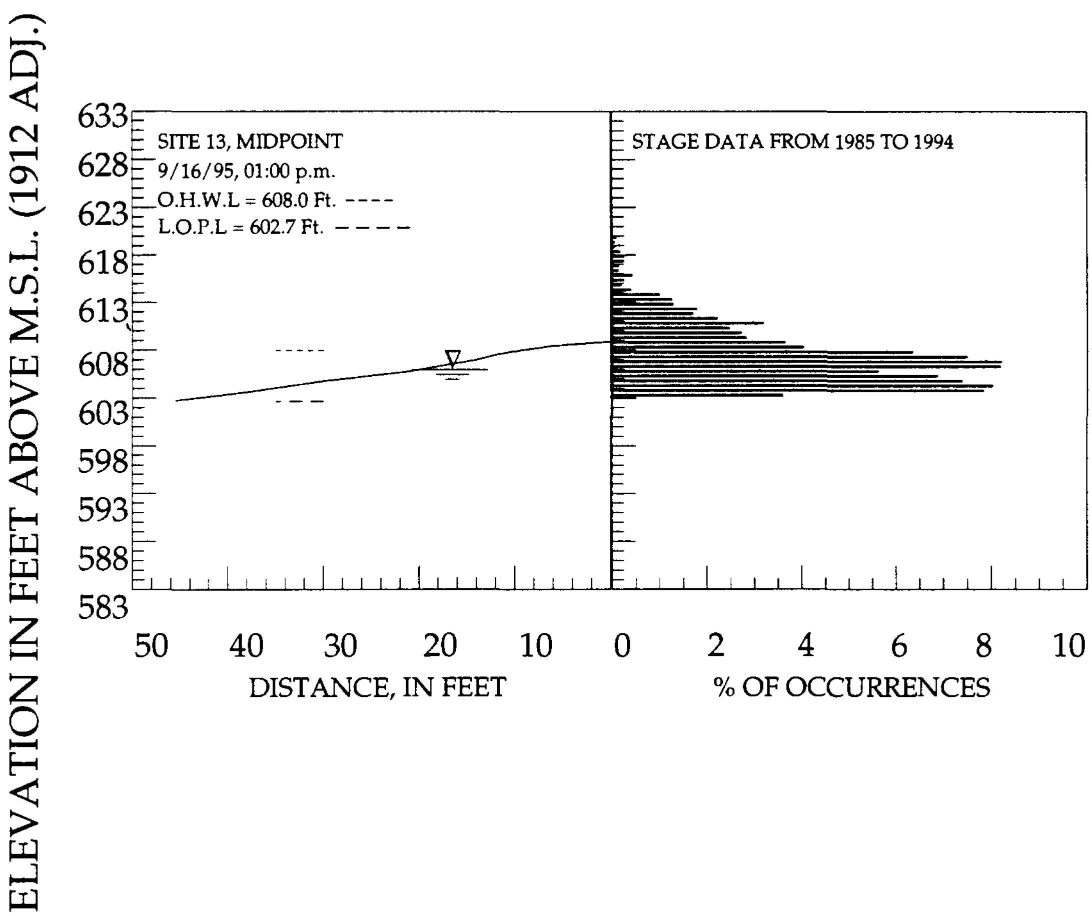
BANK PROFILE AT SITE 10 IN POOL 9 OF THE MISSISSIPPI RIVER; RM 669.5, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 8, RM 679.08



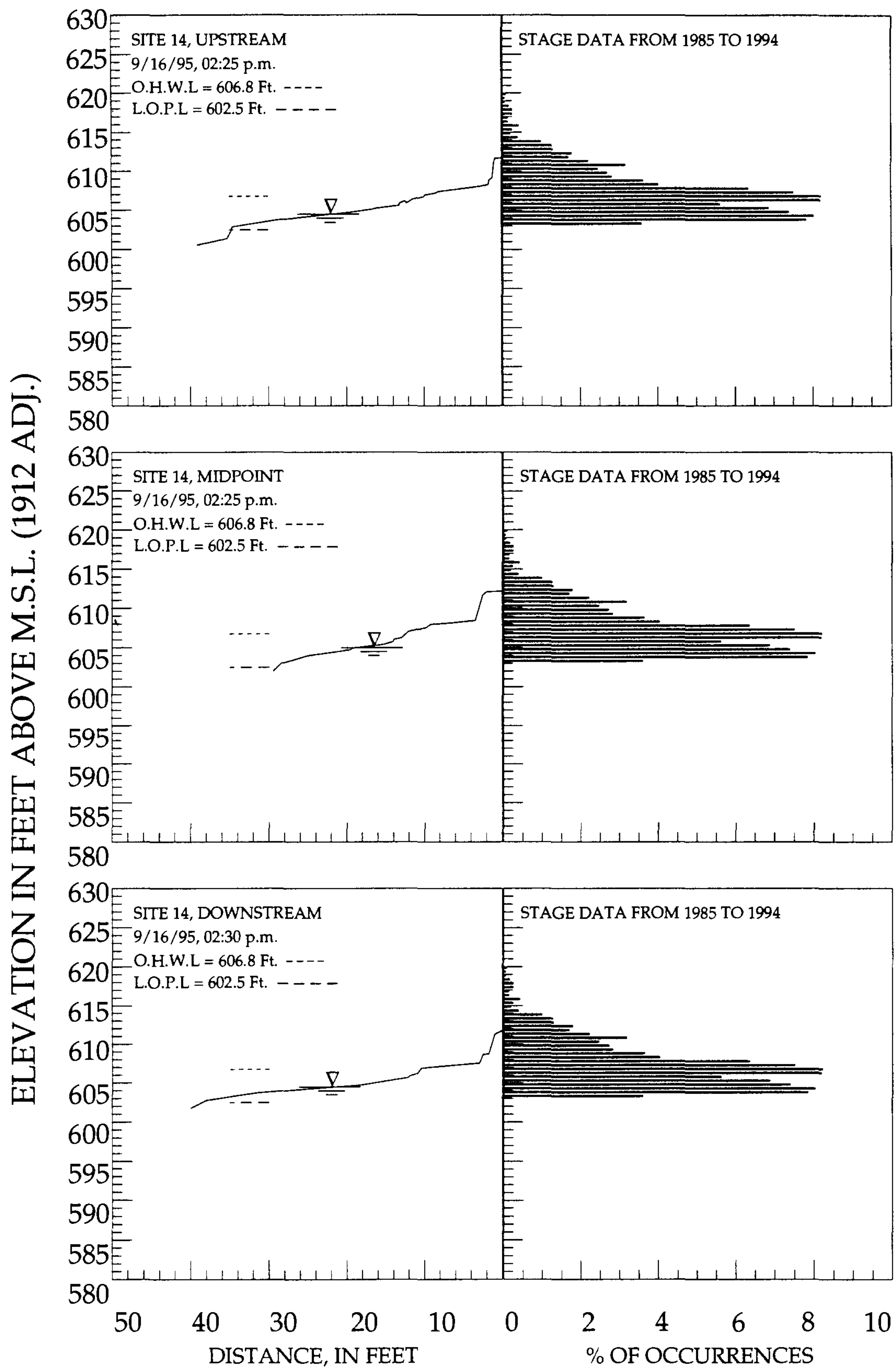
BANK PROFILE AT SITE 11 IN POOL 10 OF THE MISSISSIPPI RIVER; RM 620.5, LDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 10, RM 615.1



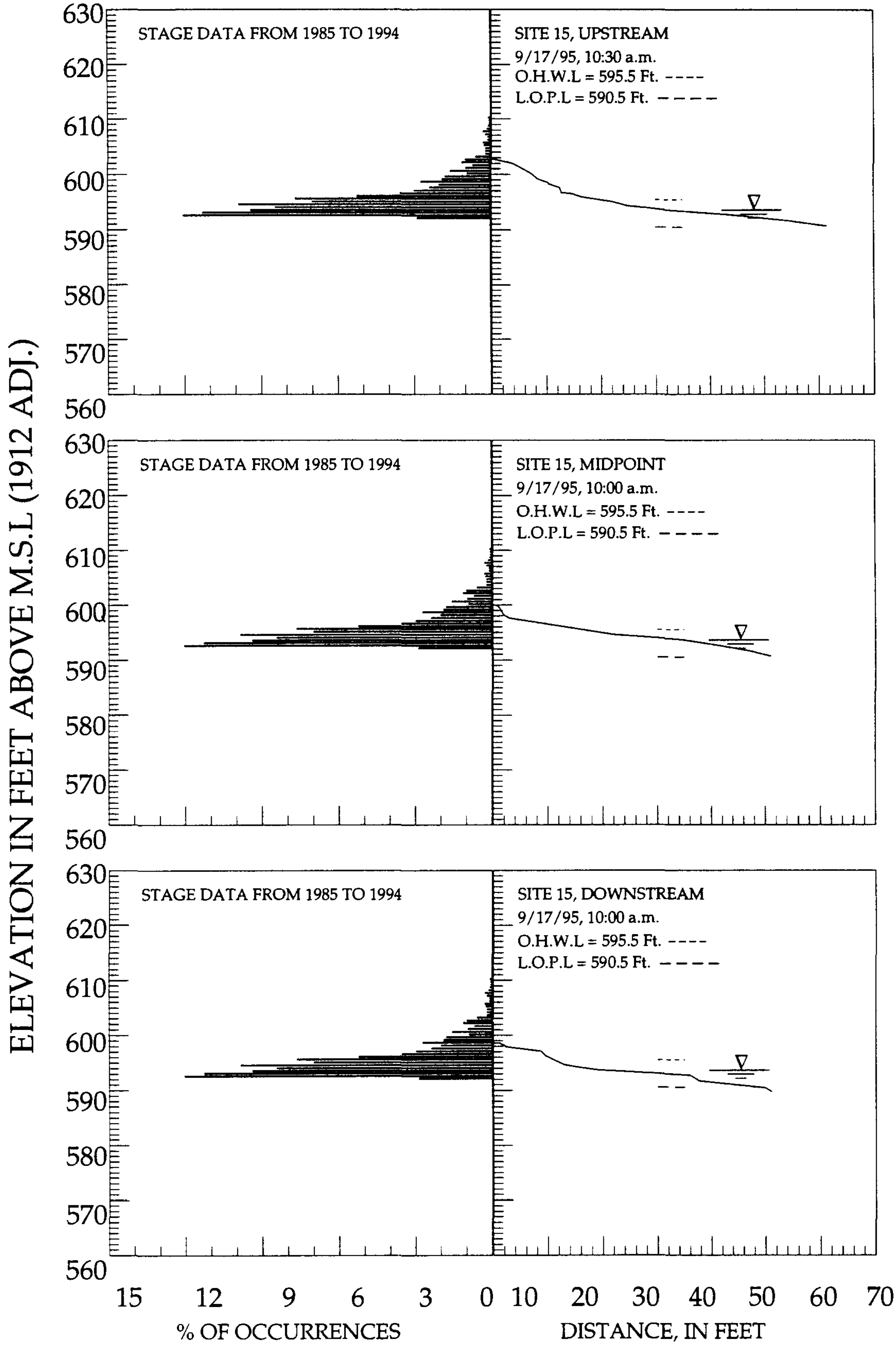
BANK PROFILE AT SITE 12 IN POOL 11 OF THE MISSISSIPPI RIVER; RM 613.6, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 10, RM 615.1



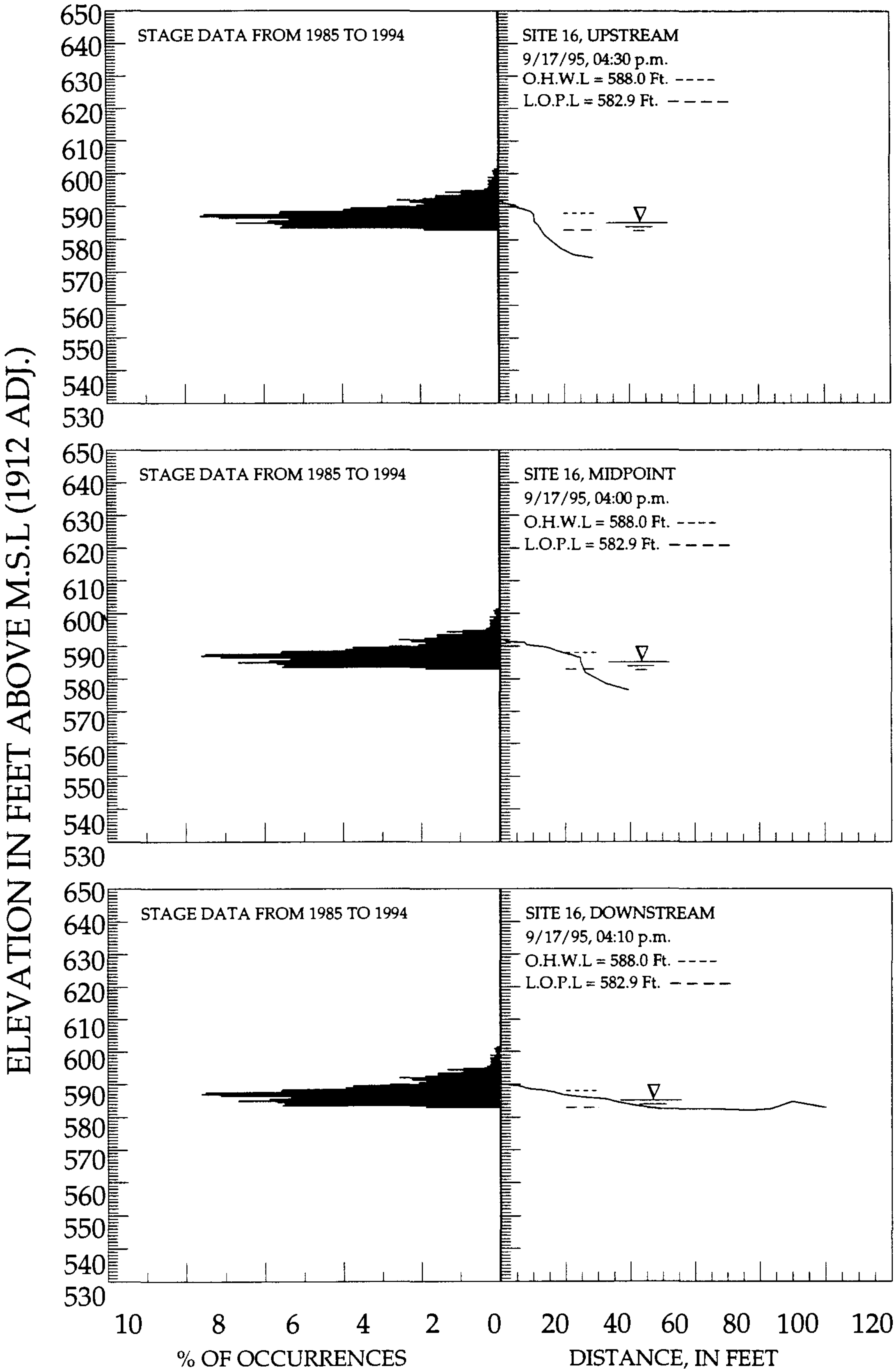
BANK PROFILE AT SITE 13 IN POOL 11 OF THE MISSISSIPPI RIVER; RM 613.6, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 10, RM 615.1



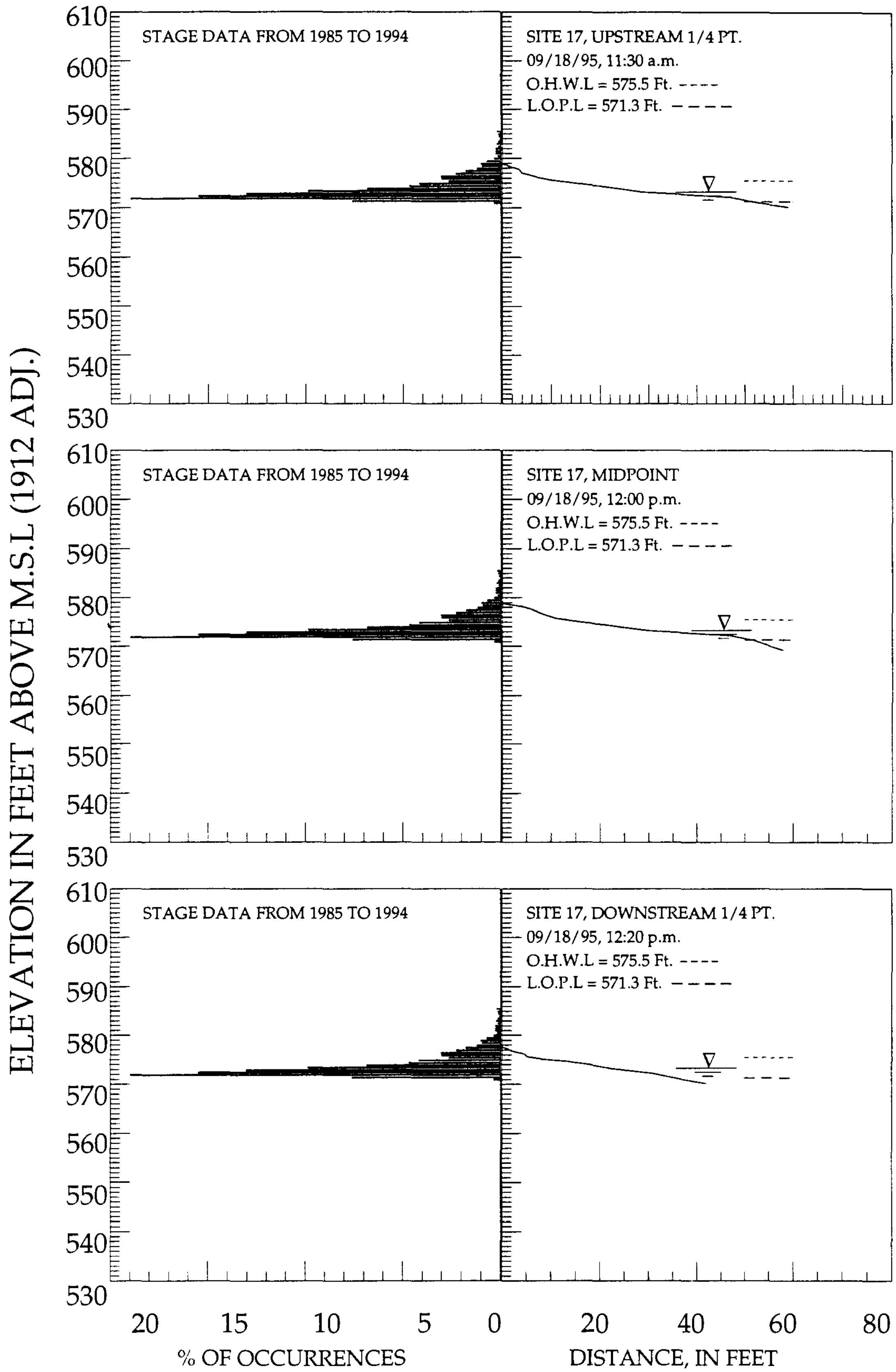
BANK PROFILE AT SITE 14 IN POOL 11 OF THE MISSISSIPPI RIVER; RM 607.5, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 10, RM 615.1



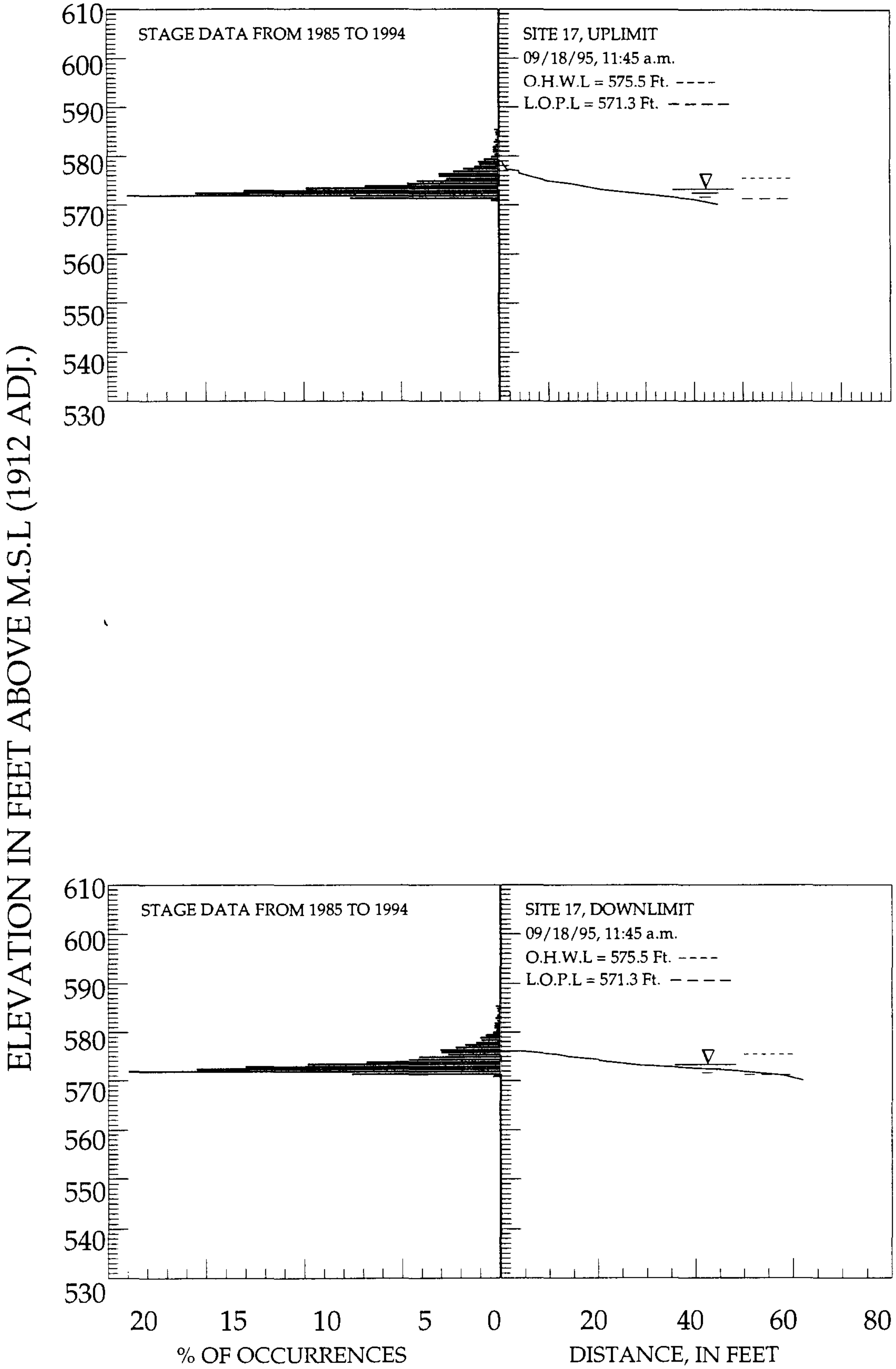
BANK PROFILE AT SITE 15 IN POOL 12 OF THE MISSISSIPPI RIVER; RM 576.0, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 11, RM 583.0



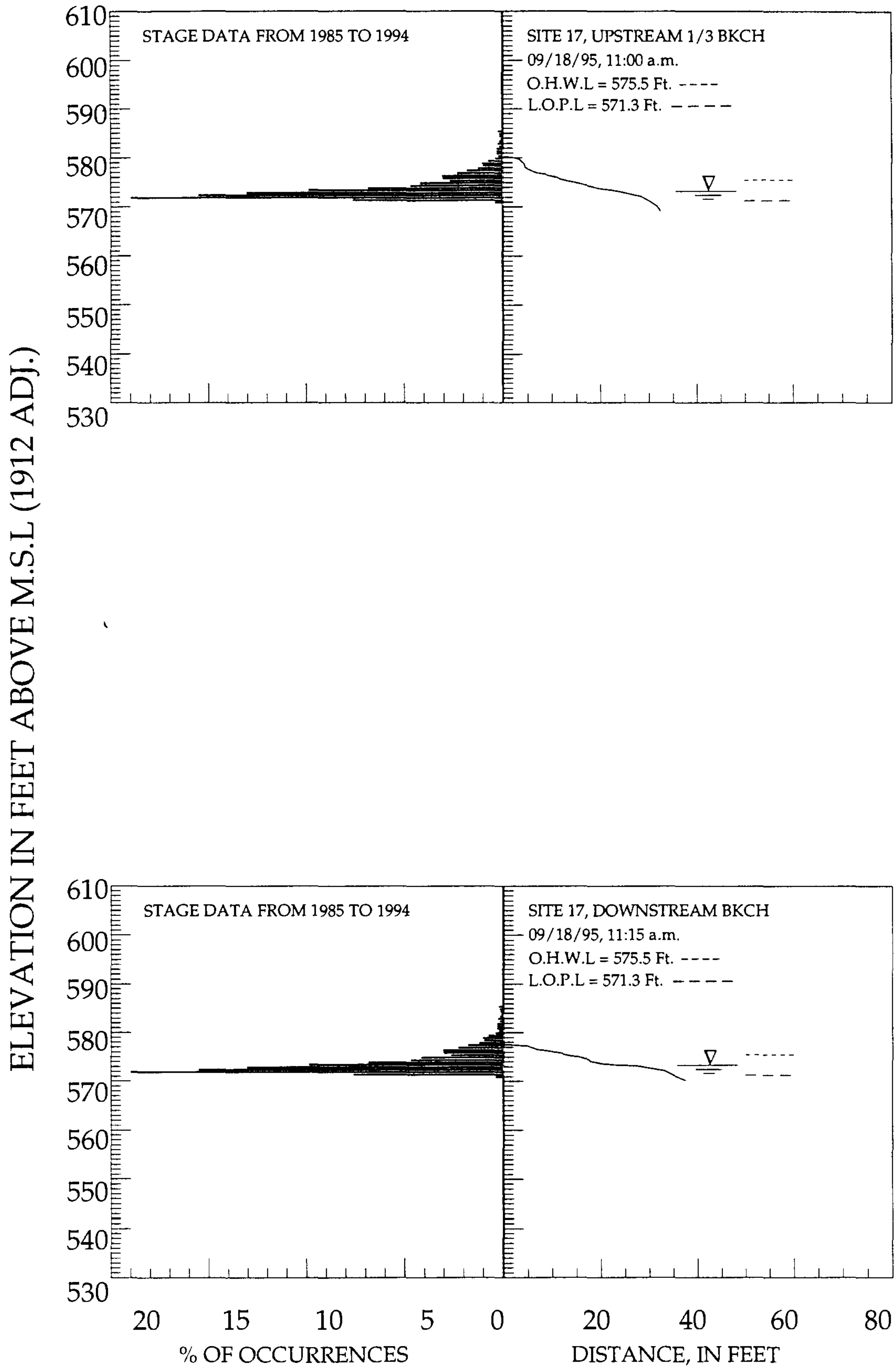
BANK PROFILE AT SITE 16 IN POOL 13 OF THE MISSISSIPPI RIVER; RM 551.9, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 12, RM 556.7



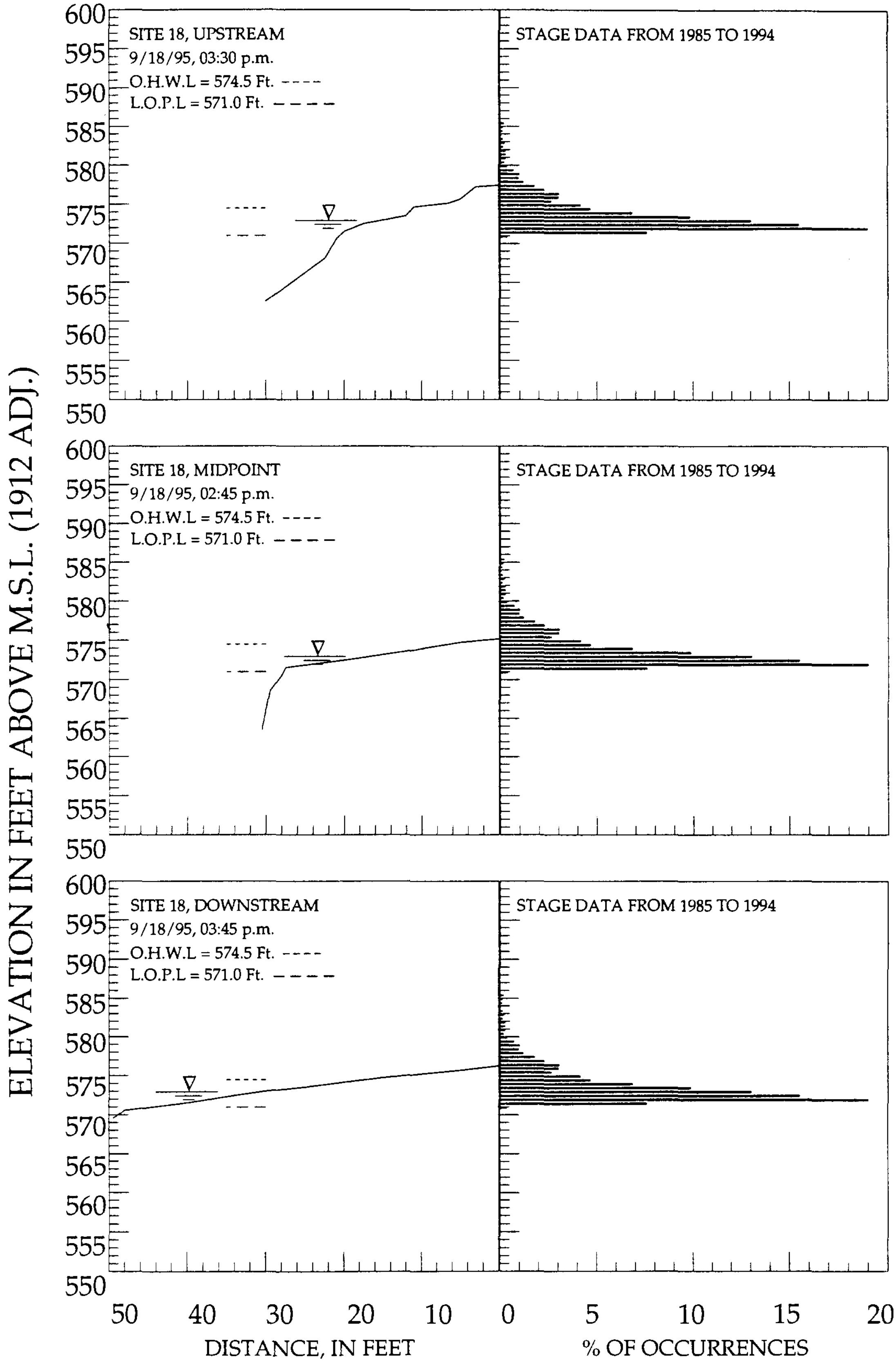
BANK PROFILE AT SITE 17 IN POOL 14 OF THE MISSISSIPPI RIVER; RM 512.7, LDB
STAGE HISTOGRAM FROM GAGE ON MISSISSIPPI RIVER NEAR CAMANCHE,IA; RM 511.9



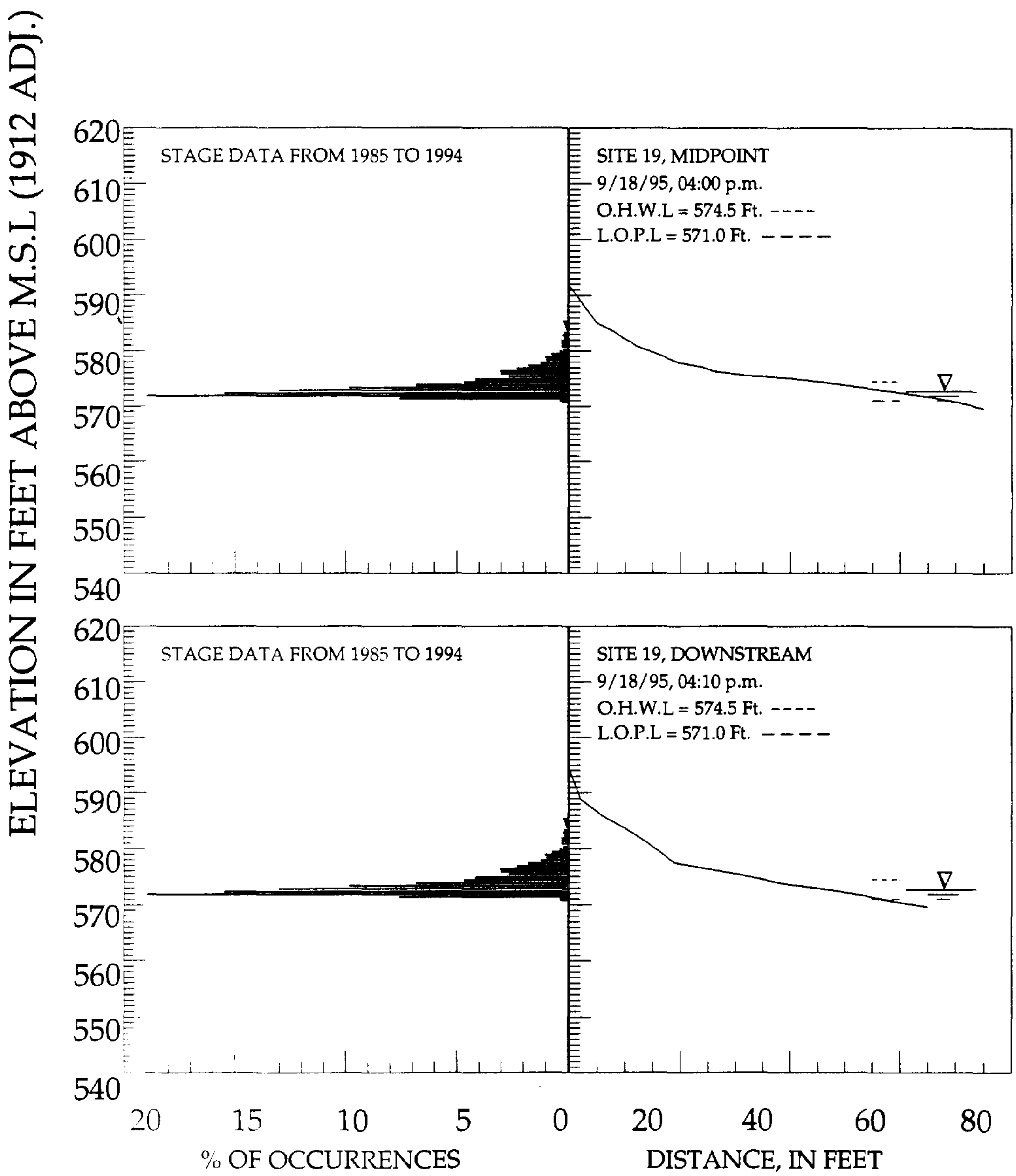
BANK PROFILE AT SITE 17 IN POOL 14 OF THE MISSISSIPPI RIVER; RM 512.7, LDB
STAGE HISTOGRAM FROM GAGE ON MISSISSIPPI RIVER NEAR CAMANCHE,IA; RM 511.9



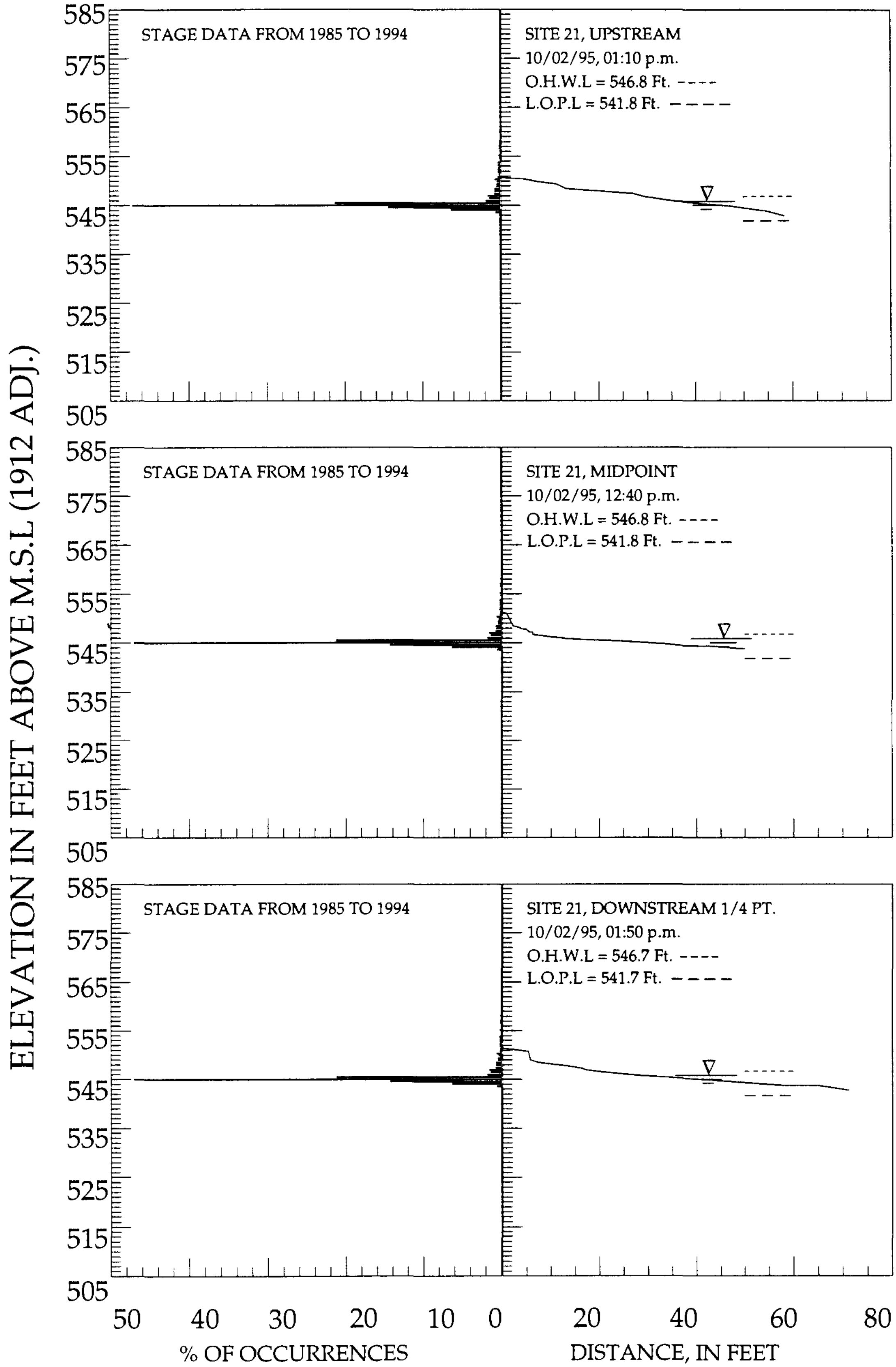
BANK PROFILE AT SITE 17 IN POOL 14 OF THE MISSISSIPPI RIVER; RM 512.7, LDB
STAGE HISTOGRAM FROM GAGE ON MISSISSIPPI RIVER NEAR CAMANCHE,IA; RM 511.9



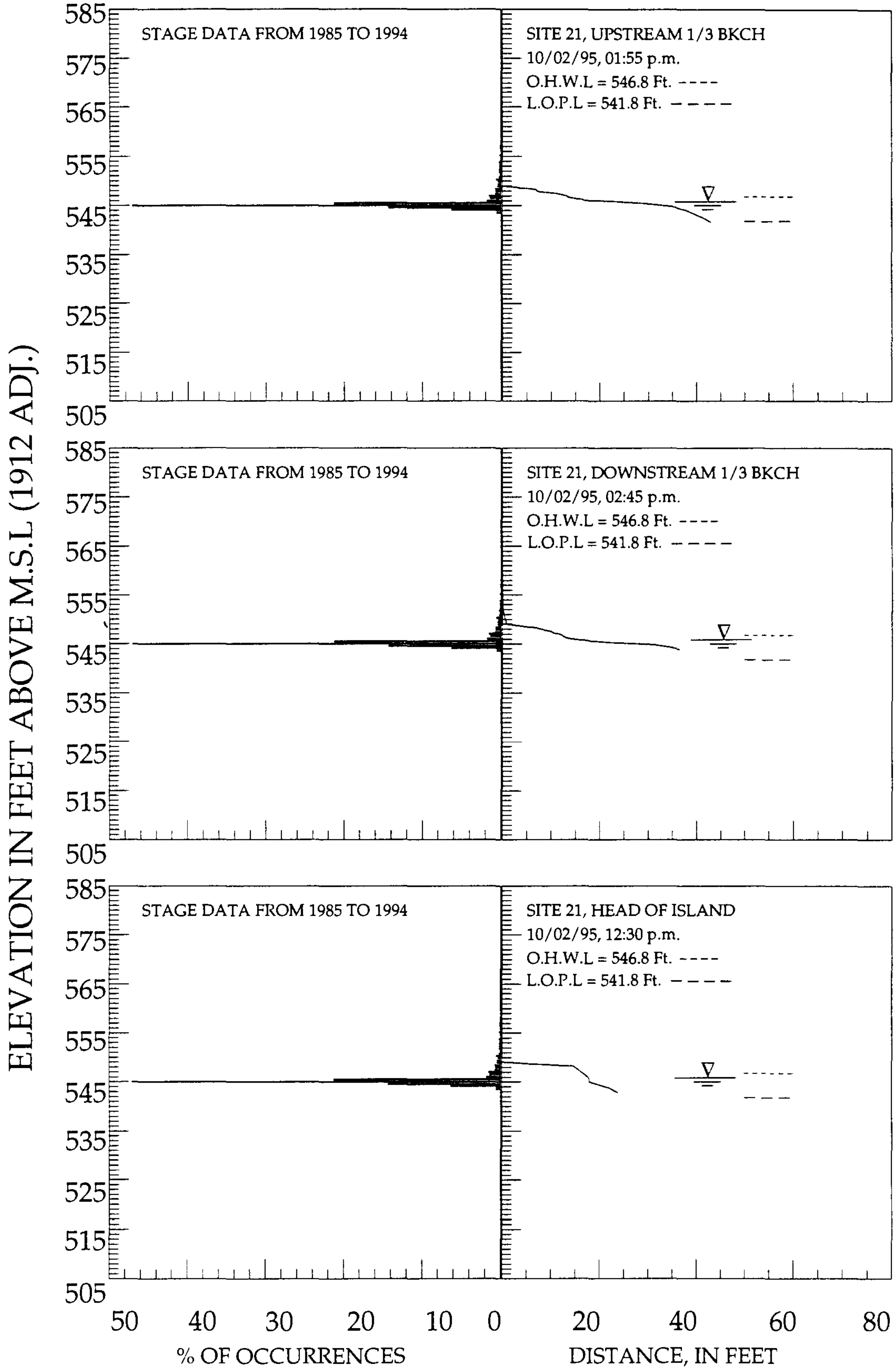
BANK PROFILE AT SITE 18 IN POOL 14 OF THE MISSISSIPPI RIVER; RM 509.2, RDB
STAGE HISTOGRAM FROM GAGE ON MISSISSIPPI RIVER NEAR CAMANCHE,IA; RM 511.9



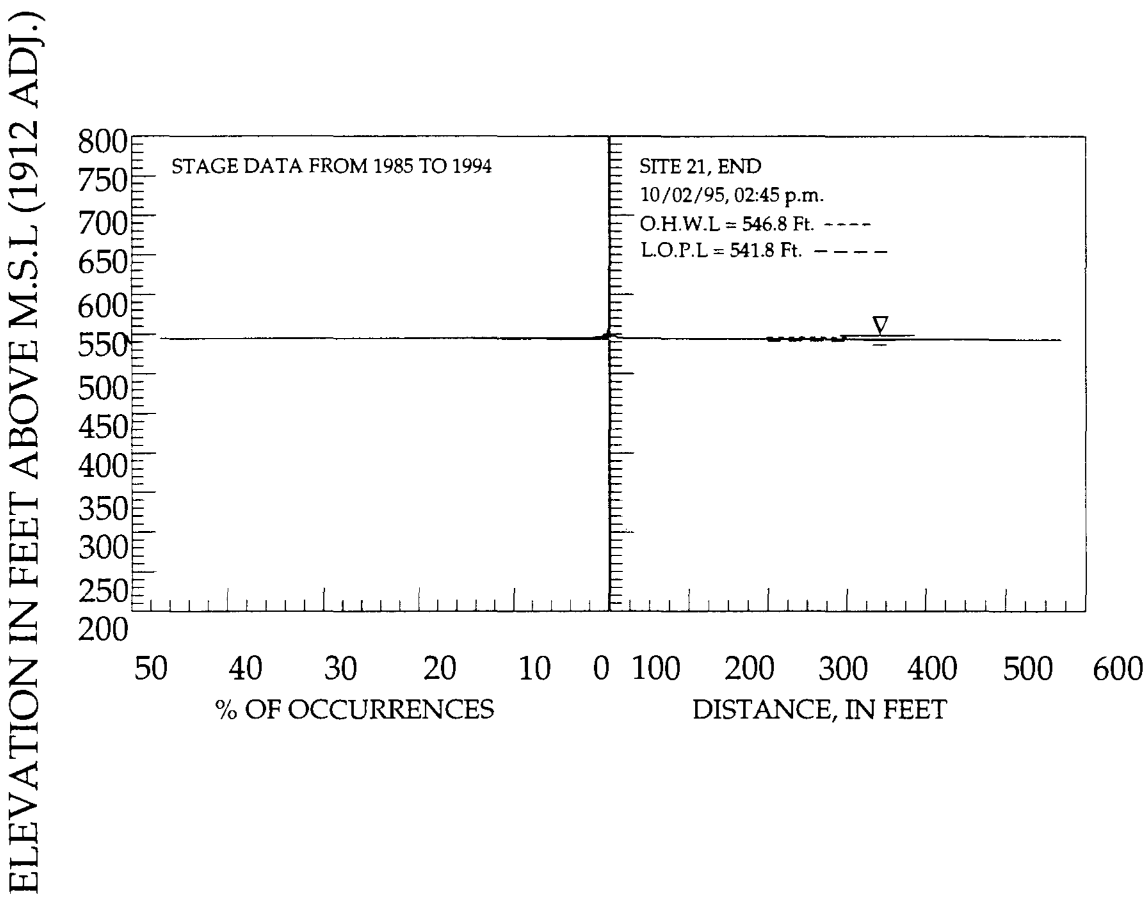
BANK PROFILE AT SITE 19 IN POOL 14 OF THE MISSISSIPPI RIVER; RM 509.2, LDB
STAGE HISTOGRAM FROM GAGE ON MISSISSIPPI RIVER NEAR CAMANCHE,IA; RM 511.9



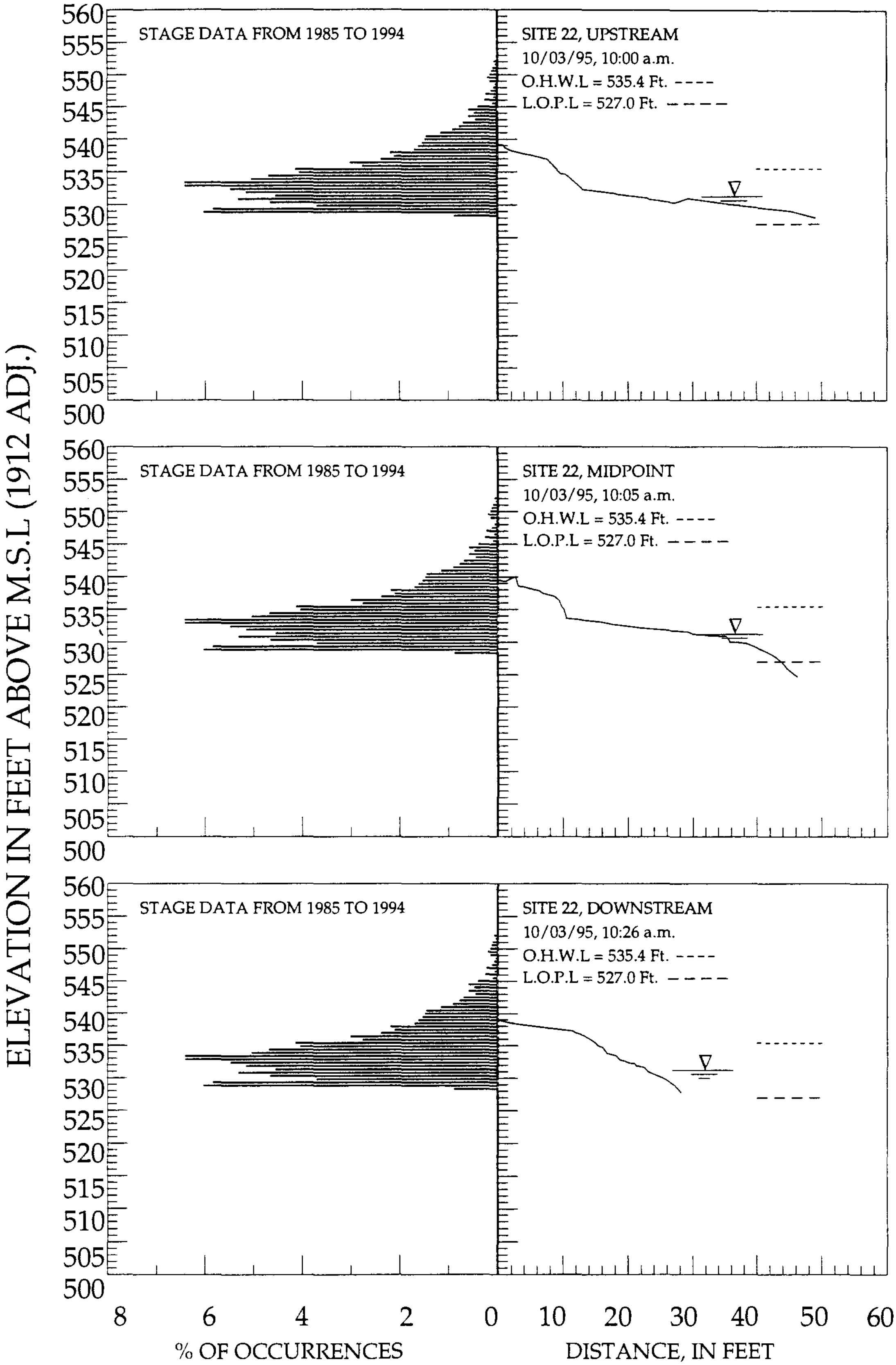
BANK PROFILE AT SITE 21 IN POOL 16 OF THE MISSISSIPPI RIVER; RM 466.7, LDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 16, RM 457.2



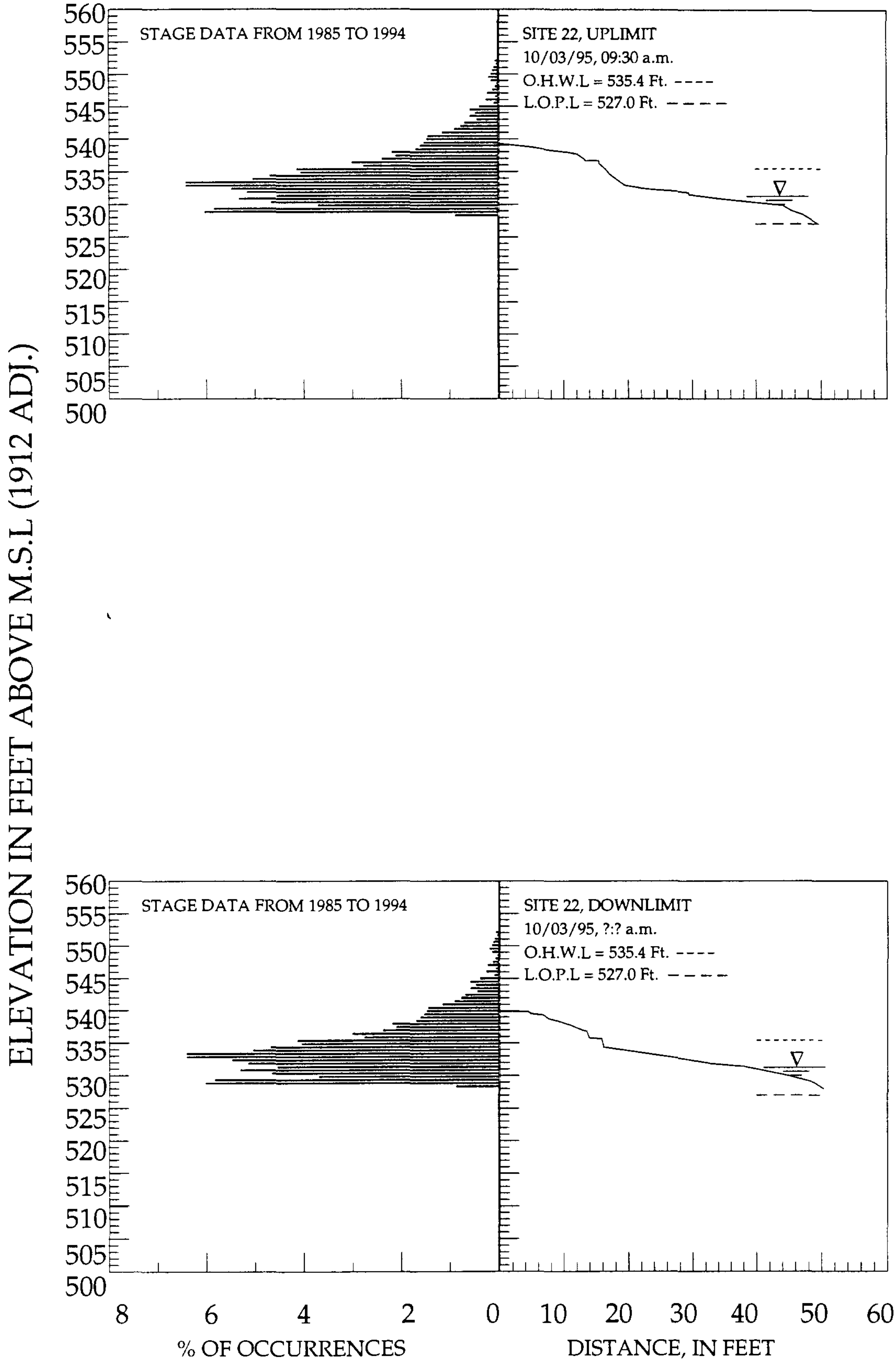
BANK PROFILE AT SITE 21 IN POOL 16 OF THE MISSISSIPPI RIVER; RM 466.7, LDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 16, RM 457.2



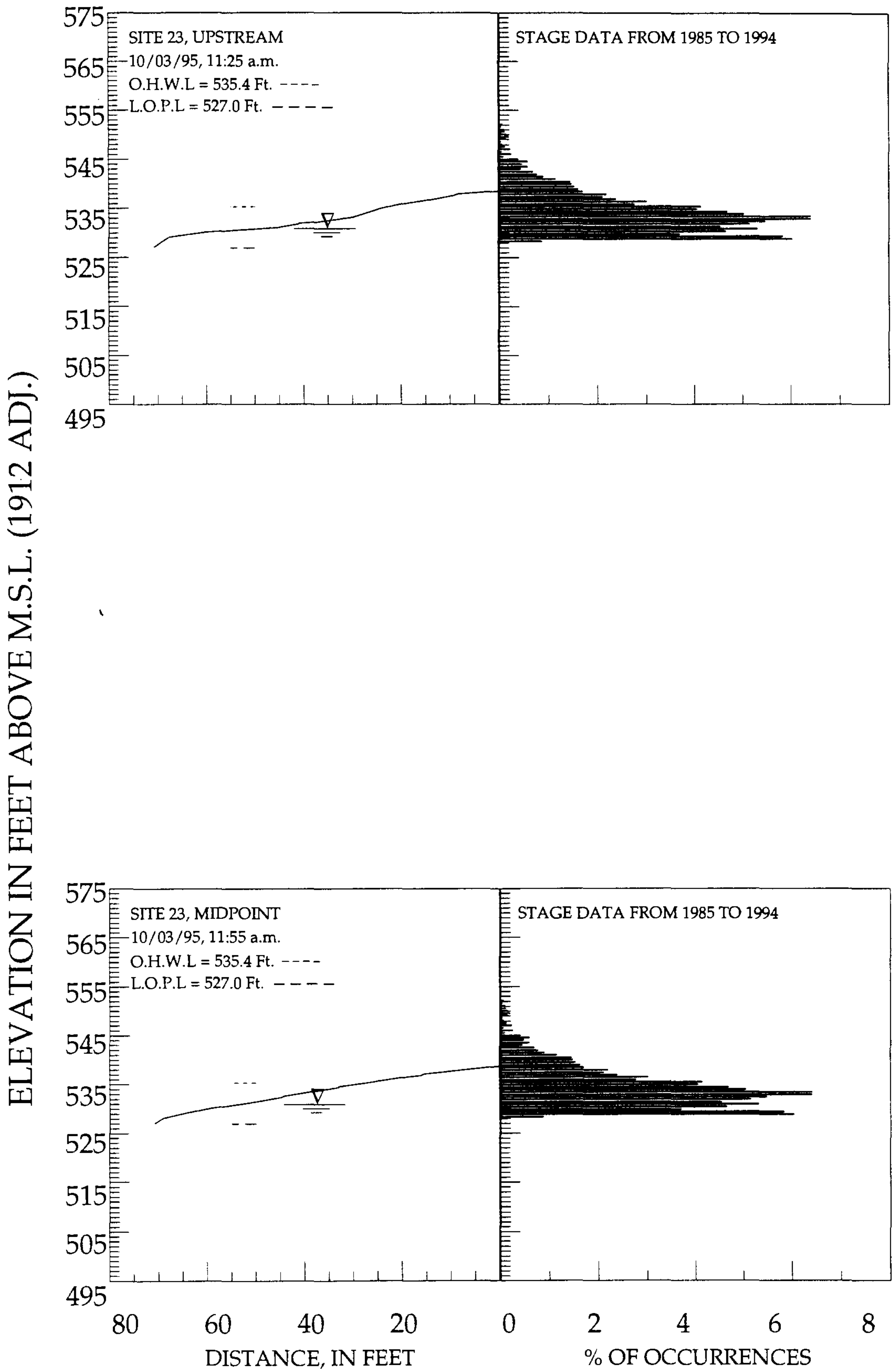
BANK PROFILE AT SITE 21 IN POOL 16 OF THE MISSISSIPPI RIVER; RM 466.7, LDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 16, RM 457.2



BANK PROFILE AT SITE 22 IN POOL 18 OF THE MISSISSIPPI RIVER; RM 436.1, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 17, RM 437.1

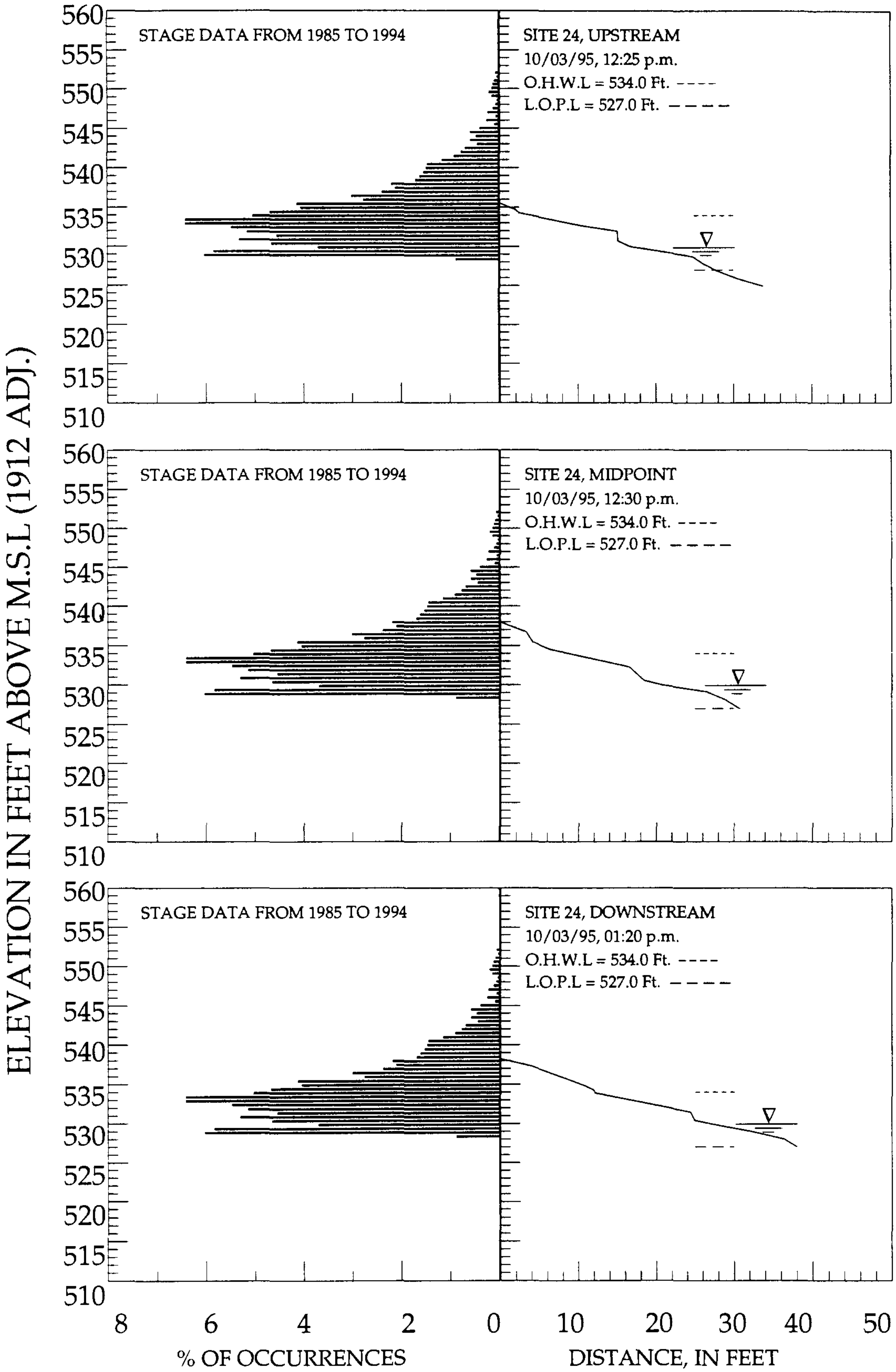


BANK PROFILE AT SITE 22 IN POOL 18 OF THE MISSISSIPPI RIVER; RM 436.1, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 17, RM 437.1

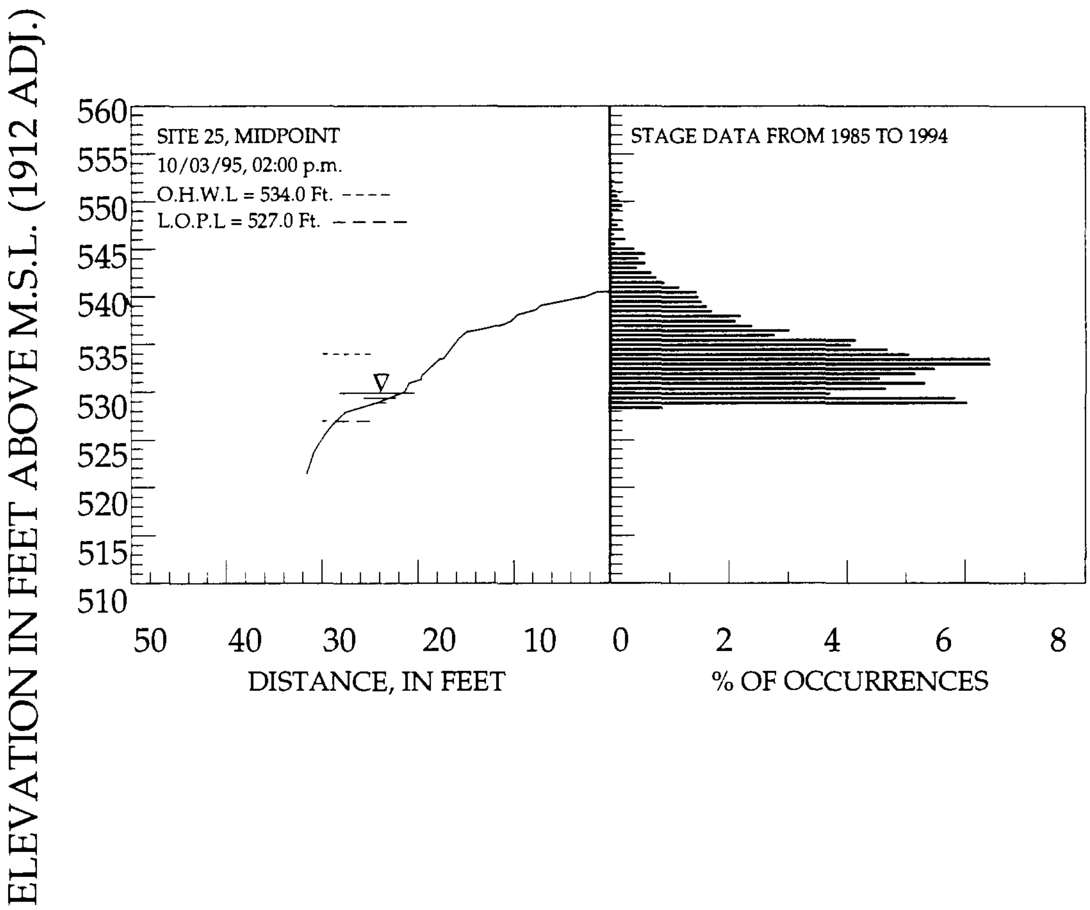


BANK PROFILE AT SITE 23 IN POOL 18 OF THE MISSISSIPPI RIVER; RM 436.4, RDB

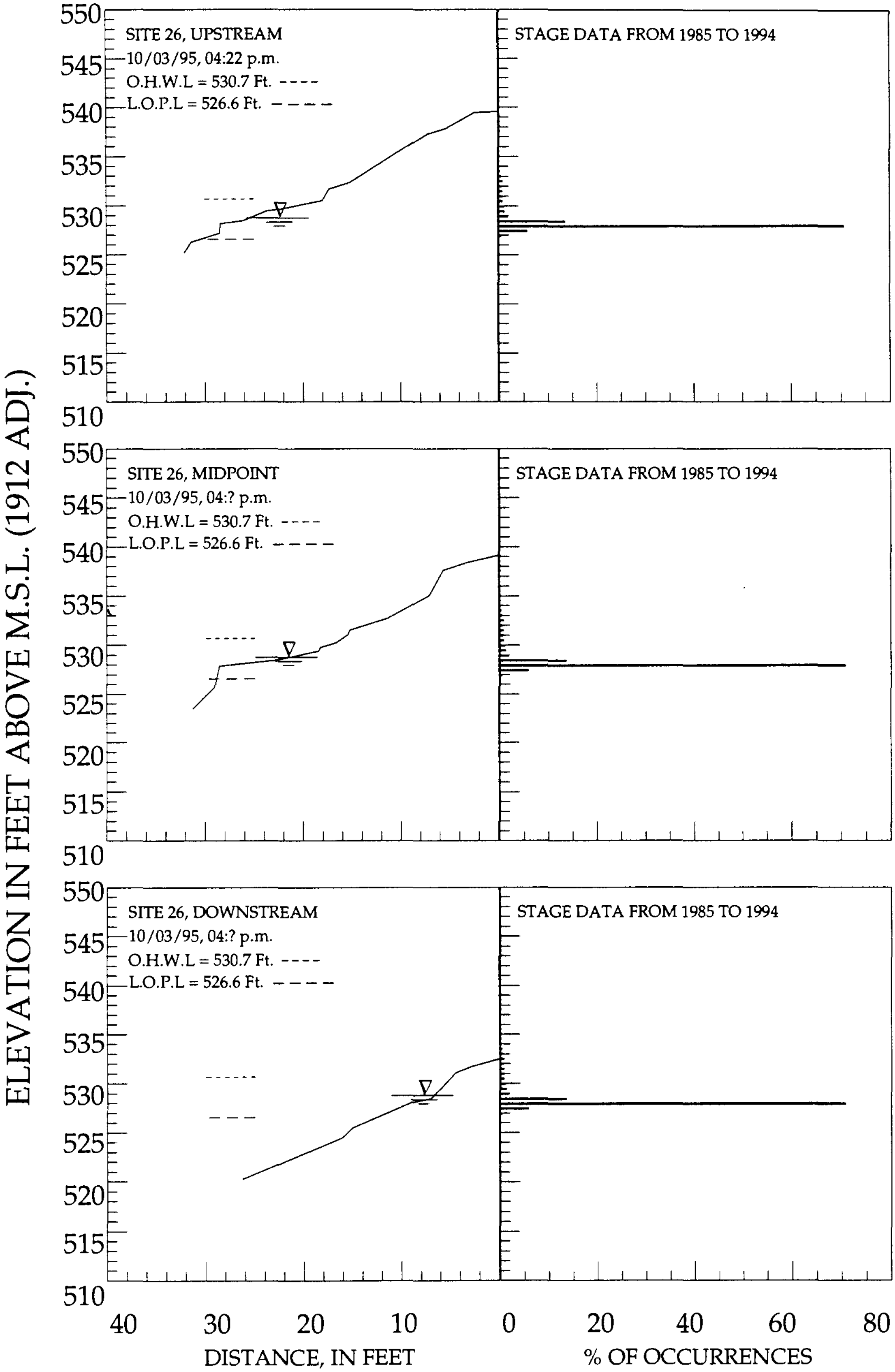
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 17, RM 437.1



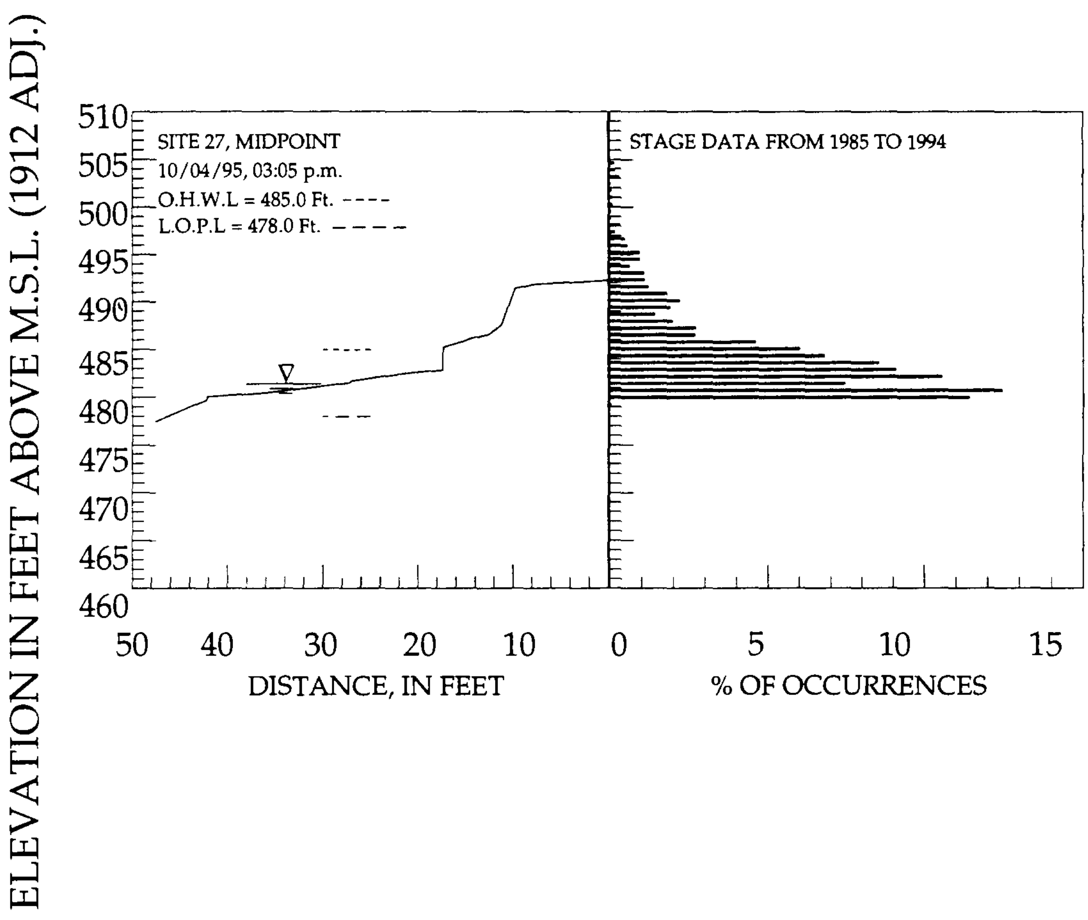
BANK PROFILE AT SITE 24 IN POOL 18 OF THE MISSISSIPPI RIVER; RM 432.3, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 17, RM 437.1



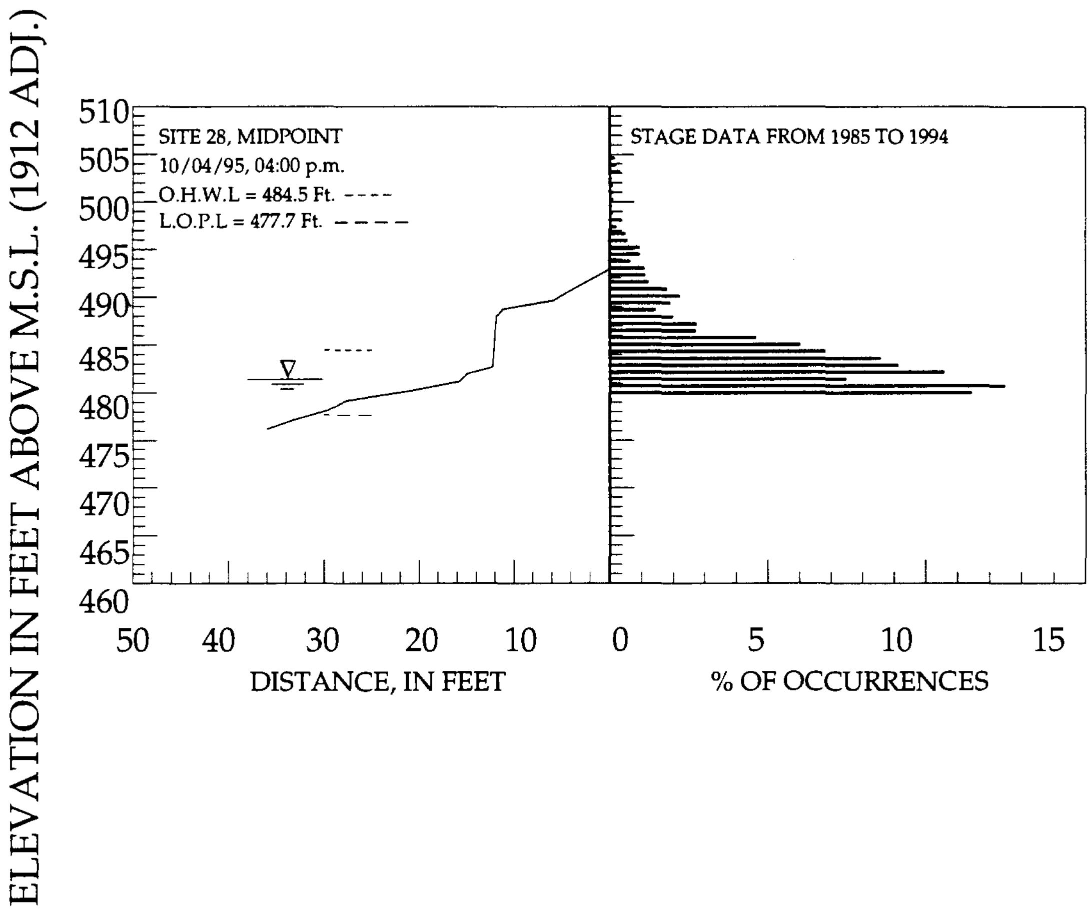
BANK PROFILE AT SITE 25 IN POOL 18 OF THE MISSISSIPPI RIVER; RM 432.3, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 17, RM 437.1



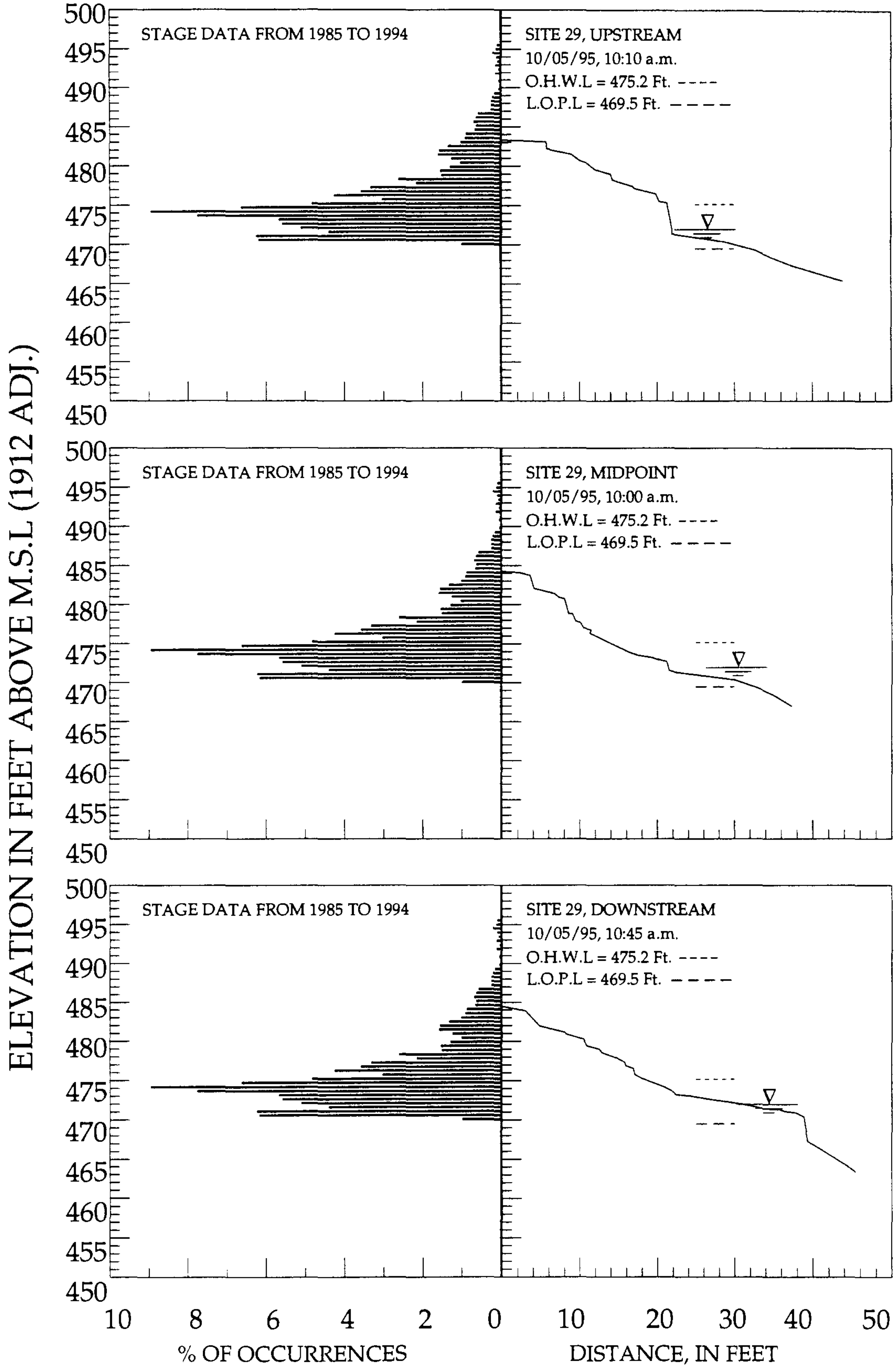
BANK PROFILE AT SITE 26 IN POOL 18 OF THE MISSISSIPPI RIVER; RM 420.0, RDB
STAGE HISTOGRAM AT POOL GAGE OF L&D 18, RM 410.5



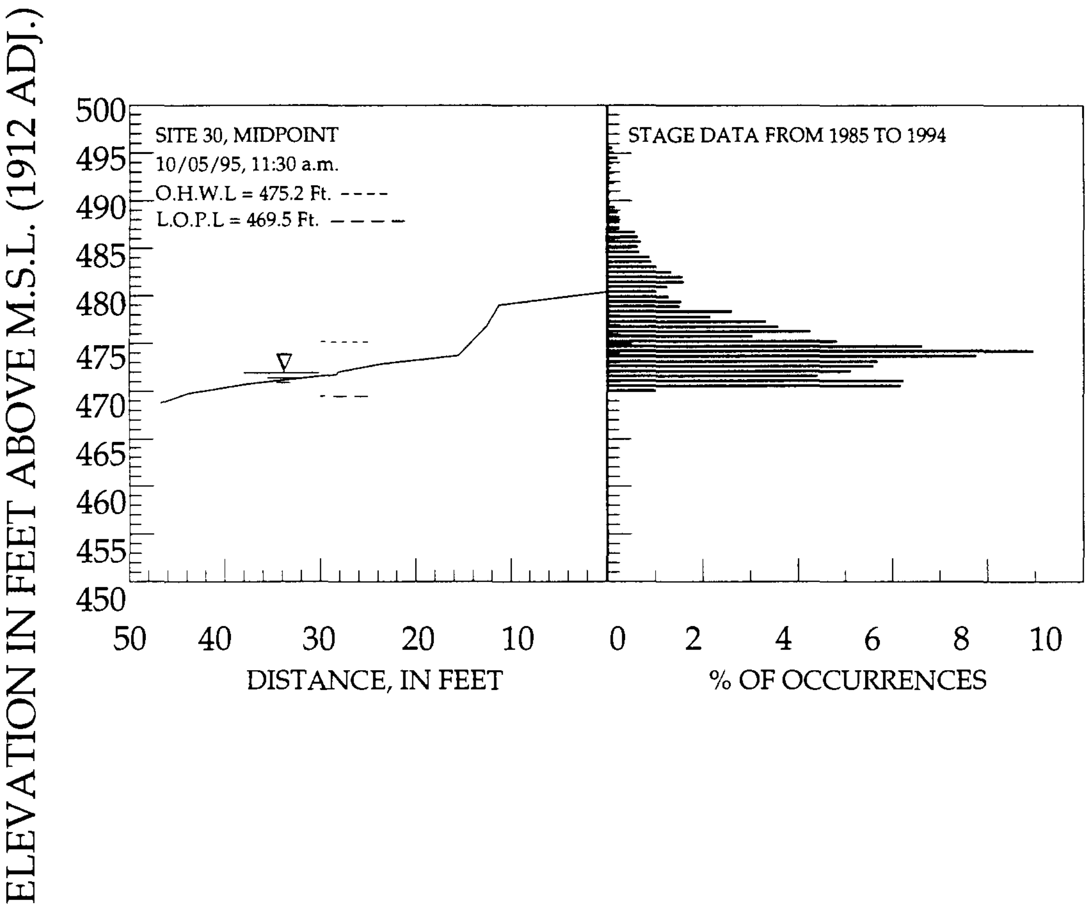
BANK PROFILE AT SITE 27 IN POOL 20 OF THE MISSISSIPPI RIVER; RM 360.0, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 19, RM 364.3



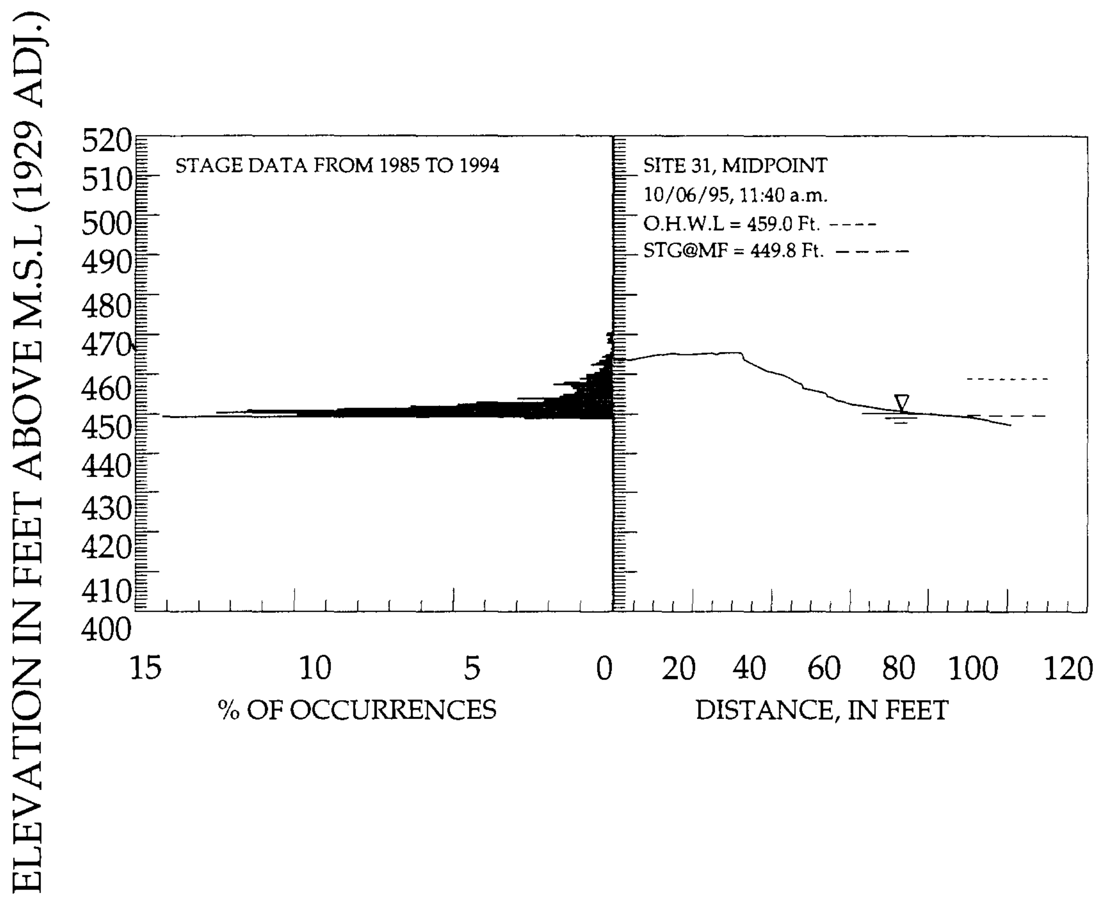
BANK PROFILE AT SITE 28 IN POOL 20 OF THE MISSISSIPPI RIVER; RM 357.6, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 19, RM 364.3



BANK PROFILE AT SITE 29 IN POOL 21 OF THE MISSISSIPPI RIVER; RM 339.3, LDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 20, RM 343.2

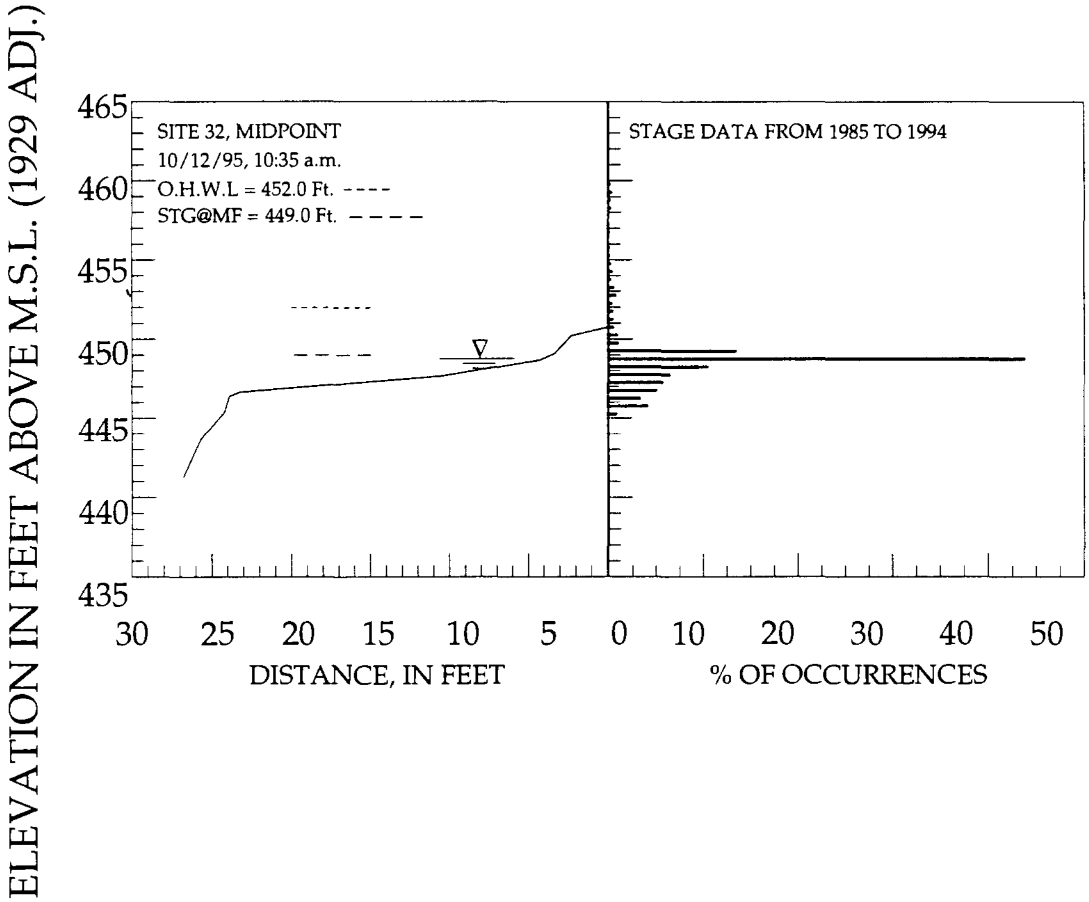


BANK PROFILE AT SITE 30 IN POOL 21 OF THE MISSISSIPPI RIVER; RM 339.3, RDB
STAGE HISTOGRAM AT TAILWATER GAGE OF L&D 20, RM 343.2



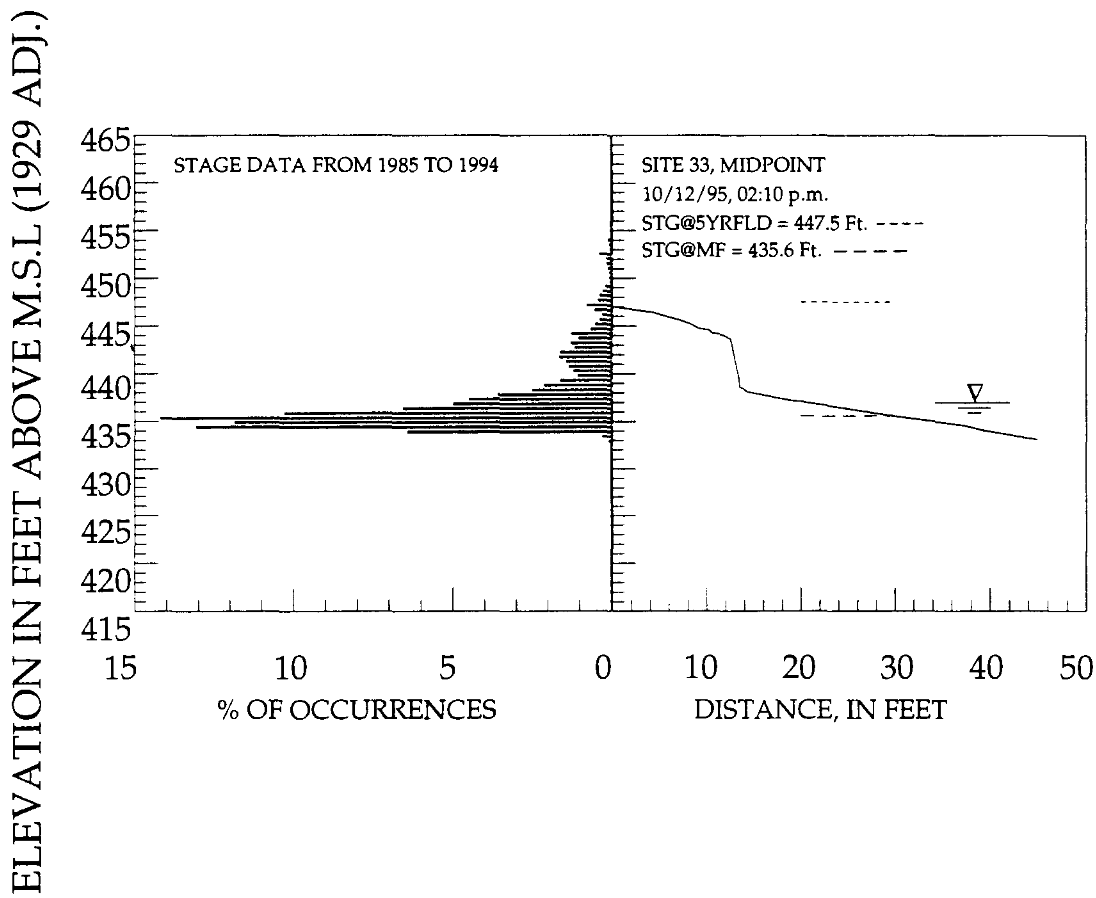
BANK PROFILE AT SITE 31 IN POOL 24 OF THE MISSISSIPPI RIVER; RM 293.0, LDB

STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER NEAR MUNDYS LANDING, MO; RM 293.0

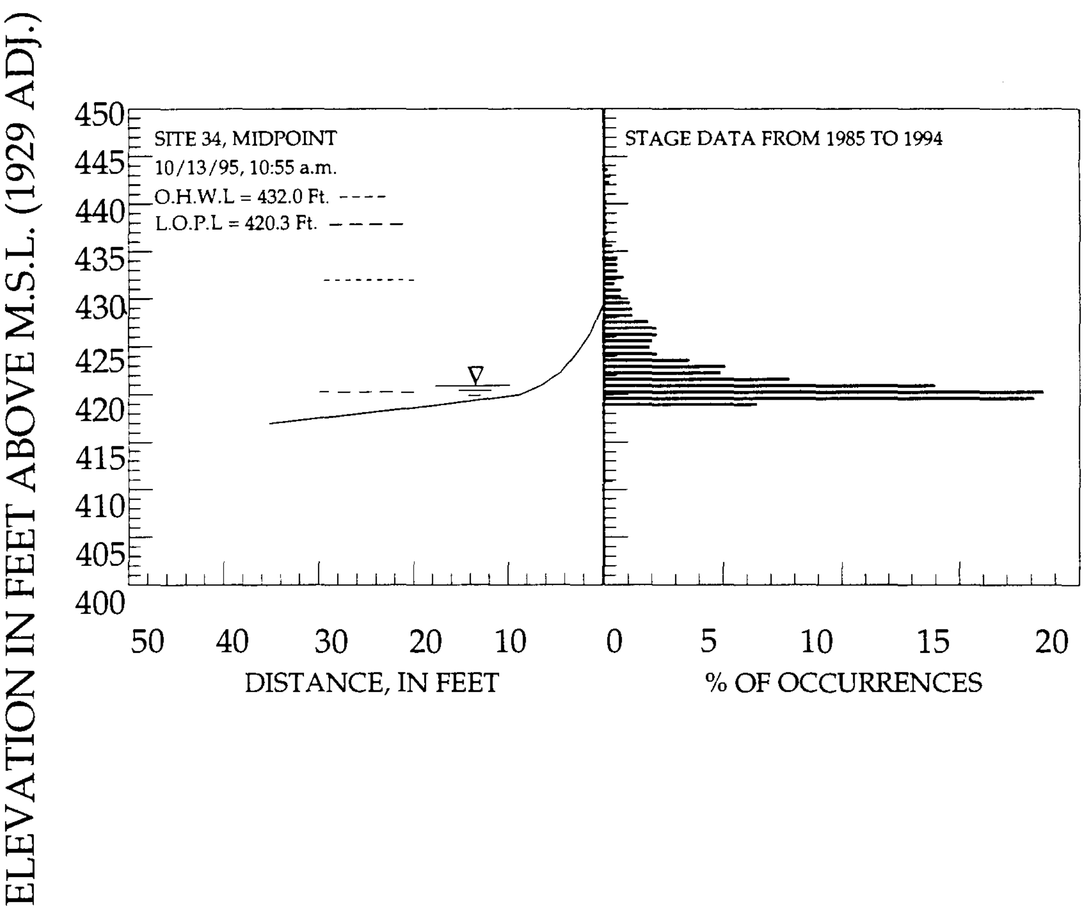


BANK PROFILE AT SITE 32 IN POOL 24 OF THE MISSISSIPPI RIVER; RM 275.3, RDB

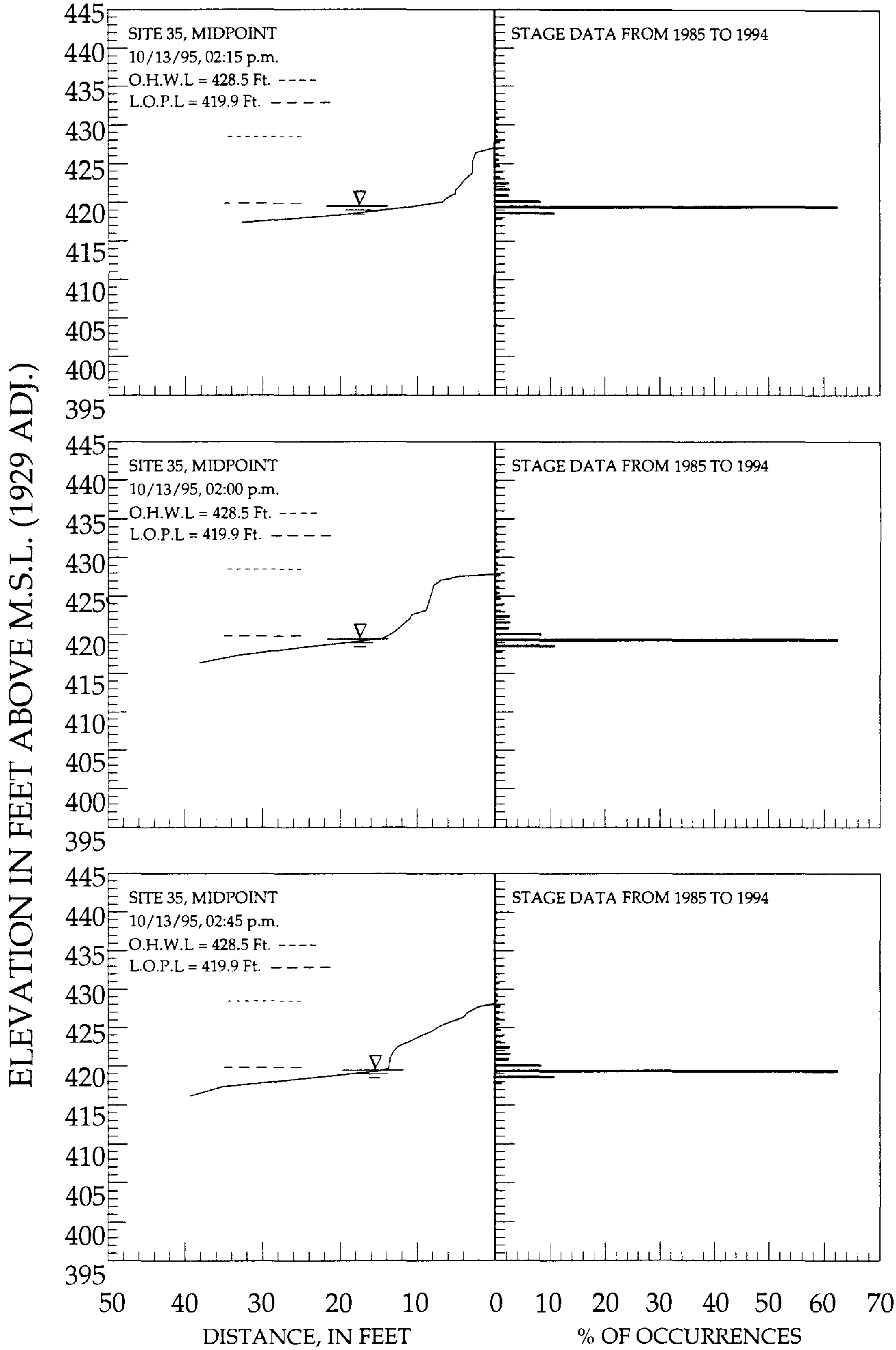
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT L&D 24 CLARKSVILLE, MO; RM 273.2



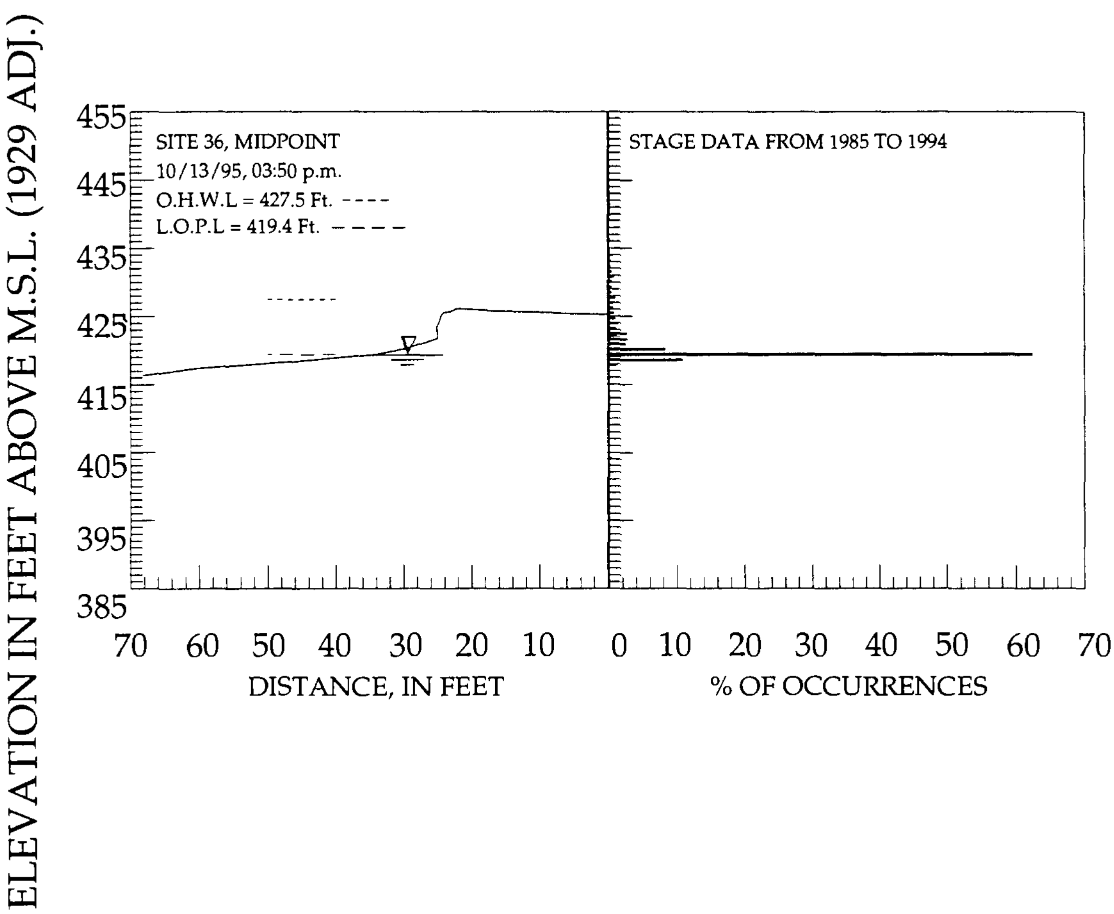
BANK PROFILE AT SITE 33 IN POOL 25 OF THE MISSISSIPPI RIVER; RM 266.5, LDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT MOSIER LANDING, IL; RM 260.3



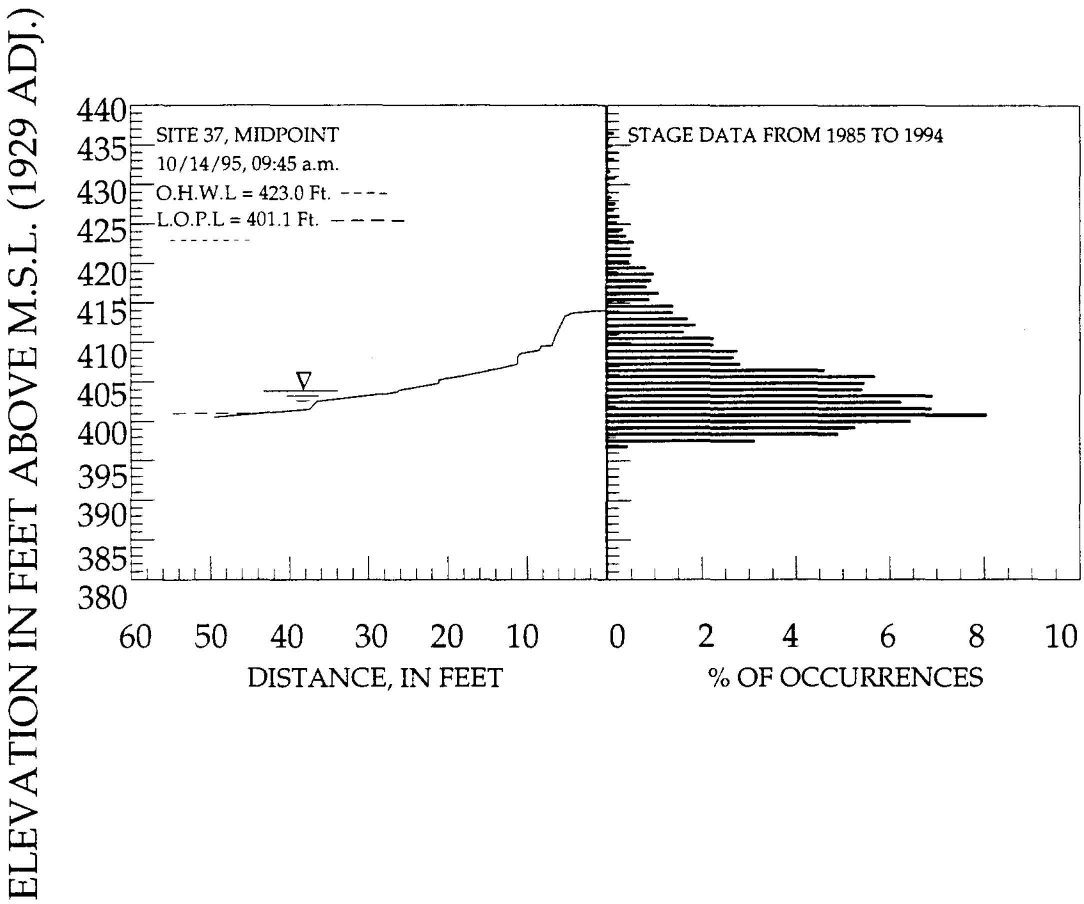
BANK PROFILE AT SITE 34 IN POOL 26 OF THE MISSISSIPPI RIVER; RM 232.2, RDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT DIXON LANDING, IL; RM 228.3



BANK PROFILE AT SITE 35 IN POOL 26 OF THE MISSISSIPPI RIVER; RM 222.1, RDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT GRAFTON, IL; RM 218.0

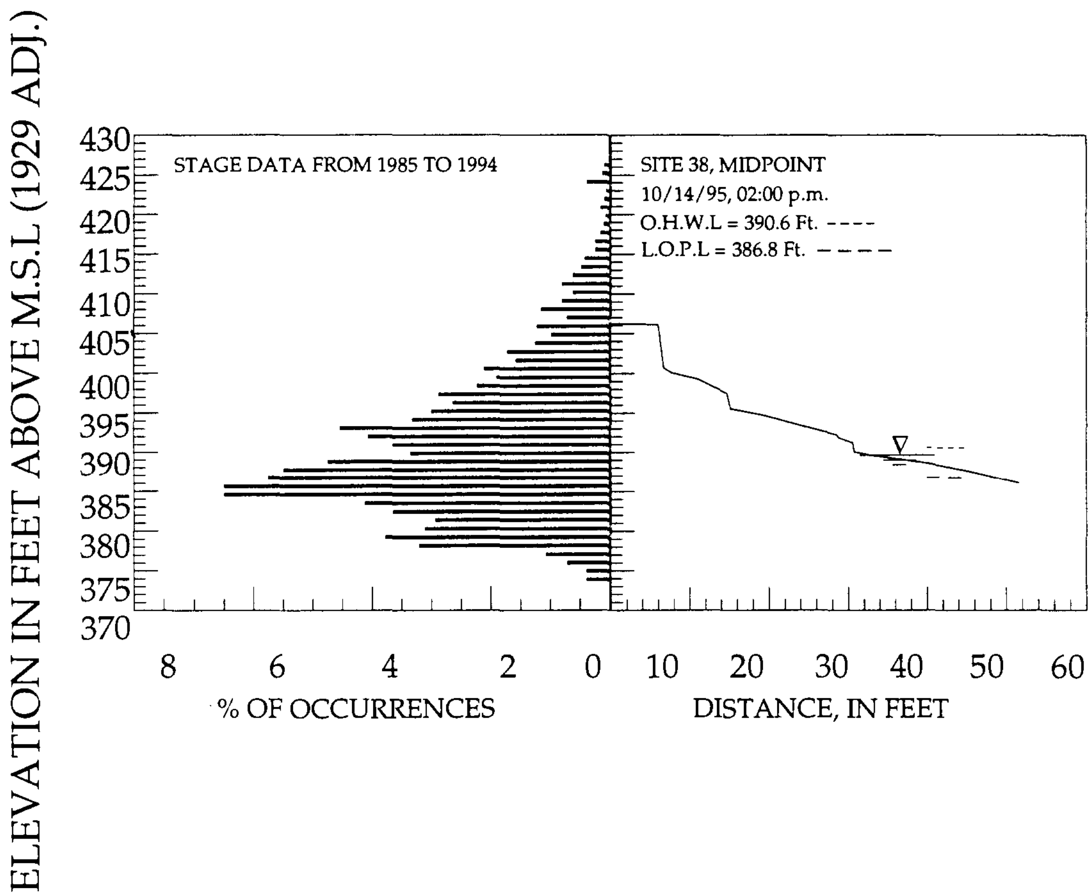


BANK PROFILE AT SITE 36 IN POOL 26 OF THE MISSISSIPPI RIVER; RM 217.5, RDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT GRAFTON, IL; RM 218.0



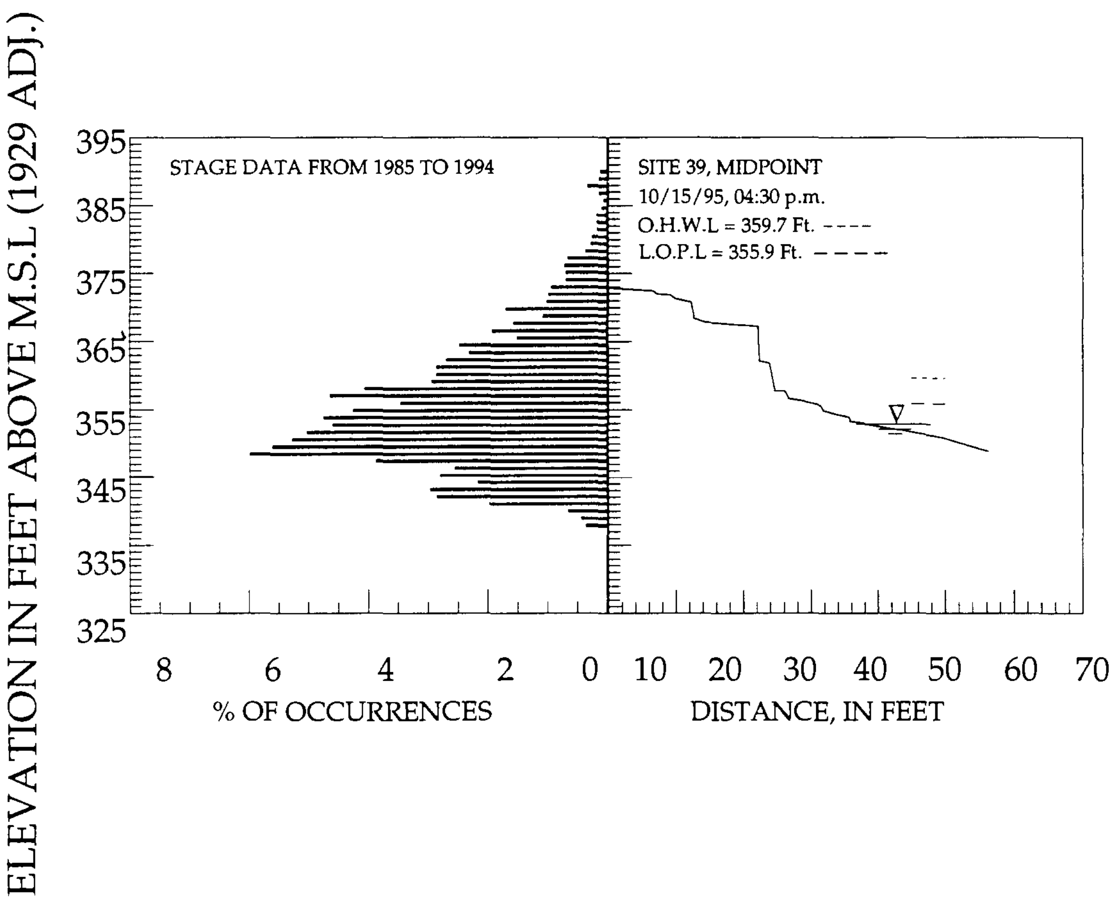
BANK PROFILE AT SITE 37 IN POOL 27 OF THE MISSISSIPPI RIVER; RM 197.6, RDB

STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT HARTFORD, IL; RM 196.8

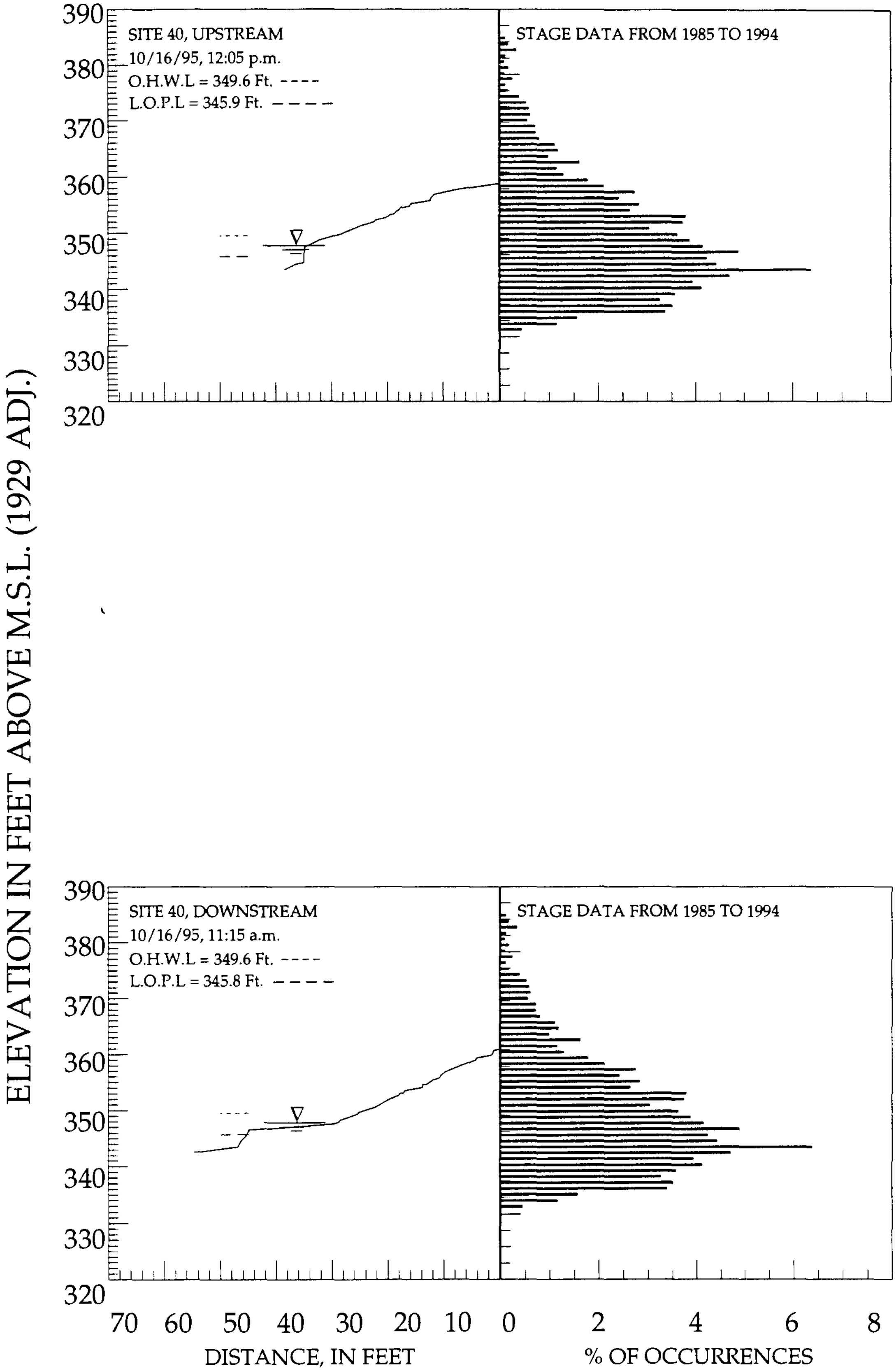


BANK PROFILE AT SITE 38 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 174.8, LDB

STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT ENGINEERS DEPOT, MO; RM 176.8

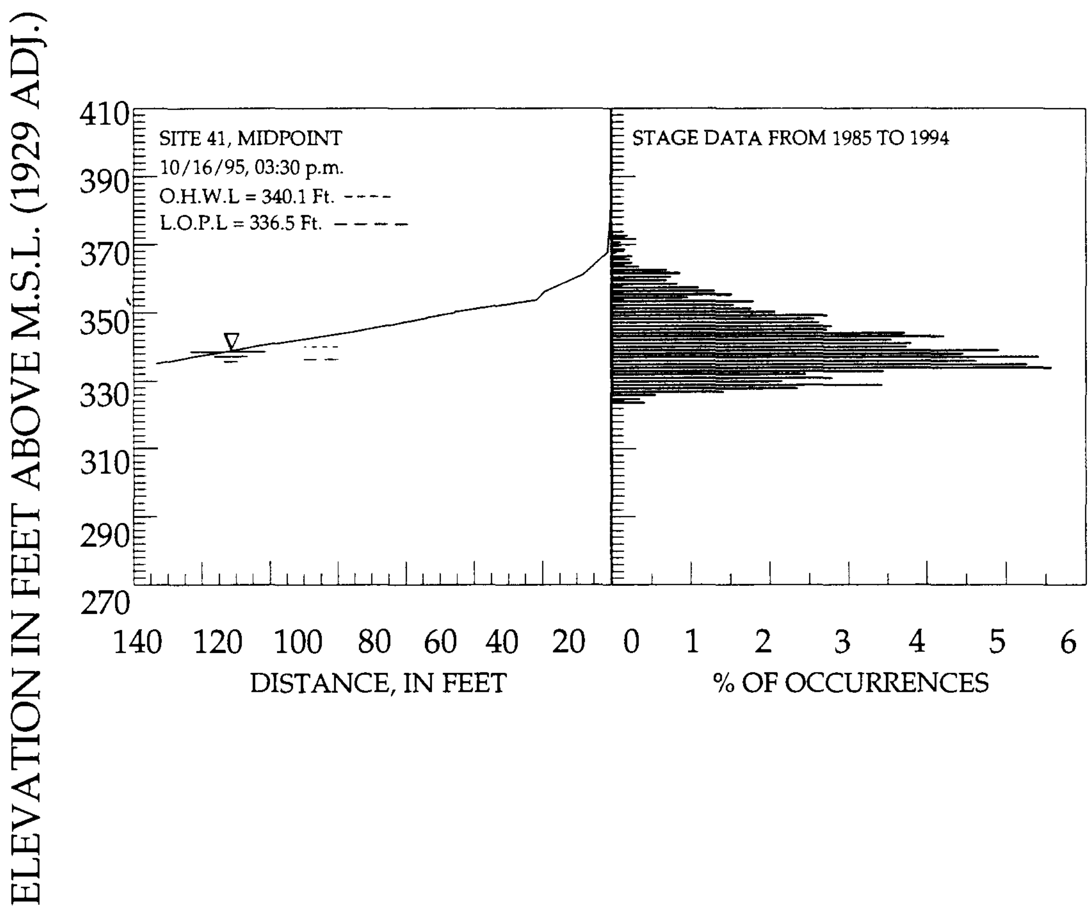


BANK PROFILE AT SITE 39 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 112.4, LDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT CHESTER, IL; RM 109.9

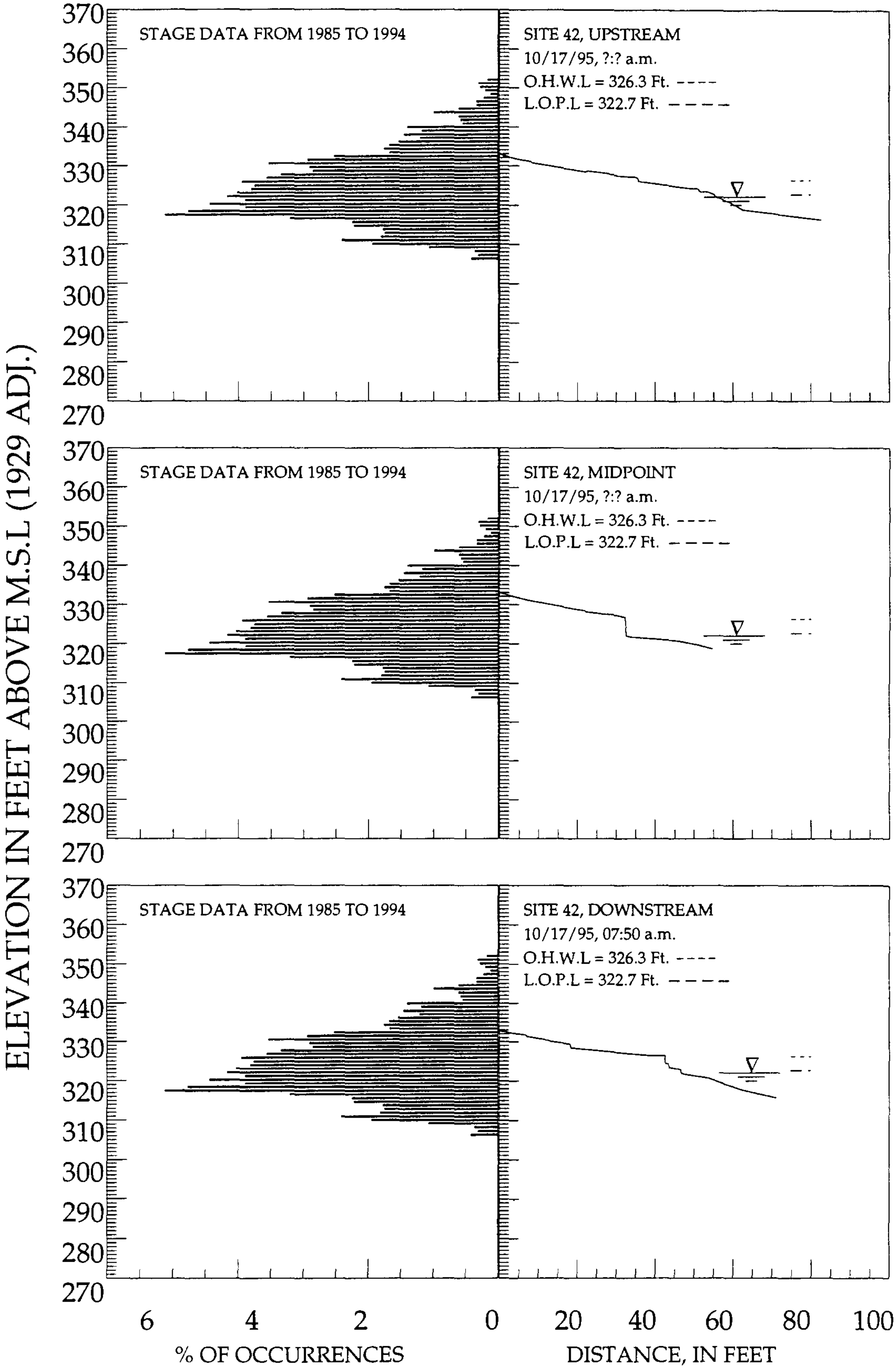


BANK PROFILE AT SITE 40 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 94.2, RDB

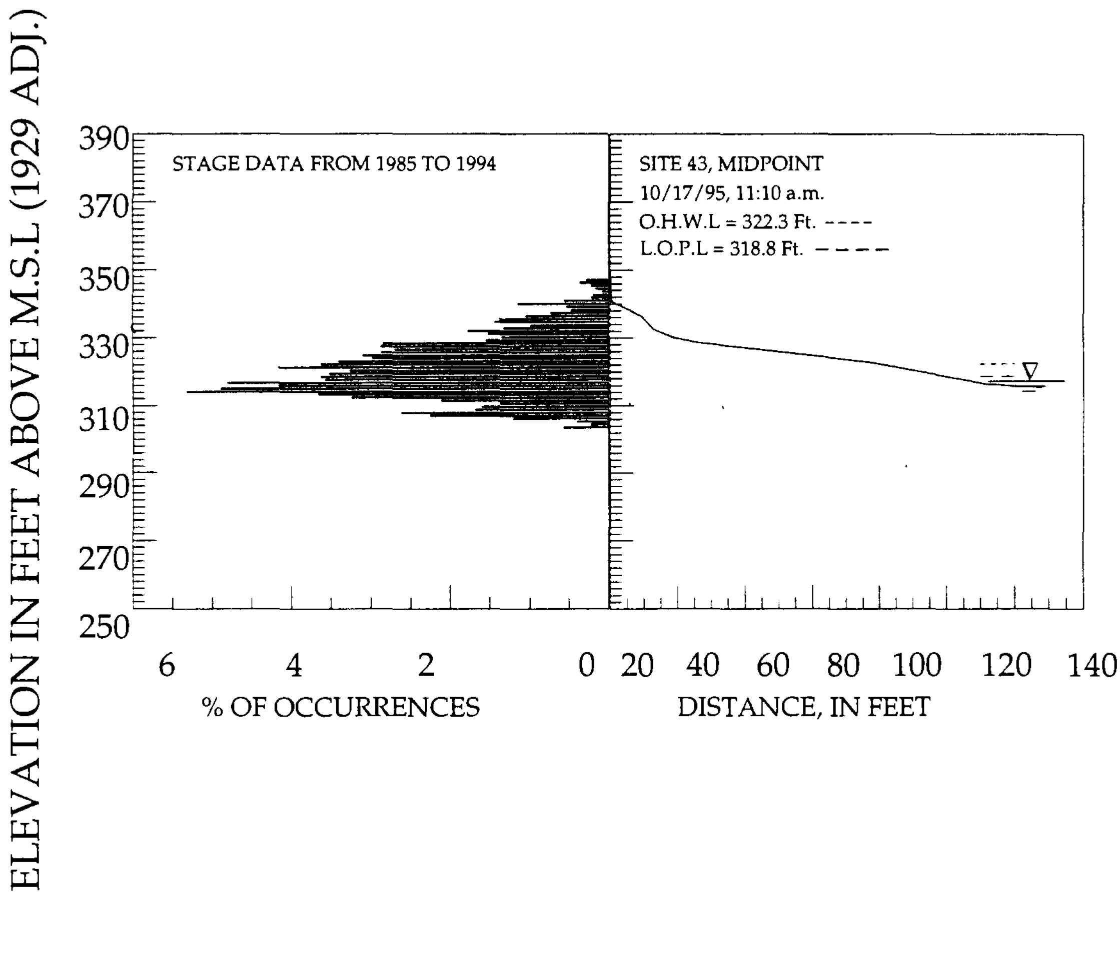
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT BISHOP LANDING, MO; RM 100.8



BANK PROFILE AT SITE 41 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 77.2, RDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT GRAND TOWER, IL; RM 81.9

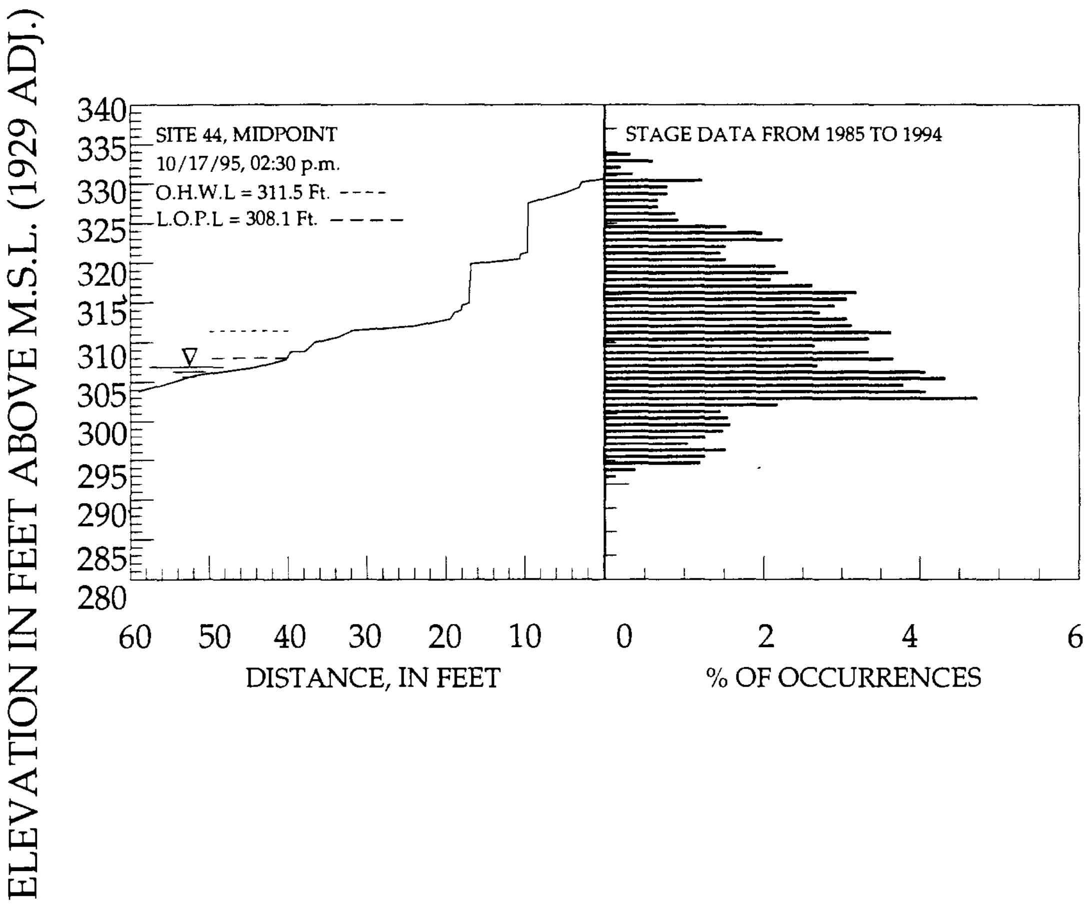


BANK PROFILE AT SITE 42 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 52.3, LDB
STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT CAPE GIRARDEAU, MO; RM 52.1



BANK PROFILE AT SITE 43 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 45.2, LDB

STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT GRAYS POINT, MO; RM 46.3



BANK PROFILE AT SITE 44 IN OPEN WATER OF THE MISSISSIPPI RIVER; RM 25.8, RDB

STAGE HISTOGRAM AT GAGE ON MISSISSIPPI RIVER AT PRICE LANDING, MO; RM 28.2

Appendix D.

Dredging History and Dredged Material and Training Structures

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site		Placement Site	Placement Type
80.0-81.0	*1940*	*285,000*	*77.7-80.0*		*--*	
Above LaGrange	*1958*	*13,111*	*80.2*		*--*	
Lock	*1992*	*4,000*	*80.2*		*80.2L*	*Mechanical*
		302,111	*3 Events*	*Average:*	*100,704*	
83.7-84.4	*1943*	*99,360*	*83.7-84.4*			
Brigg's Landing		*99,360*	*1 Event*	*Average:*	*99,360*	
87.5-89.5	*1947*	*29,274*	*88.5*		*--*	
Beardstown	*1949*	*66,963*	*88.4-89.1*		*--*	
	1987	*26,998*	*88.6*			
	1989	*40,722*	*88.2-88.6*		*88.0-88.5R*	*Beach*
	1990	*39,444*	*87.7-88.7*		*88.0-88.4R*	*Beach*
	1991	*57,612*	*87.8-88.1*		*87.5-87.8L*	
	1993	*18,968*	*87.8-88.3*		*88.1L (6,000), 88.6-88.3R (12968)*	*Beach, Inland*
	1994	*14,074*	*88.4-88.6*		*88.1-88.6R*	*Beach*
	1995	*22,848*			*88.1-88.6R*	*Beach*
		316,903	*9 Events*	*Average:*	*35,211*	
94.0-95.2	*1940*	*19,466*	*94.2-95.3*		*--*	
Sugar Island	*1943*	*16,074*	*95.7-95.9*		*--*	
	1947	*50,088*	*94.1-95.6*		*--*	
	1962	*26,506*	*94.2-94.5*		*--*	
		112,134	*4 Events*	*Average:*	*28,034*	
97.0-98.0	*1943*	*9,653*	*97.2-97.5*		*--*	
Browning	*1961*	*59,073*	*98.0*		*--*	
Landing	*1963*	*24,936*	*97.5*		*97.4R*	
		93,662	*3 Events*	*Average:*	*31,221*	
102.4-102.8	*1943*	*17,678*	*102.4-102.8*		*--*	
Elm Creek		*17,678*	*1 Event*	*Average:*	*17,678*	
108.1-108.3	*1943*	*8,733*	*108.1-108.3*		*--*	
Holmes Landing		*8,733*	*1 Event*	*Average:*	*8,733*	
109.0-109.7	*1951*	*43,528*	*109.0-109.7*		*--*	
Anderson Lake	*1990*	*29,079*	*109.0-109.5*		*109.2-109.8*	*Bankline*
		72,607	*2 Events*	*Average:*	*36,304*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
109.7-110.7	1951	43,528	109.7-110.6	--	
Grand Island	1990	19,569	109.7-110.5	110.0-110.9R	Bankline
		63,097	2 Events Average:	31,549	
110.6-112.5	1941	45,526	111.3-112.0	--	
Otter Creek	1951	65,293	110.6-112.4	--	
	1962	136,898	110.6-112.4	--	
		247,717	3 Events Average:	82,572	
112.4-114.0	1943	13,984	113.2-113.5	--	
Grand Island	1951	65,293	112.4-113.8	--	
Head	1962	136,898	112.4-114.0	--	
	1988	33,178	113.2-113.8	--	Bankline
	1995	21,094	113.0-113.3	112.5-112.9R	Bankline
		270,447	5 Events Average:	54,089	
114.0-116.0	1962	136,898	114-115.9		
Matanzas Bay	1986	11,419	115.0	115.3-115.4R	
	1994	33,072	115.0-115.5	114.7-115.7L	Beach
		181,389	3 Events Average:	60,463	
116.2-117.2	1984	75,889	116.8-117.2	116.5-117.5L	Beach
Devils Elbow	1985	46,752	116.8-117.2	116.5-117.5L	Beach
	1988	50,752	116.2-117.3	115.7-117.5L, 116.5-116.8R	Beach, Levee
	1995	28,909	116.2-116.7	115.5-116.2L	Beach
		202,302	4 Events Average:	50,576	
117.6-118.8	1941	37,333	117.6-118.8	--	
Historic Cut		37,333	1 Event Average:	37,333	
120.0-123.0	1941	88,062	120.0-121.9	--	
Quiver Island	1941	54,352	118.8-120.5	--	
	1943	199,011	120.6-122.6	--	
	1947	158,241	120.6-123.5	--	
	1951	138,167	120.0-122.1	--	
	1956	221,668	120.4-122.8	--	
	1958	194,183	120.0-122.7	--	
	1962	268,972	118.9-123.0	--	
	1967	114,641	120.1-121.4	120.2-120.6R	
	1972	119,351	120.3-121.6	121.1-121.5R	
	1977	96,203	120.7-121.4	121.2L	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1987	43,509	120.6-121.4	--	Bankline
	1990	15,013	120.7-121.0	120.65-120.75	Bankline
	1994	44,334	120.6-121.2	120.8-121.4, excl. 121.0-121.1	Bankline
		1,755,707	14 Events Average:	125,408	
125.5-126.1	1962	22,997	125.2-126.1		
Big Sister Creek		22,997	1 Event Average:	22,997	
132.0-135.0	1953	70,075	132.3-135.0	--	
Senate Island	1972	96,287	132.5-134.7	132.5-134.7L	
	1985	29,978	134.0-135.0	134.2-135.0L	
	1987	31,303	132.5-134.5	--	
	1988	135,363	133.0-134.5	133.0-134.5L	
	1991	65,263	132.4-134.5	131.9-133.5L (43,310), 134.2-134.5L (21,962)	Bank, Levee
	1994	70,203	132.9-134.4	132.6-133.9L, 134.2-134.5L	Bank,Levee
	1995	44,266	132.0-134.7	132.2-132.6L, 133.4-133.9L, 134.5-135.2L	Beach
		542,738	8 Events Average:	67,842	
135.0-136.0	1953	70,075	135.0-136.0	--	
Duck Island	1984	121,267	134.9-135.5	134.5-135.5L	
	1987	15,816	135.9-136.2	--	
	1992	15,596	135.2-136.1	134.9-135.2L, 135.5-135.8R	Beach, Bank
	1995	14,449	135.X-135.8	135.6-135.8R	Bankline
		237,203	5 Events Average:	47,441	
136.0-137.5	1942	471,100	136.2-137.5	--	
Copperas Creek	1943	36,110	136.2-136.8	--	
	1947	47,936	136.1-137.5	--	
	1953	70,075	136.0-137.5	--	
	1962	158,881	136.0-137.6	--	
	1972	115,378	136.0-137.6	136.0-137.6L	
	1977	48,168	137.1-137.5	137.3L	
	1979	72,468	136.0	137.3L	
	1987	14,122	136.5-136.8	--	Beach
	1994	31,668	136.3-137.3	136.1-137.5L, excl. 137.1-137.3	Beach
		1,065,906	10 Events Average:	106,591	
142.0-145.0	1946	125,455	143.7-145.0	--	
Lancaster Landing	1951	132,581	143.0-145.0	--	
	1974	135,860	143.9-145.0	144.5L, 147.2R	
	1984	99,664	144.0-144.5	144.0-145.0L	Beach

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1992	*34,276*	*142.5-144.5*	*142.7-143.1L, 144.5-145.0R*	*Beach*
	1994	*25,563*	*145.2-146.4*	*143.1-143.8L*	*Beach*
	1995	*15,958*	*142.8-144.4*	*142.6-143.1L, 144.6-145.0R*	*Beach*
		569,357	*7 Events Average:*	*81,337*	
145.0-146.7 Kingston Mines	*1946*	*125,455*	*145.0-146.5*	*--*	
	1951	*132,581*	*145.0-147.5*	*--*	
	1974	*43,751*	*145.0-146.4*	*144.5 & 146.5L*	
	1977	*46,081*	*145.7-147.1*	*146.5 & 146.9L*	
	1977	*56,446*	*145.2-145.7*	*146.5L*	
	1983	*32,540*	*146.1-146.7*	*146.1-146.7L*	
	1984	*57,518*	*145.5-146.0*	*145.0-146.0L*	
	1985	*69,695*	*145.0-147.0*	*145.0-147.0L*	
	1986	*21,843*	*145.5*	*145.5-145.8L*	*Beach*
	1986	*24,776*	*146.5*	*146.5-146.7L*	*Beach*
	1987	*6,717*	*145.5-145.7*	*--*	*Beach*
	1988	*57,416*	*145.2-146.9*	*--*	*Beach*
	1990	*43,611*	*146.4-146.9*	*--*	*Beach*
	1991	*48,021*	*145.7-147.2*	*145.7-147.1L*	*Beach*
	1992	*44,316*	*145.1-147.0*	*145.2-145.5L, 145.7-145.8L, 145.5-145.7R, 147.3-147.6L*	
	1994	*33,558*	*145.2-146.4*	*145.4-146.5L, excl. 145.5-145.6*	*Beach*
		844,325	*16 Events Average:*	*52,770*	
146.7-148.0 Mackinaw River	*1941*	*48,608*	*147.5-147.8*	*--*	
	1942	*111,099*	*147.5-148.0*	*--*	
	1943	*67,815*	*147.5-147.8*	*--*	
	1946	*78,685*	*146.5-147.9*	*--*	
	1949	*114,261*	*147.2-147.9*	*--*	
	1951	*77,514*	*147.5-147.9*	*--*	
	1953	*92,972*	*147.2-147.9*	*--*	
	1956	*91,365*	*147.5-147.9*	*--*	
	1959	*74,492*	*147.2-148.0*	*--*	
	1965	*254,147*	*146.9-148.0*	*146.9-148.0R*	
	1968	*155,976*	*147.2-148.0*	*146.5-149.5R*	
	1972	*93,598*	*147.2-147.9*	*147.2-147.9L*	
	1975	*85,233*	*147.7*	*147.2-148.0L*	
	1976	*33,079*	*147.7*	*147.2-148.0L*	
	1977	*195,471*	*147.1-147.8*	*147.2R*	
	1979	*48,792*	*148.0*	*147.2R*	
	1982	*170,133*	*147.4-147.6*	*147.3-148.5L*	
	1984	*36,160*	*147.0-147.6*	*147.3-147.8L*	
	1984	*92,167*	*147.5*	*147.0-148.0L*	
	1985	*28,255*	*147.4*	*147.0-148.0L*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1986	*44,382*	*147.5-147.9*	*147.7-148.0L*	
	1986	*161,280*	*147.4-147.7*	*147.4-148.2L*	
	1987	*46,603*	*146.8-147.3*	*--*	
	1989	*135,146*	*147.5-148.1*	*147.8R*	*Lonza*
	1990	*54,019*	*146.9-147.7*	*147.2-147.6L, 147.7-147.8L (25707cy), 147.8R*	*Beach, Lonza*
	1992	*38,130*	*147.1-148.0*	*147.3-147.9L (13033cy), 147.8R (25097cy)*	*Beach, Lonza*
	1992	*2,831*	*147.1-147.2*	*146.8-147.0L*	*Beach*
	1993	*116,593*	*146.0-147.8*	*146.0-147.7L*	*Beach*
	1994	*54,187*	*146.9-147.8*	*147.0-147.6L*	*Beach*
	1994	*74,539*	*146.5-146.9*	*146.4-147.0L*	*Beach*
	1995	*29,512*	*146.0-147.3*	*145.7-146.2L, 146.7-147.1L*	*Beach*
	1995	*20,064*	*147.6-147.9*	*147.9-148.3L*	*Beach*
		2,727,108	*32 Events Average:*	*85,222*	
148.0-153.1 LaMarsh Creek/ Pekin Bend	*1942*	*56,389*	*149.4-151.0*	*--*	
	1943	*55,333*	*149.5-150.1*	*--*	
	1945	*245,155*	*149.1-150.1*	*--*	
	1946	*152,110*	*147.9-149.2*	*--*	
	1947	*87,932*	*149.3-150.2*	*--*	
	1951	*129,803*	*148.2-151.4*	*--*	
	1956	*11,375*	*152.9-153.1*	*--*	
	1958	*43,950*	*149.3-150.6*	*--*	
	1968	*121,732*	*148.3-150.9*	*148.0-150.8R*	
	1977	*73,390*	*151.5-152.2*	*151.2 & 151.9R*	
	1977	*49,616*	*149.3-149.9*	*149.5L*	
	1979	*78,866*	*151.0*	*150.8R*	
	1987	*36,870*	*149.3-149.9, 151-151.1*	*--*	
	1992	*18,478*	*149.4-149.7*	*149.0-149.6L*	
	1992	*34,154*	*150.4-150.8*	*150.0-150.4R*	
	1992	*15,849*	*148.2-148.5*	*147.8L, 148.3L*	
		1,211,002	*16 Events Average:*	*75,688*	
153.1-156.6 Lick Creek	*1944*	*28,909*	*156.3-156.5*	*--*	
	1947	*52,322*	*152.7-157.0*	*--*	
	1947	*98,794*	*155.7-156.5*	*--*	
	1949	*22,674*	*156.2-156.5*	*--*	
	1951	*135,599*	*154.5-156.5*	*--*	
	1953	*50,722*	*156.1-156.6*	*--*	
	1956	*25,621*	*156.1-156.6*	*--*	
	1958	*26,643*	*156.1-156.6*	*--*	
	1963	*11,283*	*156.4*	*156.1L*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1970	18,838	156.5	156.1L	
	1971	34,761	156.5	156.1L	
	1976	22,611	156.5	156.1L	
	1977	77,108	154.5-155.5	154.8 & 155.4L	
	1982	67,948	156.1-156.5	156.5-157.0R	
	1988	44,262	156.1-156.8	--	
	1991	40,210	155.4-156.5	155.2-156.7L, 155.7-155.9R	
		758,305	16 Events Average:	47,394	
156.6-157.7 Below Peoria Lock	1941	107,633	156.4-157.7	--	
	1944	39,910	157.1-157.6	--	
	1953	50,723	156.6-157.6	--	
	1958	21,804	157.1-157.6	--	
	1963	15,721	157.3-157.6	157.5R	
	1966	11,488	157.5	157.5R	
	1967	32,302	157.1-157.5	157.5R	
	1972	44,620	156.6-157.6	156.4L & 157.5R	
	1982	84,727	157.0-157.7	157.0-157.6R	
	1991	26,496	156.7-157.6	156.5-156.7L, 156.6-157.4R	
		435,424	10 Events Average:	43,542	

LAGRANGE POOL TOTALS

Events: 177
Yardage: 12,195,545
Average: 68,901

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site		Placement Site	Placement Type
157.9-158.1	1940	15,062	157.9-158.0		--	
Above Peoria	1961	20,020	158.0		--	
Lock	1967	16,789	158.0		158.0L	
	1979	9,065	158.0		157.9L	
		60,936	4 Events	Average:	15,234	
159.0-160.0	1940	478,109	159.0-160.0		--	
Kickapoo	1941	95,711	159.0-160.0		--	
Creek	1946	15,792	160.4-160.9		--	
	1948	179,054	159.0-160.0		--	
	1950	81,354	159.1-160.0		--	
	1956	56,517	159.1-159.7		--	
	1962	96,675	159.2-160.0		--	
		1,003,212	7 Events	Average:	143,316	
161.0-163.0	1942	45,930	161.8-162.0		--	
Peoria Bridges/	1944	70,640	161.8-162.1		--	
Farm Creek	1948	32,685	161.7-162.1		--	
	1950	48,279	161.7-162.0		--	
	1953	17,800	161.6-162.0		--	
	1977	64,079	162.0-162.9		163.0L	
	1979	34,551	163.0		163.0L	
		313,964	7 Events	Average:	44,852	
166.0-168.4	1946	187,863	167.6-168.4		--	
Ten Mile Creek	1948	31,041	167.8		--	
	1969	41,217	166.8		166.8L	
		260,121	3 Events	Average:	86,707	
173.0-178.0	1944	234,295	174.5-176.6		--	
Blue Creek/	1946	153,517	173.3-174.8		--	
Rome Light	1949	242,225	174.9-176.6		--	
	1954	309,532	174.1-178.4		--	
	1959	125,981	174.0-177.0		--	
		1,065,550	5 Events	Average:	213,110	
180.8-181.8	1966	5,198	181.8		181.8R	
Senachwine	1968	70,893	180.5 & 181.8		180.5R, 181.8L / R	
Creek	1971	64,142	181.8		181.8R	
	1973	57,422	181.8		181.8L	
		*			* See last page for historic data.	
	1992	600	181.9		181.9R	Mechanical

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
		198,255	*5 Events Average:*	*39,651*	
193.3-196.3	*1942*	*46,160*	*193.3-194.3*	--	
Henry	*1944*	*7,179*	*196.0-196.3*	--	
	1948	*26,651*	*196.0-196.3*	--	
	1992	*2,500*	*196.1-196.2*	*195.7-195.9L*	*Mechanical*
		82,490	*4 Events Average:*	*20,623*	
212.0-213.7	*1946*	*94,739*	*212.3-213.7*	--	
Illinois Power		*94,739*	*1 Events Average:*	*94,739*	
214.5-215.7	*1987*	*26,587*	*215.5-215.6*	--	*Beach*
Clark Island	*1991*	*17,955*	*215.3-215.7*	*215.8-216.0L (2,546), 215.5-216.1R (15,409)*	*Beach*
	1992	*27,674*	*214.8-215.4*	*214.4-215.2R (excl.214.7-214.9)*	*Beach*
	1992	*6,000*	*214.4R*	*Mertel Sand & Gravel (3000), 214.1-214.4R (3000)*	*Mechanical*
	1995	*16,344*	*215.3-215.7*	*215.6-216.1R*	*Beach*
		94,560	*5 Events Average:*	*18,912*	
215.9-218.4	*1942*	*44,749*	*217.0-217.8*	--	
Spring Valley	*1946*	*112,365*	*216.9-218.4*	--	
	1977	*53,414*	*216.4-217.8*	--	
	1987	*8,872*	*217.0-217.5*	--	
	1988	*12,813*	*216.8-217.1*	--	
	1992	*16,159*	*215.9-217.5*	*217.1-217.3R, 216.2-216.5R*	*Stab. & Beach*
		248,372	*6 Events Average:*	*41,395*	
218.5-221.1	*1942*	*96,987*	*218.9-221.0*	--	
Spring Creek/	*1944*	*91,691*	*218.6-220.3*	--	
Huse Slough	*1946*	*36,279*	*220.1-221.1*	--	
	1953	*138,944*	*218.5-221.0*	--	
	1962	*79,416*	*218.6-220.6*	--	
	1976	*6,605*	*218.5*	*218.5L*	
	1977	*55,793*	*218.7-220.5*	*219.1-220.2R*	*Stab & Beach*
	1991	*54,195*	*218.6-220.4*	*218.8-220.8R, 220.3-220.4L*	*Beach*
		559,910	*8 Events Average:*	*69,989*	
223.3-224.2	*1944*	*53,429*	*223.5-224.1*	--	
Peru Bend	*1946*	*25,984*	*222.7-223.7*	--	
	1952	*23,951*	*223.3-224.2*	--	
		103,364	*3 Events Average:*	*34,455*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
225.4-225.7	*1991*	*8,637*	*225.4-225.7*	*225.4-226.0L*	*Stab.*
LaSalle Bend		*8,637*	*1 Events Average:*	*8,637*	
226.2-226.9	*1944*	*27,140*	*226.3-226.9*	--	
Vermillion	*1945*	*570,041*	*226.2-226.9*	--	
River	*1994*	*5,438*	*226.0-226.3*	*Mertel Sand & Gravel (1386), 225.8-226.3L (4052)*	*Mechanical*
		602,619	*3 Events Average:*	*200,873*	
227.7-228.5	*1992*	*36,288*	*227.7-228.5*	*227.3-228.0R*	*Beach*
Deer Park Light		*36,288*	*1 Events Average:*	*36,288*	
228.8-229.4	*1946*	*77,631*	*228.8-229.4*	--	
Historic Cut		*77,631*	*1 Events Average:*	*77,631*	
		*		** See last page for historic data.*	
230.2-230.8 Below Starved Rock	*1990*	*3,948*	*230.4-230.9*	*Mertel Sand & Gravel (2248), 231.4R (1700)*	*Mechanical*
Lock	*1991*	*10,101*	*230.4-230.8*	*Mertel Sand & Gravel (9106), 231.4R (995)*	*Mechanical*
	1992	*4,400*	*230.4-230.8*	*Mertel Sand & Gravel (3000), 231.4R (1400)*	*Mechanical*
	1993	*1,679*	*230.4-230.8*	*Mertel Sand & Gravel (1000), 231.2R (679)*	*Mechanical*
230.2-230.8	*1994*	*4,903*	*230.4-230.8*	*Mertel Sand & Gravel (1430), 231.2R (3473)*	*Mechanical*
Below Starved Rock	*1995*	*817*	*230.7-230.9*	*231.6-231.7R*	*Mechanical*
Lock (Cont'd)		*25,848*	*6 Events Average:*	*4,308*	

PEORIA POOL TOTALS

Events: *70*

Yardage: *4,836,496*

Average: *69,093*

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
231.2-231.5		*		* See last page for historic data.	
Above Starved Rock Lock	1990	2,300	231.3-231.4R	Mertel Sand & Gravel (500), 231.4R (1800)	Mechanical
	1994	4,986	231.2-231.6	231.5-231.7R	Mechanical
		7,286	2 Events Average:	3,643	
240.5-241.5		*		* See last page for historic data.	
Bulls Island	1987	14,852	240.5-241.4	240.4-241.5R, excl. 240.9-241.1	Beach
	1991	8,644	240.6-241.0	240.4-240.7R	Mechanical
	1992	32,532	240.3-241.6	240.4-241.3R, excl. 241.0-241.1, 241.6-241.9L	Beach
	1993	4,132	240.5-240.7	Mertel Sand & Gravel (3132), 240.4-240.7R (1000)	Mechanical
	1995	15,558	240.4-241.0	240.5-240.7R, 241.2-241.3R	Beach
		75,718	5 Events Average:	15,144	
242.2-242.8		*		* See last page for historic data.	
Milliken Creek					
		0	0 Events Average:	#DIV/0!	
244.0-244.5		*		* See last page for historic data.	
Below	1990	1,019	244.2-244.3	244.7L, 244.3R	Mechanical
Marseilles Lock	1991	4,314	244.2-244.3	244.7L (1924), 244.3R (1943), 243.7L (447)	Mechanical
	1992	1,184	244.2-244.3	244.7L	Mechanical
	1993	1,312	243.7-244.1	244.7L	Mechanical
	1994	1,283	244.1-244.1	244.4R	Mechanical
		9,112	5 Events Average:	1,822	

STARVED ROCK POOL TOTALS

Events: 12

Yardage: 92,116

Average: 7,676

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site		Placement Site	Placement Type
244.7-247.0		*			* See last page for historic data.	
Marseilles	*1990*	*13,493*	*244.6-246.8*		*244.7L*	*Mechanical*
Canal	*1991*	*1,598*	*244.6-244.8*		*244.7L*	*Mechanical*
	1993	*2,742*	*246.0-247.0*		*244.7L*	*Mechanical*
	1995	*847*	*245.1-245.3*		*245.0-245.1R (345 offload site, and 502 DMMP!)*	*Mechanical*
		18,680	*4 Events*	*Average:*	*4,670*	
249.7-250.0		*			* See last page for historic data.	
Johnson Island/						
Kickapoo Creek		*0*	*0 Events*	*Average:*	*#DIV/0!*	
251.4-251.5		*			* See last page for historic data.	
Springbrook Light Lock						
		0	*0 Events*	*Average:*	*#DIV/0!*	
253.3-253.6		*			* See last page for historic data.	*Mechanical*
Seneca						
		0	*0 Events*	*Average:*	*#DIV/0!*	
258.6-259.3		*			* See last page for historic data.	*Mechanical*
Grist Island	*1987*	*15,276*	*258.6-258.8*		*258.3-258.5L*	*Beach*
	1992	*10,584*	*258.6-258.8*		*258.2-258.5L*	*Beach*
	1995	*9,434*	*258.6-258.8*		*258.3-258.5L*	*Beach*
		35,294	*3 Events*	*Average:*	*11,765*	
260.0-261.0		*			* See last page for historic data.	*Mechanical*
Sugar Island						
		0	*0 Events*	*Average:*	*#DIV/0!*	
268		*			* See last page for historic data.	*Mechanical*
Historic Cut						
Aux Sable						
Riverv		*0*	*0 Events*	*Average:*	*#DIV/0!*	
270.8-271.4		*			* See last page for historic data.	*Mechanical*
Below Dresden	*1988*	*18,933*	*270.9-271.3*		*271.1-271.2L (14,000), 270.8-271.1L (4933)*	*Mechanical*
Island Lock	*1989*	*3,875*	*271.1-271.3*		*270.8-271.0L*	*Mechanical*

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1990	*17,095*	*270.8-271.3*	*270.7R, 271.1-271.2R, 270.8-271.1L*	*Mechanical*
	1991	*12,394*	*270.8-271.2*	*270.8-271.1L*	*Mechanical*
	1992	*1,138*	*270.8-271.2*	*270.8-271.1L, 270.7R*	*Mechanical*
	1994	*9,679*	*270.8-271.2*	*270.8-271.1L*	*Mechanical*
		63,114	*6 Events* *Average:*	*10,519*	

MARSEILLES POOL TOTALS

Events: *13*

Yardage: *117,088*

Average: *9,007*

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
271.5-272.0		*		* See last page for historic data.	*Mechanical*
Above Dresden Island Lock	*1995*	*16,200*	*271.5-271.7*	*271.5-271.7L*	*Mechanical*
		16,200	*1 Events* *Average:*	*16,200*	
273.7-274.3		*		* See last page for historic data.	*Mechanical*
Bonnel Bend	*1987*				
		0	*1 Events* *Average:*	*0*	
274.4-274.9		*		* See last page for historic data.	*Mechanical*
Grant Creek Cut Off		*0*	*0 Events* *Average:*	*#DIV/0!*	
277.2-277.5		*		* See last page for historic data.	*Mechanical*
Dupage River					
		0	*0 Events* *Average:*	*#DIV/0!*	
278.8-279.5		*		* See last page for historic data.	*Mechanical*
Treats Island	*1993*	*2,771*	*279.1-279.4*	*279.6-279.7L*	*Mechanical*
		2,771	*1 Events* *Average:*	*2,771*	
281.1-281.6		*		* See last page for historic data.	*Mechanical*
Hunting Lodge Bend		*0*	*0 Events* *Average:*	*#DIV/0!*	
285.2-285.8		*		* See last page for historic data.	*Mechanical*
Below Brandon	*1988*	*7,392*	*285.3-285.9*	*285.3-285.6R (4667), 285.6-285.7L (2725)*	*Mechanical*
Road Lock	*1990*	*1,425*	*285.5-285.7*	*285.5-285.7L*	*Mechanical*
	1991	*997*	*285.7-285.8*	*285.7L*	*Mechanical*
	1992	*709*	*285.7-285.8*	*285.8L*	*Mechanical*
	1993	*2,026*	*285.6-285.8*	*285.7-285.8L*	*Mechanical*
	1994	*6,199*	*285.6-285.8*	*285.7-285.8L (5799), 291.5R (400)*	*Mechanical*
		18,748	*6 Events* *Average:*	*3,125*	

DRESDEN ISLAND POOL TOTALS

Events: *9*

Yardage: *37,719*

Average: *4,191*

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
286.0-286.3 Above Brandon Road Lock		*		* See last page for historic data.	
		0	0 Events Average:	#DIV/0!	
290.0-291.0		*		* See last page for historic data.	
Below	1988	250	291.0-291.1	270.0L	Mechanical
Lockport	1990	100	291	271.2R	Mechanical
Lock	1990	100	291	271.1R	Mechanical
	1991	100	291	244.3R	Mechanical
	1993	50	291	285.5L	Mechanical
	1994	50	291	285.8L	Mechanical
		650	6 Events Average:	108	

BRANDON ROAD POOL TOTALS

Events: *6*

Yardage: *650*

Average: *108*

DREDGED MATERIAL PLACEMENT SITES - April 1997

Location	GREAT Site #	Site Name	Endorsement (Notes)	Total GREAT Acres Wetland	Disturbed Floodplain	Upland	Total	Total CMMP Acres Wetland	Disturbed Floodplain	Upland	Total	Wet. Diff.
MN-13.5-RMP	MN.03	Cargill	GREAT	7.0	0.0	0.0	7.0	7	0	0	7	0.0
MN-12.1-RMP	-	Kraemer Site		0.0	0.0	0.0	0.0	0	0	5	5	0.0
MN-12.0-RMP	MN.06		GREAT (a)	0.0	0.0	24.0	24.0	0	0	0	0	0.0
MN-11.4-RMP	MN.30		GREAT	32.5	0.0	32.5	65.0	0	0	0	0	-32.5
MN-10.1-RMP	-	NSP Site		0.0	0.0	0.0	0.0	0	0	7	7	0.0
MN-7.3-RMP	-	Hwy. 77 Bridge		0.0	0.0	0.0	0.0	0	0	4	4	0.0
MN-4.5-RMP	MN.28		GREAT	0.0	0.0	18.0	18.0	0	0	0	0	0.0
			TOTALS	39.5	0.0	50.5	90.0	7	0	16	23	-32.5
SC-22.0-RMP	SC.24		GREAT	16.0	0.0	0.0	16.0	0	0	0	0	-16.0
SC-18.2-RMP	SC.18		GREAT	4.0	2.0	0.0	6.0	0	0	0	0	-4.0
SC-17.5-LWP	SC.28	Above Hudson RR Bridge	GREAT	0.0	4.0	0.0	4.0	0	0	0	0	0.0
SC-17.0-LWP	SC.22	Hudson	GREAT	1.5	0.0	1.5	3.0	0	0	0	0	-1.5
SC-16.6-LWP	SC.01	Beer Can Island	GREAT	7.0	0.0	0.0	7.0	0	0	0	0	-7.0
SC-16.-17LWP	SC.3-6	Beer Can Island	GREAT	0.0	7.0	0.0	7.0	0	0	0	0	0.0
SC-13.5-RMP	SC.21		GREAT	0.0	5.0	0.0	5.0	0	0	0	0	0.0
SC-8.5-RMP	SC.27		GREAT	2.0	0.0	0.0	2.0	0	0	0	0	-2.0
SC-6.7-LWP	SC.13	Kinnickinnic Bar Upper	GREAT	0.0	9.0	0.0	9.0	0	4	0	4	0.0
SC-6.5-LWP	SC.12	Kinnickinnic Bar Lower	GREAT	0.0	17.0	0.0	17.0	0	7	0	7	0.0
SC-0.5-RMP	SC.16	Pt. Douglas Nearshore	GREAT	2.5	0.0	0.0	2.5	0	0	0	0	-2.5
SC-0.4-RMP	SC.26	Pt. Douglas Beach	GREAT	2.5	2.5	0.0	5.0	0	0	0	0	-2.5
			TOTALS	35.5	46.5	1.5	83.5	0	11	0	11	-35.5
U-857.1-RMP	U.02		GREAT	0.0	0.0	3.0	3.0	0	0	0	0	0.0
U-856.6-RMP	-	USAF Site		0.0	0.0	0.0	0.0	0	0	7	7	0.0
U-854.7-LMP	U-03		GREAT	0.0	0.0	7.0	7.0	0	0	0	0	0.0
			TOTALS	0.0	0.0	10.0	10.0	0	0	7	7	0.0
1-853.2-LMP	1.01A	Pool 1 Site	RRF - 3/84	0.0	0.0	0.0	0.0	0	0	2	2	0.0
1-853.1-RMP	1.01		GREAT	0.0	0.0	3.5	3.5	0	0	0	0	0.0
1-851.3-LME	1.07T	Below Franklin Avenue	GREAT, RRF - 3/84	0.0	11.5	0.0	11.5	0	5	0	5	0.0
1-849.5-RME	1.03T	Below Lake Street	GREAT, RRF - 3/84	0.0	6.0	0.0	6.0	0	4	0	4	0.0
1-848.5-LME	1.02T		GREAT	0.0	4.5	0.0	4.5	0	0	0	0	0.0
			TOTALS	0.0	22.0	3.5	25.5	0	9	2	11	0.0
2-843.3-RMP	2.18		GREAT (2-1)	0.0	0.0	0.0	0.0	0	0	0	0	0.0
2-841.3-LMP	2.37		GREAT	0.0	0.0	7.0	7.0	0	0	0	0	0.0
2-840.4-RMP	2.16	Highbridge	GREAT	0.0	0.0	3.4	3.4	0	0	4	4	0.0
2-838.2-RMP	2.15	Northport	GREAT (2-2)	0.0	0.0	5.5	5.5	0	0	6	6	0.0
2-837.5-RMP	2.40	St. Paul Barge Terminal	GREAT	28.0	0.0	0.0	28.0	28	0	0	28	0.0
2-837.2-LMP	2.02		GREAT (a)	0.0	0.0	69.0	69.0	0	0	0	0	0.0
2-836.8-RMP	2.14	Holman field	GREAT, Not Endorsed (2-3)	0.0	0.0	0.0	0.0	0	0	0	0	0.0
2-836.3-RMP	2.13	Southport	GREAT	18.0	0.0	0.0	18.0	18	0	0	18	0.0
2-832.5-RMP	2.10		GREAT	0.0	0.0	25.0	25.0	0	0	0	0	0.0
2-823.8-LMT	2.25T	Pine Bend		0.0	0.0	0.0	0.0	0	8	0	8	0.0
2-823.8-RMP	-	C.F. Industries	OSIT - 9/94 (b)	0.0	0.0	0.0	0.0	0	1	6	7	0.0
2-822.8-RMP	2.24	Spring Lake	RRF - 11/85 (conceptual)(b)	0.0	0.0	0.0	0.0	0	0	0	0	0.0
2-822.5-LMP	-	Shiely Pit	(2-4)	0.0	0.0	0.0	0.0	0	0	15	15	0.0
2-821.5-LMT	-	Upper Boulanger		0.0	0.0	0.0	0.0	0	4	0	4	0.0
2-821.1-LMT	2.31T	Lower Boulanger		0.0	0.0	0.0	0.0	3	5	0	8	3.0

DREDGED MATERIAL PLACEMENT SITES - April 1997

				Total GREAT Acres				Total CMMP Acres				
Location	GREAT Site #	Site Name	Endorsement (Notes)	Wetland	Disturbed Floodplain	Upland	Total	Wetland	Disturbed Floodplain	Upland	Total	Wet. Diff.
2-820.0-LMP	2.35		GREAT	0.0	0.0	25.0	25.0	0	0	0	0	0.0
2-815.4-RMP	2.30		GREAT	3.5	0.0	0.0	3.5	0	0	0	0	-3.5
			TOTALS	49.5	0.0	65.9	115.4	49	18	31	98	-0.5
3-815.1-RMP	-	Hastings	RRF - 4/90	0.0	0.0	0.0	0.0	0	0	1	1	0.0
3-814.7-RMP	-	Koch		0.0	0.0	0.0	0.0	0	0	7	7	0.0
3-814.5-LMP	3.42		GREAT	8.5	0.0	0.0	8.5	0	0	0	0	-8.5
3-814.3-RMP	3.47-8		GREAT	0.0	1.5	1.5	3.0	0	0	0	0	0.0
3-813.2-RMP	3.46	Hastings Harbor	GREAT	0.0	0.0	11.0	11.0	0	0	11	11	0.0
3-811.5-LMP	3.34	Point Douglas	GREAT	4.0	0.0	6.0	10.0	4	0	6	10	0.0
3-808.4-LWP	3.27	Dry Run Slough	GREAT	31.0	0.0	0.0	31.0	13	0	0	13	-18.0
3-802.3-RME	3.14T	Morgans	GREAT	7.0	3.5	0.0	10.5	3	0	0	3	-4.0
3-801.7-LWE	3.12T	Coulters	GREAT	6.0	6.0	0.0	12.0	2	1	0	3	-4.0
3-799.8-LWP	3.09		GREAT (3-1)	35.0	0.0	0.0	35.0	0	0	0	0	-35.0
3-798.0-LWP	-	County/Private Pits	RRF - 01/97	0.0	0.0	0.0	0.0	0	0	31	31	0.0
3-799.2-RMT	3.07	Corps Island	RRF - 12/95	0.0	0.0	0.0	0.0	2	5	0	7	2.0
			TOTALS	91.5	11.0	18.5	121.0	24.0	6.0	56.0	86.0	-67.5
4-794.7-RMP	4.63	Red Wing Yacht Club	GREAT, RRF - 11/85 (4-1)	4.0	7.0	0.0	11.0	2	4	0	6	-2.0
4-791.6-RMP	4.57	Red Wing Commercial Harbo	GREAT, RRF - 11/85	0.0	0.0	16.0	16.0	2	0	11	13	2.0
4-791.5-RMP	4.54	Red Wing Harbor Site	GREAT (a)	3.0	0.0	5.0	8.0	0	0	0	0	-3.0
4-789.6-RMP	4.49		GREAT	8.0	0.0	0.0	8.0	0	0	0	0	-8.0
4-789.3-RMT	4.48		GREAT (4-2)	1.0	0.0	0.0	1.0	0	0	0	0	-1.0
4-788.5-RMP	4.47	Colvill Park	GREAT (b)	6.0	0.0	5.0	11.0	0	0	5	5	-6.0
4-785.0-RMP	4.37-8		GREAT	0.0	0.0	13.0	13.0	0	0	0	0	0.0
4-762.7-LWT	4.29T	Reads Landing	GREAT, RRF - 4/82	0.0	9.5	0.0	9.5	0	22	0	22	0.0
4-761.1-RMP	4.25	Carrels Pit	GREAT (b)	0.0	0.0	18.0	18.0	0	0	18	18	0.0
4-761.0-RMP	4.24	Wabasha Gravel Pit	GREAT, RRF - 4/82 (4-3)	10.0	0.0	50.0	60.0	10	0	76	86	0.0
4-760.2-RMP	MDNR.2	MDNR.2	RRF - 10/83 (4-4)	0.0	0.0	0.0	0.0	0	0	30	30	0.0
4-759.7-RMP	4.20		GREAT	0.0	0.0	6.4	6.4	0	0	0	0	0.0
4-759.5-RMP	4.19		GREAT (4-4)	0.0	0.0	5.7	5.7	0	0	6	6	0.0
4-759.4-RMT	4.18		GREAT	0.0	3.0	0.0	3.0	0	0	0	0	0.0
4-759.3-RMP	4.17		RRF - 10/83 (4-4)	0.0	0.0	0.0	0.0	0	3	0	3	0.0
4-759.3-LWT	4.16T	Crats Island	RRF - 3/83, 11/85	0.0	0.0	0.0	0.0	0	22	0	22	0.0
4-757.5-LW	4.13T	Teepeeota Point	GREAT, RRF - 6/83	0.0	7.5	0.0	7.5	0	46	0	46	0.0
4-756.5-LWT	4.10T	Grand Encampment	GREAT, RRF - 6/83	0.0	4.0	0.0	4.0	0	8	0	8	0.0
4-754.0-LWP	4.02	Alma Marina	GREAT, RRF - 6/83	10.3	0.0	0.0	10.3	3	4	0	7	-7.3
			TOTALS	39.3	31.0	114.1	184.4	17	109	146	272	-22.3
5-751.5-LWP	5.26	Alma Power Plant	GREAT (5-1)	15.0	0.0	0.0	15.0	0	0	0	0	-15.0
5-751.2-LWP	5.26A		GREAT (5-1)	15.0	0.0	0.0	15.0	0	0	0	0	-15.0
5-749.8-RMP	5.24	West Newton Chute	GREAT, RRF - 10/83 (5-1)	0.0	0.0	36.0	36.0	0	0	39	39	0.0
5-748.0-RMT	5.18T	Above West Newton	GREAT	0.0	27.5	0.0	27.5	0	14	0	14	0.0
5-747.5-LWP	5.28	Buffalo City	GREAT (5-1)	0.0	0.0	15.0	15.0	0	0	0	0	0.0
5-745.8-RMT	5.12T	Above Fisher Island	GREAT, RRF - 9/85	0.0	5.5	0.0	5.5	0	14	0	14	0.0
5-744.7-LWT	5.08T	Lost Island	RRF - 3/83, 9/85	0.0	0.0	0.0	0.0	0	18	0	18	0.0
5-744.0-RMP	5.30	Weaver Bottoms	GREAT, RRF - 9/85 (5-2)	76.0	0.0	0.0	76.0	108	0	0	108	32.0
			TOTALS	0.0	33.0	36.0	69.0	0	46	39	85	0.0

DREDGED MATERIAL PLACEMENT SITES - April 1997

Location	GREAT Site #	Site Name	Endorsement (Notes)	Total GREAT Acres				Total CMMP Acres				Wet. Diff.
				Wetland	Disturbed Floodplain	Upland	Total	Wetland	Disturbed Floodplain	Upland	Total	
5A-738.2-RMP	5A.36	L/D 5 Site	GREAT, RRF - 6/83	1.0	1.0	0.0	2.0	1	1	0	2	0.0
5A-737.5-RMP	5A.23	Bass Camp	GREAT, RRF - 10/83, 12/86	7.0	0.0	0.0	7.0	0	0	0	0	-7.0
5A-734.5-LWE	5A.14T	Island 58	GREAT, RRF - 12/86	0.0	7.0	0.0	7.0	0	3	0	3	0.0
5A-733.5-LWP	5A.34	Ft. City Service Base	RRF - 12/86	0.0	0.0	0.0	0.0	2	0	0	2	2.0
5A-731.9-LWP	5A.25	Fountain City 1	GREAT, RRF - 10/83	0.0	6.0	0.0	6.0	0	6	0	6	0.0
5A-731.8-LWP	5A.32	Fountain City 2	GREAT, RRF - 10/83	34.0	0.0	0.0	34.0	22	0	0	22	-12.0
5A-730.5-LWT	5A.08T	Wilds Bend	GREAT, RRF - 3/84	5.0	4.0	0.0	9.0	0	8	0	8	-5.0
			TOTALS	47.0	18.0	0.0	65.0	25	18	0	43	-22.0
6-726.3-RMP	-	Winona Commercial Harbor		0.0	0.0	0.0	0.0	0	0	6	6	0.0
6-726.0-LMP	6.27	Winona Harbor	GREAT	0.0	0.5	0.0	0.5	0	1	0	1	0.0
6-724.6-RMP	6.20		GREAT	0.0	2.5	0.0	2.5	0	0	0	0	0.0
6-724.5-RMP	6.19		GREAT	0.0	2.5	0.0	2.5	0	0	0	0	0.0
6-723.3-RMP	6.17	Winona Industrial Park	GREAT (b)	0.0	0.0	0.0	0.0	0	0	0	0	0.0
6-720.5-RMP	6.11	Homer	GREAT	9.0	2.0	0.0	11.0	8	2	0	10	-1.0
			TOTALS	9.0	7.5	0.0	16.5	8	3	6	17	-1.0
7-714.1-LWP	7.06	Trempealeau	GREAT, RRF - 3/84	21.0	0.0	0.0	21.0	5	0	0	5	-16.0
7-713.1-RMP	7.05	Hot Fish Shop	GREAT, RRF - 3/84	12.0	0.0	0.0	12.0	0	3	0	3	-12.0
7-708.7-LWE	7.11T	Winters Landing	GREAT	0.0	1.5	0.0	1.5	1	1	0	2	1.0
7-707.3-RMP	7.25A	Dakota Boat Ramp	RRF - 3/84, 6/86	0.0	0.0	0.0	0.0	5	0	0	5	5.0
7-706.5-RMT	7.12T	Dakota Island	GREAT, RRF - 6/86	0.0	6.4	0.0	6.4	0	8	0	8	0.0
7-705.2-RMP	7.01		GREAT	0.0	1.2	0.0	1.2	0	0	0	0	0.0
7-702.5-RMP	7.20	L/D 7 Site	GREAT, RRF - 3/84 (7-1)	0.0	0.0	1.7	1.7	0	0	0	0	0.0
			TOTALS	33.0	9.1	1.7	43.8	11	12	0	23	-22.0
8-700.0-RMP	8.28		GREAT	4.0	0.0	0.0	4.0	0	0	0	0	-4.0
8-695.7-LWP	8.06	Isle La Plume	GREAT, RRF - 10/83 (8-1)	0.0	44.0	0.0	44.0	0	0	9	9	0.0
8-690.4-LWT	8.17T	Above Brownsville	GREAT	0.0	8.5	0.0	8.5	0	14	0	14	0.0
8-688.7-RMP	8.30	Brownsville Containment	GREAT, RRF - 3/84	33.0	22.0	0.0	55.0	17	17	2	36	-16.0
8-684.7-LWP	8.22	Stoddard	GREAT	0.0	0.0	4.0	4.0	0	0	0	0	0.0
			TOTALS	37.0	74.5	4.0	115.5	17	31	11	59	-20.0
9-678.0-RME	9.21T	Island 126	GREAT	0.0	10.0	0.0	10.0	0	0	0	0	0.0
9-677.7-LWP	9.15	Genoa Power Plant	GREAT, RRF - 6/86	0.0	0.0	1.0	1.0	0	0	2	2	0.0
9-676.5-RME	9.20T	Twin Island	GREAT	16.0	14.0	0.0	30.0	0	0	0	0	-16.0
9-671.8-LWP	9.11	Gantenbein	GREAT	4.5	0.0	0.5	5.0	0	0	0	0	-4.5
9-671.3-LWP	9.33		GREAT	13.0	0.0	0.0	13.0	0	0	0	0	-13.0
9-670.5-LWP	9.55	Blackhawk Park	RRF - 6/86	0.0	0.0	0.0	0.0	41	7	21	69	41.0
9-667.5-LWP	9.07	Desoto	GREAT, RRF - 6/86 (9-1)	13.0	0.0	0.0	13.0	0	0	0	0	-13.0
9-665.8-RIE	9.18T	Indian Camp Light	GREAT	2.7	0.0	0.0	2.7	0	3	0	3	-2.7
9-664.3-RIT	9.17T	Lansing	GREAT (9-2)	0.0	4.0	0.0	4.0	0	9	0	9	0.0
9-663.5-RIP	9.26		GREAT	22.0	0.0	0.0	22.0	0	0	0	0	-22.0
9-663.5-LWP	9.50T	Lansing Hwy Bridge	RRF - 12/92	0.0	0.0	0.0	0.0	5	0	0	5	5.0
9-663.0-RIP	9.03		GREAT	0.0	0.0	4.1	4.1	0	0	0	0	0.0
9-662.2-RIP	9.28		GREAT, Not Endorsed (9-3)	33.0	0.0	0.0	33.0	0	0	0	0	-33.0
9-660.0-RIP	9.47		GREAT	0.0	0.0	1.0	1.0	0	0	0	0	0.0
9-652.3-LWP	9.41	Lynxville	GREAT	4.0	0.0	4.5	8.5	0	0	0	0	-4.0
			TOTALS	75.2	28.0	11.1	114.3	46	19	23	88	-29.2

DREDGED MATERIAL PLACEMENT SITES - April 1997

				Total GREAT Acres				Total CMMP Acres				
Location	GREAT Site #	Site Name	Endorsement (Notes)	Wetland	Disturbed Floodplain	Upland	Total	Wetland	Disturbed Floodplain	Upland	Total	Wet. Diff.
10-647.1-LWP	10.17	Varo Property	GREAT, RRF - 9/85	2.0	0.0	1.5	3.5	2	0	2	4	0.0
10-646.5-LWP	10.16	Gordon Bay Landing	GREAT	6.0	0.0	0.0	6.0	0	0	0	0	-6.0
10-644.5-RIE	10.22T	Jackson Island	GREAT (10-1)	0.0	0.0	3.0	3.0	0	0	3	3	0.0
10-643.5-LWI	-	Jackson Rehandle	RRF - 9/85	0.0	0.0	0.0	0.0	3	0	0	3	3.0
10-642.4-LWP	10.40	Mississippi Gardens	GREAT, RRF - 9/85	0.0	0.0	25.8	25.8	0	0	4	4	0.0
10-635.5-LWP	10.42	Proposed Boat Harbor	RRF - 4/82 (10-2)	0.0	0.0	0.0	0.0	0	0	0	0	0.0
10-635.0-LWP	10.43	Prairie Municipal Dock	RRF - 4/82 (10-3)	0.0	0.0	0.0	0.0	0	5	0	5	0.0
10-634.6-RIP	10.41		GREAT	4.5	0.0	0.0	4.5	0	0	0	0	-4.5
10-628.0-LWP	10.01	Wyalusing Pit	GREAT, RRF - 9/85 (10-4)	0.0	0.0	8.2	8.2	0	0	6	6	0.0
10-627.8-LWP	10.24	Wyalusing Beach	RRF - 9/85 (10-5)	0.0	0.0	0.0	0.0	0	2	0	2	0.0
10-618.8-RIP	10.04	Esmann Island	GREAT, RRF - 9/85	8.2	0.0	0.0	8.2	0	0	0	0	-8.2
10-618.7-RIT	10.18	McMillan Island	RRF - 9/95	0.0	0.0	0.0	0.0	2	3	0	5	2.0
10-618.0-RIP	-	Buck Creek	RRF - 9/95	0.0	0.0	0.0	0.0	2	0	8	10	2.0
10-616.0-RIP	10.03		GREAT (a)	0.0	0.0	10.0	10.0	0	0	0	0	0.0
10-615.5-RIP	10.02		GREAT	0.0	0.0	5.5	5.5	0	0	0	0	0.0
			TOTALS	20.7	0.0	44.0	64.7	9	10	23	42	-11.7

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1975		1976		1977		1978		1979		1980		1981		
POOL	NAME	LOCATION	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
MN	Abv. Savage R.R. Br.	14.3-14.7			11	26,000	11	24,000					12	12,800			12
MN	Cargill Slip	12.8-13.6															
MN	Peterson's Bar	11.8-12.4			11	37,800							11	3,800			11
MN	Blw. Peterson's Bar	11.0-11.6															11
MN	Abv. 35W Br.	10.1															
MN	4 Mile Cut-off	4.0															
MN	Mouth of the MN River	0.0-0.9															
SC	Kinnickinnic Bar	6.0-6.5							13	20,778			13	41,000			
USAF	Mpls. Turning Basin	856.8-857.6	12	4,118	12	75,429	12	22,934	12	7,823	12	26,600					12
USAF	Abv. Lowry Ave. Br.	856.4-856.8	12	16,778	12	9,042			12	3,960	12	2,500					11
USAF	Blw. Lowry Ave. Br.	856.0-856.4															
USAF	Broadway Ave. Br.	855.3-856.1	12	4,588	12	8,614			12	9,727	12	5,500					12
USAF	Abv. Plymoth Ave. Br.	854.8-855.5	12	13,572	12	22,627	12	9,633	12	9,350	12	24,400					
1	Lower Appch. LSAF	853.4									13	600					13
1	Abv. Franklin Ave. Br.	851.6-852.4							12	28,482	12	14,100					
1	Blw. Franklin Ave. Br.	850.7-851.4	12	20,032					12	8,159	12	16,800					
1	Abv. Lake St. Br.	849.9-850.5	12	65,139	12	10,627	12	10,086	12	228	12	29,700					11
1	Blw. Lake St. Br.	848.9-849.9	11	22,312					12	15,287	12	10,900					
1	St. Paul Daymark	848.5-848.9					11	4,477			12	11,100					
1	Upper Appch. L/D 1	847.7-848.4	11	28,439	11	6,483			12	7,702							
1	L/D 1 Lock Chamber	847.6															
1	Lower Appch. L/D 1	847.4-847.5															
2	Abv. & Blw. Smith Ave.	840.0-841.3	13	5,128	13	32,015	13	1,868			12	5,700	13	20,600			13
2	Abv. Wabasha Ave. Br.	839.5-839.6															
2	St. Paul SBH	839.6	6	7,689							6	8,800					6
2	St. Paul Barge Terminal	836.4-837.8			11	101,837					13	159,000					
2	Grey Cloud Slough	827.5-828.3			13	38,414											
2	Robinson Rocks	826.1					11	7,894									
2	Pine Bend Landing	824.3-824.6															
2	Access/Pine Bend Site	823.8															
2	Pine Bend	822.7-823.7	12	13,813	13	19,189									13	28,000	
2	Boulanger Bend	820.7-821.4															
2	Boulanger Bend Lwr. Lt.	819.0-819.8					13	13,265									
2	Freeborn Light	818.7-818.9															
3	Lower Appch. L/D 2	814.9-815.1															
3	Hastings SBH	813.2															
3	Big River	804.1-806.0															
3	Coulters Island	800.8-801.9															
3	Diamond Bluff	798.8-800.4															
3	L/D 3 Aux. Gates	797.0															

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1975		1976		1977		1978		1979		1980		1981		
POOL	NAME	LOCATION	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
4	Trenton	794.0-794.6	11	32,645													
4	Cannon River	792.1-793.5															
4	Red Wing Comm. Harbor	791.5							12	3,282							
4	Red Wing SBH	791.0															6
4	Head of Lake Pepin	785.2-785.4															
4	Pepin SBH	767.0					6	292					6	2,000			
4	Chippewa Delta	763.2															
4	Reads Landing	761.8-763.8	13	105,297			12	11,206	12	140,252	12	130,300	6	9,000	12	88,500	13
4	Indian Slough	760.0															
4	Crats Island	759.0	13	110,371			11	17,749	12	90,004	12	135,500			12	52,200	13
4	Teepeeota Point	757.0-757.9	13	41,922							13	74,700					
4	Grand Encampment	755.8-756.9					11	3,671					12	10,300			
4	Beef Slough	753.8-754.1															
4	Access Channel	753.7															
4	L/D 4 Aux. Lock	752.8			6	5,657							8	6,000			
5	Island 40 Wing Dams	752.5											7	3,800			
5	Mule Bend	748.6-749.6	11	8,324					6	21,632	13	35,200	6	1,600			11
5	Mule Bend Side Channel	748.4															6
5	West Newton	748.2-747.2							12	12,958	13	32,900					13
5	Murphy's Cut	747.4															
5	Blw. West Newton	746.0-746.8	13	16,226													
5	Fisher Island	744.8-746.0	12	13,933			12	19,740	12	45,437	13	42,600					11
5	Lower Zumbro	744.0-744.6	12	13,666	12	51,751							11	10,300			
5	Minneiska	742.7-743.0															
5	Abv. Mt. Vernon Light	741.2-741.5															
5	L/D 5 Aux. Lock	738.1															
5A	Island 58	734.0-735.2	11	36,112	11	17,913			12	3,998	13	17,000					13
5A	Betsy Slough	731.0-732.0			11	10,526			12	10,910			11	34,800	12	13,200	11
5A	Wilds Bend	730.2-730.7			11	14,534			11	33,144			11	15,900	12	11,600	
5A	L/D 5A Gate Bay	728.7															
5A	L/D 5A Chamber	728.5											8	200			
5A	L/D 5A Aux. Lock	728.5													8	3,700	
6	Lower Appch. L/D 5A	728.5															
6	Blackbird Slough Sd.Ch.	727.8											6	4,400			
6	Winona Comm. Harbor	726.3															13
6	Winona SBH	726.1	6	15,345	6	2,167					6	500	6	700			6
6	Blw. Winona R.R. Br.	723.4-723.8			13	37,591											
6	Homer	720.4-721.1															
7	Lower Guidewall L/D 6	714.3					6	6,062									6
7	L/D 6 Aux. Lock	714.1-714.2															

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1975		1976		1977		1978		1979		1980		1981		
POOL	NAME	LOCATION	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
7	Lower Appch. L/D 6	714.0-714.3															
7	Richmond Island	711.4-712.3	12	41,597													12
7	Winters Landing	707.4-709.3					11	25,096	12	25,366			12	8,200	12	11,300	11
7	Dakota	706.1-706.6	11	7,428			11	4,357	12	9,666							
7	Dresbach	704.0-705.3			12	7,600			12	7,614					12	7,200	
7	Lower Dresbach Island	703.0-703.7															
7	Upper Appch. L/D 7	702.5													13	19,100	
8	LaCrosse R.R. Br.	699.8-700.4			13	18,248											13
8	Blw. LaCrosse R.R. Br.	698.7-699.4															
8	LaCrosse	698.6-698.7															
8	Abv. Brownsville	689.9-690.8	13	23,411					12	11,667							
8	Brownsville	688.7-689.4					13	23,973							13	59,100	12
8	Head of Raft Channel	687.5-688.7													11	10,500	12
8	Deadman's Slough	686.5-687.5			11	14,047											
9	L/D 8 Lower Guidewall	679.0															
9	Lower Appch. L/D 8	678.7-679.2			6	4,167											13
9	Island 126	677.5-678.4															
9	Twin Island	676.0-676.6			11	6,200											
9	Ferry Slough Sd. Ch.	672.1											6	1,000			
9	Battle Island	671.0-672.0											13	5,400			
9	Indian Camp Light	665.0-665.8							11	6,130					13	10,400	
9	Lansing Upper Light	663.8-664.9							12	57,294			12	35,000	12	19,500	13
9	Upper Aux. L/D 9	647.9															
10	Jackson Island	643.7-644.7	13	38,322											13	7,500	
10	Mississippi Gardens	642.7-643.4			13	25,934											
10	Prairie Du Chien	635.0			13	104,932											
10	Wyalusing Slough Sd.Ch.	627.9							8	34,824							
10	McMillan Island	618.4-619.6											11	4,500	11	45,400	12
	Warroad Harbor																
	Zippel Bay Harbor																
TOTALS:				706,207		709,344		206,303		625,674		784,400		231,300		387,200	

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1982	1983		1984		1985		1986		1987		1988		
POOL	NAME	LOCATION	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
MN	Abv. Savage R.R. Br.	14.3-14.7	43,500	12	39,515											
MN	Cargill Slip	12.8-13.6		12	11,808											
MN	Peterson's Bar	11.8-12.4	18,516	12	29,516							11	18,201	12	3,870	12
MN	Blw. Peterson's Bar	11.0-11.6	1,248													
MN	Abv. 35W Br.	10.1		12	36,612											
MN	4 Mile Cut-off	4.0										12	4,389			
MN	Mouth of the MN River	0.0-0.9														
SC	Kinnickinnic Bar	6.0-6.5						13	60,581							11
USAF	Mpls. Turning Basin	856.8-857.6	48,176			12	2,794					12	21,601	12	33,655	
USAF	Abv. Lowry Ave. Br.	856.4-856.8	76,631			12	36,667	12	17,772	11	37,500	12	85,560	12	2,164	12
USAF	Blw. Lowry Ave. Br.	856.0-856.4														
USAF	Broadway Ave. Br.	855.3-856.1	20,565			12	23,868					12	27,589	12	4,377	
USAF	Abv. Plymoth Ave. Br.	854.8-855.5												12	31,860	
1	Lower Appch. LSAF	853.4	1,493	13	500					13	800			12	400	
1	Abv. Franklin Ave. Br.	851.6-852.4												12	12,415	
1	Blw. Franklin Ave. Br.	850.7-851.4										11	10,894			
1	Abv. Lake St. Br.	849.9-850.5	57,605					12	29,079			11	23,763	12	3,992	
1	Blw. Lake St. Br.	848.9-849.9		12	12,802							12	41,342			
1	St. Paul Daymark	848.5-848.9										12	43,411	12	5,037	
1	Upper Appch. L/D 1	847.7-848.4														
1	L/D 1 Lock Chamber	847.6														
1	Lower Appch. L/D 1	847.4-847.5														
2	Abv. & Blw. Smith Ave.	840.0-841.3	14,717	13	7,808	13	21,794									
2	Abv. Wabasha Ave. Br.	839.5-839.6														
2	St. Paul SBH	839.6	8,413			6	26,000					6	4,409			
2	St. Paul Barge Terminal	836.4-837.8				14	210,938	13	225,793			13	32,199	13	138,655	
2	Grey Cloud Slough	827.5-828.3										11	10,698			
2	Robinson Rocks	826.1														
2	Pine Bend Landing	824.3-824.6														
2	Access/Pine Bend Site	823.8														
2	Pine Bend	822.7-823.7								12	37,469			12	22,000	12
2	Boulanger Bend	820.7-821.4														11
2	Boulanger Bend Lwr. Lt.	819.0-819.8														
2	Freeborn Light	818.7-818.9														
3	Lower Appch. L/D 2	814.9-815.1														13
3	Hastings SBH	813.2				6	5,500									
3	Big River	804.1-806.0														11
3	Coulters Island	800.8-801.9										11	3,174			12
3	Diamond Bluff	798.8-800.4								11	34,771					12
3	L/D 3 Aux. Gates	797.0								7	4,800					

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1982	1983		1984		1985		1986		1987		1988		
POOL	NAME	LOCATION	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
4	Trenton	794.0-794.6														
4	Cannon River	792.1-793.5												11	12,791	
4	Red Wing Comm. Harbor	791.5														
4	Red Wing SBH	791.0	28,000													
4	Head of Lake Pepin	785.2-785.4														
4	Pepin SBH	767.0														
4	Chippewa Delta	763.2				9	301,000	9	170,544					9	382,816	
4	Reads Landing	761.8-763.8	210,055	12	58,199	13	69,000	13	56,334							
4	Indian Slough	760.0														
4	Crats Island	759.0	139,412	13	101,541	12	90,752	12	81,419	12	209,517					
4	Teepeeota Point	757.0-757.9		13	56,081	12	61,428			11	55,102	12	20,741			
4	Grand Encampment	755.8-756.9		12	49,727	11	37,863	11	20,026	12	19,000	12	22,804			
4	Beef Slough	753.8-754.1														
4	Access Channel	753.7		7	4,662											
4	L/D 4 Aux. Lock	752.8						8	10,000					8	2,160	
5	Island 40 Wing Dams	752.5														
5	Mule Bend	748.6-749.6	24,519													13
5	Mule Bend Side Channel	748.4	4,573													
5	West Newton	748.2-747.2	21,900			12	11,300									
5	Murphy's Cut	747.4														
5	Blw. West Newton	746.0-746.8		12	29,477					12	31,606			12	15,055	
5	Fisher Island	744.8-746.0	28,147	12	47,173	12	73,489			12	142,928			12	22,755	
5	Lower Zumbro	744.0-744.6		11	37,204					11	97,793	12	24,622			
5	Minneiska	742.7-743.0														
5	Abv. Mt. Vernon Light	741.2-741.5														
5	L/D 5 Aux. Lock	738.1						8	1,957							
5A	Island 58	734.0-735.2	5,751													
5A	Betsy Slough	731.0-732.0	20,194	12	57,458	12	22,208	12	23,249	12	39,426			11	7,853	13
5A	Wilds Bend	730.2-730.7		12	36,922	12	3,953	12	43,040							12
5A	L/D 5A Gate Bay	728.7								8	150					
5A	L/D 5A Chamber	728.5						8	411							
5A	L/D 5A Aux. Lock	728.5														
6	Lower Appch. L/D 5A	728.5		13	500											
6	Blackbird Slough Sd.Ch.	727.8														
6	Winona Comm. Harbor	726.3	1,909													
6	Winona SBH	726.1	250	6	6,255			6	250	6	4,050	6	760			
6	Blw. Winona R.R. Br.	723.4-723.8														13
6	Homer	720.4-721.1						12	29,363	11	18,845					
7	Lower Guidewall L/D 6	714.3	1,363													
7	L/D 6 Aux. Lock	714.1-714.2														

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1982		1983		1984		1985		1986		1987		1988	
POOL	NAME	LOCATION	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
7	Lower Appch. L/D 6	714.0-714.3												13	500	
7	Richmond Island	711.4-712.3	5,619													
7	Winters Landing	707.4-709.3	52,796			10	14,935	12	47,986	12	59,881					12
7	Dakota	706.1-706.6								12	18,056					
7	Dresbach	704.0-705.3								12	29,551					12
7	Lower Dresbach Island	703.0-703.7										11	2,409			
7	Upper Appch. L/D 7	702.5														13
8	LaCrosse R.R. Br.	699.8-700.4	17,366			13	26,476			13	51,915					
8	Blw. LaCrosse R.R. Br.	698.7-699.4														
8	LaCrosse	698.6-698.7														13
8	Abv. Brownsville	689.9-690.8						12	39,730	11	34,872			13	23,313	
8	Brownsville	688.7-689.4	16,047	12	17,859	11	15,167	12	25,710	11	44,744	12	18,153			
8	Head of Raft Channel	687.5-688.7	12,593	12	22,014			12	25,128							14
8	Deadman's Slough	686.5-687.5														13
9	L/D 8 Lower Guidewall	679.0														
9	Lower Appch. L/D 8	678.7-679.2	5,638											13	5,322	
9	Island 126	677.5-678.4														12
9	Twin Island	676.0-676.6														
9	Ferry Slough Sd. Ch.	672.1														
9	Battle Island	671.0-672.0														
9	Indian Camp Light	665.0-665.8		13	30,841	11	13,939	12	27,509			12	21,101			12
9	Lansing Upper Light	663.8-664.9	36,833			12	113,453									12
9	Upper Aux. L/D 9	647.9				8	1,500									
10	Jackson Island	643.7-644.7														
10	Mississippi Gardens	642.7-643.4														
10	Prairie Du Chien	635.0														
10	Wyalusing Slough Sd.Ch.	627.9														
10	McMillan Island	618.4-619.6	68,688					12	67,095	11	6,895					
	Warroad Harbor			8	43,000											
	Zippel Bay Harbor															
TOTALS:			992,517		737,474		1,184,024		1,002,976		979,671		437,820		730,990	

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1989		1990		1991		1992		1993		1994		1995	
POOL	NAME	LOCATION	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
MN	Abv. Savage R.R. Br.	14.3-14.7						12	5,087							12
MN	Cargill Slip	12.8-13.6														
MN	Peterson's Bar	11.8-12.4	12,478			12	3,515	12	5,920	11	12,542			12	30,133	12
MN	Blw. Peterson's Bar	11.0-11.6														
MN	Abv. 35W Br.	10.1														
MN	4 Mile Cut-off	4.0														
MN	Mouth of the MN River	0.0-0.9								11	3,402					
SC	Kinnickinnic Bar	6.0-6.5	10,541													
USAF	Mpls. Turning Basin	856.8-857.6						12	21,568	12	20,454	12	33,993			12
USAF	Abv. Lowry Ave. Br.	856.4-856.8	16,167			12	50,185	12	15,505			12	48,598			12
USAF	Blw. Lowry Ave. Br.	856.0-856.4						12	8,871							
USAF	Broadway Ave. Br.	855.3-856.1						12	10,753			12	15,052			12
USAF	Abv. Plymoth Ave. Br.	854.8-855.5										12	12,000			12
1	Lower Appch. LSAF	853.4														
1	Abv. Franklin Ave. Br.	851.6-852.4				13	8,295									
1	Blw. Franklin Ave. Br.	850.7-851.4						13	16,583			12	25,509			
1	Abv. Lake St. Br.	849.9-850.5				12	7,909					12	25,250			12
1	Blw. Lake St. Br.	848.9-849.9										12	11,450			12
1	St. Paul Daymark	848.5-848.9														
1	Upper Appch. L/D 1	847.7-848.4														
1	L/D 1 Lock Chamber	847.6		8	40											
1	Lower Appch. L/D 1	847.4-847.5										13	1,880			
2	Abv. & Blw. Smith Ave.	840.0-841.3														
2	Abv. Wabasha Ave. Br.	839.5-839.6										13	660			
2	St. Paul SBH	839.6		6	2,678	6	1,250	6	11,817	6	10,000	6	5,966	6	8,000	6
2	St. Paul Barge Terminal	836.4-837.8								12	242,526			12	21,055	13
2	Grey Cloud Slough	827.5-828.3		12	20,120					11	13,922	12	13,168	12	15,066	
2	Robinson Rocks	826.1														
2	Pine Bend Landing	824.3-824.6								11	13,863			12	41,157	
2	Access/Pine Bend Site	823.8												6	6,000	
2	Pine Bend	822.7-823.7	15,253											12	34,407	
2	Boulanger Bend	820.7-821.4	88,294							11	36,919			12	38,185	
2	Boulanger Bend Lwr. Lt.	819.0-819.8												12	29,035	
2	Freeborn Light	818.7-818.9						11	6,437					12	58,516	
3	Lower Appch. L/D 2	814.9-815.1	10,503					13	19,061							
3	Hastings SBH	813.2														
3	Big River	804.1-806.0	3,268							11	1,295			12	16,291	
3	Coulters Island	800.8-801.9	11,120					12	31,738	11	5,675	11	13,052	12	60,390	
3	Diamond Bluff	798.8-800.4	12,966					12	12,025	11	1,143	11	14,981	12	66,681	
3	L/D 3 Aux. Gates	797.0														

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1989		1990		1991		1992		1993		1994		1995	
POOL	NAME	LOCATION	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
4	Trenton	794.0-794.6														
4	Cannon River	792.1-793.5						12	19,282	11	8,603	12	27,676			12
4	Red Wing Comm. Harbor	791.5														10
4	Red Wing SBH	791.0														
4	Head of Lake Pepin	785.2-785.4		12	11,532											
4	Pepin SBH	767.0														
4	Chippewa Delta	763.2		9	308,801	9	269,326	9	158,955					9	200,105	
4	Reads Landing	761.8-763.8						12	31,601	12	48,383					
4	Indian Slough	760.0						8	8,000							
4	Crats Island	759.0				12	41,000	12	97,821	12	72,830	12	76,945	12	65,407	12
4	Teepeeota Point	757.0-757.9				12	48,000	12	38,135	12	38,292			12	61,416	12
4	Grand Encampment	755.8-756.9				12	66,000	12	20,678	12	39,723	11	5,201	12	85,767	12
4	Beef Slough	753.8-754.1		12	16,970	12	3,501			12	10,931	11	9,427	12	18,536	
4	Access Channel	753.7														
4	L/D 4 Aux. Lock	752.8														8
5	Island 40 Wing Dams	752.5														
5	Mule Bend	748.6-749.6	40,306									12	26,962			12
5	Mule Bend Side Channel	748.4														
5	West Newton	748.2-747.2										12	13,728	13	18,891	
5	Murphy's Cut	747.4				4	2,000									
5	Blw. West Newton	746.0-746.8		12	7,200	12	7,719	12	16,665	12	12,283	12	10,993	12	15,794	12
5	Fisher Island	744.8-746.0		12	7,934			12	12,764	12	16,300			12	65,556	12
5	Lower Zumbro	744.0-744.6						12	26,866	12	56,724			12	34,764	12
5	Minneiska	742.7-743.0		12	3,208	13	34,090	12	20,759	12	15,926	12	13,694	12	24,960	12
5	Abv. Mt. Vernon Light	741.2-741.5														12
5	L/D 5 Aux. Lock	738.1														
5A	Island 58	734.0-735.2														
5A	Betsy Slough	731.0-732.0	21,993	12	13,835	12	11,469	13	43,055	12	33,465	12	27,865	13	59,230	13
5A	Wilds Bend	730.2-730.7	77,923					13	2,843			12	26,147	12	25,610	12
5A	L/D 5A Gate Bay	728.7														
5A	L/D 5A Chamber	728.5														
5A	L/D 5A Aux. Lock	728.5														
6	Lower Appch. L/D 5A	728.5														
6	Blackbird Slough Sd.Ch.	727.8														
6	Winona Comm. Harbor	726.3														10
6	Winona SBH	726.1								6	2,613					6
6	Blw. Winona R.R. Br.	723.4-723.8	14,542									12	8,601	12	16,054	
6	Homer	720.4-721.1				12	9,063									
7	Lower Guidewall L/D 6	714.3														
7	L/D 6 Aux. Lock	714.1-714.2						8	300							

DREDGE CUTS			1989		1990		1991		1992		1993		1994		1995	
POOL	NAME	LOCATION	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*	QUANTITY	*
7	Lower Appch. L/D 6	714.0-714.3		13	15,305					13	35,157					
7	Richmond Island	711.4-712.3														
7	Winters Landing	707.4-709.3	47,168			12	19,365			12	14,398			12	20,776	12
7	Dakota	706.1-706.6		11	27,986					12	14,892			12	10,405	12
7	Dresbach	704.0-705.3	19,233			12	11,204			12	17,989			12	14,927	12
7	Lower Dresbach Island	703.0-703.7		12	19,816			12	8,883	11	2,884			12	36,550	12
7	Upper Appch. L/D 7	702.5	7,193													
8	LaCrosse R.R. Br.	699.8-700.4														
8	Blw. LaCrosse R.R. Br.	698.7-699.4						12	3,716							
8	LaCrosse	698.6-698.7	8,113													
8	Abv. Brownsville	689.9-690.8		13	24,888			12	24,590	12	49,867			12	28,030	12
8	Brownsville	688.7-689.4		12	28,937	12	3,750	12	9,292	12	18,946	12	45,340	12	11,683	12
8	Head of Raft Channel	687.5-688.7	64,864			11	910	13	9,296			12	9,159			12
8	Deadman's Slough	686.5-687.5	34,725													
9	L/D 8 Lower Guidewall	679.0						8	2,645							
9	Lower Appch. L/D 8	678.7-679.2														
9	Island 126	677.5-678.4	8,044													
9	Twin Island	676.0-676.6														
9	Ferry Slough Sd. Ch.	672.1														
9	Battle Island	671.0-672.0														
9	Indian Camp Light	665.0-665.8	4,974					12	10,577	12	13,000	13	45,800	12	20,541	12
9	Lansing Upper Light	663.8-664.9	18,921	12	32,719	12	17,636	12	38,561			12	24,064	12	94,503	12
9	Upper Aux. L/D 9	647.9														
10	Jackson Island	643.7-644.7														
10	Mississippi Gardens	642.7-643.4														
10	Prairie Du Chien	635.0														
10	Wyalusing Slough Sd.Ch.	627.9														
10	McMillan Island	618.4-619.6						12	70,829	11	3,047			12	62,986	12
	Warroad Harbor															
	Zippel Bay Harbor					4	1,950									
TOTALS:			548,589		541,969		618,137		841,478		887,994		593,161		1,417,407	

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1996
POOL	NAME	LOCATION	QUANTITY
MN	Abv. Savage R.R. Br.	14.3-14.7	5,190
MN	Cargill Slip	12.8-13.6	
MN	Peterson's Bar	11.8-12.4	13,442
MN	Blw. Peterson's Bar	11.0-11.6	
MN	Abv. 35W Br.	10.1	
MN	4 Mile Cut-off	4.0	
MN	Mouth of the MN River	0.0-0.9	
SC	Kinnickinnic Bar	6.0-6.5	
USAF	Mpls. Turning Basin	856.8-857.6	56,480
USAF	Abv. Lowry Ave. Br.	856.4-856.8	57,788
USAF	Blw. Lowry Ave. Br.	856.0-856.4	
USAF	Broadway Ave. Br.	855.3-856.1	15,642
USAF	Abv. Plymoth Ave. Br.	854.8-855.5	1,800
1	Lower Appch. LSAF	853.4	
1	Abv. Franklin Ave. Br.	851.6-852.4	
1	Blw. Franklin Ave. Br.	850.7-851.4	
1	Abv. Lake St. Br.	849.9-850.5	27,915
1	Blw. Lake St. Br.	848.9-849.9	7,805
1	St. Paul Daymark	848.5-848.9	
1	Upper Appch. L/D 1	847.7-848.4	
1	L/D 1 Lock Chamber	847.6	
1	Lower Appch. L/D 1	847.4-847.5	
2	Abv. & Blw. Smith Ave.	840.0-841.3	
2	Abv. Wabasha Ave. Br.	839.5-839.6	
2	St. Paul SBH	839.6	1,067
2	St. Paul Barge Terminal	836.4-837.8	171,471
2	Grey Cloud Slough	827.5-828.3	
2	Robinson Rocks	826.1	
2	Pine Bend Landing	824.3-824.6	
2	Access/Pine Bend Site	823.8	
2	Pine Bend	822.7-823.7	
2	Boulanger Bend	820.7-821.4	
2	Boulanger Bend Lwr. Lt.	819.0-819.8	
2	Freeborn Light	818.7-818.9	
3	Lower Appch. L/D 2	814.9-815.1	
3	Hastings SBH	813.2	
3	Big River	804.1-806.0	
3	Coulters Island	800.8-801.9	
3	Diamond Bluff	798.8-800.4	
3	L/D 3 Aux. Gates	797.0	

DREDGE CUTS			1996
POOL	NAME	LOCATION	QUANTITY
4	Trenton	794.0-794.6	
4	Cannon River	792.1-793.5	39,214
4	Red Wing Comm. Harbor	791.5	668
4	Red Wing SBH	791.0	
4	Head of Lake Pepin	785.2-785.4	
4	Pepin SBH	767.0	
4	Chippewa Delta	763.2	
4	Reads Landing	761.8-763.8	
4	Indian Slough	760.0	
4	Crats Island	759.0	82,256
4	Teepeeota Point	757.0-757.9	79,350
4	Grand Encampment	755.8-756.9	58,991
4	Beef Slough	753.8-754.1	
4	Access Channel	753.7	
4	L/D 4 Aux. Lock	752.8	6,300
5	Island 40 Wing Dams	752.5	
5	Mule Bend	748.6-749.6	47,646
5	Mule Bend Side Channel	748.4	
5	West Newton	748.2-747.2	
5	Murphy's Cut	747.4	
5	Blw. West Newton	746.0-746.8	23,651
5	Fisher Island	744.8-746.0	22,991
5	Lower Zumbro	744.0-744.6	42,198
5	Minneiska	742.7-743.0	43,370
5	Abv. Mt. Vernon Light	741.2-741.5	17,259
5	L/D 5 Aux. Lock	738.1	
5A	Island 58	734.0-735.2	
5A	Betsy Slough	731.0-732.0	44,041
5A	Wilds Bend	730.2-730.7	33,657
5A	L/D 5A Gate Bay	728.7	
5A	L/D 5A Chamber	728.5	
5A	L/D 5A Aux. Lock	728.5	
6	Lower Appch. L/D 5A	728.5	
6	Blackbird Slough Sd.Ch.	727.8	
6	Winona Comm. Harbor	726.3	2,000
6	Winona SBH	726.1	1,613
6	Blw. Winona R.R. Br.	723.4-723.8	
6	Homer	720.4-721.1	
7	Lower Guidewall L/D 6	714.3	
7	L/D 6 Aux. Lock	714.1-714.2	

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			1996
POOL	NAME	LOCATION	QUANTITY
7	Lower Appch. L/D 6	714.0-714.3	
7	Richmond Island	711.4-712.3	
7	Winters Landing	707.4-709.3	22,597
7	Dakota	706.1-706.6	14,145
7	Dresbach	704.0-705.3	21,276
7	Lower Dresbach Island	703.0-703.7	21,839
7	Upper Appch. L/D 7	702.5	
8	LaCrosse R.R. Br.	699.8-700.4	
8	Blw. LaCrosse R.R. Br.	698.7-699.4	
8	LaCrosse	698.6-698.7	
8	Abv. Brownsville	689.9-690.8	21,525
8	Brownsville	688.7-689.4	74,640
8	Head of Raft Channel	687.5-688.7	34,929
8	Deadman's Slough	686.5-687.5	
9	L/D 8 Lower Guidewall	679.0	
9	Lower Appch. L/D 8	678.7-679.2	
9	Island 126	677.5-678.4	
9	Twin Island	676.0-676.6	
9	Ferry Slough Sd. Ch.	672.1	
9	Battle Island	671.0-672.0	
9	Indian Camp Light	665.0-665.8	35,043
9	Lansing Upper Light	663.8-664.9	41,509
9	Upper Aux. L/D 9	647.9	
10	Jackson Island	643.7-644.7	
10	Mississippi Gardens	642.7-643.4	
10	Prairie Du Chien	635.0	
10	Wyalusing Slough Sd.Ch.	627.9	
10	McMillan Island	618.4-619.6	40,157
	Warroad Harbor		
	Zippel Bay Harbor		
TOTALS:			1,231,465

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			TOTALS	AVG./YR.	AVG./JOB	FREQ.
POOL	NAME	LOCATION	75-96	75-96	75-96	(%)
MN	Abv. Savage R.R. Br.	14.3-14.7	156,092	22,299	22,299	32%
MN	Cargill Slip	12.8-13.6	11,808	11,808	11,808	5%
MN	Peterson's Bar	11.8-12.4	189,733	15,811	15,811	55%
MN	Blw. Peterson's Bar	11.0-11.6	1,248	1,248	1,248	5%
MN	Abv. 35W Br.	10.1	36,612	36,612	36,612	5%
MN	4 Mile Cut-off	4.0	4,389	4,389	4,389	5%
MN	Mouth of the MN River	0.0-0.9	3,402	3,402	3,402	5%
SC	Kinnickinnic Bar	6.0-6.5	132,900	33,225	33,225	18%
USAF	Mpls. Turning Basin	856.8-857.6	375,625	28,894	30,050	59%
USAF	Abv. Lowry Ave. Br.	856.4-856.8	476,817	31,788	32,884	68%
USAF	Blw. Lowry Ave. Br.	856.0-856.4	8,871	8,871	8,871	5%
USAF	Broadway Ave. Br.	855.3-856.1	146,275	13,298	13,931	50%
USAF	Abv. Plymoth Ave. Br.	854.8-855.5	125,242	15,655	16,699	36%
1	Lower Appch. LSAF	853.4	3,793	759	759	23%
1	Abv. Franklin Ave. Br.	851.6-852.4	63,292	15,823	15,823	18%
1	Blw. Franklin Ave. Br.	850.7-851.4	97,977	16,330	17,814	27%
1	Abv. Lake St. Br.	849.9-850.5	291,293	24,274	25,330	55%
1	Blw. Lake St. Br.	848.9-849.9	121,898	17,414	18,754	32%
1	St. Paul Daymark	848.5-848.9	64,025	16,006	16,006	18%
1	Upper Appch. L/D 1	847.7-848.4	42,624	14,208	17,050	14%
1	L/D 1 Lock Chamber	847.6	40	40	40	5%
1	Lower Appch. L/D 1	847.4-847.5	1,880	1,880	1,880	5%
2	Abv. & Blw. Smith Ave.	840.0-841.3	109,630	13,704	14,617	36%
2	Abv. Wabasha Ave. Br.	839.5-839.6	660	660	660	5%
2	St. Paul SBH	839.6	96,089	8,007	8,356	55%
2	St. Paul Barge Terminal	836.4-837.8	1,303,474	144,830	144,830	41%
2	Grey Cloud Slough	827.5-828.3	111,388	18,565	18,565	27%
2	Robinson Rocks	826.1	7,894	7,894	7,894	5%
2	Pine Bend Landing	824.3-824.6	55,020	27,510	27,510	9%
2	Access/Pine Bend Site	823.8	6,000	6,000	6,000	5%
2	Pine Bend	822.7-823.7	170,131	24,304	26,174	32%
2	Boulanger Bend	820.7-821.4	163,398	54,466	54,466	14%
2	Boulanger Bend Lwr. Lt.	819.0-819.8	42,300	21,150	21,150	9%
2	Freeborn Light	818.7-818.9	64,953	32,477	32,477	9%
3	Lower Appch. L/D 2	814.9-815.1	29,564	14,782	14,782	9%
3	Hastings SBH	813.2	5,500	5,500	5,500	5%
3	Big River	804.1-806.0	20,854	6,951	6,951	14%
3	Coulters Island	800.8-801.9	125,149	20,858	20,858	27%
3	Diamond Bluff	798.8-800.4	142,567	23,761	23,761	27%
3	L/D 3 Aux. Gates	797.0	4,800	4,800	4,800	5%

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			TOTALS	AVG./YR.	AVG./JOB	FREQ.
POOL	NAME	LOCATION	75-96	75-96	75-96	(%)
4	Trenton	794.0-794.6	32,645	32,645	65,290	5%
4	Cannon River	792.1-793.5	107,566	21,513	21,513	23%
4	Red Wing Comm. Harbor	791.5	3,950	1,975	1,975	9%
4	Red Wing SBH	791.0	28,000	28,000	28,000	5%
4	Head of Lake Pepin	785.2-785.4	11,532	11,532	11,532	5%
4	Pepin SBH	767.0	2,292	1,146	1,146	9%
4	Chippewa Delta	763.2	1,791,547	255,935	255,935	32%
4	Reads Landing	761.8-763.8	958,127	79,844	83,315	55%
4	Indian Slough	760.0	8,000	8,000	8,000	5%
4	Crats Island	759.0	1,464,724	91,545	94,498	73%
4	Teepeeota Point	757.0-757.9	575,167	52,288	54,778	50%
4	Grand Encampment	755.8-756.9	439,751	33,827	33,827	59%
4	Beef Slough	753.8-754.1	59,365	11,873	11,873	23%
4	Access Channel	753.7	4,662	4,662	4,662	5%
4	L/D 4 Aux. Lock	752.8	30,117	6,023	6,023	23%
5	Island 40 Wing Dams	752.5	3,800	3,800	3,800	5%
5	Mule Bend	748.6-749.6	206,189	25,774	27,492	36%
5	Mule Bend Side Channel	748.4	4,573	4,573	4,573	5%
5	West Newton	748.2-747.2	111,677	18,613	18,613	27%
5	Murphy's Cut	747.4	2,000	2,000	2,000	5%
5	Blw. West Newton	746.0-746.8	186,669	16,970	17,778	50%
5	Fisher Island	744.8-746.0	561,747	40,125	41,611	64%
5	Lower Zumbro	744.0-744.6	395,888	39,589	41,672	45%
5	Minneiska	742.7-743.0	156,007	22,287	22,287	32%
5	Abv. Mt. Vernon Light	741.2-741.5	17,259	17,259	17,259	5%
5	L/D 5 Aux. Lock	738.1	1,957	1,957	1,957	5%
5A	Island 58	734.0-735.2	80,774	16,155	17,950	23%
5A	Betsy Slough	731.0-732.0	494,777	27,488	27,488	82%
5A	Wilds Bend	730.2-730.7	325,273	27,106	27,106	55%
5A	L/D 5A Gate Bay	728.7	150	150	150	5%
5A	L/D 5A Chamber	728.5	611	306	306	9%
5A	L/D 5A Aux. Lock	728.5	3,700	3,700	3,700	5%
6	Lower Appch. L/D 5A	728.5	500	500	500	5%
6	Blackbird Slough Sd.Ch.	727.8	4,400	4,400	4,400	5%
6	Winona Comm. Harbor	726.3	3,909	1,955	1,955	9%
6	Winona SBH	726.1	34,503	3,137	3,286	50%
6	Blw. Winona R.R. Br.	723.4-723.8	76,788	19,197	19,197	18%
6	Homer	720.4-721.1	57,271	19,090	19,090	14%
7	Lower Guidewall L/D 6	714.3	7,425	3,713	3,713	9%
7	L/D 6 Aux. Lock	714.1-714.2	300	300	300	5%

RECORD OF DREDGING EVENTS (April 1997)

DREDGE CUTS			TOTALS	AVG./YR.	AVG./JOB	FREQ.
POOL	NAME	LOCATION	75-96	75-96	75-96	(%)
7	Lower Appch. L/D 6	714.0-714.3	50,962	16,987	16,987	14%
7	Richmond Island	711.4-712.3	47,216	23,608	31,477	9%
7	Winters Landing	707.4-709.3	369,864	28,451	28,451	59%
7	Dakota	706.1-706.6	106,935	13,367	14,258	36%
7	Dresbach	704.0-705.3	136,594	15,177	15,177	41%
7	Lower Dresbach Island	703.0-703.7	92,381	15,397	15,397	27%
7	Upper Appch. L/D 7	702.5	26,293	13,147	13,147	9%
8	LaCrosse R.R. Br.	699.8-700.4	114,005	28,501	28,501	18%
8	Blw. LaCrosse R.R. Br.	698.7-699.4	3,716	3,716	3,716	5%
8	LaCrosse	698.6-698.7	8,113	8,113	8,113	5%
8	Abv. Brownsville	689.9-690.8	281,893	28,189	29,673	45%
8	Brownsville	688.7-689.4	413,341	27,556	27,556	68%
8	Head of Raft Channel	687.5-688.7	189,393	21,044	21,044	41%
8	Deadman's Slough	686.5-687.5	48,772	24,386	24,386	9%
9	L/D 8 Lower Guidewall	679.0	2,645	2,645	2,645	5%
9	Lower Appch. L/D 8	678.7-679.2	15,127	5,042	5,042	14%
9	Island 126	677.5-678.4	8,044	8,044	8,044	5%
9	Twin Island	676.0-676.6	6,200	6,200	6,200	5%
9	Ferry Slough Sd. Ch.	672.1	1,000	1,000	1,000	5%
9	Battle Island	671.0-672.0	5,400	5,400	5,400	5%
9	Indian Camp Light	665.0-665.8	239,855	19,988	19,988	55%
9	Lansing Upper Light	663.8-664.9	529,993	44,166	44,166	55%
9	Upper Aux. L/D 9	647.9	1,500	1,500	1,500	5%
10	Jackson Island	643.7-644.7	45,822	22,911	30,548	9%
10	Mississippi Gardens	642.7-643.4	25,934	25,934	25,934	5%
10	Prairie Du Chien	635.0	104,932	104,932	104,932	5%
10	Wyalusing Slough Sd.Ch.	627.9	34,824	34,824	34,824	5%
10	McMillan Island	618.4-619.6	369,597	41,066	41,066	41%
	Warroad Harbor		43,000	43,000	43,000	5%
	Zippel Bay Harbor		1,950	1,950	1,950	5%
TOTALS:			16,396,100	745,277		

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
613.7-614.9	*1941*	*22,545*	*613.7-614.1*	*613.8-614.0R, 614.1R*	
Lock #10 Lower	*1942*	*22,042*	*614.0-614.2*	--	
	1942	*86,715*	*614.8-614.9*	--	
	1950	*38,635*	*613.8-614.1*	*613.8-613.9L*	
		169,937	*4 Events Average:*	*42484*	
612.7-613.5	*1940*	*172,643*	*612.7-613.5*	*613.1R, 613.2R, 613.4-613.6R, 612.9L, 613.1L, 613.2-613.4L*	
Swift Slough	*1942*	*96,999*	*612.8-613.3*	*613.2R, 613.3R, 613.4R, 612.9-613.1L, 613.2L, 613.3L*	
	1944	*57,668*	*612.7-613.2*	*613.1L, 613.2R*	
	1945	*35,666*	*612.9-613.2*	*613.2-613.3L*	
	1946	*16,130*	*612.8-613.0*	*612.9-613.0L*	
	1951	*69,194*	*612.9-613.3*	*613.1L, 613.2-613.3L*	
	1956	*20,432*	*612.9-613.2*	*612.9-613.3L*	
	1974	*28,105*	*612.9-613.1*	*612.9L*	
		496,837	*8 Events Average:*	*62105*	
612.1-612.7	*1941*	*72,834*	*612.1-612.5*	*612.3-612.6R*	
Goetz Island	*1961*	*25,629*	*612.3-612.5*	*612.6L&R*	
	1974	*29,482*	*612.3-612.5*	*612.4L, 612.3-612.5R*	
		127,945	*3 Events Average:*	*42648*	
610.0-612.1	*1940*	*92,778*	*610.3-610.9*	*610.4-610.5L, 610.6L*	
St. Louis	*1941*	*60,167*	*611.9-612.4*	*613.3-613.5R, 613.0-613.4L*	
Woodyard	*1941*	*93,548*	*610.5-610.9*	*610.6L, 610.7-610.8L, 610.9L*	
	1942	*109,783*	*610.3-610.7*	*610.2-610.3R, 610.4R, 610.5R, 610.7R*	
	1943	*106,285*	*610.3-610.7*	*610.4-610.6L, 610.7L, 610.4-610.7R*	
	1944	*66,140*	*610.5-610.9*	*611.0R, 610.8-610.9R*	
	1945	*54,032*	*610.4-610.9*	*610.5-610.8R*	
	1946	*51,222*	*610.4-610.9*	*610.5-610.6R, 610.7R, 610.9R*	
	1948	*41,601*	*610.3-610.8*	*610.5R, 610.7R*	
	1950	*23,444*	*610.4-610.7*	*610.6-610.7R*	
	1952	*39,206*	*610.3-610.9*	*610.6-610.7R, 610.9-611.0R*	
	1955	*25,874*	*610.3-610.7*	*610.4-610.5R, 610.6R*	
	1959	*24,667*	*609.9-610.2*	*610.2R*	
	1962	*56,277*	*610.3-610.7*	*610.5-610.6L, 610.7-610.9L*	
	1966	*62,567*	*610.3-610.8*	*610.5-610.6L, 610.8-610.9R*	
	1971	*62,255*	*610.3-610.8*	*610.6L, 610.8L*	
	1972	*42,259*	*610.3-610.7*	*610.3-610.5L*	
	1978	*27,018*	*610.4-610.7*	*610.2-610.3R*	
		1,039,123	*18 Events Average:*	*57729*	
608.8-610.0	*1940*	*20,378*	*609.8-610.2*	*609.9R, 610.1-610.2R*	
Turkey River	*1940*	*80,417*	*609.0-609.6*	*609.1-609.6L*	
	1942	*41,617*	*609.7-610.1*	*609.9R, 610.0R, 610.1R*	
	1942	*67,214*	*608.9-609.4*	*609.0-609.1L, 609.2-609.4L*	
	1943	*61,242*	*609.1-609.5*	*609.2-609.3L, 609.4L, 609.6L*	
	1943	*36,464*	*609.8-610.1*	*610.1R, 609.9R*	
	1944	*27,245*	*609.2-609.5*	*609.3-609.4L*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1944	48,775	609.7-610.1	609.5-610.1R	
	1945	76,978	609.0-610.1	610.0-610.1R, 609.2R, 609.4R	
	1946	72,667	609.0-609.5	609.2-609.5L	
	1946	38,843	609.7-610.0	609.9R, 610.0R	
	1948	40,444	609.0-609.4	609.1-609.2L, 609.5L	
	1952	18,578	609.3-609.6	609.5-609.7R	
	1955	41,501	609.1-609.5	609.1-609.2L, 609.3L, 609.5L	
	1956	68,021	608.8-609.4	609.0-609.6L, 609.0-609.3R	
	1958	80,221	609.5-610.0	609.7-610.0R, 610.1-610.2R	
	1959	62,899	609.1-609.5	609.6R, 609.3-609.4L, 609.5-609.6L	
	1961	25,463	609.9-610.1	610.1R, 610.2R	
	1964	27,500	609.8-610.1	610.0-610.1R	
	1964	42,712	608.9-609.3	609.0-609.1L, 609.1-609.2L, 609.3L	
	1966	74,212	609.6-610.1	609.8-609.9R, 610.1R, 610.2R	
	1966	53,109	608.9-609.3	609.0-609.3L, 609.4L	
	1968	35,554	609.8-610.1	609.9-610.0R, 610.1-610.2R	
	1971	37,116	608.9-609.2	609.0-609.3L	
	1971	43,490	609.8-610.0	609.9-610.0R	
	1973	43,615	608.8-609.2	608.7-608.9L	
	1973	49,528	609.1-610.1	609.9-610.0R, 610.1-610.2R	
	1981	8,244	609.7-610.0	Barged to Cassville, WI	
	1989	29,430	610.0	Barged to Cassville, WI	
	1990	18,991	609.3-609.5	608.6-608.7R	
		1,372,468	30 Events Average:	45749	
607.8-608.8	1942	103,250	608.0-608.4	608.1-608.2L, 608.3-608.4L, 608.5L, 608.3-608.4R	
Turkey River Lower	1946	22,578	608.1-608.3	608.1-608.2L	
	1948	68,763	608.0-608.4	608.2R, 608.4-608.5R, 608.3L, 608.5L	
	1950	53,327	608.0-608.3	608.3-608.4R	
	1951	25,583	608.0-608.3	608.0-608.3R	
	1952	66,871	607.8-608.2	607.9-608.2R, 608.3R	
	1955	64,984	608.3-608.8	608.2-608.3L, 608.5L	
		405,356	7 Events Average:	57908	
605.7-606.3	1941	73,363	605.9-606.2	605.9L, 606.1L, 606.2-606.3L, 606.0-606.2R, 606.3R	
Cassville	1942	61,315	605.9-606.2	605.9L, 606.0-606.1L, 606.1-606.3R	
	1943	109,479	605.8-606.3	605.8L, 605.9L, 606.0-606.1R, 606.2-606.3R	
	1944	51,726	605.9-606.2	606.1R, 606.3R	
	1945	59,647	605.7-606.2	605.9-606.0L, 606.1L, 606.2L, 606.3L	
	1946	48,879	605.9-606.2	605.9-606.0L, 606.0-606.2L	
	1948	54,185	605.9-606.3	606.0-606.1L, 606.3L	
		458,594	7 Events Average:	65513	
604.6-605.3	1958	132,311	604.6-605.3	604.8-605.0R, 605.1R, 605.2R, 605.3R, 605.4R	
Island 195	1965	55,333	604.9-605.3	605.1R, 605.1-605.2R, 605.2-605.4R	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
		187,644	2 Events Average:	93822	
			Events Average:		
603.8-604.6	1952	23,000	604.5-604.7	604.6-604.8R	
Buena Vista Upper	1955	29,877	604.5-604.8	604.6R, 604.6-604.8R	
	1958	138,550	603.8-604.5	604.0-604.5R	
		191,427	3 Events Average:	63809	
602.9-603.4	1955	43,435	602.9-603.1	603.0-603.2R	
Buena Vista	1958	97,623	602.9-603.4	603.0-603.2R, 603.3-603.6L	
	1965	43,165	602.9-603.2	603.2-603.4L, 602.9R	
		184,223	3 Events Average:	61408	
598.7-599.1	1968	43,600	598.7-598.9	598.8-599.0L	
Hurricane	1971	43,966	598.7-599.0	598.9-599.0L	
Island	1973	47,122	598.7-599.1	598.6-598.8L	
	1974	10,926	598.8-599.0	598.7-598.8L	
	1981	15,392	598.7-598.9	Barged to Cassville, WI	
	1989	29,963	598.6-598.9	598.6-599.0L	
	1995	23,982		Beach Nourishment	
		214,951	7 Events Average:	30707	
595.5-596.5	1974	124,332	595.5-596.5	595.7-596.0R	
Finley's	1983	12,578	596.0-596.2	595.8-596.0R	
Landing	1985	27,326	596.0-596.4	595.8-596.0R	
	1988	26,451	596.0-596.3	596.1-596.3R	
	1993	21,167	595.7-596.0	595.5R	
	1994	29,243		Sand Pad for Closure Dam, 595.5L	
		241,097	6 Events Average:	40183	

POOL 11 TOTALS

Events: 98.0

Yardage: 5089602.0
Average: 51934.7

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
581.3-581.6	*1962*	*64,033*	*581.3-581.6*	*581.4-581.6L*	
Dubuque		*64,033*	*1 Even Average:*	*64,033*	
579.2-580.1	*1941*	*142,797*	*579.2-579.9*	*579.4-579.6L, 579.7-579.9L*	
Catfish Creek	*1942*	*35,857*	*579.6-580.0*	*579.5L, 579.9L*	
	1943	*151,119*	*579.3-580.1*	*580.1-580.2R, 579.5-579.7L*	
	1944	*34,652*	*579.7-579.9*	*579.9L, 579.8L*	
	1945	*52,644*	*579.3-579.9*	*579.4L, 579.5L*	
	1946	*26,000*	*579.7-579.9*	*579.5L, 579.7L*	
	1948	*48,888*	*579.3-579.8*	*579.5-579.6L*	
	1956	*28,666*	*579.7-579.8*	*579.7-579.9L*	
	1965	*28,500*	*579.6-579.8*	*579.6L, 579.8L*	
		549,123	*9 Events Average:*	*61,014*	
574.3-574.8	*1942*	*38,421*	*574.3-574.8*	*574.5-574.6R, 574.7-574.8R*	
Catfish Crossing		*38,421*	*1 Event Average:*	*38,421*	
572.6-572.9	*1968*	*43,415*	*572.6-572.9*	*572.7-573.0R*	
Nine Mile Island		*43,415*	*1 Event Average:*	*43,415*	
568.5-568.8	*1958*	*61,700*	*568.5-568.8*	*568.5-568.8R*	
Deadman's Light	*1969*	*66,807*	*568.5-568.8*	*568.6-568.9R*	
		128,507	*2 Events Average:*	*64,254*	
566.8-568.0	*1940*	*193,791*	*566.8-567.2*	*566.7-567.3L*	
Deadman's Light Lower	*1969*	*45,435*	*567.7-568.0*	*567.8-568.2R*	
		239,226	*2 Events Average:*	*119,613*	
565.1-565.8	*1940*	*161,593*	*565.1-565.8*	*565.4-565.8L, 565.9L*	
Gordon's Ferry	*1954*	*70,656*	*565.2-565.8*	*565.3-565.9L*	
	1972	*39,817*	*565.3-565.5*	*565.5-565.7L*	
	1979	*22,534*	*565.2-565.4*	*564.9-565.1L*	
	1981	*25,328*	*565.3-565.6*	*564.9-565.1Thalweg*	
		319,928	*5 Events Average:*	*63,986*	
561.8-562.5	*1940*	*67,000*	*562.0-562.5*	*562.2L, 562.4L, 562.6L*	
Island 241 Light	*1946*	*58,137*	*561.9-562.3*	*562.0-562.3R*	
	1984	*66,051*	*561.8-562.3*	*561.9-562.1L*	
	1990	*87,582*	*561.7-562.3*	*561.9-562.3L*	
	1995	*39,718*		*Thalweg*	
		318,488	*5 Events Average:*	*63,698*	
560.4-561.1	*1940*	*50,198*	*560.4-560.7*	*560.5-560.8L*	
Bellevue Slough	*1940*	*44,820*	*560.9-561.1*	*560.9-561.1R, 561.2R*	
	1958	*25,647*	*560.5-560.8*	*560.6-560.8L, 560.8L*	
		120,665	*3 Events Average:*	*40,222*	

POOL 12 TOTALS

Events: 29
Yardage: 1,821,806
Average: 62,821

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
555.0-555.4	*1945*	*43,097*	*555.0-555.3*	*555.1-555.4R*	
Lock #12 Lower	*1946*	*29,689*	*555.0-555.3*	*555.1-555.4R*	
	1950	*16,600*	*555.1-555.4*	*555.2-555.4R*	
	1956	*34,410*	*555.1-555.4*	*555.3-555.5R*	
		123,796	*4 Events Average:*	*30,949*	
554.1-555.0	*1940*	*36,407*	*554.4-554.7*	*554.4-554.7L*	
Duck Creek	*1942*	*45,086*	*554.3-554.6*	*554.4-554.7L*	
	1943	*143,349*	*554.4-555.4*	*554.6-554.7R, 554.8-554.9R, 555.1-555.4R*	
	1945	*73,361*	*554.2-554.6*	*554.3-554.6L*	
	1946	*29,700*	*554.3-554.5*	*554.4-554.6L*	
	1948	*44,074*	*554.3-554.6*	*554.4-554.6L*	
	1950	*22,052*	*554.3-555.6*	*554.4-554.5L*	
	1955	*34,444*	*554.2-554.5*	*554.6R, 554.8R*	
	1956	*11,943*	*554.1-554.3*	*554.2-554.4R*	
	1960	*94,897*	*554.2-554.3*	*554.2-554.9R*	
	1962	*61,446*	*554.6-554.9*	*554.7-555.0R*	
		596,759	*11 Events Average:*	*54,251*	
552.7-553.8	*1962*	*30,388*	*552.7-552.9*	*552.9R, 552.9-553.0R*	
Pleasant Creek	*1973*	*48,075*	*552.7-553.0*	*552.7-552.8R, 552.9-553.1R*	
	1983	*20,186*	*553.7-553.8*	*553.5-553.7Thalweg*	
		98,649	*3 Events Average:*	*32,883*	
549.9-550.8	*1941*	*63,534*	*550.4-550.7*	*550.6-550.7L, 550.8-550.9L*	
Sand Prairie	*1955*	*112,707*	*549.9-550.4*	*550.0-550.4R*	
	1958	*45,460*	*549.9-550.2*	*550.0-550.2R*	
	1970	*65,962*	*550.3-550.7*	*550.5-550.6R, 550.7-550.8R*	
	1970	*20,000*	*549.9-550.0*	*549.9-550.1R*	
	1972	*72,102*	*549.9-550.8*	*549.8-550.0R, 550.4-550.5L, 550.6-550.9L*	
	1976	*16,497*	*550.5-550.8*	*550.8-551.0L*	
		396,262	*7 Events Average:*	*56,609*	
547.0-548.6	*1950*	*45,917*	*547.7-548.1*	*547.8-548.0L, 548.1-548.2L*	
Maquoketa	*1951*	*88,041*	*547.5-548.2*	*547.7-548.1L*	
River	*1952*	*108,394*	*547.1-547.9*	*547.3R, 547.6R, 547.8R, 547.9R*	
	1959	*68,789*	*548.2-548.6*	*548.3-548.6L*	
	1960	*70,509*	*548.2-548.5*	*548.1-548.6L*	
	1962	*172,689*	*547.7-548.4*	*547.6-548.4R*	
	1963	*113,362*	*547.7-548.2*	*547.7-547.8L, 547.9-548.0L, 547.9-548.3R*	
	1965	*138,309*	*547.2-547.9*	*547.4-547.6L, 547.6-548.1R*	
	1966	*61,643*	*547.3-547.7*	*547.4-547.5L, 547.7-547.8L*	
	1967	*77,848*	*547.2-547.6*	*547.5-547.7R, 547.4-547.6L, 547.7-547.8L*	
	1969	*72,527*	*547.1-547.5*	*547.4-547.7R, 547.3L, 547.4-547.5L*	
	1970	*123,494*	*547.1-547.9*	*547.2-547.4L, 547.5-547.6L, 547.7-*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
				547.8R,	
	1975	*12,037*	*547.9-548.2*	*547.9-548.0R*	
	1980	*73,300*	*547.2-547.6*	*--*	
	1987	*70,927*	*547.0-547.5*	*546.8-547.3R*	
		1,297,786	*15 Events Average:*	*86,519*	
546.1-547.0	*1946*	*32,052*	*546.1-546.4*	*546.1-546.3R*	
Apple River	*1974*	*24,443*	*546.8-547.0*	*546.7R*	
Island		*56,495*	*2 Events Average:*	*28,248*	
544.1-545.9	*1956*	*119,600*	*544.6-545.3*	*544.7-545.3R*	
Island 257	*1970*	*53,991*	*545.4-545.9*	*545.6-545.7R, 545.9-546.0R*	
	1973	*47,947*	*544.1-544.4*	*544.3-544.6L*	
		221,538	*3 Events Average:*	*73,846*	
540.5-541.0	*1958*	*89,360*	*540.5-541.0*	*540.7-540.9R, 541.0-541.1L*	
Lainsville Lower	*1970*	*34,770*	*540.5-540.8*	*540.5-540.6R*	
		124,130	*2 Events Average:*	*62,065*	
538.8-539.6	*1958*	*75,939*	*538.9-539.3*	*539.0-539.2R, 539.4-539.5L*	
Savanna Bay	*1970*	*33,548*	*538.8-539.2*	*539.0-539.2R*	
	1977	*24,016*	*538.8-539.2*	*539.3-539.5L*	
	1983	*16,155*	*539.0-539.3*	*538.7-538.8Thalweg*	
	1986	*68,271*	*538.8-539.4*	*538.4-538.5Thalweg, 539.3-539.4L*	
	1989	*173,697*	*538.5-539.2*	*538.4-538.5LThalweg, 539.4L*	
	1995	*56,028*		*Thalweg*	
		447,654	*7 Events Average:*	*63,951*	
532.5-533.9	*1961*	*56,231*	*533.6-533.9*	*533.6-533.8L*	
Sabula Lower	*1961*	*122,309*	*532.9-533.4*	*532.9-533.3L*	
	1972	*96,134*	*532.5-533.4*	*532.4-532.5R, 533.3-533.5L*	
	1973	*118,599*	*533.0-533.9*	*533.2-533.4L, 533.5L, 533.6-533.9L*	
	1977	*24,039*	*533.5-533.9*	*532.8-533.1L, 533.5L*	
		417,312	*5 Events Average:*	*83,462*	
531.0-531.3	*1971*	*47,489*	*531.0-531.3*	*531.2-531.4L*	
Dark Slough	*1973*	*49,677*	*531.0-531.3*	*531.1L, 531.2-531.4L*	
	1991	*153,867*	*533.0*	*534.0L, 533.2L*	
		251,033	*3 Events Average:*	*83,678*	
528.7-529.9	*1940*	*334,995*	*528.7-529.9*	*528.6-529.2L, 529.3L, 529.5L, 529.6-529.7L*	
Elk River	*1954*	*74,423*	*528.7-529.1*	*528.8L, 528.9-529.1L*	
		409,418	*2 Events Average:*	*204,709*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
525.1-525.6	1961	104,755	525.1-525.6	525.1-525.8L	
Pomme De	1972	60,429	525.2-525.6	525.1-525.4L	
Terre		165,184	2 Events Average:	82,592	

<u>POOL 13 TOTALS</u>

Events: 66
Yardage: 4,606,016
Average: 69,788

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
521.1-522.4	*1940*	*57,409*	*521.1-521.5*	*521.1L, 521.3L, 521.5L*	
Lock #13 Lower	*1940*	*12,117*	*522.2-522.4*	*522.2-522.4R*	
	1942	*38,589*	*521.2-521.5*	*521.3-521.5L*	
	1943	*3,353*	*522.3-522.4*	*522.3R*	
		111,468	*4 Events Average:*	*27,867*	
518.5-519.9	*1940*	*26,526*	*518.6-518.8*	*518.7-518.8L, 518.9L*	
Joyce's Island	*1940*	*59,570*	*519.3-519.7*	*519.4R, 519.5R, 519.5-519.7L*	
	1943	*78,057*	*519.3-519.7*	*519.5-519.7L*	
	1943	*35,639*	*518.7-519.0*	*518.8-518.9L, 519.0L*	
	1944	*89,384*	*518.6-519.0*	*518.6-518.8R*	
	1945	*83,384*	*519.2-519.7*	*519.4-519.5R, 519.6-519.7R*	
	1946	*80,674*	*518.6-519.0*	*518.7-518.8L, 518.8-519.0L*	
	1946	*56,823*	*519.4-519.9*	*519.5-519.6R, 519.8R, 520.0R*	
	1947	*29,063*	*519.4-519.7*	*519.4-519.7R*	
	1948	*74,058*	*518.7-519.0*	*518.7-519.0L*	
	1950	*30,832*	*518.7-519.0*	*518.8-518.9R*	
	1951	*117,587*	*518.5-519.0*	*518.9R*	
	1952	*74,653*	*518.5-518.9*	*518.8-519.0R, 518.7-518.9L*	
	1954	*73,766*	*518.5-519.0*	*518.7L, 518.8-518.9L, 519.0-519.1L*	
	1966	*48,110*	*518.6-519.0*	*518.7-518.8L, 518.9L, 519.0-519.1L*	
	1971	*55,050*	*518.6-519.0*	*518.5-518.8L*	
		1,013,176	*16 Events Average:*	*63,324*	
515.8-517.6	*1940*	*34,505*	*516.5-516.8*	*516.5-516.6L, 516.8L*	
Beaver Island	*1943*	*38,302*	*516.4-516.8*	*516.6-516.8L*	
	1943	*20,463*	*517.4-517.6*	*517.4R, 517.7-517.8L*	
	1946	*12,589*	*517.3-517.5*	*517.2-517.4R*	
	1955	*38,422*	*516.4-516.7*	*516.5-516.8R*	
	1968	*43,518*	*515.8-516.3*	*515.7-515.8L, 516.0-516.2L*	
	1968	*63,008*	*516.6-517.2*	*516.9-517.3R*	
	1986	*45,450*	*516.1-516.6*	*517.0-517.3L*	
	1991	*37,786*	*516.3-516.6*	*517.0-517.2L*	
		334,043	*9 Events Average:*	*37,116*	
513.0-517.6	*1942*	*94,513*	*517.5*	*517.3-517.4R*	
Beaver Slough	*1943*	*49,837*	*517.4*	*517.3R*	
	1944	*31,463*	*517.5*	*517.5R, 517.4R*	
	1945	*23,306*	*517.3-517.6*	*517.2-517.4R*	
	1946	*28,629*	*517.4*	*517.3R, 517.4R*	
	1963	*48,480*	*517.4*	*517.0R, 517.3R*	
	1964	*12,962*	*513.0-513.2*	*513.1-513.2L*	
	1964	*27,155*	*513.7-514.0*	*513.8-514.0L*	
	1965	*34,377*	*516.5-516.9*	*516.5R, 516.6-516.7R*	
	1969	*16,155*	*516.6-516.8*	*516.6-516.7R*	
	1969	*10,442*	*515.5-515.9*	*516.6-516.7L, 516.9L*	
	1969	*33,593*	*514.4-515.2*	*514.5L, 514.9-515.0L, 515.1L, 515.2-515.3L*	
	1972	*38,385*	*514.8-515.1*	*514.8-515.0L*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1975	120,018	514.3-515.3	514.2-515.2L	
		569,315	14 Events Average:	40,665	
513.4-514.4	1956	55,595	513.9-514.4	513.9-514.3R	
Albany Lower	1967	53,556	513.9-514.3	514.1-514.5R	
	1972	88,330	513.4-514.3	513.6-513.7L, 513.7-514.0L, 514.3-514.4R	
		197,481	3 Events Average:	65,827	
509.6-510.0	1940	136,809	509.6-510.0	509.8R, 509.9R, 510.0R	
Marais D'osier	1959	41,666	509.6-509.9	509.7-509.8R, 509.8-510.0R	
Slough	1968	17,056	509.7-509.8	509.8-509.9R	
		195,531	3 Events Average:	65,177	
508.4-509.1	1950	67,407	508.5-509.1	508.8-508.9R	
Adams Island	1966	53,139	508.4-508.7	508.6-508.8R	
Upper	1968	80,083	508.6-509.0	508.7-509.1R	
		200,629	3 Events Average: Events Average:	66,876	
505.6-506.0	1972	50,200	505.6-506.0	505.8-506.1L	
Wapsipinicon River		50,200	1 Event Average:	50,200	
503.3-504.0	1961	72,766	503.3-503.7	503.5-503.8R	
Steamboat	1968	150,731	503.4-504.0	503.6-503.8R, 503.8R, 503.9-504.1R, 503.6-504.1L	
Slough	1972	119,999	503.3-503.9	503.3-503.6R, 503.6-504.0R	
	1973	72,506	503.5-504.0	503.3-503.4L, 503.5-503.7L	
	1985	26,666	503.6-503.9	503.7R, 503.8-504.0R	
	1986	34,222	503.6-504.0	503.5-503.7R	
	1988	23,400	503.6-503.9	503.5-503.9R	
	1990	38,444	503.7-504.0	502.9Thalweg, 503.5-503.7R	
	1991	48,729	503.4-504.0	502.7-503.1Thalweg	
	1995	42,931		Thalweg	
		630,394	10 Events Average:	63,039	
496.1-496.6	1941	111,129	496.1-496.6	--	
Le Claire Canal		111,129	1 Event Average:	111,129	
493.7-494.8	1952	244,165	493.7-494.8	493.7-494.1R, 494.5-494.8L	
Lock #14 Upper	1963	69,988	493.8-494.3	493.9-494.0R	
	1966	68,345	493.9-494.3	493.7R, 493.8R, 493.9R	
	1969	11,590	494.4-494.5	494.4-494.5R	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1971	*48,312*	*494.5-494.8*	*494.7-494.8L*	
	1971	*86,822*	*494.0-494.3*	*493.8-494.0R*	
		529,222	*6 Events Average:*	*88,204*	

POOL 14 TOTALS

Events: 70
Yardage: 3,942,588
Average: 56,323

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
492.0-492.2	*1941*	*20,538*	*492.0-492.2*	*492.9R*	
Lock #14 Lower		*20,538*	*1 Event Average:*	*20,538*	
490.7-491.6	*1941*	*42,429*	*490.7-491.4*	*490.0R, 490.1-490.2R, 490.3-490.5R*	
Campbells	*1944*	*62,360*	*490.9-491.6*	*490.9-491.7L*	
Island	*1945*	*52,414*	*490.8-491.5*	*490.9-491.5R, 491.0-491.6L*	
	1946	*34,126*	*490.8-491.3*	*490.9-491.4R*	
	1947	*38,778*	*490.8-491.5*	*490.8-491.0R, 491.4-491.5R*	
	1965	*9,333*	*490.9-491.0*	*491.0-491.1R*	
	1969	*7,778*	*491.3*	*491.4L*	
		247,218	*7 Events Average:*	*35,317*	
489.2-490.5	*1941*	*21,896*	*490.2-490.5*	*490.3-490.5R, 490.6R*	
Winnebago	*1944*	*13,217*	*489.2-489.4*	*489.1-489.3L*	
Island	*1945*	*38,026*	*489.3-490.3*	*489.3-489.5L, 490.2-490.4R*	
	1946	*9,467*	*489.3-489.5*	*489.4-489.6L*	
	1946	*10,511*	*490.1-490.2*	*490.1-490.3R*	
	1947	*18,941*	*490.1-490.2*	*490.1-490.3R*	
	1952	*35,545*	*489.2-489.6*	*489.2-489.7L*	
	1984	*7,507*	*489.3*	--	
	1985	*6,427*	*489.3*	--	
		161,537	*9 Events Average:*	*17,949*	
483.2-483.3	*1954*	*49,202*	*483.2*	*483.2R*	
Lock #15 Upper	*1967*	*4,630*	*482.9*	--	
		53,832	*2 Events Average:*	*26,916*	

POOL 15 TOTALS
Events: 19
Yardage: 483,125
Average: 25,428

Dredge Cut	*Year Dredged*	*Dredging Amount (yd3)*	*Dredging Site*	*Placement Site*	*Placement Type*
482.2-482.9	*1940*	*124,483*	*482.7*	*482.6L*	
Lock #15 Lower	*1944*	*12,169*	*482.7-482.9*	*482.6L*	
	1946	*34,360*	*482.5-482.9*	*482.6L, 482.7L*	
	1954	*27,797*	*482.3-482.9*	*482.6L, 482.7L*	
	1958	*12,999*	*482.9*	*482.8L*	
	1960	*31,747*	*482.3-482.7*	*482.6-482.8L*	
	1965	*9,228*	*482.6-482.9*	*482.6L, 482.7L*	
	1972	*13,008*	*482.6-482.8*	*482.6-482.7L*	
	1973	*24,861*	*482.3-482.6*	*482.6-482.7L*	
	1975	*27,095*	*482.4-482.7*	*482.6L*	
	1979	*9,956*	*482.5-482.8*	*482.6-482.7L*	
	1980	*20,559*	*482.2-482.5*	*482.6-482.7L*	
	1981	*26,624*	*482.1-482.5*	*481.6-481.7L, 481.8L, 481.9-482.0L*	
	1984	*18,825*	*482.5-482.8*	*482.7-482.8L*	
	1985	*9,548*	*482.6-482.8*	*482.6-482.7L*	
	1987	*3,582*	*482.7*	*Barged to beneficial users.*	
	1987	*45,984*	*482.4-482.8*	*481.8-482.1L*	
	1988	*850*	*482.0*	*481.9L*	
	1989	*25,567*	*482.3-482.5*	*481.9-482.1L*	
	1994	*16,144*		*Stockpile along Left. Bank*	
		495,386	*20 Events Average:*	*24,769*	
481.2-482.2	*1940*	*12,373*	*482.0*	*482.6L*	
Centennial	*1941*	*53,794*	*481.2-482.2*	*--*	
Bridge	*1941*	*25,731*	*481.2-482.2*	*--*	
	1965	*10,000*	*481.2-481.3*	*481.1R, 481.2R*	
	1967	*5,276*	*481.3-481.4*	*481.2-481.3R*	
	1973	*47,766*	*481.5-482.0*	*481.5-481.8L, 481.9-482.0L, 482.0-482.1L*	
	1976	*17,841*	*481.5-481.9*	*481.5-481.8L*	
	1977	*17,991*	*481.5-482.0*	*481.8L, 481.8-482.1L*	
	1978	*11,576*	*481.6-481.9*	*481.5-481.8L*	
	1990	*27,348*	*481.5-482.0*	*481.7-481.9L*	
	1995	*15,333*		*Bankline*	
	1995	*11,620*		*Bankline*	
		256,649	*12 Events Average:*	*21,387*	
478.9-479.1	*1942*	*25,495*	*479.0*	*478.7-478.8L*	
Offerman Island	*1946*	*2,525*	*478.9-479.1*	*--*	
		28,020	*2 Events Average:*	*14,010*	
472.0-473.2	*1944*	*81,885*	*472.6-473.2*	*472.9-473.3L, 472.6-472.8R*	
Buffalo	*1946*	*21,741*	*472.5-472.9*	*--*	
	1953	*59,136*	*472.4-473.0*	*472.5-472.8R, 472.9-473.0R*	
	1961	*63,333*	*472.7-473.2*	*472.9-473.2L*	
	1966	*57,249*	*472.2-472.6*	*472.3-472.7R*	
	1980	*62,578*	*472.0-472.5*	*472.5-472.8R*	
	1983	*40,797*	*472.1-472.5*	*472.5-472.8R, 472.9-473.2L*	
	1985	*32,962*	*472.1-472.5*	*472.4-472.7R*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1987	*53,616*	*472.0-472.5*	*471.7-472.0R, 472.4-472.7R*	
	1989	*53,444*	*472.0-472.5*	*471.7-471.9R*	
	1991	*64,265*	*472.1-472.4*	*471.7-471.9R, 472.4-472.6R*	
	1993	*27,396*	*472.0-472.2*	*471.9R*	
		618,402	*12 Events Average:*	*51,534*	
469.1-469.7	*1966*	*121,322*	*469.1-469.6*	*469.3-469.6R, 469.4-469.8L*	
Montpelier	*1970*	*54,912*	*469.3-469.7*	*469.4-469.7L*	
		176,234	*2 Events Average:*	*88,117*	
463.7-464.5	*1947*	*93,019*	*463.7-464.5*	*463.7-463.9L, 464.0-464.3L*	
Fairport		*93,019*	*1 Event Average:*	*93,019*	
460.7-461.7	*1962*	*59,022*	*461.2-461.5*	*461.3-461.6R*	
Hershey Chute	*1969*	*31,176*	*461.3-461.5*	*461.4-461.6R*	
	1972	*43,685*	*461.0-461.4*	*461.2-461.6R*	
	1986	*77,511*	*460.7-461.7*	*461.3-461.7R*	
	1991	*76,682*	*461.2-461.8*	*461.5R*	
	1993	*72,050*	*461.2-461.8*	*461.4-461.6R*	
	1994	*33,867*		*Bankline*	
	1995	*27,333*		*Upland*	
		421,326	*8 Events Average:*	*52,666*	
457.6-458.8	*1941*	*30,956*	*457.6-457.8*	*457.7-457.8L*	
Hershey Chute Lower		*30,956*	*1 Events Average:*	*30,956*	

POOL 16 TOTALS
Events: 58
Yardage: 2,119,992
Average: 36,552

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
456.2-457.0	1940	106,637	456.2-457.0	456.1R, 456.2-456.3R, 456.4-456.5R, 456.6R, 456.8R	
Lock #16 Lower	1944	47,722	456.5-456.8	456.5-456.7R, 456.8-456.9R	
		154,359	2 Events Average:	77,180	
452.9-454.5	1943	169,450	453.7-454.5	453.9L, 454.0L, 454.2L, 454.3L, 454.4L, 454.5-454.6L	
Muscatine	1947	122,911	453.8-454.5	--	
Island	1951	8,852	453.5-453.8	453.6-453.7L	
	1957	207,129	453.0-453.8	453.1-453.8R	
	1963	42,822	452.9-453.2	453.0-453.3L	
	1964	28,889	453.1-453.3	453.0-453.2L	
	1968	37,778	453.9-454.2	454.3L	
	1968	24,443	453.1-453.3	453.0-453.2L	
		642,274	8 Events Average:	80,284	
451.5-451.8	1971	46,102	451.5-451.8	451.4-451.5L, 451.8-451.9L	
Muscatine Prairie		46,102	1 Event Average:	46,102	
447.2-448.2	1941	85,214	447.2-448.2	448.0-448.2R	
Bass Island	1943	44,399	447.8-448.1	447.9-448.0R, 448.1-448.2L	
	1944	54,542	447.8-448.1	447.9-448.1R	
	1946	122,237	447.7-448.1	448.1L, 448.2L, 448.0-448.1R	
	1950	61,896	447.7-448.1	447.8-448.0L	
	1951	40,233	447.7-448.1	447.8R, 447.9-448.0R	
	1953	79,745	447.5-448.0	447.7-447.8R, 447.9-448.0R, 448.1R	
	1957	76,780	447.5-448.0	447.6-447.7R, 447.8R, 447.8-448.0R	
	1961	94,266	447.6-448.1	447.8-448.2L	
	1964	42,222	447.6-447.9	447.8-448.0L	
	1966	99,583	447.6-448.1	447.6-447.8R, 447.8-448.2L	
	1969	71,388	447.7-448.0	447.8-448.2L	
	1973	68,657	447.5-448.0	447.8-448.1L	
	1974	45,028	447.6-448.0	447.9-448.0L, 448.0-448.1L	
	1979	8,711	447.6-447.8	447.8-448.0L	
	1982	66,120	447.5-447.8	447.8-448.0L, 447.4-447.5R	
	1985	84,068	447.5-447.9	447.8-447.9R	
	1987	110,389	447.5-447.9	447.8-447.9R	
	1994	42,282		Beach	
		1,297,760	19 Events Average:	68,303	
446.1-446.2	1969	10,000	446.1-446.2	446.2-446.3R	
Barkis Island		10,000	1 Event Average:	10,000	
441.1	1994	40,425			
Lake Odesa		40,425	1 Event Average:	40,425	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
437.7-438.7	*1941*	*193,352*	*437.7-438.7*	*437.8-437.9R, 438.0-438.4R*	
Lock #17 Upper		*193,352*	*1 Event Average:*	*193,352*	

POOL 17 TOTALS
Events: 33
Yardage: 2,384,272
Average: 72,251

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
436.7-437.0	*1945*	*34,691*	*436.7-437.0*	*436.8-437.0R*	
Lock #17 Lower	*1970*	*11,896*	*437.1*	*--*	
		46,587	*2 Events Average:*	*23,294*	
435.2-436.2	*1940*	*268,487*	*435.9-436.0*	*435.1L, 435.3L, 435.4-435.6L, 435.6-436.1R*	
Keg Island	*1941*	*70,893*	*435.6-436.2*	*437.7-438.0R, 438.1-438.2R, 438.0-438.3L*	
	1942	*96,893*	*435.3-435.9*	*435.4-435.5L, 435.6-435.8L, 435.7R, 435.8-436.0R*	
	1943	*44,009*	*435.4-436.0*	*435.6-435.7R, 435.8-435.9R, 436.0R*	
	1945	*99,953*	*435.3-435.9*	*435.4-435.8L, 435.5-436.0R*	
	1946	*60,533*	*435.3-435.9*	*435.5R, 435.6-435.9R*	
	1949	*64,042*	*435.2-435.7*	*435.5L*	
	1952	*57,778*	*435.3-435.7*	*435.4-435.6L, 435.6-435.7L*	
	1955	*34,468*	*435.2-435.4*	*435.2-535.5L*	
		797,056	*9 Events Average:*	*88,562*	
432.9-434.2	*1947*	*36,666*	*433.9-434.2*	*434.1L*	
New Boston	*1960*	*37,721*	*433.6-433.8*	*433.7-433.9L*	
Upper	*1962*	*87,834*	*433.4-433.8*	*433.6-433.8R, 433.8-433.9L, 434.0L*	
	1965	*39,311*	*433.6-433.8*	*433.7-433.8L*	
	1967	*66,666*	*433.6-434.0*	*433.9-434.2L*	
	1969	*85,472*	*433.5-434.0*	*433.8-433.9L, 433.9-434.1L*	
	1970	*79,371*	*433.5-433.9*	*433.9-434.0L, 433.6-433.9R*	
	1971	*20,245*	*433.6-433.7*	*433.6L*	
	1972	*18,009*	*433.0-433.2*	*432.9-433.0R*	
	1972	*17,111*	*433.6-433.8*	*433.8-434.0L*	
	1973	*34,694*	*433.5-433.8*	*433.7-433.9L*	
	1975	*44,989*	*433.5-433.9*	*433.9L, 434.0L*	
	1976	*26,963*	*433.5-433.9*	*433.9L, 434.0L, 434.1L*	
	1981	*29,974*	*432.9-433.2*	*433.3-433.4R*	
		625,026	*14 Events Average:*	*44,645*	
431.0-432.0	*1940*	*34,729*	*431.3-431.9*	*431.4-431.5L, 431.6-431.7L, 431.8L*	
Edwards River	*1942*	*80,878*	*431.2-432.0*	*431.3-431.5L, 431.6-431.7L, 431.8-431.9L*	
	1944	*84,122*	*431.3-432.0*	*431.4-432.1L*	
	1945	*14,961*	*431.0-431.6*	*431.2-431.3L, 431.5-431.6L*	
	1946	*43,514*	*431.2-431.9*	*431.4-431.5R, 431.7R, 431.9R*	
	1947	*19,244*	*431.0-431.8*	*431.3-431.8L*	
	1952	*13,655*	*431.4-431.7*	*431.5-431.7L*	
	1964	*21,295*	*431.4-431.7*	*431.3R, 431.6R, 431.7-431.8R*	
	1965	*40,757*	*431.2-431.7*	*431.4-431.8R*	
	1966	*42,999*	*431.2-431.8*	*431.4-431.8R, 431.9R*	
	1970	*28,519*	*431.4-431.7*	*431.5-431.6R, 431.6-431.8R*	
	1971	*32,956*	*431.3-431.8*	*431.6-431.8R*	
	1972	*7,615*	*431.4-431.8*	*431.7R, 431.8R, 431.9R*	
	1976	*17,188*	*431.3-431.6*	*431.6R, 431.7R*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1977	*5,885*	*432.0*	*--*	
		488,317	*15 Events Average:*	*32,554*	
428.3-429.0	*1949*	*9,162*	*428.3-429.0*	*428.6-428.7L*	
Keithsburg		*9,162*	*1 Event Average:*	*9,162*	
426.8-427.5	*1941*	*77,339*	*426.8-427.4*	*427.0-427.5R*	
Keithsburg	*1943*	*92,840*	*426.9-427.4*	*427.1R, 427.2-427.3R, 427.4R*	
Upper	*1944*	*74,177*	*426.9-427.4*	*427.1-427.3R, 427.5-427.6R*	
	1945	*106,334*	*427.0-427.5*	*427.1L, 427.2-427.5L*	
	1947	*83,890*	*426.9-427.4*	*427.0-427.5R*	
	1951	*68,733*	*426.8-427.4*	*426.9-427.3R*	
	1952	*61,592*	*426.9-427.3*	*427.2-427.3L, 427.3-427.5L*	
	1953	*31,081*	*427.1-427.4*	*427.3-427.4L, 427.1L*	
	1955	*85,373*	*426.9-427.4*	*427.1R, 427.2-427.5R*	
	1956	*67,252*	*426.9-427.4*	*427.0-427.5R*	
	1959	*58,566*	*426.9-427.3*	*427.1-427.4R*	
	1960	*60,843*	*426.9-427.3*	*426.7-427.4R*	
	1961	*59,889*	*426.9-427.4*	*427.1L, 427.3L, 427.3-427.4R*	
	1962	*58,234*	*426.9-427.3*	*427.1-427.3R*	
	1965	*30,000*	*427.0-427.2*	*427.1-427.3R*	
	1971	*48,759*	*426.8-427.2*	*427.1-427.4R*	
	1993	*32,933*	*426.8-427.2*	*427.6L*	
		1,064,902	*16 Events Average:*	*66,556*	
425.1-426.7	*1941*	*32,581*	*425.9-426.7*	*425.3R*	
Keithsburg	*1946*	*11,689*	*426.0-426.1*	*426.0-426.1L*	
Lower	*1946*	*25,122*	*425.9-426.2*	*425.9-426.2L*	
	1947	*25,149*	*425.9-426.3*	*425.9-426.2L, 426.2-426.4L*	
	1950	*49,603*	*425.8-426.2*	*425.9-426.3L*	
	1951	*50,993*	*425.8-426.3*	*425.9-426.2L*	
	1952	*54,432*	*425.7-426.4*	*425.8-426.4L*	
	1953	*55,274*	*425.7-426.5*	*425.7-425.9L, 426.0-426.1L, 426.2L, 426.3-426.4L, 426.5L*	
	1955	*84,916*	*425.7-426.3*	*425.8-426.3L, 426.3-426.4L*	
	1959	*60,091*	*425.4-425.9*	*425.5-425.9L*	
	1963	*5,215*	*425.6-425.8*	*--*	
	1963	*89,998*	*425.6-426.0*	*425.7-426.0L*	
	1965	*43,234*	*425.7-426.0*	*425.8-426.1L*	
	1966	*78,183*	*425.7-426.0*	*425.8-426.1L, 425.6-425.8R*	
	1967	*29,317*	*425.7-425.9*	*425.7-426.0L*	
	1968	*9,111*	*425.8-425.9*	*425.9L*	
	1970	*42,474*	*425.4-425.7*	*425.5-425.9L*	
	1971	*95,026*	*425.4-426.4*	*425.6L, 425.7-425.8L, 425.9-426.0L, 426.2-426.4L*	
	1972	*84,255*	*425.6-426.4*	*425.8-426.0L, 426.2-426.5L*	
	1974	*37,443*	*425.8-426.1*	*425.8L*	
	1975	*74,241*	*425.7-426.1*	*425.5-425.6L, 425.8L, 425.9L*	
	1978	*11,166*	*425.5-425.8*	*425.5-425.8L*	
	1979	*38,911*	*425.7-426.1*	*425.8L, 425.9-426.0L*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1980	30,969	425.5-425.9	425.4-425.5R, 425.5-425.6R	
	1981	27,516	425.4-425.8	425.8-426.0R	
	1982	32,141	425.7-426.1	426.0-426.1R	
	1983	21,693	425.5-425.8	426.2-426.4R	
	1984	25,000	--	--	
	1984	83,956	425.4-426.2	425.8-426.0R	
	1985	95,964	425.1-425.8	425.5-425.7R	
	1986	39,448	425.7-426.2	425.9R	
	1987	48,963	425.3-425.6	426.3-426.5R	
	1990	55,658	425.2-425.4	425.7-425.9L	
	1993	25,288	425.1-425.3	425.3-425.7L	
		1,575,020	34 Events Average:	46,324	
423.5-424.7	1951	50,555	424.1-424.7	424.2L, 424.3-424.6L, 424.7L	
Huron Island	1965	82,557	424.1-424.5	424.2-424.3R, 424.4-424.6R	
	1971	51,978	424.2-424.5	424.4-424.5R, 424.6R, 424.5-424.6L	
423.5-424.7	1973	37,690	424.0-424.3	424.2L, 424.3-424.4L	
Huron Island	1974	90,412	423.8-424.4	424.1-424.3R	
(Continued)	1982	60,509	423.7-424.1	424.8-424.9L, 424.9R, 424.0-424.1L	
	1986	36,207	423.5-424.0	424.2L, 424.2-424.3L	
	1990	21,367	423.6-423.7	424.0-424.3L	
	1993	25,288		Bank stabilization	
		456,563	9 Events Average:	50,729	
420.5-421.9	1948	59,501	421.0-421.5	421.3L, 421.5-421.6L	
Johnson Island	1949	70,081	421.1-421.6	421.4L	
	1986	97,587	421.2-421.9	421.9-422.3L	
	1992	43,936	420.8-421.2	419.7-419.9R	
		271,105	4 Events Average:	67,776	
418.5-420.5	1941	61,479	419.9-420.2	419.9-420.2R, 420.3R	
Benton Island	1946	53,686	420.1-420.5	420.1-420.4L	
	1948	60,001	419.8-420.3	419.8-419.9L	
	1955	108,128	419.5-420.0	419.8-420.0L	
	1957	123,761	419.9-420.5	420.1-420.4R, 420.5-420.6R	
	1961	57,192	419.8-420.2	420.0-420.3R	
	1962	40,611	419.9-420.2	420.0-420.2R	
	1964	35,866	419.5-419.7	419.6-419.8R	
	1964	58,103	418.5-418.8	418.5-418.7L, 418.8L	
	1968	79,741	419.0-419.4	419.1-419.5L, 419.2-419.4R	
	1973	55,983	418.7-419.5	419.1-419.2L, 419.2-419.3R	
	1987	60,222	418.9-419.4	419.4-419.5R	
	1993	61,145	420.0-420.5	419.7-419.9R	
	1994	40,134	420.5	beach	
	1995	57,111		beach	
		953,163	15 Events Average:	63,544	
414.7-415.2	1961	66,470	414.7-415.2	414.8-415.2R	
Oquawka		66,470	1 Events Average:	66,470	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
411.0-412.4	1941	192,971	411.7-412.4	411.9L, 412.0-412.1L, 412.3L, 412.4L	
Lock #18 Upper	1970	48,473	411.2-411.4	411.3-411.5L	
	1973	50,445	411.1-411.5	411.1-411.3L	
	1980	39,411	411.0-411.3	411.1-411.3L	
	1983	29,293	411.1-411.3	411.1-411.3L	
		360,593	5 Events Average:	72,119	

POOL 18 TOTALS
Events: 126
Yardage: 6,713,964
Average: 53,285

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
408.5-410.3	*1940*	*26,633*	*409.0-409.4*	--	
Lock #18 Lower	*1940*	*31,738*	*410.0-410.3*	*410.1L*	
	1942	*63,840*	*408.2-409.1*	*408.8-409.1R, 408.3-408.6R*	
	1943	*25,536*	*409.9-410.3*	*409.9L, 410.0-410.1L*	
		147,747	*4 Events Average:*	*36,937*	
407.0-408.5	*1940*	*24,104*	*407.8*	--	
Drew Chute	*1940*	*83,947*	*407.5-407.9*	*407.6-407.7R.407.6-407.7L, 407.9-408.0L*	
	1941	*170,642*	*408.0-409.2*	*408.6-409.0R, 409.1-409.3R, 408.1-408.2R, 408.3-408.6R*	
	1941	*68,358*	*407.0-409.2*	--	
	1942	*69,253*	*407.5-407.9*	*407.7-408.0R, 407.5-407.7L, 407.8L*	
	1943	*148,484*	*407.5-408.5*	*407.6-407.7L, 407.8-407.9L, 408.1-408.3L, 408.3-408.6R*	
	1944	*71,615*	*407.9-408.5*	*408.1-408.6R*	
	1946	*130,025*	*407.6-408.6*	*408.0-408.6R, 408.7R*	
	1947	*20,300*	*408.1-408.4*	*408.2-408.5R*	
	1947	*36,585*	*407.5-407.8*	*407.7-407.8R*	
	1949	*101,611*	*407.5-407.9*	*407.6-407.7R, 407.9R*	
	1949	*40,647*	*407.0-407.3*	*407.2-407.3R*	
	1950	*74,280*	*407.0-407.8*	*407.1R, 407.3R, 407.6R, 407.8R*	
	1951	*93,138*	*407.1-408.4*	*407.2-407.3L, 407.6-407.8L, 408.1-408.3L*	
	1952	*130,637*	*407.0-408.3*	*407.1-407.2L, 407.3-407.7L, 407.8-407.9L, 408.1-408.4L*	
	1954	*51,484*	*407.0-407.4*	*407.2R, 407.2-407.3R*	
	1954	*72,481*	*407.8-408.4*	*408.2R, 408.2-408.5R, 408.0-408.1L, 408.1-408.4L*	
	1956	*44,088*	*407.9-408.3*	*407.8-408.1L*	
	1963	*58,565*	*407.7-408.1*	*407.9-408.1L, 408.1-408.3L*	
		1,490,244	*19 Events Average:*	*78,434*	
405.9-407.0	*1940*	*63,769*	*406.8-407.5*	*407.2R, 407.3-407.4R, 406.9-407.1R*	
Rush Island	*1940*	*152,127*	*406.0-406.6*	*406.0-406.5L*	
	1942	*128,545*	*406.4-407.4*	*406.4-406.7L, 407.0-407.3R, 407.1-407.4L*	
	1943	*38,194*	*407.0-407.2*	*407.0-407.1R*	
	1943	*141,809*	*406.1-406.6*	*406.3-406.4R, 406.5R*	
	1945	*231,140*	*406.2-407.3*	*406.3-406.5L, 406.6-406.7R, 406.8-406.9R, 407.0-407.3R*	
	1947	*118,907*	*406.2-406.7*	*406.4-406.9R*	
	1949	*62,478*	*406.1-406.5*	*406.1-406.2L, 406.4-406.5L*	
	1951	*152,743*	*406.0-406.8*	*405.9-406.0L, 406.1-406.2L, 406.3-406.5L, 406.5L*	
	1952	*67,555*	*406.1-406.7*	*406.3-406.5L, 406.6-406.8L*	
	1954	*151,893*	*406.0-406.7*	*406.3-406.6R, 406.7-406.9R*	
	1956	*162,196*	*406.0-406.7*	*406.1R, 406.3-406.6R, 406.8R*	
	1960	*84,776*	*406.0-406.6*	*406.1R, 406.2-406.6R*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1962	63,510	406.0-406.5	406.0R, 406.1R, 406.3-406.5R, 406.6-406.7R	
	1965	82,400	406.1-406.6	406.1R, 406.3-406.6R, 405.9-406.1L	
	1967	65,488	406.0-406.4	406.1R, 406.2-406.5R, 406.6-406.7L	
	1971	46,322	405.8-406.2	406.0-406.1R, 406.3-406.4R	
	1972	55,482	405.9-406.2	405.9-406.1L	
	1973	77,221	406.0-406.6	405.9-406.1L, 406.3-406.4R	
		1,946,555	19 Events Average:	102,450	
404.8-405.9 Rush Island Lower	1945	76,187	405.0-405.5	405.1-405.2R, 405.2-405.6R	
	1948	70,112	404.9-405.4	405.0-405.3R	
	1957	150,501	404.8-405.4	404.9R, 405.0-405.3R, 405.3-405.5R	
	1960	41,598	405.0-405.4	404.8-405.4R, 405.3-405.5R	
	1962	33,000	405.1-405.3	405.1R, 405.2-405.3R, 405.3-405.4R	
	1964	70,199	405.0-405.3	405.2R, 405.3-405.4R	
	1968	30,578	405.1-405.3	405.2-405.4R, 405.4	
	1972	57,584	405.5-405.9	405.7-406.0L	
		529,759	8 Events Average:	66,220	
404.3-404.6 Burlington Bridge	1971	59,232	404.3-404.6	404.6-404.7L	
	1972	31,478	404.4-404.6	404.5-404.6L	
		90,710	2 Events Average:	45,355	
401.1-401.6 Burlington Bluff	1957	72,674	401.2-401.6	401.3-401.4L, 401.5-401.6L, 401.5-401.7R, 401.8R	
	1965	47,000	401.1-401.4	401.3-401.5L	
	1968	43,288	401.2-401.5	401.3-401.6L	
		162,962	3 Events Average:	54,321	
399.1-400.5 Craigel Island	1940	82,652	400.0-400.5	400.1-400.2L, 400.3-400.6L	
	1942	53,085	400.1-400.5	400.2L, 400.3-400.4L, 400.5-400.6L	
	1944	121,454	400.1-400.7	400.2-400.8L	
	1944	57,946	399.6-399.9	399.9-400.0L	
	1950	59,488	399.2-399.6	399.2-399.4L	
	1951	41,544	400.1-400.3	400.1-400.4L	
	1952	27,267	400.0-400.4	400.1-400.2L, 400.3-400.4L	
	1954	30,812	399.6-399.9	399.7-399.9L	
	1956	62,304	399.7-400.3	399.8-400.4L	
	1957	53,588	399.1-399.6	399.2-399.3L, 399.4-399.7L	
	1960	51,000	399.8-400.2	399.7-400.4L	
	1964	78,100	399.4-399.8	399.5-399.8L	
	1965	10,510	399.3-399.4	399.3-399.4L	
	1965	21,334	400.1-400.2	400.2-400.3L	
	1969	122,143	399.3-400.2	399.3-399.5L, 399.6-399.8L, 400.1L, 400.3-400.4L	
	1972	37,799	399.7-400.0	399.6-399.9L	
	1974	23,788	399.8-400.0	399.9-400.0L	
	1981	14,400	399.4-399.7	399.7-399.9L	
	1983	49,463	399.4-399.8	399.7-400.0L	
	1984	24,676	399.4-399.7	399.3-399.5L	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1991	52,089	399.2-399.7	399.5L	
	1995	16,093		Bankline	
		1,091,535	22 Events Average:	49,615	
397.9-399.1	1940	83,926	398.6-399.1	398.6-398.9L	
Kemp's Landing	1949	66,365	398.6-399.1	398.9L	
	1951	24,926	398.5-398.8	398.8R	
	1955	32,634	398.4-398.6	398.5-398.6L	
	1965	43,800	398.3-398.5	398.4-398.6L	
	1971	43,315	398.3-398.5	398.2-398.3L	
	1973	34,500	398.3-398.5	398.1-398.3L	
	1974	31,456	398.3-398.6	398.1-398.3L	
	1979	1,433	398.2	398.1-398.2L	
	1981	17,156	398.0-398.2	397.9-398.0R	
	1983	18,262	397.9-398.2	398.0-398.3L	
	1987	54,588	397.6-398.2	398.0-398.1L	
	1991	32,025	397.6-398.0	398.0R	Stockpile
	1994	60,630		398.1L	Stockpile
		545,016	14 Events Average:	38,930	
397.0-397.5	1991	43,149	397.1-397.5	398.1L	
Kemp's Landing Lower		43,149	1 Event Average:	43,149	
394.2-395.0	1944	160,525	394.2-394.8	394.5-394.9R	
Shokokon	1947	144,815	394.4-395.0	394.5-395.0R	
Slough	1951	49,898	394.3-394.9	394.4-394.9R	
	1953	163,230	394.3-394.9	394.4-394.9R, 2 rows 200' apart	
	1966	47,555	394.4-394.8	394.5-394.9R	
	1969	54,481	394.5-394.7	394.6-394.7R	
		620,504	6 Events Average:	103,417	
390.2-391.0	1955	182,708	390.2-391.0	390.0-390.5R, 390.7-390.8R	
Dallas City		182,708	1 Event Average:	182,708	
364.2-364.5	1944	70,542	364.3-364.5	--	
Lock #19 Upper	1968	34,023	364.2-364.3	364.3L	
		104,565	2 Events Average:	52,283	

POOL 19 TOTALS

Events: 101
Yardage: 6,955,454
Average: 68,866

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
361.2-363.9	1971	5,934	363.7-363.9	363.7L	
Lock #19 Lower	1971	61,566	361.9-362.4	362.4-362.5L	
	1973	35,712	361.2-361.4	361.4-361.5L	
	1982	16,889	363.3-363.8	--	
		120,101	4 Events Average:	30,025	
358.3-358.8	1964	76,599	358.3-358.8	358.4-358.9L	
Fox Island	1965	51,236	358.3-358.7	358.5-358.7L	
Upper		127,835	2 Events Average:	63,918	
356.4-357.6	1945	182,718	356.7-357.4	356.9-357.5L	
Fox Island	1946	42,271	356.7-357.1	356.8-357.0R	
Towhead	1947	174,914	356.6-357.6	356.9-357.5R	
	1948	156,043	356.4-357.0	356.4R, 356.5-357.1R	
		555,946	4 Events Average:	138,987	
354.4-356.0	1955	54,951	355.5-356.0	355.6-356.0R	
Fox Island	1956	41,315	354.7-355.1	354.5-355.0L	
	1957	193,307	354.4-355.0	354.3-355.2L	
	1959	78,833	355.6-356.0	355.8-356.1R	
	1959	57,087	354.6-354.9	354.8-354.9L	
	1960	109,108	355.3-355.8	355.0-355.7L	
	1962	223,455	354.5-355.6	354.5-355.2L, 355.0-355.6R, 355.6-355.8R	
	1964	98,061	354.5-355.0	354.6-355.0L	
	1965	14,801	354.7-354.8	354.7-354.8L	
	1965	152,767	354.9-355.8	355.0-355.1L, 355.3-355.7L	
	1966	55,561	354.6-355.9	354.7L, 354.8-354.9L	
	1967	204,614	354.6-355.9	354.6-355.1L, 355.1-355.5R, 355.6-355.9R	
	1969	74,855	355.1-355.8	355.3-355.5R, 355.6-355.9R	
	1972	100,056	355.1-355.7	355.3-355.4R, 355.6-355.9R	
	1973	286,035	354.4-355.7	354.6-354.8L, 355.1-355.4R, 355.6-355.9R	
	1974	95,134	354.5-355.2	354.7-354.9L, 355.2-355.4R	
	1975	137,471	354.5-355.5	355.1-355.5R	
		1,977,411	17 Events Average:	116,318	
352.6-353.4	1942	32,889	352.9-353.2	352.9-353.3L	
Fox River	1943	31,124	352.9-353.2	352.9-353.1L, 353.2L	
	1944	103,004	352.6-353.2	352.6-353.0L, 353.1-353.2L	
	1945	75,111	352.8-353.3	352.9-353.4L	
	1946	61,874	352.8-353.1	352.8-353.1L, 353.2L	
	1946	91,710	352.7-353.4	352.7L, 352.9-353.1L, 353.2-353.4L	
	1947	105,196	352.6-353.4	352.7-353.4L	
	1948	50,814	352.6-353.1	352.6-353.0L	
		551,722	8 Events Average:	68,965	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
351.1-352.0	*1961*	*69,966*	*351.3-351.7*	*351.2-351.3R, 351.4-351.7R*	
Gregory Lower	*1964*	*124,843*	*351.2-351.7*	*351.4-351.7R*	
	1967	*23,426*	*351.3-351.5*	*351.4-351.6R*	
	1970	*28,166*	*351.3-351.5*	*351.4-351.6R*	
	1973	*36,380*	*351.2-351.5*	*351.1-351.2R*	
	1973	*17,370*	*351.9-352.0*	*352.0-352.1L*	
	1974	*28,467*	*351.1-351.3*	*351.1-351.2R*	
		328,618	*7 Events Average:*	*46,945*	
348.5-349.6	*1959*	*65,944*	*348.9-349.4*	*349.1-349.2L, 349.3L, 349.4L, 349.5L*	
Buzzard Island	*1962*	*140,845*	*348.5-349.4*	*349.0L, 349.1L, 349.1R, 349.2-349.4R*	
	1965	*33,666*	*349.0-349.2*	*349.2-349.3R*	
	1966	*20,704*	*349.0-349.2*	*349.3R, 349.1-349.3L*	
	1968	*30,093*	*348.6-348.8*	*348.8-349.0L*	
	1969	*86,610*	*348.9-349.4*	*349.2-349.5R, 349.0-349.2L, 349.3-349.5L*	
	1970	*36,389*	*348.5-348.9*	*348.6-348.7L, 348.9-349.0L*	
	1973	*52,877*	*349.1-349.6*	*349.5-349.7R*	
	1974	*143,542*	*349.0-349.5*	*349.0-349.2R, 349.3R, 349.4-349.5R*	
	1976	*68,075*	*349.0-349.6*	*348.9-349.1R*	
	1979	*65,254*	*348.8-349.4*	*348.9-349.2R*	
	1980	*68,996*	*348.7-349.3*	*348.9-349.2R*	
	1982	*147,902*	*349.0-349.5*	*349.2-349.5R*	
	1983	*42,122*	*349.0-349.4*	*348.9-349.0R*	
	1984	*67,631*	*348.9-349.3*	*349.2-349.3R*	
	1985	*82,013*	*348.6-349.4*	*349.0-349.1R*	
	1986	*59,000*	*348.8-349.6*	*349.1-349.2R*	
	1987	*105,169*	*348.5-349.4*	*348.1-348.6Thalweg*	
	1989	*112,730*	*348.6-349.3*	*348.5-348.6Thalweg*	
	1992	*96,279*	*348.0-348.7*	*347.7-348.1T*	*Thalweg*
	1993	*77,112*	*348.9-349.3*	*348.7R, 348.5T*	*Thalweg*
		1,602,953	*21 Events Average:*	*76,331*	
345.1-345.4	*1964*	*47,398*	*345.1-345.4*	*345.3-345.5R*	
Brownsville Island		*47,398*	*1 Event Average:*	*47,398*	
343.2-344.3	*1942*	*4,336*	*343.2-343.4*	*343.4L*	
Lock #20 Upper	*1944*	*3,727*	*343.1-343.2*	*--*	
	1946	*5,565*	*343.3*	*342.9-343.1L*	
	1963	*135,607*	*343.4-343.9*	*343.7-343.9R*	
	1966	*101,434*	*343.8-344.2*	*344.0-344.3R*	
	1967	*189,599*	*343.6-344.3*	*343.8-344.2R*	
		440,268	*6 Events Average:*	*73,378*	

POOL 20 TOTALS
Events: 70
Yardage: 5,752,252
Average: 82,175

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
342.2-343.2 Lock #20 Lower	*1940*	*104,375*	*342.2-343.2*	*342.3L, 342.5L, 342.6-342.8L, 342.9-343.1L*	
	1942	*14,216*	*343.1*	*--*	
	1943	*42,866*	*342.9-343.2*	*343.0-343.1L*	
	1944	*20,258*	*342.9-343.2*	*--*	
	1945	*66,989*	*342.8-343.2*	*342.8-343.0R*	
	1946	*6,967*	*342.9-343.1*	*342.9-343.1L*	
	1947	*15,700*	*342.9-343.1*	*342.8-343.0L*	
	1948	*30,898*	*342.6-342.9*	*342.8-343.0L*	
	1950	*59,428*	*342.5-343.1*	*342.6-342.7L, 342.9-343.0L*	
	1951	*43,351*	*342.6-343.1*	*342.7-343.1L*	
	1953	*22,618*	*342.9-343.1*	*342.8L, 342.9-343.1L*	
	1955	*14,316*	*342.9-343.1*	*342.9-343.0L*	
	1962	*51,118*	*342.9-343.1*	*342.8-343.0L*	
	1967	*67,818*	*342.8-343.2*	*342.9L, 342.9-343.1L*	
	1988	*343*	*343.0*	*349.0R*	
		561,261	*15 Events Average:*	*37,417*	
341.4-341.9	*1946*	*44,189*	*341.4-341.9*	*341.4-341.8L, 341.9-342.1R*	
Canton		*44,189*	*1 Event Average:*	*44,189*	
338.5-339.5 Howards Crossing	*1944*	*162,791*	*338.7-339.5*	*338.8-339.6L*	
	1946	*124,611*	*338.5-339.1*	*338.6-338.7L, 338.8L, 338.9-339.1L*	
	1947	*115,476*	*338.6-339.5*	*338.8-339.5L*	
	1948	*54,797*	*337.9-338.2*	*338.0-338.2R, 338.0-338.3L*	
	1950	*20,383*	*337.8-338.0*	*338.0-338.1R*	
	1951	*88,693*	*338.9-339.4*	*338.4-339.4L*	
	1952	*103,355*	*338.6-339.5*	*338.7-338.8L, 338.8-339.5L*	
	1952	*48,451*	*337.7-338.1*	*337.9R, 338.0-338.2R*	
	1954	*73,409*	*338.8-339.5*	*338.9L, 339.1-339.2L, 339.3L, 339.4-339.5L*	
	1955	*71,865*	*337.8-338.1*	*337.9R, 338.0-338.2R*	
	1960	*39,442*	*337.9-338.2*	*338.0-338.2L*	
	1964	*28,688*	*339.1-339.4*	*339.3-339.5L*	
	1965	*28,472*	*338.7-339.0*	*338.8-339.0R*	
	1966	*73,555*	*338.6-339.3*	*338.7L, 338.8-339.4L*	
	1967	*40,141*	*338.1-338.8*	*338.2-338.3L, 338.3-338.4L, 338.5-338.7L, 338.8-338.9L*	
	1974	*227,148*	*338.5-340.3*	*338.6-338.7L, 339.0-339.6L, 340.2-340.3L*	
	1980	*47,503*	*337.8-338.2*	*338.2-338.3R*	
	1988	*43,166*	*337.9-338.2*	*337.9-338.1R*	
	1988	*2,000*	*338.0*	*339.0L*	
	1989	*45,139*	*337.9-338.7*	*338.4-338.5L, 338.9-339.0L*	
	1991	*44,865*	*337.9-338.2*	*336.6-336.8R*	
	1995	*10,500*	*338.8*		*Bankline*
		1,494,450	*22 Events Average:*	*67,930*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
335.9-337.4 LaGrange	*1944*	*10,167*	*336.1-336.2*	*336.0-336.2L*	
	1944	*15,583*	*336.7-336.9*	*336.8-336.9L*	
	1945	*76,977*	*336.4-336.9*	*336.6-336.9R*	
	1946	*65,174*	*336.6-336.9*	*336.7L,336.9L*	
	1947	*51,504*	*336.4-337.1*	*336.5-336.9R*	
	1948	*17,269*	*336.7-337.0*	*336.9-337.0L*	
	1951	*41,500*	*335.9-336.3*	*336.0-336.3L*	
	1951	*47,203*	*336.9-337.4*	*337.0-337.3R*	
	1952	*94,178*	*336.2-337.3*	*336.2-336.4L, 336.5-336.7L, 336.9-337.2L*	
	1953	*64,633*	*336.4-337.1*	*336.5-336.6L, 336.7L, 336.9L, 337.0-337.1L*	
	1955	*37,695*	*336.5-336.9*	*336.7-336.9R*	
	1956	*51,234*	*336.2-336.6*	*336.0-336.6L, 336.5-336.8R*	
	1960	*54,108*	*336.9-337.4*	*337.2-337.4R*	
	1964	*47,820*	*335.9-336.3*	*336.3L, 336.0-336.3R*	
	1965	*33,819*	*336.0-336.3*	*336.3-336.4L, 336.0-336.4R*	
	1966	*27,615*	*336.9-337.2*	*336.9-337.0R*	
	1967	*50,388*	*336.9-337.2*	*337.1L, 337.2-337.3L*	
	1967	*98,310*	*336.0-336.7*	*336.0-336.4R, 336.5-336.8R*	
	1968	*20,028*	*336.1-336.3*	*336.0-336.2R*	
	1968	*10,666*	*337.3-337.4*	*337.4-337.5R*	
	1970	*43,667*	*335.9-336.2*	*335.9-336.1R.336.0-336.1L*	
	1972	*87,533*	*336.0-336.5*	*336.0-336.3R, 336.6-336.7R*	
	1973	*36,955*	*336.0-336.3*	*336.1-336.4R*	
	1975	*60,723*	*335.9-336.6*	*336.1R, 336.2-336.3R, 336.4R, 336.5-336.6R*	
	1980	*2,111*	*337.2-337.3*	*337.0-337.1R*	
	1980	*8,883*	*336.7-336.9*	*336.3-336.4R*	
	1980	*10,593*	*336.1-336.3*	*336.2-336.4R*	
	1983	*22,474*	*336.0-336.3*	*336.0-336.3R*	
	1985	*16,956*	*335.8-336.1*	*336.4R*	
	1987	*88,563*	*336.1-336.9*	*336.6-336.9R*	
	1989	*67,595*	*336.0-336.6*	*336.4-336.5R, 336.6-336.9R*	
	1991	*46,333*	*336.1-336.5*	*336.0-336.3R, 336.4R*	
		1,408,257	*32 Events Average:*	*44,008*	
332.5-333.9 Willow Island	*1947*	*13,700*	*333.0-333.1*	*333.0-333.1L*	
	1948	*36,676*	*332.9-333.3*	*332.9-333.4L*	
	1953	*126,957*	*332.5-333.2*	*332.6-332.7L, 332.8-332.9L, 332.9-333.2L, 333.2-333.4L*	
	1963	*31,059*	*332.6-333.9*	*332.7L, 332.9L, 333.0L, 333.1L*	
	1967	*80,358*	*332.6-333.2*	*332.8-333.3L*	
	1967	*63,643*	*332.6-333.2*	*332.8-333.3L*	
	1970	*31,022*	*332.8-333.1*	*332.9-333.1L*	
	1973	*69,013*	*332.7-333.1*	*332.6R, 332.7-332.8R*	
	1983	*35,944*	*332.8-333.2*	*332.8-333.2R*	
	1984	*27,628*	*332.8-333.0*	*332.6-332.7R, 332.8R, 333.0-333.1R*	
	1985	*29,950*	*332.5-332.9*	*332.8R, 332.9R, 333.1R, 333.2R*	
	1986	*68,156*	*332.4-333.1*	*332.1L, 332.6R*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1987	*54,229*	*332.3-333.0*	*331.9-332.2L*	
	1990	*102,450*	*332.4-333.1*	*331.8-332.2L*	
	1991	*78,038*	*332.7-333.1*	*331.9-332.3L*	
		848,823	*15 Events Average:*	*56,588*	
330.9-332.6 Hogback/Lone Tree	*1951*	*34,593*	*331.4-331.5*	*331.6-331.9L*	
	1955	*51,917*	*331.1-331.4*	*331.0-331.2R*	
	1957	*59,766*	*331.8-332.2*	*331.9-332.0L, 332.1L, 332.2L*	
	1959	*47,322*	*332.1-332.6*	*332.2-332.3L, 332.4-332.6L, 332.7L*	
	1960	*47,055*	*331.6-332.2*	*331.4-332.3L*	
	1963	*132,358*	*331.6-332.1*	*331.7-332.2L*	
	1966	*61,665*	*331.7-332.0*	*331.8-332.2L*	
	1967	*160,718*	*331.4-332.6*	*331.6-331.9L, 332.0-332.1L, 332.2-332.3L, 332.4-332.7L*	
	1967	*127,287*	*331.4-332.6*	*331.5-332.0L, 332.1-332.3L, 332.4-332.6L*	
	1971	*47,233*	*331.6-331.9*	*331.8-332.0L*	
	1972	*58,092*	*331.6-332.0*	*331.7-332.1L*	
	1972	*64,937*	*330.9-331.3*	*330.8-331.0R*	
	1973	*78,283*	*331.5-331.8*	*331.7-332.0L*	
	1982	*11,278*	*331.0-331.1*	*331.8-332.2L*	
	1982	*22,686*	*331.9-332.1*	*331.8-332.2L*	
	1983	*27,982*	*331.7-331.9*	*331.7-332.2L*	
	1984	*66,726*	*330.9-331.7*	*331.5-331.6L, 331.8L, 331.9-332.1L*	
	1985	*60,186*	*331.4-331.7*	*331.7-331.8L, 331.9-332.0L, 332.1L*	
	1986	*16,955*	*331.1-331.5*	*331.8-332.0L*	
	1987	*35,334*	*331.1-331.5*	*331.4-331.5L*	
	1991	*70,091*	*331.7-332.5*	*331.9-332.2L*	
	1992	*38,279*	*331.7-332.1*	*331.4L*	
	1993	*61,794*	*331.3-332.1*	*331.5-331.9R, 332.0L*	
	1994	*131,870*	*330.9-332.1*	*Stockpile @ Union Township*	
	1995	*60,277*	*331.5-332.1*	*Stockpile & Beach*	
	1995	*23,740*	*331.2-331.5*	*Stockpile & Beach*	
		1,598,424	*26 Events Average:*	*61,478*	
328.0-329.2 Bay Island	*1945*	*53,486*	*328.8-329.2*	*328.9-329.1L*	
	1959	*437,264*	*328.2-329.1*	*328.1-328.8L, 328.9L*	
	1960	*164,572*	*328.0-328.7*	*328.0-328.7L*	
	1962	*115,745*	*328.0-328.6*	*328.1-328.5R, 328.6-328.7R*	
	1968	*21,778*	*328.1-328.2*	*328.1R*	
		792,845	*5 Events Average:*	*158,569*	
326.5-327.9 Quincy Bridge	*1959*	*184,076*	*327.3-327.8*	*327.5-327.8L Channel Realignment*	
	1963	*23,066*	*327.7-327.9*	*327.5-327.7L*	
	1965	*23,911*	*327.4-327.5*	*327.6L*	
	1966	*41,410*	*327.1-327.4*	*327.4-327.5L*	
	1967	*188,392*	*327.0-327.9*	*327.4-327.7L, 327.8-327.9L*	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1968	*69,116*	*327.4-327.7*	*327.5-327.6R*	
	1969	*49,044*	*326.9-327.2*	*327.1R, 327.3R*	
	1970	*38,866*	*326.5-326.7*	*326.7-326.8R*	
		617,881	*8 Events Average:*	*77,235*	

POOL 21 TOTALS
Events: 124
Yardage: 7,366,130
Average: 59,404

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
323.3-324.7 Lock #21 Lower	1940	244,452	323.6-324.5	323.9L, 324.0L, 324.2L, 324.4L, 324.5L	
	1941	3,280	324.9	324.9R	
	1943	66,069	324.2-324.7	324.4L, 324.6L	
	1944	54,713	323.6-323.8	323.8-323.9R	
	1945	41,401	323.6-323.8	323.6-323.8R	
	1945	39,532	323.3-324.7	324.4-324.6R	
	1948	51,977	324.0-324.7	324.2-324.4L, 324.5-324.6L	
	1969	29,287	324.3-324.6	324.1-324.3L, 324.4L	
	1969	66,499	323.7-323.9	323.9-324.0L	
	1970	23,278	323.6-323.8	323.7-323.9L	
	1971	40,648	324.2-324.5	324.2L, 324.4L	
	1971	41,166	323.6-323.8	323.8-323.9L	
	1972	42,657	323.6-324.0	323.9-324.1L	
	1987	46,111	323.6-323.8	323.6-323.8L	
		791,070	14 Events Average:	56,505	
319.7-321.2 NE Missouri Power	1940	71,789	319.8-320.2	319.9-320.2L	
	1940	50,314	320.7-321.1	320.8-321.0L, 321.1L	
	1941	144,408	320.2-321.2	320.4-320.6L, 320.7-320.9L, 321.0-321.1L	
	1942	133,392	320.9-321.0	320.3-320.4L, 320.5L,320.6-320.7L, 320.9L, 321.0L, 321.1L	
	1943	118,507	320.1-321.1	320.3L, 320.5L, 320.7L, 320.9L, 321.1L	
	1945	132,181	320.0-321.0	320.2-320.6L, 320.6-320.7L, 320.8-321.0L	
	1946	104,546	320.1-321.1	320.2-320.3L, 320.5-320.6L, 320.8-320.9L, 320.9-321.1L	
	1947	40,268	320.1-320.8	320.3-320.7L	
	1948	49,367	320.2-320.7	320.3-320.8L	
	1950	93,740	320.0-320.5	319.7-320.2R, 320.4-320.6L	
	1953	63,081	319.9-320.5	320.2-320.5L	
	1956	66,973	319.9-320.4	319.7-320.6L	
	1960	92,431	319.7-320.8	319.4-320.8L	
	1963	136,065	319.8-320.7	320.0-320.3L	
	1965	85,510	319.9-320.4	320.0-320.4L, 320.5R	
	1967	53,688	319.8-320.1	319.9-320.2L	
	1968	43,885	320.0-320.4	320.2-320.5L	
	1971	46,426	320.0-320.4	320.3-320.5L	
	1972	79,267	319.9-320.3	320.0-320.2L, 320.4R	
	1973	47,384	319.9-320.2	320.0L	
	1975	18,844	320.0-320.2	320.0R, 320.4R	
	1976	60,310	319.9-320.4	320.3-320.4R	
	1981	65,530	319.7-320.2	320.4-320.5R	
	1983	87,580	319.8-320.4	320.4-320.5R	
	1987	155,216	319.7-320.3	319.4-319.5L, 320.4-320.5L, 320.3R	
	1991	147,979	320.0	319.8-320.2L, 320.3R	
	1994	60,000	319.9	320.0R Stockpile	
		2,248,681	27 Events Average:	83,284	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
317.2-319.3	1940	69,970	317.7-319.3	317.9-318.4L	
Beebe Island	1941	77,278	317.9-318.3	317.9-318.3L	
Upper	1942	83,820	317.2-318.3	317.6-317.8L.317.9-318.1L	
	1943	64,818	318.0-318.2	317.9-318.1L	
	1945	85,029	317.7-318.2	317.7-318.3L	
	1946	31,255	317.9-318.2	317.9-318.2L	
	1948	64,806	317.8-318.3	317.8-318.4L	
		476,976	7 Events Average:	68,139	
316.0-316.9	1940	61,143	316.1-316.6	316.2L, 316.5L, 316.3-316.6R	
Beebe Island	1941	58,551	316.0-316.5	316.1-316.6R	
	1961	55,739	316.1-316.5	316.3-316.5R	
	1962	105,267	316.2-316.8	316.5-316.6L, 316.7-316.9L	
	1965	128,143	316.2-316.9	316.5-316.6L, 316.6-317.0L	
	1966	116,555	316.0-316.9	316.1-316.3L, 316.5L, 316.6-316.9L	
	1967	167,678	316.1-316.8	316.1-316.3L, 316.4L, 316.7-316.9L	
	1973	71,666	316.1-316.7	316.3-316.5R, 316.7-316.8L	
	1975	71,177	316.0-316.4	316.1L, 316.2L	
	1984	48,284	316.0-316.3	316.0-316.3L	
	1987	167,121	315.8-316.8	315.1-315.4R, 316.5-316.7L	
	1992	75,278	315.8-316.8	315.2-315.4R	Is. Creation
	1993	70,733	315.9-316.5	316.0-316.5L	
		1,197,335	13 Events Average:	92,103	
312.8-314.9	1944	55,234	313.9-314.4	314.1-314.5L	
Whitney Light	1947	27,889	314.5-314.9	314.6-314.9L	
	1948	40,342	314.3-314.8	314.4-314.8L	
	1950	30,055	314.4-314.7	314.5-314.7L	
	1951	38,677	314.2-314.5	314.3-314.5L	
	1952	36,906	314.1-314.5	314.2-314.4L	
	1952	45,533	313.2-313.6	313.4-313.6R	
	1953	46,505	313.3-313.7	313.4-313.7R	
	1954	31,117	313.1-313.7	313.2-313.5R	
	1954	69,661	314.0-314.5	314.2-314.5L	
	1959	82,774	313.9-314.3	314.0-314.3L	
	1960	61,544	312.8-313.3	312.9-313.1L, 313.8-313.9L, 314.0-314.2L	
	1963	116,921	313.3-313.9	313.5-313.6R, 313.8-314.0R	
	1966	141,586	312.9-313.6	313.1R, 313.2-313.4R, 313.5-313.6R, 313.7-313.8R	
	1968	94,425	313.0-313.7	313.3R, 313.4-313.5R, 313.3L, 313.4-313.6L, 313.7L	
	1969	65,597	313.2-313.5	313.3-313.6L	
	1972	52,656	312.9-313.4	313.2-313.6R	
	1973	91,199	312.8-313.5	312.9-314.4R	
	1975	24,878	313.8-314.2	313.6-313.7R, 314.3-314.4R	
	1978	18,800	313.2-313.6	313.1-313.2L	
	1979	32,466	313.0-313.4	313.2-313.3L	
	1980	44,436	313.0-313.5	312.9-313.2R	
	1982	99,524	313.0-313.4	312.7-313.0Thalweg	
	1983	27,815	313.1-313.5	312.9-313.3R	

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
	1984	34,008	312.8-313.3	312.9-313.1R, 313.1-313.3R	
	1990	39,635	313.3-313.5	312.9-313.0Thalweg	
	1991	51,148	313.5	312.6Thalweg	
	1993	46,800	312.8-313.2	312.5-312.8T	Thalweg
	1995	30,740	313.1	Thalweg	
		1,578,871	29 Events Average:	54,444	
311.5-312.1 Turtle Island	1941	25,384	311.9-312.1	312.0-312.1L	
	1942	69,575	311.7-312.1	311.8-312.1R, 311.8-312.0L, 312.1-312.2L	
	1943	50,633	311.8-312.0	311.8-312.0R	
	1956	24,860	311.6-312.0	311.8-312.2L	
	1959	78,483	311.7-312.1	311.8-312.3L	
	1960	56,889	311.7-312.0	311.6-312.3L	
	1962	66,221	311.5-311.9	311.7-311.8R, 311.9-312.0R	
	1970	63,333	311.7-312.0	311.9-312.0L, 312.1-312.2L, 312.0-312.1R	
	1972	52,400	311.7-312.0	311.9-312.2L	
	1973	71,881	311.5-311.9	311.4-311.7R	
		559,659	10 Events Average:	55,966	
308.7-308.8 Hannibal	1941	20,640	308.7-308.8	308.6-308.7R	
		20,640	1 Event Average:	20,640	
306.0-306.5 Cave Hollow Light	1961	85,810	306.0-306.5	306.2-306.5L	
		85,810	1 Event Average:	85,810	
304.0 Wing Dam #17	1982	39,445	304.0	304.1L	
		39,445	1 Event Average:	39,445	
301.5-303.4 Lock #22 Upper	1944	57,214	302.1-302.5	302.2-302.6R	
	1948	259,964	301.8-302.4	302.0-302.5R	
	1960	84,268	302.9-303.3	303.0-303.4R	
	1960	38,053	302.2-302.5	302.2-302.5R, 302.3-302.5L	
	1971	54,259	302.0-302.3	302.2-302.4R	
	1973	54,288	302.9-303.4	302.8-303.1L	
	1979	25,941	302.3-302.5	302.6-302.7R	
	1982	103,247	302.1-303.1	302.6-302.8L	
	1983	87,542	301.9-302.3	302.6-302.7L	
	1983	76,611	302.0-302.5	302.2-302.6R	
	1984	42,167	301.7-302.1	301.9-302.3R	
	1989	34,995	301.9-302.1	302.3-302.4R	
	1994	25,000	301.9	302.7R	
		943,549	13 Events Average:	72,581	

POOL 22 TOTALS
Events: 116
Yardage: 7,942,036
Average: 68,466

Dredge Cut	Year Dredged	Dredging Amount (yd3)	Dredging Site	Placement Site	Placement Type
300.3-300.9	*1944*	*70,970*	*300.9-301.2*	*300.9-301.0L*	
Lock #22 Lower	*1948*	*2,520*	*300.4*	--	
	1961	*30,014*	*300.5-300.9*	*300.5-300.7R*	
	1962	*39,823*	*300.5-300.8*	*300.5-300.7R*	
	1965	*45,156*	*300.4-300.8*	*300.5-300.7R*	
	1966	*36,432*	*300.5-300.9*	*300.2-300.4R, 300.5R, 300.4L, 300.5-300.6L*	
	1966	*13,067*	*300.5-300.7*	*300.5-300.8R*	
	1967	*54,776*	*300.4-300.8*	*300.5-300.8L*	
	1969	*56,374*	*300.3-300.7*	*300.4-300.7L*	
	1980	*30,829*	*300.5-300.8*	*300.5-300.8R*	
	1980	*33,741*	*300.5-300.8*	--	
	1981	*46,578*	*300.3-300.7*	*300.6-300.8R, 300.8R*	
	1990	*26,311*	*300.4-300.6*	*300.7-300.9R*	
	1,994	*59,295*	*300.7*	*Beach*	
		545,886	*14 Events Average:*	*38,992*	

POOL 24 TOTALS
Events: 13
Yardage: 545,886
Average: 41,991

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
24	1	297.6	R	1883	450.5	1912	1368		REP 1912	RA 1910		2,840	2,487
24	1	297.6	R	1883	450.5	1912	1368		REP 1912	RA 1910		0	0
24		298.1	CL	1977		1977	1090	455.0				19,588	0
24	8	298.4	R	1908	450.6	1930	550		REP & EXT 500' 1930			4,270	9,771
24	16	298.6	R	1930	445.8	1930	400					3,729	7,970
24	7	298.8	CL	1908	456.8	1908	400					877	918
24	15	299.3	CL	1927	446.2	1935	800		REP & EXT 250' 1935			4,667	8,866
24	14	299.8	L	1925	446.4	1925	1825					4,398	7,601
24	13	300.0	L	1925	446.5	1925	850					2,494	5,217
24	17	300.4	R	1930	447.6	1930	1000					1,649	2,761
24	5	301.0	CL	1897	450.1	1931	800		RA & REP 1931	RA & REP 1916 & 1930		3,351	8,043
24	12	301.0	L	1918	447.0	1937	925		REM 925' 1937			1,389	2,360

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
22	6	301.4	L	1897	450.3	1995	1830	456.6	RA, REP 1750' & EXT 80' 1995	REP 1950		3,166	10,272
22	3	301.9	L	1894	450.4	1995	1090	456.6	RA & REP 1080' 1995	REP 1915 & 1916		3,767	8,878
22	10	301.9	R	1915	451.9	1938	970		REM 500' 1938	REP 1915		2,397	6,561
22	4	302.2	L	1894	450.5	1995	800	456.6	RA & REP 800' 1995	REP 1915 & 1916, REM 250' 1918		3,112	6,592
22	9	302.2	R	1915	452.0	1938	1550		REM 500' 1938	REP 1915		3,669	7,138
22	11	302.5	R	1915	452.0	1995	865	456.6	RA & REP 620' 1995	REP 1915, REM 800' 1938		3,928	10,495
22	2	302.8	CL	1893	452.2	1980	983	452.2	REP 1980	REP 1915		1,514	2,320
22	17	304.1	L	1918	452.9	1982	1400	452.9	REP 1982	REP 1925, REP 1935, REP 1980, REP 1981		1,893	3,563
22	16	304.4	L	1918	453.1	1925	1250		RA & REP 1925			1,910	4,747
22	15	304.7	R	1915	453.2	1981	395	453.2	REP 1981	REM 170' 1950		1,448	3,950
22	14	305.0	R	1914	453.5	1981	250	453.5	REP 1981	REM 575' 1950		1,945	5,204
22	18	305.0	CL	1930	453.4	1950	650	459.5	RA 1950			2,653	4,388
22	13	305.2	R	1914	453.6	1950	260		REM 500' 1950			2,371	5,779
22	12	305.4	R	1914	453.6	1950	735		REM 190' 1950	REP 1931		1,176	4,897
22	4	305.6	L	1895	453.3	1917	685		REP 1917	REP 117' & EXT 475' 1915, REP 1916		3,769	9,072
22	11	305.6	R	1914	452.8	1931	490		REP 1931			1,103	2,658
22	5	305.9	L	1895	451.6	1930	1975		REP 1930			4,041	0
22	6	306.2	L	1898	451.3	1898	1750					1,643	6,085
22	7	306.5	L	1898	451.5	1898	1600					2,035	8,236
22	8	306.7	L	1898	452.1	1898	1485					3,170	8,845
22	1	308.2	CL	1880	451.3	1880	1440					4,106	366
22	2	308.9	L	1880		1904			EXT 450' 1903	REP 1884		5,834	3,566
22	10	309.1	L	1903	454.4	1903						2,529	4,721
22	3	309.3	L	1883	463.9	1915	800		EXT 300' 1915	REP 1900		382	0
22	9	309.4	L	1903	454.4	1903						1,508	2,682
22	35	310.7	L	1928	456.0	1930	550		REP 1930			2,159	5,300
22	9	310.9	R	1894	454.5	1983	900	454.5	REP 1983	REP 1896		2,087	2,131
22	7	311.0	CR	1894		1894	252				APRON ONLY	448	382
22	34	311.0	L	1928	456.1	1934	575		REP 1934			3,007	3,124
22	10	311.2	R	1894	454.8	1928	740		EXT 350' 1928			4,389	4,484
22	11	311.4	R	1894	454.9	1928	500		EXT 400' 1928			4,557	2,171
22	8	311.7	R	1894	455.6	1928	900		EXT 400' 1928	REP 1896		4,278	4,954
22	5	311.8	CL	1893		1928	2974		REP 1928	REP 1895 & 1903		12,342	10,747
22	12	311.9	R	1894	455.2	1928	500		REP & EXT 150' 1928			3,238	2,761
22	6	312.4	L	1893	452.5	1893					SILTED IN	2,993	4,998
22	18	312.7	R	1895	455.6	1984	420	456.5	REP & RA 1984	REP 1930		1,761	3,931
22	21	312.7	L	1895	453.1	1930	1275		REP & EXT 325' 1930			3,768	9,579
22	20	313.0	R	1895	453.3	1984	630	456.5	REP & RA 1984	REP 1928		635	1,707
22	36	313.0	L	1928	459.3	1930	800		EXT 600' 1930			2,992	3,326
22	19	313.2	R	1895	453.4	1984	924	456.5	REP & RA 1984	REP 1928		753	2,253
22	37	313.2	L	1930	457.4	1930	600					926	1,027
22	13	313.4	R	1895	456.1	1984	960	456.5	REP & RA 1984	REP 1928		3,803	10,039
22	22	313.7	R	1895	453.7	1984	1000	456.5	REP & RA 1984	REP 1928		1,820	5,927
22	16	314.0	R	1895	453.8	1928	940		REP 1928	EXT 250' 1917		2,598	5,571
22	17	314.1	L	1895	453.9	1984	900	453.9	REP 1984	REP & EXT 300' 1928, RA & REP 1957		2,383	7,449
22	3	314.4	L	1889	457.2	1958	1000		RA & REP 1958	REP 1901, RA & REP 1917		4,866	4,836
22	14	314.5	CR	1895	456.7	1958	1400		RA & REP 1958	REP & EXT 275' 1916		7,443	15,365
22	4	314.8	L	1889	457.4	1959	750		RA & REP 1959	REP 1901, REM 500' 1916		3,676	3,030

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
22	15	315.0	CR	1895	457.0	1895	205				GONE	288	289
22	1	315.4	R	1887	456.8	1917	2600		REP 1903	EXT 800' 1895 & 86' 1896, REP 1888 & 1889		13,970	22,040
22	24	315.8	R	1903		1994	1300	459.4	REP 960' 1994			1,118	2,276
22	27	316.0	CL	1903	458.3	1903	250					558	621
22	23	316.1	R	1903	459.4	1994	2200	459.4	REP 1220' 1994	REP & EXT 350' 1915		5,702	13,154
22	25	316.3	R	1903	459.6	1994	1350	459.6	REP 900' 1994	REP & EXT 380' 1915, REM 280' 1957		4,316	11,259
22	26	316.3	L	1903	457.6	1903	650					1,687	2,872
22	28	316.5	R	1903	459.7	1994	1275	459.7	REP 800' & EXT 475' 1994	EXT 270' 1915, REM 355' 1956		2,466	5,286
22	29	316.8	R	1904	459.7	1994	650	459.7	REP 600' & EXT 50' 1994	REP & EXT 70' 1915, REP 1932, REM 300' 1956		2,374	5,496
22	32	316.9	L	1915	457.7	1915	1070					906	3,662
22	30	317.1	L	1915	459.8	1994	1350	459.8	REP 850' 1994			2,681	7,904
22	2	317.3	CL	1889	457.8	1900	1460		REP 1900	REM 300' 1896		13,277	5,589
22	31	317.5	L	1915	459.9	1994	2270	459.9	REP 650' 1994			3,018	9,653
22	33	317.9	L	1915	458.0	1932	1930		REP 1932			5,837	15,516
22	1	318.7	CR	1883	461.5	1904	244		REP 1904	RA 1896, REP 1900 & 1903	BURIED	5,394	3,367
22	3	318.8	L	1933		1937	638					1,363	1,598
22	2	319.1	L	1933		1937	625					1,264	1,147
22	9	319.9	R	1897	459.7	1935	50		REM ALL BUT 50' 1935			498	1,464
22	10	320.1	R	1897	459.9	1935	50		REM ALL BUT 50' 1935			728	2,265
22	11	320.4	R	1897	459.9	1935	50		REM ALL BUT 50' 1935			591	1,653
22	13	320.4	L	1897	460.0	1897	2300					8,095	21,648
22	12	320.6	R	1897	460.2	1935	50		REM ALL BUT 50' 1935			342	1,312
22	33	320.8	L	1929	461.7	1929	1600					4,074	10,595
22	32	321.1	L	1929	461.8	1937	938					1,477	2,341
22	31	321.3	L	1927	461.8	1937	1084					1,851	3,179
22	30	321.6	L	1926	462.0	1937	950		EXT 450' 1927			2,630	4,376
22	29	321.8	L	1926	462.1	1937	800					4,743	6,143
22	28	322.0	R	1926	462.2	1937	780					2,068	1,577
22	5	322.1	CR	1894	461.3	1937	400		REP 1926	RA 1901, RA & REP 1923		6,683	5,265
22	27	322.2	R	1926	462.3	1937	900					1,734	2,240
22	26	322.4	R	1926	462.4	1937	975		EXT 740' 1927			1,292	2,281
22	25	322.6	R	1926	462.5	1937	920					2,479	5,915
22	24	322.8	CR	1923		1923	215					501	808
22	44	322.9	L	1933		1937	660					858	1,230
22	43	323.1	L	1933		1937	520					802	801
22	6	323.5	CR	1894	461.8	1937	920		RA & REP 1903	RA 1901		3,865	3,105
22	23	323.8	R	1923	462.9	1937	1245		REP & EXT 1929			4,569	13,564
22	22	324.0	R	1923	465.0	1937	850		REP & EXT 1929			3,278	7,962
22	42	324.1	L	1930		1938	1205		REM 395' 1938	REM END 1935		2,835	3,904
22	34	324.2	R	1929	463.0	1937	800					1,032	1,395
22	40	324.3	L	1930	465.2	1938	932		REM 300'1938	REM END 1935		2,315	2,761
22	37	324.4	R	1929	463.2	1929	1050					1,680	2,324
22	41	324.5	L	1930	464.2	1930	600				REM	1,902	1,981
22	36	324.7	R	1929	463.3	1936	850		REM 850' 1936			1,925	2,161

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
21	35	325.0	R	1929	463.4	1936	1300		REM 1936			2,354	5,439
21	19	325.3	R	1901	462.6	1936	1450		REM 1050' 1936	REP & EXT 190' 1927, RA 1929		4,737	9,269
21	46	325.4	L	1909		1969						0	0
21	18	325.9	R	1900	462.8	1926	1550		REP 1926			3,381	7,666
21	4	326.4	CR	1884	465.0	1937	930				UNDER COUNTY ROAD	492	75
21	2	326.6	R	1879		1879	600				FERRY LANDING	1,641	825
21	14	326.8	R	1897	464.2	1937	1645		REP 1928			2,001	5,151
21	20	327.1	R	1904	468.3	1970	480		REP & EXT 1970	REP & EXT 100' 1930, REM 225' 1949		1,152	2,761
21	1	327.3	R	1879		1969	1200		REP & EXT 1969	REP & EXT 200' 1930, REM 300' 1949, REP 1963		10,690	11,577
21	21	327.3	R	1904	468.4	1904	930					1,030	4,383
21	3	327.5	CL	1881	468.4	1881	166				UNDER R.R. EMBANKMENT	812	594
21	7	327.5	L	1896		1959	851		REM 200' 1959			0	819
21	38	327.5	R	1930		1949	580		REM 170' 1949			2,953	4,883
21	39	327.6	L	1930	465.5	1959	800		REM 300' 1959			2,945	3,999
21	8	327.7	L	1896		1959	1179		REM 375' 1959			0	778
21	A	328.1	L	1868		1959			REM 400' 1959		RAILROAD DAM	0	0
21	45	328.3	R	1968	470.0	1968	1100					0	0
21	17	328.4	L	1898	462.9	1963	1000		REM 1963			2,813	6,876
21	15	328.7	R	1898	462.3	1963	2170		RA & EXT 1550' 1963	REM 860' 1959		6,235	13,998
21	16	329.0	L	1898	463.5	1963	380	470.0	RA 380' 1961	REM 1433' 1959		4,033	9,337
21	30	329.1	R	1927	463.6	1961	1570		EXT 720', RA & REP 850' 1961			1,126	2,069
21	7	329.3	L	1898	463.7	1959	210		REM 440' 1959	RA & REP 1908		2,031	3,920
21	29	329.4	R	1924		1961	1350		EXT 450', RA & REP 900' 1961			2,706	5,510
21	6	329.8	R	1896	460.1	1963	1270		EXT 105',RA & REP 1165' 1963	RA 1898, REP 1908		2,433	5,670
21	3	330.0	CR	1891		1891	250				UNDER COTTONWOOD IS.	1,249	467
21	2	330.1	R	1891		1937	1125		REP 1898			2,262	1,441
21	5	330.3	R	1896	463.5	1961	1300		RA & REP 640' 1961	EXT 770' 1911, REM 500' 1959		2,678	6,707
21	8	330.6	R	1898	467.0	1961	1560		RA & REP 860' 1961	EXT 525' 1911, REM 540' 1959		3,628	10,792
21	31	330.6	L	1927	464.6	1962	785		EXT 185', RA & REP 600' 1962			1,058	1,622
21	28	330.8	L	1924		1937	862					1,527	6,207
21	9	330.9	R	1898	466.4	1961	500		RA & REP 500' 1961	RA & EXT 1918, REM 385' 1959		2,076	4,504
21	27	331.0	L	1924		1963	1450		RA & REP 995' 1963			2,631	8,231
21	32	331.2	R	1932	461.6	1988	120	468.0	REP 1988	REM 300' 1956, RA & REP 120' 1961		3,075	5,468
21	1	331.3	L	1891	465.8	1937	2811		RA & EXT 1937			8,276	12,064
21	21	331.7	L	1919	468.0	1937	1050					131	76
21	22	331.9	L	1919	468.2	1988	730	468.2	REP 1988			107	97
21	23	332.1	L	1923	468.4	1937	580					93	44
21	24	332.2	L	1922	468.5	1937	350					647	1,690
21	20	332.3	R	1918	468.6	1988	600	468.6	REP 140' 1988	REM 300' 1957		856	1,098
21	4	332.4	CL	1923	468.8	1937	211					1,091	1,545
21	19	332.5	R	1918	468.7	1988	435	468.7	REP 140' 1988	REM 200' 1957		657	964
21	18	332.6	R	1918	468.8	1988	300	468.6	REP 150' 1988	REM 200' 1957, REP 1987		501	655
21	17	332.7	CL	1918	467.8	1988	795	467.8	REP 1988	REP 1927 & 1930, RA & REP 1970, REP 1987	GOOD	487	1,241
21	16	332.9	L	1918	469.0	1987	1075	469.0	REP 1987	REP 1930	GOOD	1,521	3,351
21	15	333.2	L	1915	468.2	1987	875	468.2	REP 1987	RA & REP 1923, RA & REP 1924	GOOD	1,428	4,332
21	14	333.5	L	1915	468.4	1988	1200	468.4	REP 625' 1988	RA & REP 1923, RA & REP 1924		1,908	5,148
21	26	333.7	L	1924		1988	1200	468.0	REP 700' 1988			1,993	4,953
21	25	333.9	L	1924		1937	1270					2,517	5,990

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
21	10	334.5	L	1915	468.1	1937	1430		REP 1927	RA 1926		1,385	3,630
21	11	335.1	L	1915	468.5	1937	775		RA 1927			1,047	2,908
21	12	335.4	L	1915	468.6	1937	830		RA 1927			1,138	3,233
21	13	335.8	L	1915	468.9	1981	520	468.9	REP 1981	RA 1927		602	1,878
21	16	336.1	L	1914	471.2	1957	670		REM 320' 1957			2,142	5,340
21	5	336.3	CL	1884	470.4	1955	1000		RA & REP 1955	REP 1885, 1886 & 1892		1,323	1,323
21	15	336.3	L	1914	471.2	1987	850	471.2	REP 1987	REM 270' 1957	GOOD	2,733	6,635
21	29	336.5	L	1927	469.4	1927	350					1,006	3,499
21	14	336.8	R	1913	471.5	1913	700					1,646	5,252
21	7	336.9	L	1887	470.6	1957	800		REM 290' 1957	REP 1892 & 1927		450	2,020
21	12	337.0	R	1913	469.6	1913	900					1,798	4,844
21	28	337.2	L	1927	469.8	1957	425		REM 200' 1957			2,071	5,181
21	11	337.3	R	1913	469.8	1913	1200					2,495	8,097
21	13	337.5	R	1913	470.0	1913	1000					2,668	7,846
21	10	337.7	R	1895	469.1	1926	870		REP 1926	RA 1913		1,539	2,281
21	9	338.0	R	1895	466.2	1926	700		RA 1926	RA 1896		1,016	1,297
21	6	338.1	CL	1884		1884	325				GONE	1,408	1,408
21	8	338.1	R	1895	466.3	1926	475		REP & EXT 1926	RA & EXT 75' 1895, RA 1900		2,285	2,910
21	18	338.4	L	1915	470.4	1987	900	470.4	REP 1987	RA 1926, RA 1934	GOOD	1,508	4,929
21	3	338.9	L	1883	468.6	1915	1400		REP 1915	RA 1884, 1893 & 1914		2,881	3,158
21	4	339.2	CL	1884	470.8	1884	1200					3,647	3,647
21	17	339.2	L	1914	472.0	1914	1300					4,761	10,848
21	2	340.3	CL	1879	469.4	1955	620		RA & REP 1955	RA 1881, 1892, 1896, 1907, 1923 & 1930		3,227	830
21	31	340.5	L	1930	475.6	1930	1725					2,707	3,483
21	30	340.8	L	1930	479.5	1930	1450					3,601	4,841
21	22	341.1	L	1923		1927	830		RA 1927			697	2,145
21	23	341.3	L	1923	472.5	1930	965		REP 1930	REP 1927		2,973	10,754
21	24	341.3	CL	1923	473.0	1927	230		RA & REP 1927		GONE	260	293
21	21	341.5	L	1922	474.1	1923	1025		REP 1923			3,273	9,527
21	1	341.7	CL	1879	472.2	1907	1095		REP 1907	RA & REP 1881 & 94, REP 1883, 89, 95, & 96		7,423	2,278
21	20	341.8	L	1922	474.3	1922	1020					2,420	5,770
21	19	342.3	L	1922	473.0	1955	1508		RA & REP 1955	REP 1930		2,815	7,368
20	33	343.9	R	1930	474.0	1938	75		REM 675' 1938	REM 400' 1935		1,636	2,280
20	27	344.0	L	1925	473.0	1925	1350					2,492	6,372
20	32	344.2	R	1930	474.1	1938	710		REM 340' 1938			1,348	1,605
20	26	344.3	L	1925	473.2	1925	1220					1,364	2,710
20	25	344.5	L	1925	473.3	1925	620					1,174	2,921
20	22	344.7	R	1930	474.4	1930	800					3,595	7,902
20	21	344.9	R	1930	475.4	1930	900					1,714	1,730
20	20	345.2	R	1930	475.5	1930	700					1,526	1,369
20	19	345.4	L	1927	473.6	1982	600	473.6	REP 1982			1,443	3,115
20	2	345.6	L	1891	471.8	1927	925		REP 1927	REP 1899 & 1900		3,757	1,362
20	6	345.6	CR	1900	473.7	1930	600		REP 1930			3,213	3,633
20	1	345.9	L	1889	473.8	1930	1250		REP 1930	REP & EXT 550' 1900		6,537	4,775
20	7	345.9	R	1900	473.8	1929	600		REP 1929			1,562	1,723
20	5	346.3	CL	1899	471.0	1930	1150		REP 1930	REP 1900, 1907 & 1915		6,373	7,968
20	3	346.7	CR	1891		1907	1300		REP 1907	REP 1893, 1899, 1900 & 1905		4,139	2,000
20	10	346.9	R	1905	475.2	1915	1300		REP & EXT 300' 1915			2,269	5,726

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
20	12	346.9	L	1907	471.2	1915	1730		REP 1915			2,994	5,803
20	14	347.1	L	1915	473.9	1915	1925					3,024	7,922
20	8	347.3	L	1904	476.5	1987	2000	476.5	REP 1987			6,713	13,755
20	18	348.0	L	1927	474.8	1987	1100	474.8	REP 1987			993	3,277
20	4	348.3	CL	1895	474.6	1895	333					1,958	2,548
20	9	348.3	L	1904	475.8	1987	950	475.8	REP TO 950' 1987			2,124	4,577
20	16	348.6	L	1925	475.0	1987	1315	475.0	REP 1987			3,644	10,605
20	15	348.7	CR	1925	476.1	1987	145	476.1	REP 1987			675	947
20	13	349.0	CL	1908	477.1	1987	800	477.1	REP, RA & EXT 200' 1987	REP 1916 & 1920, REP 1980 & 1982		834	965
20	17	349.0	L	1927	475.1	1988	1200	475.1	EXT 300' 1988	REP 1987		1,005	2,659
20	NA	349.0	R	1988	475.1	1988	400	475.1				5,448	0
20	NA	349.4	L	1988	477.2	1988	1000	477.2				14,050	0
20	11	349.4	CL	1905	474.2	1905	460		REP 1980			2,108	3,436
20	7	349.7	CR	1898	472.4	1972	1355		REP 1972	RA 1908		3,498	7,053
20	8	349.8	L	1908	476.4	1987	1225	476.4	REP 300' 1987	REP & EXT 1930		4,038	8,766
20	10	350.4	R	1912	471.8	1912	1500					4,470	4,933
20	11	350.8	R	1912	477.8	1982	1350	477.8	REP 1982			853	2,697
20	9	351.0	R	1911	474.5	1911	2300					6,257	10,528
20	12	351.3	R	1913	473.2	1913	1475					8,524	12,159
20	18	352.8	L	1930		1934	1225		REP 1934			1,741	3,066
20	19	353.0	CL	1948	481.0	1949	400		REP 1949			0	0
20	14	353.1	L	1915	474.8	1959	1280		REP 1959	REP 1920, 1924, 1927 & 1949		3,734	13,150
20	1	354.1	CL	1880		1909	1805		RA 1900			8,722	7,487
20	5	354.6	L	1894	478.0	1924	1350		REP 1924	REP 1894 & 1904, REP & EXT 550' 1915		3,257	5,782
20	2	354.7	CL	1882		1882	320					8,722	7,487
20	4	354.9	L	1893	478.1	1924	850		REP 1924	RA 1909, REP 1904 & 1916		4,087	5,182
20	6	355.2	L	1893	478.4	1924	1170		REP 1924	REP & EXT 1916, REP 1923		3,495	6,378
20	3	355.4	L	1893	478.6	1930	450		EXT 320' 1930	RA 1909, 1914 & 1915		5,011	10,849
20	17	355.5	R	1925	477.6	1979	425	476.0	REP 1979	EXT 100' & 525' 1930		5,607	7,205
20	13	355.6	L	1914	479.8	1930	1000		EXT 300' 1930	REP 1927		4,445	9,532
20	16	355.8	L	1925	478.0	1930	567		REP & EXT 208' 1930			3,003	7,331
20	15	356.1	CR	1916	474.4	1916	825					98	484
20	6	356.9	R	1894	474.8	1948	1180		REM 752' 1948	EXT 260' 1895, REP 1904 & 1916		6,602	7,252
20	8	357.3	R	1895	474.9	1948	338		REM 375' 1948	EXT 600' 1911, REP 1919		4,406	10,265
20	25	357.6	L	1916	475.0	1922	1250				SAND FILL TO SURFACE	1,343	4,096
20	27	357.9	L	1916	475.0	1916	950				SAND FILL TO SURFACE	893	1,911
20	26	358.2	L	1916	475.1	1916	1050				SAND FILL TO SURFACE	953	1,918
20	3	358.4	CR	1889	475.1	1974	257		REP 1974	REP 1898, 1917, 1947, 1949, 1959 & 1972	GOOD	1,635	680
20	15	358.5	L	1913	475.1	1913	1575					712	2,587
20	14	358.9	L	1913	475.2	1913	1250					650	2,246
20	13	359.2	L	1913	475.3	1982	1500	475.3	REP 1982			645	2,475
20	16	359.4	R	1913	475.3	1913	650					549	1,354
20	18	359.4	L	1913	475.3	1913	880					666	2,701
20	2	359.5	R	1880	475.3	1883			REP 1883			1,756	2,029
20	19	359.7	R	1913	475.3	1913	570					627	2,133
20	1	359.9	R	1880	475.4	1913	910		EXT 430' 1913			4,452	6,419
20	7	360.2	R	1893	475.5	1913	1200		EXT 490' 1913			4,414	5,026
20	4	360.5	R	1892	475.6	1911	1420		EXT 600' 1911	REP 1898		7,905	13,364

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
20	5	360.7	L	1892	475.7	1893	800		REP 1893			2,856	4,564
20	17	360.8	R	1913	475.7	1913	900					1,029	2,848
20	9	360.9	L	1911	475.8	1913	400		EXT 200' 1913			2,482	5,770
20	12	361.2	L	1913	475.9	1913	750					919	2,913
20	10	361.4	L	1911	476.2	1964	175		REP 1964			470	1,460
20	11	361.8	L	1913	476.3	1913	1275					1,274	3,505
20	20	362.4	L	1913	478.6	1959	1800		REP 1959			2,987	1,926
20	22	362.7	L	1913	476.9	1931	1240		REP 1931			7,341	1,307
20	24	362.9	L	1913	477.2	1931	1050		REP 1931			3,970	2,506
20	23	363.2	L	1913	477.3	1930	1050		REP 1930			6,583	1,596
20	21	363.5	L	1913	477.4	1935	800		REM 500' 1935	REP 1926 & 1931, EXT 325' 1930		4,880	413

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
19		374.8		1926	503.2	1926	600				BREAKWATER	7,429	0
19	1	375.0	R	1882		1882	540				GONE	741	494
19	3	375.0	CR	1882		1882	45				GONE	20	15
19	2	375.1	CR	1882	504.0	1882	100				GONE	148	100
19	4	375.2	CR	1882	500.0	1882	3268				GONE	4,257	4,363
19	8	378.8	R	1891	504.4	1891	1150				GONE	3,629	3,716
19	7	379.0	R	1891	505.9	1891	976				GONE	3,287	3,712
19	6	380.0	CL	1899	505.6	1899	720				GONE	3,353	1,235
19	5	380.4	CL	1887	505.6	1900	500		REP 1900		GONE	4,720	1,413
19	7	380.9	R	1889		1909	1500		REP 1909		GONE	3,319	3,016
19	6	381.3	L	1889		1889	1120				GONE	3,512	3,097
19	5	381.6	L	1889		1889	860				GONE	3,584	5,110
19	3	382.5	CL	1883	508.3	1883	509				GONE	4,391	989
19	1	382.8	CL	1877	503.4	1885	1100		REP 1885	REP 1878, 1879 & 1883		3,266	3,853
19	10	382.9	L	1900	502.4	1900	1325				GONE	1,668	2,773
19	9	383.1	L	1900	502.5	1900	2035				GONE	4,330	9,632
19	2	383.3	CL	1879		1885	700		REP 1885		GONE	1,517	605
19	8	383.4	L	1900	506.6	1900	1265				GONE	5,752	11,163
19	A	384.0	L	1889		1889					BUILT BY SANTA FE RR	0	0
19	C	384.6	L	1890		1890					BUILT BY SANTA FE RR	687	2,472
19	B	384.8	L	1890		1890					BUILT BY SANTA FE RR	0	0
19	21	385.8	CR	1889	508.8	1907	558		REP 1907		GONE	2,096	3,045
19	19	386.2	R	1889	506.4	1895	1258		REP 1895		GONE	2,516	3,585
19	18	386.6	R	1889	504.5	1889	700					2,308	4,295
19	16	387.0	CR	1889	509.2	1907	565		REP 1907	REP 1902 & 1903		1,962	3,462
19	17	387.2	R	1889	505.3	1895	1550		EXT 150' 1895			4,945	8,761
19	29	387.3	CR	1909	507.8	1909	576					2,392	4,836
19	20	387.4	R	1895	504.8	1895	800					1,866	2,934
19	14	388.1	R	1889	508.0	1895	2740		EXT 500' 1895	REP 1892		7,509	13,210
19	13	388.5	R	1889	507.2	1899	2240		RA TO 4' STAGE 1899	REP 1892		11,807	19,862
19	25	388.7	R	1899	504.4	1899	970					1,730	3,150
19	12	389.0	R	1889	507.5	1899	1610		RA TO 4' STAGE 1899	EXT 100' 1898		8,964	15,209
19	23	389.2	L	1898	505.6	1898	800					300	677
19	11	389.4	R	1889	508.8	1898	1200		EXT 800' 1898			4,286	7,140
19	22	389.4	L	1898	505.8	1898	1240					504	1,699
19	21	389.5	L	1897	508.8	1903	1600		REP 1903	REP 1898		1,335	2,417
19	8	389.8	L	1897	509.0	1897	800					878	3,411
19	24	391.2	CR	1899	513.8	1905	207		REP 1905	REP 1902	GONE	176	305
19	26	391.2	CR	1905	506.8	1905					GONE	82	120
19	27	391.2	CR	1905	506.8	1905					GONE	82	120
19	28	391.2	CR	1905	506.8	1905					GONE	82	120
19	2	391.4	CR	1878		1878						438	778
19	7	391.4	CL	1893	506.9	1893	1300		REP 1898			2,837	4,975
19	1	391.5	CR	1878		1878						438	778
19	3	391.5	CR	1878		1878						438	778
19	5	391.7	L	1893	510.1	1893	1050					4,525	8,160
19	6	392.1	R	1893	510.3	1893	940					2,720	5,572
19	9	392.4	CR	1893	510.4	1893	258		REP 1898			284	615

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
19	4	392.5	CR	1898	514.5	1892	660		REP 1898			451	1,976
19	10	394.3	CR	1895	507.3	1903	1200		REP & EXT 1100' 1903			6,089	9,645
19	8	395.1	R	1895	511.6	1937	1225		EXT 350' 1899			2,910	3,663
19	7	395.3	R	1895	510.1	1937	800					903	3,071
19	6	395.5	R	1895	510.8	1937	900					2,335	3,410
19	5	396.1	R	1895	508.7	1937	764					1,629	2,288
19	3	396.2	CL	1895	512.2	1937	913				GONE	6,134	6,182
19	4	396.5	CL	1895	508.3	1937	239				GONE	206	1,029
19	15	397.3	R	1899	512.6	1983	800	512.6	REP 1983			2,840	2,648
19	12	398.2	L	1899	513.1	1937	1600		REP 1905			1,550	3,709
19	13	398.3	CL	1899	513.1	1937	210				GONE	578	702
19	14	398.8	L	1899	513.4	1983	1000	513.4	REP 1983			3,461	6,076
19	1	399.5	CL	1882	517.1	1937	1000		REP 1889	REP 1887	GONE	10,747	2,934
19	2	400.0	CL	1881	516.4	1937	900		REP 1887	REP 1882 & 1886	GONE	5,120	0
19	10	400.3	L	1899	513.9	1937	1100					3,358	4,753
19	9	400.5	L	1899	514.0	1937	800					2,930	4,687
19	11	400.8	L	1899	514.1	1937	900					3,142	4,447
19	17	404.2	L	1902		1937	870					2,516	5,039
19	18	404.3	L	1902	515.8	1937	320	510.8				2,591	4,143
19	20	404.6	R	1903	515.9	1935	450		REM 1935			1,154	1,988
19	19	404.9	R	1903	516.0	1937	3020	513.0	REP 1908			5,031	9,460
19	3	405.2	CR	1881	516.7	1937	460					1,225	960
19	22	405.3	CR	1905		1937	70				GONE	204	262
19	16	405.5	CL	1897	513.4	1935	2080		REM 1935	RA 1900, REP 1902 & 1912		2,614	6,974
19	8	405.7	L	1890	516.1	1937	280	514.1	EXT 660' 1900			3,652	5,166
19	10	405.8	L	1890		1910	320	515.2	REM 1901	REP 1891	GONE	515	752
19	2	406.0	CR	1881		1937	196				GONE	1,198	1,013
19	11	406.0	L	1900	516.7	1937	440					1,586	3,291
19	7	406.2	L	1900	516.8	1937	380	513.8				1,444	2,963
19	6	406.3	L	1890	516.5	1937	570	515.0	REP 1905	REP 1891		2,240	2,313
19	9	406.3	R	1891	516.9	1937	810		REP 1900			2,146	3,403
19	5	406.5	L	1890	516.6	1937	340	514.1	REP 1900	REP 1891		1,425	1,303
19	12	406.8	R	1891		1937	945		REP 1900			2,137	1,822
19	4	406.9	CR	1889		1937	830		REP 1900	RA 1891 & 1892, REP 1894 & 1896		10,842	6,666
19	1	407.0	CR	1877		1937			REP 1897	REP 1878, 1880, 1889, 1890, 1894 & 1896		1,464	3,286
19	21	407.5	CR	1905		1937	400				O'CONNELL SLOUGH	1,619	2,542
19	13	408.0	L	1897	518.0	1937	410	515.0				974	2,311
19	14	408.2	L	1897	518.0	1937	540	516.0				1,040	1,774
19	15	408.4	CR	1897	518.1	1937	486					932	2,521
19	23	408.8	CR	1948	521.0	1948	1800					13,904	0
19	4	410.0	CR	1905		1937	370	513.7				1,355	1,999

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
18	6	412.8	CL	1915	520.0	1937	650	524.0	REP 1929			2,765	2,883
18	10	412.8	R	1915	521.0	1937	720	515.5	REP & EXT 225' 1929			786	1,183
18	7	412.9	L	1915	524.0	1937	400	523.5	REP 1929		BUILT ON SAND FILL	1,033	1,406
18	9	413.0	R	1915	524.5	1938	810	522.0	REM 150' 1938	EXT 70' 1929	BUILT ON SAND FILL 608'	864	2,118
18	8	413.2	R	1915	521.1	1937	820	518.8	REP 1929		BUILT ON SAND FILL 175'	1,494	3,079
18	5	413.3	CL	1915	521.1	1937	660	517.8			NOT COMPLETE, SANDED IN	1,365	2,749
18	19	413.4	R	1927	522.2	1937	425	522.2				432	880
18	20	413.5	L	1929	526.3	1937	1425	524.8				1,687	0
18	16	413.8	L	1927	521.4	1938	850	521.0	REM 300' 1938			862	1,868
18	15	413.9	L	1927	521.4	1983	700	521.4	REP 1983			845	459
18	18	414.0	R	1927	521.4	1937	504	522.9				383	628
18	17	414.2	R	1927	521.5	1937	980	518.5				998	1,412
18	14	415.0	R	1927	521.8	1983	835	521.8	REP 1983			755	1,008
18	13	415.3	R	1927	521.9	1937	1050	520.5				987	1,227
18	12	415.7	R	1927	522.1	1983	550	522.1	REP 1983			965	685
18	1	415.8	R	1897	524.1	1937	870	520.6	REP & EXT 200' 1927	REP 1900		2,889	5,093
18	2	415.8	CR	1897	521.1	1937	1400	521.0	REP 1931	RA 1900, REP 1927, 1928 & 1929		4,772	5,753
18	11	415.9	R	1927	522.1	1937	1425	520.1				2,187	1,891
18	3	416.3	R	1900	521.2	1937	1140	521.0				5,623	9,416
18	6	416.7	R	1897	520.4	1937	1960	521.4	REP & EXT 1927			6,773	9,794
18	5	417.0	R	1897	521.5	1937	1480	520.5	REP & EXT 1927			3,921	4,722
18	29	417.0	L	1927	522.5	1937	775	523.0				1,543	462
18	4	417.2	R	1897	521.5	1937	1180	519.9	REP 1927			2,091	2,482
18	28	417.2	L	1927	522.5	1937	1475	520.9				1,753	2,759
18	25	417.4	R	1927	523.6	1937	425	521.5				853	6,260
18	27	417.7	L	1927	521.7	1937	2050	521.0				1,697	2,772
18	26	417.9	L	1927	527.8	1937	2590	520.5				3,166	2,668
18	31	418.2	L	1929	522.9	1937	1600	522.0				2,268	5,889
18	14	418.5	L	1924		1937	1400	519.5				2,501	5,647
18	15	418.9	L	1924		1938	1000	521.9	REM 275' 1938			2,579	8,962
18	18	418.9	R	1924		1937	700	519.4				1,439	4,389
18	11	419.1	R	1918	522.2	1937	100	521.2				208	359
18	13	419.2	R	1918	522.3	1937	320	519.0				434	1,220
18	16	419.2	L	1924		1938	600	521.8	REM 350' 1938			2,202	6,194
18	12	419.4	R	1918	522.3	1937	600	520.0				1,097	2,902
18	17	419.4	L	1924		1938	450	521.8	REM 200' 1938			477	1,906
18	10	419.5	CR	1918	522.4	1937	1717	520.1			NOT COMPLETED	3,374	9,536
18	1	419.8	CL	1892	522.5	1963	568	521.5	RA & REB 450' DNSTRM 1963	REP 1899 & 1923		1,206	2,403
18	30	419.9	L	1927	523.6	1963	700	521.2	RA & REP 1963			1,129	855
18	2	420.3	CR	1895	522.7	1992	1400	525.0	RA & REP 1992			2,120	6,878
18	24	420.4	R	1926	522.7	1992	950	525.0	RA & REP 1992			1,504	5,926
18	23	420.6	R	1926	522.8	1992	600	525.0	RA & REP 1992			849	1,355
18	22	420.9	R	1926	523.0	1992	600	525.0	RA & REP 1992			1,509	2,500
18	21	421.1	R	1926	523.1	1992	450	525.0	RA & REP 1992			581	1,010
18	20	421.3	R	1926	523.2	1992	450	525.0	RA & REP 1992			2,360	4,267
18	7	421.5	CR	1903	523.3	1963	400	522.3	REP 1963	REP 1924, RA & REP 1954		732	1,054
18	19	421.5	R	1926	523.3	1992	450	525.0	RA & REP 1992			1,098	5,450
18	9	421.8	R	1905	523.4	1937	860	523.1	EXT 1924			2,340	6,478

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
18	3	421.9	CR	1895	524.4	1963	900	519.8	REP 1963	REP 1905, REP & EXT 150' 1927, RA & REP 1954		1,822	5,590
18	8	421.9	R	1905	523.3	1937	910	523.3	EXT 1924			2,276	6,539
18	9	422.5	R	1903	527.2	1937	1475	528.7	REP & EXT 440' 1929			3,107	5,683
18	8	422.7	R	1903	526.6	1937	1490	527.8	REP & EXT 750' 1929			2,985	4,930
18	34	423.1	R	1928	524.0	1937	1320	523.3				951	1,526
18	32	423.4	R	1928	524.1	1937	1260	522.4				2,446	7,937
18	4	423.7	CR	1899	524.2	1991	445	524.2	REP 1991			956	894
18	5	423.8	R	1899	524.2	1991	1420	524.2	REP 1,150' 1991	REP 1928		1,649	2,057
18	7	424.0	L	1899	524.4	1937	450	522.1	REP 1925			984	1,463
18	35	424.1	R	1928	524.4	1991	1220	524.4	REP 340' 1991			1,162	1,256
18	6	424.4	L	1899	524.5	1937	1320	523.9	REP 1925			3,320	4,033
18	33	424.4	R	1928	524.6	1991	615	524.6	REP 500' 1991			756	718
18	3	424.7	L	1899	524.6	1991	1200	524.6	REP 1991	REP & EXT 260' 1925		4,254	4,838
18	30	424.7	R	1925	524.7	1991	600	524.7	REP 480' 1991			850	2,805
18	2	425.0	L	1899	524.9	1991	1660	524.9	REP 1991	REP & EXT 350' 1925		4,303	5,694
18	18	425.2	CR	1889	525.9	1991	555	525.9	REP 1991	REP 1891, 1892, 1895,1897 & 1928, RA & REP 1953, REP		3,072	2,092
18	16	425.3	L	1891	523.5	1986	1780	523.5	REP 1986	RA 1899, REP & EXT 200' 1925, REP 1985		4,689	8,485
18	15	425.7	L	1889	525.3	1986	2155	525.3	REP 1986	REP 1891, RA & EXT 125' 1899, REP 1923, REP 1985		6,392	5,773
18	29	425.7	R	1925	525.2	1937	580	523.7				774	3,332
18	14	426.0	L	1892	525.4	1986	2000	525.4	REP 1986	RA & EXT 500' 1899, REP 1923, REP 1985		5,378	9,044
18	28	426.0	R	1925	525.4	1937	1240	522.2				2,886	8,900
18	13	426.2	L	1892	525.5	1986	1110	525.5	REP 1986	RA 1899, REP 1923, REP 1926		4,480	4,015
18	26	426.3	R	1925	525.6	1937	1545	523.1				2,124	9,701
18	31	426.5	L	1928	525.7	1986	365	525.7	REP 1986			801	2,614
18	27	426.6	R	1925	525.8	1985	670	525.8	REP 1985			969	4,518
18	21	426.9	CR	1923	526.0	1937	290	524.3				919	1,416
18	25	426.9	R	1923	526.0	1937	685	524.0				1,840	3,964
18	1	427.0	CL	1889	527.0	1981	495	527.0	REP 1981	REP 1928		3,538	1,999
18	23	427.2	R	1923	526.1	1937	1000	524.8				3,688	9,270
18	24	427.4	R	1923	526.2	1937	1020	526.1				1,705	3,938
18	22	427.7	R	1923	526.4	1937	940	524.8				2,134	5,620
18	12	428.0	R	1905	526.5	1937	1105	525.1	EXT 200' 1919, SAND FILL			1,740	4,764
18	10	428.2	R	1904	526.7	1937	1225	524.8	EXT 370' 1919	200' SAND FILL REP 1918		3,134	7,445
18	20	428.4	R	1918	526.7	1937	1100	524.3				2,297	7,199
18	11	428.6	R	1905	526.8	1910	465		REM 1910			772	1,665
18	19	428.6	R	1916	526.3	1937	580	526.4	REP & EXT 1919			2,828	6,410
18	24	428.7	R	1919	530.1		580				GONE	239	456
18	2	428.8	R	1905	526.9	1949	170		REM 400' 1949	REP 1919		812	1,588
18	37	428.8	R	1928	526.9	1937	1110					927	2,149
18	1	428.9	R	1904	526.9	1954	1130		RA & REP 1954	REP 1909 & 1928		3,730	5,730
18	39	429.1	R	1928	527.0	1986	1585	527.0	REP 1986			1,375	1,748
18	36	429.4	R	1928	527.2	1986	1430	527.2	REP 1986			2,282	2,160
18	40	429.7	CR	1928	527.0	1928	100				GONE	15	60
18	38	429.8	R	1928	527.3	1937	1520					2,121	2,255
18	35	430.1	R	1928	527.5	1937	1800					1,975	1,768
18	20	430.5	R	1927	533.6	1937	1930					1,660	1,969
18	21	430.8	R	1927	523.7	1937	1735		REM 150' 1932			2,289	3,868
18	23	431.1	R	1927	529.8	1937	1527		REM 335' 1932			1,839	3,814

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
18	24	431.3	R	1927	529.8	1937	829		REM 215' 1932			2,325	1,935
18	31	431.4	L	1927	528.8	1937	450					735	2,200
18	25	431.5	R	1927	529.9	1937	495		REM 65' 1932			1,861	6,183
18	30	431.6	L	1927	528.9	1937	770					1,387	2,948
18	26	431.8	R	1927	531.0	1937	798					508	108
18	13	431.9	L	1926	530.0	1937	400		EXT 100' 1927			6,826	2,545
18	12	432.1	L	1926	529.1	1937	370					9,931	965
18	27	432.1	R	1927	530.1	1937	1170					853	1,299
18	29	432.6	R	1927	530.3	1985	1050	530.3	REP 1985			2,160	1,015
18	18	433.0	R	1927	535.4	1937	1155					4,298	4,776
18	15	433.5	R	1927	531.6	1978	1400	531.6	REP 1978			2,751	4,915
18	28	433.7	L	1927	534.7	1985	430	534.7	REP 1985			504	755
18	16	433.8	R	1927	531.7	1937	500					1,108	3,166
18	22	434.0	L	1927	529.7	1937	1190					1,832	1,548
18	17	434.2	CR	1927	531.8	1947	1300		REM 500' 1947	REP 1931		2,734	3,358
18	19	434.3	L	1927	536.8	1937	1175					2,066	940
18	14	434.7	L	1927	533.9	1937	1655					1,972	1,486
18	8	435.0	L	1924		1937	1505					2,960	7,981
18	3	435.3	R	1916	530.1	1937	580					870	2,092
18	7	435.3	CL	1919		1937	1210					2,547	6,946
18	6	435.6	R	1918	529.2	1937	500					996	3,041
18	9	435.7	L	1924		1937	780					1,517	4,465
18	5	435.8	R	1917	529.2	1937	720					1,508	3,417
18	11	435.9	L	1924	530.2	1937	280		EXT 250' 1927			408	1,226
18	10	436.0	R	1924		1937	400					1,063	3,937
18	34	436.7	CR	1927	530.5	1937	460					1,033	2,135
18	32	437.0	R	1927	529.6	1937	459		REM 141' 1935			1,817	4,347
18	33	437.2	R	1927	530.6	1937	449		REM 151' 1935		GONE	1,181	3,979

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
17	4	437.4	R	1917	529.7	1937	675		REP 1927			1,025	2,685
17	20	437.6	R	1917	529.8	1937	720		REP & EXT 325' 1927			2,287	5,896
17	19	437.8	R	1917	529.9	1937	450		REP 1927			1,631	3,244
17	17	437.9	L	1917	529.9	1938	640		REM 600' 1938	REP 1926		1,243	3,102
17	18	438.0	CR	1917	530.0	1937	160		REP 1927			1,189	1,167
17	41	438.1	L	1926	530.0	1938	785		REM 730' 1938			1,194	2,735
17	42	438.4	L	1926	530.1	1938	670		REM 650' 1938			579	1,073
17	37	438.6	L	1926	530.2	1938	460		REM 450' 1938			763	918
17	39	439.0	R	1926	530.3	1937	878					823	1,813
17	8	439.2	CR	1901	530.4	1937	920	528.6	REP 1926			3,125	4,695
17	36	439.2	CL	1926	530.4	1937	405					441	839
17	40	439.2	R	1926	530.4	1937	881		REP 1928			1,101	2,453
17	35	439.4	L	1926	530.4	1937	365					260	901
17	38	439.5	R	1926	530.4	1937	840					830	2,412
17	34	439.6	L	1926	530.5	1937	420					280	861
17	32	439.8	L	1926	530.6	1937	450					297	905
17	33	439.8	R	1926	530.6	1937	255					1,439	3,191
17	14	440.9	L	1916	526.9	1916	48					10	49
17	13	441.3	L	1916	531.0	1937	1050					1,878	5,926
17	9	441.4	CL	1908	535.5	1909	160		REP 1909		GONE	396	646
17	12	441.5	L	1916	531.1	1937	1140					1,621	4,960
17	11	441.8	L	1916	531.3	1916	840					1,297	3,599
17	44	442.8	R	1928	531.7	1937	409					348	1,698
17	45	443.0	R	1928	531.8	1937	710					631	799
17	43	443.2	R	1928	531.9	1937	700					582	428
17	15	443.3	CL	1917	531.9	1937	180					1,758	1,853
17	16	443.6	R	1917	532.0	1937	1080		REP 1934			2,308	5,820
17	22	443.8	R	1924		1937	945		REM TOP & ENDS 1935	REP 1934		1,468	3,750
17	21	444.1	R	1924		1937	850		REM TOP & ENDS 1935	REP 1934		2,245	4,673
17	1	444.2	CL	1895	532.8	1937	950	530.2	REP 1935	REP 1899, 1917, 1925 & 1934		3,710	5,267
17	7	444.4	R	1899	532.4	1937	855	533.0	REP 1935	EXT 200' 1924, REP 1934		2,318	3,792
17	6	444.6	R	1899	532.5	1937	850	533.3	REP 1935	REP 1934		2,279	2,710
17	10	444.6	CR	1908	532.5	1937	120		REP 1927		GONE	222	370
17	4	444.8	L	1899	532.6	1937	1490	530.0				6,082	7,508
17	5	444.8	R	1899	532.5	1937	555	533.1	REP 1935	REP 1934		2,636	2,640
17	3	445.0	L	1895	532.6	1937	160	531.6	REP 1899			1,880	4,322
17	29	445.2	L	1925		1937	390					536	1,794
17	30	445.5	L	1925		1937	695					1,622	4,739
17	31	445.7	L	1925		1937	440					1,547	3,668
17	25	445.9	R	1925		1937	525					3,942	1,997
17	2	446.1	CL	1895	533.0	1937	1110	531.1	REP 1925	REP 1899		3,192	4,168
17	23	446.1	R	1925		1937	1120		REM TOP 1935			1,788	5,814
17	24	446.4	R	1925		1937	490		REM TOP 1935			946	3,386
17	27	446.4	L	1925		1937	600					804	3,259
17	28	446.6	L	1925		1937	620					1,516	4,805
17	26	446.7	R	1925		1937	620					812	3,284
17	9	447.0	R	1925	533.4	1937	1060	531.1				1,008	5,322
17	7	447.3	CR	1916	533.2	1937	870	532.7				1,300	2,361

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
17	8	447.5	R	1917	533.6	1937	1560	530.7				2,090	5,151
17	10	447.6	L	1925	533.6	1937	620	531.6				731	3,261
17	6	447.8	R	1916	533.7	1937	1980	533.2				2,812	6,978
17	5	448.0	R	1916	533.8	1937	1070	531.4				1,601	5,019
17	22	448.3	L	1928	533.8	1937	275	536.0				837	544
17	21	448.5	L	1928	533.9	1937	470	536.9				843	458
17	4	448.8	L	1916	534.0	1937	2255	532.7				3,573	9,409
17	20	449.2	L	1928	534.0	1937	1238	538.0				1,409	947
17	19	449.5	L	1928	534.1	1937	889	539.1				1,357	1,296
17	18	449.7	L	1928	534.2	1937	625	537.8				1,555	848
17	11	450.0	L	1928	534.2	1937	612	531.9				221	871
17	28	450.2	L	1933	534.3	1937	830	534.4				1,009	1,202
17	27	450.3	L	1933	534.3	1937	700	534.6				1,430	1,144
17	26	450.6	L	1933	534.4	1937	565	535.2				984	944
17	25	450.8	L	1933	534.4	1937	615	534.8				1,006	1,037
17	17	451.1	L	1928	534.5	1937	790	535.1				1,003	842
17	16	451.4	L	1928	534.5	1937	1200	536.3				918	1,280
17	15	451.7	L	1928	534.6	1937	1310	535.6				2,396	7,048
17	3	451.9	CL	1928	536.6	1937	570	528.3				1,814	3,740
17	13	452.1	L	1928	534.6	1937	1300	537.6				1,475	1,708
17	2	452.4	L	1928	534.7	1937	1320	536.0				1,572	1,174
17	14	452.7	L	1928	534.8	1937	1340	534.7				1,374	1,562
17	12	453.0	L	1928	534.9	1937	1650	534.7				2,029	3,896
17	1	454.4	CL	1916	535.1	1937	1670	532.6	RA 1924			16,120	2,019
17	24	455.0	L	1928	535.3	1937	1290	536.2				1,619	2,144
17	23	455.4	L	1928	535.4	1937	1150	533.9				2,368	7,654
17	30	455.8	L	1924	535.5	1937	585	536.2			GONE	558	1,717
17	35	455.8	L	1928	535.5	1937	1150	540.5				1,124	1,981
17	9	456.1	R	1896	534.6	1937	750	532.5				2,124	2,529
17	34	456.2	L	1928	535.7	1937	820	538.2				1,112	748
17	8	456.3	R	1896	534.7	1937	1000	531.2				2,674	2,823
17	7	456.4	R	1896	534.8	1937	1110	532.8				3,609	3,594
17	17	456.5	L	1898	535.9	1937	700	538.4	REM 1935	REP 1928		2,695	2,276
17	18	456.7	L	1898	535.9	1937	300	540.3	REM 1935	REP 1899 & 1928		2,177	1,056
17	27	457.2	R	1924	536.1	1935	425				REM	726	2,065

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
16	25	457.4	R	1924	536.2	1935	500				REM	573	1,509
16	24	457.6	R	1924	536.3	1937	435	533.2				728	1,621
16	29	457.7	L	1924	537.4	1937	590	535.8	REP & EXT 200' 1927			840	3,387
16	26	457.9	L	1924	537.5	1968	1135	536.0	RA & REP 1968	REP 1927		2,098	6,462
16	14	458.0	CR	1897	536.4	1937	133	536.8	REP 1928	REP 1898, 1899 & 1924		820	433
16	13	458.1	CR	1897	536.6	1937	325	539.4	REP 1928	REP 1898, 1904 & 1924		1,355	1,115
16	6	459.7	CL	1889	537.2	1937	1240	537.4	REP 1927	REP 1916		10,289	8,435
16	16	459.8	CR	1898	537.3	1898	100				GONE	185	190
16	33	460.0	CL	1927	537.4	1937	308	534.4				643	2,458
16	31	460.1	L	1927	537.4	1937	650	544.6				329	527
16	21	460.3	L	1913	537.5	1937	655	539.5	REP 1927			1,049	2,791
16	32	460.3	R	1927	537.5	1937	325	545.5				134	381
16	20	460.5	L	1913	537.6	1937	335	539.9	REP 1926			822	642
16	22	460.5	R	1914	537.6	1937	610	537.6	REP 1924			2,122	5,507
16	4	460.7	CL	1889	539.2	1937	230	537.0	REP 1926			2,285	1,820
16	28	460.7	R	1924	537.7	1937	920	534.9				940	3,458
16	23	460.9	R	1914	537.9	1937	580	537.1				1,098	3,099
16	11	461.0	CL	1897	537.9	1994	1240	541.0	RA, REP 1240' & EXT 90' 1994	REP 1898 & 1928	GONE	5,310	3,740
16	3	461.1	CL	1889	538.9	1937	180	536.1	REP 1916	REP 1899		2,227	1,884
16	10	461.1	CL	1897	538.0	1897	347				GONE	1,378	988
16	2	461.2	CL	1889	539.0	1937	455	536.1	REP 1924	REP 1914 & 1916		2,829	2,432
16	19	461.5	R	1913	538.2	1994	650	541.0	RA & REP 650' 1994			1,044	2,888
16	15	461.8	CR	1898	538.3	1898	132				GONE	211	200
16	12	462.1	R	1897	537.4	1937	1780	536.3				5,250	6,137
16	1	462.6	L	1895	538.6	1937	540	536.8				1,399	1,435
16	4	462.8	R	1895	538.6	1994	960	541.0	RA & REP 960' 1994	REP 1896 & 1916, REM 210' 1939		2,445	2,594
16	46	462.8	L	1916	538.6	1916	620				SILTED IN	435	1,175
16	2	463.0	L	1895	538.7	1994	550	541.0	RA & REP 550' 1994	REP 1896, REP 1916		3,018	2,463
16	3	463.0	R	1895	538.7	1994	560	541.0	RA & REP 560' 1994	REP 1896, REP 1916		2,122	1,945
16	44	463.4	L	1915	538.9	1937	385	539.5				604	1,607
16	36	463.5	L	1915	539.0	1937	2790	538.5				6,681	16,919
16	39	463.5	L	1915	539.0	1994	680	541.0	RA & REP 680' 1994			727	1,668
16	40	463.8	L	1915	539.1	1994	940	541.0	RA & REP 940' 1994			1,973	5,007
16	43	464.0	L	1915	539.1	1937	670	538.3				1,129	3,099
16	45	464.0	R	1915	539.1	1937	800	539.2				1,427	3,786
16	38	464.1	L	1915	539.2	1937	140	538.7				638	1,620
16	42	464.2	R	1915	539.2	1937	1100	537.1				1,981	5,172
16	37	464.4	L	1915	539.3	1937	260	538.3				627	1,590
16	41	464.5	R	1915	539.4	1937	885	538.2				1,803	4,637
16	23	464.7	R	1912	539.5	1937	540	537.3				865	1,507
16	22	464.9	R	1912	539.6	1937	810	536.6				1,459	2,475
16	20	465.0	CL	1911	539.6	1937	410	538.9	REP 1915			1,087	1,139
16	19	465.2	R	1911	540.2	1937	540	538.1				2,681	5,352
16	21	465.2	R	1912	539.7	1937	380	538.7			GONE	1,137	1,687
16	18	465.4	R	1911	540.3	1937	740	538.2				3,878	7,754
16	33	465.6	R	1914	539.9	1937	410	537.2				924	2,607
16	17	465.8	R	1910	540.5	1937	990	538.5				2,716	5,687
16	16	466.0	R	1910	540.6	1937	840	538.6				2,890	6,555

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
16	32	466.1	L	1914	540.1	1939	650	538.9	REM 150' 1939			662	1,437
16	29	466.2	R	1914	540.2	1937	650	537.5				1,285	3,480
16	30	466.4	R	1914	540.2	1937	580	542.4				995	2,823
16	31	466.6	R	1914	540.3	1937	605	539.0				836	2,696
16	35	466.8	R	1914	540.4	1937	578	547.2	REP 1928			1,352	4,234
16	28	467.0	L	1914	540.5	1937	190	534.9				457	685
16	34	467.0	R	1914	540.5	1937	470	539.5	REP 1928			2,074	4,673
16	15	467.2	CL	1904	540.6	1937	1230	541.5	REP 1928	REP & EXT 735' 1914		1,606	4,382
16	26	467.2	L	1914	540.6	1937	410	541.6	REP 1928			362	745
16	14	467.4	L	1904	540.7	1937	300	540.0	REP 1914			479	1,385
16	27	467.4	L	1914	540.7	1937	875	541.7	REP 1928			559	1,723
16	13	467.6	L	1904	540.8	1937	625	541.8	REP 1928	REP & EXT 225' 1914		1,100	3,438
16	24	467.7	L	1913	538.8	1937	100	540.3	REP 1928			977	993
16	12	467.8	L	1904	540.8	1937	190	541.8	REP 1928			495	1,441
16	11	467.9	L	1903	540.9	1937	325	542.4	REP 1928			1,025	1,956
16	0	468.1	L	1887	541.0	1937	92	542.0	REP 1928	REP 1915	GONE	411	0
16	10	468.1	L	1897	541.0	1937	405	542.8	REP 1928	REP 1915		1,556	2,199
16	9	468.3	L	1897	541.1	1937	840	539.6	REP 1928	REP & EXT 450' 1915		2,580	4,892
16	8	468.5	L	1897	541.2	1937	970	539.8	REP & EXT 475' 1915			2,217	4,025
16	7	468.7	L	1897	541.3	1937	950	540.3	REP & EXT 475' 1915			2,391	4,380
16	6	468.9	L	1897	541.5	1937	900	540.4	REP & EXT 415' 1915			3,264	5,726
16	5	469.0	L	1897	541.5	1937	870	540.1	REP & EXT 300' 1915			3,080	4,646
16	25	469.3	L	1913	541.6	1937	770	537.1				1,843	5,748
16	39	469.5	L	1913	541.7	1937	880	538.8				1,677	4,913
16	38	469.7	L	1913	541.7	1937	965	540.2				1,491	4,552
16	45	469.9	L	1914	541.8	1937	935	540.5				1,018	2,433
16	36	470.1	R	1913	541.9	1937	400	539.0				615	1,664
16	44	470.1	L	1914	541.9	1937	735	540.5				931	2,522
16	37	470.2	R	1913	542.0	1938	465	539.2	REM 200' 1938			1,502	4,007
16	40	470.4	R	1913	542.0	1938	330	537.6	REM 250' 1938			2,064	5,252
16	31	470.5	CL	1912	542.0	1937	450	541.5	REP 1915	EXT 400' 1913		1,215	1,714
16	32	470.5	L	1912	542.0	1937	235	541.0	EXT 200' 1913			590	1,112
16	41	470.6	R	1913	542.1	1937	330	540.3				716	1,883
16	35	470.8	L	1913	542.2	1938	1020	541.4	REM 100' 1938			2,425	5,361
16	42	470.8	R	1913	542.2	1937	375	539.7				535	1,159
16	34	471.0	L	1913	542.4	1938	1065	541.2	REM 130' 1938			2,181	4,686
16	33	471.2	L	1913	542.4	1937	1170	540.5				1,763	4,002
16	43	471.5	L	1913	542.5	1937	320	540.0				847	1,851
16	26	472.0	CL	1912	542.7	1990	887	542.7	REP 350' 1990	REP 1915		1,833	1,914
16	30	472.0	R	1912	542.8	1990	550	542.8	REP 1990		NOT COMPLETED	607	1,190
16	27	472.2	R	1912	542.8	1937	250	541.2	EXT 200' 1913			833	1,236
16	28	472.6	R	1912	542.9	1990	1080	542.0	REP 1990			2,470	4,847
16	1	472.7	CL	1884	544.0	1990	1110	540.3	REP 1928	REP 1887 & 1895		8,548	3,298
16	29	472.8	R	1912	543.0	1990	550	542.0	REP 1990			1,681	3,187
16	PR	472.9	L	1897	549.0	1907	240		REP 1907		PIER AT ANDALUSIA, IL.	1,405	325
16	8	473.0	L	1896	543.1	1957	750	541.8	REM 600' 1957	EXT 200' 1899, REP 1912		3,134	3,353
16	7	473.1	L	1896	543.2	1957	770	542.0	REM 550' 1957	REP & EXT 270' 1912		1,133	1,786
16	2	473.3	CL	1881	543.3	1937	130	542.1	REP 1915	REP 1884 & 1912		1,405	851

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
16	6	473.3	L	1896	543.2	1957	600	543.4	REM 350' 1957	EXT 200' 1899, REP 1912		2,155	2,658
16	18	473.5	L	1908	543.3	1957	575	542.7	REM 300' 1957	REP 1912		1,230	2,289
16	25	473.5	R	1912	543.3	1937	330	542.8				692	1,285
16	24	473.6	R	1912	543.3	1937	310	541.7				710	1,168
16	3	473.7	CL	1895	544.3	1937	300	543.0	REP 1915	REP 1907 & 1912		2,757	3,583
16	16	473.7	L	1907	543.3	1957	975	542.5	REM 200' 1957	REP 1912		1,194	2,227
16	4	473.9	L	1895	543.4	1937	900	542.9	REP 1912			3,501	3,726
16	19	473.9	R	1908	543.4	1937	630	543.1	REP 1912			770	1,588
16	5	474.1	L	1896	543.5	1937	820	542.7	REP 1912			2,793	2,569
16	17	474.1	R	1907	543.5	1937	570	542.4	REP 1912			695	1,530
16	15	474.3	R	1907	543.5	1937	430	542.6	REP 1912			735	1,578
16	23	474.3	L	1912	543.5	1937	1010	543.0				2,138	3,449
16	10	474.5	R	1907	543.6	1937	120	542.2	REP 1912			632	1,376
16	22	474.5	L	1912	543.6	1937	935	542.8				2,162	3,250
16	9	474.7	R	1907	543.7	1907	130		EXT 130' 1912		GONE	406	551
16	21	474.7	L	1911	543.7	1937	830	543.0				1,879	3,529
16	20	474.9	L	1911	543.8	1968	615	542.8	REM 240' 1968			1,587	2,679
16	14	475.1	L	1903	543.9	1968	620	542.7	REM 260' 1968	REP & EXT 450' 1908, REP 1912		1,211	2,293
16	13	475.3	L	1903	543.9	1968	1250	542.6	REM 470' 1968	EXT 380' 1907, REP & EXT 310' 1912		2,254	4,318
16	12	475.5	L	1903	544.0	1968	940	542.6	REM 520' 1968	EXT 280' 1907, REP & EXT 220' 1912		1,996	4,158
16	11	475.7	L	1903	544.1	1968	860	543.8	REM 530' 1968	REP & EXT 225' 1907, REP 1912 & 1913		2,138	9,788
16	22	475.9	R	1901	544.1	1937	320	542.6				574	897
16	19	476.0	L	1901	544.2	1968	2170	538.3	REM 470' 1968	REP & EXT 220' 1907		3,081	5,084
16	21	476.1	R	1901	544.2	1968	530	541.4	REM 160' 1968			953	1,498
16	18	476.2	L	1901	544.2	1968	1340	541.9	REM 320' 1968	REP & EXT 210' 1907		2,343	3,683
16	16	476.3	L	1901	544.3	1968	1260	542.4	REM 300' 1968	REP & EXT 250' 1907		2,163	3,858
16	20	476.3	R	1901	544.3	1937	760	543.2				1,617	2,243
16	15	476.5	L	1901	544.3	1968	1120	542.1	REM 250' 1968	REP & EXT 266' 1907, REP 1911		2,030	4,388
16	32	476.5	CL	1911	544.3	1937	1225	543.7				2,355	4,923
16	14	476.6	L	1901	544.3	1968	730	542.7	REM 110' 1968	REP & EXT 90' 1907, REP 1911		1,447	2,752
16	24	476.8	R	1901	544.4	1967	290	542.6	REM 210' 1967	REP 1913		464	647
16	25	476.8	L	1901	544.4	1937	730	542.7	EXT 100' 1912			2,043	1,424
16	26	476.9	L	1901	544.4	1937	380	544.4				361	680
16	23	477.0	R	1901	544.5	1967	390	542.5	REM 200' 1967	REP 1904		568	1,053
16	28	477.1	L	1901	544.5	1967	690	542.9	REM 170' 1967	EXT 350' 1912, REP 1913		5,497	450
16	17	477.2	R	1901	546.5	1967	340	543.4	REM 170' 1967	RA 1904, REP & EXT 200' 1926		3,447	743
16	13	477.3	CR	1901	546.5	1937	1545	548.2	REP 1931	REP 1902, 1912, 1913, 1914, 1925 & 1926		1,298	1,424
16	27	477.3	L	1901	544.6	1967	1100	540.5	REM 430' 1967	EXT 70' 1912, REP 1913		3,892	3,225
16	29	477.5	L	1902	544.6	1967	840	542.5	REM 140' 1967			9,491	635
16	30	477.7	L	1902	544.7	1967	910	542.5	REM 90' 1967			6,265	1,710
16	31	478.0	L	1902	544.7	1967	1000	543.2	REM 70' 1967			7,739	0
16	12	478.1	R	1897	544.8	1937	480	542.5	REP 1926	REP 1912 & 1914		1,158	1,270
16	11	478.2	L	1897	543.8	1967	890	542.9	REM 60' 1967			2,665	3,134
16	10	478.4	L	1897	543.8	1937	600	542.1	REP 1913			2,823	3,168
16	7	478.6	R	1896	543.9	1967	610	541.4	REM 150' 1967			7,016	8,001
16	8	478.6	R	1896	543.9	1937	1500	543.0				2,555	2,725
16	9	478.6	L	1897	543.9	1937	438	543.6				1,060	1,053
16	6	478.7	R	1896	544.0	1967	990	541.9	REM 220' 1967	REM 170' 1939		4,431	5,164

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
16	5	479.0	R	1896	546.0	1967	913	546.2	REM 260' 1967	REP 1929, REM 190' 1939		4,054	3,382
16	A	479.1	L	1896	545.2	1937	250	542.7	REP 1892		ROCK RIVER MOUTH	0	0
16	B	479.1	L	1896	545.2	1937	345	543.4	REP 1892		ROCK RIVER MOUTH	0	0
16	C	479.1	L	1896	545.2	1937	735	543.5	RA & REP 1902		ROCK RIVER MOUTH	0	0
16	3	479.2	R	1896	546.2	1967	612	546.4	REM 200' 1967	REP 1929, REM 445' 1939		2,818	2,477
16	2	479.4	R	1896	546.2	1967	1015	546.2	REM 200' 1967	REP 1929, REM 415' 1939		3,260	3,008
16	4	479.6	R	1896	546.3	1937	790	544.5	REM 240' 1939	REP 1929, REM 50' 1936		2,392	1,862
16	84	479.8	CL	1897	547.4	1937	187	548.4	RA & REP 1902		GONE	1,000	0
16	38	479.9	R	1929	546.0	1937	720	542.5				3,260	8,809
16	37	480.2	R	1929	546.0	1937	515	542.0				2,688	6,956
16	36	480.4	R	1929	546.0	1937	690	544.0				1,675	4,335
16	34	480.7	R	1929	546.6	1937	760	543.7				2,648	7,609
16	1	480.8	CR	1896	549.6	1937	1470	555.6	RA & REP 1903		ROAD FOR CREDIT IS.	5,059	5,323
16	35	481.0	R	1929	546.2	1937	1426	546.3				1,898	1,763
16	33	481.2	R	1929	546.9	1937	990	544.7				2,572	7,421

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	MOST RECENT SURVEY LENGTH	MOST RECENT SURVEY ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
15	30	486.2	R	1912		1936			REM 1025' 1936			0	0
15	31	486.4	R	1912		1936			REM 839' 1936			0	0
15	16	486.5	R	1895		1936	1150		REM 915' 1936	REP, WID & EXT 500' 1899		9,121	0
15	27	486.6		1898		1899	400				GONE	6,398	0
15	20	486.7		1897		1899	1600		REM 1899		GONE	9,253	1,919
15	26	486.7		1898		1899	350				REM	2,549	0
15	32	486.7	LR	1912		1936			REM 722' IA & 300' IL 1936			0	0
15	25	486.8		1898		1899	450				REM	3,678	0
15	24	486.9		1898		1899	400				REM	5,712	0
15	33	486.9	LR	1912		1936			REM 290' IA & 550' IL 1936			0	0
15	23	487.0		1898		1899	300				GONE	4,590	0
15	22	487.1		1898		1899	200				GONE	4,705	0
15	34	487.1	LR	1912		1936			REM 100' IA & 500' IL 1936			0	0
15	21	487.2		1897		1899	825		WID 1898		GONE	9,823	0
15	35	487.3	R	1912		1936			REM 200' 1936			0	0
15	17	487.4		1895		1899	600		WID 1898	REP 1896	GONE	9,630	0
15	19	487.5		1896		1899	500				GONE	4,920	0
15	36	487.5	LR	1912		1936			REM 400' IA & 200' IL 1936			0	0
15	18	487.6	R	1896		1936	1330		REM 500' 1936		GONE	2,420	880
15	37	487.7	LR	1912		1936			REM 400' IA & 300' IL 1936			0	0
15	10	487.8	CL	1892		1936	605		REM 500' 1936			0	0
15	94	487.9	R	1895		1936	1250		REM 1200' 1936			7,223	1,090
15	11	487.9		1895		1899	2435		REM 800' 1897	EXT 335' 1896		13,211	0
15	38	487.9	L	1917		1936			REM 450' 1936			0	0
15	10	488.0		1892		1899	300				GONE	0	0
15	13	488.0		1895		1899	80				GONE	523	300
15	9	488.1	R	1890		1936	535		REM 535' 1936			5,858	0
15	11	488.1		1893		1899	1650		REM 1899			21,981	0
15	39	488.1	L	1917		1936			REM 600' 1936			0	0
15	84	489.7	L	1892		1899	850		RA & WID 1896			3,598	0
15	7	489.8	CL	1891		1900	1080		WID 1900	REP 1894, EXT 100' 1895		6,646	347
15	64	489.9	R	1891		1899	850		WID 1899	REP 1893, EXT 20' 1894, WID 1897 & 1898		10,024	0
15	8	490.6	CL	1900		1901	750		REP & WID 1901	WID 1900		250	0
15	3	491.0	R	1891		1899	1550		RA, PAV & EXT 100' 1895	EXT 300' 1892, REP 1893		19,686	0
15	15	491.2	L	1893		1899	700		PAV & EXT 500' 1895			4,264	0

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
14	14	494.8		1895		1899	150				GONE	334	0
14	6	494.9	R	1901		1901					GONE	1,535	0
14	84	495.2	L	1890		1900	240		WID 1900	RA & WID 1897, REP 1899		7,139	0
14	29	495.8		1899		1899	150				REM	2,764	0
14	12	495.9	CR	1894		1899	277		RA & WID 1899		GONE	5,111	0
14	28	496.0		1899		1899	1250				REM	6,546	0
14	3	499.8	CR	1924	567.5	1937	680	565.8	REP 1925			17,613	0
14	2	500.1	R	1924	567.6	1937	1890	566.0	EXT 825' 1927	EXT 385' 1925		8,526	12,728
14	1	500.4	R	1924	567.6	1937	970	567.7				2,133	0
14	10	500.8	R	1927	567.7	1937	1090	565.4				7,730	15,080
14	14	501.0	R	1927	567.7	1937	900	566.2				1,642	5,318
14	13	501.2	R	1927	567.7	1937	451	567.0				1,218	3,380
14	12	501.3	R	1927	567.7	1937	335	567.7				358	1,076
14	11	501.4	L	1927	567.7	1937	601	566.8				1,574	4,623
14	9	501.8	L	1927	567.8	1937	1444	568.0				3,194	6,607
14	8	502.0	L	1927	567.8	1937	1469	567.8				4,268	9,287
14	5	502.1	L	1925	567.8	1937	1044	569.6	EXT 245' 1926			1,034	1,175
14	4	502.3	L	1925	567.8	1937	1505	571.2	EXT 1050' 1926			1,092	1,570
14	7	502.5	L	1926	567.8	1937	1477	572.8				2,293	3,234
14	6	502.7	L	1926	567.8	1937	918	569.6				706	930
14	40	502.9	L	1926	567.8	1937	1300	566.9				1,889	4,965
14	39	503.2	L	1926	567.8	1989	1295	567.8	REP 300' 1989			1,646	3,997
14	38	503.3	L	1926	567.8	1989	610	567.8	REP 300' 1989			602	1,189
14	24	503.4	CL	1924	567.8	1937	905	568.3				2,400	0
14	19	503.8	L	1922	567.9	1989	2523	567.9	REP 1,400' 1989	EXT 900' 1924, REP 1925		14,215	0
14	35	504.0	L	1925	567.9	1989	1395	567.9	REP 1,295' 1989			3,892	8,308
14	34	504.1	L	1925	568.0	1989	955	568.0	REP 455' 1989			534	940
14	33	504.3	L	1925	568.0	1989	495	568.0	REP 145' 1989			337	109
14	32	504.4	L	1925	568.0	1989	270	568.0	REP 120' 1989			173	242
14	18	504.6	CR	1922	568.0	1937	335	566.7				0	0
14	17	505.4	CR	1921	569.0	1990	700	569.0	REP 1990			15,192	0
14	25	505.9	R	1924	568.1	1937	1656	569.5				1,190	2,020
14	26	506.0	R	1924	568.1	1937	841	568.9				893	1,145
14	27	506.2	R	1924	568.1	1937	483	568.8				313	489
14	28	506.2	CL	1924	568.1	1937	470	566.3				2,225	1,081
14	29	506.4	L	1925	568.2	1937	1030	567.2				593	1,645
14	31	506.6	L	1925	568.2	1937	1175	569.7				777	1,216
14	30	506.8	L	1925	568.2	1937	885	569.5				616	968
14	22	507.0	L	1923	568.2	1937	605	567.8				378	1,637
14	21	507.2	L	1923	568.2	1937	445	568.4				215	1,098
14	20	507.3	L	1923	568.3	1938	415	568.5	REM 350' 1938			1,941	0
14	23	507.6	CR	1923	568.3	1937	568	567.0				296	1,111
14	13	509.2	CR	1910	567.6	1937	735	573.8				2,746	5,002
14	12	509.3	R	1910	569.6	1937	550	566.6				2,109	4,257
14	16	509.6	R	1919	569.2	1937	2072	567.8	EXT 980' 1925			3,930	10,169
14	37	509.8	R	1925	568.7	1937	1230	568.8				1,192	1,974
14	15	510.0	R	1919	569.2	1937	1146	568.7	REP & EXT 625' 1925			3,154	7,673
14	11	510.1	R	1910	569.8	1937	1215	569.6	REP & EXT 285' 1925			4,445	8,870

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
14	14	510.1	R	1910		1910	525				GONE	132	485
14	10	510.3	R	1910	569.9	1937	1103	568.7	REP 1925			3,650	6,397
14	8	510.4	CL	1899	568.9	1937	210	568.3	REP 1925			1,140	1,462
14	36	510.5	R	1925	568.9	1937	825	568.6				1,120	2,856
14	3	511.1	CR	1899	569.0	1937	580	568.4				1,157	1,632
14	4	511.1	R	1899	569.0	1937	857	568.4	REP 1925			1,613	3,235
14	2	511.3	R	1898	568.1	1937	1359	568.4	REP 1925			2,417	3,695
14	7	511.3	L	1899	569.1	1937	85	567.3				327	264
14	9	511.3	L	1899	569.1	1899	450				SANDED IN	2,345	4,503
14	1	511.4	CL	1898	569.1	1937	705	567.4			GONE	530	704
14	6	511.5	L	1899	569.1	1938	500	568.6	REM 200' 1938			2,973	3,647
14	5	511.6	L	1899	569.2	1938	583	570.0	REM 150' 1938			2,078	2,778
14	4	511.8	L	1899	569.2	1937	808	567.8				2,428	2,838
14	2	511.9	CL	1898	569.2	1937	271	566.0			GONE	1,721	1,830
14	3	512.0	L	1899	569.2	1937	614	567.4				2,323	3,242
14	16	512.6	L	1924	569.3	1937	1533	566.6	REP 1925			1,885	3,667
14	15	512.9	L	1923	569.4	1937	1764	568.6				2,028	6,142
14	14	513.2	L	1923	569.5	1937	1113	567.6	REP 1925			1,595	3,534
14	13	513.3	L	1923	569.5	1937	490	568.5	REP 1925			667	1,416
14	5	513.5	CR	1899	569.5	1937	70	567.6			GONE	2,163	2,510
14	22	513.5	R	1925	569.5	1937	430	569.1				482	678
14	21	513.6	R	1925	569.6	1937	575	570.1				519	785
14	20	513.8	R	1925	569.6	1937	760	568.4				1,599	4,322
14	32	517.1	L	1928	570.4	1937	330	575.4				312	486
14	31	517.3	L	1928	570.4	1937	468	575.9				402	845
14	30	517.4	L	1928	570.5	1937	708	575.0				556	1,461
14	17	517.5	R	1924	570.5	1961	1300	569.2	REP & EXT 1961		BUILT BY DIPPER DREDGE	0	0
14	1	518.1	CL	1891	569.6	1937	240	565.1				1,451	1,936
14	14	518.2	L	1891	575.7	1891	25				SANDED IN	250	300
14	6	518.3	L	1900	570.7	1937	1280	569.7				2,822	3,677
14	7	518.6	L	1900	570.7	1937	2030	569.1	REP 1929	REM 300' 1926		4,874	4,973
14	8	519.0	L	1900	570.7	1937	948	570.3	REP 1929	REP 1913, REP & REM 350' 1926		3,289	4,170
14	9	519.0	R	1900	570.7	1937	220	567.7				1,062	1,435
14	26	519.1	L	1927	570.8	1937	458	572.8				427	450
14	12	519.2	L	1919	573.2	1937	442	570.2			SAND FILL	1,024	2,209
14	18	519.3	CR	1924	570.8	1952	426	569.1	RA & REP 1952	REP 1928 & 1929		611	1,406
14	27	519.3	R	1928	570.8	1937	229	571.8				204	296
14	11	519.4	L	1919	573.2	1937	448	571.5			SAND FILL	896	1,621
14	28	519.4	R	1928	570.8	1937	440	572.8				735	995
14	10	519.5	L	1919	573.1	1937	372	571.8			SAND FILL	728	1,867
14	29	519.6	R	1928	570.8	1937	895	572.0				892	1,462
14	24	519.8	R	1927	570.8	1937	1306	573.8				1,175	1,477
14	19	519.9	CR	1924	570.8	1937	153	568.8				556	713
14	23	520.0	R	1927	570.8	1937	1117	574.6				1,147	1,226
14	26	520.2	L	1911	575.9	1937	525	574.4				4,334	3,263
14	25	520.2	R	1927	570.9	1937	525	573.4				794	1,235
14	25	520.4	L	1907	570.9	1937	509	572.2				583	1,026
14	24	520.6	L	1907	571.0	1937	865	569.7				1,069	1,813

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
14	44	521.3	L	1926	571.0	1937	875	570.4				1,017	3,566
14	48	521.5	L	1926	571.1	1937	250	573.6				387	331
14	5	521.6	CR	1895	571.1	1895	54				SANDED IN	190	194
14	12	521.7	CL	1897	574.2	1897	35				SANDED IN	179	185
14	47	521.7	L	1926	571.1	1939	58	571.1	REM 50' 1939		END REMOVED FOR L\D 13	143	135
14	7	521.8	CR	1895	573.3	1895	400				SANDED IN	1,081	692
14	39	521.9	R	1924	571.3	1937	625	574.6	REP & EXT 375' 1928			759	2,078
14	6	522.0	CR	1895	572.3	1895	250				SANDED IN	843	661
14	4	522.1	R	1894	571.3	1894	475				GONE, DAM 38 HERE NOW	2,576	2,209
14	38	522.1	R	1924	571.3	1937	702	571.1	REP & EXT 50' 1928			313	693
14	3	522.2	R	1894	571.4	1937	600	568.9	REP & EXT 175' 1924			4,867	5,967
14	1	522.3	CR	1894	571.4	1937	382	570.8	REP 1924			3,067	2,278
14	2	522.3	CR	1894	571.4	1937	656	571.4	REP 1924			2,971	2,678
14	40	522.4	R	1924	571.4	1939	591	571.4	REM 500' 1939		REMOVED FOR L\D 13	481	566
14	49	522.5	R	1928	571.5	1939	600	574.5	REM 275' 1935		END REMOVED FOR L\D 13	1,572	2,072

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
13	33	522.7	R	1924	571.5	1939	600	574.7	REM 200' 1939	REP & EXT 182' 1928, REM 550' 1936	END REMOVED FOR L\D 13	1,854	4,781
13	32	522.8	R	1924	571.6	1937	630	573.3				525	1,080
13	31	523.1	R	1924	571.7	1937	632	574.2				527	898
13	30	523.2	R	1924	571.8	1937	693	573.3				774	845
13	29	523.4	R	1924	571.9	1937	679	574.1				654	1,089
13	28	523.6	R	1924	572.0	1937	821	572.3				895	1,336
13	27	523.8	R	1924	572.0	1937	775	571.4				1,211	1,181
13	20	523.9	L	1904	572.1	1937	327	570.1	REP & REM 60' 1926			732	1,726
13	21	524.0	R	1904	572.1	1937	653	572.8	EXT 195' 1924			1,527	3,251
13	17	524.1	CR	1904	572.1	1937	277	569.9				796	884
13	19	524.1	L	1904	572.3	1937	766	570.5	REM 75' 1926			1,220	2,781
13	22	524.1	R	1904	569.1	1904	450				SILTED IN	872	1,990
13	15	524.4	CL	1904	572.4	1937	615	570.7				2,039	4,108
13	18	524.6	CR	1904	572.4	1937	282	570.5				1,334	2,306
13	16	525.0	CL	1904	572.5	1937	350	569.5				1,983	4,320
13	14	525.4	CL	1898	573.2	1937	500	571.2	REP 1904			1,357	2,883
13	13	525.5	CL	1898	573.2	1937	868	572.1	REP 1904			3,434	7,024
13	23	525.8	L	1905	572.8	1937	1920	572.3	REP & EXT 200' 1929			2,455	7,039
13	11	526.7	CL	1896	573.2	1937	717	573.6	REP 1929	RA 1904		3,329	3,826
13	10	527.2	CL	1896	571.5	1896	332				SANDED IN	1,341	1,116
13	43	527.4	L	1925	573.5	1937	1208	571.8	EXT 280' 1929	EXT 175' 1926		4,478	7,293
13	41	527.5	L	1924	573.6	1937	1068	569.5	REP & EXT 400' 1926			1,263	3,221
13	42	527.6	L	1924	573.6	1937	750	571.8	EXT 250' 1929			624	1,444
13	8	527.8	CL	1895	574.7	1937	52	571.9			GONE	4,845	5,568
13	46	527.8	L	1926	573.7	1937	703	572.8				1,131	2,583
13	9	528.0	CL	1895	574.8	1895	180				SANDED IN	1,467	1,267
13	45	528.0	L	1926	573.7	1937	689	574.0				1,306	3,165
13	37	528.2	L	1924	573.8	1937	730	573.4	REP 1929			728	2,528
13	36	528.3	L	1924	573.8	1937	695	574.0				327	728
13	35	528.4	L	1924	573.9	1937	590	574.9				495	838
13	34	528.6	L	1924	574.0	1937	461	575.5				488	875
13	33	528.7	L	1924	574.0	1940	200	573.6	REM 170' 1940	REP 1924 & 1926		464	855
13	32	528.8	L	1924	574.1	1940	50	573.1	REM 548' 1940	REP 1926		801	1,338
13	27	528.9	CR	1924	574.1	1937	235	572.5	REP 1926			575	808
13	31	528.9	CL	1924	574.2	1940	955	572.4	REM 955' 1940			2,572	3,408
13	28	529.1	CR	1924	574.2	1937	341	573.5	REP 1929	REP 1925 & 1926		982	1,550
13	30	529.3	R	1924	574.3	1937	328	571.3				135	376
13	29	529.6	R	1924	574.4	1937	827	573.6	REP 1929			807	1,815
13	26	529.8	R	1924	574.5	1937	37	573.5	REP 1924			128	357
13	26	529.9	CL	1924	574.5	1940	470	573.0	REM 1940			1,478	2,309
13	25	530.0	L	1924	574.5	1940	301	572.8	REM 1940	REP 1929		1,125	2,812
13	35	530.1	R	1924	574.6	1937	1050	575.0	REP 1926			505	1,058
13	34	530.3	R	1924	574.7	1937	885	575.6	REP 1926	REP 1925		569	1,132
13	24	530.6	L	1923	574.8	1937	448	574.5	REP 1929			1,638	3,526
13	37	530.6	R	1925	574.8	1937	505	575.5				1,173	1,149
13	23	530.7	L	1923	574.8	1937	795	574.5	REP 1929			1,209	2,401
13	36	530.7	R	1925	574.9	1937	139	577.2				569	845
13	22	531.2	L	1923	575.0	1937	1020	574.2	REP & EXT 150' 1929			1,394	2,523

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
13	21	531.4	L	1923	575.1	1937	921	574.1				1,239	2,474
13	20	531.5	L	1923	575.2	1937	800	573.6				1,368	3,159
13	38	531.6	CR	1925	575.2	1937	61	576.0			GONE	93	202
13	19	531.7	L	1923	575.2	1937	450	574.4	REP 1929			1,493	2,500
13	48	531.9	L	1929	575.3	1937	179	575.0				674	942
13	47	532.3	R	1929	575.4	1937	532	577.2				850	1,349
13	46	532.4	R	1929	575.4	1937	694	577.4				1,054	1,424
13	45	532.6	R	1929	575.4	1937	577	577.1				1,034	1,098
13	44	532.8	R	1929	575.5	1937	294	574.8				663	1,841
13	15	533.1	CR	1917	575.6	1962	1160	573.9	RA & REP 1962	REP 1923 & 1929		4,343	7,117
13	17	533.3	R	1917	575.6	1937	765	576.0	REP 1929	REP 1928		1,666	6,942
13	16	533.4	L	1917	575.6	1937	684	575.6	REP 1929			1,197	3,704
13	43	533.4	R	1928	575.7	1937	602	573.7	REP 1929			676	835
13	13	533.6	L	1917	575.7	1937	795	575.7	REP 1929			2,750	6,529
13	14	534.0	L	1917	575.8	1937	1066	575.8	REP 1929			1,838	4,849
13	18	534.4	CL	1919	575.9	1937	113	572.7			GONE	514	690
13	12	534.5	L	1917	575.9	1937	1100	576.4	REP 1929			2,000	4,614
13	11	534.8	L	1917	576.0	1937	739	576.5	REP 1929			1,889	4,589
13	9	535.2	L	1916	576.1	1937	695	577.4	REP 1929			841	2,714
13	10	535.7	L	1916	578.2	1977	793	578.2	REP 1977			719	2,220
13	8	535.9	L	1916	579.3	1977	802	579.3	REP 1977			640	1,846
13	7	536.1	L	1916	576.3	1937	564	577.5	REP 1927			716	1,811
13	42	536.3	L	1927	576.4	1937	409	577.9			APPROX 270' FROM SHORE	650	645
13	41	536.4	L	1927	576.4	1937	263	578.4			APPROX 500' FROM SHORE	314	420
13	6	536.6	CR	1906	576.5	1937	300	574.5				1,886	2,794
13	39	536.6	L	1927	576.5	1937	850	579.5				1,101	1,458
13	3	536.8	L	1905	576.5	1937	976	577.7	REP 1928			1,541	3,662
13	40	536.8	R	1927	576.5	1937	550	581.5	EXT 225' 1928			929	1,616
13	1	536.9	CR	1905	577.0	1937	310	575.0			SILTED IN	784	1,266
13	5	536.9	R	1906	576.5	1937	825	582.7	REP 1928			1,385	3,128
13	2	537.0	L	1905	576.6	1937	573	582.6	REP 1928			921	1,798
13	4	537.1	R	1905	576.6	1978	1230	576.6	REP 1978	EXT 300' 1906, REP 1977	GOOD	2,318	5,149
13	12	538.7	CR	1894	577.0	1894	115				SILTED IN	688	790
13	8	538.8	CL	1892	578.0	1909	197		REP 1909		SILTED IN	1,014	832
13	9	538.9	CR	1894	577.0	1894	510				SILTED IN	3,174	4,669
13	10	539.2	R	1894	577.1	1937	955	575.6				2,928	3,917
13	11	539.5	R	1894	577.2	1937	380	576.9				1,419	1,548
13	5	540.4	CR	1892	578.4	1937	200	576.9				863	740
13	13	540.4	CR	1894	579.4	1894	903				SILTED IN	4,885	6,376
13	4	540.7	CR	1892	577.7	1937	852	578.1	REP 1931	REP 1918		2,049	1,942
13	27	540.7	L	1927	577.5	1937	382	579.5				521	609
13	7	540.8	R	1892	577.6	1937	717	577.7	REP 1931	REP 1926		1,755	1,884
13	6	540.9	R	1892	577.6	1937	360	577.1	REP 1931			1,884	2,503
13	26	541.0	L	1927	577.6	1937	1267	574.2				595	1,851
13	25	541.2	L	1927	577.7	1937	245	582.3				496	465
13	1	541.4	CR	1887	578.8	1937	336	576.3				1,882	1,227
13	3	541.4	R	1887	578.8	1892	660		REM 350' 1892		GONE	6,489	4,391
13	24	541.4	L	1927	577.8	1937	1390	583.0				1,535	2,309

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
13	2	541.6	R	1887	578.8	1937	600	573.8	REP 1892			4,027	2,827
13	23	541.6	L	1927	577.8	1937	915	585.3				1,246	1,603
13	22	541.7	L	1927	577.8	1937	390	583.8	REP 1927			646	1,748
13	21	543.3	CL	1924	578.5	1937	1015	580.5	REP 1926	REP 1924		2,537	4,668
13	16	543.4	CR	1923	578.5	1937	630	576.9	REP 1926	REP 1924		955	1,750
13	20	543.6	L	1923	578.5	1937	422	579.0				785	1,435
13	19	543.7	L	1923	578.6	1937	209	578.8				374	574
13	14	544.4	L	1922	578.8	1962	626	578.9	REM 90' 1962			503	1,324
13	18	544.5	L	1923	578.9	1962	1285	576.9	REM 260' 1962			895	2,720
13	17	544.6	L	1923	578.9	1962	775	577.2	REM 200' 1962			1,013	2,619
13	12	544.7	R	1923	578.9	1937	485	578.2				1,413	2,931
13	15	544.7	L	1922	578.9	1937	210	577.2				909	1,741
13	11	544.8	R	1922	579.0	1937	715	578.0				689	2,417
13	10	545.0	R	1917	579.1	1937	768	578.1	EXT 430' 1922			894	2,073
13	9	545.1	R	1917	579.1	1937	720	578.0	EXT 200' 1923			1,426	3,083
13	16	545.9	R	1924	579.4	1978	598	579.4	REP 1978		GOOD	683	1,923
13	1	546.0	CL	1892	579.4	1937	750	577.5				2,280	1,789
13	15	546.0	R	1924	579.4	1978	478	579.4	REP 1978		GOOD	693	1,939
13	2	546.2	CL	1892	580.5	1892	100				SILTED IN	586	329
13	14	546.2	R	1924	579.4	1978	563	579.4	REP 1978		GOOD	667	2,250
13	13	546.3	R	1924	579.5	1978	452	579.5	REP 1978	REP 1926	GOOD	630	2,213
13	32	546.3	CL	1933	579.5	1937	400	580.5				2,682	2,997
13	34	547.0	L	1934	579.7	1995	1640	578.8	REP 955' 1995			1,586	2,475
13	33	547.2	L	1934	579.8	1995	1295	579.9	REP 800' 1995			1,893	2,301
13	31	547.5	L	1933	579.9	1995	1035	579.6	REP 935' 1995			3,947	6,708
13	30	547.7	L	1933	580.0	1995	1137	580.0	REP 485' 1995	REP 1979		1,888	3,067
13	29	547.9	L	1933	580.1	1995	620	580.1	REP 550' 1995	REP 1979		1,404	2,503
13	28	548.1	L	1933	580.1	1979	1646	582.6	NOTCHED 1979	REM 60' 1962		3,106	5,510
13	27	548.3	L	1932	580.2	1962	621	584.0	REP, REM 150' & RA 270' 1962			1,422	974
13	26	548.5	L	1932	580.3	1979	1082	584.0	NOTCHED 1979	REP & RA 990' 1962		2,271	1,799
13	25	548.7	L	1932	580.4	1979	886	581.0	NOTCHED 1979	REM 100' 1962		1,490	1,168
13	24	548.9	L	1932	580.5	1937	521	581.2				975	842
13	23	550.1	R	1929	580.8	1976	935	583.0	REP 1976		GOOD	1,278	1,691
13	22	550.3	R	1929	580.9	1976	1083	583.0	REP 1976		GOOD	1,510	1,976
13	21	550.4	R	1929	580.9	1976	951	583.0	REP 1976		GOOD	1,333	1,719
13	7	550.7	R	1916	581.0	1976	736	583.0	REP 1976	REP & REM ? 1934, REM 200' 1941		2,106	5,947
13	8	551.5	L	1916	581.3	1937	290	582.0	REP 1934	REP 1929		684	1,459
13	6	551.6	R	1916	581.3	1937	854	581.6	REP 1934	REP 1928		1,315	4,466
13	5	551.8	R	1916	581.3	1937	1203	580.9	REP 1928			1,683	5,021
13	20	552.0	R	1929	581.4	1937	1463	580.4				2,079	4,512
13	18	552.1	R	1928	581.4	1937	1065	581.9				2,731	6,945
13	17	552.3	R	1928	581.5	1937	939	581.6	REP 1934			2,576	6,493
13	4	552.5	R	1916	581.5	1937	807	582.0	REP 1934			1,335	3,793
13	3	552.6	R	1916	581.6	1937	840	581.6	REP 1934			2,334	5,755
13	19	552.8	CR	1928	581.7	1928	140				SILTED IN	422	815
13	39	553.9	CL	1925	582.0	1937	500	580.2	REP 1927			1,464	3,380
13	46	553.9	L	1927	582.0	1937	440	583.0				967	3,341
13	45	554.1	L	1927	582.0	1937	285	581.5	REP 1934			1,498	3,277

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
13	19	554.4	R	1901	582.1	1937	1204	581.4	REP & EXT 300' 1925	REP 1914, EXT 550' 1915		2,068	4,508
13	18	554.6	R	1901	582.2	1937	1313	582.1	REP 1934	REP 1914, REP & EXT 250' 1925		3,239	7,753
13	17	554.9	R	1901	582.3	1937	1262	582.5	REP 1934	REP & EXT 150' 1925		1,614	4,069
13	31	555.1	R	1914	582.5	1937	560	582.6	REP 1934	REP 1925		617	1,975
13	10	555.2	R	1897	585.6	1897	30				SILTED IN	151	150
13	3	555.4	R	1897	581.6	1937	1270	582.6	REP 1914			2,687	3,750
13	8	555.5	L	1897	573.6	1937	125	577.5				1,090	1,179
13	4	555.6	R	1897	581.6	1937	846	581.4	REP 1934	REP 1914		2,616	4,449
13	7	555.8	R	1897	581.7	1937	469	580.7	REP 1914			1,207	1,632
13	9	555.8	L	1897	581.7	1937	1219	581.7	REP & EXT 265' 1927	REP & EXT 150' 1914		2,884	4,758
13	5	556.0	R	1897	581.7	1937	364	582.1	REP 1914			633	818
13	6	556.0	L	1897	581.7	1937	870	583.3	REP & EXT 400' 1927	REP 1925		3,297	5,540
13	44	556.2	L	1927	582.8	1937	935	583.3				2,582	5,404
13	43	556.4	L	1927	582.8	1937	797	584.8				1,025	1,303
13	42	556.6	L	1927	582.9	1937	340	585.2	REM 100' 1937		END REMOVED FOR L\D 12	958	1,228
13	2	556.7	CL	1878	586.9	1937	1050	586.0	REP 1889		CAUSEWAY 1894	11,042	12,987
12	41	556.8	L	1927	582.9	1937	475		REM 475' 1937		END REMOVED FOR L\D 12	992	1,055
12	40	556.9	L	1927	583.0	1937	220	587.4	REM 150' 1937		END REMOVED FOR L\D 12	888	1,078
12	11	557.0	L	1900	587.0	1937	200	583.6	REP 1913	REP 1902 & 1903		2,955	3,958
12	1	557.1	CL	1878	577.0	1900	250				GONE 1900	185	185
12	30	557.6	L	1913	583.1	1937	295	582.3				444	786
12	29	557.8	L	1913	583.2	1937	667	582.0				941	1,986
12	21	558.0	L	1913	583.3	1937	896	582.0				1,320	2,463
12	25	558.2	L	1913	583.3	1937	670	582.1				1,574	3,404
12	28	558.3	R	1913	583.4	1937	455	581.6				1,334	2,793
12	26	558.4	R	1913	583.4	1937	748	581.3				1,627	3,849
12	27	558.4	L	1913	583.4	1937	406	581.4				1,224	2,989
12	24	558.7	R	1913	583.5	1937	469	581.5				751	1,906
12	22	558.8	R	1913	583.5	1937	1450	583.0			SANDED IN	1,736	5,774
12	23	558.8	R	1913	583.5	1937	500	581.7				771	1,972
12	20	558.9	R	1913	583.6	1937	520	582.0				1,051	2,552
12	16	559.4	R	1901	583.7	1937	1590	582.6	REP 1925			2,642	5,193
12	14	559.7	CR	1901	583.2	1937	658	582.7	60' HOLE CUT IN DAM 1926			1,596	2,424
12	13	560.0	L	1901	583.8	1937	485	582.5				2,451	3,700
12	12	560.2	CL	1900	583.9	1937	381	582.9				2,958	5,163
12	15	560.5	CR	1901	583.9	1937	608	581.5	REP 1926			2,023	2,780
12	32	560.5	L	1914	583.9	1937	500	583.5				1,337	1,455
12	33	560.6	L	1914	584.0	1937	490	583.7				1,378	1,836
12	34	560.8	L	1914	584.0	1937	435	582.3				1,409	2,558
12	35	560.9	R	1914	584.1	1937	800	583.7				1,405	3,884
12	47	561.8	CR	1927	584.3	1937	550	582.8				2,205	3,879
12	38	562.1	R	1922	584.3	1937	413	584.4				1,389	2,169
12	37	562.2	R	1922	584.3	1937	984	582.6				2,886	5,682
12	36	562.4	R	1922	584.4	1937	305	581.5				1,690	3,373
12	24	563.3	R	1929	584.6	1937	545	584.9				742	721
12	23	563.5	R	1929	584.7	1937	772	585.8				1,033	1,064
12	22	563.7	R	1929	584.8	1937	778	586.3				1,085	1,091
12	3	563.9	R	1902	584.9	1937	960	584.3	REP 1922			2,025	3,591

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
12	2	564.0	CL	1897	585.9	1937	248	583.1	REP 1922	RA 1898 & 1918		2,022	2,570
12	4	564.1	R	1902	585.0	1937	799	584.3	REP & REM 160' 1926	REP 1922		2,708	5,573
12	21	564.3	R	1922	585.6	1937	500	583.6				974	1,592
12	19	565.4	L	1913	585.4	1937	565	584.7				1,735	3,031
12	18	565.5	R	1913	585.5	1937	913	586.4	REM 1940	REP 1928		1,574	2,397
12	20	565.8	R	1913	585.6	1937	1143	585.7	REM 1940	REP 1928		2,348	4,151
12	14	566.8	CR	1912	587.9	1937	890	586.1	REM 1940	REP 1926 & 1928		5,244	8,908
12	15	567.1	R	1912	586.0	1940	367	584.4	REM 496' 1940	REP 1928		2,761	5,152
12	17	567.3	R	1913	586.1	1940	350	584.1	REM 340' 1940	EXT 250' 1929		3,716	8,651
12	12	567.8	L	1911	587.3	1937	389	583.9	REP 1931			830	1,665
12	11	567.9	L	1911	587.4	1937	382	586.0	REP 1931			812	1,450
12	16	568.1	R	1913	586.4	1937	610	587.4	REP 1928			975	1,744
12	10	568.3	R	1902	586.5	1937	854	587.0	REP 1928	EXT 170' 1912, 120' 1913		1,172	3,131
12	13	568.5	R	1912	586.6	1937	796	588.1	REP 1928			1,253	2,342
12	5	568.7	R	1902	586.6	1937	702	587.2	REP 1928	REP 1922		1,359	2,856
12	6	568.9	R	1902	586.7	1937	480	585.5	REP 1922	REP 1918		1,302	2,466
12	9	568.9	L	1902	587.2	1913	140		REP & EXT 100' 1913		SILTED IN	1,320	1,651
12	8	569.1	L	1902	587.7	1937	400	588.0	REP 1928	REP & EXT 100' 1913		1,204	2,576
12	1	569.2	CL	1895	586.8	1937	1114	586.0	REP 1929	REP 1913 & 1928		7,116	7,566
12	7	569.2	L	1902	587.8	1937	477	588.3	REP 1928	REP & EXT 100' 1913		1,013	1,886
12	27	569.4	L	1913	586.8	1937	575	588.3	REP 1928			1,023	1,131
12	28	569.6	L	1913	586.9	1937	768	586.4				3,198	3,623
12	32	569.9	L	1913	587.0	1937	255	587.5	REP 1929			630	1,312
12	22	570.0	L	1911	588.3	1937	610	587.7				3,534	8,777
12	31	570.1	L	1913	587.0	1937	381	587.1	REP 1929			1,582	2,055
12	30	570.3	L	1913	587.1	1937	340	587.1	REP 1929			3,804	6,561
12	29	570.5	L	1913	587.1	1937	835	585.4				4,260	6,412
12	26	570.7	L	1912	587.2	1937	1150	587.1				3,106	4,677
12	21	570.8	CL	1911	586.3	1937	260	585.1				847	958
12	20	571.2	L	1911	588.4	1937	1422	587.0	REP 1913			4,646	9,365
12	43	571.6	L	1928	587.5	1937	1135	586.4				1,191	4,879
12	19	571.8	L	1911	588.6	1937	640	587.8	REP 1928			1,594	2,488
12	16	571.9	R	1911	588.6	1937	350	588.6	REP 1928			537	1,224
12	15	572.1	R	1911	588.6	1937	650	586.5				1,105	1,950
12	45	572.2	CL	1928	587.7	1937	181	586.7				1,535	2,269
12	14	572.3	R	1911	588.7	1937	798	587.2				2,536	4,393
12	9	572.8	CL	1898	588.3	1937	120	588.0	REP 1929	REP 1911		361	737
12	33	572.8	R	1913	587.8	1937	634	588.2				931	2,241
12	13	573.0	L	1911	588.9	1937	453	588.4	REP 1929			1,183	1,964
12	17	573.0	R	1911	588.9	1937	473	587.4	REP 1929			1,792	2,490
12	7	573.2	CR	1897	586.9	1897	60				SANDED IN	134	206
12	12	573.2	L	1911	588.9	1937	560	587.7				4,155	9,533
12	2	573.3	CR	1893	589.0	1937	388	587.9				882	840
12	8	573.3	CR	1897	586.9	1897	100				SANDED IN	126	172
12	11	573.3	L	1911	588.9	1937	760	587.4	REP 1929			2,134	5,228
12	18	573.3	R	1911	588.9	1937	378	586.9	REP 1929			1,848	3,189
12	3	573.9	CR	1893	589.1	1937	427	586.3				1,208	1,100
12	10	574.1	CL	1911	587.1	1937	340	586.9	REP 1929			2,331	3,147

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
12	25	574.1	R	1912	588.2	1937	543	586.7				2,210	4,700
12	24	574.3	R	1912	587.2	1937	1625	587.5				1,272	3,545
12	23	574.5	R	1911	589.2	1937	869	587.2				2,970	5,016
12	34	574.9	R	1926	588.3	1937	464	586.8	REP 1928			375	1,143
12	44	575.0	R	1928	588.4	1937	355	586.2				1,675	4,846
12	6	575.1	L	1893	588.4	1937	674	587.9	REP 1928			1,854	1,473
12	5	575.4	L	1893	588.4	1937	935	588.0	REP 1929	REP 1918		4,879	4,791
12	4	575.6	L	1893	588.5	1937	1369	586.0	REP 1918			4,734	4,525
12	1	576.3	CL	1893	588.7	1937	1800	588.0				8,379	5,103
12	42	576.4	L	1927	588.7	1937	581	589.3				1,182	2,023
12	41	576.6	L	1927	588.8	1937	786	589.5				770	1,398
12	39	576.8	L	1927	588.8	1937	1414	590.3				1,154	2,063
12	40	576.8	L	1927	588.8	1937	803	590.5				941	1,528
12	38	577.0	L	1927	588.9	1937	925	587.9				1,129	1,566
12	37	577.3	L	1927	588.9	1937	698	589.9				928	1,388
12	36	577.4	L	1927	589.0	1937	632	589.8				706	1,228
12	35	577.6	L	1927	589.0	1937	748	592.5				817	1,265
12	47	578.6	L	1929	589.3	1937	628	588.6				957	2,242
12	46	578.7	L	1929	589.3	1937	903	590.0				1,028	3,096
12	33	579.0	L	1929	589.4	1937	925	589.7				1,053	2,984
12	32	579.2	L	1927	589.5	1937	963	587.5	EXT 675' 1928			1,323	5,839
12	31	579.5	L	1927	589.5	1960	910	587.7	REP & REM 200' 1960			1,171	7,940
12	30	579.7	L	1927	589.6	1960	507	589.5	REM 225' 1960	REM 100' 1936, 50' 1937		1,317	4,083
12	10	579.8	L	1910	590.6	1910					SANDED IN	624	648
12	6	579.9	R	1901	589.7	1937	431	588.2	REP 1928	REP 1911		5,538	8,077
12	15	580.1	R	1912	589.7	1937	660	589.4	REP 1928			1,540	3,253
12	14	580.3	R	1912	589.8	1937	730	590.3	REP 1928			2,179	4,997
12	13	580.5	R	1912	589.9	1937	924	588.4				1,901	4,157
12	18	580.9	R	1914	590.0	1937	920	590.0				586	1,499
12	12	581.3	R	1912	590.2	1937	860	589.8	REP 1929			1,579	2,143
12	28	581.5	L	1918	590.7	1937	1431	589.7	REP 1927			2,427	8,429
12	11	581.6	R	1912	590.2	1937	562	589.3	REP 1929	REP 1920		1,981	4,150
12	16	581.7	L	1914	590.3	1937	950	589.9	REP 1929			2,148	6,714
12	19	581.9	L	1915	590.4	1937	1089	588.4	REP & EXT 90' 1929			1,514	4,473
12	29	582.1	L	1919	590.4	1937	973	589.1	REP & EXT 125' 1929			1,130	3,128
12	9	582.3	L	1908	590.5	1937	931	590.0	REP 1929			2,153	5,027
12	17	582.5	L	1914	590.6	1937	1184	589.8	REP 1929			2,535	6,321
12	8	582.8	L	1908	590.6	1929	550		REM 1937	REP 1917 & 1929	REMOVED FOR L\D 11	2,288	4,137

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
11	3	583.2	CL	1893	591.7	1909	720		REM 1937	REP 1909	END REMOVED FOR L\D 11	2,813	3,215
11	27	583.2		1915	590.7	1929	500		REP 1929		REMOVED FOR L\D 11	816	1,399
11	4	583.3	L	1893	590.8	1937	740	591.6	REP 1909			3,365	3,538
11	5	583.4	L	1893	590.8	1937	715	590.4	REP 1929	REP 1909, EXT 175' 1915		2,922	4,199
11	26	583.4	R	1915	590.8	1938	300	588.4	REM 100' 1938	REP 1929, REM 300' 1936		1,069	2,507
11	25	583.6	R	1915	590.8	1975	400	603.0	RA 125' 1975	REM 100' 1936, 220' 1938		3,506	7,034
11	1	583.9	CR	1893	591.0	1945	980	587.0	REP 1945	REP 1918 & 1929, REP & REM ?? 1926		2,179	1,784
11	2	584.3	CR	1893	591.1	1937	530	589.9	REP 1918	REP 1901, 1908 & 1913		2,864	2,000
11	20	584.3	L	1915	591.2	1938	975	588.4	REM 75' 1938			1,094	1,967
11	24	584.4	R	1915	591.2	1937	660	590.1				1,211	2,377
11	21	584.6	L	1915	591.3	1937	727	591.3	REP 1930			880	1,932
11	23	584.6	R	1915	591.2	1937	1020	589.4				1,973	3,608
11	22	584.8	R	1915	591.3	1937	1276	592.3				1,731	4,061
11	7	588.0	CL	1904	592.6	1937	450	591.6	REP 1928			2,239	3,880
11	28	588.2	L	1915	592.7	1937	729	590.7				1,093	3,123
11	27	588.4	L	1915	592.8	1937	857	591.6	REP 1929			1,521	3,500
11	19	588.6	L	1904	592.9	1937	753	592.6	REP 1929			1,431	3,148
11	17	588.7	CL	1904	592.9	1937	565	590.9	REP 1930	REP 1928 & 1929		2,789	3,330
11	18	588.9	L	1904	593.0	1937	1660	592.1	REP & EXT 430' 1929			3,353	6,855
11	20	589.6	CL	1904	591.3	1937	520	593.7	REP 1929	REP 1928		5,252	10,564
11	1	589.8	CL	1893	594.3	1937	166	591.8	REP 1904			695	774
11	24	590.0	R	1911	594.4	1937	775	594.4	REP 1929			1,013	2,155
11	45	590.1	L	1929	593.4	1937	367	591.6				2,568	4,981
11	23	590.2	R	1911	594.5	1937	1166	595.0	REP 1929			1,283	2,109
11	25	590.2	CL	1911	591.5	1937	400	590.5	REP 1928			2,063	3,546
11	46	590.3	L	1929	593.5	1937	370	591.5				1,769	3,208
11	22	590.5	R	1911	594.6	1937	1145	594.6	REP 1929			1,672	3,319
11	21	590.8	R	1911	594.7	1937	1025	594.2	REP & EXT 100' 1928			2,614	5,924
11	26	591.0	R	1911	593.8	1937	850	592.8	REP & EXT 260' 1928			2,693	6,314
11	40	591.1	L	1928	593.8	1937	397	594.5				559	703
11	37	591.2	L	1928	593.9	1937	1189	594.9				1,181	1,533
11	39	591.2	R	1928	593.9	1937	613	594.6				544	605
11	38	591.3	R	1928	594.0	1937	383	596.5				521	406
11	6	591.4	L	1895	593.0	1937	1300	592.3	REP 1929	REP 1927 & 1928		4,367	6,776
11	31	591.6	L	1923	594.1	1937	1370	592.0	REP & EXT 875' 1927			2,880	10,354
11	7	591.8	L	1895	593.1	1937	1430	594.0	REP 1927			5,448	7,312
11	5	592.2	L	1895	593.8	1937	1100	595.3				14,558	21,244
11	4	592.4	L	1895	594.9	1937	425	594.1				1,433	1,792
11	2	592.6	CL	1895	595.4	1895	810				SILTED IN	5,907	7,833
11	3	592.7	L	1895	595.4	1937	477	594.0	REP 1904			1,547	1,501
11	34	593.1	L	1925	594.6	1937	511	594.8	EXT 350' 1926			734	2,035
11	33	593.3	L	1925	594.7	1937	545	594.9				388	1,246
11	15	593.6	CL	1900	594.8	1937	700	593.9				1,753	2,121
11	32	593.6	L	1925	594.8	1937	410	590.4				408	807
11	29	593.7	L	1915	594.9	1937	766	594.7	REP & EXT 200' 1926			2,340	5,951
11	30	593.7	R	1915	594.9	1937	455	594.3	REP 1925			560	1,776
11	36	593.9	R	1927	594.9	1937	613	594.2				1,303	4,494
11	42	593.9	L	1928	594.9	1937	740	597.7				803	673

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
11	35	594.1	R	1926	595.0	1937	735	593.2				1,315	4,779
11	41	594.1	L	1928	595.0	1937	735	598.0				574	983
11	14	594.3	R	1900	595.1	1937	842	596.9	REP 1928	REP 1913		1,118	3,155
11	13	594.5	R	1900	595.2	1937	751	596.5	REP & EXT 90' 1928	REP 1913		1,532	3,271
11	12	594.7	R	1900	595.2	1937	600	596.5	REP 1928	REP 1913		1,174	2,283
11	16	594.9	R	1900	592.3	1937	685	596.8	REP & EXT 125' 1928	REP 1913		1,922	2,873
11	8	595.1	CL	1900	595.6	1994	512	595.6	REP 512' & EXT 288' 1994	REP 1928		2,617	2,938
11	11	595.1	R	1900	595.4	1937	678	597.4	REP & EXT 200' 1928	REP 1913		2,156	4,238
11	9	595.2	CL	1900	595.4	1994	254	595.4	REP BANK PROT.	REP 1928		1,948	3,782
11	10	595.2	R	1900	595.5	1937	415	595.7	REP & EXT 75' 1928	REP 1913		1,559	3,247
11	43	595.4	R	1928	595.6	1937	226	599.1				226	323
11	44	595.5	L	1928	595.6	1937	374	594.3				508	1,695
11	17	595.7	L	1915	595.7	1937	850	595.2	REP 1928			1,324	2,904
11	18	595.9	R	1915	595.8	1937	540	598.3	REP 1928			838	2,048
11		596.0	CL	1994	600.0	1994	889	600.0				19,120	0
11	19	596.1	R	1915	595.8	1937	445	596.5	REP 1928			1,345	3,005
11	39	596.4	L	1928	595.9	1937	236	597.9				228	228
11	5	596.7	L	1900	596.0	1937	1749	593.8	REP 1931	REP 1913, 1915 & 1928		2,647	4,192
11	38	597.1	L	1927	596.2	1937	256	594.0				708	2,379
11	37	597.2	L	1927	596.2	1937	350	594.2				1,027	3,295
11	3	597.3	CL	1900	596.3	1937	1278	594.8	REP 1931			5,047	7,947
11	36	597.4	L	1927	596.3	1937	490	594.9				810	2,665
11	35	597.5	L	1927	596.5	1937	486	595.7				927	2,930
11	34	597.7	L	1927	596.5	1937	398	595.0				774	1,829
11	33	597.9	L	1927	596.5	1937	390	595.2				639	2,199
11	32	598.0	L	1927	596.5	1937	356	595.0				643	1,354
11	10	598.2	L	1904	596.6	1937	491	594.6	EXT 265' 1927	REP 1912		1,105	2,392
11	4	598.4	CL	1900	596.7	1900	110				SANDED IN	586	977
11	9	598.4	L	1904	596.7	1988	566	596.7	REP 116' 1988	REP 1912 & 1913		771	1,468
11	8	598.6	L	1904	596.8	1988	650	596.8	REP 300' 1988	REP 1912 & 1913, EXT 210' 1927		1,282	2,969
11	7	598.8	L	1904	596.9	1988	634	596.9	REP 1988	REP 1912, EXT 350' 1927		1,806	4,410
11	2	599.1	CL	1898	597.4	1991	1000	599.0	REP, RA & EXT 60' 1991	REP 1900, 1904, 1908, 1911, 1927 & 1931		8,777	17,662
11	6	599.1	L	1904	596.9	1988	679	596.9	REP 254' 1988	REP 1911, EXT 170' 1927		1,423	2,789
11	12	599.3	L	1912	596.6	1988	1740	596.6	REP 1988	EXT 540' 1927		3,880	7,304
11	23	599.8	CL	1918	597.3	1937	520	596.9	REP 1929			1,560	4,481
11	20	600.1	L	1915	597.3	1937	545	597.6	REP 1929			1,421	4,510
11	31	600.3	L	1927	597.4	1937	801	597.4	REP 1929			1,154	3,434
11	15	600.4	L	1914	597.4	1937	1490	597.2				2,941	7,478
11	14	600.6	R	1914	597.5	1981	400	596.7	REP 1976		GOOD	849	3,402
11	13	600.7	R	1914	597.5	1981	663	596.0	REP 1976		GOOD	1,360	3,614
11	16	600.7	L	1915	597.5	1915	1200				SANDED IN	1,533	3,535
11	22	601.0	L	1918	597.6							676	1,500
11	21	601.1	L	1918	597.6	1937	680	596.6				497	1,075
11	40	601.6	R	1928	597.7	1937	455	599.5				1,370	3,500
11	30	601.8	CR	1927	597.8	1928	270	597.8	EXT TO 270' 1928			1,212	2,626
11	29	601.9	R	1927	597.8	1937	360	596.8	EXT 210' 1929	EXT 65' 1928		1,044	3,141
11	28	602.1	R	1927	597.8	1976	1000	596.9	REP 1976		GOOD	1,660	4,235
11	1	602.2	CR	1887	598.8	1937	627	599.5	REP 1927	REP 1908 & 1917		6,112	4,240

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
11	27	602.4	R	1927	597.9	1981	1154	596.9	REP 1976		GOOD	1,302	3,469
11	11	602.8	R	1908	598.0	1976	895	597.4	REP 1976	REP 1926	GOOD	3,465	6,002
11	24	602.9	R	1926	598.0	1937	1191	597.0				3,348	7,373
11	26	603.1	R	1926	598.1	1937	621	597.6				628	1,532
11	25	603.2	R	1926	598.1	1937	229	596.0	REP 1929			1,278	4,069
11	52	604.0	R	1923	598.4	1937	800	597.3	REP 1927			1,123	4,176
11	51	604.3	R	1915	598.7	1976	400	597.3	REP 1976	REP 1925	GOOD	920	2,278
11	5	604.4	CR	1898	599.3		445				SILTED IN	548	1,378
11	6	604.5	CR	1898	599.3	1937	730	597.8	REP 1929	REP 1915, 1925 & 1927		1,603	3,885
11	50	604.5	R	1915	598.7	1976	394	598.9	REP 1976	REP 1925	GOOD	621	1,315
11	49	604.7	R	1915	598.8	1937	327	597.3	REP 1925			417	840
11	45	604.9	L	1915	598.9	1937	500	598.4	REP 1925			989	1,473
11	44	605.1	L	1915	599.1	1937	950	599.1	REP 1925			1,103	2,079
11	48	605.2	R	1915	599.1	1937	473	597.6	REP 1925			1,824	3,561
11	39	605.4	L	1915	599.1	1925	1375		REP 1925		SILTED IN	1,386	3,144
11	57	605.6	L	1927	599.2	1937	1380	599.0				1,609	4,437
11	4	605.8	CL	1887	600.3	1937	414	597.3	REP 1929	REP 1915 & 1927		3,383	1,832
11	53	605.8	L	1927	599.3	1937	1000	599.2				1,395	4,528
11	46	605.9	L	1915	599.4	1927	1300		EXT 340' 1927	REP 1925		2,153	5,054
11	47	606.1	L	1915	599.4	1937	712	599.2	REP 1925			1,326	2,540
11	56	606.1	L	1927	599.4	1937	1255	599.1				2,334	5,050
11	59	606.3	R	1928	599.5	1937	417	599.0				2,093	4,751
11	60	606.6	R	1928	599.7	1937	603	599.2				2,262	4,871
11	36	606.7	R	1914	601.7	1937	983	601.2	REP 1934	EXT 300' 1925, REP & EXT 45' 1926		5,544	19,246
11	55	606.9	R	1927	599.9	1937	450	599.2	EXT 350' 1928			1,549	4,258
11	54	607.0	R	1927	600.0	1937	270	599.8				549	2,048
11	38	607.2	R	1914	600.0	1937	1129	599.9	EXT 100' 1927	REP 1925		1,148	3,067
11	63	607.7	L	1932	600.2	1937	220	597.7				1,456	2,995
11	35	607.8	R	1911	600.2	1911	720				SILTED IN	1,842	3,315
11	62	607.8	L	1929	600.2	1956	651	593.0				687	1,072
11	61	607.9	L	1929	600.3	1956	936	599.3	REM 300' 1956			2,516	5,973
11	33	608.1	L	1911	600.3	1937	386	598.8	REP 1925			1,060	1,907
11	34	608.1	R	1911	600.3	1937	1115	598.3	REP 1929	REP 1925		3,846	7,416
11	2	608.3	L	1880	600.4	1937	185	598.8				1,792	994
11	3	608.3	L	1880	600.4	1937	987	598.9	REP 1928	REP & EXT 380' 1911, REP 1925		3,314	5,483
11	1	608.4	CL	1879	601.4	1979	520		RA & REP 1887		IN CASSVILLE SLOUGH	3,098	2,349
11	32	608.5	L	1911	601.4	1976	697	600.2	REP 1976		GOOD	1,357	1,583
11	13	608.7	L	1900	600.5	1937	545	599.0	REP 1925			1,010	1,990
11	10	608.9	L	1898	601.0	1937	541	600.3	EXT 100' 1933	REP 1915 & 1925		787	1,585
11	12	608.9	R	1900	600.5	1937	507	600.5	REP 1933	REP & EXT 100' 1915, REP 1925 & 1932		1,481	3,103
11	9	609.1	L	1898	601.7	1937	416	600.5	REP 1933	REP & EXT 150' 1915, REP 1925 & 1932		570	1,322
11	11	609.1	R	1898	601.1	1937	800	599.6	REP 1933	REP 1900, 1915, 1925 & 1932		1,348	5,375
11	8	609.2	R	1898	601.1	1937	1022	600.5	REP 1915			1,299	3,778
11	43	609.2	L	1915	600.6	1991	383	600.6	REP 233' 1991	REP 1933		641	1,815
11	40	609.4	R	1915	602.2	1937	300	604.7	REP 1933			213	384
11	42	609.4	L	1915	600.7	1991	600	600.7	REP 200' 1991	REP 1933		777	1,885
11	37	609.5	L	1914	600.7	1991	510	600.7	REP 210' 1991	REP 1933		842	1,966
11	41	609.5	R	1915	601.7	1937	124	601.6	REP 1933			172	354

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
11	7	609.6	R	1898	601.3	1937	880	601.3	EXT 200' 1914			1,289	3,182
11	31	609.7	L	1906	600.8	1991	601	600.8	REP 110' 1991	REP 1933		833	1,871
11	20	609.8	R	1900	600.8	1937	632	600.6	REP 1933	REP & EXT 275' 1906, 450' 1914		1,575	4,079
11	28	609.8	L	1906	600.8	1991	472	600.8	REP 415' 1991	REP 1933		1,035	1,919
11	15	609.9	L	1900	600.8	1937			REM 300' 1908	REM 300' 1903	MISSING 1937	672	1,299
11	30	609.9	R	1906	600.8	1937	761	601.8	REP 1928	EXT 200' 1914		2,013	3,892
11	29	610.0	R	1906	600.8	1937	620	602.3	REP 1933	REP 1928		729	1,363
11	14	610.1	CL	1900	600.8	1991	670	600.8	REP 635' 1991	REP 1905, 1932 & 1933		2,617	3,506
11	21	610.2	R	1903	600.8	1937	635	601.0	REP 1933	EXT 120' 1914, REP 1928		897	2,587
11	24	610.3	L	1903	600.9	1937	613	601.9	REP 1933	EXT 130' 1914		2,269	5,200
11	22	610.4	R	1903	600.9	1976	724	603.0	REP 300' 1976	REP 1915 & 1933	GOOD	1,086	2,448
11	27	610.4	L	1906	600.9	1937	492	602.4	REP 1933	EXT 100' 1914		1,214	2,730
11	26	610.5	L	1906	601.0	1906	300	601.0			SILTED IN	406	705
11	23	610.6	R	1903	601.0	1976	690	603.0	REP 1976	REP 1915, 1933 & 1950	GOOD	780	2,265
11	16	610.8	CR	1900	601.0	1937	445	600.5	REP 1915			893	1,389
11	17	610.8	R	1900	601.0	1937	735	602.0	REP 1933	EXT 150' 1906, REP & EXT 20' 1915		1,202	2,625
11	18	611.0	R	1900	601.1	1937	1101	602.5	REP 1933	REP 1915 & 1928, EXT 310' 1906		1,506	3,005
11	19	611.1	R	1900	601.1	1937	860	602.1	REP 1933	REP & EXT 525' 1906, REP 1927		1,643	3,255
11	25	611.2	R	1906	601.2	1937	540	602.0	REP 1933	REP 1915 & 1927		1,644	3,814
11	58	611.5	CL	1927	601.3	1937	73	602.8				498	511
11	2	611.6	CL	1884	603.4	1885	540		REP 1885		IN CASSVILLE SLOUGH	5,564	3,325
11	72	611.9	CL	1927	601.4	1937	59	603.4				325	381
11	24	612.1	R	1909	601.5	1937	388	601.2	REP 1928			1,786	3,906
11	33	612.1	R	1913	601.5	1938	209	602.3	REM 140' 1938			810	1,546
11	34	612.2	L	1913	601.6	1938	171	602.8	REM 120' 1938			824	1,290
11	23	612.3	L	1909	602.6	1937	784	601.6	REP 1928	REP 1912, EXT 200' 1914		2,293	5,270
11	35	612.3	R	1913	601.6	1937	270	607.6			GOOD, ROCK QUARRY DOCK	615	1,128
11	29	612.4	R	1913	601.6	1937	408	603.6	REP 1929			848	1,226
11	28	612.5	R	1913	601.7	1976	581	603.2	REP 1976	REP 1929	GOOD	1,075	1,789
11	9	612.6	L	1903	601.8	1976	1259	603.0	REP 1976	EXT 300' 1913, REP 1914, REP 1928		3,383	7,106
11	8	612.8	L	1903	601.8	1976	1269	603.0	REP 1976	REP 1928, EXT 135' 1913	GOOD	3,786	6,169
11	7	612.9	CL	1903	601.9	1937	663	601.9	REP 1928			1,701	2,783
11	59	612.9	L	1913	601.9	1976	300	603.0	REP 1976	REP 1928	GOOD	831	1,484
11	56	613.1	R	1913	602.0	1976	250	603.0	REP 1976	REP 1929, 1932 & 1933	GOOD	527	983
11	12	613.1	L	1903	602.0	1976	1198	603.0	REP 1976	REP 1911 & 1928	GOOD	1,488	2,585
11	55	613.3	R	1913	602.0	1976	445	603.0	REP 1976	REP 1929, 1932 & 1933	GOOD	650	2,113
11	58	613.3	L	1913	602.1	1976	870	603.0	REP 1976	REP 1929	GOOD	2,115	4,364
11	54	613.4	R	1913	602.1	1976	1050	603.0	REP 1976	REP & EXT 65' 1929, REP 1932 & 1933	GOOD	1,944	5,294
11	57	613.4	L	1913	602.1	1976	490	603.0	REP 1976	REP 1929		1,312	3,468
11	61	613.6	R	1913	602.2	1976	514	603.0	REP 1976	REP 1929	GOOD	1,736	3,907
11	69	613.7	R	1914	602.3	1976	682	603.0	REP 1976	REP 1929	GOOD	1,808	3,280
11	73	613.9	R	1929	602.5	1937	665	601.5	REP 1933	REP 1932		663	1,806
11		613.9	CL	1983	599.0	1984	190	599.0			ACKERMAN'S CUT	0	0
11		613.9	CL	1983	600.0	1984	240	600.0			ACKERMAN'S CUT	0	0
11	4	614.1	L	1891	602.6	1899	625		REM 425' 1899		IN CASSVILLE SLOUGH	1,643	2,089
11	5	614.1	L	1891	601.6	1899	135				IN CASSVILLE SLOUGH	807	1,232
11	70	614.1	R	1914	602.6	1937	682	603.6	REP 1925	EXT 250' 1915		933	1,958
11	22	614.3	CL	1908	602.2	1937	1130	605.7	REP 1929	REP 1909, 1911, 1917, 1925, 1926, & 1927	6' CONCRETE CAP 1926	4,645	7,805

POOL	OLD DAM NO.	NEW DAM NO.	DAM TYPE	YEAR BUILT	DESIGN ELEV.	MOST RECENT SURVEY YEAR	LENGTH	ELEV.	MOST RECENT WORK	OTHER WORK	PRESENT CONDITION	TO ROCK	ORIG. BRUSH
11	62	614.3	CR	1914	602.7	1937	1270	604.0				1,691	2,702
11	65	614.3	R	1914	602.7	1937	575	604.2	REP 1929	REP 1925		1,205	2,754
11	64	614.4	R	1914	602.7	1937	433	602.7	REM 250' 1937	EXT 200'1925, REP 1929		1,203	3,649
11	63	614.5	R	1914	602.8	1937	1100	603.8	REM 100' 1937	EXT 200'1925, REP 1929		1,277	2,999
11	71	614.9	L	1925	603.0	1936	200		REM 1936		REMOVED FOR L\D 10	434	1,445
11	25	615.0	L	1912	601.5	1976		601.5	REB 1976	REM 1936	REMOVED FOR L\D 10	706	1,257

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Chain of Rocks (Old River)	2	189.6L	16	St. Louis
Chain of Rocks (Old River)	2	189.0L (Trail)	12	St. Louis
Chain of Rocks (Old River)	2	189.3L (Spur)	14	St. Louis
Mosenthien Island	2	188.9L	13	St. Louis
Mosenthien Island	2	188.3L	10	St. Louis
Sawyer Bend (Mosenthien)	3	187.7L	9	St. Louis
Sawyer Bend (Mosenthien)	3	186.9L	8	St. Louis
Sawyer Bend (Mosenthien)	3	186.3L	7	St. Louis
Sawyer Bend (Mosenthien)	3	185.8L	6	St. Louis
Sawyer Bend (Mosenthien)	3	185.4L	5	St. Louis
Chain of Rocks Canal Entrance	3	184.1R (Trail)	11	St. Louis
Chain of Rocks Canal Entrance	3	183.5R (Kicker)	0	St. Louis
St. Louis Harbor	4	177.8L	U	St. Louis
St. Louis Harbor	4	177.3L	U	St. Louis
Arsenal Island	5	175.8L	U	St. Louis
Arsenal Island	5	175.6L	U	St. Louis
Jefferson Barracks Area	6	170.5L	U	St. Louis
Jefferson Barracks Area	6	170.3L	U	St. Louis
Jefferson Barracks Area	6	170.0L	U	St. Louis
Jefferson Barracks Bridge	6	168.8L	13	St. Louis
Cliff Cave Area	6	167.6L	16	St. Louis
Cliff Cave Area	6	167.5L	15	St. Louis
Cliff Cave Area	6	167.3L	15	St. Louis
Cliff Cave Area	6	167.0L	15	St. Louis
Cliff Cave Area	6	166.5L	12	St. Louis
Cliff Cave Area	6	166.4R	16	St. Louis
Cliff Cave Area	6	166.2R	14	St. Louis
Cliff Cave Area	6	166.1R	17	St. Louis
Cliff Cave Area	6	166.0R	20	St. Louis
Luhr-Pulltight Area	7	165.9R	18	St. Louis
Luhr-Pulltight Area	7	165.85L	16	St. Louis
Luhr-Pulltight Area	7	165.7R	16	St. Louis
Luhr-Pulltight Area	7	165.5R	14	St. Louis
Luhr-Pulltight Area	7	165.3R	14	St. Louis
Luhr-Pulltight Area	7	165.15R	14	St. Louis
Luhr-Pulltight Area	7	164.95L	19	St. Louis
Luhr-Pulltight Area	7	164.9R	14	St. Louis
Luhr-Pulltight Area	7	164.7R	14	St. Louis
Luhr-Pulltight Area	7	164.35L	15	St. Louis
Carl Baer-Fines Bluff Area	7	164.0R	20	St. Louis
Carl Baer-Fines Bluff Area	7	163.65R	19	St. Louis
Carl Baer-Fines Bluff Area	7	163.6L	5	St. Louis
Carl Baer-Fines Bluff Area	7	163.5L	9	St. Louis
Carl Baer-Fines Bluff Area	7	163.35L	20	St. Louis
Carl Baer-Fines Bluff Area	7	163.0L	19	St. Louis
Carl Baer-Fines Bluff Area	7	162.6L	13	St. Louis
Fines Bluff-Meramec River	7	162.3L	14	St. Louis

LOCATION	*SHEET NO.*	*MILE*	*TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)*	*GAGE*
Fines Bluff-Meramec River	7	161.9L	21	St. Louis
Fines Bluff-Meramec River	7	161.4L	20	St. Louis
Fines Bluff-Meramec River	7	161.2L	20	St. Louis
Fines Bluff-Meramec River	7	160.8L	15	St. Louis
Fines Bluff-Meramec River	7	160.5L	20	St. Louis
Meramec River-Waters Point	7	160.2L	15	St. Louis
Meramec River-Waters Point	7	160.0L	14	St. Louis
Meramec River-Waters Point	8	159.8L	14	St. Louis
Meramec River-Waters Point	8	159.75R	6	St. Louis
Meramec River-Waters Point	8	159.6L	14	St. Louis
Meramec River-Waters Point	8	159.55R	13	St. Louis
Meramec River-Waters Point	8	159.4L	14	St. Louis
Meramec River-Waters Point	8	159.25R	15	St. Louis
Meramec River-Waters Point	8	159.15L	14	St. Louis
Meramec River-Waters Point	8	158.9R	15	St. Louis
Meramec River-Waters Point	8	158.85L	14	St. Louis
Meramec River-Waters Point	8	158.6L	14	St. Louis
Foster-Glen Park	8	158.1L	15	St. Louis
Foster-Glen Park	8	157.8L	15	St. Louis
Foster-Glen Park	8	157.6L	15	St. Louis
Foster-Glen Park	8	157.35L	14	St. Louis
Foster-Glen Park	8	157.0L	14	St. Louis
Foster-Glen Park	8	156.7L	14	St. Louis
Foster-Glen Park	8	156.25L	19	St. Louis
Foster-Glen Park	8	156.0L	15	St. Louis
Glenn Park-Bushberg	8	155.55L	16	St. Louis
Glenn Park-Bushberg	8	155.2L	15	St. Louis
Glenn Park-Bushberg	9	154.9L	14	St. Louis
Glenn Park-Bushberg	9	154.6L	15	St. Louis
Bushberg-Herculaneum	9	154.3L	14	St. Louis
Bushberg-Herculaneum	9	154.0R	5	St. Louis
Bushberg-Herculaneum	9	153.9L	5	St. Louis
Bushberg-Herculaneum	9	153.7R	5	St. Louis
Bushberg-Herculaneum	9	153.7L	15	St. Louis
Bushberg-Herculaneum	9	153.5R	5	St. Louis
Bushberg-Herculaneum	9	153.5L	9	St. Louis
Bushberg-Herculaneum	9	153.1R	5	St. Louis
Bushberg-Herculaneum	9	152.9L	8	St. Louis
Bushberg-Herculaneum	9	152.5L	5	St. Louis
Bushberg-Herculaneum	9	151.9L	5	St. Louis
Bushberg-Herculaneum	9	151.7R	12	St. Louis
Bushberg-Herculaneum	9	151.5R	13	St. Louis
Bushberg-Herculaneum	9	151.35R	13	St. Louis
Bushberg-Herculaneum	9	151.3L	5	St. Louis
Herculaneum-Crystal City	9	151.0L	5	St. Louis
Herculaneum-Crystal City	9	150.6L	5	St. Louis
Herculaneum-Crystal City	9	150.6R	15	St. Louis

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Herculaneum-Crystal City	9	150.45R	17	St. Louis
Herculaneum-Crystal City	9	150.3L	U	St. Louis
Herculaneum-Crystal City	9	150.2R	5	St. Louis
Herculaneum-Crystal City	9	150.0R	5	St. Louis
Herculaneum-Crystal City	9	150.0L	5	St. Louis
Herculaneum-Crystal City	9	149.7R	5	St. Louis
Herculaneum-Crystal City	9	149.3R	18	St. Louis
Herculaneum-Crystal City	9	149.2L	5	St. Louis
Crystal City-St. Nicholas Rock	10	148.95L	15	St. Louis
Crystal City-St. Nicholas Rock	10	148.9R	5	St. Louis
Crystal City-St. Nicholas Rock	10	148.5L	5	St. Louis
Crystal City-St. Nicholas Rock	10	148.3R	5	St. Louis
Crystal City-St. Nicholas Rock	10	148.1L	5	St. Louis
Crystal City-St. Nicholas Rock	10	147.65L	5	St. Louis
Crystal City-St. Nicholas Rock	10	147.1L	5	St. Louis
St. Nichols Rock-Michaels Towhead	10	146.6R	21	St. Louis
St. Nichols Rock-Michaels Towhead	10	146.6L	5	St. Louis
St. Nichols Rock-Michaels Towhead	10	146.25L	5	St. Louis
St. Nichols Rock-Michaels Towhead	10	146.2R	5	St. Louis
Michaels Towhead-Lowrey	10	145.4L	8	St. Louis
Michaels Towhead-Lowrey	10	145.3R	19	St. Louis
Michaels Towhead-Lowrey	10	145.15R	5	St. Louis
Michaels Towhead-Lowrey	10	145.05R	15	St. Louis
Michaels Towhead-Lowrey	10	145.0L	5	St. Louis
Michaels Towhead-Lowrey	10	144.9R	13	St. Louis
Michaels Towhead-Lowrey	10	144.8L	8	St. Louis
Michaels Towhead-Lowrey	10	144.6R	10	St. Louis
Michaels Towhead-Lowrey	10	144.5L	5	St. Louis
Michaels Towhead-Lowrey	10	144.4L	5	St. Louis
Michaels Towhead-Lowrey	10	144.2R	10	St. Louis
Michaels Towhead-Lowrey	10	144.0R	10	St. Louis
Michaels Towhead-Lowrey	10	144.0L	5	St. Louis
Michaels Towhead-Lowrey	10	143.8L	5	St. Louis
Michaels Towhead-Lowrey	10	143.8R	10	St. Louis
Michaels Towhead-Lowrey	10	143.6L	5	St. Louis
Michaels Towhead-Lowrey	10	143.5R	5	St. Louis
Michaels Towhead-Lowrey	10	143.45L	5	St. Louis
Lowrey-Rush Island	11	143.0R	5	St. Louis
Lowrey-Rush Island	11	142.55R	U	St. Louis
Lowrey-Rush Island	11	142.25R	5	St. Louis
Lowrey-Rush Island	11	142.0L	20	St. Louis
Lowrey-Rush Island	11	141.75R	5	St. Louis
Lowrey-Rush Island	11	141.7L	5	St. Louis
Lowrey-Rush Island	11	141.4L	5	St. Louis
Lowrey-Rush Island	11	141.3R	5	St. Louis
Lowrey-Rush Island	11	141.1L	6	St. Louis
Lowrey-Rush Island	11	141.05R	5	St. Louis

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Lowrey-Rush Island	11	140.9R	20	St. Louis
Lowrey-Rush Island	11	140.85L	7	St. Louis
Lowrey-Rush Island	11	140.7R	15	St. Louis
Lowrey-Rush Island	11	140.4L	7	St. Louis
Rush Island-Ames Island	11	139.9L	7	St. Louis
Rush Island-Ames Island	11	139.5L	20	St. Louis
Rush Island-Ames Island	11	139.2L	20	St. Louis
Rush Island-Ames Island	11	139.0L	14	St. Louis
Rush Island-Ames Island	11	138.75L	14	St. Louis
Rush Island-Ames Island	11	138.4L	18	St. Louis
Rush Island-Ames Island	12	137.95L	16	St. Louis
Ames Island-Brickeys	12	137.5L	14	St. Louis
Ames Island-Brickeys	12	137.0L	14	St. Louis
Ames Island-Brickeys	12	136.7L	14	St. Louis
Ames Island-Brickeys	12	136.45L	14	St. Louis
Ames Island-Brickeys	12	136.15L	14	St. Louis
Brickeys-Establishment Island	12	135.85L	14	St. Louis
Brickeys-Establishment Island	12	135.6L	14	St. Louis
Brickeys-Establishment Island	12	135.4L	14	St. Louis
Brickeys-Establishment Island	12	135.2L	14	St. Louis
Brickeys-Establishment Island	12	135.0L	14	St. Louis
Brickeys-Establishment Island	12	134.8L	14	St. Louis
Brickeys-Establishment Island	12	134.7L	17	St. Louis
Brickeys-Establishment Island	12	134.3L	18	St. Louis
Brickeys-Establishment Island	12	134.0L	15	St. Louis
Brickeys-Establishment Island	12	133.65L	14	St. Louis
Establishment Island-Fort Chartres	12	133.3L	15	St. Louis
Establishment Island-Fort Chartres	12	132.95L	15	St. Louis
Establishment Island-Fort Chartres	12	132.95R	16	St. Louis
Establishment Island-Fort Chartres	12	132.8R	14	St. Louis
Establishment Island-Fort Chartres	12	132.6R	15	St. Louis
Establishment Island-Fort Chartres	12	132.3R (Spur)	14	St. Louis
Establishment Island-Fort Chartres	12	132.2R (Trail)	-5	St. Louis
Establishment Island-Fort Chartres	12	132.05R (Spur)	14	St. Louis
Establishment Island-Fort Chartres	12	132.05L	U	St. Louis
Establishment Island-Fort Chartres	13	131.95R (Trail)	-5	St. Louis
Establishment Island-Fort Chartres	13	131.8R	14	St. Louis
Crooks-White Sand	13	130.5L	-10	St. Louis
Crooks-White Sand	13	130.3L	14	St. Louis
Crooks-White Sand	13	130.1L	14	St. Louis
Crooks-White Sand	13	129.85L	8	St. Louis
Crooks-White Sand	13	129.5L	18	St. Louis
Crooks-White Sand	13	129.2L	16	St. Louis
Crooks-White Sand	13	128.8L	14	St. Louis
Crooks-White Sand	13	128.6L	14	St. Louis
White Sand-Little Rock	13	126.6L	14	St. Louis
Little Rock-Ste. Genevieve Island	14	125.3R	?	St. Louis

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Little Rock-Ste. Genevieve Island	14	125.0L	20	St. Louis
Little Rock-Ste. Genevieve Island	14	124.9R	10	St. Louis
Little Rock-Ste. Genevieve Island	14	124.7L	14	St. Louis
Little Rock-Ste. Genevieve Island	14	124.55R	14	St. Louis
Little Rock-Ste. Genevieve Island	14	124.5L	14	St. Louis
Little Rock-Ste. Genevieve Island	14	124.2R	15	St. Louis
Little Rock-Ste. Genevieve Island	14	124.2L	22	St. Louis
Little Rock-Ste. Genevieve Island	14	124.0L	22	St. Louis
Little Rock-Ste. Genevieve Island	14	123.9R	19	St. Louis
Little Rock-Ste. Genevieve Island	14	123.8L	20	St. Louis
Little Rock-Ste. Genevieve Island	14	123.75R	14	St. Louis
Little Rock-Ste. Genevieve Island	14	123.6R	21	St. Louis
Little Rock-Ste. Genevieve Island	14	123.6L	20	St. Louis
Little Rock-Ste. Genevieve Island	14	123.4L	14	St. Louis
Little Rock-Ste. Genevieve Island	14	123.2R	14	St. Louis
Little Rock-Ste. Genevieve Island	14	123.15L	15	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	122.9R	14	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	122.9L	14	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	122.6R	20	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	122.45L	12	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	121.9L	14	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	121.7L	14	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	121.5L	14	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	121.3R	20	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	121.15R	18	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	121.0L	13	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	120.65L	20	St. Louis
Ste.Genevieve Island-Ste.Genevieve Bend	14	120.1L	21	St. Louis
Moro Island-Ellis Grove	15	119.5L	14	St. Louis
Moro Island-Ellis Grove	15	119.4R	20	St. Louis
Moro Island-Ellis Grove	15	119.3R	18	St. Louis
Moro Island-Ellis Grove	15	119.2R	20	St. Louis
Moro Island-Ellis Grove	15	119.05R	20	St. Louis
Moro Island-Ellis Grove	15	118.9R	17	St. Louis
Moro Island-Ellis Grove	15	118.7R	16	St. Louis
Moro Island-Ellis Grove	15	118.6R	17	St. Louis
Moro Island-Ellis Grove	15	118.45R	14	St. Louis
Moro Island-Ellis Grove	15	118.2R	14	St. Louis
Moro Island-Ellis Grove	15	118.0R	14	St. Louis
Moro Island-Ellis Grove	15	117.8R	5	St. Louis
Moro Island-Ellis Grove	15	117.6R	5	St. Louis
Moro Island-Ellis Grove	15	117.35R	5	St. Louis
Moro Island-Ellis Grove	15	117.2R (Trail)	5	St. Louis
Ellis Grove-Farmers	15	116.8R	14	St. Louis
Ellis Grove-Farmers	15	116.15R	22	St. Louis
Ellis Grove-Farmers	15	115.75L (Trail)	5	St. Louis
Ellis Grove-Farmers	15	115.65L (Trail)	5	St. Louis

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Ellis Grove-Farmers	15	115.55L (Trail)	10	St. Louis
Farmers-Cherokee Landing	15	114.95L	16	St. Louis
Farmers-Cherokee Landing	15	114.7L	14	St. Louis
Farmers-Cherokee Landing	15	114.35R	18	St. Louis
Farmers-Cherokee Landing	15	114.3L	14	St. Louis
Farmers-Cherokee Landing	15	114.15R	13	St. Louis
Farmers-Cherokee Landing	15	114.05L	14	St. Louis
Farmers-Cherokee Landing	16	113.85R	20	St. Louis
Farmers-Cherokee Landing	16	113.75L	14	St. Louis
Farmers-Cherokee Landing	16	113.65R	18	St. Louis
Farmers-Cherokee Landing	16	113.5L	14	St. Louis
Farmers-Cherokee Landing	16	113.45R	14	St. Louis
Farmers-Cherokee Landing	16	113.25L	20	St. Louis
Farmers-Cherokee Landing	16	113.2R	20	St. Louis
Farmers-Cherokee Landing	16	113.0R	7	St. Louis
Farmers-Cherokee Landing	16	112.85R	17	St. Louis
Farmers-Cherokee Landing	16	112.7R	16	St. Louis
Farmers-Cherokee Landing	16	112.5R	18	St. Louis
Cherokee Landing-Chester	16	112.1L	14	St. Louis
Cherokee Landing-Chester	16	111.8L	14	St. Louis
Cherokee Landing-Chester	16	111.35L	14	St. Louis
Cherokee Landing-Chester	16	111.3R	20	St. Louis
Cherokee Landing-Chester	16	111.15R	18	St. Louis
Cherokee Landing-Chester	16	111.1L	14	St. Louis
Cherokee Landing-Chester	16	111.0R	16	St. Louis
Cherokee Landing-Chester	16	110.85R	14	St. Louis
Cherokee Landing-Chester	16	110.6R (Trail)	5	St. Louis
Chester-Ford Transfer Dock	16	108.7R	18	Chester
Chester-Ford Transfer Dock	16	108.5R	16	Chester
Chester-Ford Transfer Dock	16	108.33R	15	Chester
Chester-Ford Transfer Dock	16	108.2R	15	Chester
Chester-Ford Transfer Dock	16	108.0R	16	Chester
Chester-Ford Transfer Dock	17	107.8R	13	Chester
Chester-Ford Transfer Dock	17	107.65R	15	Chester
Chester-Ford Transfer Dock	17	107.5R	11	Chester
Chester-Ford Transfer Dock	17	107.3R	15	Chester
Chester-Ford Transfer Dock	17	107.1R	9	Chester
Chester-Ford Transfer Dock	17	106.8R	12	Chester
Chester-Ford Transfer Dock	17	106.55R	13	Chester
Chester-Ford Transfer Dock	17	106.5R	16	Chester
Chester-Ford Transfer Dock	17	106.3R	16	Chester
Chester-Ford Transfer Dock	17	105.9R	18	Chester
Chester-Ford Transfer Dock	17	105.7R	U	Chester
Chester-Ford Transfer Dock	17	105.55R	16	Chester
Chester-Ford Transfer Dock	17	105.4R	15	Chester
Chester-Ford Transfer Dock	17	105.1R	15	Chester
Ford Transfer Dock-Anchor	17	104.9R	13	Chester

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Ford Transfer Dock-Anchor	17	104.55R	15	Chester
Ford Transfer Dock-Anchor	17	104.25R	15	Chester
Ford Transfer Dock-Anchor	17	103.85R	15	Chester
Ford Transfer Dock-Anchor	17	103.8L (Trail)	15	Chester
Ford Transfer Dock-Anchor	17	103.6L (Trail)	15	Chester
Ford Transfer Dock-Anchor	17	103.45R	15	Chester
Ford Transfer Dock-Anchor	17	103.4L	15	Chester
Ford Transfer Dock-Anchor	17	103.2L	14	Chester
Ford Transfer Dock-Anchor	17	103.0R	15	Chester
Ford Transfer Dock-Anchor	17	103.0L	15	Chester
Ford Transfer Dock-Anchor	17	102.9L (Trail)	7	Chester
Ford Transfer Dock-Anchor	17	102.8R	15	Chester
Ford Transfer Dock-Anchor	17	102.65R	15	Chester
Ford Transfer Dock-Anchor	17	102.6L	15	Chester
Ford Transfer Dock-Anchor	17	102.2R	U	Chester
Ford Transfer Dock-Anchor	17	102.1L	15	Chester
Anchor-Liberty Island	18	101.55R	15	Chester
Anchor-Liberty Island	18	101.45L	15	Chester
Anchor-Liberty Island	18	100.85L	U	Chester
Anchor-Liberty Island	18	100.7R	15	Chester
Anchor-Liberty Island	18	100.5R	15	Chester
Anchor-Liberty Island	18	100.3L	15	Chester
Anchor-Liberty Island	18	100.25R	15	Chester
Anchor-Liberty Island	18	100.05R (Trail)	15	Chester
Anchor-Liberty Island	18	99.95L	10	Chester
Anchor-Liberty Island	18	99.9R	15	Chester
Anchor-Liberty Island	18	99.75R	15	Chester
Anchor-Liberty Island	18	99.55R	15	Chester
Anchor-Liberty Island	18	99.1R	15	Chester
Liberty Island-Wagners	18	98.7R	15	Chester
Liberty Island-Wagners	18	98.2R	16	Chester
Liberty Island-Wagners	18	98.0L	18	Chester
Liberty Island-Wagners	18	97.9L	18	Chester
Liberty Island-Wagners	18	97.8L	16	Chester
Liberty Island-Wagners	18	97.7L	18	Chester
Liberty Island-Wagners	18	97.7R	15	Chester
Wagners-Roman Landing	18	97.0R	15	Chester
Wagners-Roman Landing	18	96.7R	15	Chester
Wagners-Roman Landing	18	96.35R	15	Chester
Wagners-Roman Landing	18	96.15R	15	Chester
Roman Landing-Backbone	19	95.2L (Trail)	-1	Chester
Roman Landing-Backbone	19	94.65R	13	Chester
Roman Landing-Backbone	19	94.6R	15	Chester
Roman Landing-Backbone	19	94.4R	15	Chester
Roman Landing-Backbone	19	94.25R	15	Chester
Roman Landing-Backbone	19	94.15R	13	Chester
Backbone-Seventy Six Towhead	19	93.0L	15	Chester

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Backbone-Seventy Six Towhead	19	92.2L	15	Chester
Backbone-Seventy Six Towhead	19	91.7L	15	Chester
Backbone-Seventy Six Towhead	19	91.5R(Trail)	15	Chester
Backbone-Seventy Six Towhead	19	91.35R	15	Chester
Backbone-Seventy Six Towhead	19	91.15R	15	Chester
Seventy Six Towhead-Cumberland Rock	19	90.9R	15	Chester
Seventy Six Towhead-Cumberland Rock	19	90.7R	15	Chester
Seventy Six Towhead-Cumberland Rock	19	90.5R	15	Chester
Seventy Six Towhead-Cumberland Rock	20	89.3L	15	Chester
Seventy Six Towhead-Cumberland Rock	20	89.0L	15	Chester
Seventy Six Towhead-Cumberland Rock	20	88.2L	15	Chester
Seventy Six Towhead-Cumberland Rock	20	87.8L	15	Chester
Seventy Six Towhead-Cumberland Rock	20	87.6L	15	Chester
Seventy Six Towhead-Cumberland Rock	20	87.3L	15	Chester
Cumberland Rock-Brunkhorst	20	87.0L	15	Chester
Cumberland Rock-Brunkhorst	20	86.8L	15	Chester
Cumberland Rock-Brunkhorst	20	86.5L	15	Chester
Cumberland Rock-Brunkhorst	20	86.4R	15	Chester
Cumberland Rock-Brunkhorst	20	86.25L	15	Chester
Cumberland Rock-Brunkhorst	20	86.1R	15	Chester
Cumberland Rock-Brunkhorst	20	86.0L	15	Chester
Cumberland Rock-Brunkhorst	20	85.95R	15	Chester
Cumberland Rock-Brunkhorst	20	85.7R	15	Chester
Cumberland Rock-Brunkhorst	20	85.7L	15	Chester
Cumberland Rock-Brunkhorst	20	85.45R	15	Chester
Cumberland Rock-Brunkhorst	20	85.4L (Trail)	15	Chester
Cumberland Rock-Brunkhorst	20	85.25R	15	Chester
Cumberland Rock-Brunkhorst	20	85.1R	15	Chester
Cumberland Rock-Brunkhorst	20	85.0R	15	Chester
Brunkhorst-Grand Tower	21	79.5L	16	Chester
Brunkhorst-Grand Tower	21	79.35R	U	Chester
Brunkhorst-Grand Tower	21	79.3L	17	Chester
Brunkhorst-Grand Tower	21	79.1L	17	Chester
Grand Tower-Birmingham	22	78.15L	15	Chester
Grand Tower-Birmingham	22	78.0L (Trail)	13	Chester
Grand Tower-Birmingham	22	77.9L (Trail)	11	Chester
Grand Tower-Birmingham	22	77.65L	16	Chester
Grand Tower-Birmingham	22	77.5L	16	Chester
Grand Tower-Birmingham	22	77.25L	20	Chester
Grand Tower-Birmingham	22	77.1L	15	Chester
Grand Tower-Birmingham	22	76.5L	13	Chester
Grand Tower-Birmingham	22	76.1L	11	Chester
Birmingham-Hines	22	75.5L	9	Chester
Birmingham-Hines	22	75.45R	7	Chester
Birmingham-Hines	22	75.3R	20	Chester
Birmingham-Hines	22	75.0L	14	Chester
Birmingham-Hines	22	74.6L	21	Chester

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Birmingham-Hines	22	74.3L	16	Chester
Birmingham-Hines	22	74.15L	16	Chester
Birmingham-Hines	22	73.8L	20	Chester
Hines-Hanging Dog Bluff	22	73.15L	18	Chester
Hines-Hanging Dog Bluff	22	73.0R	U	Chester
Hines-Hanging Dog Bluff	23	72.9L	20	Chester
Hines-Hanging Dog Bluff	23	72.7L	15	Chester
Hines-Hanging Dog Bluff	23	72.4L	13	Chester
Hines-Hanging Dog Bluff	23	72.3R	13	Chester
Hines-Hanging Dog Bluff	23	71.7L	11	Chester
Hanging Dog Bluff-Teatable	23	71.3R	U	Chester
Hanging Dog Bluff-Teatable	23	71.25L	11	Chester
Hanging Dog Bluff-Teatable	23	71.2R	U	Chester
Hanging Dog Bluff-Teatable	23	71.05R	11	Chester
Hanging Dog Bluff-Teatable	23	71.0R	20	Chester
Hanging Dog Bluff-Teatable	23	70.9L	10	Chester
Hanging Dog Bluff-Teatable	23	70.65R	15	Chester
Hanging Dog Bluff-Teatable	23	70.6L	11	Chester
Hanging Dog Bluff-Teatable	23	70.35R	13	Chester
Hanging Dog Bluff-Teatable	23	70.05L	20	Chester
Hanging Dog Bluff-Teatable	23	69.9R	11	Chester
Hanging Dog Bluff-Teatable	23	69.5R	9	Chester
Hanging Dog Bluff-Teatable	23	69.4L	15	Chester
Hanging Dog Bluff-Teatable	23	69.05R	20	Chester
Hanging Dog Bluff-Teatable	23	69.05L	13	Chester
Hanging Dog Bluff-Teatable	23	68.5L	11	Chester
Hanging Dog Bluff-Teatable	23	68.2L	12	Chester
Teatable-Moccasin Springs	24	67.8L	19	Chester
Teatable-Moccasin Springs	24	67.55R	15	Chester
Teatable-Moccasin Springs	24	67.4R	16	Chester
Teatable-Moccasin Springs	24	67.3L	15	Chester
Teatable-Moccasin Springs	24	67.2R	16	Chester
Teatable-Moccasin Springs	24	67.0R	18	Chester
Teatable-Moccasin Springs	24	66.9R	20	Chester
Teatable-Moccasin Springs	24	66.75R (Trail)	30	Chester
Teatable-Moccasin Springs	24	66.7L	15	Chester
Teatable-Moccasin Springs	24	66.5R	20	Chester
Moccasin Springs-Sheppard Point	24	66.0L	20	Chester
Moccasin Springs-Sheppard Point	24	65.95R	13	Chester
Moccasin Springs-Sheppard Point	24	65.85L	18	Chester
Moccasin Springs-Sheppard Point	24	65.75R	9	Chester
Moccasin Springs-Sheppard Point	24	65.55L	20	Chester
Moccasin Springs-Sheppard Point	24	65.3L	20	Chester
Moccasin Springs-Sheppard Point	24	65.15L	20	Chester
Moccasin Springs-Sheppard Point	24	64.9L	5	Chester
Moccasin Springs-Sheppard Point	24	64.75L	20	Chester
Moccasin Springs-Sheppard Point	24	64.55L	20	Chester

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Moccasin Springs-Sheppard Point	24	64.35L	20	Chester
Moccasin Springs-Sheppard Point	24	64.05R	15	Chester
Moccasin Springs-Sheppard Point	24	63.95L	20	Chester
Moccasin Springs-Sheppard Point	24	63.7R	16	Chester
Moccasin Springs-Sheppard Point	24	63.7L	20	Chester
Moccasin Springs-Sheppard Point	24	63.5L	20	Chester
Moccasin Springs-Sheppard Point	24	63.4L	16	Chester
Moccasin Springs-Sheppard Point	24	63.35R	7	Chester
Moccasin Springs-Sheppard Point	24	63.2L	20	Chester
Moccasin Springs-Sheppard Point	24	63.1R	14	Chester
Moccasin Springs-Sheppard Point	24	63.0L	16	Chester
Shepard Point-Dusky Bar	25	62.85R	18	Chester
Shepard Point-Dusky Bar	25	62.75L	7	Chester
Shepard Point-Dusky Bar	25	62.65L	7	Chester
Shepard Point-Dusky Bar	25	62.5R	15	Chester
Shepard Point-Dusky Bar	25	62.5L	7	Chester
Shepard Point-Dusky Bar	25	62.2L	7	Chester
Shepard Point-Dusky Bar	25	62.2R(Trail)	15	Chester
Shepard Point-Dusky Bar	25	61.95L	7	Chester
Shepard Point-Dusky Bar	25	61.8L	7	Chester
Shepard Point-Dusky Bar	25	61.8R	15	Chester
Shepard Point-Dusky Bar	25	61.5L	20	Chester
Shepard Point-Dusky Bar	25	61.4R	13	Chester
Shepard Point-Dusky Bar	25	61.4L	7	Chester
Shepard Point-Dusky Bar	25	61.25R	15	Chester
Shepard Point-Dusky Bar	25	61.2L	20	Chester
Shepard Point-Dusky Bar	25	61.05R	7	Chester
Shepard Point-Dusky Bar	25	61.05L	20	Chester
Shepard Point-Dusky Bar	25	60.9R	16	Chester
Shepard Point-Dusky Bar	25	60.85L(Trail)	11	Chester
Shepard Point-Dusky Bar	25	60.6L	18	Chester
Shepard Point-Dusky Bar	25	60.5L	20	Chester
Shepard Point-Dusky Bar	25	60.45R	16	Chester
Dusky Bar-Devils Island	25	60.05R	7	Chester
Dusky Bar-Devils Island	25	59.8R	15	Chester
Dusky Bar-Devils Island	25	59.65R	15	Chester
Dusky Bar-Devils Island	25	59.4R	15	Chester
Dusky Bar-Devils Island	25	59.2R	15	Chester
Dusky Bar-Devils Island	25	58.8R	15	Chester
Dusky Bar-Devils Island	25	58.8L	7	Chester
Dusky Bar-Devils Island	25	58.5L	7	Chester
Dusky Bar-Devils Island	25	58.4R	15	Chester
Dusky Bar-Devils Island	25	58.0R	15	Chester
Dusky Bar-Devils Island	25	57.6R	15	Chester
Dusky Bar-Devils Island	25	57.4L	22	Chester
Dusky Bar-Devils Island	25	57.25R	15	Chester
Dusky Bar-Devils Island	25	57.2L	20	Chester

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Dusky Bar-Devils Island	25	57.15L	20	Chester
Dusky Bar-Devils Island	25	57.15R	15	Chester
Devils Island-Cape Rock	26	56.85L	20	Chester
Devils Island-Cape Rock	26	56.7L	20	Chester
Devils Island-Cape Rock	26	56.6L	18	Chester
Devils Island-Cape Rock	26	56.45L	18	Chester
Devils Island-Cape Rock	26	54.45R	15	Chester
Devils Island-Cape Rock	26	56.2R	15	Chester
Devils Island-Cape Rock	26	56.05R	15	Chester
Devils Island-Cape Rock	26	55.9L	15	Chester
Devils Island-Cape Rock	26	55.85R	20	Chester
Devils Island-Cape Rock	26	55.3L	12	Chester
Devils Island-Cape Rock	26	55.1L	12	Chester
Devils Island-Cape Rock	26	54.7L	16	Chester
Cape Rock-Cape Girardeau	26	53.05L	16	Chester
Cape Rock-Cape Girardeau	26	52.8L	7	Chester
Cape Rock-Cape Girardeau	26	52.5L	7	Chester
Cape Rock-Cape Girardeau	26	52.2L	7	Chester
Cape Rock-Cape Girardeau	26	51.8L	7	Cape Girardeau
Cape Girardeau-Cape Bend	26	51.4L	13	Cape Girardeau
Cape Girardeau-Cape Bend	26	51.05L	13	Cape Girardeau
Cape Girardeau-Cape Bend	27	50.8L	13	Cape Girardeau
Cape Girardeau-Cape Bend	27	50.4L	13	Cape Girardeau
Cape Girardeau-Cape Bend	27	50.0L	13	Cape Girardeau
Cape Girardeau-Cape Bend	27	49.85L	U	Cape Girardeau
Cape Girardeau-Cape Bend	27	49.55L	13	Cape Girardeau
Cape Bend-Grays Point	27	48.03L(Chute)	17	Cape Girardeau
Cape Bend-Grays Point	27	47.8R	U	Cape Girardeau
Cape Bend-Grays Point	27	47.6R	13	Cape Girardeau
Cape Bend-Grays Point	27	47.6L	13	Cape Girardeau
Cape Bend-Grays Point	27	47.3R	U	Cape Girardeau
Cape Bend-Grays Point	27	47.2L	13	Cape Girardeau
Cape Bend-Grays Point	27	47.0L	13	Cape Girardeau
Cape Bend-Grays Point	27	45.8L		Cape Girardeau
Grays Point-Thebes	27	44.5R	13	Cape Girardeau
Grays Point-Thebes	27	44.2R	13	Cape Girardeau
Thebes-Commerce	28	43.9R	13	Cape Girardeau
Thebes-Commerce	28	43.6R	13	Cape Girardeau
Thebes-Commerce	28	42.7L	19	Cape Girardeau
Thebes-Commerce	28	42.3L	13	Cape Girardeau
Thebes-Commerce	28	42.1R	22	Cape Girardeau
Thebes-Commerce	28	41.85L	23	Cape Girardeau
Thebes-Commerce	28	41.7R	20	Cape Girardeau
Thebes-Commerce	28	41.55R	20	Cape Girardeau
Thebes-Commerce	28	41.35R	U	Cape Girardeau
Thebes-Commerce	28	41.3R(Trail)	U	Cape Girardeau
Thebes-Commerce	28	41.0R	U	Cape Girardeau

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Thebes-Commerce	28	40.8R	20	Cape Girardeau
Thebes-Commerce	28	40.8L	22	Cape Girardeau
Thebes-Commerce	28	40.4L	26	Cape Girardeau
Thebes-Commerce	28	40.2R	22	Cape Girardeau
Thebes-Commerce	28	40.05R	20	Cape Girardeau
Thebes-Commerce	28	40.0L	U	Cape Girardeau
Thebes-Commerce	28	39.7R	13	Cape Girardeau
Commerce-Allen Towhead	28	39.5L(Trail)	26	Cape Girardeau
Commerce-Allen Towhead	28	39.45R	25	Cape Girardeau
Commerce-Allen Towhead	28	39.2R	26	Cape Girardeau
Commerce-Allen Towhead	29	38.85R	U	Cape Girardeau
Commerce-Allen Towhead	29	38.55R	21	Cape Girardeau
Commerce-Allen Towhead	29	38.4R	26	Cape Girardeau
Commerce-Allen Towhead	29	38.3L	26	Cape Girardeau
Commerce-Allen Towhead	29	38.2R	21	Cape Girardeau
Commerce-Allen Towhead	29	38.05L	20	Cape Girardeau
Commerce-Allen Towhead	29	37.95R	26	Cape Girardeau
Commerce-Allen Towhead	29	37.7R	20	Cape Girardeau
Commerce-Allen Towhead	29	37.6R	26	Cape Girardeau
Commerce-Allen Towhead	29	37.6L	26	Cape Girardeau
Commerce-Allen Towhead	29	37.35L	24	Cape Girardeau
Commerce-Allen Towhead	29	37.15L	22	Cape Girardeau
Allen Towhead-Goose Isalnd	29	36.95L	U	Cape Girardeau
Allen Towhead-Goose Isalnd	29	36.7L	24	Cape Girardeau
Allen Towhead-Goose Isalnd	29	36.45L	26	Cape Girardeau
Allen Towhead-Goose Isalnd	29	36.05L	13	Cape Girardeau
Allen Towhead-Goose Isalnd	29	35.8L	24	Cape Girardeau
Allen Towhead-Goose Isalnd	29	35.6L	24	Cape Girardeau
Allen Towhead-Goose Isalnd	29	35.4L	26	Cape Girardeau
Allen Towhead-Goose Isalnd	29	35.2L	17	Cape Girardeau
Allen Towhead-Goose Isalnd	29	35.0L	26	Cape Girardeau
Allen Towhead-Goose Isalnd	29	34.95R	13	Cape Girardeau
Allen Towhead-Goose Isalnd	29	34.65R	13	Cape Girardeau
Allen Towhead-Goose Isalnd	29	34.05R	14	Cape Girardeau
Goose Island-Commercial Point	29	33.3R	27	Cape Girardeau
Goose Island-Commercial Point	30	32.7R	13	Cape Girardeau
Commercial Point-Daniels	30	32.2R	U	Cape Girardeau
Commercial Point-Daniels	30	32.15L	16	Cape Girardeau
Commercial Point-Daniels	30	32.05L	16	Cape Girardeau
Commercial Point-Daniels	30	32.0R	16	Cape Girardeau
Commercial Point-Daniels	30	31.8L	16	Cape Girardeau
Commercial Point-Daniels	30	31.7L	16	Cape Girardeau
Commercial Point-Daniels	30	31.5L	16	Cape Girardeau
Commercial Point-Daniels	30	31.4L	16	Cape Girardeau
Commercial Point-Daniels	30	31.25L	16	Cape Girardeau
Commercial Point-Daniels	30	31.0L	16	Cape Girardeau
Daniels-Prices	30	30.5R	-17	Cape Girardeau

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Daniels-Prices	30	30.4R	-17	Cape Girardeau
Daniels-Prices	30	30.15R	-17	Cape Girardeau
Daniels-Prices	30	30.1R	-17	Cape Girardeau
Daniels-Prices	30	30.0R	-17	Cape Girardeau
Daniels-Prices	30	29.8R	-17	Cape Girardeau
Daniels-Prices	30	29.6R	-17	Cape Girardeau
Daniels-Prices	30	29.4R	-17	Cape Girardeau
Prices-Hacker Bend	30	28.0L	13	Cape Girardeau
Prices-Hacker Bend	30	27.6R	25	Cape Girardeau
Prices-Hacker Bend	30	27.45R	26	Cape Girardeau
Prices-Hacker Bend	30	27.45L	14	Cape Girardeau
Prices-Hacker Bend	30	27.3R	26	Cape Girardeau
Prices-Hacker Bend	30	27.2L	13	Cape Girardeau
Prices-Hacker Bend	30	27.1R	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	26.85L	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	26.8R	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	26.7R	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	26.4R	14	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	26.2R	14	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.6R	14	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.5L	26	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.4L	26	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.35L	26	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.3R	18	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.2L	26	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.1L	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	25.0R	17	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	24.9L	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	24.8L	9	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	24.6L	U	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	24.55R	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	24.2L	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.9L	26	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.8R(Trail)	26	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.7R	16	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.4R	-2	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.3R	-2	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.2R	13	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.1R	-2	Cape Girardeau
Hacker Bend-Dogtooth Bend	31	23.0R	-2	Cape Girardeau
Dogtooth Bend-Thompson	31	22.3L(Closure)	26	Cape Girardeau
Dogtooth Bend-Thompson	31	21.7L	U	Cape Girardeau
Dogtooth Bend-Thompson	31	21.15L	13	Cape Girardeau
Dogtooth Bend-Thompson	31	20.5L	13	Cape Girardeau
Thompson-Scudder	31	19.6R	U	Cape Girardeau
Thompson-Scudder	31	19.5(Trail)	10	Cape Girardeau
Thompson-Scudder	31	19.4R	19	Cape Girardeau

LOCATION	SHEET NO.	MILE	TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)	GAGE
Thompson-Scudder	31	19.2R(Trail)	13	Cape Girardeau
Thompson-Scudder	31	19.0R	13	Cape Girardeau
Thompson-Scudder	31	18.8R	13	Cape Girardeau
Thompson-Scudder	31	18.45R	13	Cape Girardeau
Thompson-Scudder	31	18.3R	13	Cape Girardeau
Thompson-Scudder	31	18.0R	13	Cape Girardeau
Thompson-Scudder	32	17.8R	U	Cape Girardeau
Thompson-Scudder	32	17.45R	25	Cape Girardeau
Thompson-Scudder	32	16.8R	13	Cape Girardeau
Scudder-Grand Lake Towheaad	32	16.0R	U	Cape Girardeau
Scudder-Grand Lake Towheaad	32	15.2R	13	Cape Girardeau
Scudder-Grand Lake Towheaad	32	14.5R(Trail)	13	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	14.15R	15	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.95R	15	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.75R	24	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.65R	26	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.6L	24	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.35L(Trail)	24	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.15L(Trail)	24	Cape Girardeau
Grand Lake Towhead-Beech Ridge	32	13.05L(Trail)	24	Cape Girardeau
Beech Ridge-Hurricane	32	12.3R(Closure)	26	Cape Girardeau
Beech Ridge-Hurricane	33	11.95L	23	Cape Girardeau
Beech Ridge-Hurricane	33	11.8L(Trail)	22	Cape Girardeau
Beech Ridge-Hurricane	33	11.7L	23	Cape Girardeau
Beech Ridge-Hurricane	33	11.6L	13	Cape Girardeau
Beech Ridge-Hurricane	33	11.4L	13	Cape Girardeau
Beech Ridge-Hurricane	33	11.2L	13	Cape Girardeau
Beech Ridge-Hurricane	33	10.9L	21	Cape Girardeau
Beech Ridge-Hurricane	33	10.8L	13	Cape Girardeau
Hurricane-I 57 Bridge	33	10.5L	13	Cape Girardeau
Hurricane-I 57 Bridge	33	10.15L	13	Cape Girardeau
Hurricane-I 57 Bridge	33	10.1R	U	Cape Girardeau
Hurricane-I 57 Bridge	33	9.95R	U	Cape Girardeau
Hurricane-I 57 Bridge	33	9.85R	U	Cape Girardeau
Hurricane-I 57 Bridge	33	9.85L	13	Cape Girardeau
Hurricane-I 57 Bridge	33	9.7R	U	Cape Girardeau
Hurricane-I 57 Bridge	33	9.55R	U	Cape Girardeau
Hurricane-I 57 Bridge	33	9.4R	16	Cape Girardeau
Hurricane-I 57 Bridge	33	8.7L	13	Cape Girardeau
Hurricane-I 57 Bridge	33	8.0L(Trail)	15	Cape Girardeau
Hurricane-I 57 Bridge	33	7.6L	16	Cape Girardeau
I 57 Bridge-Eliza Point	33	7.25L	23	Cape Girardeau
I 57 Bridge-Eliza Point	34	6.95L	23	Cape Girardeau
I 57 Bridge-Eliza Point	34	6.75L	U	Cape Girardeau
I 57 Bridge-Eliza Point	34	6.65R	13	Cape Girardeau
I 57 Bridge-Eliza Point	34	6.6L	U	Cape Girardeau
I 57 Bridge-Eliza Point	34	6.45L	16	Cape Girardeau

LOCATION	*SHEET NO.*	*MILE*	*TERMINAL (RIVER) END DIKE ELEVATION (St. Louis Gage Equivalent)*	*GAGE*
I 57 Bridge-Eliza Point	34	6.3L	U	Cape Girardeau
I 57 Bridge-Eliza Point	34	6.1L	U	Cape Girardeau
Eliza Point-Stevenson	34	5.4L	13	Cape Girardeau
Eliza Point-Stevenson	34	5.2L	13	Cape Girardeau
Eliza Point-Stevenson	34	5.1L(Closure)	26	Cape Girardeau
Stevenson-Greenfield Bend	34	4.3L(Trail)	13	Cape Girardeau
Stevenson-Greenfield Bend	34	4.0L	U	Cape Girardeau
Greenfield Bend-Cairo Point	34	1.35R	13	Cape Girardeau
Greenfield Bend-Cairo Point	34	1.2R	21	Cape Girardeau
Greenfield Bend-Cairo Point	34	0.85R	13	Cape Girardeau
Greenfield Bend-Cairo Point	34	0.0R	U	Cape Girardeau

Appendix E.

Historical Traffic Volume and Fleeting Areas on the Illinois Waterway and Upper Mississippi River

NUMBER OF BARGES
UPBOUND LOADED

MISSISSIPPI RIVER

LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
51	197	195	172	298	262	264	314	298	305	260	618	716	713	664	788	784
52	732	551	485	656	699	623	909	729	661	641	826	716	720	661	789	784
1	798	597	549	678	696	618	865	725	659	648	828	708	723	658	795	780
2	1740	1719	1310	1674	1708	1831	2130	1636	1743	1780	1767	1733	1967	1872	2137	1871
3	1854	1690	1358	1682	1741	1827	2132	1670	1756	1754	1735	1725	1960	1889	2163	1877
4	1918	1739	1414	1746	1771	1871	2199	1757	1808	1820	1803	1745	2079	1890	2193	1931
5	2071	1915	1602	1937	1892	1954	2244	1898	1890	1980	1938	1938	2167	2055	2444	2048
55	2075	1887	1601	1891	1894	1955	2253	1922	1920	1975	1941	1960	2150	2104	2455	2037
6	2227	2091	1696	1995	2070	2183	2565	2201	2201	2231	2137	2099	2424	2247	2690	2297
7	2215	2083	1737	2035	2061	2196	2537	2178	2145	2213	2115	2125	2263	2257	2677	2275
8	2347	2239	1746	2243	2333	2469	2825	2399	2382	2473	2397	2379	2746	2516	2941	2526
9	3302	3102	2764	3096	3271	3083	3839	3184	3273	3316	3029	3010	3502	3200	3690	3540
10	3272	3122	2822	3149	3348	3141	4044	3241	3347	3422	3218	3173	3679	3374	3881	3713
11	3599	3481	3160	3494	3709	3335	3649	3483	3600	3592	3278	3343	3945	3710	4329	4156
12	3835	3720	3436	3861	4144	3757	4158	4016	4103	4311	3991	3805	4242	3518	4296	3844
13	3828	3697	3422	3865	4195	3754	4155	4012	4121	4307	4041	3831	4204	3495	4282	3862
14	4528	4157	4003	4463	4915	4556	4933	4744	4948	5084	4831	4505	4877	4044	5030	4156
15	4872	4496	4427	4746	5285	4882	5280	5088	5368	5360	5105	4933	5189	4300	5320	4416
16	4989	4776	4722	5106	5603	5166	5642	5385	5623	5622	5434	5107	5374	4455	5651	4770
17	5188	4962	4967	5602	5860	5706	6063	5886	6083	6128	5969	5612	5799	4586	5909	4995
18	4998	4937	4963	5642	5823	5683	6058	5875	6145	6168	5980	5621	5818	4580	5909	5009
19	5072	4736	4593	5255	5829	5709	6002	5748	6087	6155	5921	5547	5666	4348	5748	4778
20	5183	4915	4610	5298	5815	5718	6049	5889	6290	6248	6033	5672	5800	4434	5898	5008
21	5298	4841	4568	5111	5973	5631	6034	5948	6231	6182	6003	5628	5816	4626	6196	5094
22	5364	4817	4515	5235	6017	5692	6109	6046	6251	6203	5997	5595	5836	4627	6238	5193
24	5283	4882	4481	5327	6283	5832	6372	6209	6474	6338	6009	5672	5893	4753	6356	5507
25	5299	4866	4518	5349	6286	5824	6377	6226	6491	6383	6029	5674	5930	4769	6376	5475
26	11977	11927	9278	12118	13858	12905	14954	14093	14657	14023	14038	13777	13295	12339	16919	14568
27	12370	12495	11041	13034	14904	13969	15918	15399	15737	14996	14257	14527	14265	13141	17623	15396

ILLINOIS WATERWAY

LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	1710	2006	1566	2131	1959	2091	2321	2292	2740	2538	3015	2443	2373	5030	4128	3397
2	8059	7857	6717	7120	5911	6840	8237	6543	7757	7143	7649	6699	6832	14124	8494	6116
3	8165	7881	6873	7275	6017	6938	8322	6583	7776	7173	7729	6797	6898	14262	8632	6228
4	8213	7954	6870	7580	6390	7139	8603	6967	8206	7557	8135	7283	7410	15146	9230	6652
5	7855	7904	6822	7233	6429	6855	8055	6297	7240	6757	7477	6983	7259	14364	8885	6625
6	8074	8051	6861	7334	6512	6905	8109	6361	7647	6879	7586	7107	7407	14640	9124	6954
7	8504	9388	7748	8476	8004	8207	9819	7663	8911	7948	8792	8187	8172	16622	10222	8327
8	6185	7033	5797	6748	7091	6799	8169	7616	7994	7933	8437	8032	7362	7266	9989	8854

NUMBER OF BARGES
DOWNBOUND LOADED

MISSISSIPPI RIVER

LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
51	937	455	337	509	528	506	383	260	200	201	200	281	570	276	308	357
52	1023	567	551	721	627	567	486	319	228	216	210	296	586	277	315	362
1	993	573	547	722	624	572	499	321	222	212	204	297	582	285	317	372
2	7369	7824	7584	10282	8847	7148	5680	5557	6266	5952	7434	5954	6375	3164	4078	4190
3	6421	7036	6816	9400	8196	6140	5424	5490	6214	5976	7443	5991	6466	3154	4075	4206
4	6856	7539	7209	9827	8558	6390	5760	5814	6527	6257	7742	6393	6767	3406	4436	4804
5	6754	7482	6832	9683	8469	6246	5771	5729	6414	6191	7634	6249	6776	3353	4445	4804
55	6730	7401	7070	9721	8472	6247	5798	5778	6419	6212	7693	6237	6694	3344	4448	4795
6	7622	8095	7183	10649	9177	6604	6160	6466	7363	7276	8926	7513	7828	3982	5155	6227
7	7606	8149	7370	10611	9202	6585	6189	6485	7409	7270	8930	7533	7398	3828	5197	6232
8	7807	8326	6658	10812	9388	6605	6336	6634	7553	7358	8996	7542	8177	4059	5268	6446
9	7443	8018	6973	10519	9128	6407	6084	6508	7366	7129	8879	7577	8110	4137	5362	6529
10	8816	9473	7990	12046	10045	6862	6549	7520	8827	8657	10435	9165	9586	4965	6258	8463
11	8738	9305	8255	11882	9953	6835	5866	7523	8696	8483	10186	9018	9665	5004	6336	8523
12	9371	10189	9058	13205	10994	7437	6665	9549	10490	10451	12381	10777	11804	5977	7003	10099
13	9330	10218	9077	13217	10977	7418	6678	9631	10579	10804	12759	11159	12117	6232	7243	10354
14	11095	12835	11379	16258	13190	9049	8577	12887	14193	14291	16767	14563	15608	8547	10046	14259
15	10499	12255	11028	15810	12774	8604	8282	12581	13755	13579	16048	13862	14791	8033	9372	13760
16	11431	13717	12340	17134	14203	9247	9227	13693	14946	14610	17213	14613	15511	8539	9830	14624
17	12884	14462	13152	17911	14779	9522	9678	14628	16067	15614	18232	15327	16083	8958	10240	15008
18	13179	15094	13725	18378	15318	9858	10041	15084	16537	15934	18632	15908	16542	9459	10696	15672
19	14801	16448	14603	19051	16851	10525	10923	16155	17761	17001	19661	17036	17961	10761	11750	16903
20	15252	16827	15175	19327	17323	10827	11318	16551	18274	17426	20095	17494	18404	11135	12263	17601
21	15842	17382	15804	20021	17844	11419	12134	17446	19170	17990	20808	18186	19112	11830	12779	18034
22	16184	17628	16213	20196	18215	11759	12518	17885	19544	18326	21136	18472	19392	12101	13140	18378
24	17081	18357	16894	20799	18904	12324	13175	18518	20102	18964	20823	19144	20132	12900	13923	19046
25	16978	18297	16847	20842	18966	12315	13174	18516	20066	18950	20798	19191	20027	12916	13922	18997
26	32942	34022	31693	37981	34287	40987	27283	33689	34763	33208	35727	34729	35381	28149	28981	35855
27	37838	37838	38037	41681	36711	29513	30293	37559	38502	36328	38252	38036	38384	30994	32032	38700

ILLINOIS WATERWAY

LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	2205	2166	1500	2031	1776	1839	1837	2344	2057	2033	2097	2631	2470	5838	4232	4177
2	4903	4616	4012	4139	3266	3061	2942	2581	2954	3295	3608	3778	3611	7776	3894	3324
3	5149	4873	4327	4379	3448	3288	3147	2838	3050	3295	3597	3793	3613	7674	3885	3286
4	5909	5508	4824	5209	4209	3959	3811	3504	3750	3908	4242	4410	4354	9142	4506	3908
5	7033	6712	6292	6607	5502	4911	4854	4729	4833	5297	6001	5615	5419	11996	5883	5257
6	8421	7935	7587	7776	6529	5841	5677	5832	6114	6503	7329	6669	6568	14434	7137	6824
7	10781	11912	11964	12321	10660	9273	9173	9695	10421	10489	12167	11222	11225	23772	11929	12982
8	13174	14225	15374	15036	13220	12022	11686	12561	12884	12792	14648	13280	13390	13952	13929	15525

NUMBER OF BARGES

UPBOUND EMPTY

MISSISSIPPI RIVER

LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
51	902	422	285	455	478	462	375	215	178	171	170	234	473	192	207	214
52	975	514	458	605	574	511	469	268	200	184	178	241	487	196	206	210
1	964	515	472	595	575	509	434	268	204	199	187	248	487	199	216	215
2	6087	6538	6426	8802	7443	5608	3880	3931	4671	4519	5941	4449	4912	1772	2440	2684
3	4938	5725	5590	7913	6795	4574	3582	3892	4621	4520	5968	4485	4905	1739	2410	2670
4	5276	6148	5907	8236	7021	4741	3843	4144	4830	4723	6187	4807	5196	1913	2610	3081
5	5024	6021	5366	8029	6841	4556	3644	3964	4653	4509	5991	4585	4968	1768	2510	2984
55	5017	5953	5591	8057	6859	4593	3696	3928	4665	4526	5968	4615	5077	1761	2485	3041
6	5752	6453	5683	8829	7399	4720	3782	4389	5366	5347	6992	5592	5927	2080	2985	4242
7	5753	6541	5827	8785	7406	4733	3787	4437	5463	5316	7031	5635	5703	1935	2946	4186
8	5868	6539	5102	8810	7376	4606	3745	4382	5359	5252	6935	5540	5856	2081	2844	4283
9	5198	5936	5023	8187	6272	3893	2713	3536	4369	4202	6072	4908	5179	1825	2374	3957
10	6452	7275	5916	9581	7124	4314	2969	4442	5767	5550	7572	6324	6513	2493	3134	5739
11	6166	7013	5946	9255	6669	4092	2597	4225	5460	5335	7284	6159	6477	2506	3154	5753
12	6581	7550	6416	10213	7235	4384	2939	5719	6818	6712	8848	7472	8130	3212	3341	6898
13	6462	7566	6481	10230	7281	4395	2951	5795	6989	7072	9217	7834	8443	3428	3519	7236
14	7872	9780	8257	12908	8944	5445	4096	8432	9773	9903	12542	10657	11321	5268	5712	10830
15	7222	9239	8004	12404	8672	5020	3852	8181	9331	9183	11845	9929	10577	4837	4976	10315
16	7942	10394	8857	13385	9696	5447	4395	8905	10219	9859	12549	10412	11037	5138	5052	10818
17	9093	10956	9485	13859	9686	5500	4432	9398	10830	10344	13138	10763	11221	5264	5007	10940
18	8962	11547	10084	14319	10154	5754	4750	9916	11372	10777	13519	11223	11674	5635	5438	11530
19	10658	12633	11019	15432	11299	6331	5595	11032	12655	11799	14609	12440	13223	7020	6572	12730
20	11123	12983	11356	15783	11571	6581	5852	11335	12924	12158	14902	12793	13657	7392	6931	13176
21	11786	13500	11949	16304	12069	7066	6635	12046	13630	12604	15452	13374	14191	7980	7257	13587
22	12048	13498	12302	16427	12357	7287	6944	12393	13884	12840	15774	13535	14328	8113	7409	13670
24	12829	14466	13080	17046	12933	7867	7457	12927	14275	13426	15906	14164	15060	8921	8102	14079
25	12848	14452	13059	17040	12906	7895	7463	12919	14259	13378	15928	14137	15053	8913	8035	14120
26	24948	26422	25275	29781	23039	16948	16064	22719	23212	22328	24135	23658	25285	18977	15794	24407
27	29617	30322	31093	33152	25056	19932	18843	25602	26472	25262	26572	26354	27349	21158	18174	26853

ILLINOIS WATERWAY

LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	1694	1535	1136	1488	1286	1168	1136	1652	1203	1135	1109	1674	1548	3814	2959	3029
2	3186	2709	2611	2241	1566	1419	1167	1111	1222	1311	1407	1454	1663	2942	1291	1004
3	3315	3018	2926	2560	1764	1584	1269	1273	1282	1305	1391	1424	1620	2918	1304	1007
4	3782	3232	3172	2892	2180	1858	1561	1364	1341	1376	1428	1536	1855	3468	1277	1075
5	4564	4220	4308	3998	2865	2407	2148	2079	1927	2075	2309	2048	2296	5204	1664	1467
6	5795	5459	5389	5009	3725	3162	2763	2907	2618	2959	3373	2793	3195	7236	2444	2579
7	7598	8293	9031	8515	6572	5371	4867	5512	5737	5789	7102	6170	6919	14428	5611	7294
8	9689	10351	11933	10787	8449	7445	6642	7437	7319	7233	8371	7483	8325	8791	6824	9290

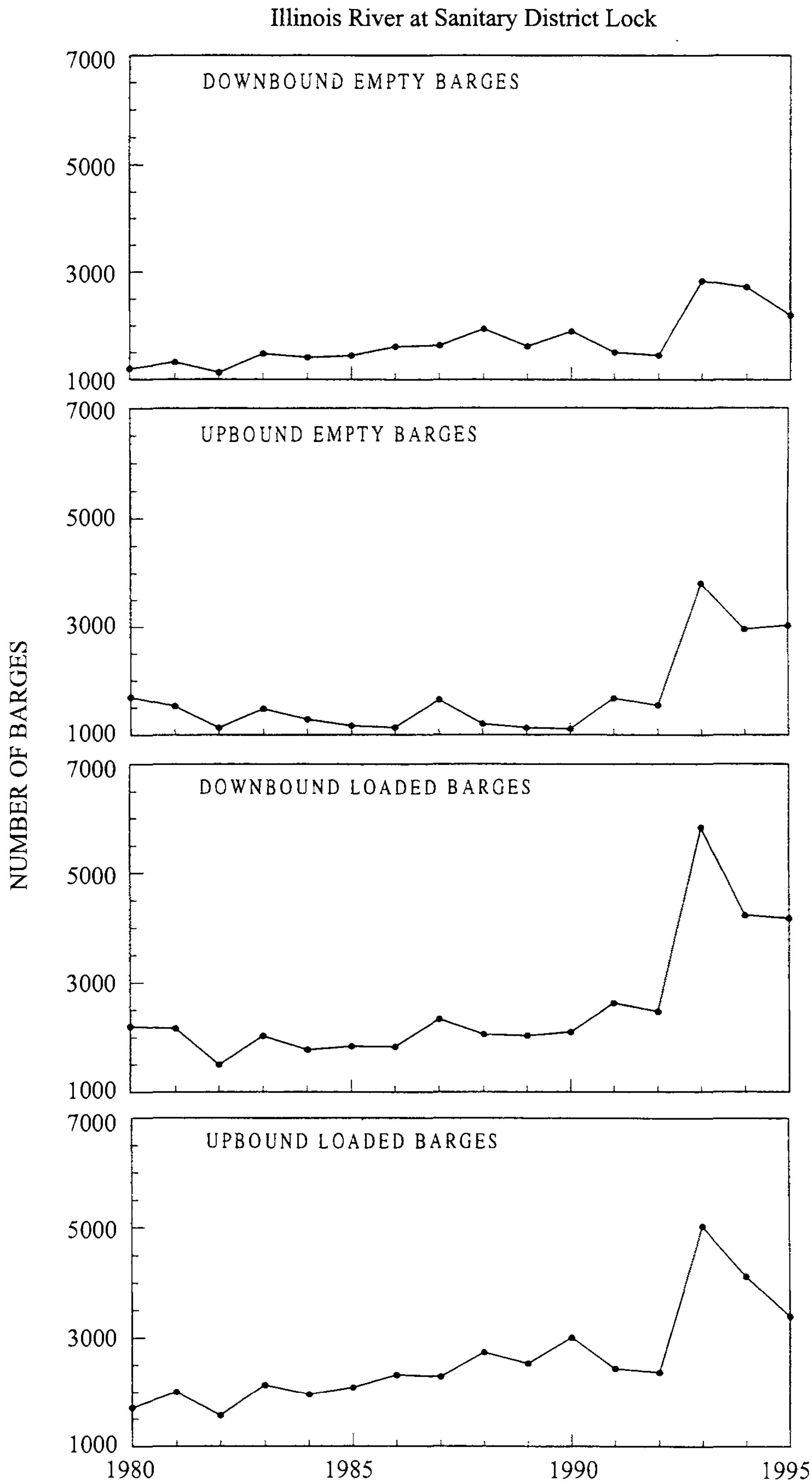
NUMBER OF BARGES
DOWNBOUND EMPTY

MISSISSIPPI RIVER

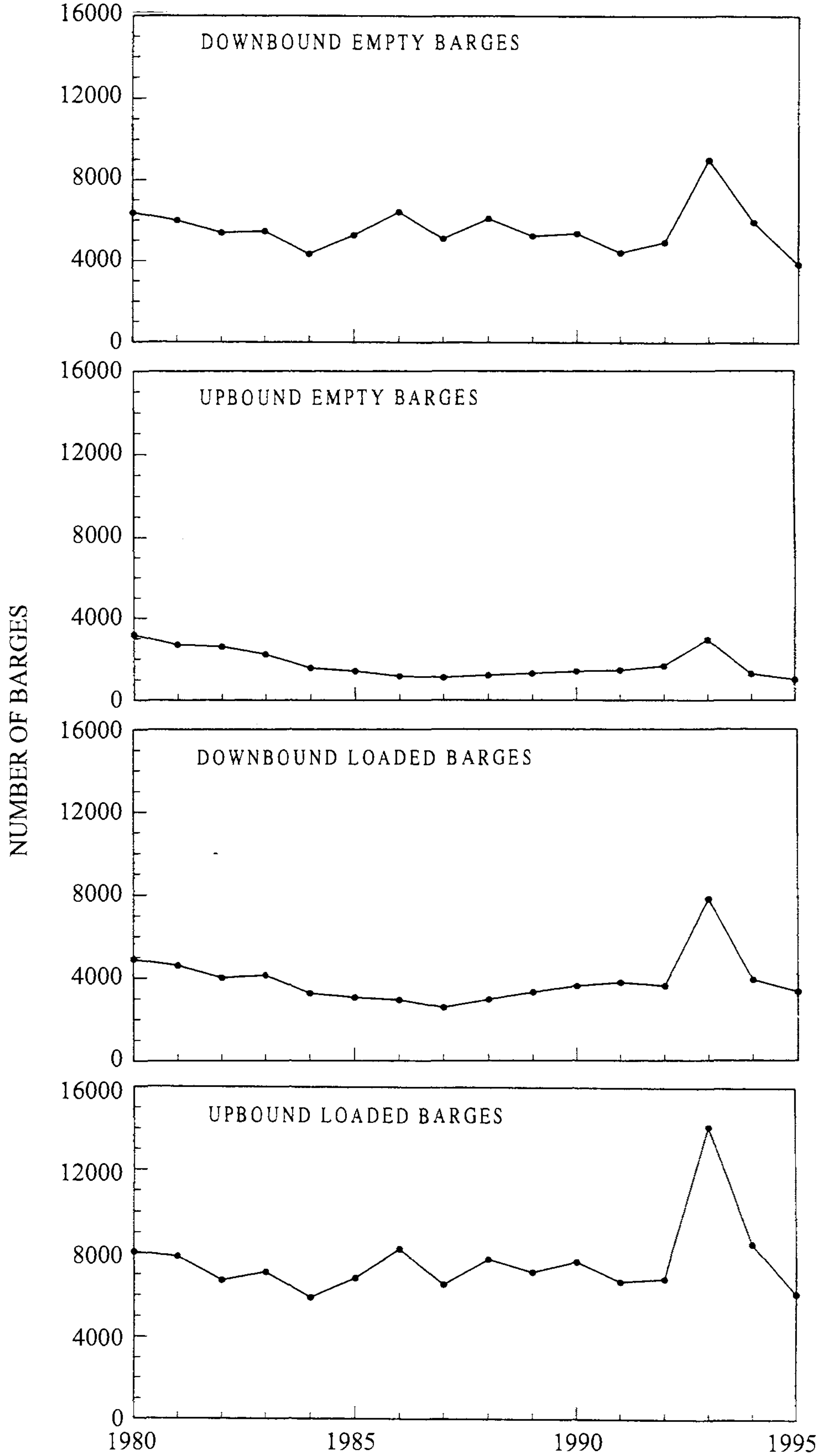
LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
51	156	147	122	250	213	216	291	257	275	245	595	653	625	583	685	638
52	685	497	411	535	629	558	885	680	628	616	799	655	619	585	684	636
1	755	544	457	546	622	552	910	684	627	594	806	648	623	590	681	639
2	502	491	185	220	225	212	317	243	195	302	299	239	415	501	484	331
3	488	491	143	186	194	202	338	250	211	281	269	184	438	502	465	333
4	470	446	143	167	175	181	296	168	214	256	242	216	396	428	430	234
5	484	511	197	207	184	187	342	195	166	304	253	203	356	528	527	296
55	486	530	167	191	179	192	318	205	188	285	262	208	355	534	528	294
6	524	558	182	180	190	210	343	221	228	270	302	336	390	429	506	306
7	514	569	216	210	177	211	345	222	187	283	268	288	327	441	511	290
8	537	523	219	213	217	260	455	266	270	344	346	428	507	460	515	339
9	1090	1172	876	778	344	372	710	305	323	359	336	314	470	893	700	941
10	1060	1104	727	751	295	387	632	334	349	351	351	419	475	889	707	922
11	1125	1269	868	779	349	434	531	358	385	413	368	424	637	1204	1148	1326
12	1119	1363	842	776	367	492	594	354	426	532	447	434	496	768	630	614
13	1137	1422	856	824	394	503	616	363	444	537	439	440	499	750	599	632
14	1349	1342	935	870	533	670	747	468	600	633	551	535	575	767	666	663
15	1657	1587	1271	1161	980	993	1079	816	1001	952	885	904	852	1080	1018	973
16	1719	1701	1289	1134	1005	1035	1142	799	945	868	746	777	813	1022	902	923
17	1612	1601	1464	1384	778	1214	1174	909	1014	1037	874	882	869	814	685	763
18	1583	1582	1370	1391	795	1156	1140	894	992	991	831	869	854	793	662	772
19	1205	1184	940	904	809	1062	1035	837	999	938	828	856	835	613	637	500
20	1153	1041	809	879	751	994	1016	862	1016	920	828	898	867	633	644	532
21	1208	1098	687	598	866	822	923	736	883	726	678	757	743	708	790	579
22	1110	1050	660	550	850	747	877	793	799	670	606	773	713	622	650	534
24	1158	996	668	694	905	861	1080	804	867	679	626	768	778	760	678	612
25	1182	1030	685	657	938	897	1087	809	884	708	637	795	785	784	698	656
26	3874	3866	3058	3301	3632	13788	3939	3459	3453	2743	2836	3129	3255	2807	3704	3090
27	4087	4294	3908	3892	4354	3879	4411	4104	3775	3285	2959	3235	3464	2894	3732	3225

ILLINOIS WATERWAY

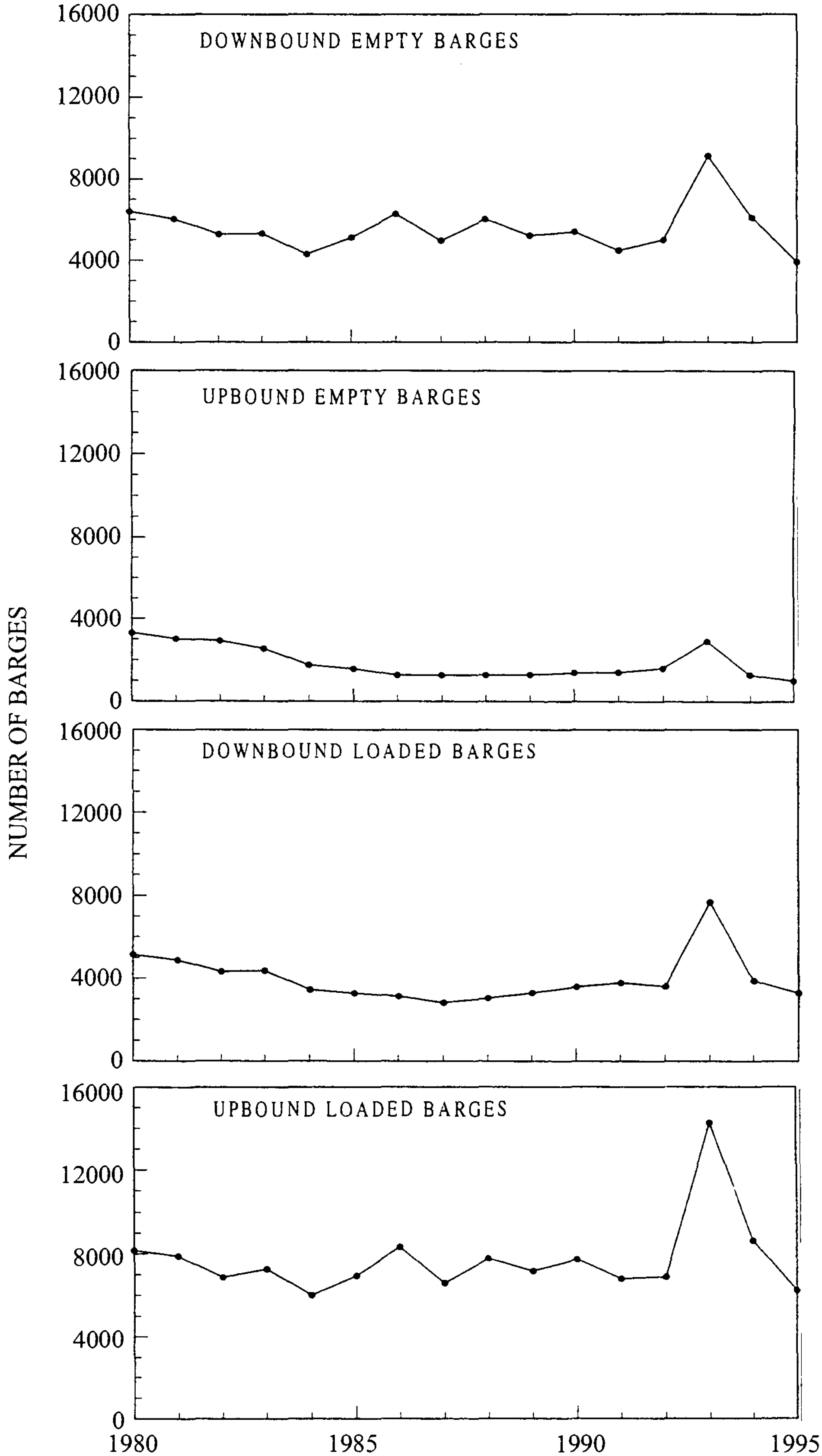
LOCK	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	1197	1322	1132	1485	1407	1444	1616	1638	1946	1622	1904	1510	1452	2840	2728	2201
2	6379	5996	5390	5474	4345	5283	6424	5110	6097	5241	5376	4430	4958	9020	5938	3865
3	6409	6047	5291	5326	4299	5126	6282	4962	6035	5224	5398	4485	5001	9124	6095	3914
4	6096	5837	5081	5130	4231	5066	6198	4868	5869	5061	5238	4498	4972	9124	6033	3996
5	5536	5454	4554	4560	3804	4437	5263	3684	4323	3515	3658	3548	4184	7294	4659	2856
6	5618	5504	4479	4491	3757	4311	5152	3441	4286	3325	3516	3409	4083	7186	4424	2722
7	5276	5669	4727	4759	4009	4438	5418	3453	4423	3418	3411	3343	3926	6886	4044	2447
8	2529	2934	2578	2733	2604	2442	3020	2745	2636	2438	2283	2239	2536	2106	3069	2440


Illinois River at Sanitary District Lock
DOWNBOUND EMPTY BARGES
UPBOUND EMPTY BARGES
DOWNBOUND LOADED BARGES
UPBOUND LOADED BARGES
NUMBER OF BARGES
7000
5000
3000
1000
1980
1985
1990
1995

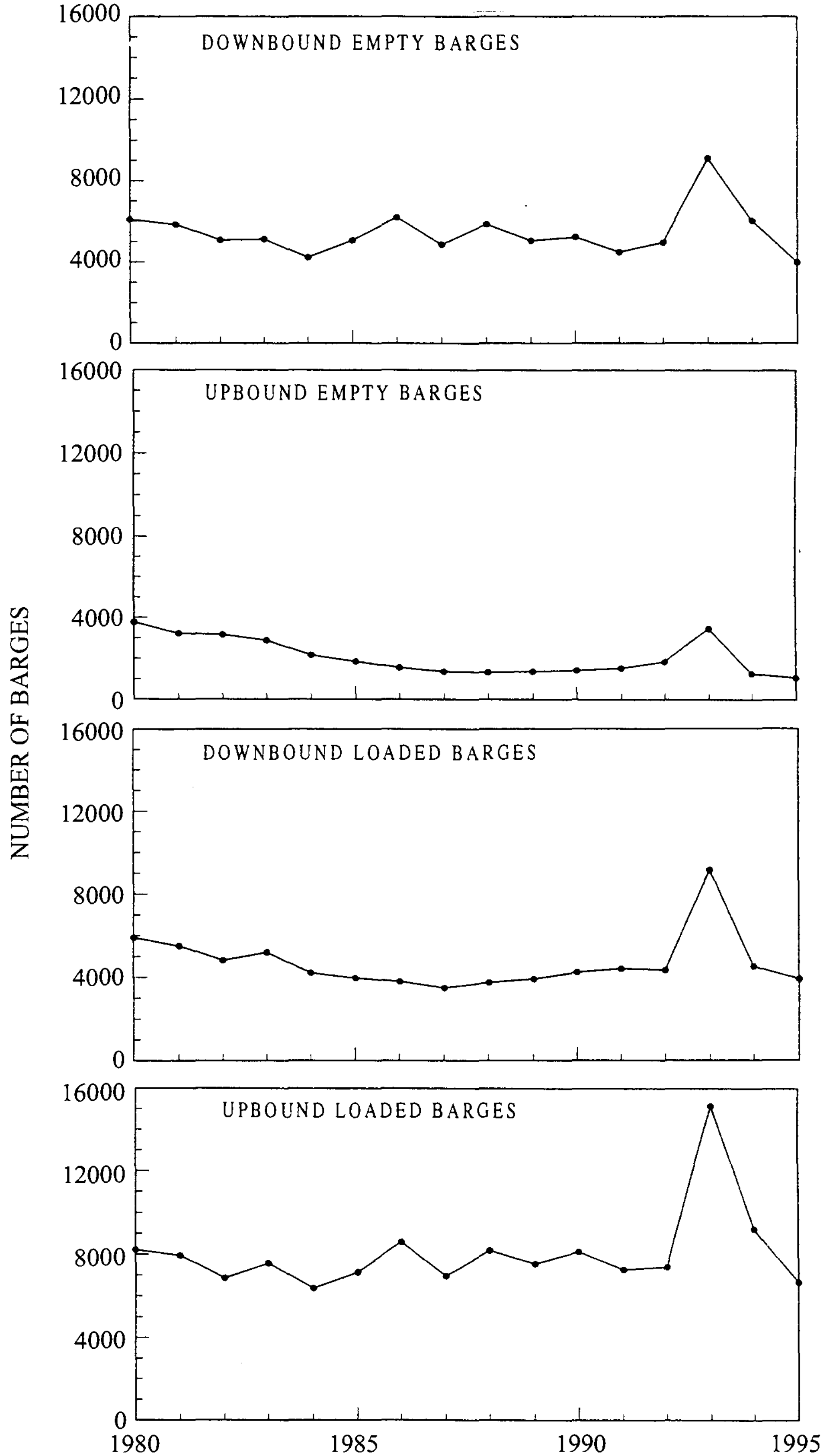
Illinois River at Lockport Lock



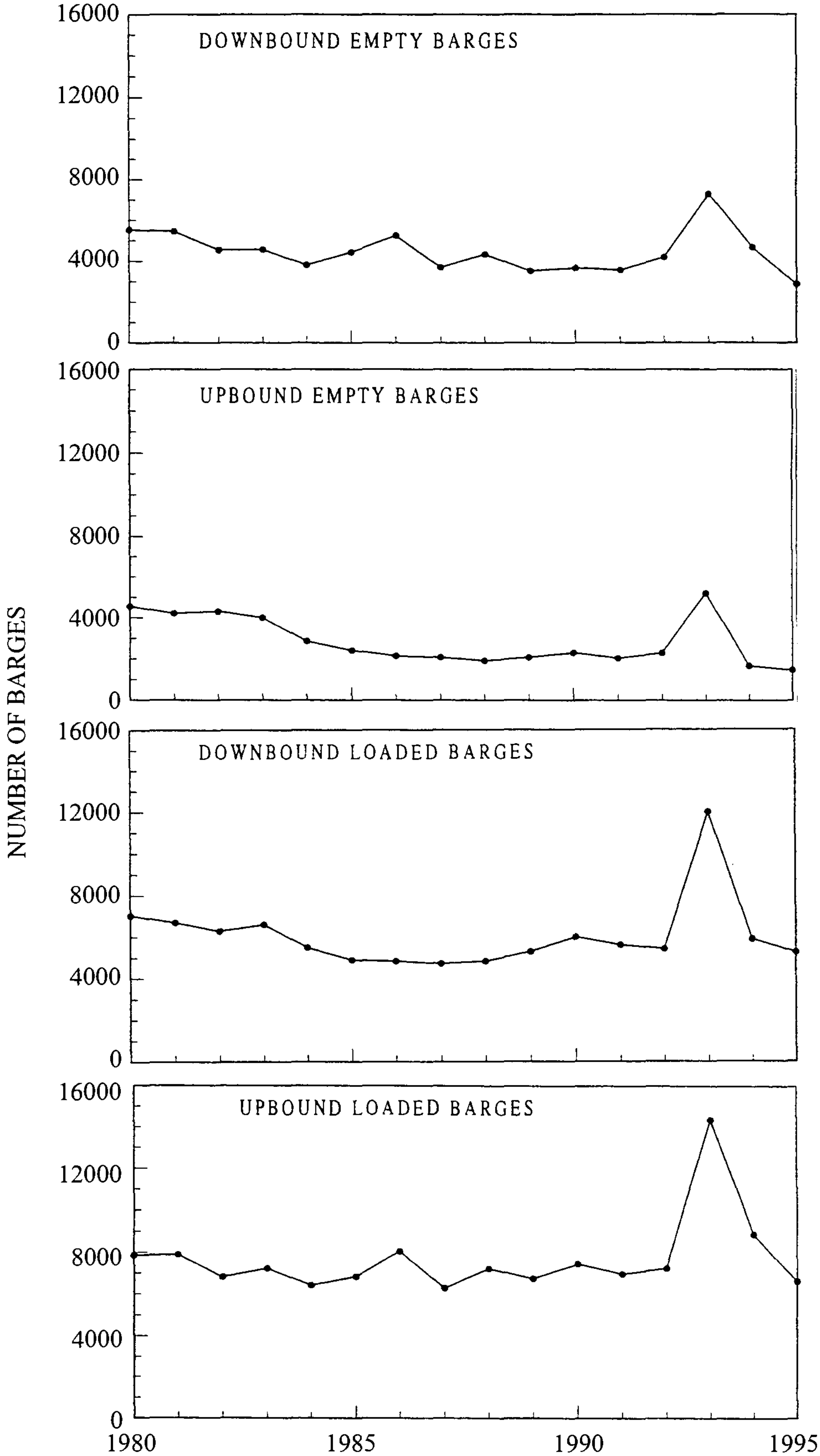
Illinois River at Brandon Road Lock



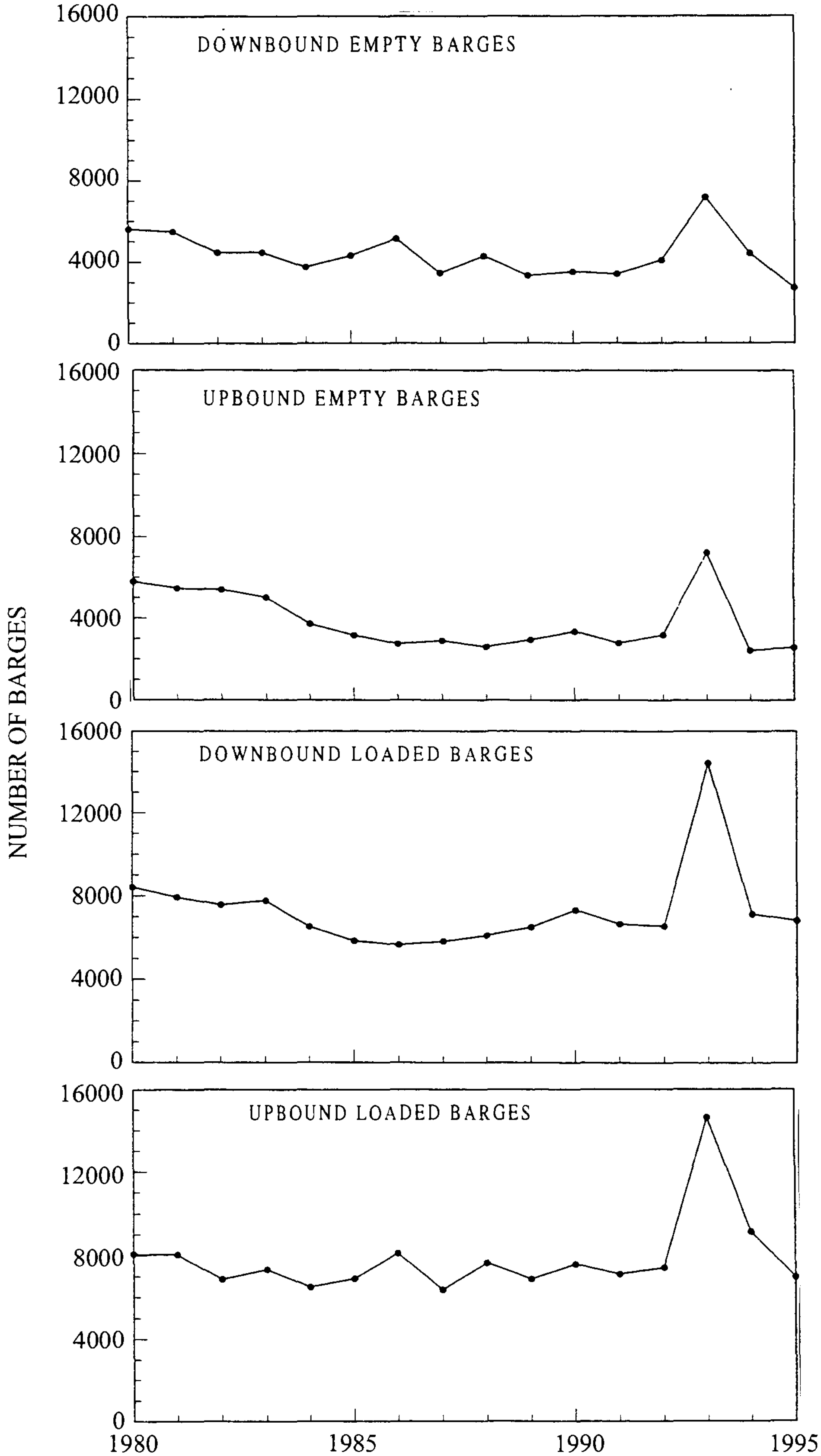
Illinois River at Dresden Island Lock



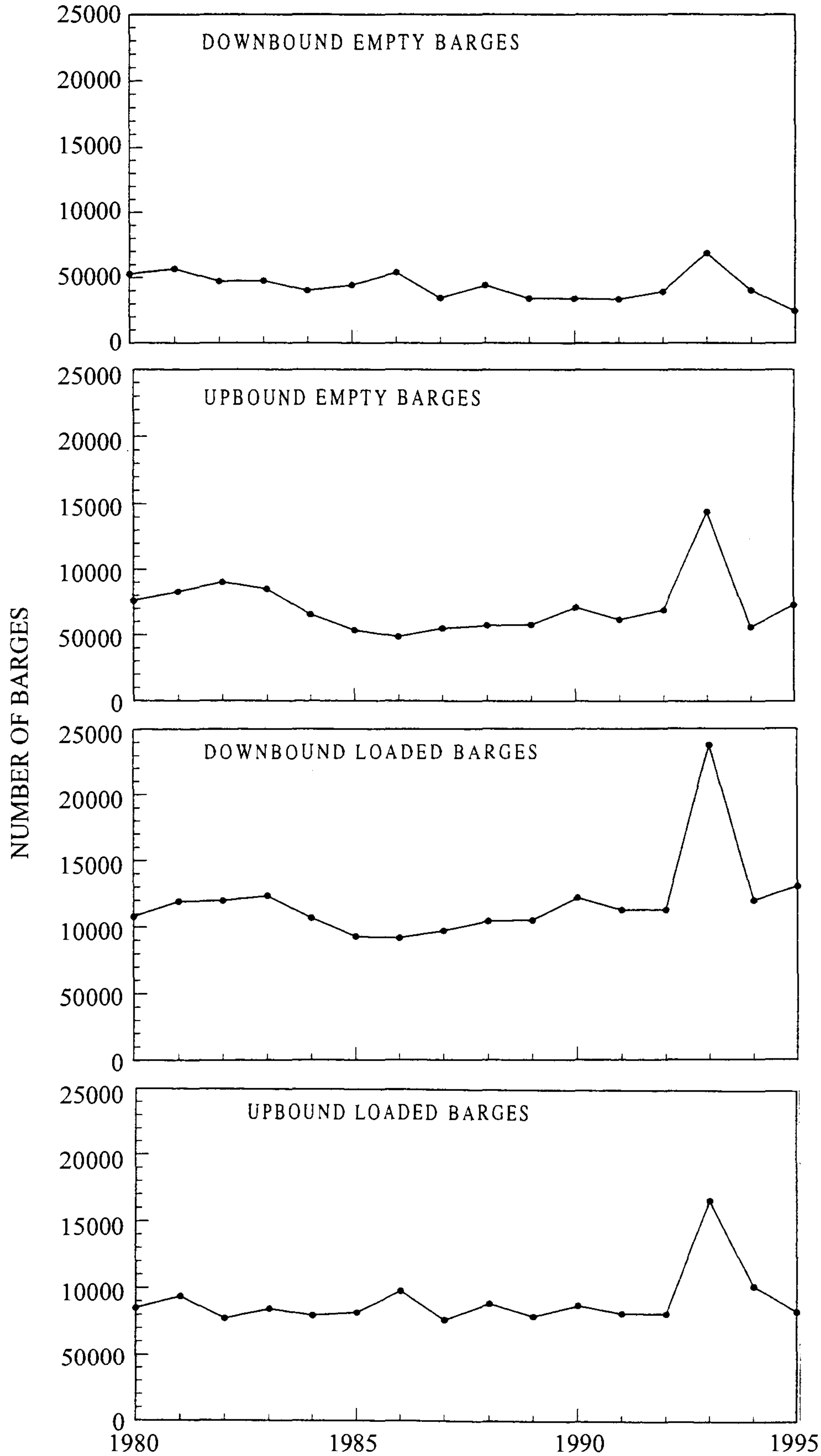
Illinois River at Marseilles Lock



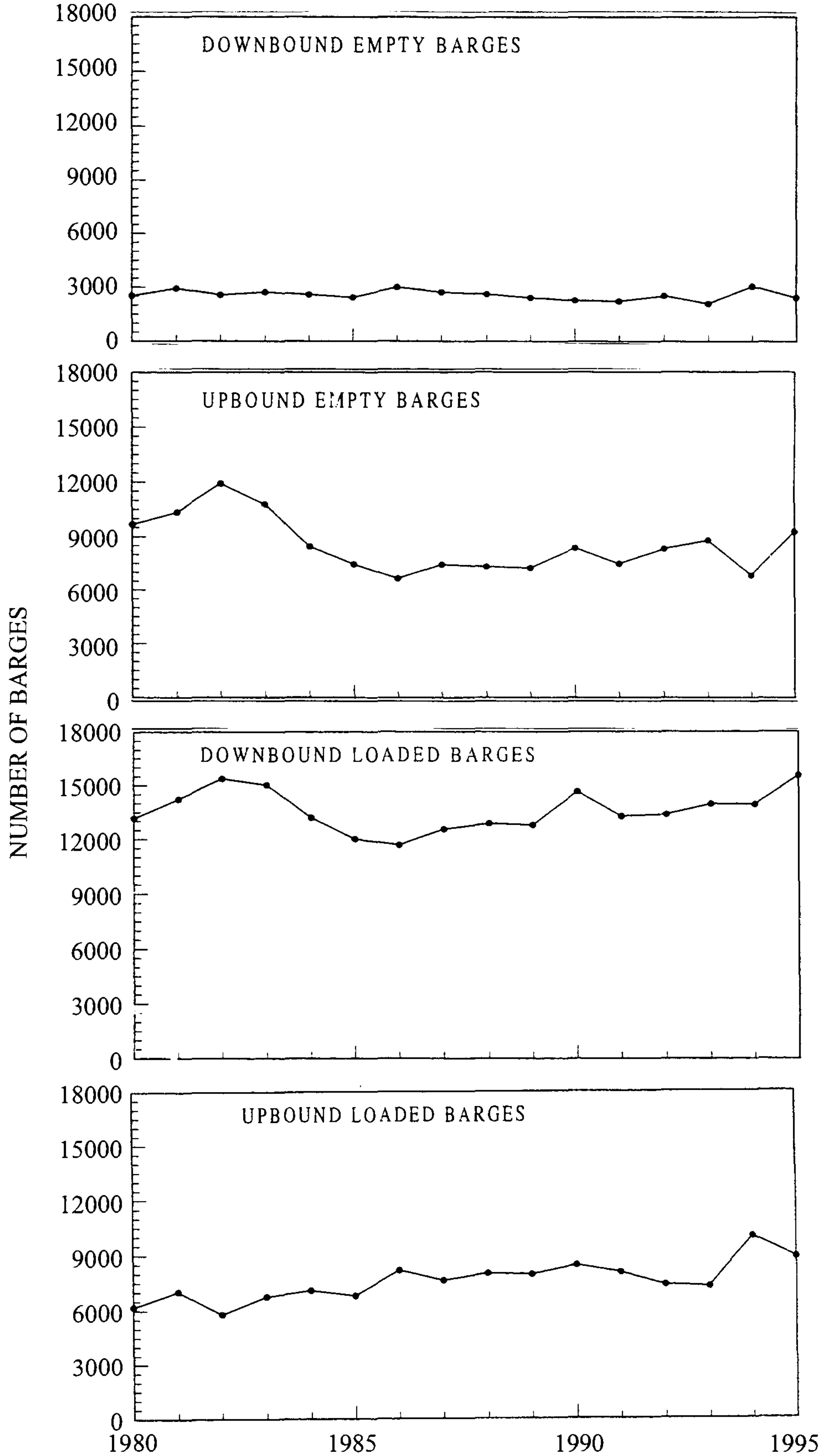
Illinois River at Starved Rock Lock

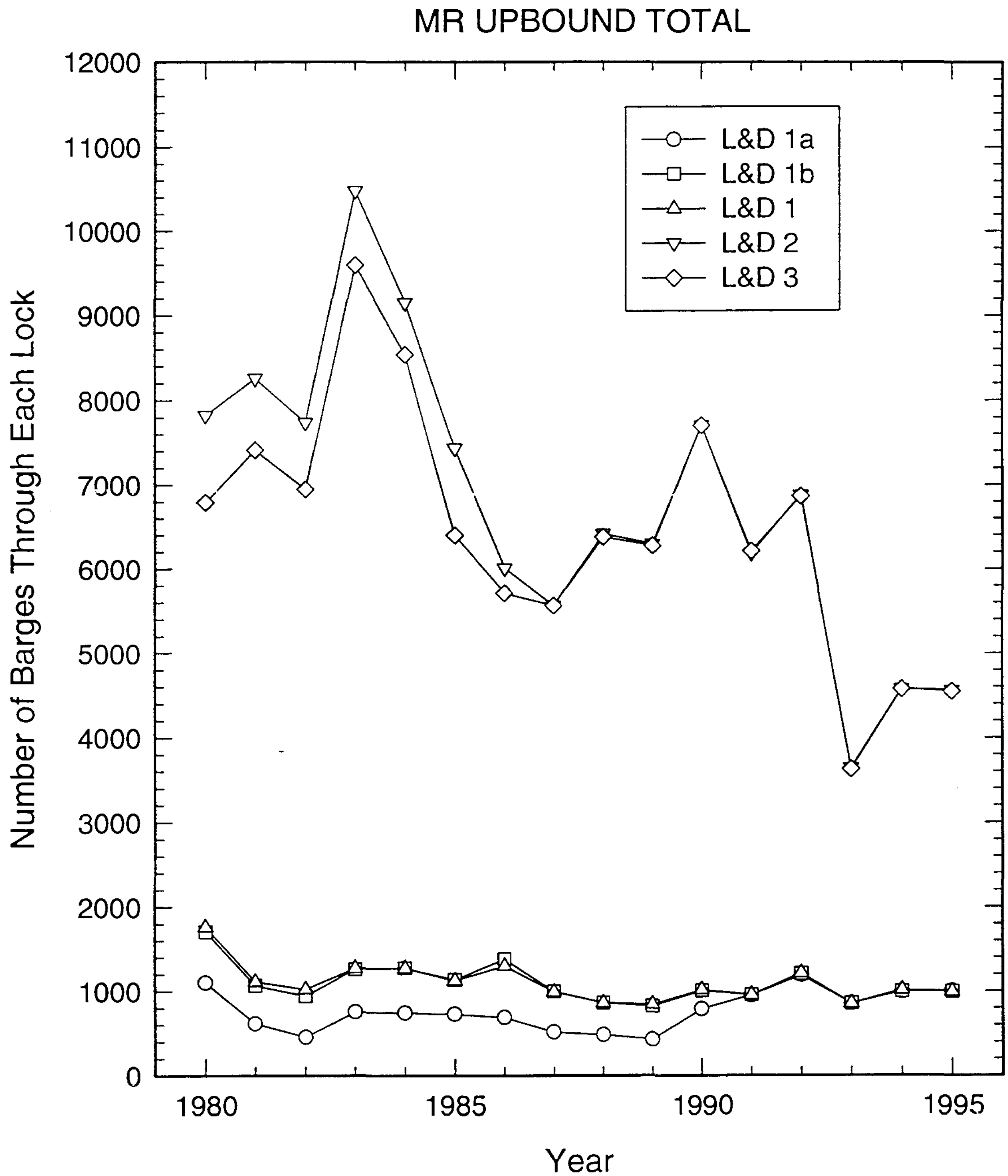


Illinois River at Peoria Lock

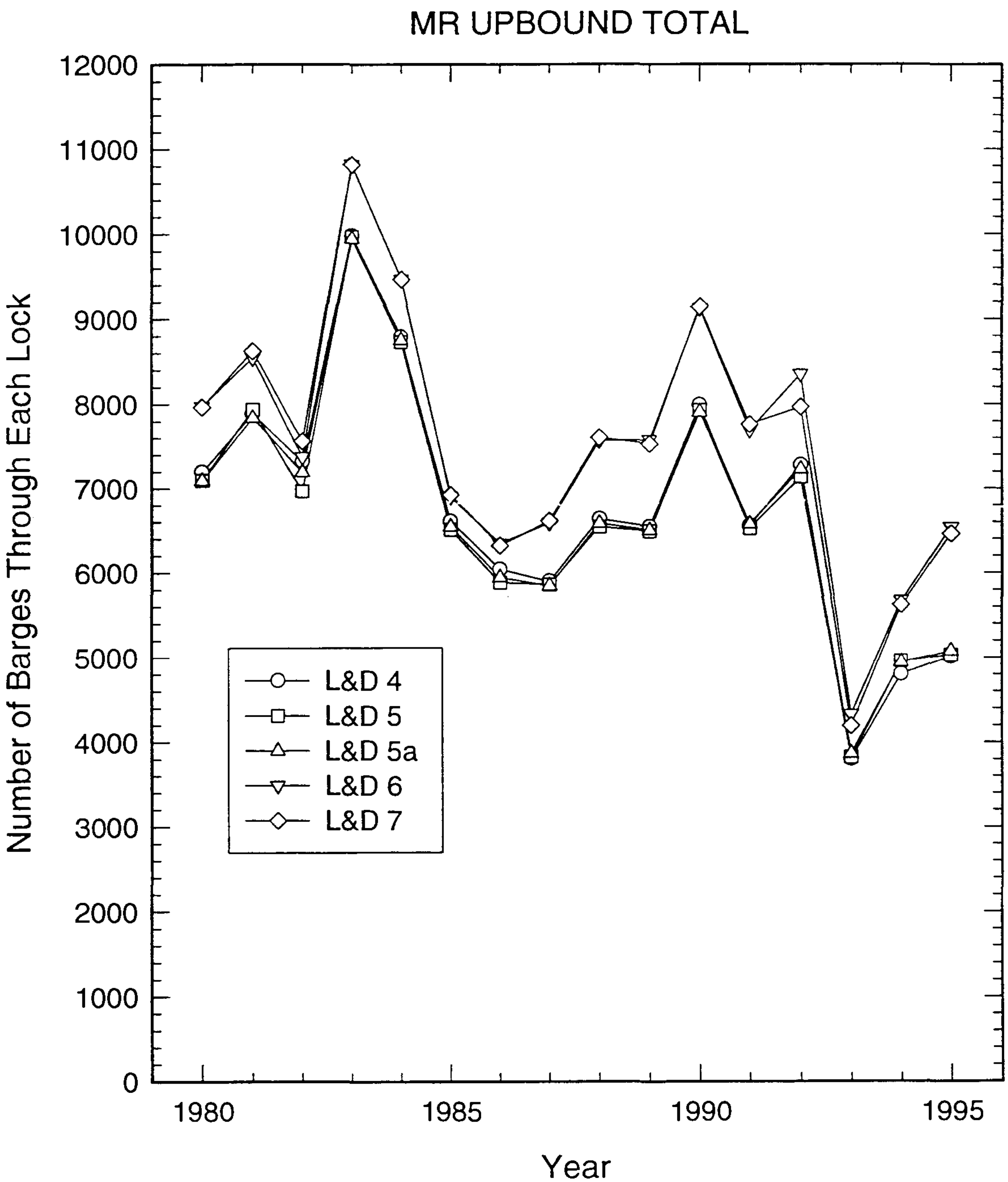


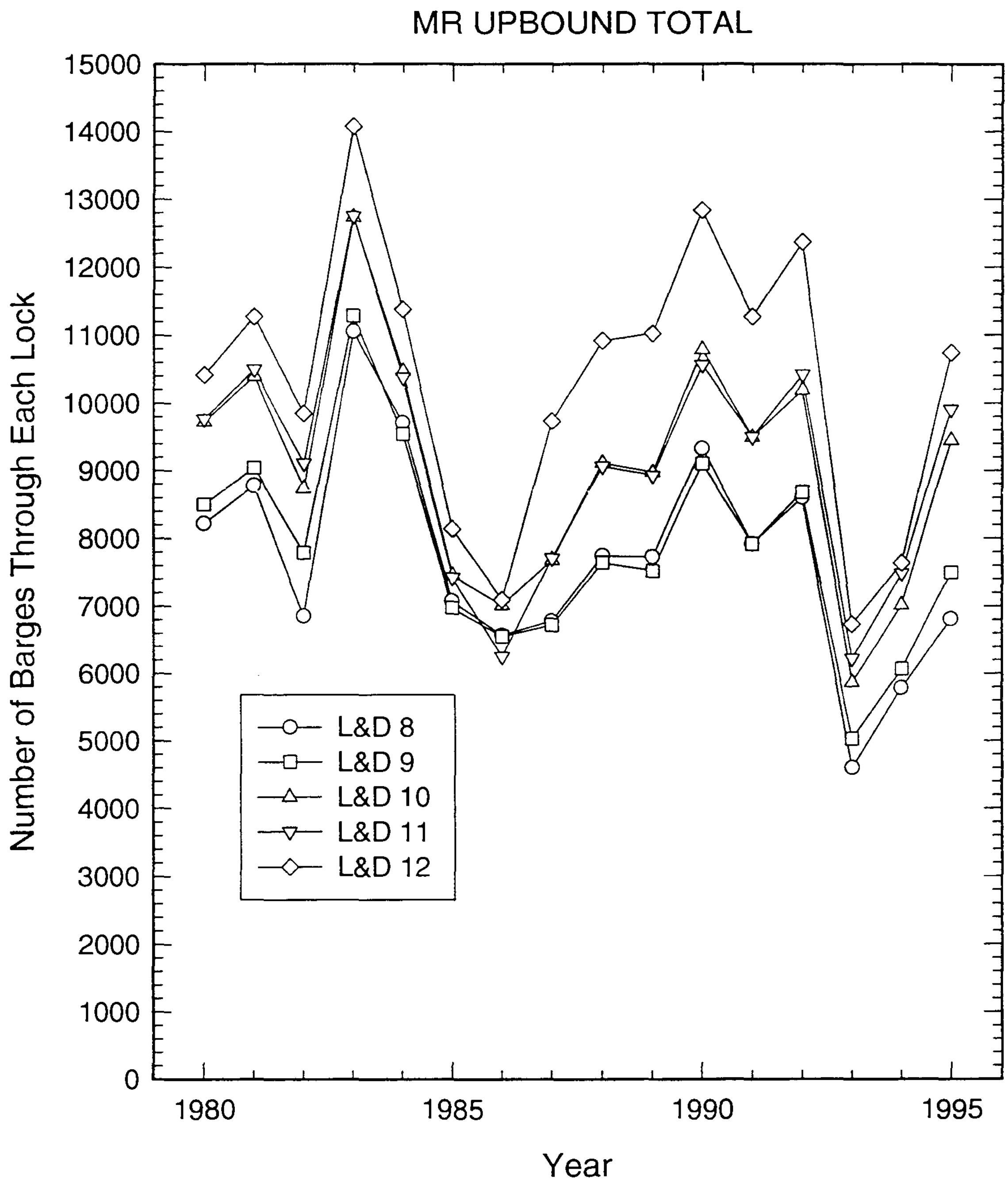
Illinois River at La Grange Lock

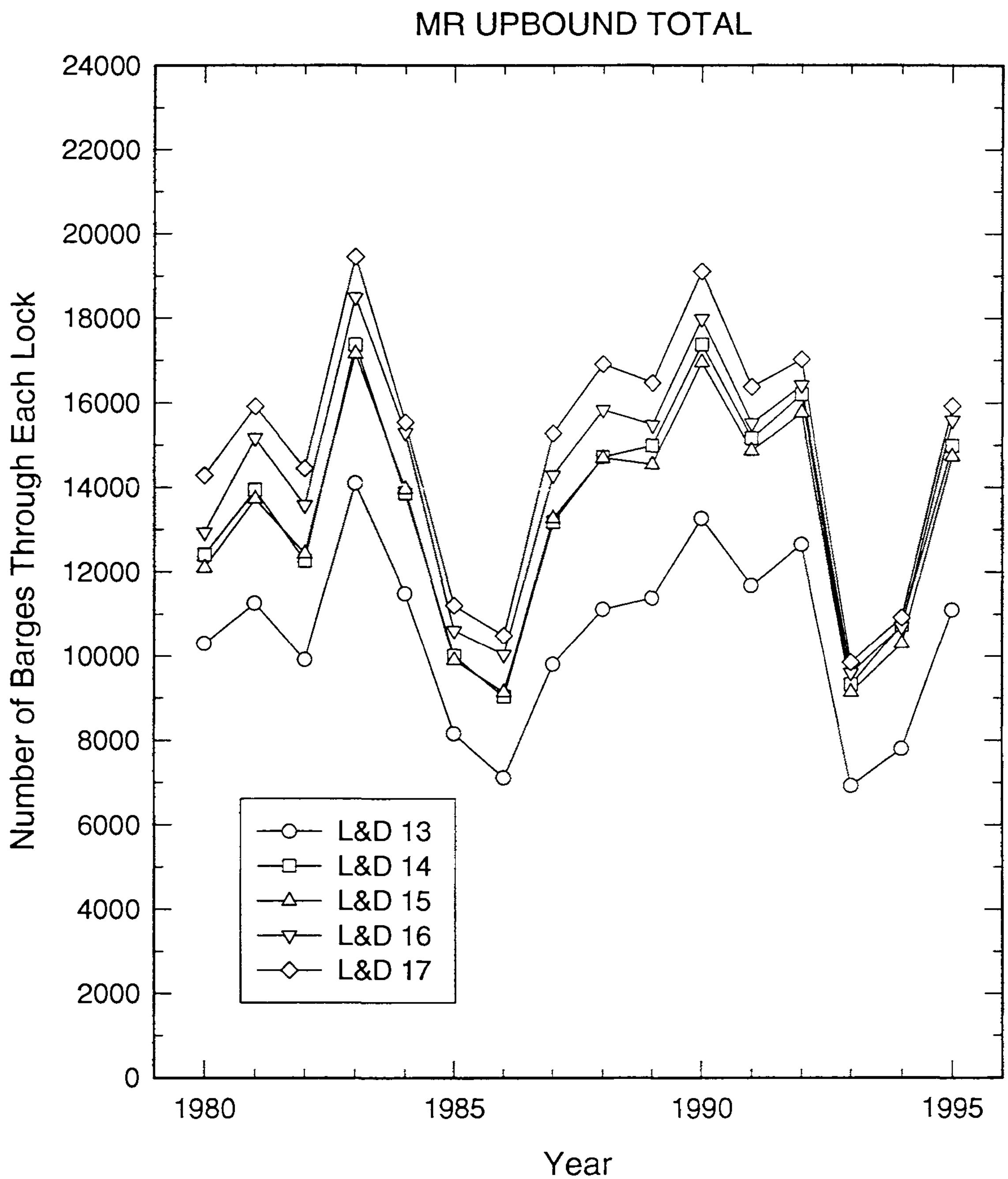


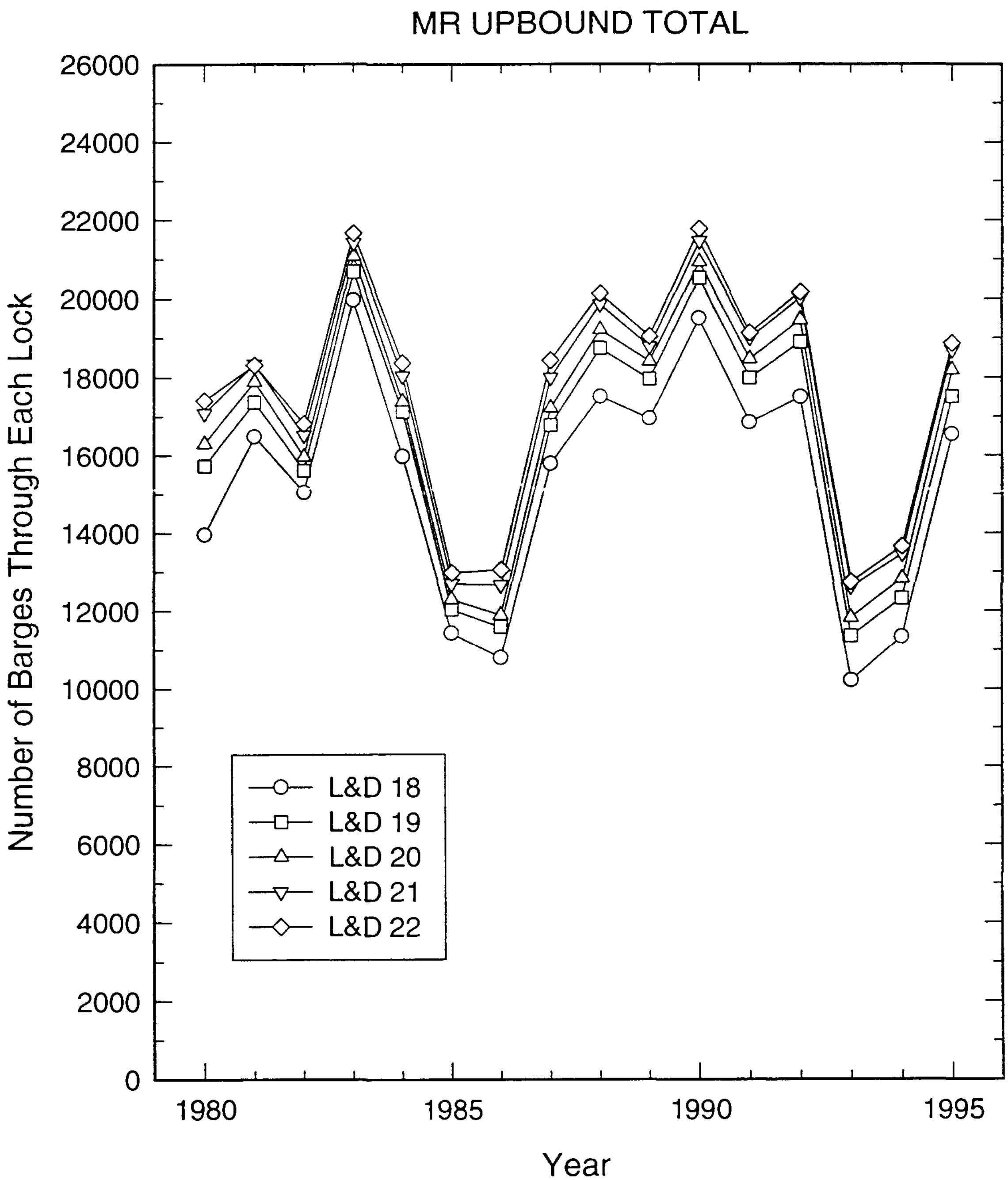


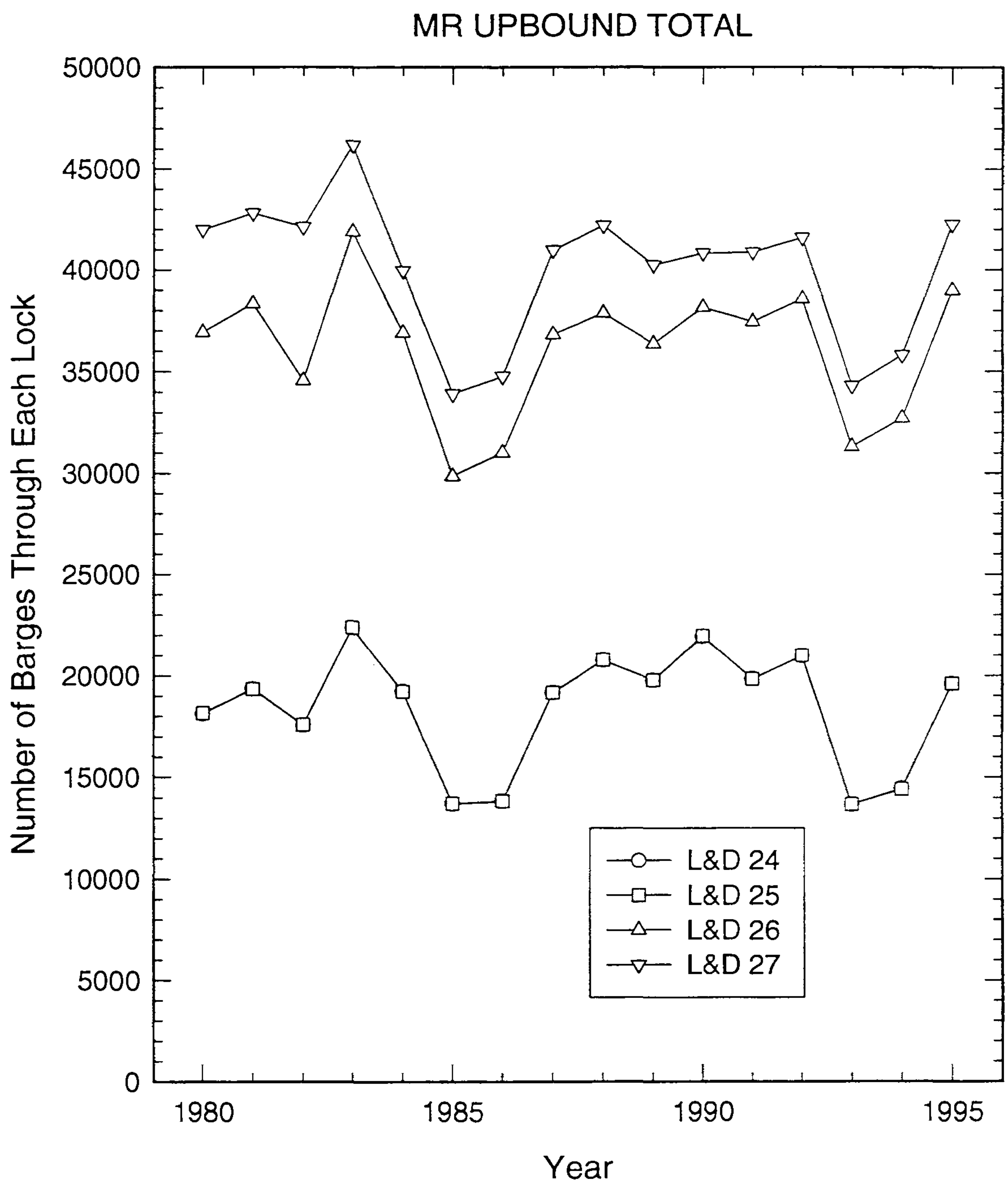
MR UPBOUND TOTAL
Number of Barges Through Each Lock
Year
L&D 1a
L&D 1b
L&D 1
L&D 2
L&D 3
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
1980
1985
1990
1995


MR UPBOUND TOTAL
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Number of Barges Through Each Lock
1980
1985
1990
1995
Year
L&D 4
L&D 5
L&D 5a
L&D 6
L&D 7

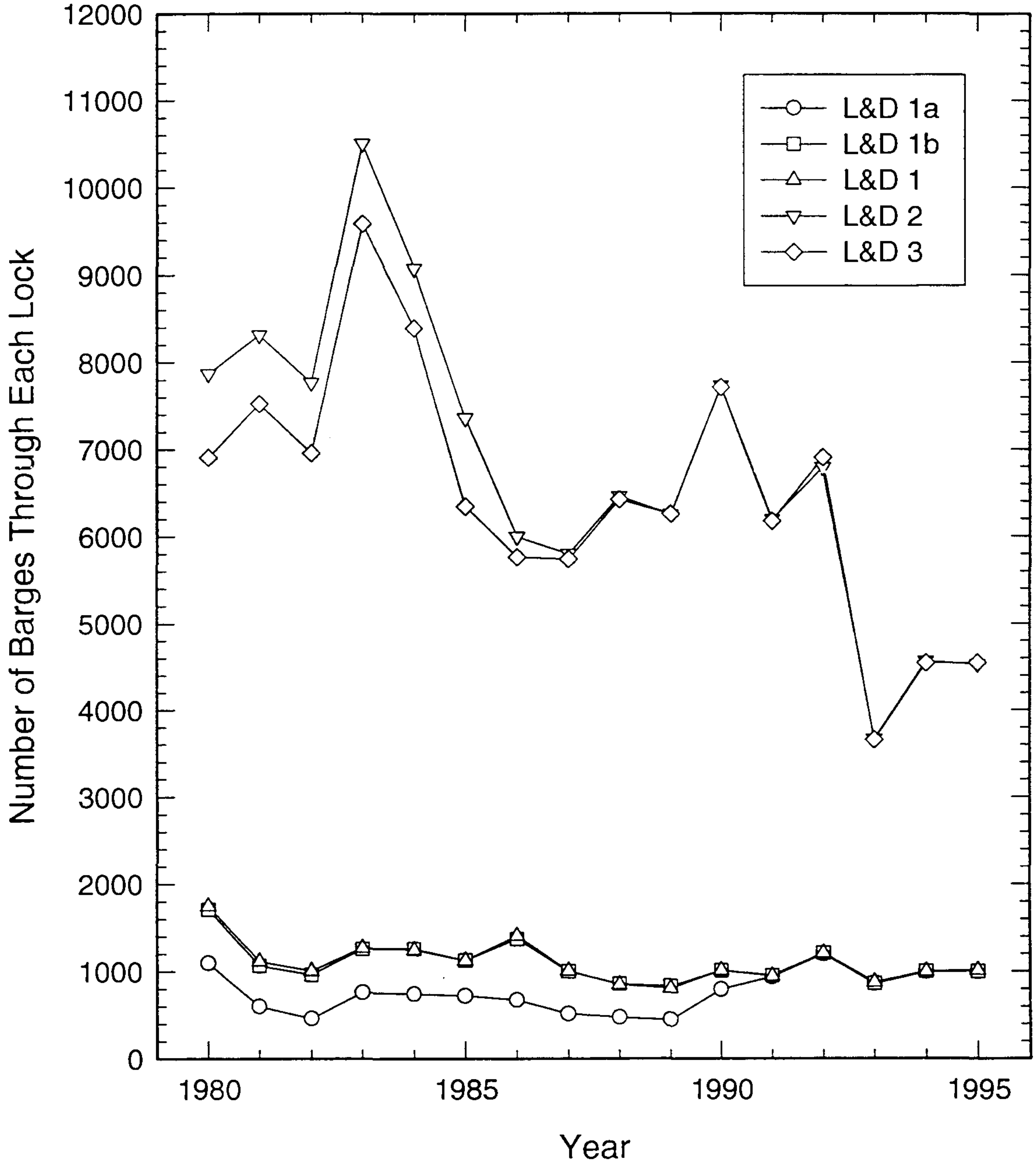

MR UPBOUND TOTAL
Number of Barges Through Each Lock
Year
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1980
1985
1990
1995
L&D 8
L&D 9
L&D 10
L&D 11
L&D 12

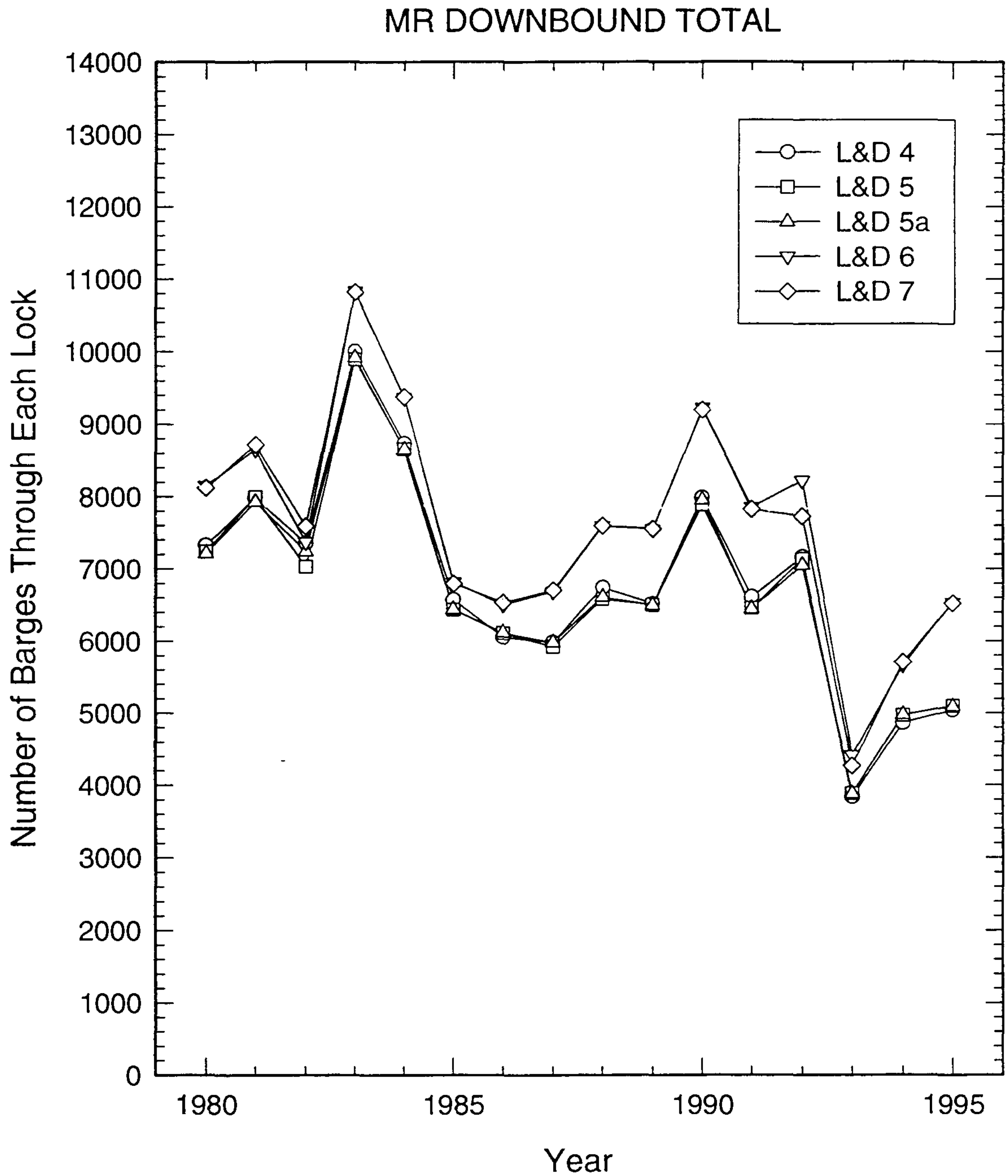

MR UPBOUND TOTAL
Number of Barges Through Each Lock
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1980
1985
1990
1995
Year
L&D 13
L&D 14
L&D 15
L&D 16
L&D 17


MR UPBOUND TOTAL
Number of Barges Through Each Lock
Year
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1980
1985
1990
1995
L&D 18
L&D 19
L&D 20
L&D 21
L&D 22

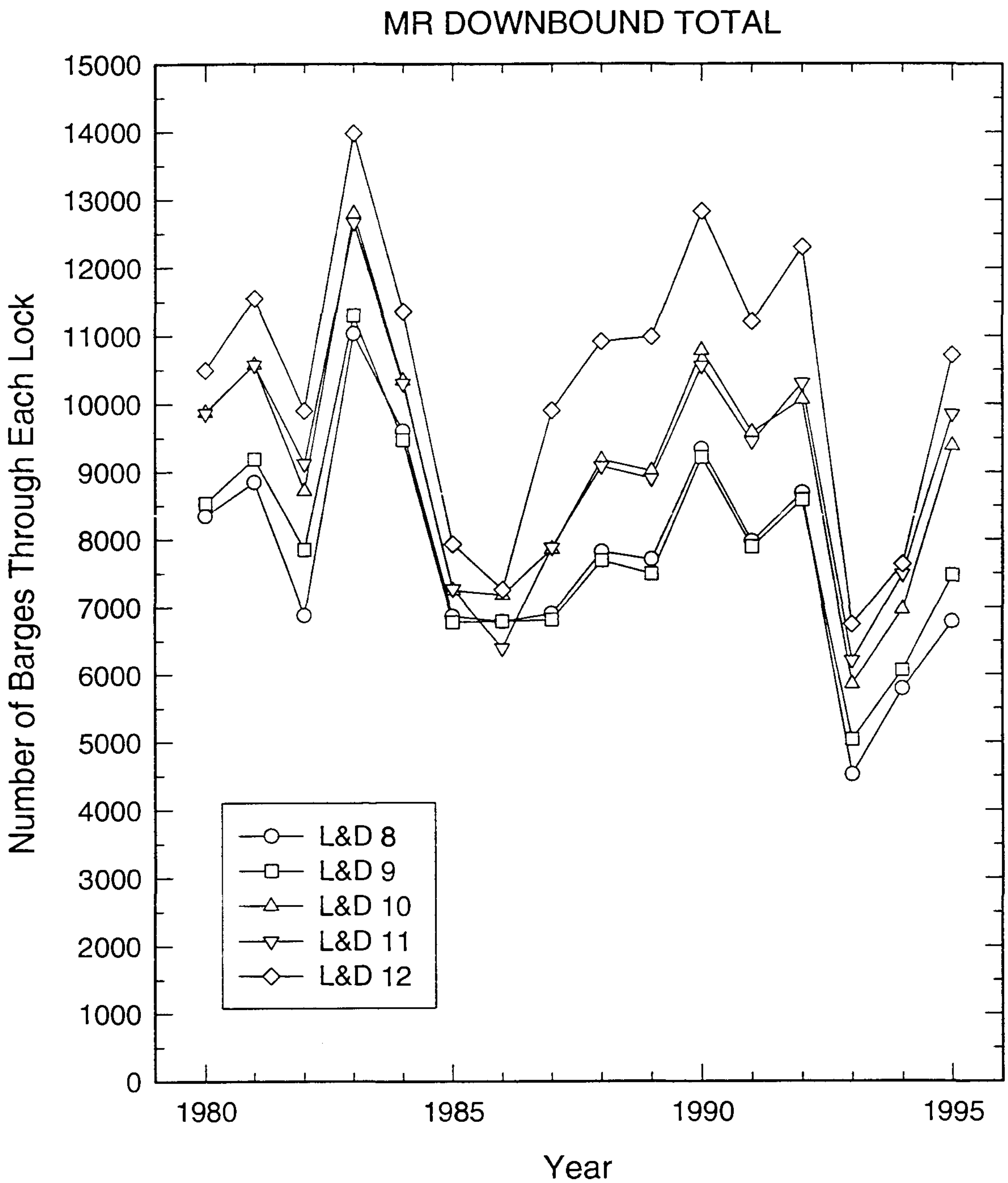

MR UPBOUND TOTAL
Number of Barges Through Each Lock
Year
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
1980
1985
1990
1995
L&D 24
L&D 25
L&D 26
L&D 27

MR DOWNBOUND TOTAL

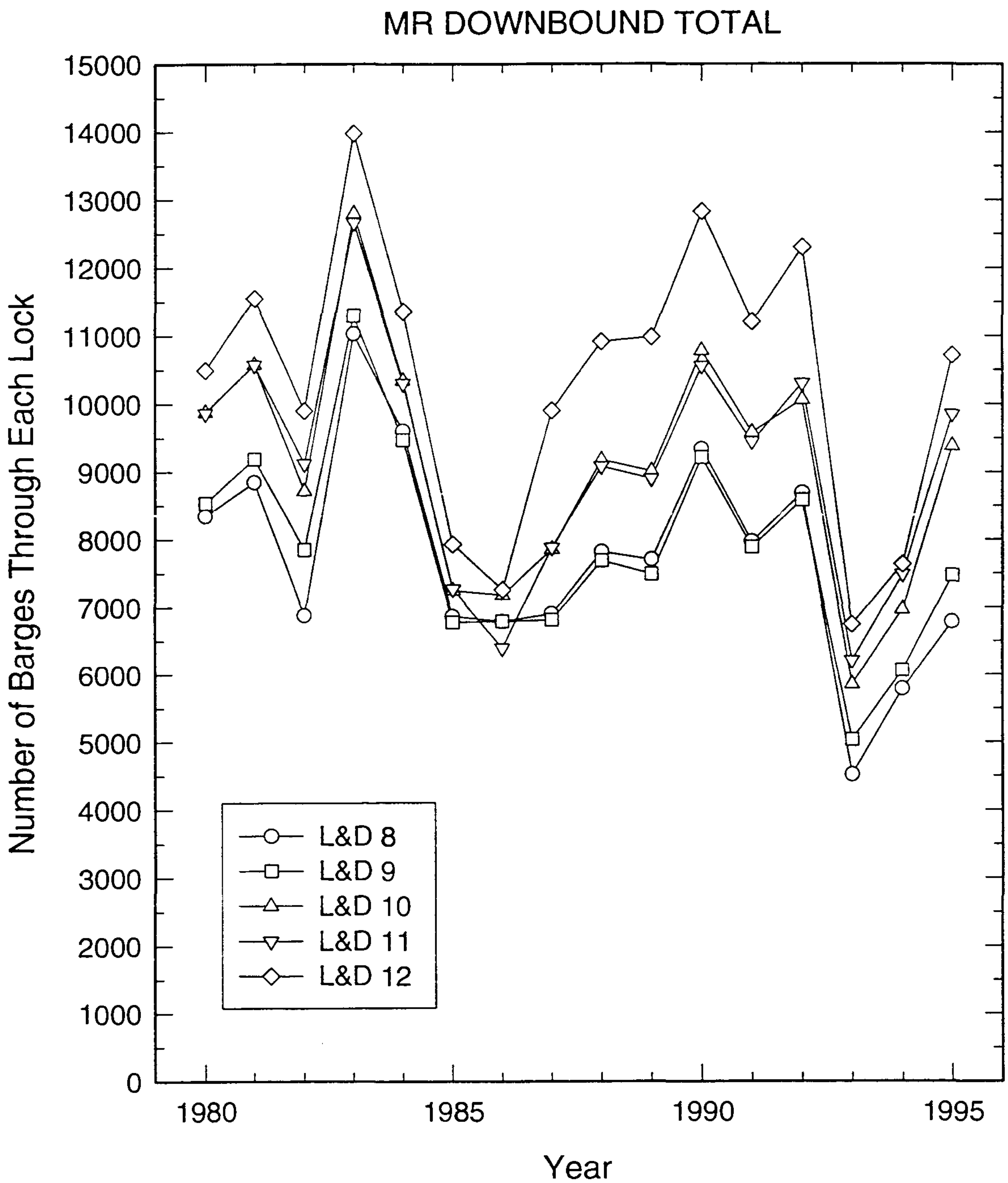


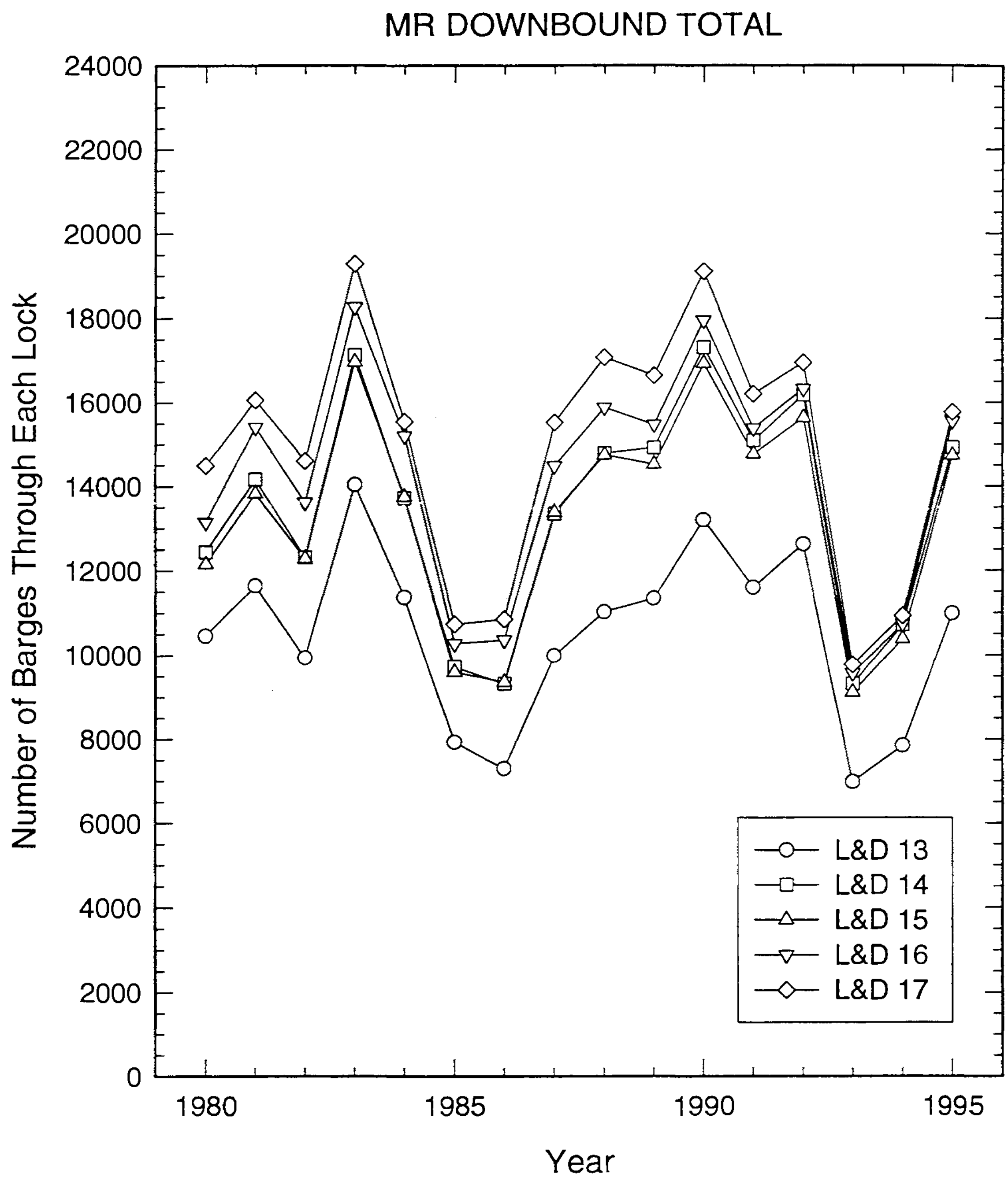


MR DOWNBOUND TOTAL
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Number of Barges Through Each Lock
1980
1985
1990
1995
Year
L&D 4
L&D 5
L&D 5a
L&D 6
L&D 7

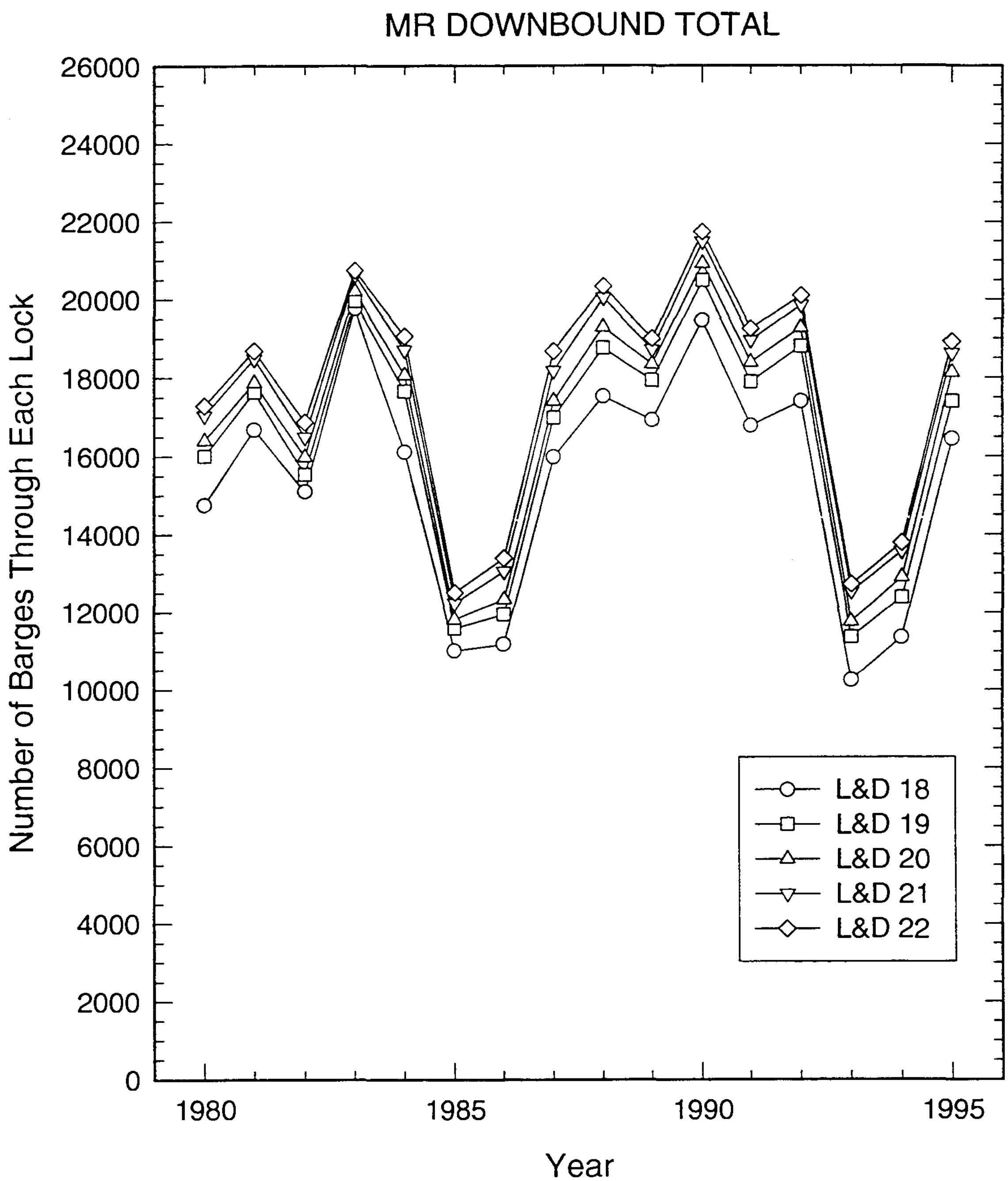


MR DOWNBOUND TOTAL
Number of Barges Through Each Lock
Year
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1980
1985
1990
1995
L&D 8
L&D 9
L&D 10
L&D 11
L&D 12

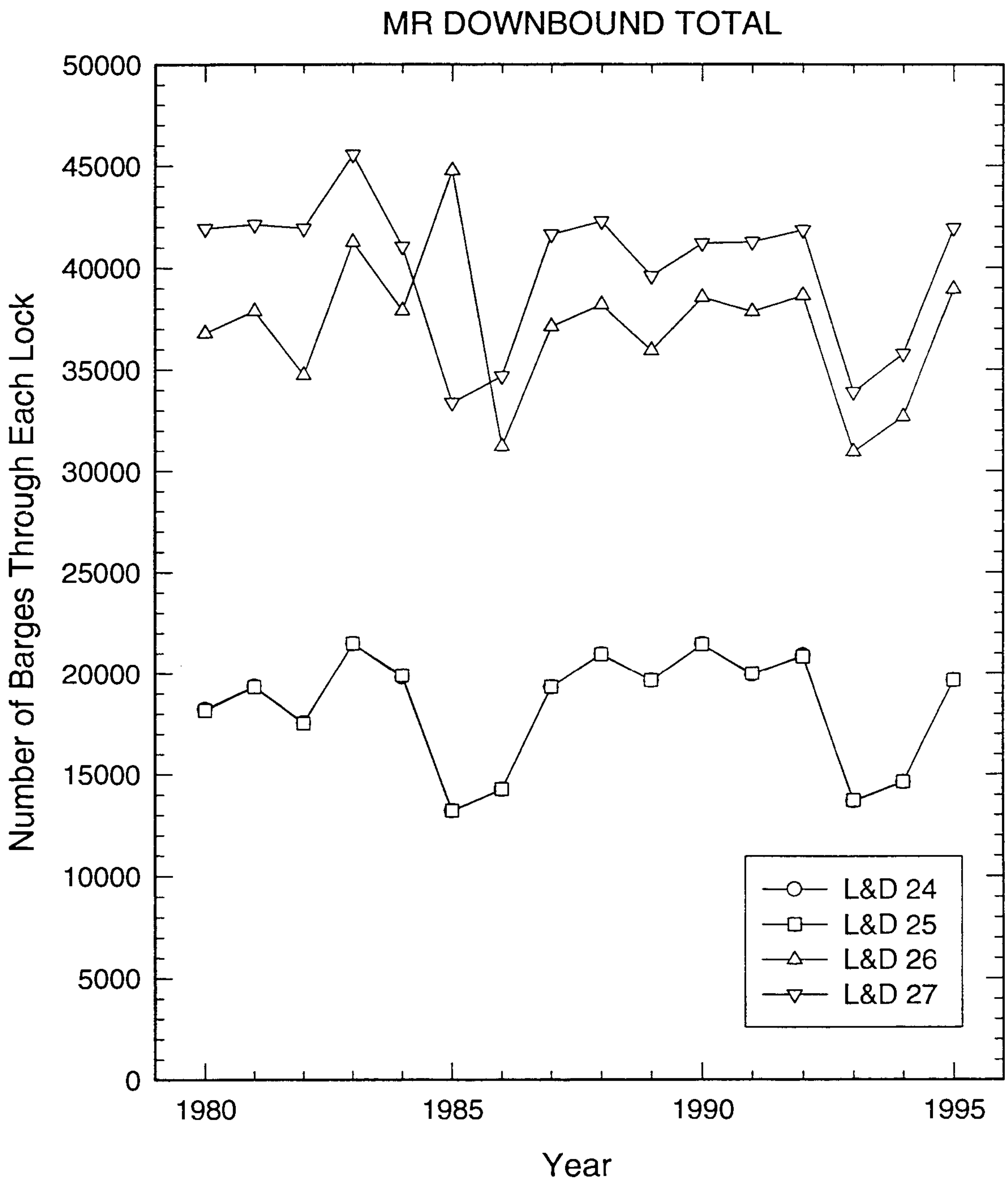

MR DOWNBOUND TOTAL
Number of Barges Through Each Lock
Year
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1980
1985
1990
1995
L&D 8
L&D 9
L&D 10
L&D 11
L&D 12



MR DOWNBOUND TOTAL
Number of Barges Through Each Lock
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1980
1985
1990
1995
Year
L&D 13
L&D 14
L&D 15
L&D 16
L&D 17



MR DOWNBOUND TOTAL
Number of Barges Through Each Lock
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1980
1985
1990
1995
Year
L&D 18
L&D 19
L&D 20
L&D 21
L&D 22


MR DOWNBOUND TOTAL
Number of Barges Through Each Lock
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1980
1985
1990
1995
Year
L&D 24
L&D 25
L&D 26
L&D 27

District	River	Town	State	Chart No.	LOC. REF No.	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi	Remarks
NCR	IWW	Lemont	IL	65	1	302.5	R	Lockport	50	Egan Marine Corp	708-739-0947	Lemont East	
NCR	IWW	Lemont	IL	65	2	301.2	R	Lockport	25	Egan Marine Corp		Lemont Ind Dist Slip B	
NCR	IWW	Lemont	IL	65	3	301.5	R	Lockport	50	Illinois Marine Towing, Inc.	708-257-3400		
NCR	IWW	Lemont	IL	65	4	300.0	R	Lockport	40	Marine Handline & Fleeting Co.	708-739-5000		
NCR	IWW	Lemont	IL	65	5	299.8	R	Lockport	36	ACBL	800-457-6377		
NCR	IWW	Lemont	IL	64/65	6	298.5	L	Lockport	52	National Marine, Inc.	708-257-2317	Lemont West	
NCR	IWW	Lemont	IL	65	7	299.4	R	Lockport	25	ACBL		Lemont Slip No. 2	
NCR	IWW	Lemont	IL	65	8	299.1	R	Lockport	25	Material Service Corp	815-838-3420	Lemont Slip No. 1	
NCR	IWW	Lemont	IL	65	9	299.0	R	Lockport	58	Ham Tug and Fleeting (Garvey)	708-739-2030		
NCR	IWW	Lockport	IL	64	10	295.0	R	Lockport	25	Material Service Corp		Lockport	
NCR	IWW	Joliet	IL	62	11	287.0	R	Brandon Road	50	Illinois Marine Towing, Inc.		Upper	
NCR	IWW	Joliet	IL	62	12	286.0	R	Brandon Road	80	Spivey Marine & Harbor	815-467-9702	Brandon Road Fleet	
NCR	IWW	Joliet	IL	61	13	281.3	R	Dresden	10	Canal Barge	815-467-2502	Channahon	
NCR	IWW	Joliet	IL	61	14	280.5	R	Dresden	60	Spivey Marine & Harbor		Hunting Lodge Fleet	
NCR	IWW	Channahon	IL	61	15	279.0	R	Dresden	45	Illinois Marine Towing, Inc.			
NCR	IWW	Morris	IL	58	16	263.0	R	Marseilles	60	Garvey Fleeting	815-942-9629		
NCR	IWW	Morris	IL	58	17	262.0	R	Marseilles	300	Material Service Corp.			
NCR	IWW	Seneca	IL	56	18	253.0	L	Marseilles	40	Black Marine	815-357-6666		
NCR	IWW	Ottawa	IL	54	19	241.6	R	Starved Rock	42	ARTCO	815-925-7338		
NCR	IWW	Ottawa	IL	53	20	237.8	R	Starved Rock	42	ARTCO			
NCR	IWW	Ottawa	IL	53	21	237.2	R	Starved Rock	70	Garvey Fleeting			
NCR	IWW	LaSalle	IL	49	22	224.0	R	Peoria	110	ARTCO			
NCR	IWW	Peru	IL	49	23	222.0	R	Peoria	22	Mertel Gravel	815-223-0468		
NCR	IWW	Spring Valle	IL	48	24	218.0	L	Peoria	18	CGB Marine Services	800-628-3785	Cargill	
NCR	IWW	Spring Valle	IL	48	25	218.0	R	Peoria	21	CGB MArine Services		Savitch	
NCR	IWW	Spring Valle	IL	48	26	217.6	R	Peoria	100	CGB Marine Services		Perona	
NCR	IWW	Hennepin	IL	47	27	212.2	L	Peoria	20	Louisiana Dock Co.	800-457-6377		
NCR	IWW	Hennepin	IL	47	28	211.6	L	Peoria	12	Louisiana Dock Co.			
NCR	IWW	Hennepin	IL	46	29	208.4	R	Peoria	40	CGB Marine Services		CGB Princeton	
NCR	IWW	Hennepin	IL	46	30	208.1	L	Peoria	60	ARTCO		Dore	
NCR	IWW	Hennepin	IL	46	31	206.7	L	Peoria	60	CGB Marine Services			
NCR	IWW	Hennepin	IL	45/46	32	205.7	R	Peoria	100	CGB Marine Services		CGB Princeton	

District	River	Town	State	Chart No.	LOC. REF No.	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi	Remarks
NCR	IWW	Hennepine	IL	45	33	202.0	R	Peoria	65	CGB Marine Services	815-925-7357	Princeton Game	
NCR	IWW	Lacon	IL	43	34	189.2	L	Peoria	25	Trumbull River Service	309-246-8119	Fisher's Slough	
NCR	IWW	Lacon	IL	42	35	188.2	R	Peoria	36	Trumbull River Service			
NCR	IWW	Peoria	IL	33	36	160.3	L	Peoria	70	Tabor Marine Service	309-673-0423		
NCR	IWW	Pekin	IL	32	37	153.0	L	LaGrange	100	Garvey Fleeting	815-942-9629	Kingston	
NCR	IWW	Havana	IL	26	38	119.0	R	LaGrange	130	Jack Tanner Towing Co.	309-543-3156	Coggeshall	
NCR	IWW	Beardstown	IL	21	39	91.4	L	LaGrange	30	Logsdon Tug Service	217-323-1290	Knoxville	
NCR	IWW	Beardstown	IL	20/21	40	89.3	R	LaGrange	40	Logsdon Tug Service		AMAX	
NCR	IWW	Beardstown	IL	20	41	88.4	L	LaGrange	15	Logsdon Tug Service		Logsdon (office fleet)	
NCR	IWW	Beardstown	IL	20	42	87.4	R	LaGrange	50	Logsdon Tug Service		Schuyler	

District	River	Town	State	Chart No.	LOC. Ref. No.	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi.
LMS	UMR	Batchtown	IL	98	1	240.8	L	Mel Price	125	Grantz's Marine Service, Inc. (6)	618-396-2247	West Point Anchor
LMS	UMR,SLH	Alton	IL	103	2	205.9	L	Mel Price	100	Norman Brothers, Inc.	618-466-8192	Norman Brothers
LMS	UMR,SLH	St. Louis	MO	104	3	199.4	R	27	200	Lewis & Clark Marine, Inc.	618-876-1116	Maple Island
LMS	UMR,SLH	Wood River	IL	104	4	198.8	L	27	80	Lewis & Clark Marine, Inc.		Wood River Fleet
LMS	UMR,SLH	Wood River	IL	104	5	198.0	L	27	24	American Boat Company	618-337-8877	
LMS	UMR,SLH	St. Louis	MO	104	6	196.6	R	27	75	Lewis & Clark Marine, Inc.		Mobile Island
LMS	UMR,SLH	Hartford	IL	105	7	195.5	L	27	80	Lewis & Clark Marine, Inc.		Hartford Fleet
LMS	UMR,SLH	St. Louis	MO	105	8	191.3	R	27	125	Massman Construction Company	314-821-0042	
LMS	UMR,SLH	Granite City	IL	106	9	187.6	L	27	60	Lewis 7 Clark Marine, Inc.		Tri-City Regional Port District
LMS	UMR,SLH	St. Louis	MO	106	10	182.0	R	Cairo	5	Kiesel Marine Service, Inc.	314-421-0328	
LMS	UMR,SLH	East St. Louis	IL	107	11	179.0	L	Cairo	50	B.N.B. Towing Service, Inc.	314-621-8587	Peabody Fleet
LMS	UMR,SLH	St. Louis	MO	107	12	178.9	R	Cairo	24	Reidy Terminal, Inc.	314-481-8828	Chouteau Fleet
LMS	UMR,SLH	St. Louis	MO	107	13	178.8	R	Cairo	50	B.N.B. Towing Service, Inc.		Trussel Fleet
LMS	UMR,SLH	East St. Louis	IL	107	14	178.8	L	Cairo	30	CGB Marine Services (Eagle Fleet & Service)	314-421-3575	A & B Fleet
LMS	UMR,SLH	St. Louis	MO	107	15	178.6	R	Cairo	50	B.N.B. Towing Services, Inc.		Nooter Wire Fleet
LMS	UMR,SLH	St. Louis	MO	107	16	178.5	R	Cairo	50	B.N.B. Towing Services, Inc.		Valley Fleet
LMS	UMR,SLH	Cahokia	IL	107	17	178.5	L	Cairo	45	CGB Marine Services (Eagle Fleet & Service)		Cahokia Fleet
LMS	UMR,SLH	St. Louis	MO	107	18	178.3	R	Cairo	9	CGB Marine Services (Eagle Fleet & Service)		Office Fleet
LMS	UMR,SLH	Monsanto	IL	107	19	178.0	L	Cairo	30	Midway Marine, Inc.	314-894-3805	Monasnto Fleet
LMS	UMR,SLH	St. Louis	MO	107	20	177.7	R	Cairo	45	Reidy Terminal, Inc.		Barton Street
LMS	UMR,SLH	Cahokia	IL	107	21	177.7	L	Cairo	25	Midway Marine, Inc.		Cahokia Anchor
LMS	UMR,SLH	St. Louis	MO	107	22	177.4	R	Cairo	25	CGB Marine Services (Eagle Fleet & Service)		George Street
LMS	UMR,SLH	East St. Louis	IL	107	23	177.3	L	Cairo	70	CGB Marine Services (Eagle Fleet & Service)		Riverport #1 Anchor
LMS	UMR,SLH	East St. Louis	IL	107	24	177.2	L	Cairo	70	CGB Marine Services (Eagle Fleet & Service)		Riverport #2 Anchor
LMS	UMR,SLH	East St. Louis	IL	107	25	176.9	L	Cairo	20	Midway Marine, Inc.		Phillip Cell
LMS	UMR,SLH	East St. Louis	IL	107	26	176.6	L	Cairo	24	Reidy Terminal, Inc.		St. Louis Grain Cell
LMS	UMR,SLH	East St. Louis	IL	107	27	175.8	L	Cairo	36	Midway Marine, Inc.		Arsenal Island Dike
LMS	UMR,SLH	East St. Louis	IL	107	28	175.5	L	Cairo	36	Midway Marine, Inc.		Arsenal Island #1
LMS	UMR,SLH	St. Louis	MO	107	29	175.3	R	Cairo	60	Reidy Terminal, Inc.		Upper Fleet
LMS	UMR,SLH	St. Louis	MO	107	30	175.1	R	Cairo	75	Reidy Terminal, Inc.		Lower Fleet
LMS	UMR,SLH	East St. Louis	IL	107	31	175.1	L	Cairo	30	Midway Marine, Inc.		Arsenal Island #2
LMS	UMR,SLH	St. Louis	MO	107	32	174.7	R	Cairo	36	Midway Marine, Inc.		Belle Rieves Upper
LMS	UMR,SLH	East St. Louis	IL	107	33	174.7	L	Cairo	20	Midway Marine, Inc.		Arsenal Island #3 Highwater
LMS	UMR,SLH	East St. Louis	IL	107	34	174.5	L	Cairo	50	Riverway Harbor Service St. Louis, Inc.	618-286-4571	Arsenal #1
LMS	UMR,SLH	East St. Louis	IL	107	35	174.4	L	Cairo	20	Midway Marine, Inc.		Arsenal Island #4 Highwater
LMS	UMR,SLH	St. Louis	MO	107	36	174.2	R	Cairo	36	Midway Marine, Inc.		Belle Rieves Lower
LMS	UMR,SLH	East Carondelet	IL	107	37	174.2	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Arsenal #2
LMS	UMR,SLH	East Carondelet	IL	107	38	174.0	L	Cairo	60	Riverway Harbor Service St. Louis, Inc.		Arsenal #3

District	River	Town	State	Chart No.	LOC. Ref. No.	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi.
LMS	UMR,SLH	East Carondelet	IL	107	39	173.7	L	Cairo	60	Riverway Harbor Service St. Louis, Inc.		Arsenal #4
LMS	UMR,SLH	East Carondelet	IL	107	40	173.5	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Arsenal #5
LMS	UMR,SLH	East Carondelet	IL	107	41	173.3	L	Cairo	45	Riverway Harbor Service St. Louis, Inc.		Arsenal #6
LMS	UMR,SLH	East Carondelet	IL	107	42	173.1	L	Cairo	20	Riverway Harbor Service St. Louis, Inc.		Arsenal #7
LMS	UMR,SLH	St. Louis	MO	107	43	173.0	R	Cairo	36	Midway Marine, inc.		Nagel
LMS	UMR,SLH	East Carondelet	IL	107	44	173.0	L	Cairo	50	Riverway Harbor Service St. Louis, Inc.		Davis Anchor #1
LMS	UMR,SLH	East Carondelet	IL	107	45	172.8	L	Cairo	20	Riverway Harbor Service St. Louis, Inc.		Upper Davis
LMS	UMR,SLH	East Carondelet	IL	107	46	172.4	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Davis Anchor #2
LMS	UMR,SLH	East Carondelet	IL	107	47	172.3	L	Cairo	20	Riverway Harbor Service St. Louis, Inc.		Lower Davis
LMS	UMR,SLH	East Carondelet	IL	107	48	172.2	L	Cairo	30	Riverway Harbor Service St. Louis, Inc.		Davis Anchor #3
LMS	UMR,SLH	East Carondelet	IL	107	49	172.1	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Anchor #1
LMS	UMR,SLH	East Carondelet	IL	107	50	172.0	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Anchor #2
LMS	UMR,SLH	Lemay	MO	108	51	171.8	R	Cairo	20	Midway Marine, Inc.		LDC Shipyard
LMS	UMR,SLH	Lemay	MO	108	52	171.8	L	Cairo	30	Riverway Harbor Service St. Louis, Inc.		Riverway Bank #1
LMS	UMR,SLH	Lemay	MO	108	53	171.6	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Bank #2
LMS	UMR,SLH	Lemay	MO	108	54	171.5	R	Cairo	36	Midway Marine, Inc.		Notre Dame #2
LMS	UMR,SLH	Lemay	MO	108	55	171.5	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Anchor #3
LMS	UMR,SLH	Lemay	MO	108	56	171.3	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Bank #3
LMS	UMR,SLH	Lemay	MO	108	57	171.2	R	Cairo	36	Midway Marine, Inc.		Notre Dame #3
LMS	UMR,SLH	Lemay	MO	108	58	171.0	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Bank #4
LMS	UMR,SLH	Jefferson Barrac	MO	108	59	170.7	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Bank #5
LMS	UMR,SLH	Jefferson Barrac	MO	108	60	170.4	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Riverway Bank #6
LMS	UMR,SLH	Jefferson Barrac	MO	108	61	168.5	R	Cairo	30	Midway Marine, Inc.		Jefferson Barracks #1
LMS	UMR,SLH	Jefferson Barrac	MO	108	62	168.0	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Carroll Anchor #1
LMS	UMR,SLH	Jefferson Barrac	MO	108	63	167.9	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Carroll Anchor #2
LMS	UMR,SLH	Jefferson Barrac	MO	108	64	167.7	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Carroll Bank #1
LMS	UMR,SLH	Jefferson Barrac	MO	108	65	167.6	L	Cairo	40	Riverway Harbor Service St. Louis, Inc.		Carroll Bank #2
LMS	UMR,SLH	Jefferson Barrac	MO	108	66	167.4	R	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #2
LMS	UMR,SLH	Jefferson Barrac	MO	108	67	167.2	R	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #3
LMS	UMR,SLH	Jefferson Barrac	MO	108	68	166.8	R	Cairo	40	Midway Marine, Inc.		Jefferson Barracks #4
LMS	UMR,SLH	Jefferson Barrac	MO	108	69	166.4	R	Cairo	25	Midway Marine, Inc.		Jefferson Barracks #4 A
LMS	UMR,SLH	St. Louis	MO	108	70	165.9	R	Cairo	30	Midway Marine, Inc.		Jefferson Barracks Anchor #1
LMS	UMR,SLH	St. Louis	MO	108	71	165.6	R	Cairo	30	Midway Marine, Inc.		Jefferson Barracks Anchor #2
LMS	UMR,SLH	St. Louis	MO	108	72	165.5	L	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #7
LMS	UMR,SLH	St. Louis	MO	108	73	165.2	L	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #7 A
LMS	UMR,SLH	St. Louis	MO	109	74	164.7	L	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #7 B
LMS	UMR,SLH	St. Louis	MO	109	75	164.5	L	Cairo	20	Midway Marine, Inc.		Jefferson Barracks #7 C
LMS	UMR,SLH	St. Louis	MO	109	76	164.2	L	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #8

District	River	Town	State	Chart No.	LOC. Ref. No.	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi.
LMS	UMR,SLH	St. Louis	MO	109	77	163.8	L	Cairo	36	Midway Marine, Inc.		Jefferson Barracks #9
LMS	UMR,SLH	St. Louis	MO	109	78	162.8	L	Cairo	48	Midway Marine, Inc.		Jefferson Barracks #11 Highwater
LMS	UMR,SLH	St. Louis	MO	109	79	162.4	L	Cairo	48	Midway Marine, Inc.		Jefferson Barracks #12 Highwater
LMS	UMR,SLH	Kimmswick	MO	109	80	160.0	R	Cairo	50	Apex Oil Company	314-889-9600	Chesley Island
LMS	UMR,SLH	Selma	MO	112	81	145.0	R	Cairo	18	Central Contracting & Marine, Inc.	314-946-0185	
LMS	UMR	Ste. Genevieve	MO	115	82	127.0	R	Cairo	70	Tower Rock Stone Company	no number	Tower Rock Fleet
LMS	UMR	Ste. Genevieve	MO	115	83	126.2	R/L	Cairo	75	Southern Illinois Transfer Company, Inc.	618-826-2015	
LMS	UMR	Ste. Genevieve	MO	115	83	126.2	R/L	Cairo	75	Southern Illinois Transfer Company, Inc.		
LMS	UMR	Ste. Genevieve	MO	115	84	122.0	R	Cairo	25	Southern Illinois Transfer Company, Inc.	618-524-3100	
LMS	UMR	Kaskaskia Island	IL	116	85	117.5	L	Cairo	16	Mid-South Towing Company		Kaskaskia Fleet
LMS	UMR	Kaskaskia Island	IL	116	86	115.7	R	Cairo	60	Mid-South Towing Company		Farmers Fleet
LMS	UMR	Kaskaskia Island	IL	116	87	114.6	R	Cairo	40	Mid-South Towing Company		Okaw Fleet
LMS	UMR	Chester	IL	117	88	108.0	L	Cairo	50	Southern Illinois Transfer Company, Inc.		
LMS	UMR	Cora	IL	119	89	98.5	L	Cairo	4	Cora Coal Terminal	618-763-4798	
LMS	UMR	Gorham	IL	121	90	85.6	L	Cairo	30	Jackson County PTL River Terminal	618-997-9371	Jackson County Dock
LMS	UMR	Cape Girardeau	MO	125	91	50.5	L	Cairo	40	Cape Girardeau Fleeting, Inc.	314-651-4040	
LMS	UMR	Gray's Point	MO	126	92	47.5	L	Cairo	12	Cape Girardeau Fleeting, Inc.		
LMS	UMR	Gray's Point	MO	126	93	47.0	R	Cairo	50	West Lake Quarry & Material Company, Inc.	314-739-1122	Gray's Point Fleet
LMS	UMR	Birds Point	MO	130	94	1.9	R	Cairo	36	CGB Marine Services (Eagle Fleet & Service)		
LMS	UMR	Cairo	IL	130	95	0.8	L	Cairo	85	CGB Marine Services (Eagle Fleet & Service)		

District	River	Town	State	Chart No.	OC.	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi.	Remarks
NCR	UMR	Cassville	WI	45	1	607.0	L	11	20	Cassville River Terminal	608-725-2311		Bob Hudson - VP
NCR	UMR	Cassville	WI	45	2	607.0	R	11	60	Cassville River Terminal			Bob Hudson
NCR	UMR	Dubuque	IA	49	3	580.0	L	12	9	Newt Marine Service	319-557-1855		
NCR	UMR	Dubuque	IA	49	4	580.0	R	12	12	Dubuque Harbor Service	608-725-2311	Dove Harbor	
NCR	UMR	Dubuque	IA	49	5	579.7	R	12	34	Dubuque Harbor Service			
NCR	UMR	Dubuque	IA	49	6	579.5	L	12	40	Newt Marine Service			
NCR	UMR	Dubuque	IA	49	7	576.7	L	12	30	Dubuque harbor Service			
NCR	UMR	Dubuque	IA	49	8	576.7	R	12	48	Dubuque Harbor Service			
NCR	UMR	Dubuque	IA	49	9	576.0	L	12	30	Newt Marine Service			
NCR	UMR	Savanna	IL	55	10	537.0	L	13	20	Consolidated Grain Barge	815-273-4246		
NCR	UMR	Clinton	IA	58	11	517.3	R	14	20	Clinton Harbor Service	319-242-0962	Beaver Island	
NCR	UMR	Clinton	IA	58	12	517.7	L	14	30	Clinton Harbor Service		Little Rock Island	
NCR	UMR	Camanche	IA	58	13	513.2	R	14	24	Clinton Harbor Service		Island	
NCR	UMR	Camanche	IA	58	14	512.4	R	14	30	Clinton Harbor Service		Pond	
NCR	UMR	Camanche	IA	58	15	512.8	R	14	80	Clinton Harbor Service		Slough	
NCR	UMR	Linwood	IA	64	16	475.0	L	16	160	Blackhawk Fleet, Inc.	319-322-3510	Smiths Island	
NCR	UMR	Muscatine	IA	67	17	454.0	L	17	100	Blackhawk Fleet, Inc.		Muscatine Island	
NCR	UMR	New Boston	IL	70	18	432.0	R	18	30	R&R Marine	309-867-3271		
NCR	UMR	Keithsburg	IL	70	19	426.0	R	18	30	R&R Marine			
NCR	UMR	Burlington	IA	74	20	407.0	L	19	20	Matteson Marine Service	319-754-5318		
NCR	UMR	Burlington	IA	74	21	406.0	L	19	15	Matteson Marine Service			
NCR	UMR	Burlington	IA	74	22	405.6	R	19	50	Matteson Marine Service		Baby Rush Island	
NCR	UMR	Burlington	IA	74	23	401.0	L	19	20	Matteson Marine Service			
NCR	UMR	Burlington	IA	74	24	401.0	R	19	18	Matteson Marine Service			
NCR	UMR	Fort Madison	IA	77	25	383.0	R	19	80	Hall Towing	319-372-3078		
NCR	UMR	Galland	IA	79	26	371.0	R	19	30	Orba Johnson Transshipme	319-463-7162		
NCR	UMR	Keokuk	IA	80	27	362.5	R/L	20	75	Canton Marine Towing	314-288-3740		
NCR	UMR	Keokuk	IA	80	27	362.5	R/L	20	75	Canton Marine Towing			
NCR	UMR	Canton	MO	83	28	345.0	R	20	20	Canton Marine Towing			
NCR	UMR	Quincy	IL	86	29	326.0	R	21	150	Canton Marine Towing			
NCR	UMR	Hannibal	MO	88	30	308.0	L	22	75	Canton Marine Towing		Glasscox Island	

District	River	Town	State	Chart No.	LOC. Ref. Nol	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi.	Remarks
NCS	Minn	Savage	MN	2	1	14.9	R	2	14	Dakota Barge	612-731-6399	Continental Grain Fleet	
NCS	Minn	Savage	MN	3	2	13.7	L	2	20	Upper River Services	612-292-9293	Credit River Fleet	
NCS	Minn	Savage	MN	3	3	13.2	L	2	22	Upper River Services		Port Cargill Fleet (loaded)	
NCS	Minn	Savage	MN	3	4	12.5	R	2	28	Upper River SErvices		Port Cargill Fleet (empty)	
NCS	Minn	Savage	MN	3	5	11.5	R	2	9	Dakota Barge		Kraemer Property	
NCS	Minn	Savage	MN	3	6	11.0	R	2	8	Dakota Barge		Peavey Fleet	
NCS	UMR	Minneapolis	MN	10	7	857.1	L	2	16			NSP	
NCS	UMR	St. Paul	MN	12	8	843.5	R	2	16	Upper River Services		Minn. River Mouth Fleet	
NCS	UMR	St. Paul	MN	12	9	841.0	L	2	12	Upper River Services		Omaha Fleet	
NCS	UMR	St. Paul	MN	12	10	840.9	L	2	16	Upper River Services		NSP Fleet	
NCS	UMR	St. Paul	MN	12	11	840.2	L	2	21	Dakota Barge		High Bridge Fleet	
NCS	UMR	St. Paul	MN	12	12	840.0	L	2	8	Upper River Services		Harvest States Fleet	
NCS	UMR	St. Paul	MN	12	13	839.1	R	2	15	Dakota Barge		Robert St. Fleet	
NCS	UMR	St. Paul	MN	12	14	838.4	R	2	27	Dakota Barge		Mid-America Fleet	
NCS	UMR	St. Paul	MN	12	15	838.5	L	2	36	Upper River Services		Twin City Fleet	
NCS	UMR	St. Paul	MN	12	16	838.0	L	2	63	Upper River Services		North Port Fleet	
NCS	UMR	St. Paul	MN	13	17	837.7	R	2	15	Dakota Barge		Hangar Fleet	
NCS	UMR	St. Paul	MN	13	18	837.0	R	2	60	Upper River Services (for ACBL)		Airport Fleet	
NCS	UMR	St. Paul	MN	13	19	836.2	R	2	21	Dakota Barge		Dakota Barge Fleet	
NCS	UMR	St. Paul	MN	13	20	836.0	R	2	15	Upper River Services		Southport Fleet	
NCS	UMR	St. Paul	MN	13	21	835.6	L	2	27	Dakota Barge		Belt Line Fleet	
NCS	UMR	St. Paul	MN	13	22	835.0	L	2	27	Dakota Barge		Valley Line Fleet	
NCS	UMR	So. St Paul	MN	13	23	834.6	R	2	15	Dakota Barge		Concord St. Fleet	
NCS	UMR	St. Paul	MN	13	24	834.3	L	2	39	Upper River Services		Kaposia Fleet	
NCS	UMR	So. St. Paul	MN	13	25	834.0	R	2	15	Dakota Barge		South St. Paul Fleet	
NCS	UMR	St. Paul	MN	13	26	834.0	L	2	39	Upper River Services		Packing House Fleet (inaccessable)	
NCS	UMR	St. Paul	MN	13	27	833.8	L	2	36	Upper River Services		North Star Fleet (inaccessable)	
NCS	UMR	St. Paul	MN	13	28	833.6	L	2	27	Upper River Services		Red Rock Fleet	
NCS	UMR	St. Paul	MN	13	29	833.3	L	2	21	Upper River Services		Pigs Eye East Fleet	
NCS	UMR	St. Paul	MN	13	30	833.3	L	2	54	Upper River Services		Pigs Eye West Fleet	
NCS	UMR	Red Wing	MN	19	31	788.5	L	4	15	Red Wing River Towing, Inv.	612-388-6324		
NCS	UMR	Alma	WI	24	32	751.4	L	5	18	Genoa Dock Corp	608-689-2301	At Dairyland Power Coop., Alma, WI	
NCS	UMR	Winona	MN	28	33	727.1	R	6	12	Cassville River Terminal			
NCS	UMR	Winona	MN	28	34	726.3	R	6	24	Cassville River Terminal			
NCS	UMR	Winona	MN	28	35	726.3	L	6	53	Cassville River Terminal			
NCS	Blac	La Crosse	WI	32	36	0.9	L	8	9	Brennan Marine, Inc.	608-782-3670	On Black River between Ports 40 and 41	
NCS	UMR	La Crosse	WI	32	37	696.3	L	8	19	Brennan Marine, Inc.		Adjacent to La Crosse city dock	
NCS	UMR	Genoa	WI	34	38	678.5	L	9	48	Genoa Dock Corp		At Dairyland Power Coop., Genoa, WI	

District	River	Town	State	Chart No.	LOC. Ref. Nol	River Mile	River Bank	Lock Pool	Capacity	Operator	Phone No.	Fleet Desi.	Remarks
NCS	UMR	Lansing	IA	37	39	659.6	R	9	60	Brennan Marine, Inc.		At Interstate Power plant	
NCS	UMR	Lansing	IA	37	39	659.6	R	9	60	Brennan Marine, Inc.		At Interstate Power plant	
NCS	UMR	Prairia du Che	WI	41	40	636.0	R	10	48	Cassville River Terminal		Bob Hudson, CRT	
NCS	UMR	Pairie du Chie	WI	41	41	636.1	L	10	30	Cassville River Terminal		Operated for PS&G	
NCS	UMR	Prairie du Chi	WI	41	42	632.5	L	10	60	Cassville River Terminal		Indian Isle (main) Fleet	
NCS	UMR	Clayton	IA	43	43	623.5	R	10	96	Clayton Tug Service	319-964-2172	Below Ag. Products Terminal Co.	
NCS	UMR	Clayton	IA	43	43	623.5	R	10	96	Clayton Tug Service		Below Ag. Products Terminal Co.	

Appendix F.

Particle Size Distribution on the Illinois Waterway and Upper Mississippi River

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	279.5	obser-vation	RDB	236		Marseilles	back side T' Reat's Island right side back channel
ILWW	275.5	obser-vation	RDB	235		Marseilles	Will Co. Forest Preserve Island lower bank sample glacial
ILWW	275.5	obser-vation	RDB	234		Marseilles	Will Co. Forest Preserve Island lower bank sample glacial
ILWW	270.3	UP2	LDB	218	mp	Marseilles	sample 1, bench
ILWW	270.3	UP1	RDB	272	up	Marseilles	U1A
ILWW	270.3	UP2	LDB	221	mp	Marseilles	sample 4, top of bank
ILWW	270.3	UP2	LDB	183	up	Marseilles	core 2B, 2' of water
ILWW	270.3	UP2	LDB	226	mp	Marseilles	2' of water, C2A
ILWW	270.3	UP2	LDB	264	mp	Marseilles	berm sample 2 sore large Rock
ILWW	270.3	UP2	LDB	263	mp	Marseilles	sample 3, bank face
ILWW	270.3	UP2	LDB	247	mp	Marseilles	1' of water, C1A
ILWW	270.3	UP1	RDB	230	mp	Marseilles	MIB
ILWW	270.3	UP1	RDB	232	dn	Marseilles	D2A, 2' of water
ILWW	270.3	UP1	RDB	233	dn	Marseilles	D1A, 1' of water
ILWW	270.3	UP1	RDB	268	up	Marseilles	U2B
ILWW	270.3	UP1	RDB	228	mp	Marseilles	#2, bank face
ILWW	270.3	UP1	RDB	219	mp	Marseilles	M2B
ILWW	270.3	UP1	RDB	227	mp	Marseilles	#1 bench, 2" surface
ILWW	270.3	UP1	RDB	225	mp	Marseilles	sample 1, bench 2" second layer
ILWW	270.3	UP1	RDB	273	up	Marseilles	UIB
ILWW	270.3	UP1	RDB	269	up	Marseilles	U2A
ILWW	270.3	UP1	RDB	220	mp	Marseilles	M2A
ILWW	270.3	UP1	RDB	224	mp	Marseilles	M1A
ILWW	270.3	UP1	RDB	223	mp	Marseilles	crest, #3
ILWW	270.3	UP2	LDB	222	mp	Marseilles	1' of water C1B
ILWW	269.9	obser-vation	LDB	231		Marseilles	#1, scarp, bank face
ILWW	269.9	obser-vation	LDB	256		Marseilles	#2, scarp

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	264.3	UP3	LDB	239	up	Marseilles	core 1B below 0.4' 1' of water
ILWW	264.3	UP3	LDB	240	up	Marseilles	core 1C below 1' of tube sampler
ILWW	264.3	UP3	LDB	244	up	Marseilles	core 1A 0.4' top of tube 1' of water
ILWW	264.3	UP3	LDB	248	dn	Marseilles	core 1B 0.4' below surface 1' of water
ILWW	264.3	UP3	LDB	250	dn	Marseilles	core 1A 0.4' from top 1' of water
ILWW	264.3	UP3	LDB	229	dn	Marseilles	profile core 2B 2' of water
ILWW	264.3	UP3	LDB	257	dn	Marseilles	2' of water core 2A 0.4' of top
ILWW	264.3	UP3	LDB	265	mp	Marseilles	below 0.4 core 1B 1' of water imp
ILWW	264.3	UP3	LDB	267	mp	Marseilles	core 1A 0.4 top portion 1' of water
ILWW	264.3	UP3	LDB	275	mp	Marseilles	bench sample 1, 2" below surface imp
ILWW	264.3	UP3	LDB	280	mp	Marseilles	bank sample2
ILWW	264.3	UP3	LDB	271	mp	Marseilles	sample 3, crest
ILWW	264.3	UP3	LDB	270	mp	Marseilles	core 2, 2' of water
ILWW	264.3	UP3	LDB	260	up	Marseilles	core 2B, 2' of water below 1'
ILWW	264.3	UP3	LDB	258	up	Marseilles	core 2A 2' of water top 1'
ILWW	262.1	UP5	RDB	243	mp	Marseilles	2' of water core 2A top 6"
ILWW	262.1	UP4	LDB	278	mp	Marseilles	sample #1, 1.5" below surface
ILWW	262.1	UP4	LDB	252	mp	Marseilles	core 1 0.4' below from top, 1' of water
ILWW	262.1	UP5	RDB	253	mp	Marseilles	1' of water core 1B, top 0.3-0.6
ILWW	262.1	UP4	LDB	255	mp	Marseilles	core 2B 0.4' below, 2' of water
ILWW	262.1	UP5	RDB	237	mp	Marseilles	2' of water core 2B, below 6"
ILWW	262.1	UP4	LDB	238	mp	Marseilles	core 2A 0.4' top portion, 2' of water
ILWW	264.3	UP3	LDB	244	dn	Marseilles	core 1A0.4' top of tube, 1' of water
ILWW	262.1	UP4	LDB	242	dn	Marseilles	2' of water, core 2B below 0.4'
ILWW	262.1	UP4	LDB	259	dn	Marseilles	2' of water, core 2A 0.4 top
ILWW	262.1	UP5	RDB	251	mp	Marseilles	core 1C 6" below 1' of water
ILWW	262.1	UP4	LDB	261	dn	Marseilles	core 1A 0.2 of top portion of water
ILWW	262.1	UP4	LDB	274	mp	Marseilles	sample #3 bench
ILWW	262.1	UP4	LDB	245	up	Marseilles	core 1' of water
ILWW	262.1	UP4	LDB	254	up	Marseilles	core 2A top 0.4, 2' of water

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	262.1	UP4	LDB	279	mp	Marseilles	surface sample 3, crest
ILWW	262.1	UP4	LDB	266	mp	Marseilles	sample 2, bank
ILWW	262.1	UP4	LDB	246	up	Marseilles	core 2B below 0.4', 2' of water
ILWW	262.1	UP5	RDB	277	mp	Marseilles	sample #1, bench
ILWW	262.1	UP5	RDB	262	mp	Marseilles	sample #3, crest
ILWW	262.1	UP5	RDB	276	mp	Marseilles	sample #2, bank face
ILWW	154.6	UP5	RDB	249	mp	Marseilles	core 1A 0.3" top, 1' of water
ILWW	154.6	12	LDB	45	up	La Grange	15' off W.E. 1.8 below ground
ILWW	154.6	12	LDB	47	up	La Grange	15' off W.E. @ surface
ILWW	243.4	2	LDB	2	mp	Marseilles	sample 3 @ top
ILWW	243.4	2	LDB	15	mp	Marseilles	3½ below top bk
ILWW	243.2	2	LDB	20	mp	Marseilles	@ W.E.
ILWW	242.8	1	LDB	21	mp	Marseilles	water edge
ILWW	242.8	1	LDB	23	mp	Marseilles	bench
ILWW	242.8	1	LDB	28	mp	Marseilles	scarp
ILWW	243.8	1	LDB	24	mp	Marseilles	1A sample 2 @ W.E. 0.3' below surface
ILWW	236	reach 3	RDB	17	up	Starved Rock	3' deep.
ILWW	235.8	3	RDB	30	mp	Starved Rock	TR sample 1 midpoint bank material
ILWW	235.8	3	RDB	27	mp	Starved Rock	TR sample 2 5' below the top midpoint
ILWW	229	5	RDB	14	mp	Peoria	sample @ T.O.B. (sediment in piping hole)
ILWW	229	5	RDB	6	mp	Peoria	sample 1' depth
ILWW	229	5	RDB	19	mp	Peoria	sample 4' landward of W.E.
ILWW	229	5	RDB	13	mp	Peoria	sediment @ top
ILWW	228.1	4	LDB	29	up	Peoria	sample 8' landward of W.E.
ILWW	228.1	4	LDB	26	up	Peoria	sample T.O.B.
ILWW	228.1	4	LDB	22	up	Peoria	sample in 3' depth water
ILWW	228	4	LDB	25	mp	Peoria	sample (edge of grass) midpoint
ILWW	228	4	LDB	8	mp	Peoria	sample 2 (near the top) midpoint

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	210.0	6	RDB	10	dn	Peoria	sample failure face (subaqueous)
ILWW	210.0	6	RDB	1	mp	Peoria	sample 3, top bank
ILWW	210.0	6	RDB	11	mp	Peoria	sample 2, bench
ILWW	210.0	6	RDB	12	mp	Peoria	berm
ILWW	203.9	7	LDB	5	up	Peoria	sample on levee
ILWW	203.9	7	LDB	9	up	Peoria	sample 40' off W.E. in 2.5' water
ILWW	203.9	7	LDB	7	up	Peoria	sample dessicated material 20' on bank sample #3
ILWW	203.5	7	LDB	3	mp	Peoria	sample 2 berm/scarp area
ILWW	203.5	7	LDB	4	mp	Peoria	sample 1, bench
ILWW	184.8	8	LDB	70	mp	Peoria	sample 2, top of bank
ILWW	184.7	8	LDB	66	mp	Peoria	sample in 1 depth = 30' out of W.E.
ILWW	179.8	9	LDB	61	mp	Peoria	sample 2, top of bank
ILWW	179.8	9	LDB	68	mp	Peoria	sample 1, bench
ILWW	160.0	10	RDB	69	dn	Peoria	sample in 2 depth water
ILWW	160.0	10	RDB	58	mp	Peoria	sample 1, upper scarp
ILWW	160.0	10	RDB	57	mp	Peoria	sample 3, top of bank
ILWW	160.0	10	RDB	60	mp	Peoria	sample 2, low sharp scarp
ILWW	155.5	11	RDB	54	up	La Grange	upst sample 1N 1' depth
ILWW	155.3	11	RDB	64	mp	La Grange	2 ft. sub-aqua core 6.75 in
ILWW	155.3	11	RDB	44	mp	La Grange	sample 2, mid bench midpoint section
ILWW	155.3	11	RDB	55	mp	La Grange	2 ft. sub-aqa core - 6.75 in B hor = 3.0-6.0 in
ILWW	155.3	11	RDB	71	mp	La Grange	sample 3, berm
ILWW	155.3	11	RDB	43	mp	La Grange	sample 1, low bench
ILWW	155.3	11	RDB	42	mp	La Grange	sample 4, top bank
ILWW	154.6	12	LDB	48	up	La Grange	@ 1' depth, 20' off W.E.
ILWW	154.5	12	LDB	65	mp	La Grange	2 ft. sub-aqua sample core 15.0 in
ILWW	154.5	12	LDB	56	mp	La Grange	2 ft. sub-aqua sample core = 15.0 in A hor = 0-4.25 in
ILWW	154.4	12	LDB	46	mp	La Grange	sample 3, berm

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	154.4	12	LDB	33	mp	La Grange	sample bench 20' off shore
ILWW	154.4	12	LDB	53	mp	La Grange	sample 1, bench near shore
ILWW	154.4	12	LDB	50	mp	La Grange	sample 4, top bank
ILWW	150.6	13	LDB	59	mp	La Grange	2 ft. sub-aqua core core 15.5 in B hor = 3.0-6.0 in
ILWW	150.6	13	LDB	67	mp	La Grange	2 ft. sub-aqua sample core = 15.5 in A hor = 0-3.0 in
ILWW	150.5	13	LDB	36	mp	La Grange	sample 3, top bank
ILWW	150.5	13	LDB	41	mp	La Grange	sample 1, top of scarp
ILWW	150.5	13	LDB	49	mp	La Grange	sample 2, bench
ILWW	129.3	14	RDB	76	mp	La Grange	sample 1, bench
ILWW	129.3	14	RDB	51	mp	La Grange	sample 3, berm
ILWW	129.3	14	RDB	83	mp	La Grange	sample 4, top bank
ILWW	129.3	14	RDB	37	mp	La Grange	2 ft. sub aqua sample core = 8" B hor=3"-6"
ILWW	129.3	14	RDB	34	mp	La Grange	sample 2, bench
ILWW	129.3	14	RDB	35	mp	La Grange	2 ft. sub-aqua sample core = 8N A hor = 0"-3"
ILWW	129.2	14	RDB	40	dn	La Grange	sample @ 2 depth
ILWW	116.5	15	RDB	32	mp	La Grange	sample 2 (scarp)
ILWW	116.5	15	RDB	39	mp	La Grange	2 ft. sub-aqua sample core = 15.5 in C horizon = 2.5-9.75 in.
ILWW	116.5	15	RDB	74	mp	La Grange	2 ft. sub-aqua sample core = 15.5 in B horizon = 0.75-2.5 in.
ILWW	116.5	15	RDB	75	mp	La Grange	sample 1 (bench)
ILWW	116.5	15	RDB	31	mp	La Grange	sample 3 levee slope top of levee material
ILWW	116.5	15	RDB	82	mp	La Grange	2 ft. sub-aqua sample core = 15.5 in a hor. = 0.-0.75 in
ILWW	109.5	16	LDB	79	mp	La Grange	sample 1, bench
ILWW	109.5	17	RDB	80	mp	La Grange	sample 2, berm
ILWW	109.5	17	RDB	52	mp	La Grange	sample 3, top bank
ILWW	109.5	16	LDB	38	mp	La Grange	sample #2, berm

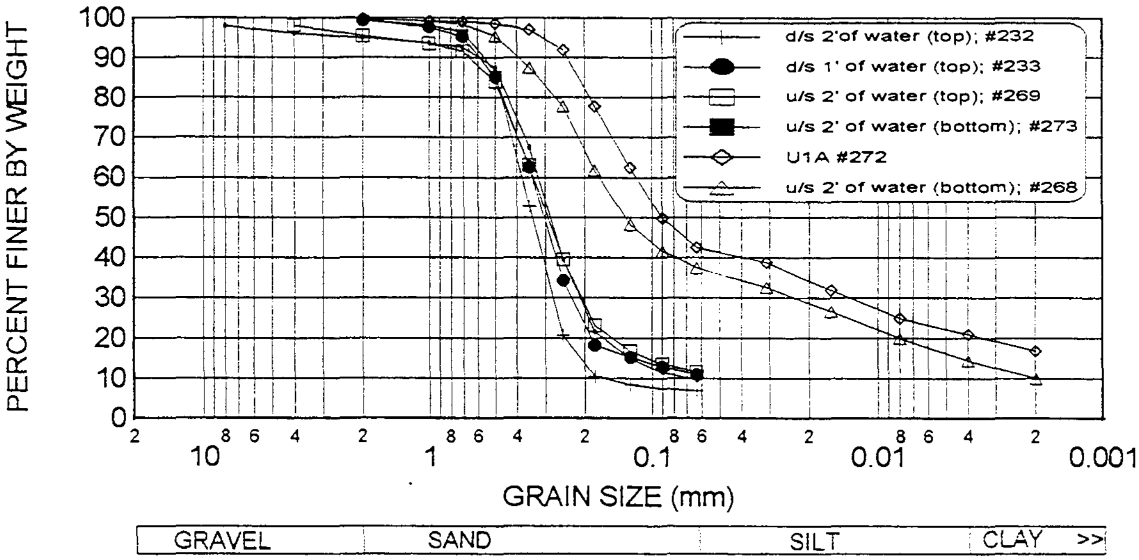
River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	109.5	16	LDB	81	mp	La Grange	2 ft. sub-aqua core = 11.5 A hor = 0-4.5 in
ILWW	109.5	16 or 17?	RDB	77	mp	La Grange	sample 1, bench
ILWW	109.5	16	LDB	73	mp	La Grange	sample 3, scarp
ILWW	109.5	16	LDB	85	mp	La Grange	2 ft. sub-aqua core B hor = 4.5-9.0
ILWW	109.2	16	LDB	72	dn	La Grange	sample @ 2' depth
ILWW	94.3	18	RDB	93	up	La Grange	D/S of Sugar Creek Stable bank surfacial
ILWW	94.2	18	RDB	86	mp	La Grange	2 ft. sub-aqua sample core = 1.5A hor = 0-3.5
ILWW	94.2	18	RDB	92	mp	La Grange	sample 2, berm
ILWW	94.2	18	RDB	91	mp	La Grange	sample 1, bench
ILWW	94.2	18	RDB	96	mp	La Grange	sample 3, bank top
ILWW	94.2	18	RDB	89	mp	La Grange	2 ft. sub-aqua sample core = 9.5 B hor = 3.5-6.0
ILWW	91.2	19	RDB	97	mp	La Grange	sample 1, bench top
ILWW	91.2	19	RDB	84	mp	La Grange	2 ft. sub-aqua sample core = 6' A hor = 0-4.0 in
ILWW	91.2	19	RDB	95	mp	La Grange	sample 2, scarp
ILWW	91.2	19	RDB	98	mp	La Grange	sample 3, top bank
ILWW	79.4	20	RDB	90	mp	La Grange	sample 3, top bank
ILWW	79.4	20	RDB	88	mp	La Grange	sample, bench
ILWW	79.4	20	RDB	94	mp	La Grange	sample 2, scarp
ILWW	61.7	21	RDB	100	mp	Alton	sample 3, top bank
ILWW	61.7	21	RDB	101	mp	Alton	sample 2, berm
ILWW	61.7	21	RDB	102	mp	Alton	sample 1, bench
ILWW	61.5	21	RDB	117	dn	Alton	2 ft. sub-aqua core 13.5 A hor = 0-3.5
ILWW	61.5	21	RDB	116	dn	Alton	2 ft. sub-aqua core = 13.5 B hor = 3.5-7.0
ILWW	61.4	21	RDB	99	dn	Alton	1' sed in river surfacial 6"
ILWW	45.1	22	RDB	119	mp	Alton	2 ft. sub-aqua sample core = 15.5 A hor = 0-4.5

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
ILWW	45.1	22	RDB	107	mp	Alton	sample 1, bench
ILWW	45.1	22	RDB	103	mp	Alton	sample 2, scarp
ILWW	45.1	22	RDB	104	up	Alton	sample @ 1' depth
ILWW	45.1	22	RDB	105	mp	Alton	top bank sample 3
ILWW	45.1	22	RDB	118	up	Alton	2 ft. sub-aqua sample core = 13.5 B hor = 4.5-9.0
ILWW	23.4	23	RDB	115	mp	Alton	2 ft. sub-aqua sample core = 10.0 A hor = 0-3.5
ILWW	23.4	23	RDB	106	mp	Alton	sample 2, bench
ILWW	23.4	23	RDB	108	mp	Alton	sample 3, top bank
ILWW	23.4	23	RDB	113	mp	Alton	sample 1, bench
ILWW	23.4	23	RDB	114	mp	Alton	2 ft. sub-aqua sample core = 10" B hor = 3.5-7.0
ILWW	23.4	23	RDB	110	mp	Alton	sediment sample at 2'
ILWW	179.0	9	LDB	63	dn?	Alton	sed sample bet 2' or 3' under water
ILWW	13.0	24	LDB	111	mp	Alton	2 ft. sub-aqua sample core 11 B hor = 5-10
ILWW	13.0	24	LDB	109	mp	Alton	sample 1, scarp
ILWW	13.0	24	LDB	112	mp	Alton	2 ft. sub-aqua sample 13.0 core 11" a hor = 0-5"
ILWW	184.8	8	LDB	62	mp	Alton	scarp face sample #1
ILWW	209.7	6	RDB	16	dn	Alton	sample 6 = 15' off W.E.
ILWW	242.0	1	LDB	18	up	Alton	sample 50' off the edge
ILWW	94.2	18	RDB	87	dn	Alton	Sugar Creek Stabel bank 6" below surface sample
ILWW	91.2	19	RDB	78	mp	Alton	2 ft. sub-aqua core 6.0B horizon 4-6

ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

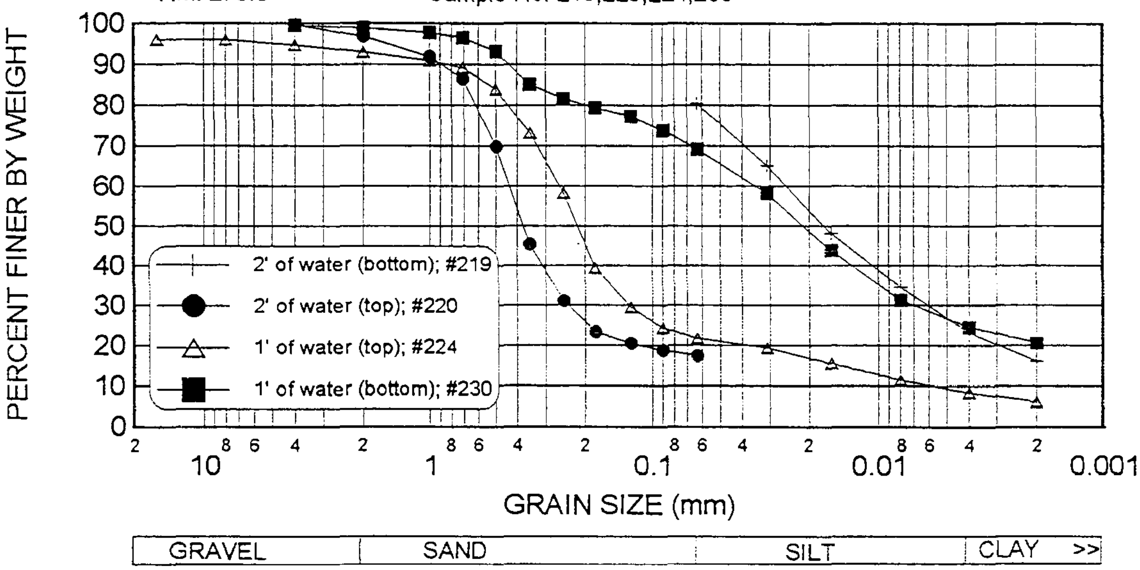
River: ILWW
Site No: UP1
RM: 270.3

Bank: RDB(up & dn)
Pool: Marseilles
Sample No: 232,233,268,269,273,272



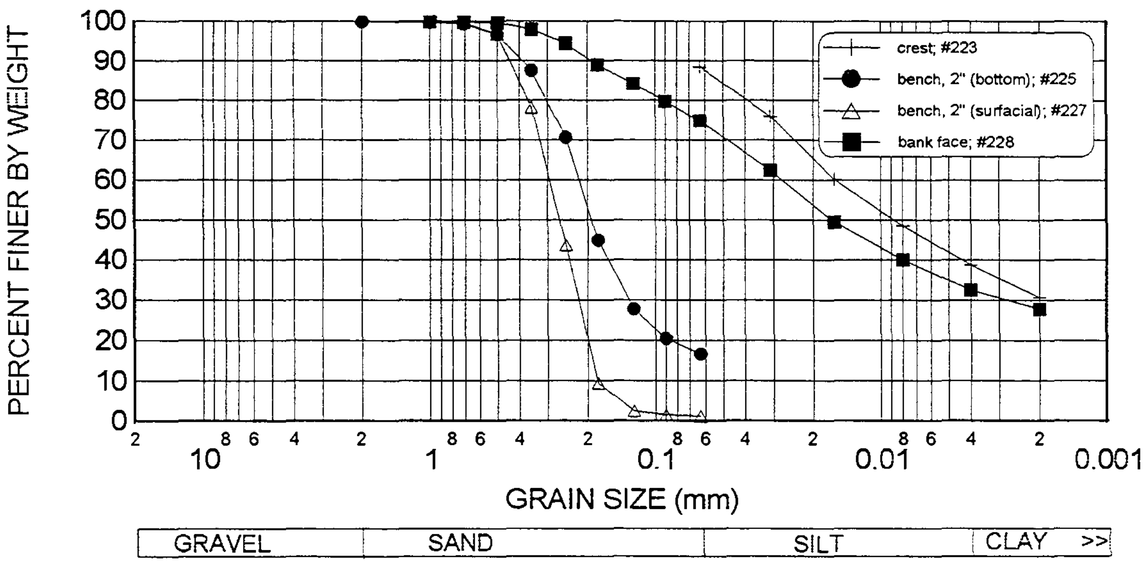
River: ILWW
Site No: UP1
RM: 270.3

Bank: RDB(mp)
Pool: Marseilles
Sample No: 219,220,224,230

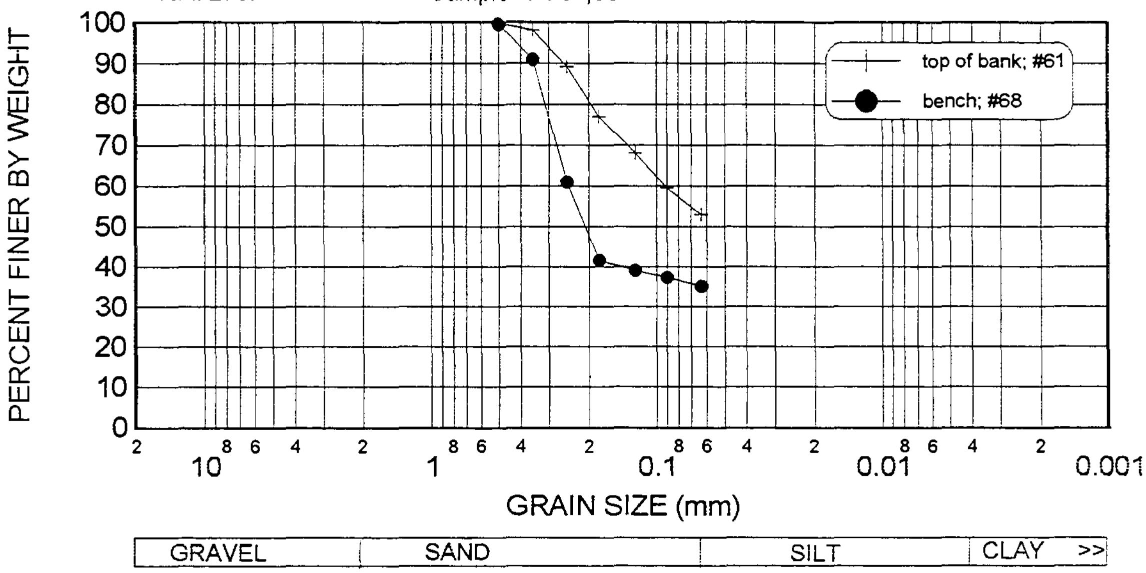


ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: ILWW
Site No: UP1
RM: 270.3
Bank: RDB(mp)
Pool: Marseilles
Sample No: 223,225,227,228



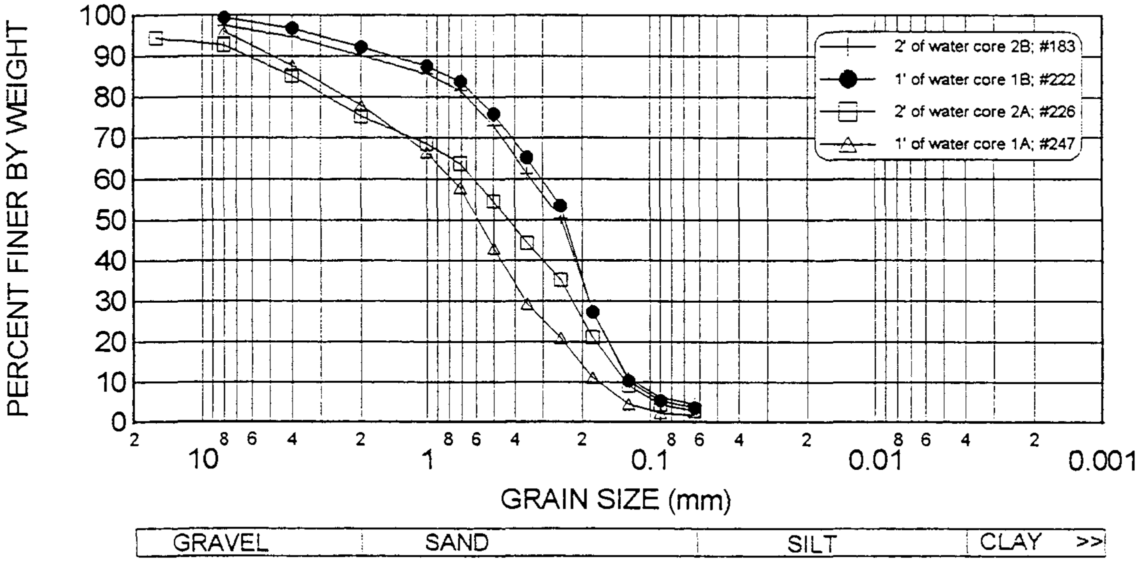
River: ILWW
Site No: 9
RM: 270.3
Bank: LDB(mp)
Pool: Peoria
Sample No: 61,68



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

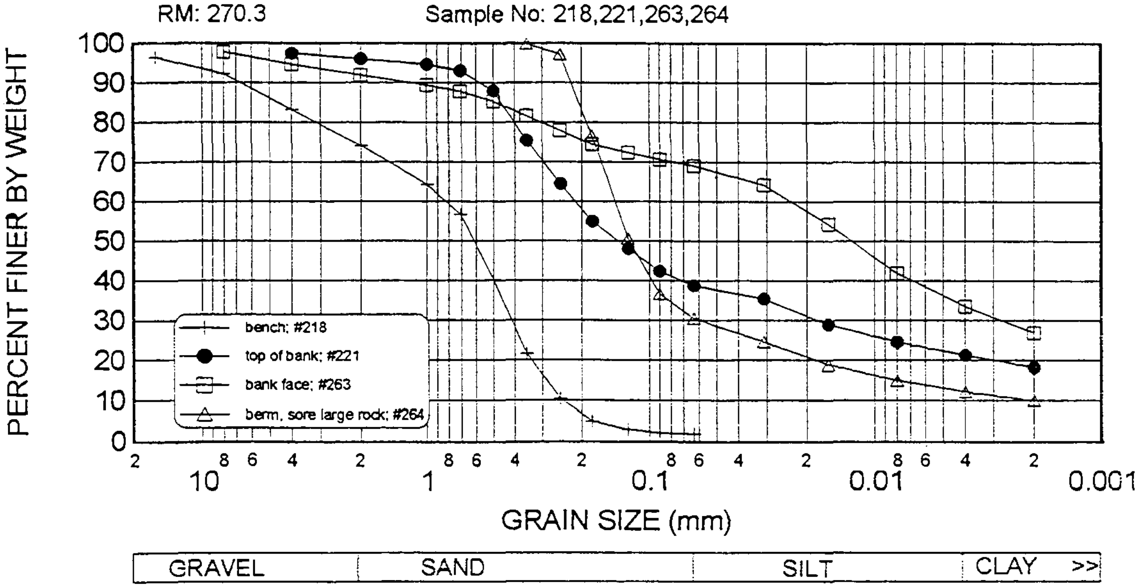
River: ILWW
Site No: UP2
RM: 270.3

Bank: LDB(core samples from up,mp & dn)
Pool: Marseilles
Sample No: 183,222,226,247

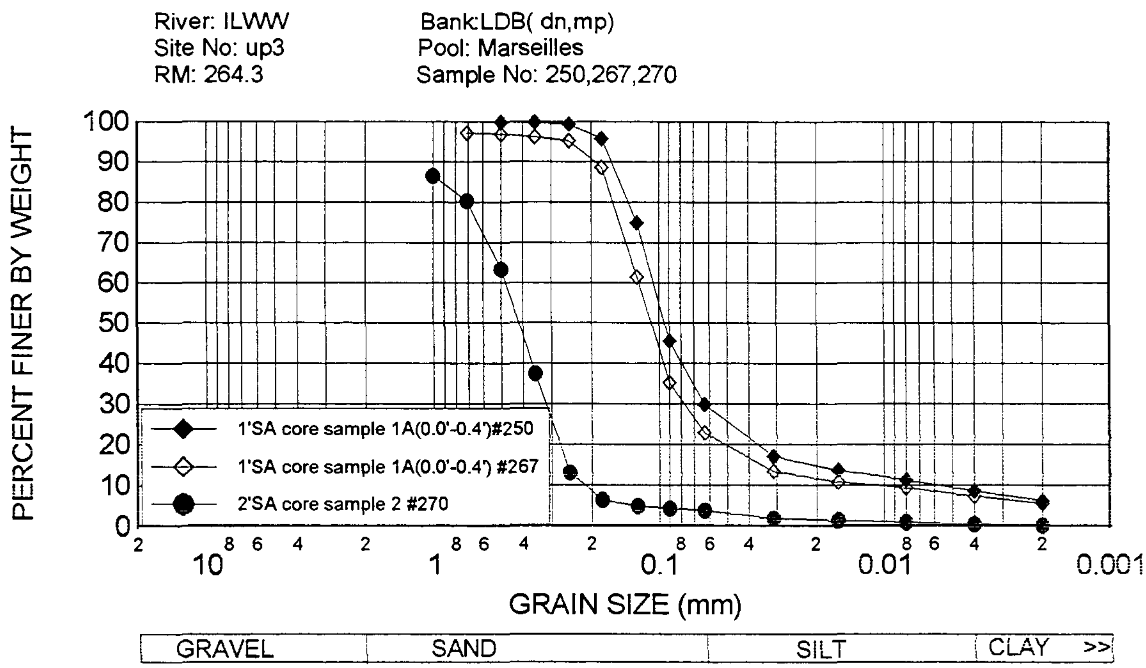


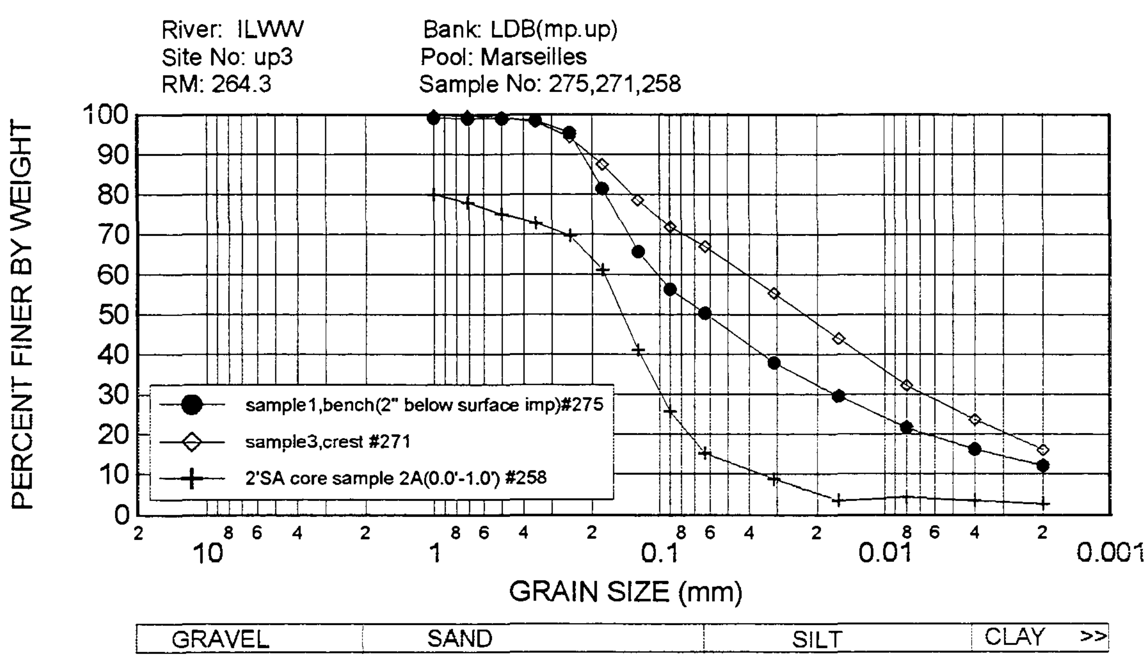
River: ILWW
Site No: UP2
RM: 270.3

Bank: LDB(mp)
Pool: Marseilles
Sample No: 218,221,263,264

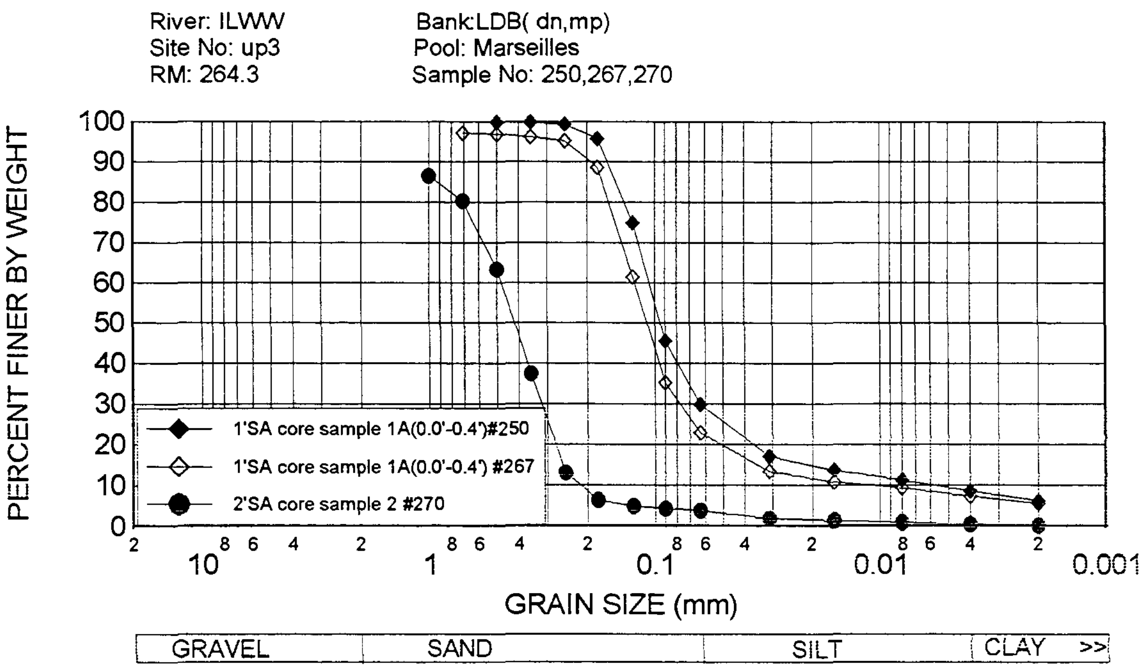


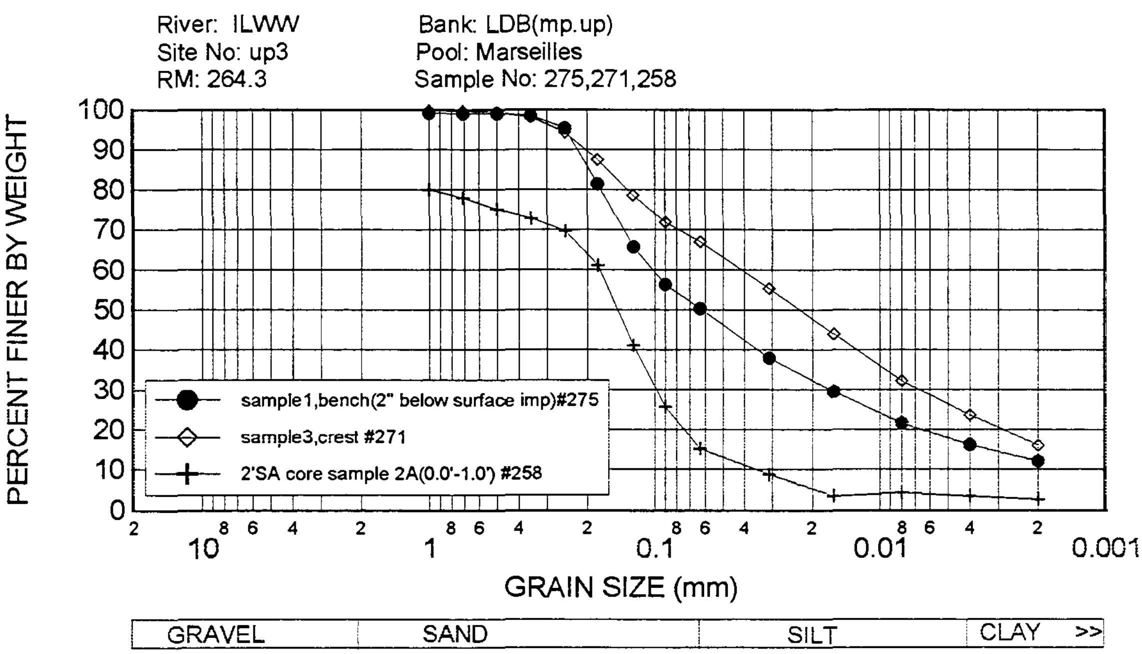
ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995





ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

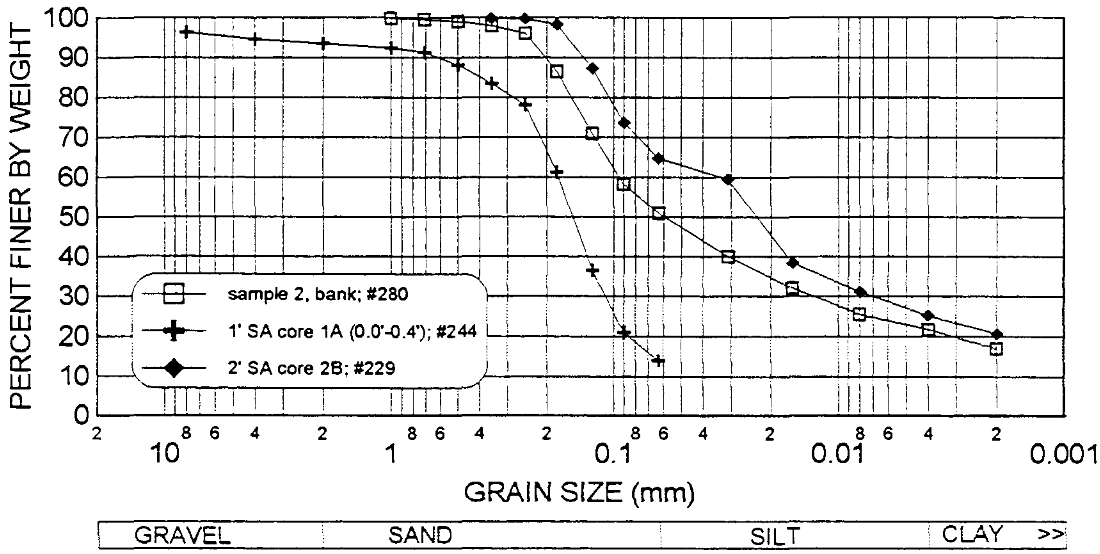




ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

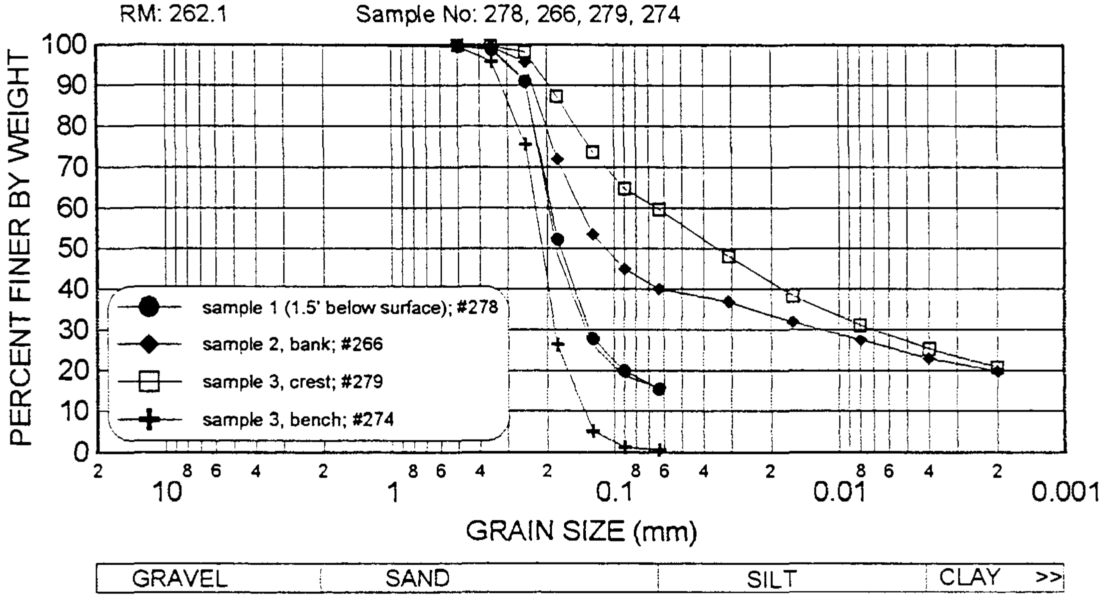
River: ILWW
Site No: UP3
RM: 264.3

Bank: LDB (core and surface samples from up, mp, and dn)
Pool: Marseilles
Sample No: 280, 244, 229



River: ILWW
Site No: UP4
RM: 262.1

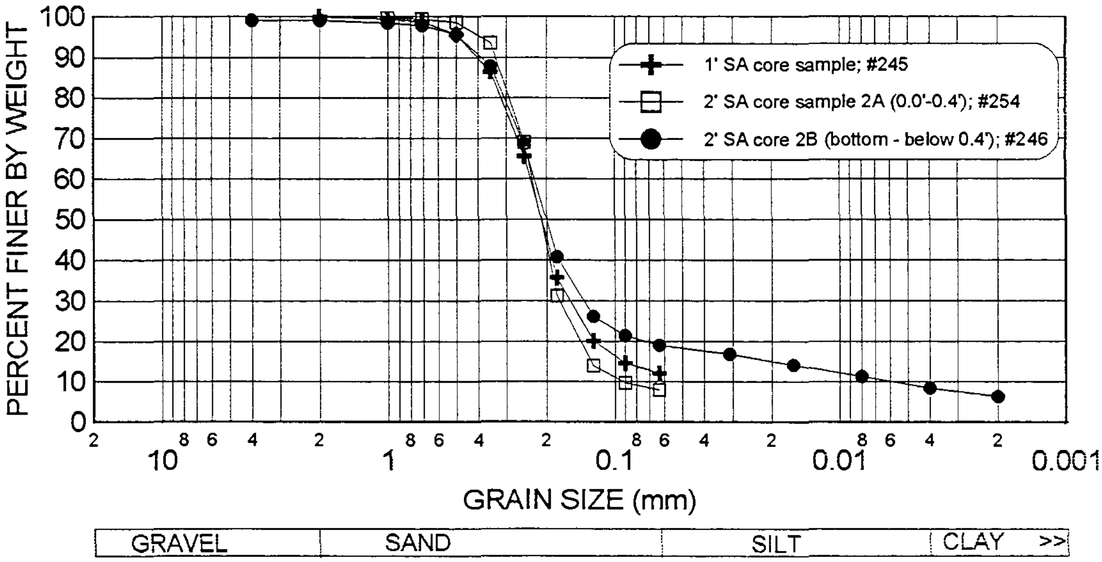
Bank: LDB (mp)
Pool: Marseilles
Sample No: 278, 266, 279, 274



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

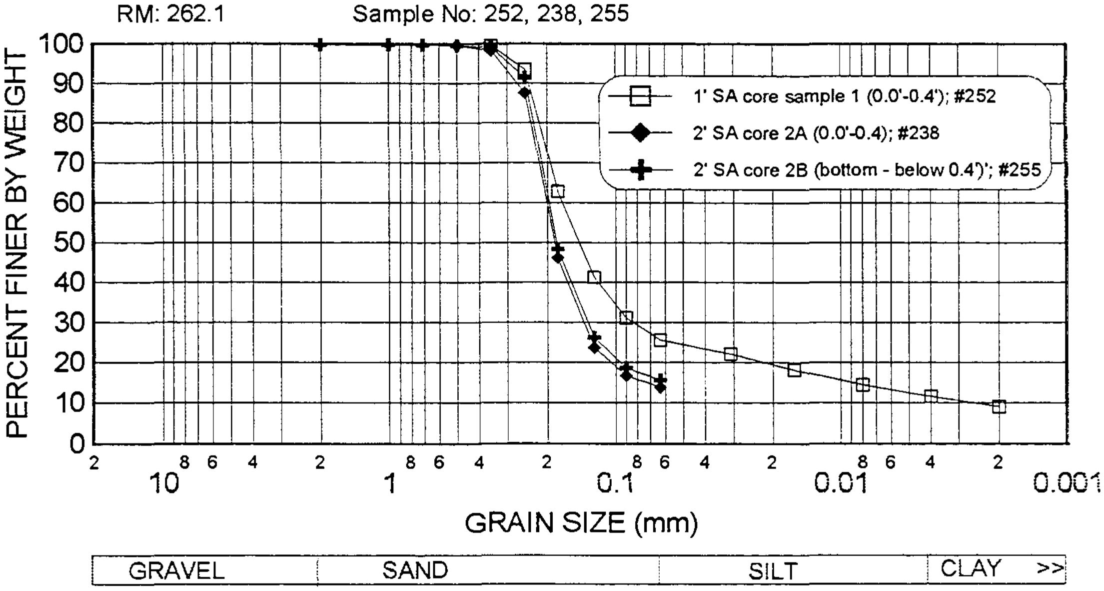
River: ILWW
Site No: UP4
RM: 262.1

Bank: LDB (core samples from up)
Pool: Marseilles
Sample No: 245, 254, 246



River: ILWW
Site No: UP4
RM: 262.1

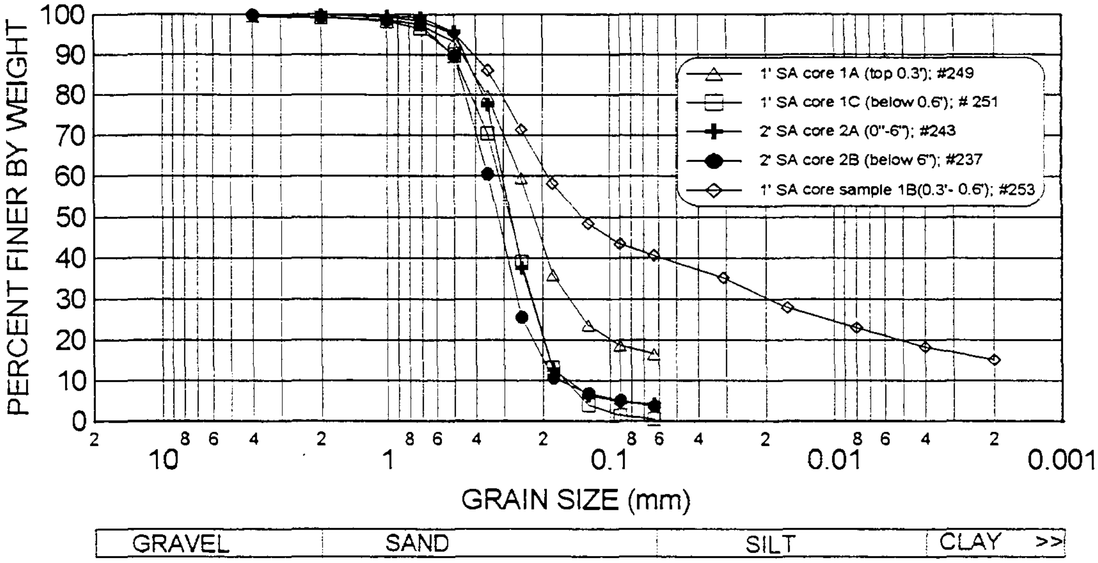
Bank: LDB (core samples from mp)
Pool: Marseilles
Sample No: 252, 238, 255



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

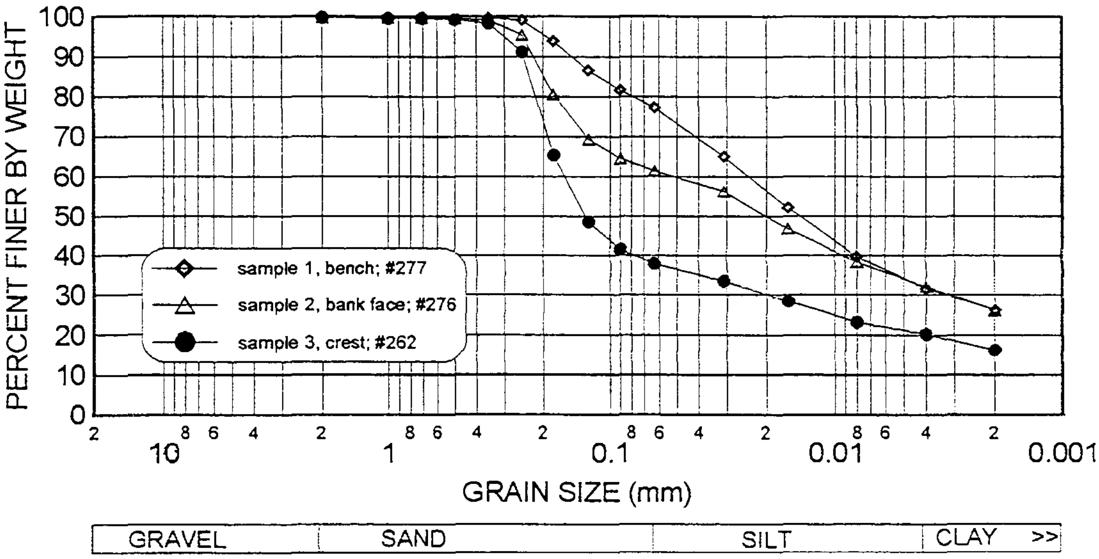
River: ILWW
Site No: UP5
RM: 262.1

Bank: RDB (core samples from mp)
Pool: Marseilles
Sample No: 249, 253, 251, 243, 237



River: ILWW
Site No: UP5
RM: 262.1

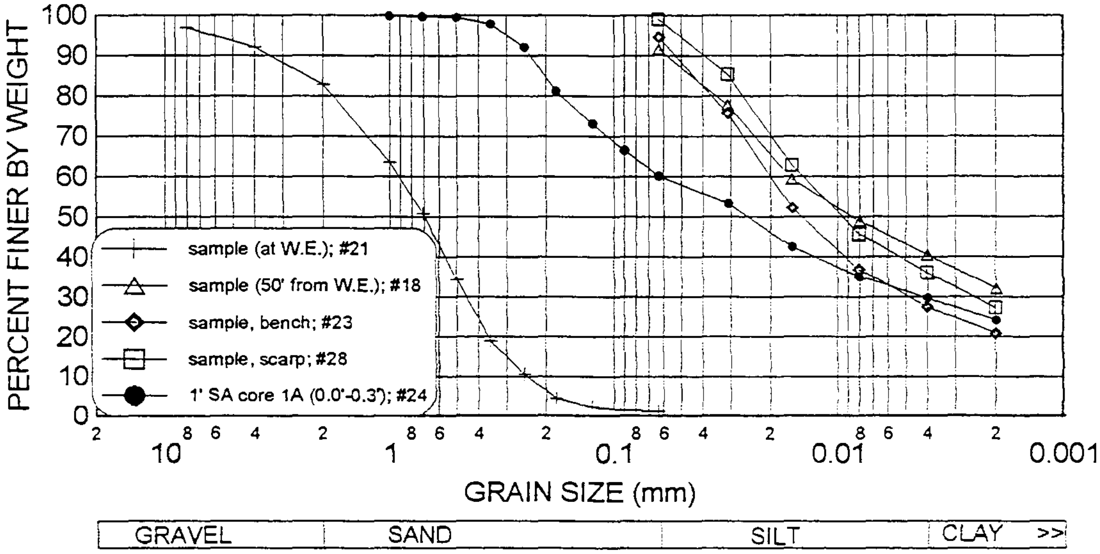
Bank: RDB (mp)
Pool: Marseilles
Sample No: 277, 276, 262



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

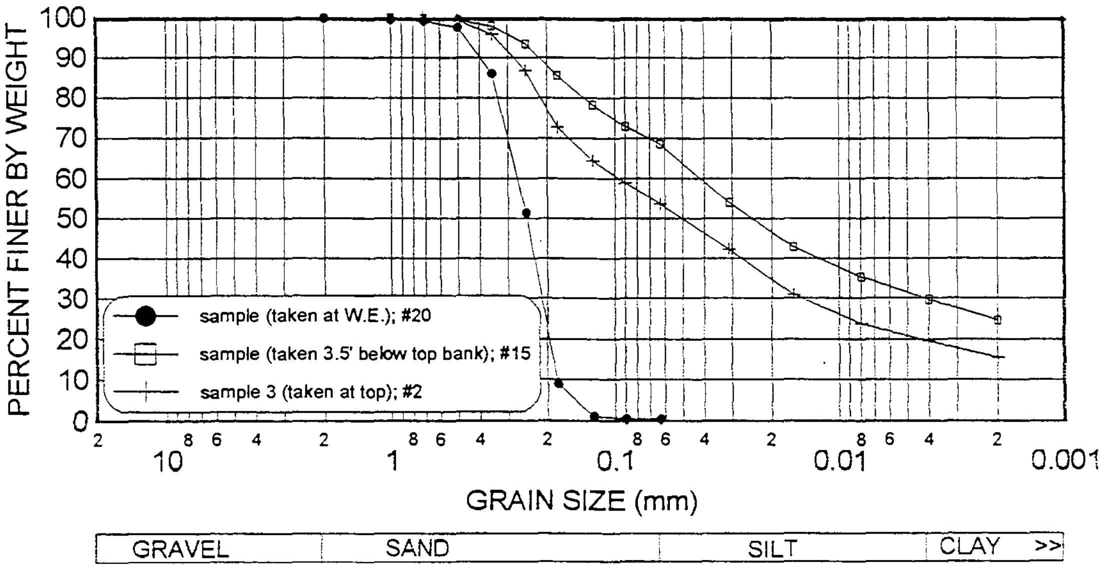
River: ILWW
Site No: 1
RM: 242.8

Bank: LDB(surface and core samples from mp and up)
Pool: Marseilles and Alton
Sample No: 21, 18, 23, 28, 24

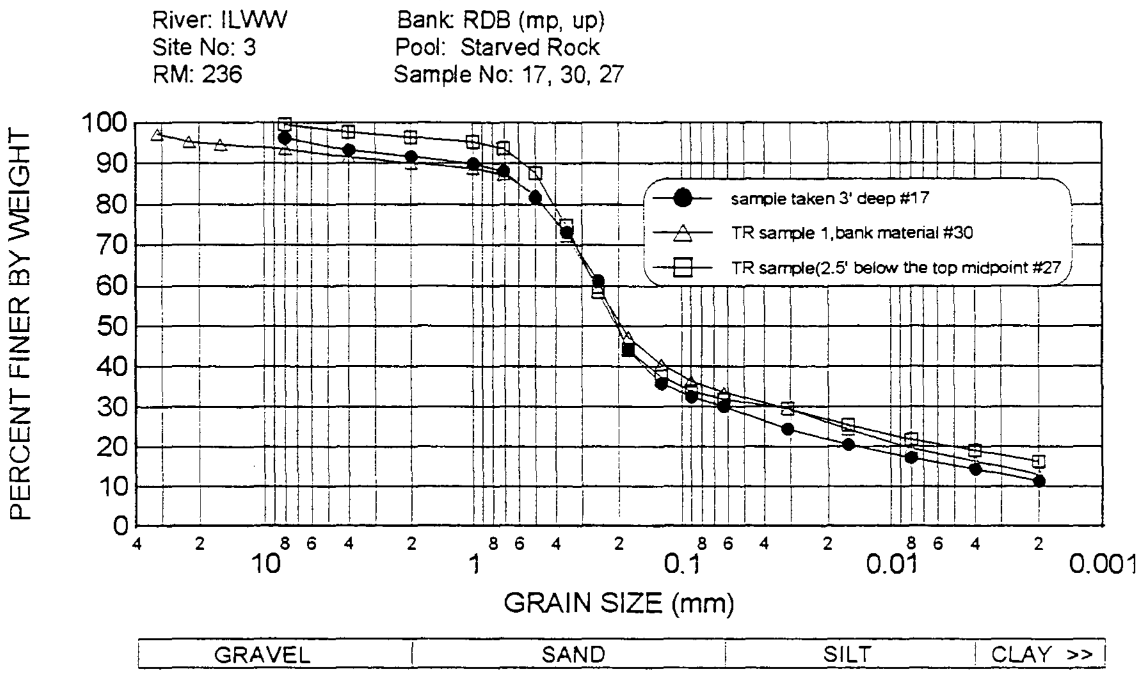


River: ILWW
Site No: 2
RM: 243.4

Bank: LDB (mp)
Pool: Marseilles
Sample No: 20, 15, 2



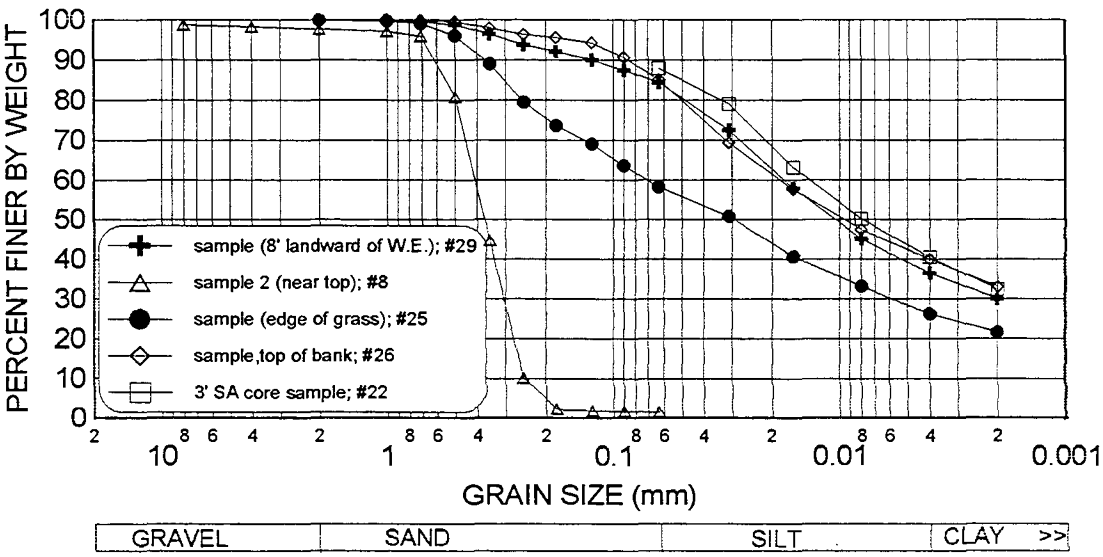
ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

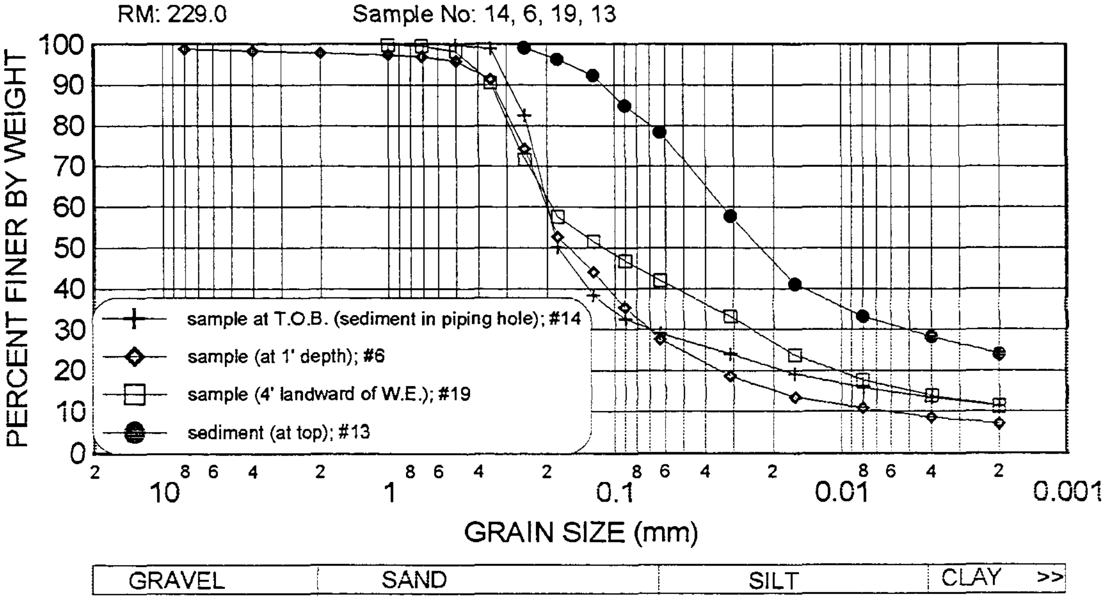
River: ILWW
Site No: 4
RM: 228.1

Bank: LDB (core and surface samples from up & mp)
Pool: Peoria
Sample No: 29, 8, 25, 26, 22



River: ILWW
Site No:5
RM: 229.0

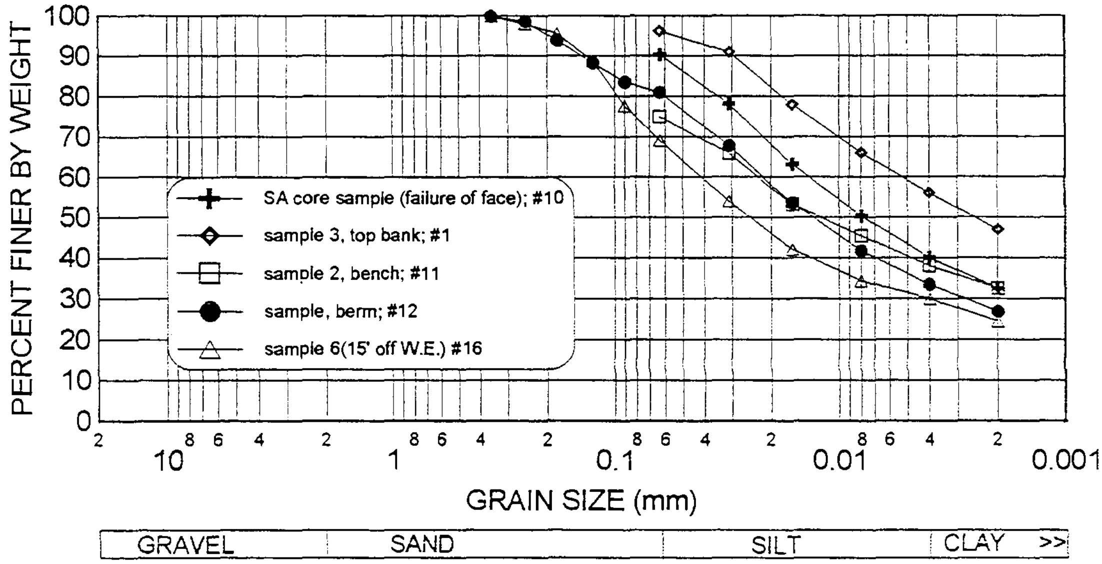
Bank: RDB (mp)
Pool: Peoria
Sample No: 14, 6, 19, 13



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

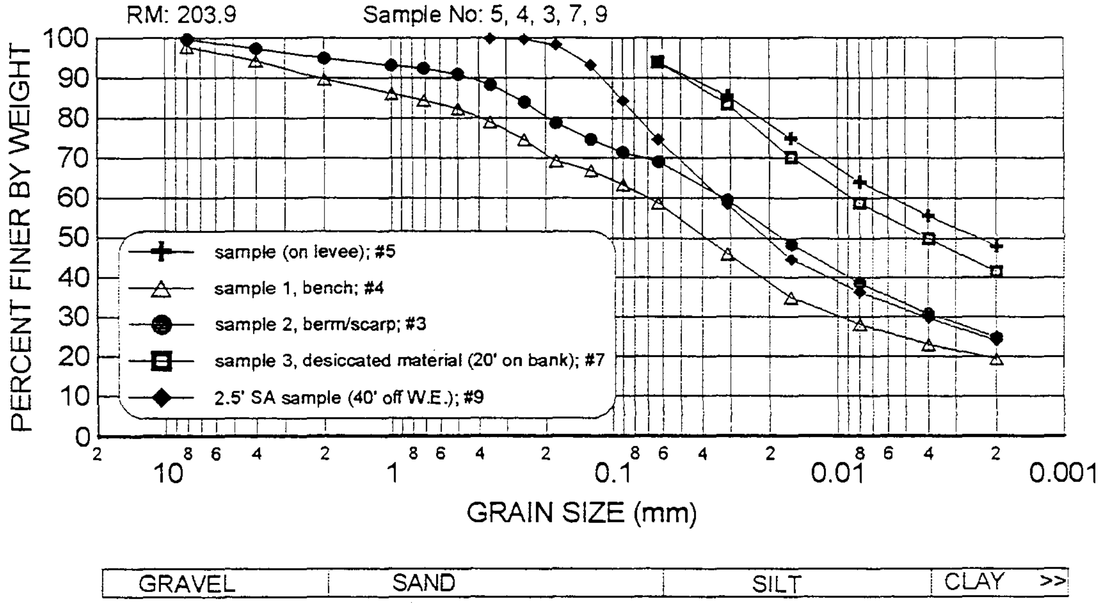
River: ILWW
Site No: 6
RM: 210.0

Bank: RDB (core and surface samples from mp and dn)
Pool: Peoria and Alton
Sample No: 10, 1, 11, 12, 16



River: ILWW
Site No: 7
RM: 203.9

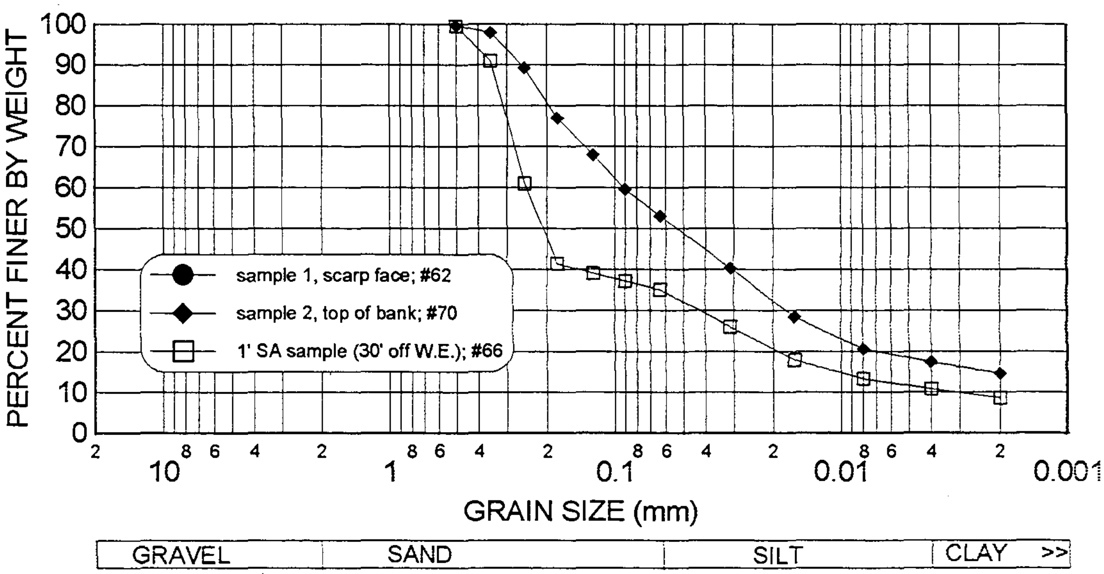
Bank: LDB (core and surface samples from up and mp))
Pool: Peoria
Sample No: 5, 4, 3, 7, 9



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

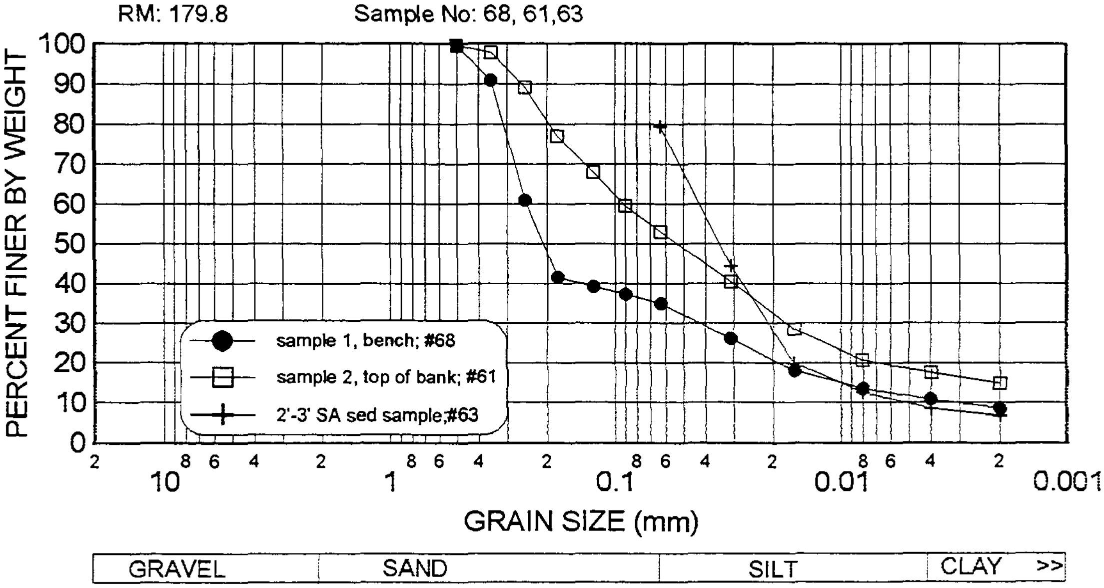
River: ILWW
Site No: 8
RM: 184.7

Bank: LDB(core and surface samples from mp and dn)
Pool: Peoria and Alton
Sample No: 62, 70, 66



River: ILWW
Site No: 9
RM: 179.8

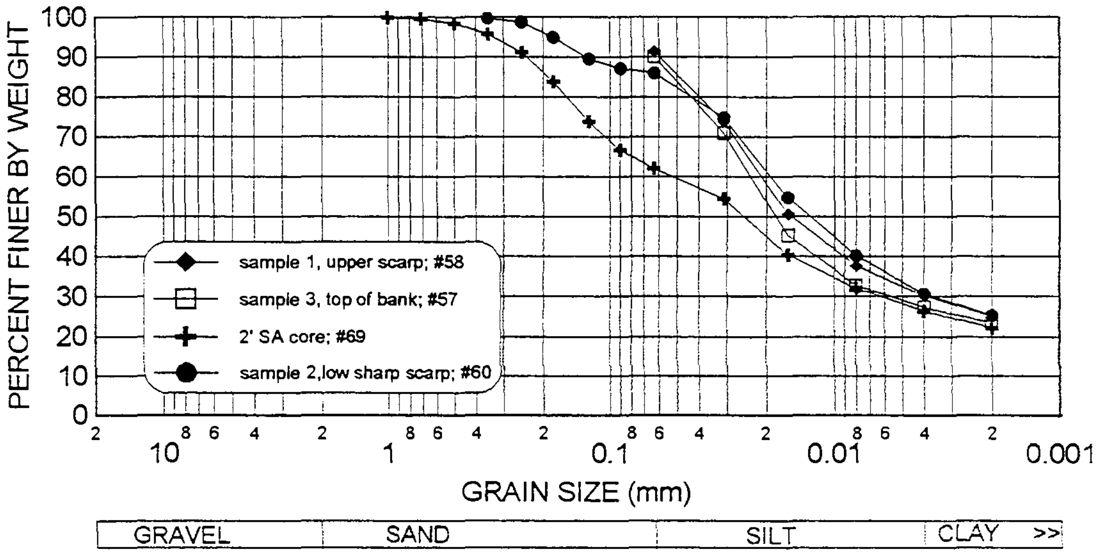
Bank: LDB (mp)
Pool: Peoria
Sample No: 68, 61,63



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: ILWW
Site No: 10
RM: 160

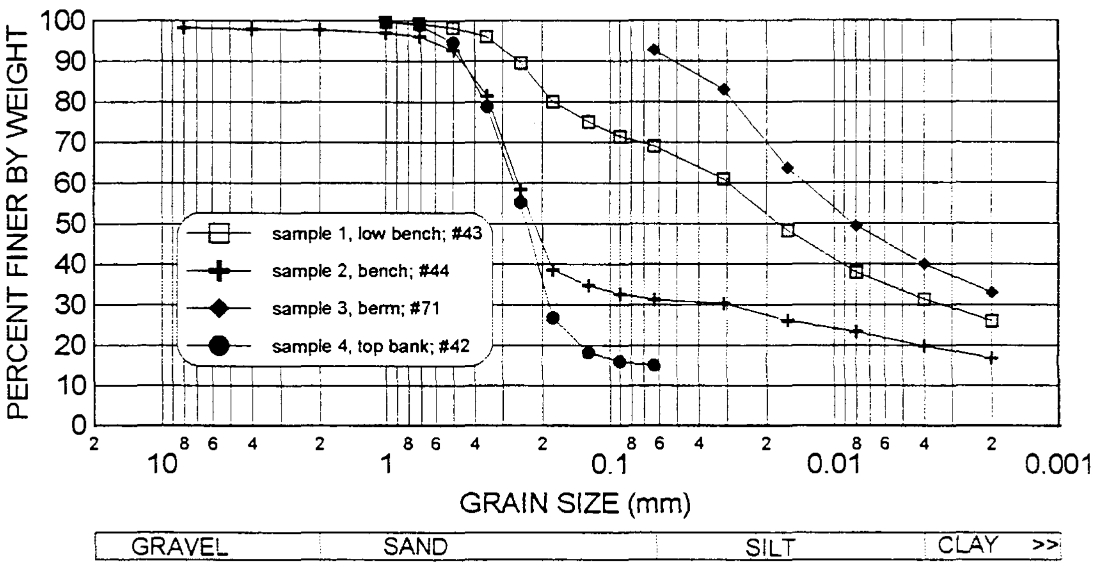
Bank: RDB (core and surface samples from mp and dn)
Pool: Peoria
Sample No: 58, 60, 57, 69



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

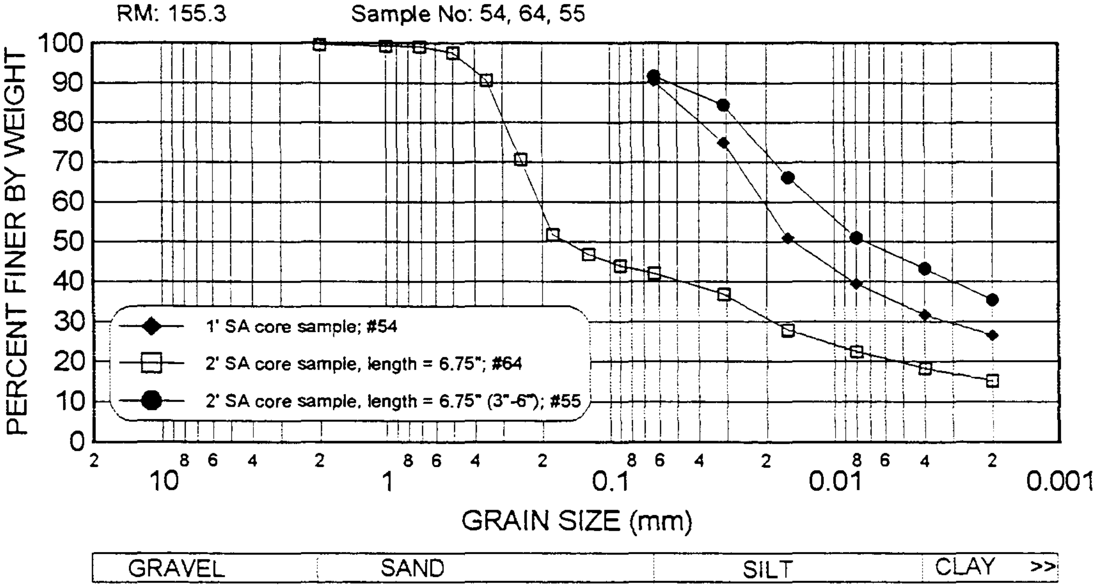
River: ILWW
Site No: 11
RM: 155.3

Bank: RDB (mp)
Pool: La Grange
Sample No: 43, 44, 71, 42



River: ILWW
Site No: 11
RM: 155.3

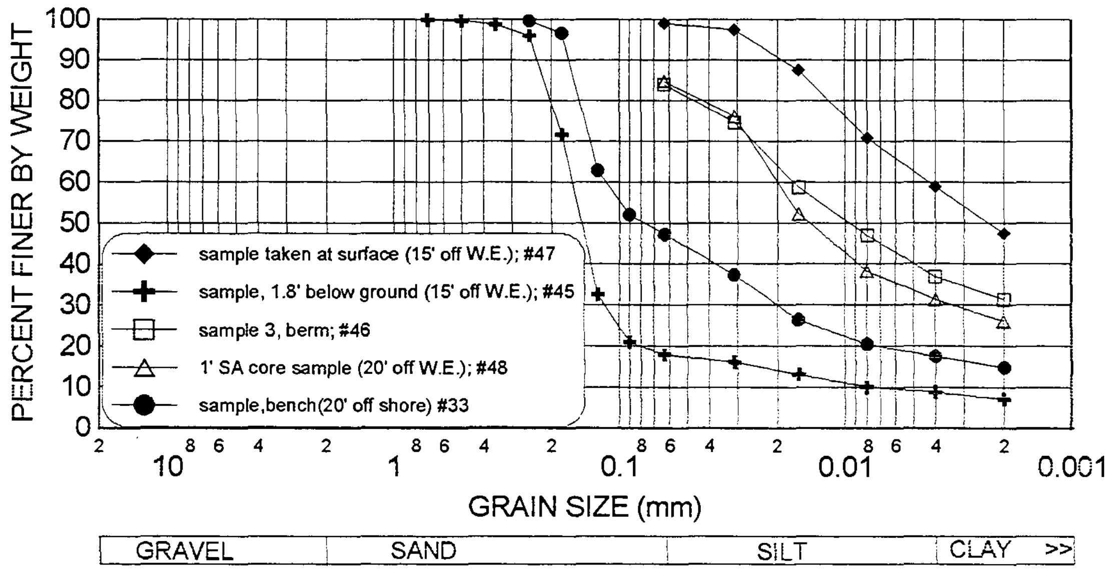
Bank: RDB (core samples from up and mp)
Pool: La Grange
Sample No: 54, 64, 55



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

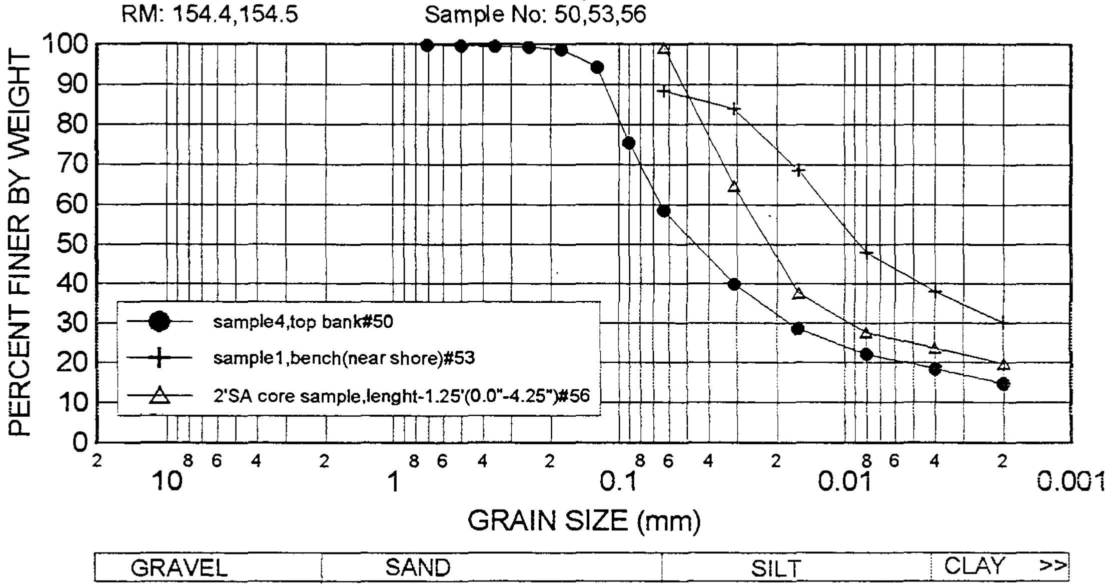
River: ILWW
Site No: 12
RM: 154.5

Bank: LDB (up, mp)
Pool: La Grange
Sample No: 47, 45, 33, 46, 48



River: ILWW
Site No: 12
RM: 154.4,154.5

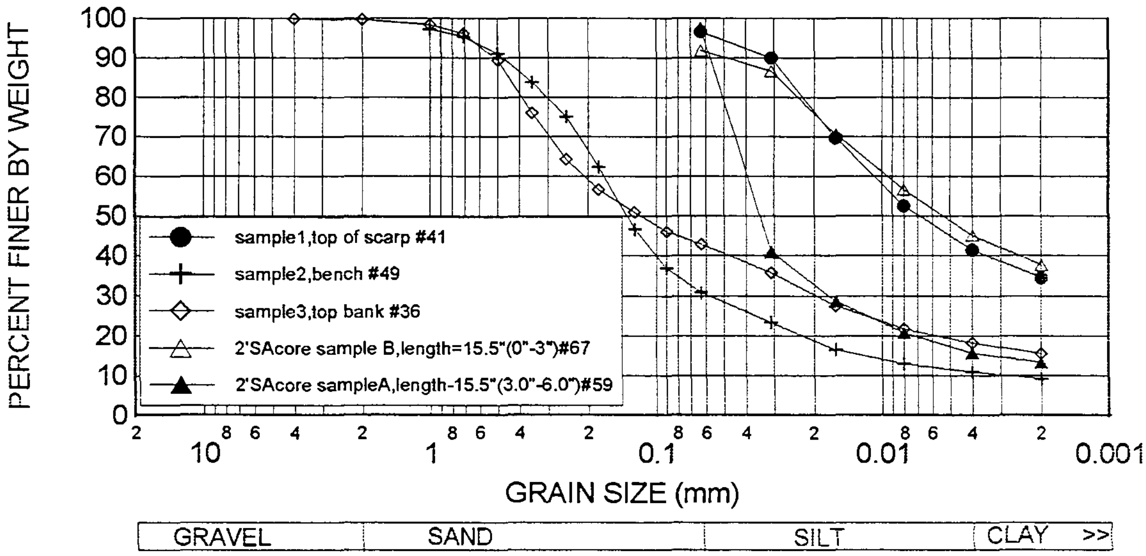
Bank: LDB (mp)
Pool: La Grange
Sample No: 50,53,56



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: ILWW
Site No: 13
RM: 150.6

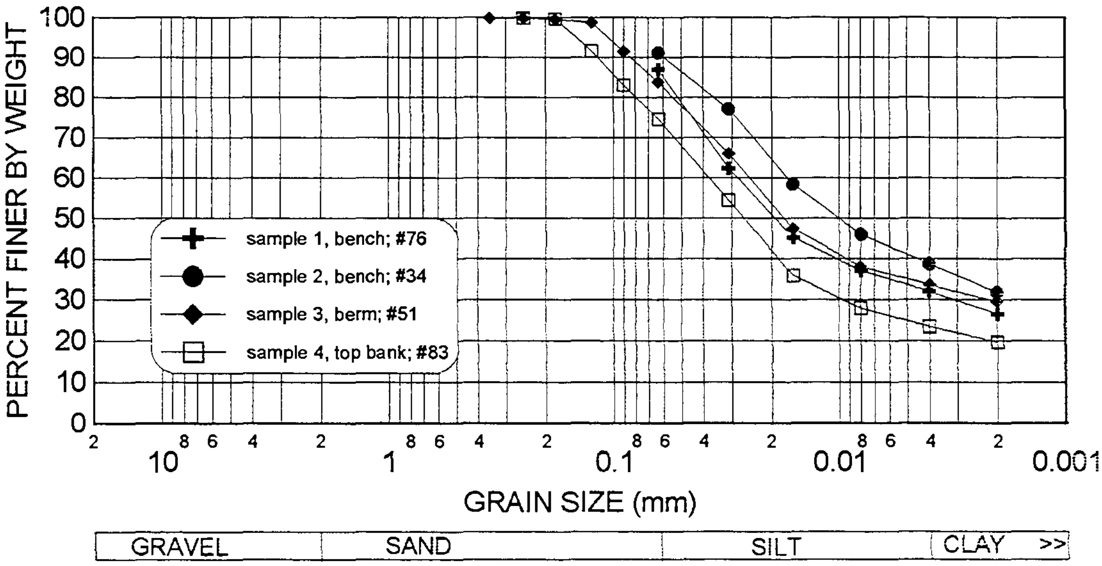
Bank:LDB(surface and core samples from mp)
Pool: La Grange
Sample No: 41,49,36,67,59



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

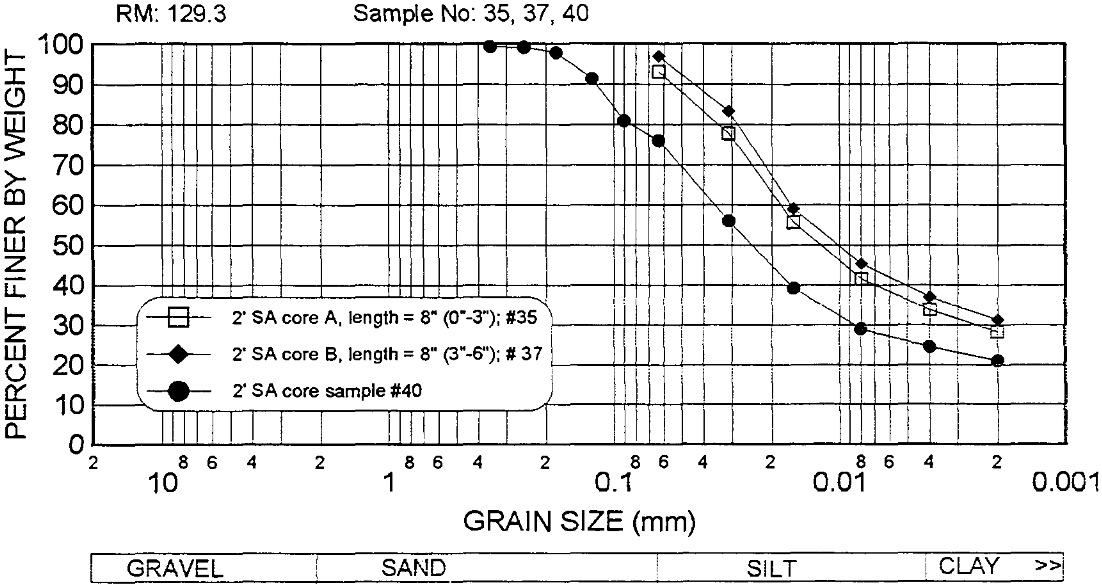
River: ILWW
Site No: 14
RM: 129.3

Bank: RDB (mp)
Pool: La Grange
Sample No: 76, 34, 51, 83



River: ILWW
Site No: 14
RM: 129.3

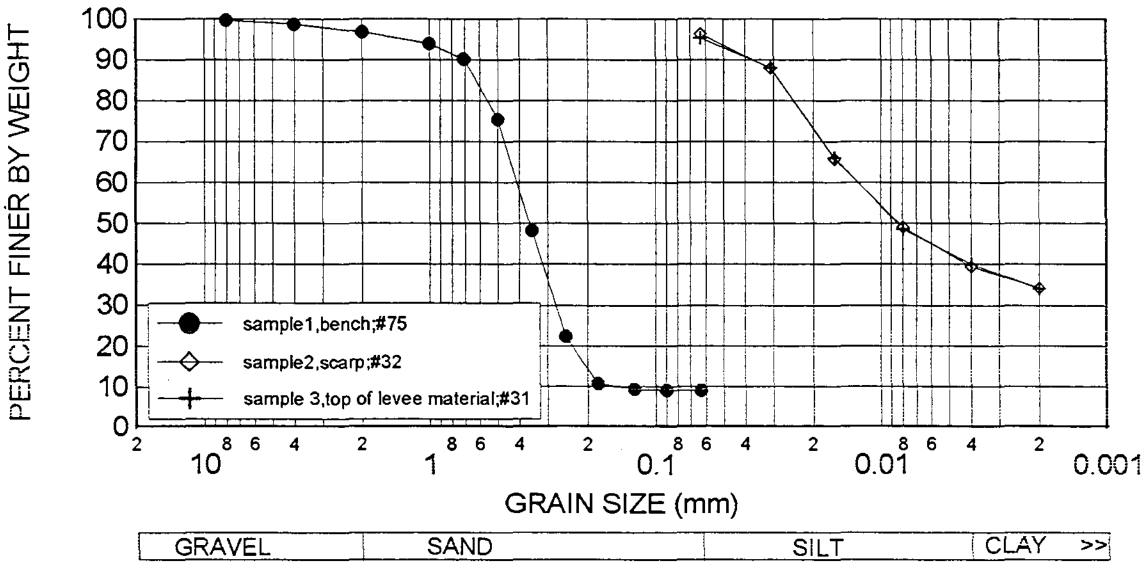
Bank: RDB (core samples from mp and dn)
Pool: La Grange
Sample No: 35, 37, 40



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

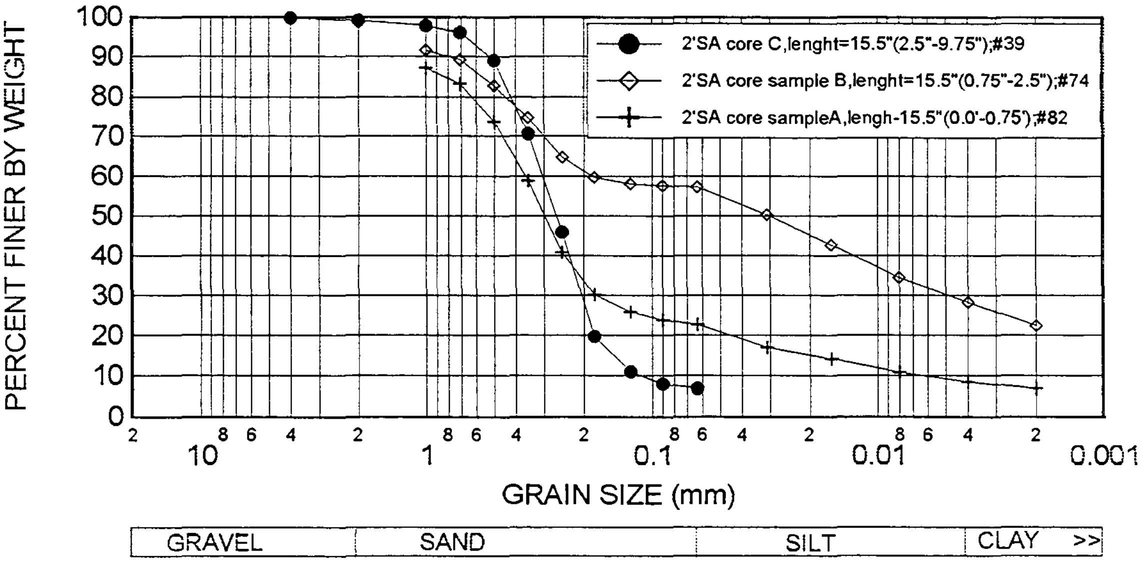
River: ILWW
Site No: 15
RM: 116.5

Bank:RDB(surface samples from mp)
Pool: La Grange
Sample No: 75,32,31

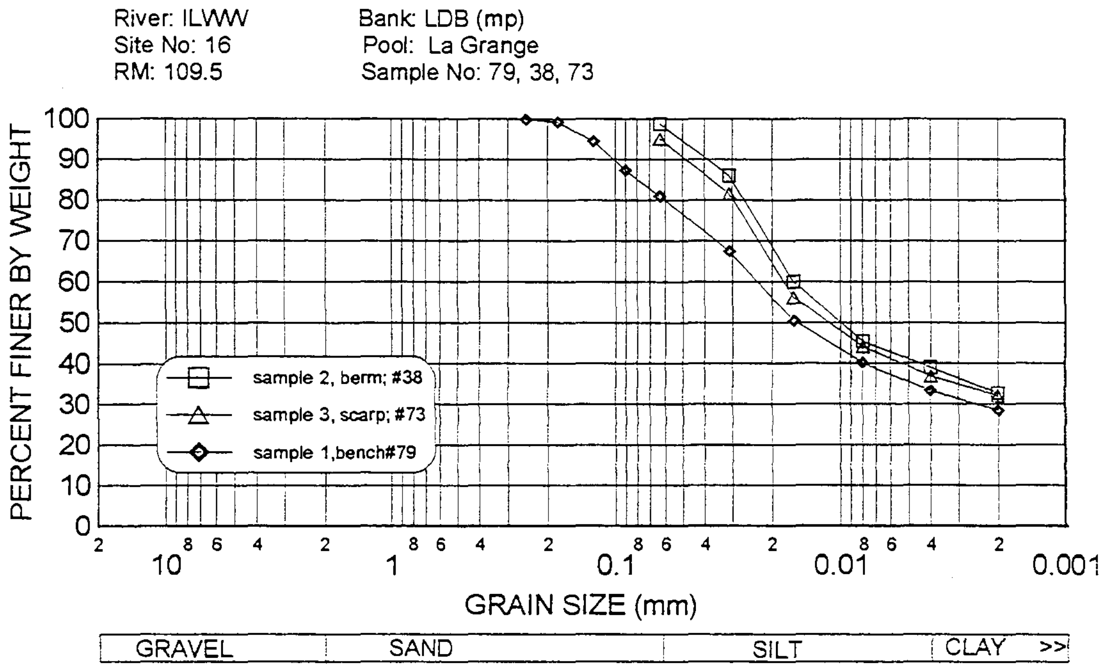


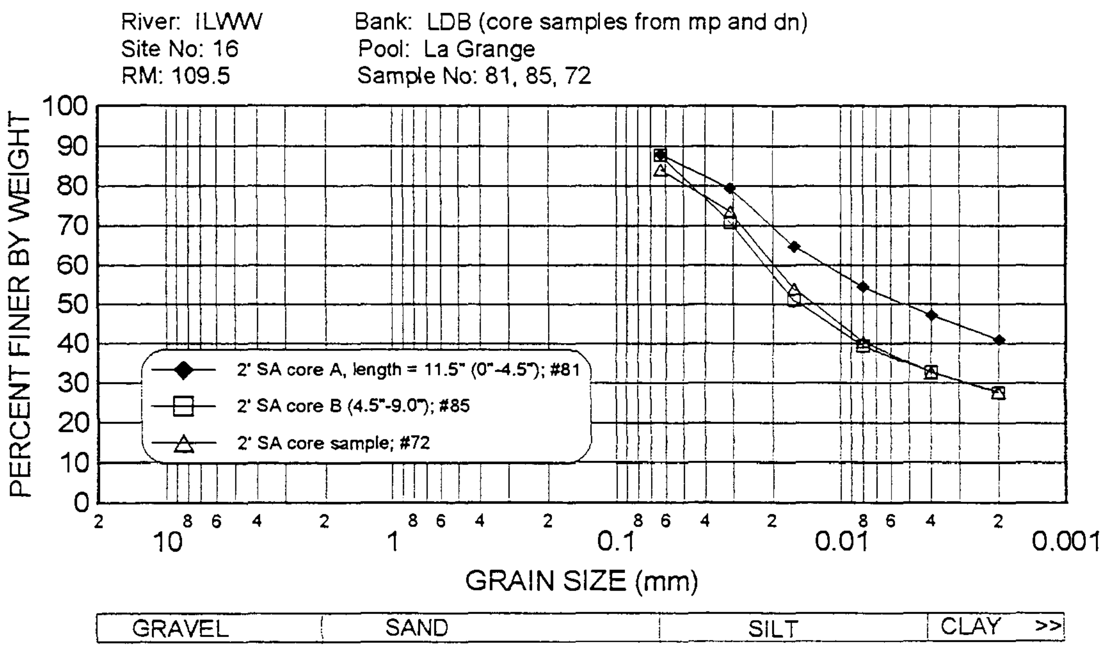
River: ILWW
Site No: 15
RM: 116.5

Bank: RDB(core samples from mp,up)
Pool: La Grange
Sample No: 39,74,82



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

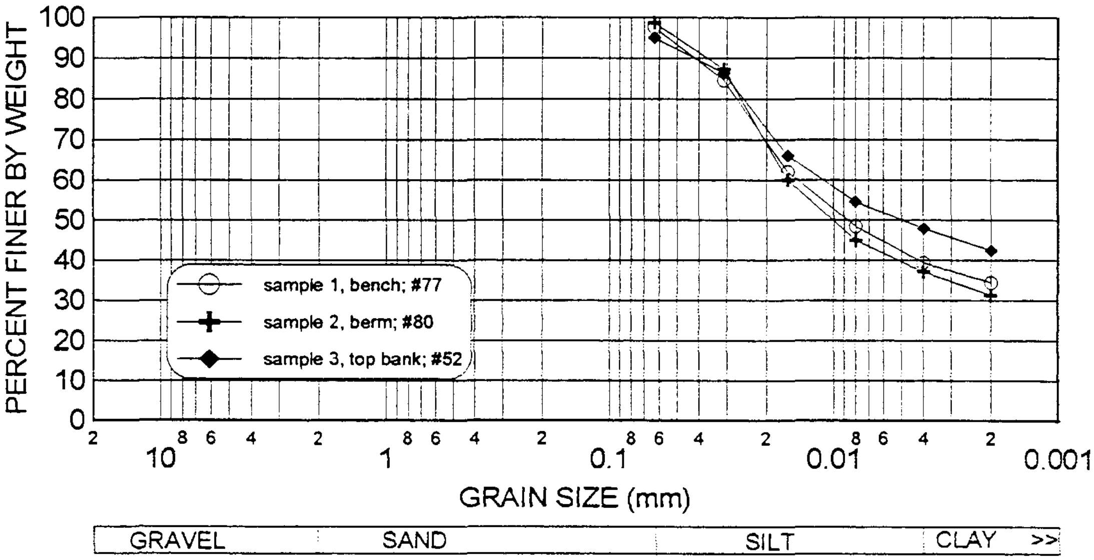




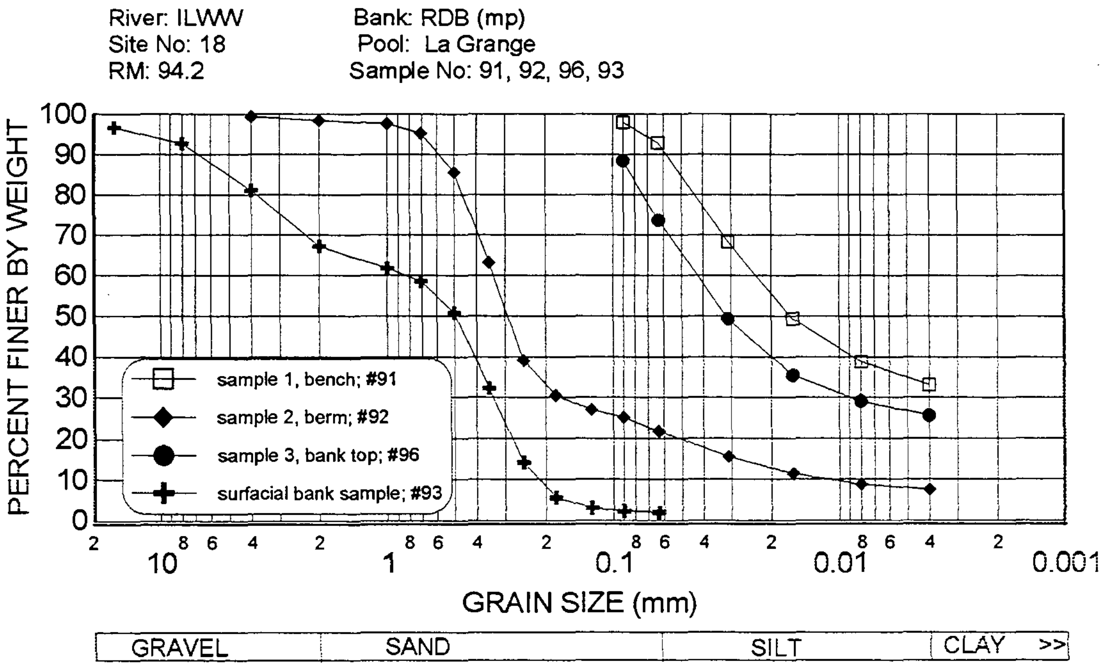
ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

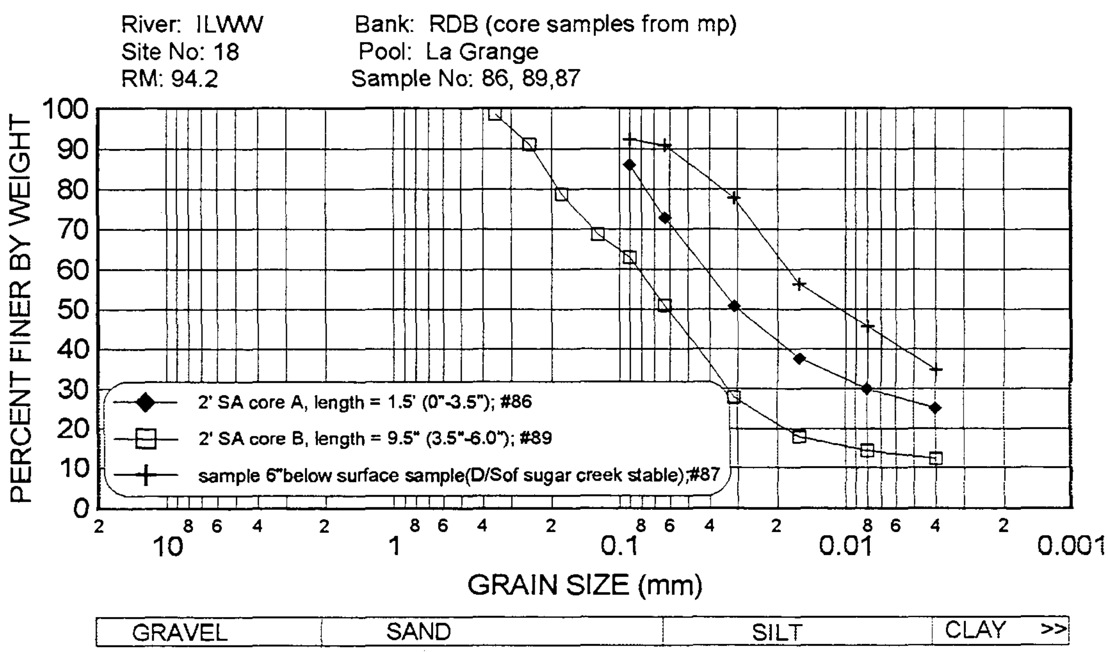
River: ILWW
Site No: 17
RM: 109.5

Bank: RDB (mp)
Pool: La Grange
Sample No: 77, 80, 52



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

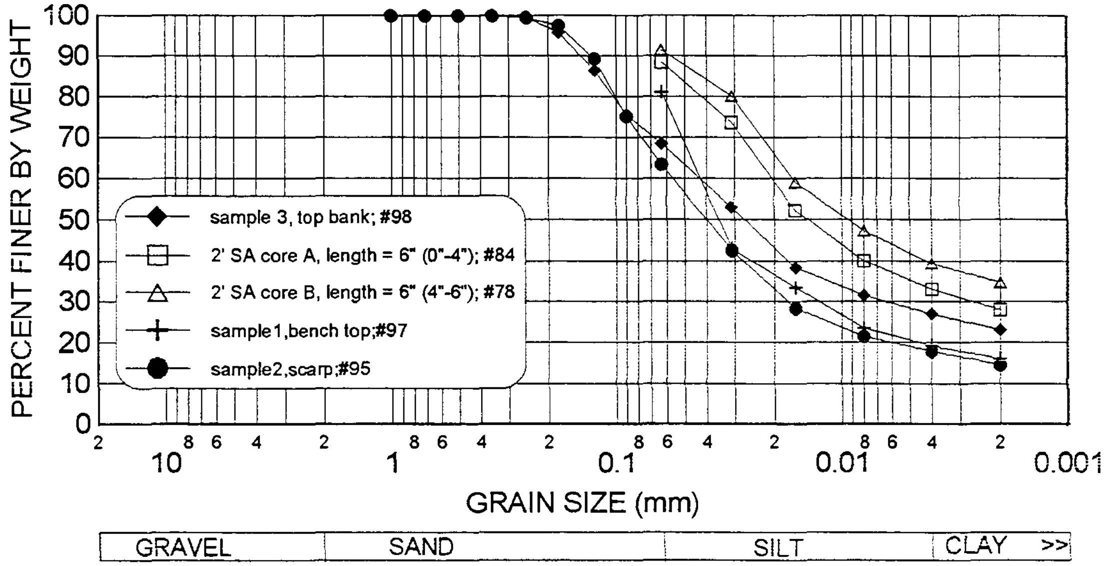




ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

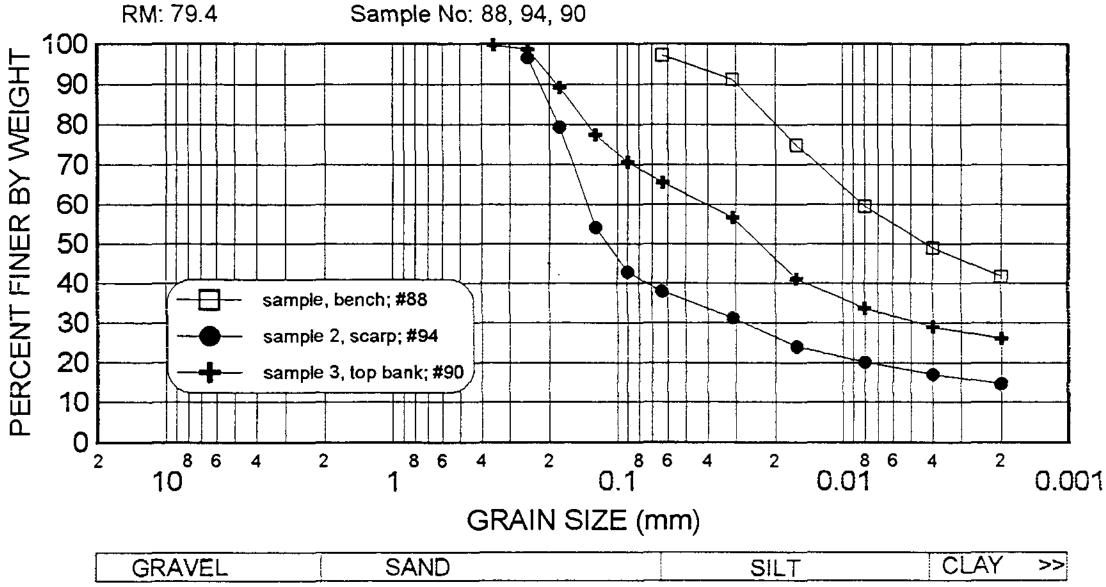
River: ILWW
Site No: 19
RM: 91.2

Bank: RDB (core and surface samples from mp)
Pool: La Grange
Sample No: 98, 84, 78,97,95



River: ILWW
Site No: 20
RM: 79.4

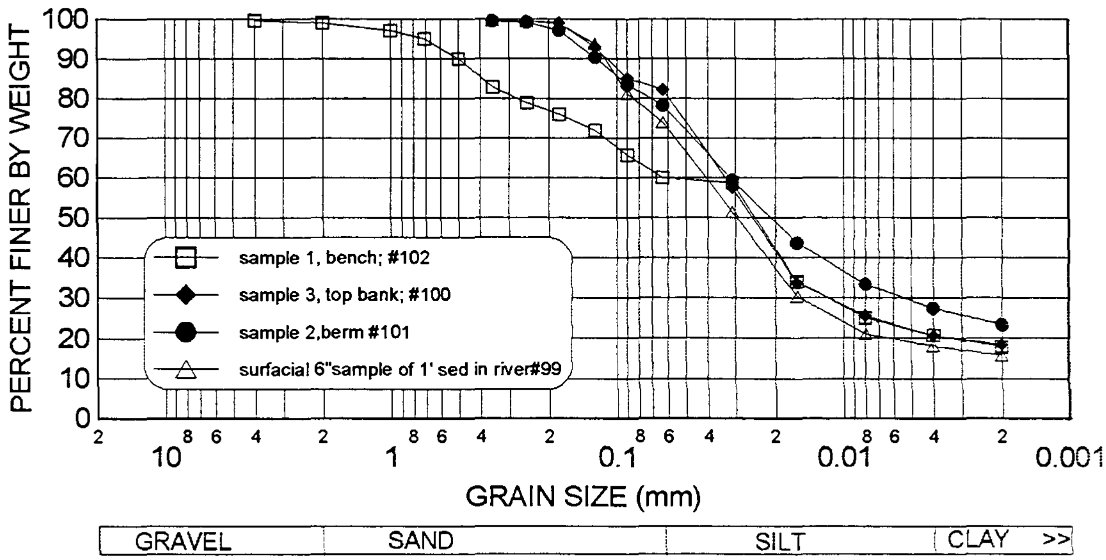
Bank: RDB (mp)
Pool: La Grange
Sample No: 88, 94, 90



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

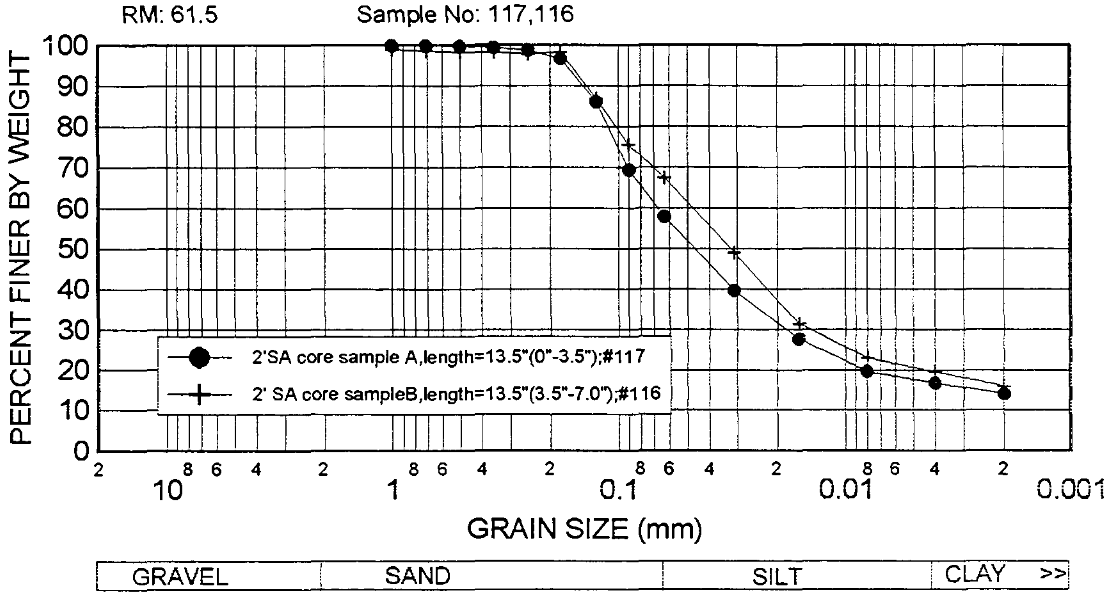
River: ILWW
Site No: 21
RM: 61.7

Bank: RDB (mp, dn)
Pool: Alton
Sample No: 102, 101, 100, 99



River: ILWW
Site No: 21
RM: 61.5

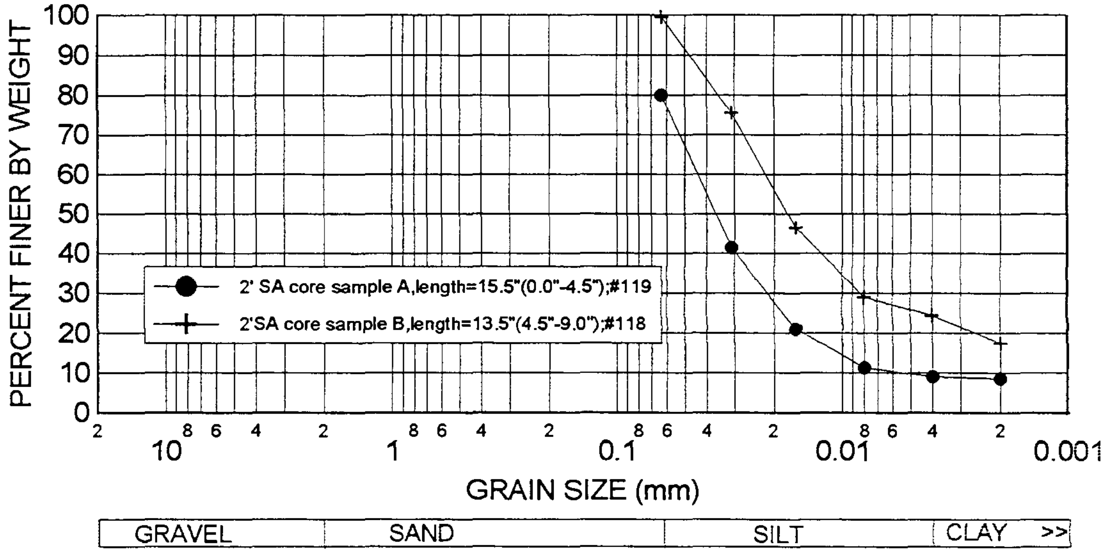
Bank: RDB (core samples from dn)
Pool: Alton
Sample No: 117,116



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

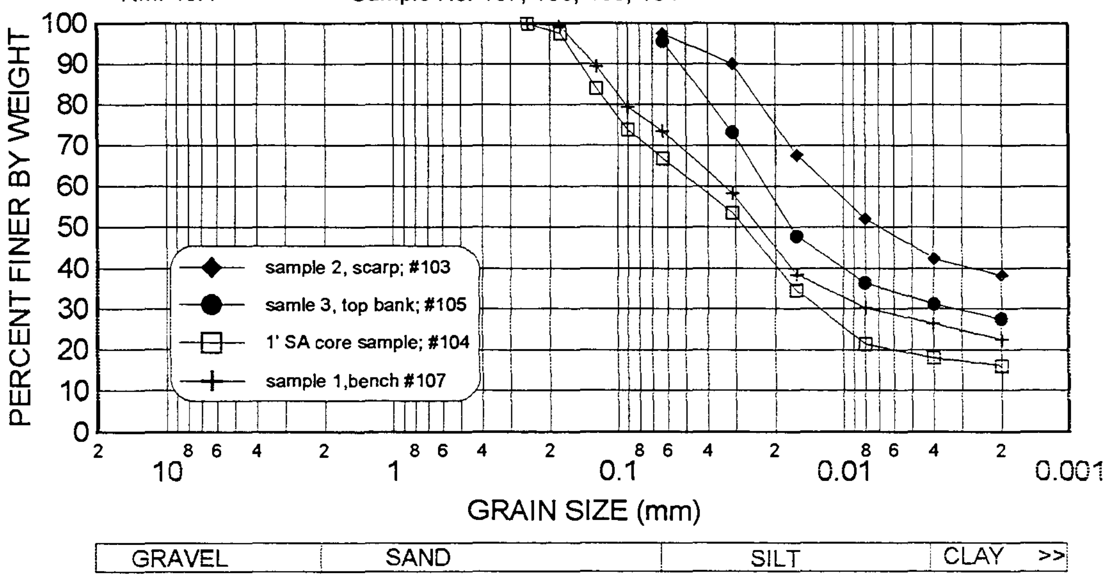
River: ILWW
Site No: 22
RM: 45.1

Bank: RDB (mp, up)
Pool: Alton
Sample No: 119,118

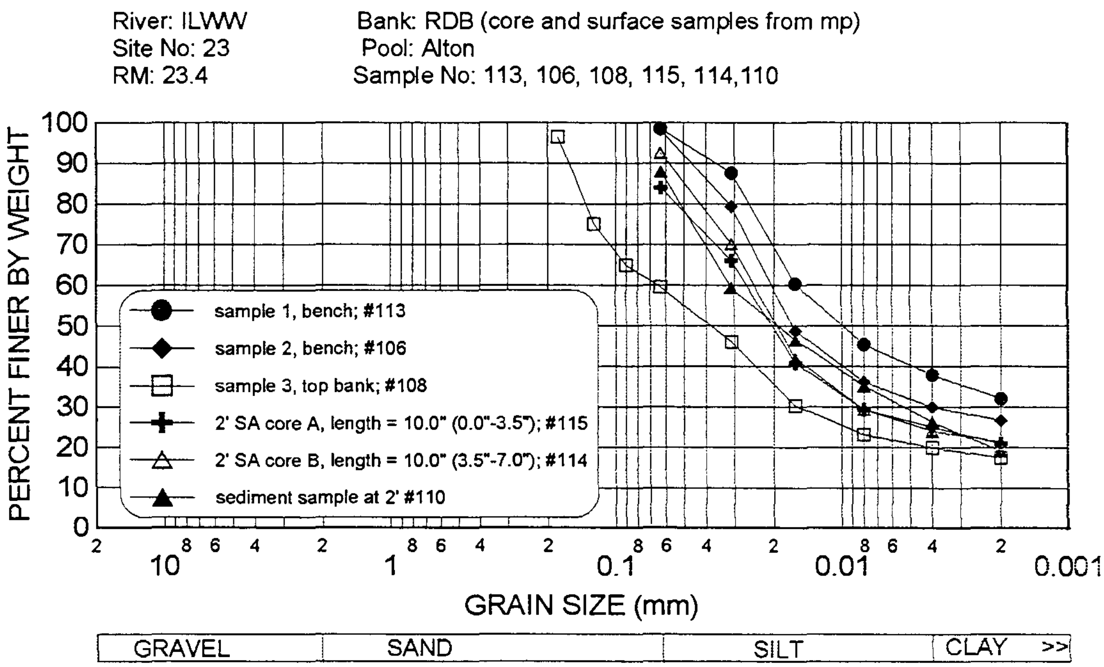


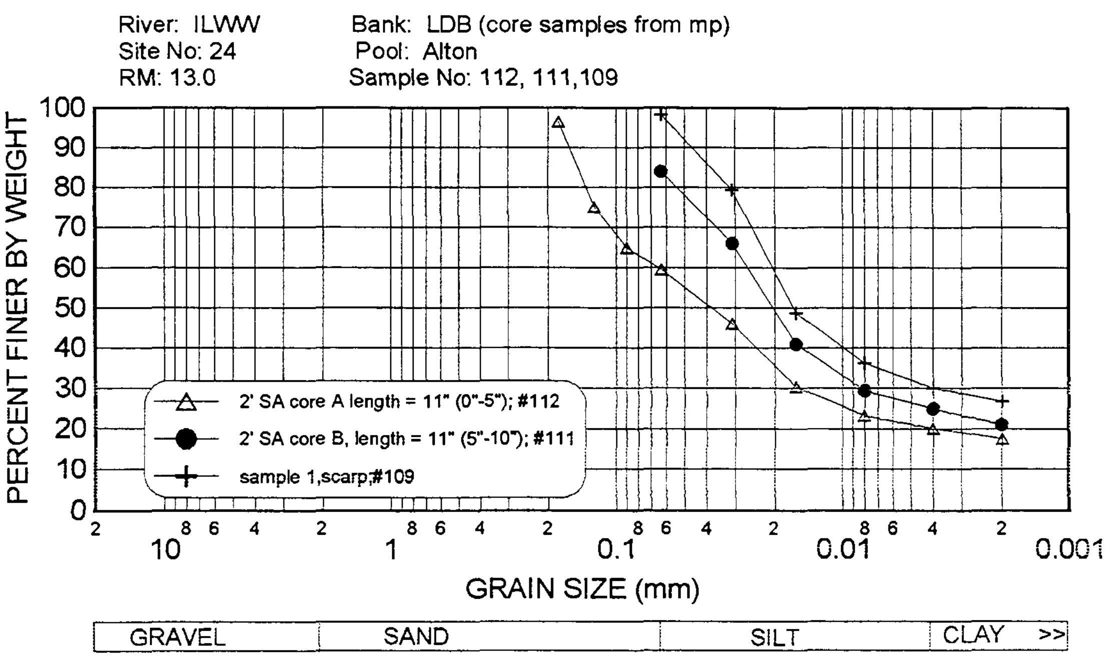
River: ILWW
Site No: 22
RM: 45.1

Bank: RDB (core and surface samples from up and mp)
Pool: Alton
Sample No: 107, 103, 105, 104



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995





River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	825.5	1	RDB	1181	mp	2	Sample 2, 4' below sample 1
UMR	825.5	1	RDB	1182	mp	2	sample 1, 6' below surface
UMR	791.7	2	RDB	1198	up	4	U2, d = 2'
UMR	791.7	2	RDB	1187	up	4	sample U1 @ depth = 1'
UMR	791.7	2	RDB	1188	mp	4	sample 1, bank crest
UMR	791.5	2	RDB	1183	dn	4	sample D1, @ depth 1'
UMR	791.7	2	RDB	1186	mp	4	core sample @ depth = 1'
UMR	791.7	2	RDB	1194	mp	4	sample 2, bench
UMR	791.7	2	RDB	1184	mp	4	sample 4, 1' below W.E.
UMR	791.5	2	RDB	1185	dn	4	sample D2, @ depth = 2'
UMR	791.7	2	RDB	1189	mp	4	sample 3, W.E.
UMR	763.2	3	LDB	1174	up	4	sample U2, depth = 2'
UMR	763.2	3	LDB	1175	up	4	sample U1, depth 1'
UMR	763.4	3	LDB	1176	dn	4	sample D1, d = 1'
UMR	763.4	3	LDB	1177	dn	4	sample D2, depth = 2'
UMR	763.4	3	LDB	1178	mp	4	sample 2, bench
UMR	763.4	3	LDB	1180	mp	4	sample C1 @ depth = 1'
UMR	763.3	3	LDB	1179	mp	4	sample 1, bench
UMR	751.1	4	LDB	1199	mp	4	C2, @ depth = 2', top sample
UMR	751.1	4	LDB	1196	up	5	U1 @ depth = 1'
UMR	751.1	4	LDB	1193	mp	5	@ depth = 1'
UMR	751.1	4	LDB	1169	mp	5	sample 2 (scarp)
UMR	751.1	4	LDB	1170	mp	5	sample 1 (bench), surfacial 6"
UMR	751.1	4	LDB	1173	mp	5	@ depth = 1'
UMR	751.1	4	LDB	1172	dn	5	sample D1 @ depth = 1'
UMR	751.1	4	LDB	1171	dn	5	sample D2 @ depth = 2'
UMR	746.4	5	LDB	1167	mp	5	sample C2A, depth = 2' (top portion)
UMR	746.4	5	LDB	1168	mp	5	sample C2B depth = 2' (bottom portion)
UMR	746.5	5	LDB	1192	up	5	@ depth 1', U1
UMR	746.3	5	LDB	1197	dn	5	D2A, depth = 2' (top portion)

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	746.4	5	LDB	1160	mp	5	sample C1A @ depth = 1' (top portion)
UMR	746.3	5	LDB	1161	dn	5	D1, depth = 1'
UMR	746.4	5	LDB	1162	mp	5	sample 2, bench (1' deep)
UMR	746.3	5	LDB	1163	dn	5	D2B depth = 2' (bottom portion)
UMR	746.4	5	LDB	1164	mp	5	sample C1B @ depth = 1' (bottom sample)
UMR	746.4	5	LDB	1165	mp	5	sample 1, bench surface
UMR	746.4	5	LDB	1166	mp	5	sample 3, bank crest
UMR	727.4	6	RDB	1147	mp	6	sample C2, depth = 2'
UMR	727.4	6	RDB	1148	mp	6	sample 1, top of bank crest
UMR	727.4	7	LDB	1149	mp	6	sample 3, top of bank
UMR	727.4	6	RDB	1150	up	6	U2, @ depth = 2'
UMR	727.4	6	RDB	1151	dn	6	D2, @ depth = 2'
UMR	727.4	7	LDB	1152	mp	6	C2, @ depth = 2'
UMR	727.4	6	RDB	1146	dn	6	sample D1 @ water depth = 1'
UMR	727.4	6	RDB	1145	mp	6	sample 3A, surfacial 6"
UMR	727.4	7	LDB	1144	mp	6	sample 1B, 6" lower bench surface
UMR	727.4	7	LDB	1143	mp	6	sample 2, berm (scarp)
UMR	727.4	6	RDB	1195	mp	6	sample 2, bench
UMR	727.4	7	LDB	1142	mp	6	sample C1 @ depth = 1'
UMR	727.4	6	RDB	1153	up	6	core U1 @ depth = 1'
UMR	727.4	6	RDB	1154	mp	6	sample 3B, 6" depth (lower layer)
UMR	727.4	6	RDB	1155	mp	6	sample C1, depth = 1'
UMR	727.4	7	LDB	1156	mp	6	sample 1A, bench surface
UMR	677.7	8	RDB	1157	up	9	sample U1 @ depth = 1'
UMR	677.7	8	RDB	1158	mp	9	sample C2 @ water depth = 2'
UMR	677.5	9	LDB	1159	mp	9	sample 3 (top of bank)
UMR	677.7	8	RDB	1129	mp	9	sample C1 @ water depth = 1'
UMR	677.5	9	LDB	1131	mp	9	sample C2 @ water depth = 2'
UMR	677.5	9	LDB	1132	mp	9	sample C1 @ water depth = 1'

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	677.7	8	RDB	1133	mp	9	sample 2 (scarp)
UMR	677.7	8	RDB	1134	up	9	sample U2 @ water depth = 2'
UMR	677.7	8	RDB	1135	mp	9	sample 3, top of bank
UMR	677.5	9	LDB	1136	mp	9	sample 1B (bench, bottom)
UMR	677.7	8	RDB	1137	mp	9	sample 1A (bench surface)
UMR	677.5	9	LDB	1138	mp	9	sample 2 (scarp)
UMR	677.7	8	RDB	1139	mp	9	sample 1B, bench (bottom)
UMR	677.5	9	LDB	1140	mp	9	sample 1A (bench near surface)
UMR	677.3	8	RDB	1130	dn	9	sample D1 @ water depth = 1'
UMR	677.3	8	RDB	1141	dn	9	sample D2 @ water depth = 2'
UMR	669.5	10	RDB	120	mp	9	sample 1A (bench surface, top)
UMR	669.5	10	RDB	121	mp	9	sample 2 (scarp)
UMR	670.0	10	RDB	122	up	9	sample U1, @ depth = 1'
UMR	669.5	10	RDB	123	mp	9	sample C2, @ depth = 2'
UMR	669.5	10	RDB	124	dn	9	sample D2 wd = 2'
UMR	669.5	10	RDB	125	dn	9	sample D1 wd = 1'
UMR	669.5	10	RDB	126	mp	9	sample C1 wd = 1'
UMR	670.0	10	RDB	127	up	9	sample U2, @ depth = 2'
UMR	669.5	10	RDB	128	mp	9	sample 1B (bench: 2/10' below surface)
UMR	669.5	10	RDB	129	mp	9	sample 3 (top of bank)
UMR	620.5	11	LDB	156	dn	10	sample D2 Water depth = 2'
UMR	620.5	11	LDB	155	mp	10	sample C1 wd = 1'
UMR	620.5	11	LDB	154	dn	10	sample D1 wd = 1'
UMR	620.5	11	LDB	153	up	10	sample U2 wd = 2'
UMR	620.5	11	LDB	149	up	10	sample U1 wd = 1'
UMR	620.5	11	LDB	148	mp	10	sample 3, top of bank
UMR	620.5	11	LDB	147	mp	10	sample 1B bench bottom below 2/10'
UMR	620.5	11	LDB	141	mp	10	sample 1A bench surface 2/10'
UMR	620.5	11	LDB	140	mp	10	sample 2 berm
UMR	612.5	12	LDB	159	up	11	profile core 2B 2' of water below 6"

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	613.6	12	LDB	130	mp	11	berm sample 1
UMR	613.6	13	RDB	134	mp	11	sample 3 top bank
UMR	613.6	12	LDB	132	mp	11	sample 2 top bank
UMR	613.6	13	RDB	131	mp	11	sample 2 berm
UMR	613.5	12	LDB	145	up	10	profile core U2A 2' of depth 6" top
UMR	613.6	13	RDB	158	mp	11	sample 1 bench
UMR	607.5	14	RDB	151	dn	11	sample D1A (top portion) water depth 1'
UMR	607.5	14	RDB	133	mp	11	sample 2 (scarp)
UMR	607.5	14	RDB	150	mp	11	sample 3, top of bank
UMR	607.5	14	RDB	139	mp	11	sample 1, bench
UMR	607.5	14	RDB	136	dn	11	sample D2 water depth = 2'
UMR	607.5	14	RDB	135	dn	11	Cassville sample DIB (bottom portion), wd = 1'
UMR	576.0	15	LDB	182	up	12	U2, 2' of water
UMR	576.0	15	LDB	169	up	12	U1B, 1' of water, lower 6"
UMR	576.0	15	LDB	170	dn	12	DIA, 1' of water, top 4"
UMR	576.0	15	LDB	171	dn	12	C1, 1' of water
UMR	576.0	15	LDB	172	dn	12	D2, 2' of water
UMR	576.0	15	LDB	168	dn	12	D1B, 1' of water bottom 4"
UMR	576.0	15	LDB	167	up	12	UIA, 1' of water upper 6"
UMR	576.0	15	LDB	162	mp	12	sample 1B (bench) below 2/10'
UMR	576.0	15	LDB	163	mp	12	sample 1A (bench) 1A top 2/10'
UMR	576.0	15	LDB	164	mp	12	sample 2 (scarp)
UMR	576.0	15	LDB	165	dn	12	C2, 2' of water
UMR	576.0	15	LDB	166	mp	12	sample 3 (top bank)
UMR	551.9	16	LDB	175	mp	13	sample 1, water edge
UMR	551.9	16	LDB	180	dn	13	D2
UMR	551.9	16	LDB	178	dn	13	D1
UMR	551.9	16	LDB	174	mp	13	sample 3, top of bank
UMR	551.9	16	LDB	173	mp	13	sample 2, berm

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	512.7	17	LDB	181	mp	14	sample 3, top of bank
UMR	512.7	17	LDB	179	mp	14	sample 1B (bench below 2/10')
UMR	512.7	17	LDB	177	mp	14	sample 1A (bench top 2/10')
UMR	512.7	17	LDB	176	mp	14	sample 2 (berm)
UMR	512.7	17	LDB	217	mp	14	M2B, 2' of water, lower core
UMR	512.7	17	LDB	215	up lmt Head Island	14	H2, 2' of water
UMR	512.7	17	LDB	214	up lmt Head Island	14	H1B, 1' of water, lower core
UMR	512.7	17	LDB	213	up lmt Head Island	14	H1A, 1' of water, upper core
UMR	512.7	17	LDB	212	mp	14	M2A, 2' of water, upper core
UMR	512.7	17	LDB	211	island toe	14	2A, 2' of water, upper core
UMR	512.7	17	LDB	185	back channle up	14	BU1A, 1' of water upper core
UMR	512.7	17	LDB	187	back channel up	14	BU2, 2' of water
UMR	512.7	17	LDB	193	back channel dn	14	BD2B, 2' of water, lower core
UMR	512.7	17	LDB	194	back channel dn	14	BD2A, 2' of water, lower core
UMR	512.7	17	LDB	195	back channel dn	14	BD1B, 2' of wter, lower core
UMR	512.7	17	LDB	197	mp	14	M1, 1' of water
UMR	512.7	17	LDB	200	island toe	14	2B, 2' of water, lower core
UMR	512.7	17	LDB	201	island toe	14	1B, 1' of water, lower core

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	512.7	17	LDB	203	back channel dn	14	BD1A, 1' of water, upper core
UMR	512.7	17	LDB	208	island toe	14	1A, 1' of water, upper core
UMR	512.7	17	LDB	209	back channel up	14	BU1B, 1' of water, lower core
UMR	509.2	19	LDB	188	dn	14	1' of water
UMR	509.2	19	LDB	189	dn	14	D2, 2' of water
UMR	509.2	19	LDB	190	dn	14	D1, 1' of water
UMR	509.2	18	RDB	196	dn	14	1' of water
UMR	509.2	19	LDB	198	dn	14	2' of water
UMR	509.2	18	RDB	184	dn	14	1' of water
UMR	509.2	19	LDB	204	mp	14	sample 2, berm
UMR	509.2	19	LBD	216	mp	14	sample 1 (bench)
UMR	509.2	18	RDB	210	mp	14	sample 2, top of bank
UMR	509.2	19	LDB	207	mp	14	sample 4, top of bank
UMR	509.2	19	LDB	206	mp	14	sample 3 (scrap)
UMR	509.2	18	RDB	205	mp	14	sample 1, bench
UMR	509.2	18	RDB	202	up	4	U2, 2' of water
UMR	509.2	18	RDB	143	up	14	U1 (exclude 2" of sand on surface) 1' of water
UMR	509.2	18	RDB	160	dn	14	D2A, 2' of water
UMR	509.2	18	RDB	186	dn	14	D2B, 2' of water
UMR	466.7	21	LDB	1128	island back side	16	1' SA sample core length = 1.3' B Hor = 0.55-1.3'
UMR	466.7	21	LDB	1127	island toe	16	1' SA sample core length = 1.4' A Hor = 0.0'-0.55'
UMR	466.7	21	LDB	1115	mp	16	2' SA core sample core length 0.75' A Hor = 0-0.15'
UMR	466.7	21	LDB	1126	island head	16	1' SA core sample core length = 1.3' B Hor = 0.6'-1.2'
UMR	466.7	21	LDB	1125	mp	16	1' SA core sample core length = 1.5' C Hor = 1.0'-1.5'

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	466.7	21	LDB	1124	mp	16	1' SA core sample core length =1.5' A Hor = 0.0-0.3'
UMR	466.7	21	LDB	1123	mp	16	2' subaqueous core sample core length = 0.75' C Hor = 0.3'-0.75'
UMR	466.7	21	LDB	1114	island toe	16	1' Sa core sample core length = 1.4' C Hor = 0.7'-0.9'
UMR	466.7	21	LDB	1122	mp	16	1' SA core sample core length = 1.5' B Hor = 0.3'-1.0'
UMR	466.7	21	LDB	1113	island head	16	1' SA core sample core length = 1.3' A Hor = 0.0-0.6'
UMR	466.7	21	LDB	1121	dn island back side	16	1' SA core sample core length = 1.35' A Hor = 0.0-0.55'
UMR	466.7	21	LDB	1112	mp	16	sample 1B, bottom
UMR	466.7	21	LDB	1111	mp	16	sample 3, scarp face
UMR	466.7	21	LDB	1110	mp	16	sample 2, berm
UMR	466.7	21	LDB	1109	mp	16	sample 1A, top of bank
UMR	466.7	21	LDB	1120	island head	16	1' SA core sample core length = 1.3' C Hor = 1.2'-1.3'
UMR	466.7	21	LDB	1119	island toe	16	1' SA core sample core length = 1.4' B Hor = 0.55'-0.70'
UMR	466.8	21	LDB	1118	up 1/3	16	1' SA core sample core length = 1.35' B Hor = 0.55-1.35
UMR	466.7	21	LDB	1117	island toe	16	1' SA core sample core length = 1.4' d Hor = 0.9'-1.4'
UMR	466.8	21	LDB	1116	up 1/3	16	1' SA core sample core length = 1.3' A Hor 0.0-0.55'
UMR	466.7	21	LDB	1108	mp	16	sample #4 crest
UMR	466.7	21		1107	mp	16	1' SA core sample core length = 1.1' B Hor = 0.35'-1.1'
UMR	436.4	22	LDB	1086	up	18	1' SA core sample core length = 1.1' A Hor = 0.0-0.2'
UMR	436.4	23	RDB	1098	dn	18	1' SA core sample core length = 0.65' C Hor = 0.55'-0.65'
UMR	436.4	22	LDB	1106	mp	18	S#3 bank face
UMR	436.4	23	RDB	1084	dn	18	1' SA core sample core length = 0.65' B Hor = 0.15'-0.55

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	436.4	23	RDB	1089	up	18	1' SA core sample core length 1.1' B Hor = 0.5'-1.1'
UMR	436.4	23	RDB	1085	up	18	1' SA core sample core length = 1.1' A Hor = 0.0-0.5'
UMR	436.4	22	LDB	1087	dn	18	0.5' SA core sample core length 1.0' B Hor 0.2'-1.0'
UMR	436.4	22	LDB	1088	up	18	1' SA core sample core length 1.1' B Hor 0.2-1.1'
UMR	436.4	22	LDB	1105	mp	18	S2, berm
UMR	436.4	22	LDB	1104	mp	18	S#4, crest
UMR	436.4	22	LDB	1103	mp	18	S1 bench 1A top
UMR	436.4	22	LDB	1102	dn	18	0.5' SA core sample core length = 1.0' A Hor 0.0-0.2'
UMR	436.4	22	LDB	1101	dn	18	1 SA core sample core length = 1.05' B Hor 0.15'-1.05'
UMR	436.4	23	RDB	1100	up	18	S1A bench (sand) top 1"
UMR	436.4	23	RDB	1099	dn	18	1' SA core sample core length = 0.65' A Hor = 0.0'-0.15'
UMR	436.4	23	RDB	1097	up	18	S1B 1" below u/s rocks at 1' below
UMR	436.4	23	RDB	1096	up	18	S3, crest
UMR	436.4	22	LDB	1095	up	18	1' SA core sample core length = 1.15' A Hor = 0.0'-0.25'
UMR	436.4	22	LDB	1094	mp	18	1' SA core sample core length = 1.0' B Hor = 0.2'-1.0'
UMR	436.4	22	LDB	1093	mp	18	1' SA core sample core length = 1.0' A Hor = 0.0-0.2'
UMR	436.4	22	LDB	1092	dn	18	1' SA core sample core length 1.05' A Hor 0-0.15'
UMR	436.4	22	LDB	1091	up	18	1' SA core sample core length = 1.15' B Hor 0.25'-1.15'
UMR	436.4	23	RDB	1090	up	18	S2, bench (clay)
UMR	432.3	25	RDB	1083	mp	18	1' subaqueous core sample core length = 1.2' B Hor = 0.7'-1.2'
UMR	432.3	25	RDB	1082	mp	18	1' subaqueous core length = 1.2' A Hor = 0.0-0.7'

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	432.3	25	RDB	1081	mp	18	1' subaqueous core sample core length 0.8' A Hor = 0.-0.8' mid pt
UMR	432.3	25	RDB	1080	mp	18	S2, bank face
UMR	432.3	25	RDB	1079	mp	18	S1, crest
UMR	432.3	24	LDB	1078	mp	18	S2, bench
UMR	432.3	25	RDB	1077	mp	18	S3, water edge (1' above)
UMR	432.3	24	LDB	1076	mp	18	S1, water edge
UMR	420.0	26	RDB	1074	mp	18	0.5' SA core sample core length = 1.05' B Hor = 0.7'-1.05'
UMR	420.0	26	RDB	1075	mp	18	0.5 SA core sample core length = 1.05' A Hor = 0.0-0.7'
UMR	420.0	26	RDB	1073	mp	18	S1B below 6"
UMR	420.0	26	RDB	1072	mp	18	S3 crest (or berm)
UMR	420.0	26	RDB	1071	mp	18	S1A top 6"
UMR	420.0	26	RDB	1070	mp	18	S2, scarp face
UMR	360.0	27	RDB	1048	mp	20	sample 2 (scarp)
UMR	360.0	27	RDB	1049	mp	20	sample 3 (bank)
UMR	360.0	27	RDB	1050	mp	20	sample 1, bench surface
UMR	360.0	27	RDB	1047	mp	20	1' subaqueous core sample, core sample = 1.1'
UMR	357.6	28	RDB	1046	mp	20	Fox Island sample 1 (top scarp)
UMR	357.6	28	RDB	1045	mp	20	Fox Island sample 2 (bottom scarp)
UMR	339.4	29	LDB	1069	up	21	1' SA core sample core length = 0.95' A Hor = 0-0.15'
UMR	339.4	29	LDB	1068	up	21	1' SA core sample core length = 0.95' B Hor = ?
UMR	339.3	30	RDB	1067	mp	21	1' SA core sample core length = 1.15' C Hor = 0.85'-1.15'
UMR	339.4	29	LDB	1066	dn	21	0.5' SA core sample core length = 1.25', A Hor 0-0.25'
UMR	339.3	30	RDB	1065	mp	21	1' SA core sample core length = 1.15' A Hor = 0.-0.15'
UMR	339.3	29	LDB	1064	mp	21	1' SA core sample core length = 1.4' B Hor 0.3'-0.9'

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	339.3	29	LDB	1063	mp	21	1' subaqueous core sample core length 1.4' C Hor 0.9'-1.4'
UMR	339.3	29	LDB	1062	mp	21	1' subaqueous core sample 1.4' core sample A Hor = 0.0-0.3'
UMR	339.3	30	RDB	1061	mp	21	1" subaqueous core sample bank core length 1.15 B Hor = ?
UMR	339.4	29	LDB	1060	dn	21	0.5 subaqueous core sample core lenght = 1.25' (H = 0.25'-1.25')
UMR	339.3	30	RDB	1059	mp	21	S2A, scarp top 4"
UMR	339.3	29	LDB	1058	mp	21	sample 1 (bench)
UMR	339.3	29	LDB	1051	mp	21	sample 2 (scarp)
UMR	339.3	30	RDB	1057	mp	21	S2B, scarp bottom 6"
UMR	339.3	29	LDB	1056	mp	21	sample 4 (bank 6" deep)
UMR	339.3	30	RDB	1055	mp	21	S1A, bench top 6"
UMR	339.3	30	RDB	1054	mp	21	S3 crest
UMR	339.3	29	LDB	1053	mp	21	sample 3 (bank surface)
UMR	339.2	30	RDB	1052	mp	21	S1B bench 6" below
UMR	293.0	31	LDB	1044	mp	23	sample 3 (bank)
UMR	293.0	31	LDB	1043	mp	23	sample 1A (bench surface)
UMR	293.0	31	LDB	1042	mp	23	sample 1B (bench 4" below)
UMR	293.0	31	LDB	1041	mp	23	sample 2 (berm)
UMR	275.3	32	RDB	1035	mp	24	core length = 0.95' A Hor = 0.0'-0.45'
UMR	275.3	32	RDB	1034	mp	24	core length = 0.95' B Hor = 0.45'-0.95'
UMR	275.3	32	RDB	1033	mp	24	sample 1 (scarp)
UMR	275.3	32	RDB	1032	mp	24	sample 2 (bank)
UMR	266.8	obser-vation	LDB	1030	tip of slim isl	25	sample 2 (5' below top of scarp)
UMR	266.8	obser-vation	LDB	1028	tip of slim isl	25	sample 3 (7.5 below top of scarp) bench
UMR	266.8	obser-vation	LDB	1023	tip of slim isl	25	sample 1 (3' below of scarp top)
UMR	266.5	33	LDB	1024	mp	25	sample 3A, (bank surface x=0'

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	266.5	33	LDB	1025	mp	25	sample 2 (scarp)
UMR	266.5	33	LDB	1026	mp	25	core sample @ water depth = 1' core length = 0.4'
UMR	266.5	33	LDB	1027	mp	25	sample 1A (bench top 3/10')
UMR	266.5	33	LDB	1029	mp	25	sample 3B, (bank surface) x=8'
UMR	266.5	33	LDB	1031	mp	25	sample 1B, bench 3/10' below surface
UMR	232.2	34	RDB	1036	mp	26	sample 1 (bank)
UMR	232.2	34	RDB	1037	mp	26	core length 0.95' 1 ft core B Hor 0.45-0.95
UMR	232.2	34	RDB	1038	mp	26	sample 2 (scarp)
UMR	232.2	34	RDB	1039	mp	26	sample 1 (scarp water edge)
UMR	232.2	34	RDB	1040	mp	26	core length 0.95 ft 1 ft core A Hor 0.0'-0.45'
UMR	222.1	35	RDB	1022	mp	26	sample 3, bank
UMR	222.1	35	RDB	1021	mp	26	sample 2, scarp
UMR	222.1	35	RDB	1020	mp	26	sample 1, bench
UMR	222.1	35	RDB	1019	mp	26	core 1 1' of water: total core height 0.75'
UMR	217.5	36	RDB	1018	mp	26	sample 2, scarp
UMR	217.5	36	RDB	1017	mp	26	sample 1B (bench, 6" below)
UMR	217.5	36	RDB	1013	mp	26	sample 3 B (bank bean) field?
UMR	217.5	36	RDB	1014	mp	26	core sample @ water depth = 2' core length = 12"
UMR	217.5	36	RDB	1015	mp	26	sample 3, bank
UMR	217.5	36	RDB	1016	mp	26	sample 1A (bench) surface
UMR	200.2	observation site	RDB	1012		27	sample 1, scarp
UMR	197.6	37	RDB	1001	mp	27	sample 2, scarp
UMR	197.6	37	RDB	1000	mp	27	sample 1, bench
UMR	197.6	37	RDB	1002	mp	27	core sample @ water depth = 1' core length = 1.25' A Hor -= 0-0.2'
UMR	197.6	37	RDB	1003	mp	27	sample 3, bank

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	197.6	37	RDB	1004	mp	27	length 0.95 B Hor 0.1-0.45
UMR	197.6	37	RDB	1005	mp	27	1' of water core length 1.25' Hor E 1.0-1.25'
UMR	197.6	37	RDB	1006	mp	27	1' of water core length 1.25' Hor D 0.8'-1.0'
UMR	197.6	37	RDB	1007	mp	27	lenght 0.95 Hor A 0-0.1
UMR	197.6	37	RDB	1008	mp	27	core length 1.25' C Hor 0.45'-0.8'
UMR	197.6	37	RDB	1009	mp	27	1' water depth core length = 1.25' B Hor 0.2'-0.45'
UMR	197.6	37	RDB	1010	mp	27	length 0.95 D 0.65-0.95
UMR	197.6	37	RDB	1011	mp	27	length 0.95 C 0.45-0.65
UMR	174.8	38	LDB	999	mp	open river	sample 1, bench St. Louis water eage
UMR	174.8	38	LDB	997	mp	open river	sample 3, crest 4' from stake, St. Louis
UMR	174.8	38	LDB	998	mp	open river	sample 2, 7.2' from stake 5' below from crest scarp
UMR	168.5	S#2	LDB	993		open river	lower scarp face
UMR	168.5	S#4	LDB	994		open river	face of upper scarp face
UMR	168.5	S#1	LDB	995		open river	basal sand inpoint control
UMR	168.5	S#3	LDB	996		open river	base of upper scarp
UMR	112.4	39	LDB	988	mp	open river	sample 2, scarp
UMR	112.4	39	LDB	987	mp	open river	sample 4, bank
UMR	112.4	39	LDB	986	mp	open river	sample 1A, bench surface
UMR	112.4	39	LDB	985	mp	open river	sample 3, lower bank
UMR	112.4	39	LDB	989	mp	open river	sample 1B, bench 3' below surface
UMR	112.4	39	LDB	990	mp	open river	core 1' of water B Hor 0.45-0.55 total core 0.95'
UMR	112.4	39	LDB	991	mp	open river	total core 0.95' A Hor = 0-0.45' core 1' of water
UMR	112.4	39	LDB	992	mp	open river	core 1' of water C Hor = 0.55-0.95 total 0.95'
UMR	94.1	40	RDB	976	dn	open river	sample 2, scarp
UMR	94.1	40	RDB	977	dn	open river	sample 3, top bank
UMR	94.1	40	RDB	978	dn	open river	sample 1, bench

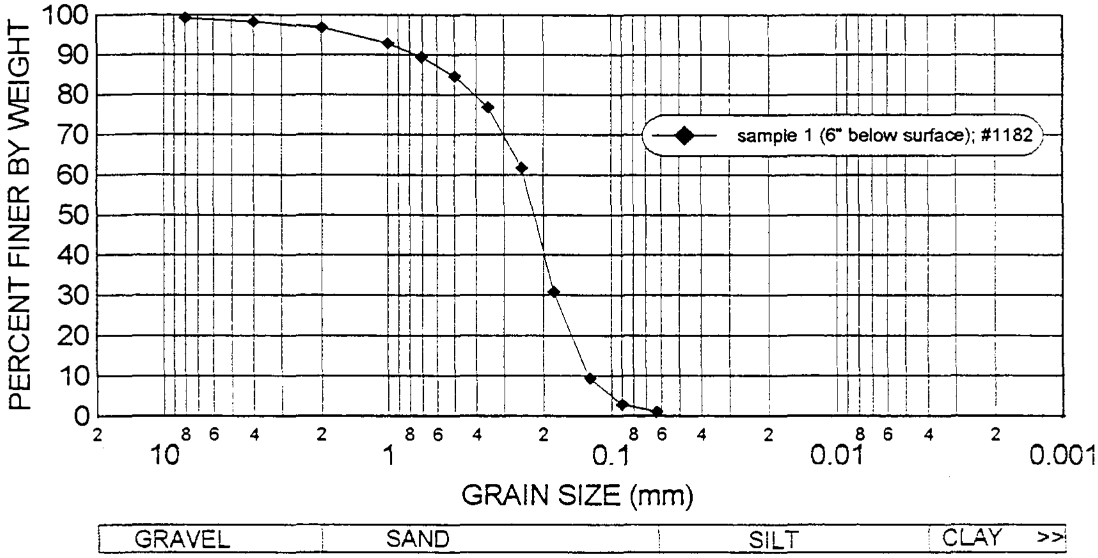
River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	87.2	obser. site	LDB	975		open river	bench
UMR	77.2	41	RDB	974	mp	open river	sample 1, bank face
UMR	52.3	42	LDB	981	mp	open river	sample 2, scarp
UMR	52.3	42	LDB	980	mp	open river	sample 3, lower bank
UMR	52.3	42	LDB	979	mp	open river	sample 4, bank
UMR	52.3	42	LDB	983	mp	open river	sample 1, bench
UMR	52.3	42	LDB	984	mp	open river	2' below H_2O surface core length = 1.0' A Hor = 1.0'
UMR	45.2	43	LDB	972	mp	open river	S1 toe S? Hor 4-5 slacking FD. wave sample 1
UMR	45.2	43	LDB	973	mp	open river	sample 2, upper face, 5' from crest
UMR	25.8	44	RDB	963	mp	open river	2' H_2O Depth core length = 1.2' A Hor = 0-0.2'
UMR	25.8	44	RDB	964	mp	open river	2' H_2O Depth core length = 1.2' B Hor = 0.2'-1.2'
UMR	25.8	44	RDB	965	mp	open river	sample 4 (upper scarp)
UMR	25.8	44	RDB	966	mp	open river	sample 2 (berm)
UMR	25.8	44	RDB	967	mp	open river	sample 3 (lower scarp)
UMR	25.8	44	RDB	968	mp	open river	1' H_2O Depth core length = 1.25' A Hor = 0.0-0.35'
UMR	25.8	44	RDB	969	mp	open river	1' H_2O Depth core length = 1.25' C Hor = 0.5'-1.0'
UMR	25.8	44	RDB	982	mp	open river	sample 1, bench
UMR	25.8	44	RDB	970	mp	open river	1' H_2O Depth core length = 1.25'B Hor = 0.35'-0.5'
UMR	25.8	44	RDB	971	mp	open river	1' H_2O Depth core length = 1.25' D Hor = 1.0'-1.25'
UMR	509.2	18	RDB	199	mp		M1A, 1' of water
UMR	509.2	18	RDB	192	mp	14	M2A, 2' of water
UMR	509.2	18	RDB	191	mp		M2B, 2' of water
UMR	509.2	18	RDB	161	mp	14	M2B, 12" lower from top
UMR	613.5	12	LDB	157	up		U1B, 1' of water, below 3" of surface
UMR	613.5	12	LDB	152	up		1A, 1' of water upper 3"

River	River Mile	Site	Location	Sample No.	Bnkprf	Pool No.	Specific Site
UMR	607.5	14	RDB	146	mp		Cassville center core C1, 1' of water
UMR	607.5	14	RDB	144	up		Cassville core U1, 1' water
UMR	607.5	14	RDB	142	dn		C2B, Cassville center ,2' of water 9 lower part
UMR	607.5	14	RDB	138	mp		C2A, Cassville center, 2' of water top A"
UMR	607.5	14	RDB	137	up		core U2, Cassville, 2' water
UMR	25.8	44	RDB	1190	mp		sample 1 (bank)
UMR	466.7	21	LDB	1191	mp		2' subaqueous core sample core length = 0.75' B Hor 0.15'-0.3'

ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

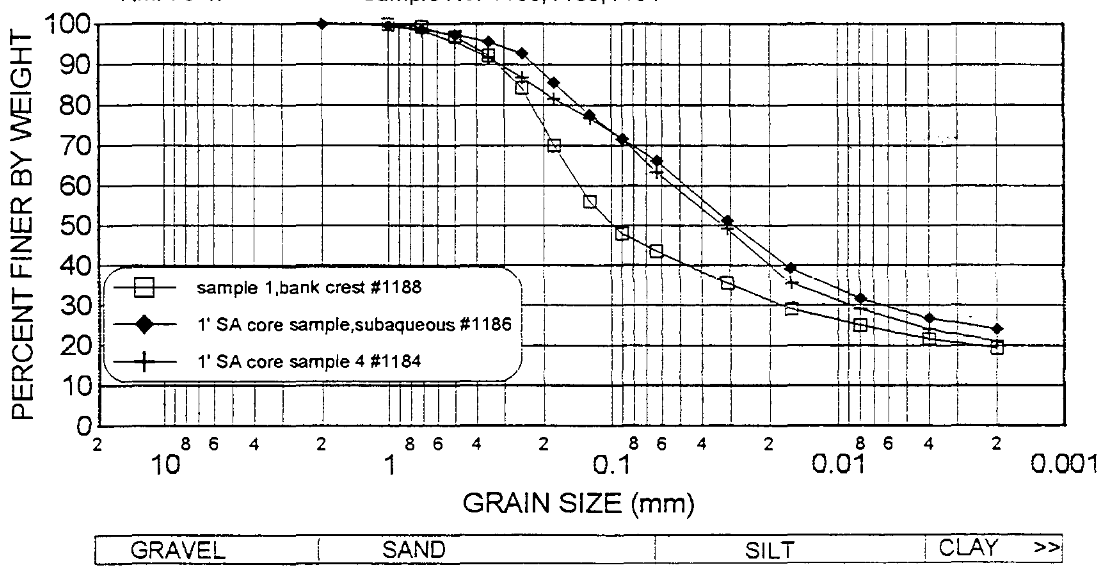
River: UMR
Site No: 1
RM: 825.5

Bank: RDB (mp)
Pool No: 2
Sample No: 1182



River: UMR
Site No: 2
RM: 791.7

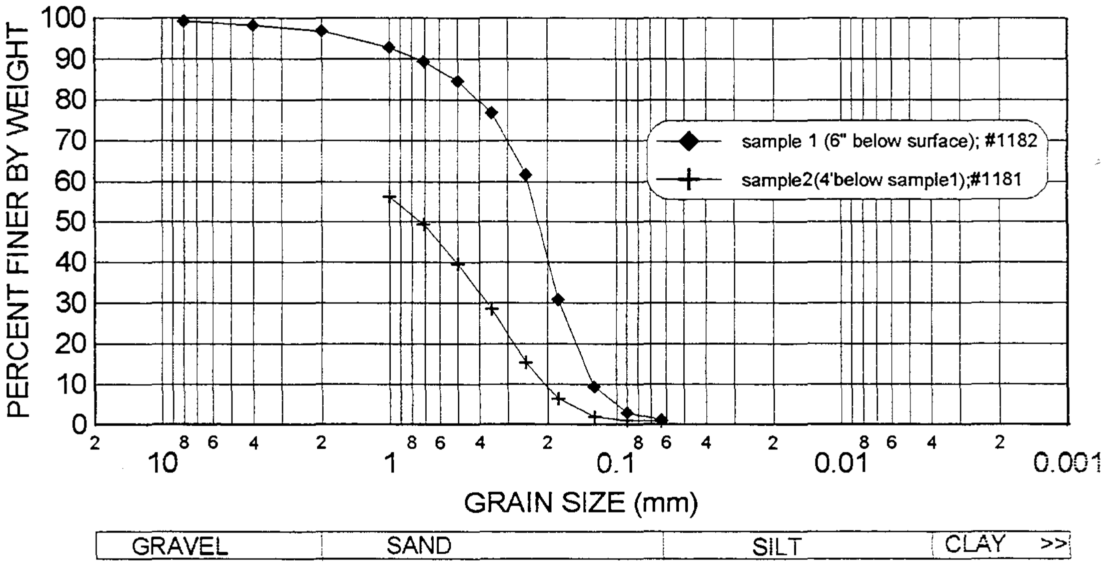
Bank: RDB
Pool No: 4
Sample No: 1188,1186,1184



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

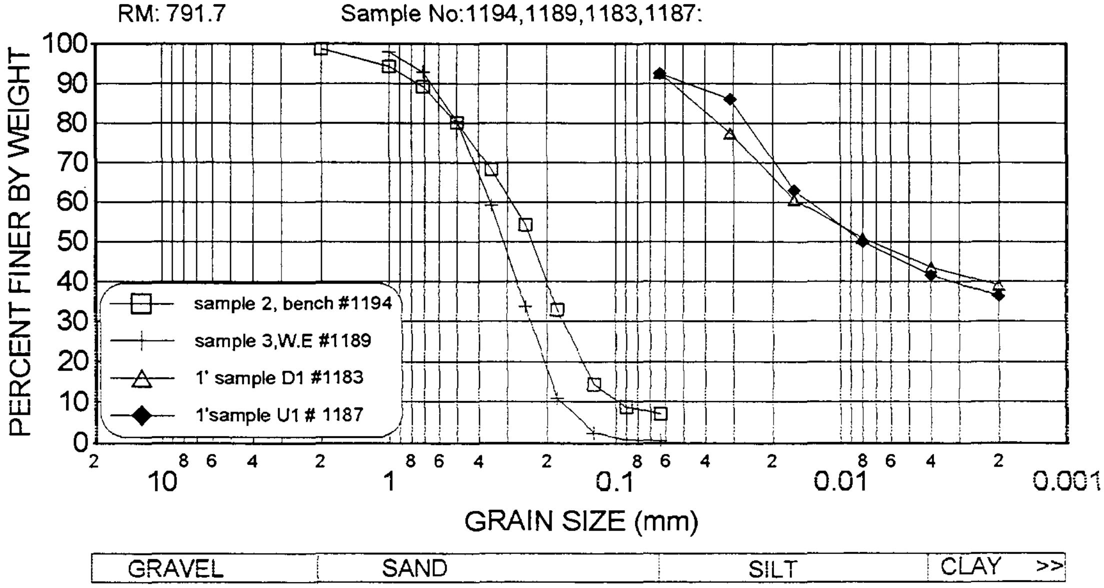
River: UMR
Site No: 1
RM: 825.5

Bank: RDB (mp)
Pool No: 2
Sample No: 1182,1181



River: UMR
Site No: 2
RM: 791.7

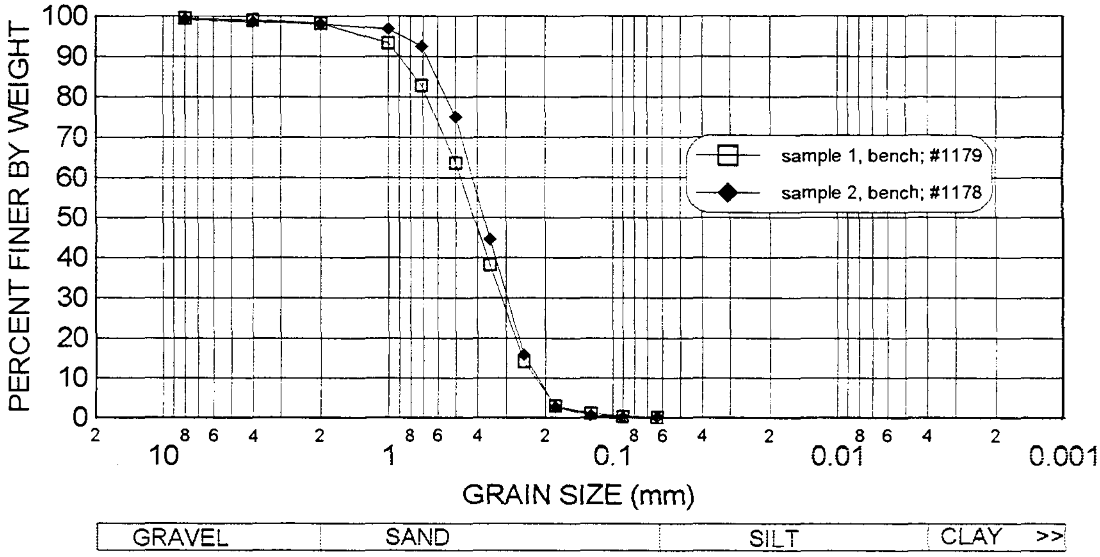
Bank: RDB(bench and W.E samples from mp,dn and up)
Pool No: 4
Sample No:1194,1189,1183,1187:



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

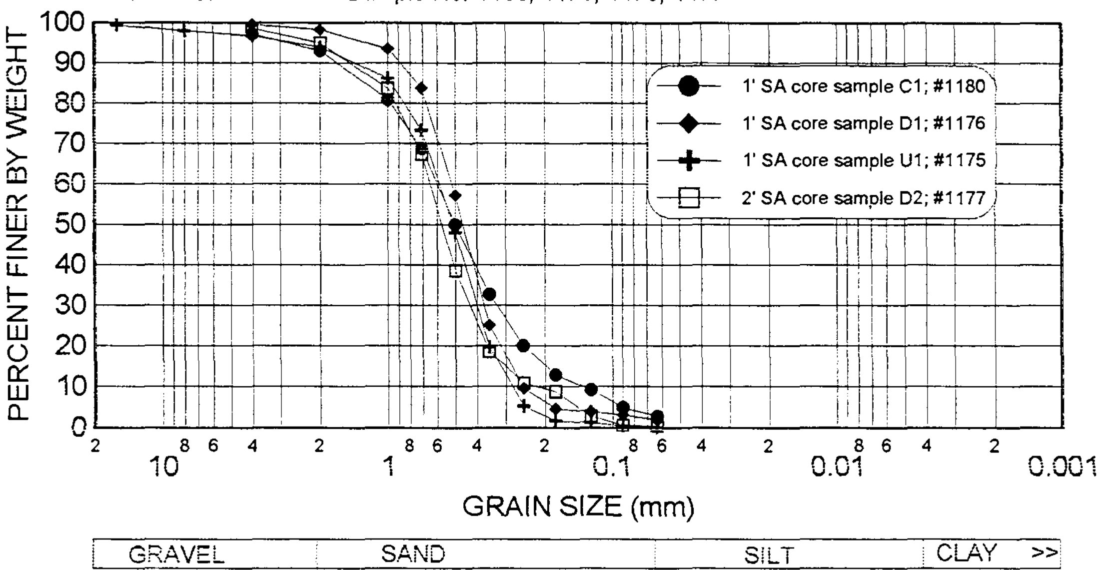
River: UMR
Site No: 3
RM: 763.4

Bank: LDB (mp)
Pool No: 4
Sample No: 1179, 1178



River: UMR
Site No: 3
RM: 763.4

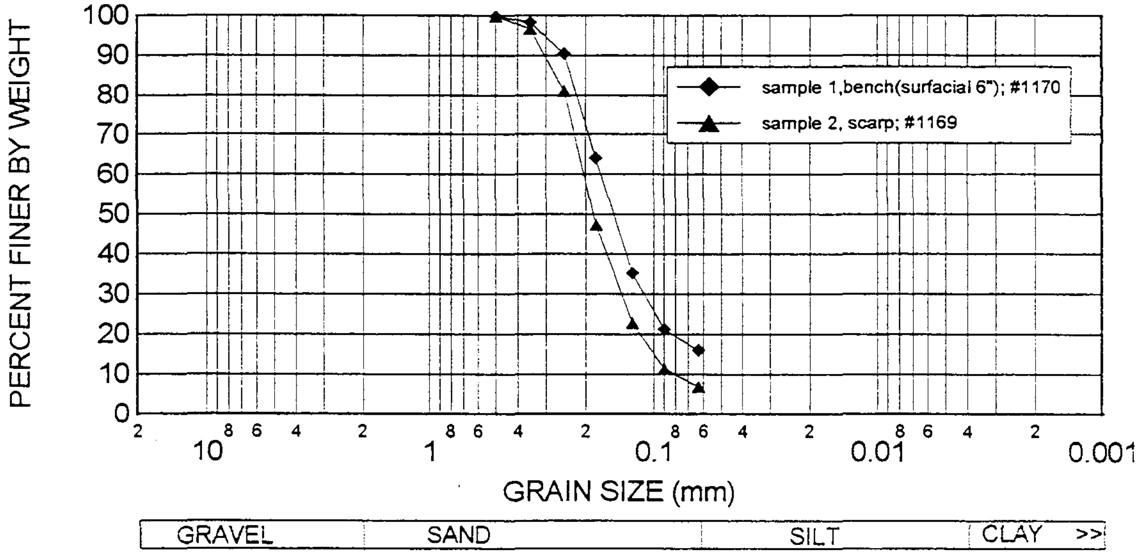
Bank: LDB (core samples from up, mp, and dn)
Pool No: 4
Sample No: 1180, 1176, 1175, 1177



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

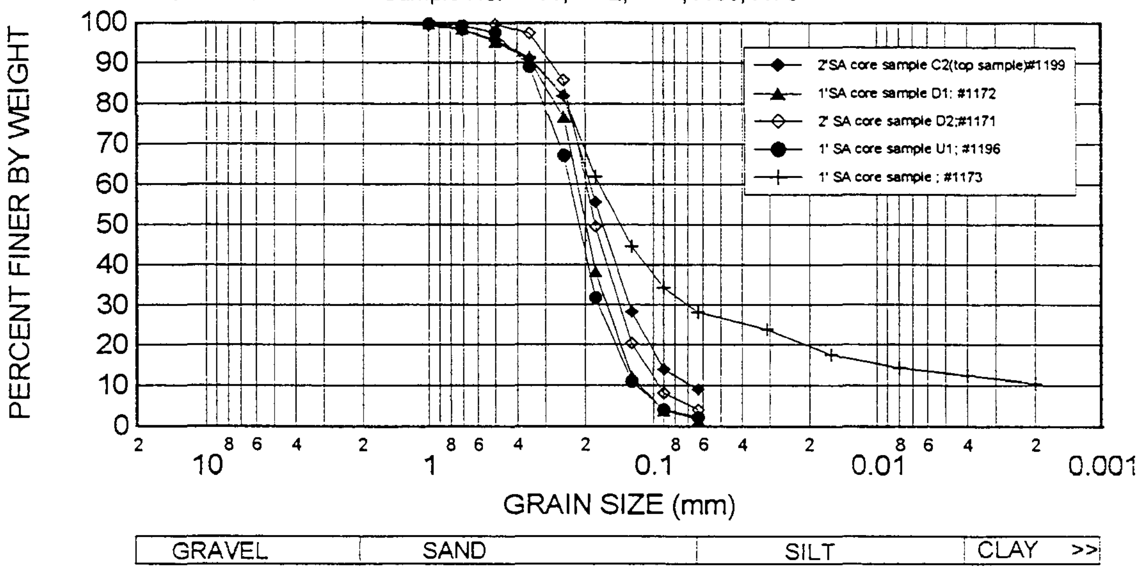
River: UMR
Site No: 4
RM: 751.1

Bank: LDB (mp)
Pool No: 5
Sample No: 1170,1169

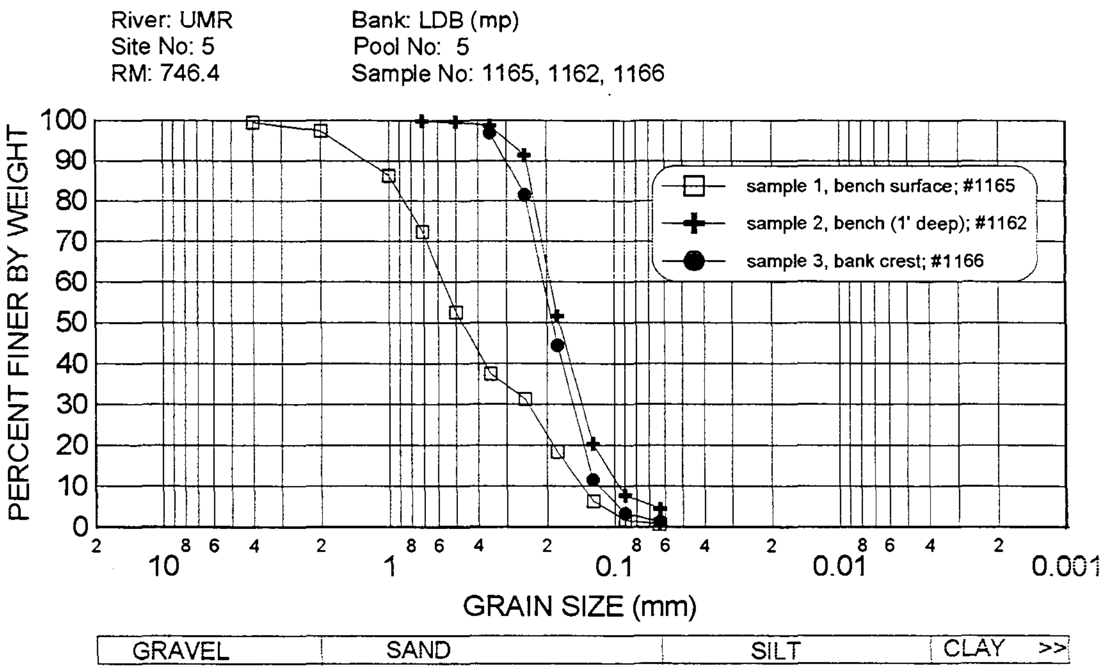


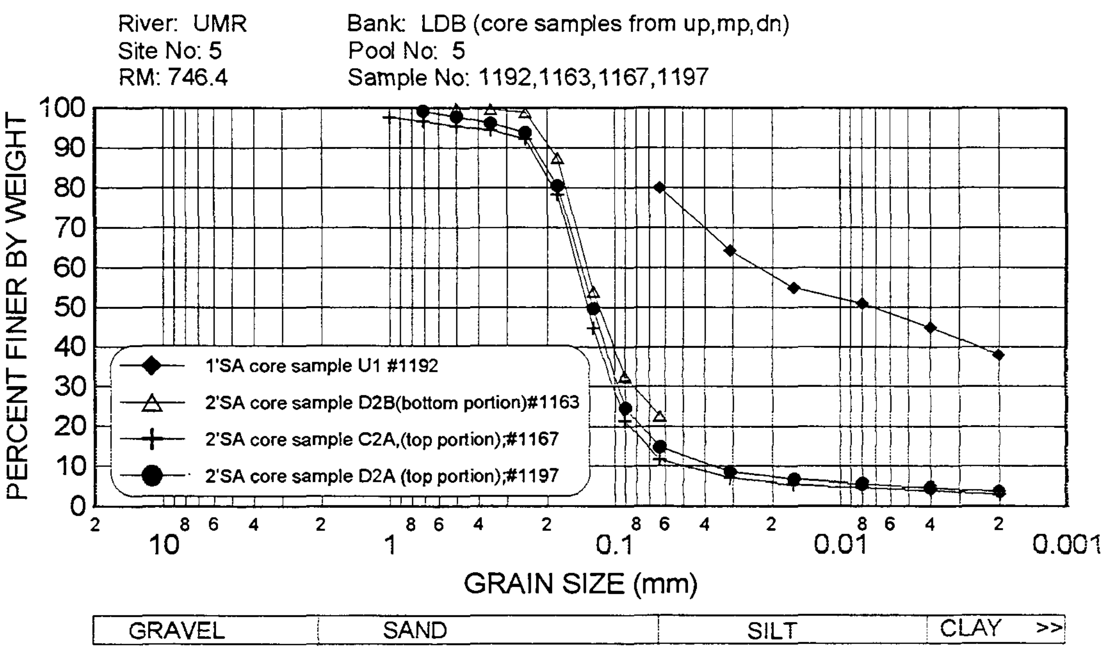
River: UMR
Site No: 4
RM: 751.1

Bank: LDB(core sample from up,md and dn)
Pool No: 5
Sample No: 1199,1172,1171,1196,1173



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

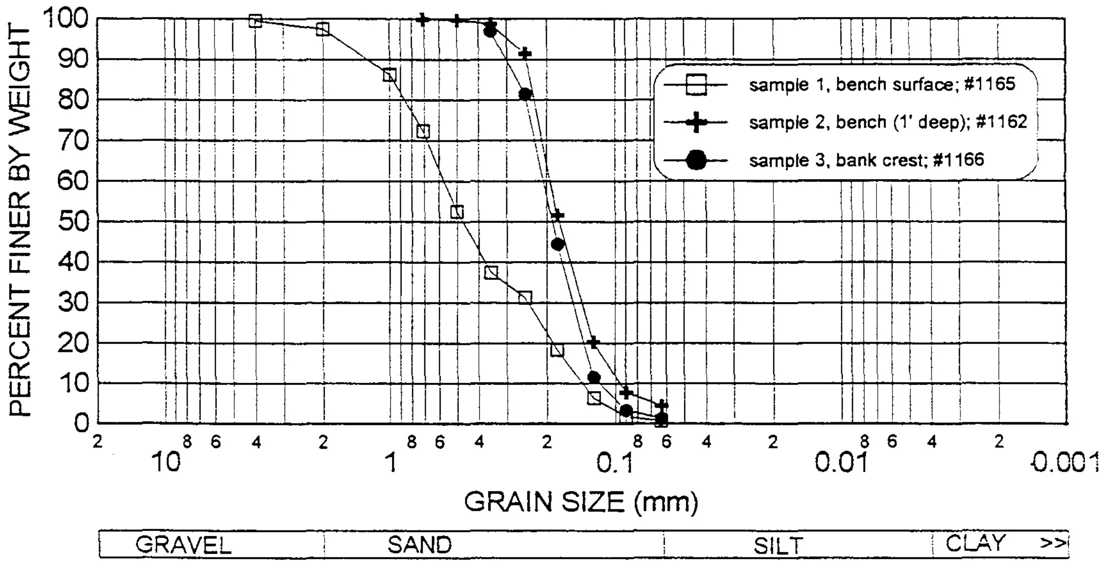




ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

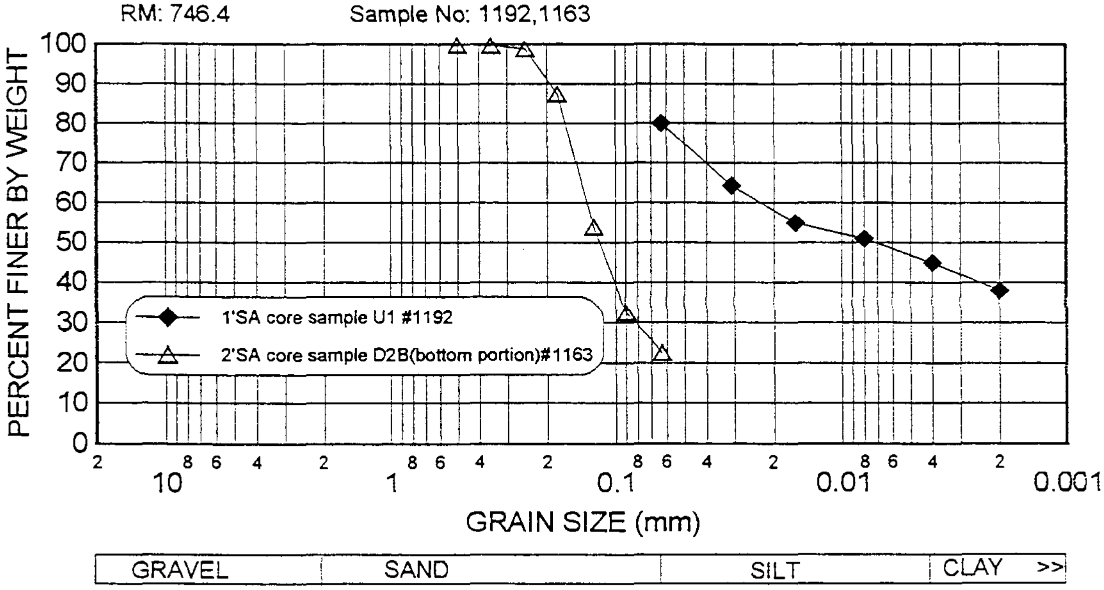
River: UMR
Site No: 5
RM: 746.4

Bank: LDB (mp)
Pool No: 5
Sample No: 1165, 1162, 1166



River: UMR
Site No: 5
RM: 746.4

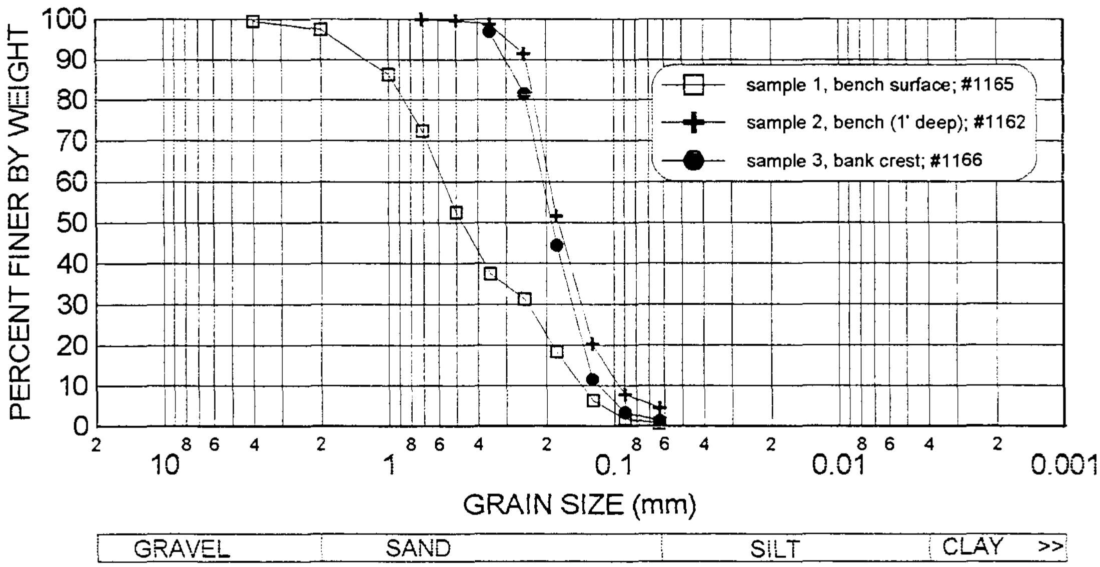
Bank: LDB (core samples from up,dn)
Pool No: 5
Sample No: 1192,1163



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

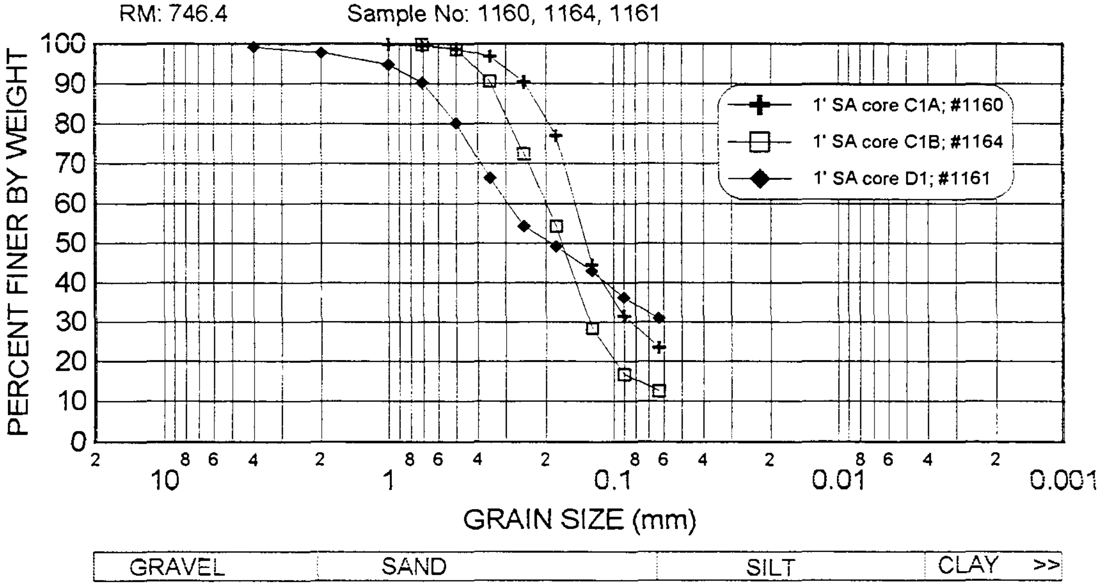
River: UMR
Site No: 5
RM: 746.4

Bank: LDB (mp)
Pool No: 5
Sample No: 1165, 1162, 1166



River: UMR
Site No: 5
RM: 746.4

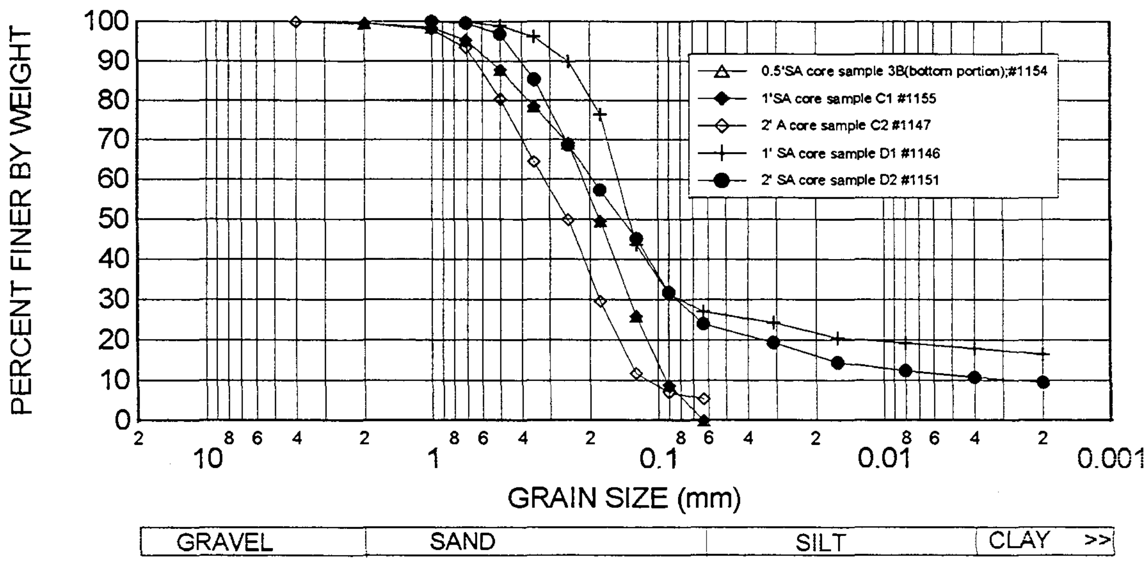
Bank: LDB (core samples from mp, dn)
Pool No: 5
Sample No: 1160, 1164, 1161



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

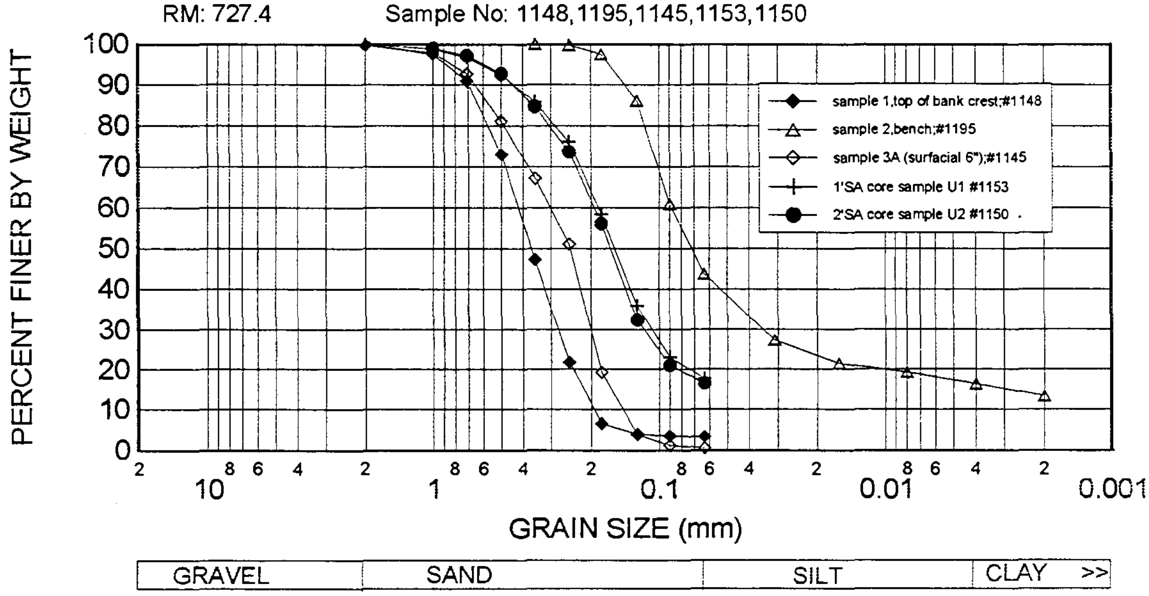
River: UMR
Site No: 6
RM: 727.4

Bank: RDB(core sample from mp and dn)
Pool No: 6
Sample No: 1154,1155,1147,1146,1151



River: UMR
Site No: 6
RM: 727.4

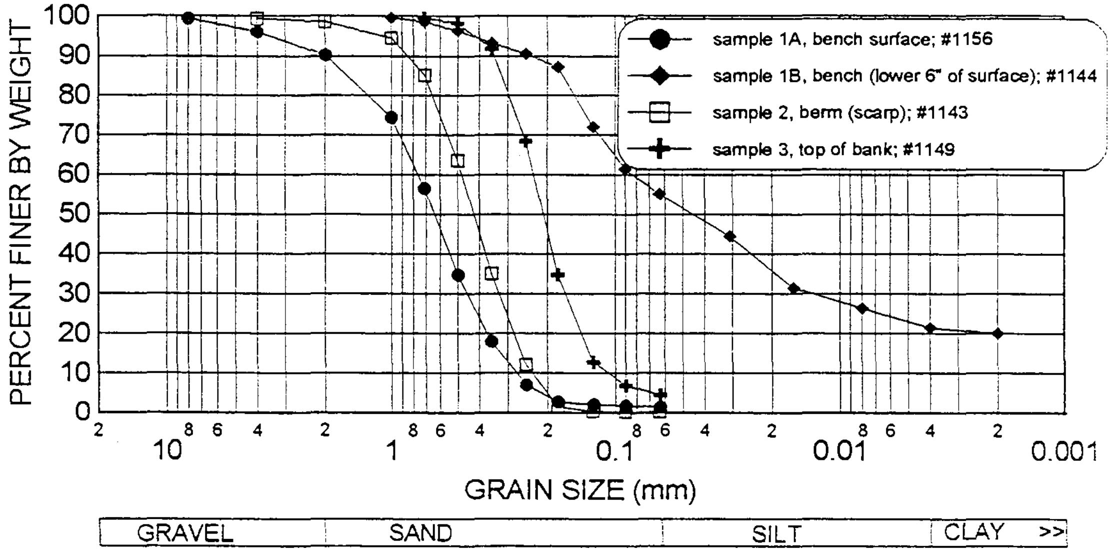
Bank: RDB(mp,up)
Pool No: 6
Sample No: 1148,1195,1145,1153,1150



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

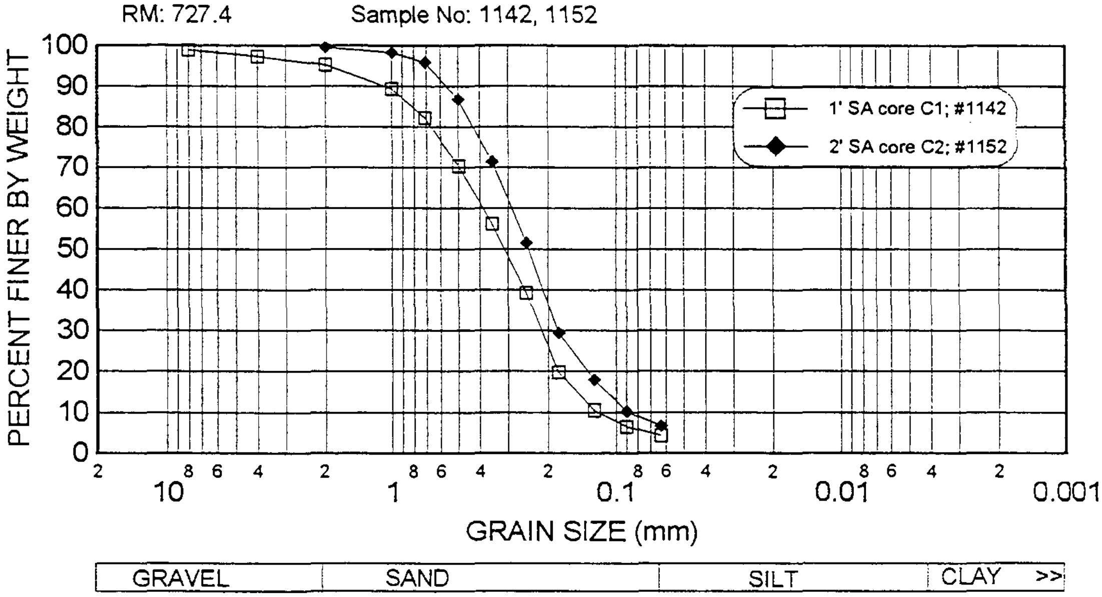
River: UMR
Site No: 7
RM: 727.4

Bank: LDB (mp)
Pool No: 6
Sample No: 1156, 1144, 1143, 1149



River: UMR
Site No: 7
RM: 727.4

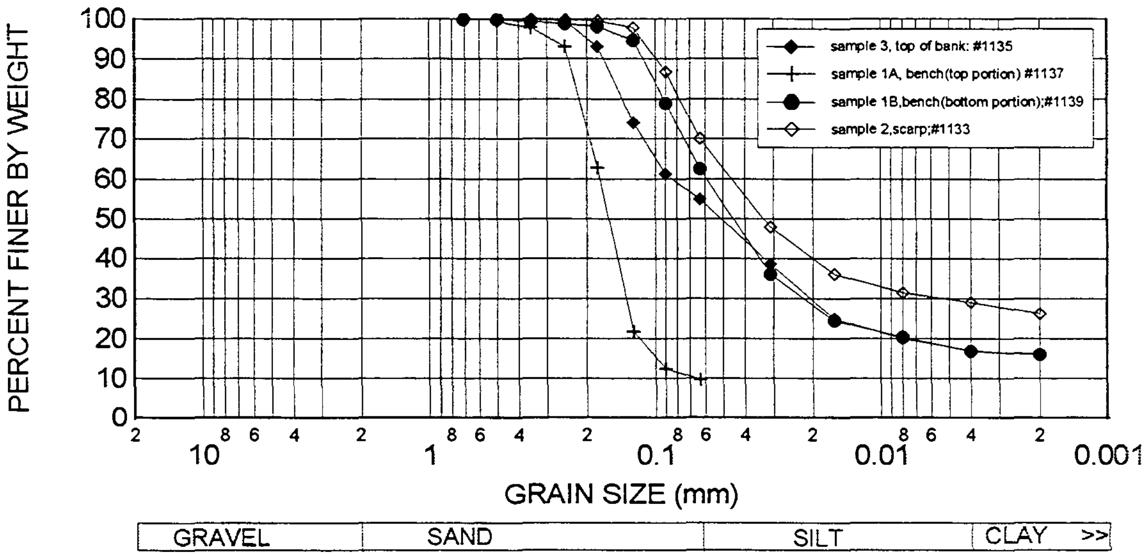
Bank: RDB (core samples from mp)
Pool No: 6
Sample No: 1142, 1152



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

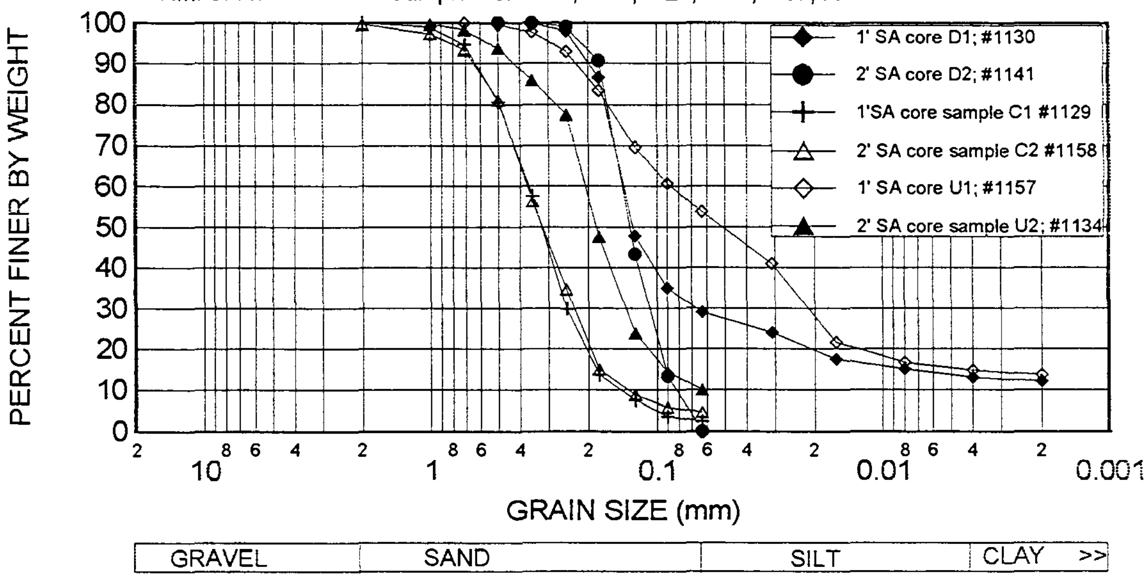
River: UMR
Site No: 8
RM: 677.7

Bank: RDB(mp)
Pool No: 9
Sample No: 1135,1137,1139,1133



River: UMR
Site No: 8
RM: 677.7

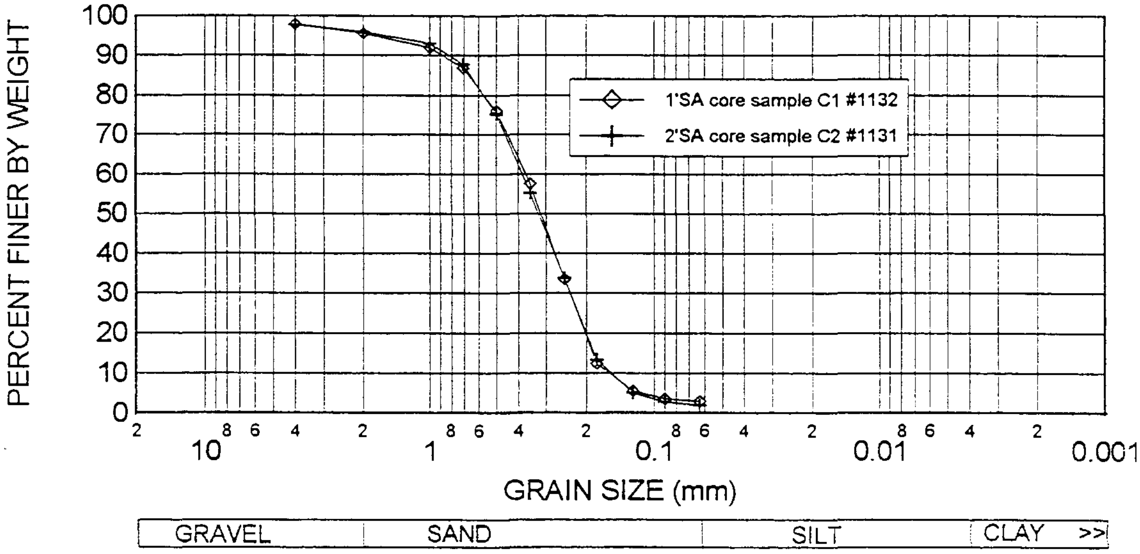
Bank: RDB(core samples from up,mp and dn)
Pool No: 9
Sample No: 1130,1141,1129,1158,1157,1134



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

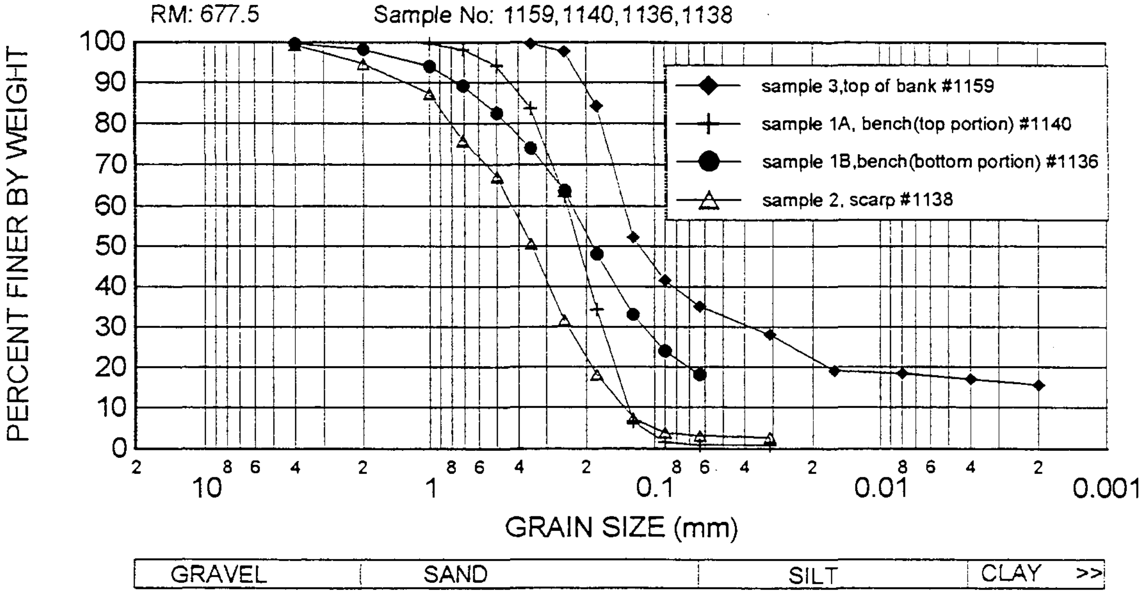
River: UMR
Site No: 9
RM: 677.5

Bank: LDB (core sample mp)
Pool No:9
Sample No: 1132,1131



River: UMR
Site: 9
RM: 677.5

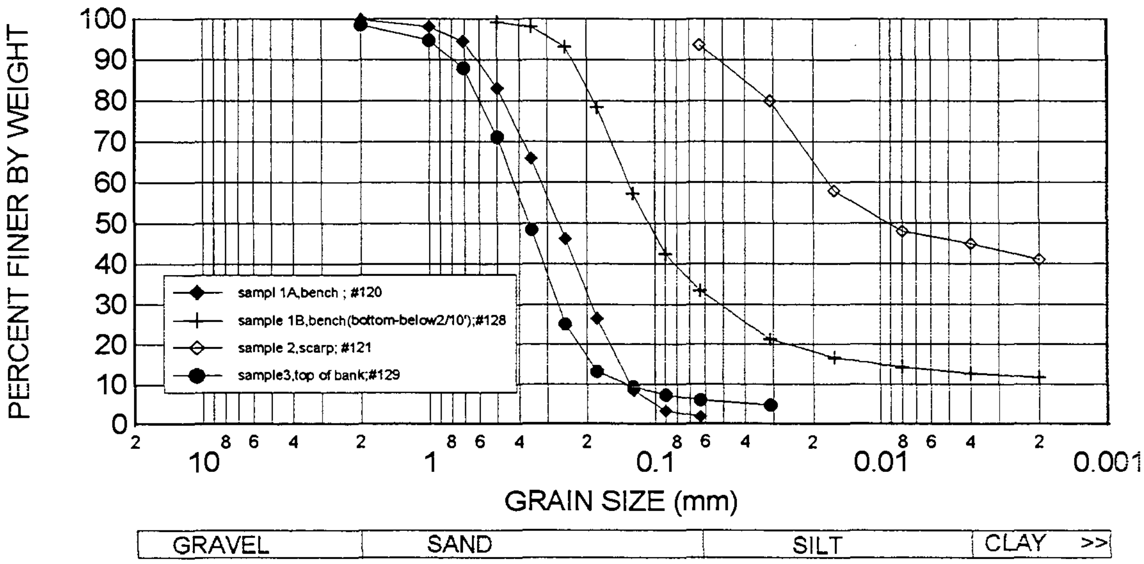
Bank: LDB (mp)
Pool: 9
Sample No: 1159,1140,1136,1138



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

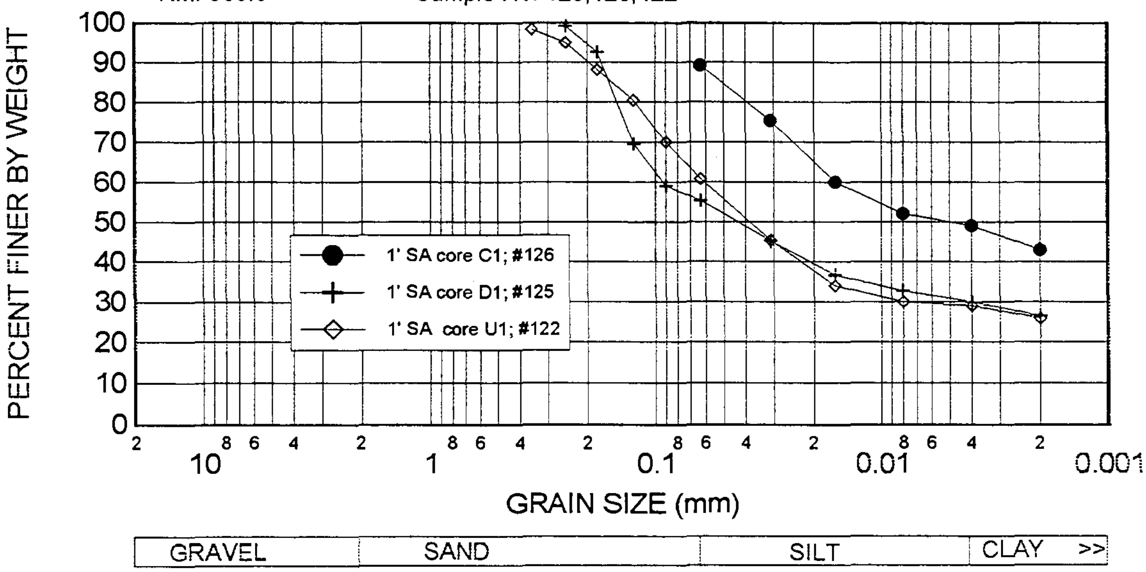
River: UMR
Site No: 10
RM: 669.5

Bank: RDB(surface samples from up,mp,dn)
Pool No: 9
Sample No: 120,128,121,129



River: UMR
Site No: 10
RM: 669.5

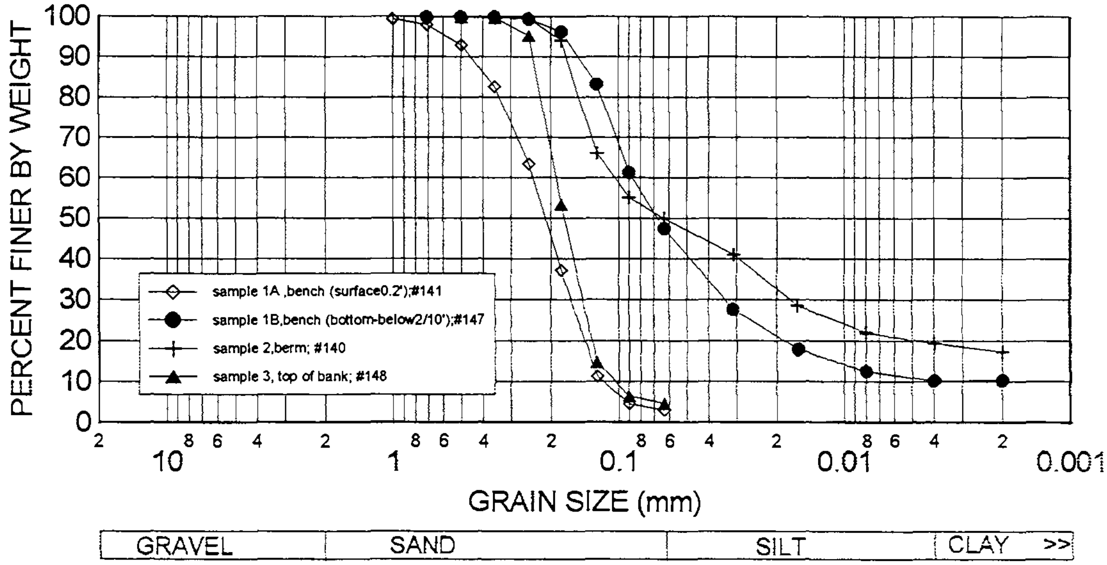
Bank: RDB (core samples from up,mp,dn)
Pool No: 9
Sample No: 126,125,122



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

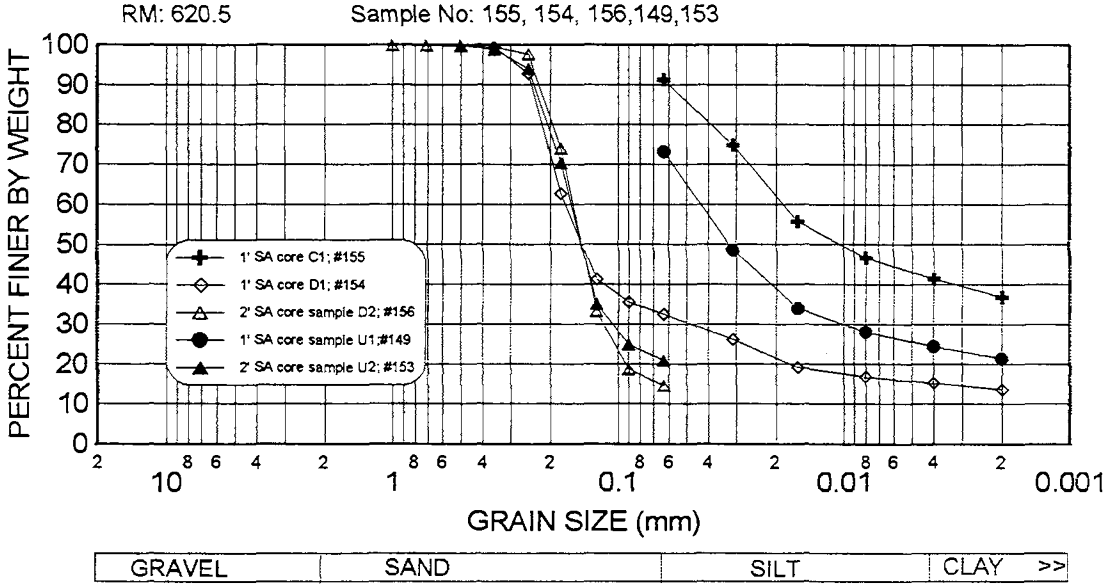
River: UMR
Site No: 11
RM: 620.5

Bank: LDB (mp)
Pool No: 10
Sample No: 141,147,140,148



River: UMR
Site No: 11
RM: 620.5

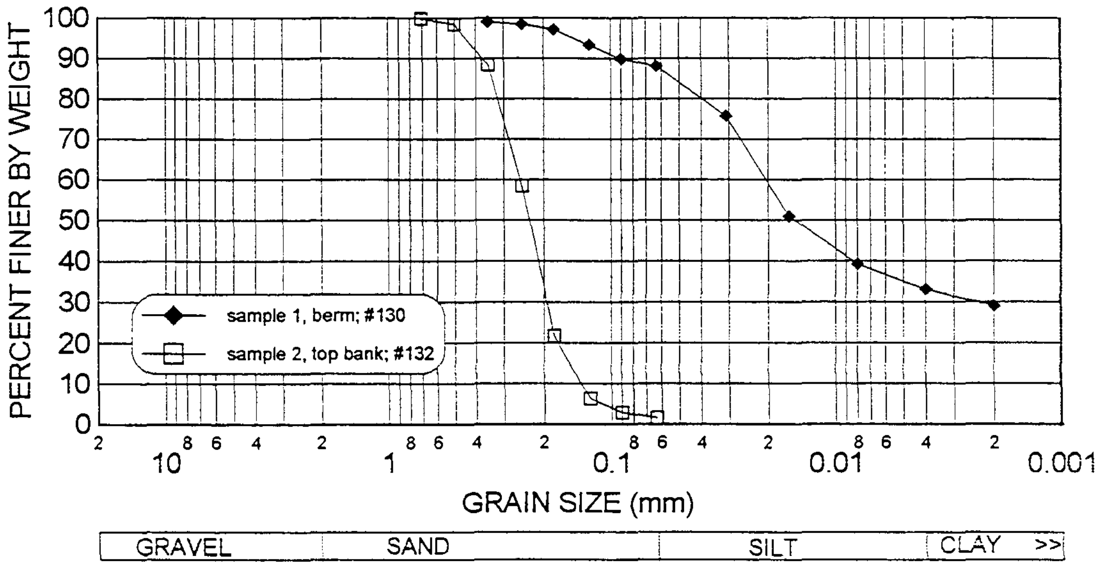
Bank: LDB (core samples from up, mp, and dn)
Pool No: 10
Sample No: 155, 154, 156,149,153



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

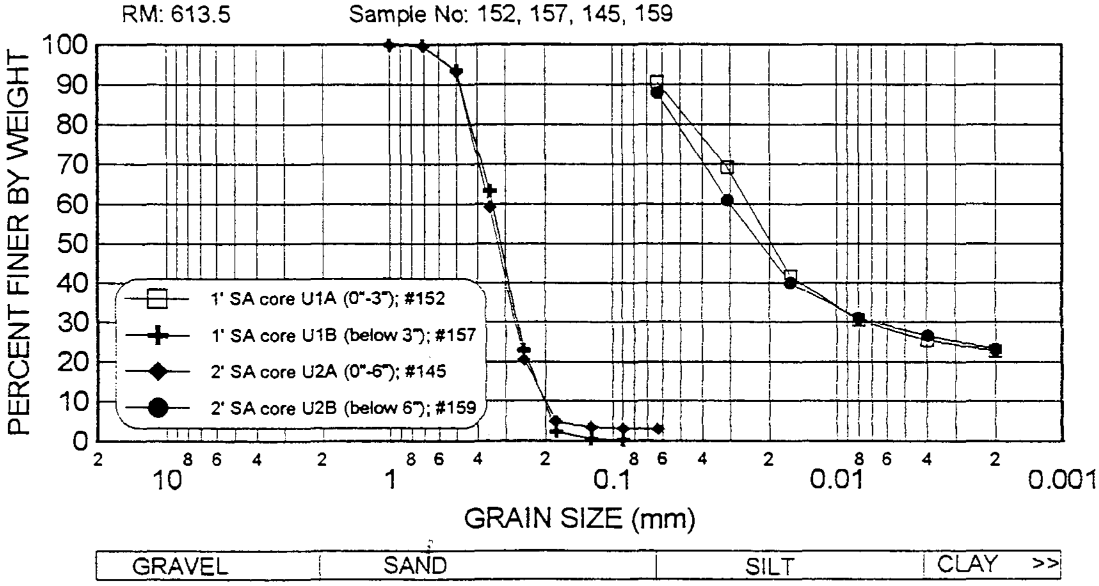
River: UMR
Site No: 12
RM: 613.6

Bank: LDB (mp)
Pool No: 11
Sample No: 130, 132

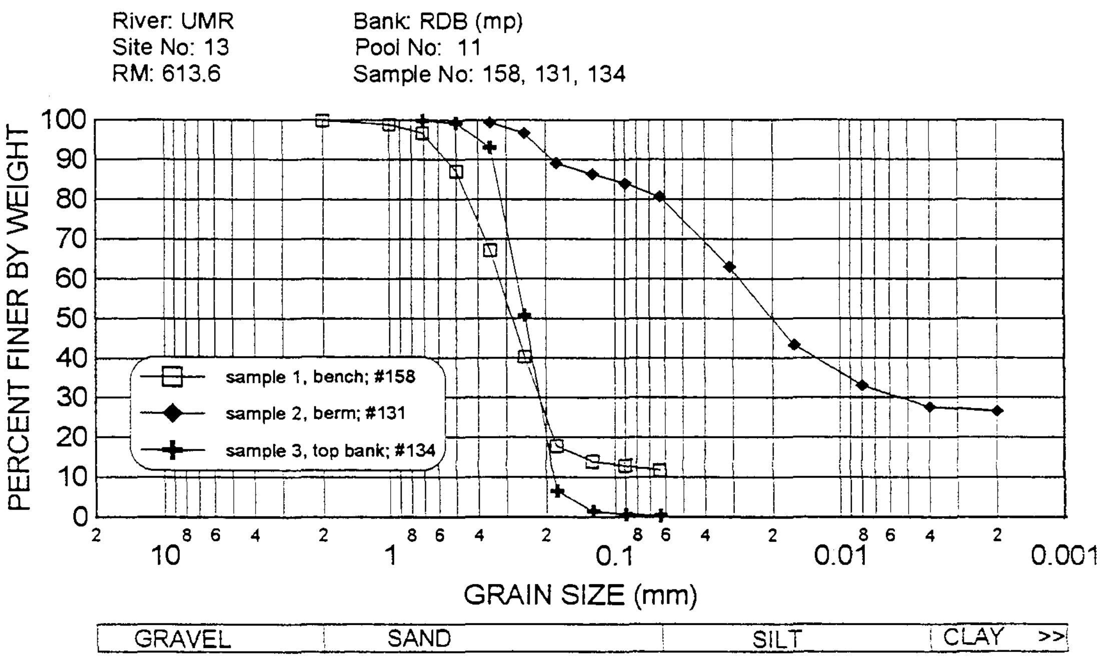


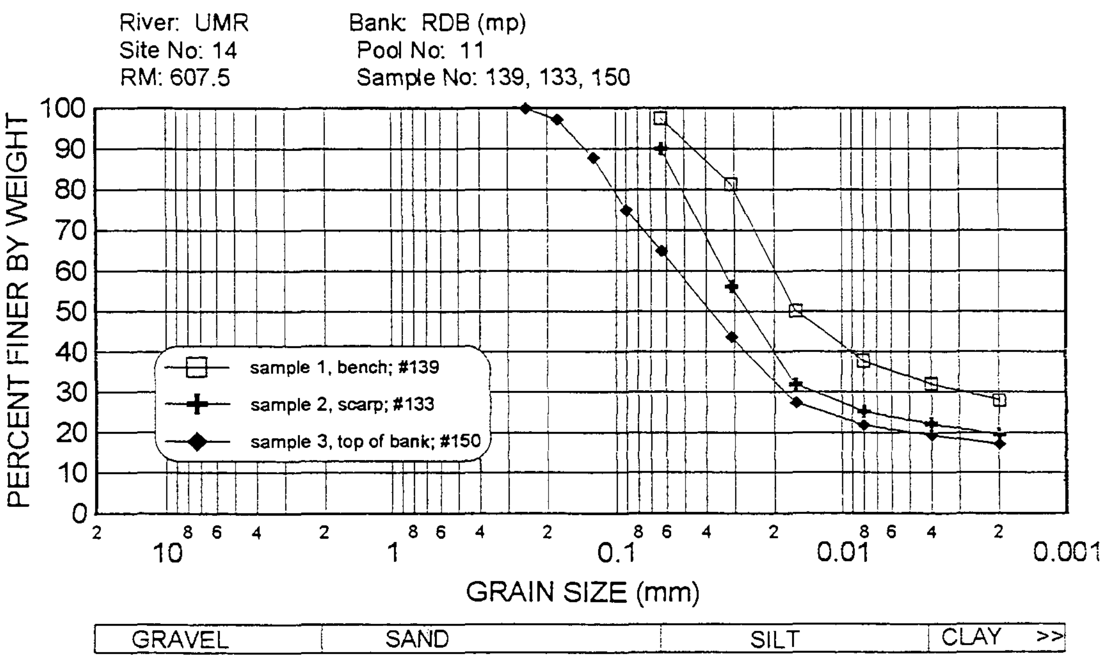
River: UMR
Site No: 12
RM: 613.5

Bank: LDB (core samples from up)
Pool No: 11
Sample No: 152, 157, 145, 159



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

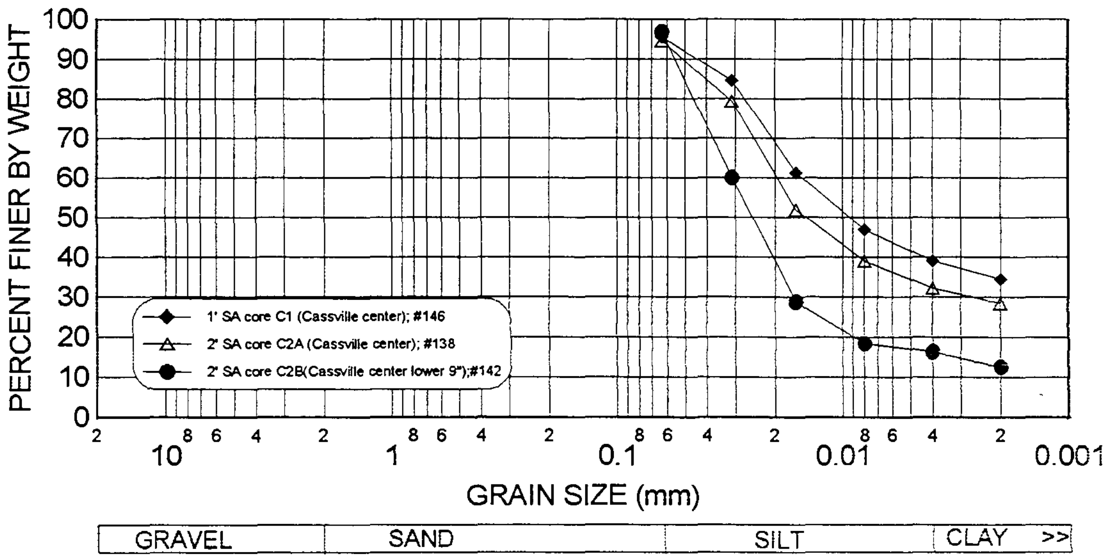




ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

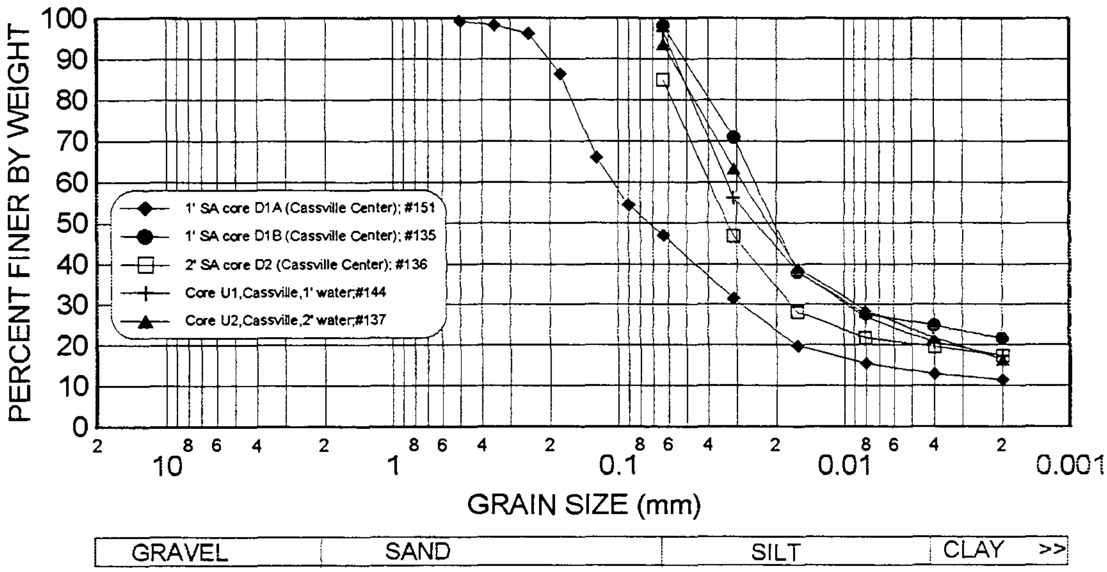
River: UMR
Site No: 14
RM: 607.5

Bank: RDB (core samples from mp,dn)
Pool No: 11
Sample No: 146, 138,142



River: UMR
Site No: 14
RM: 607.5

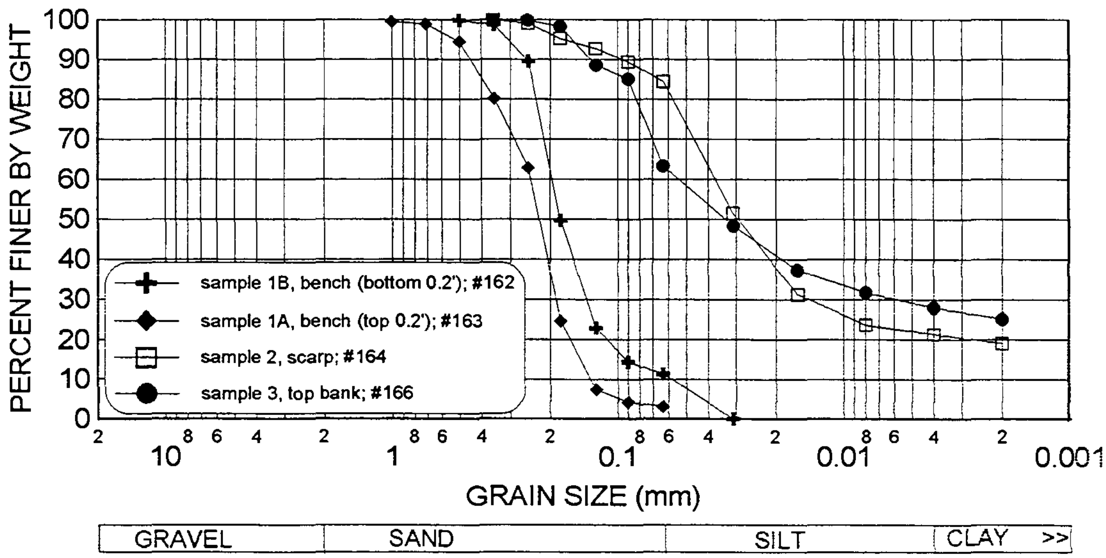
Bank: RDB (core samples from dn,up)
Pool No: 12
Sample No: 151, 135, 136, 144,137



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

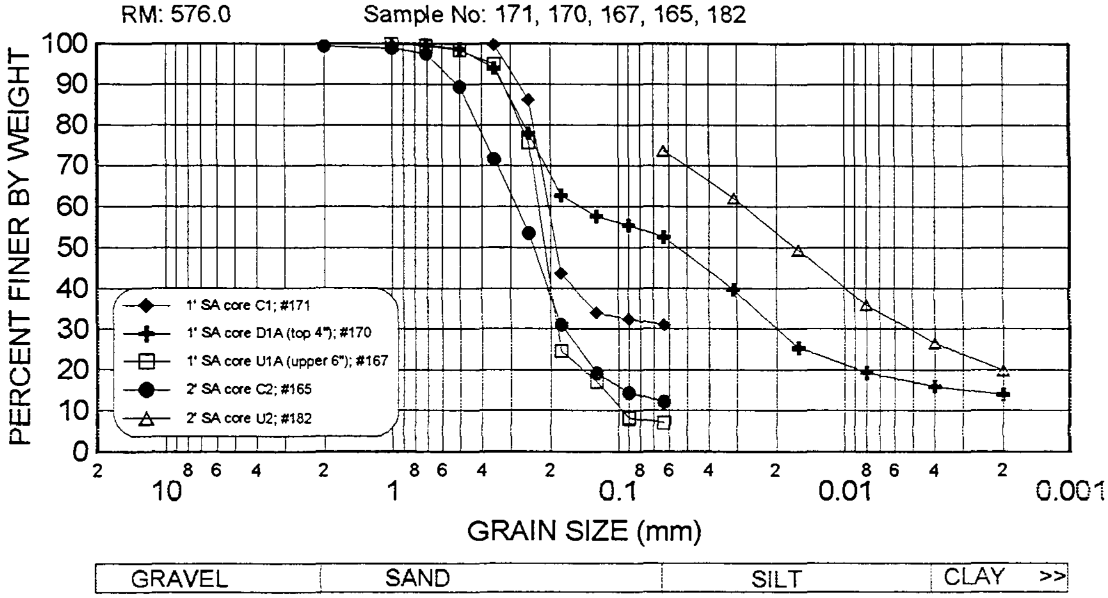
River: UMR
Site No: 15
RM: 576.0

Bank: LDB (mp)
Pool No: 12
Sample No: 162, 163, 164, 166



River: UMR
Site No: 15
RM: 576.0

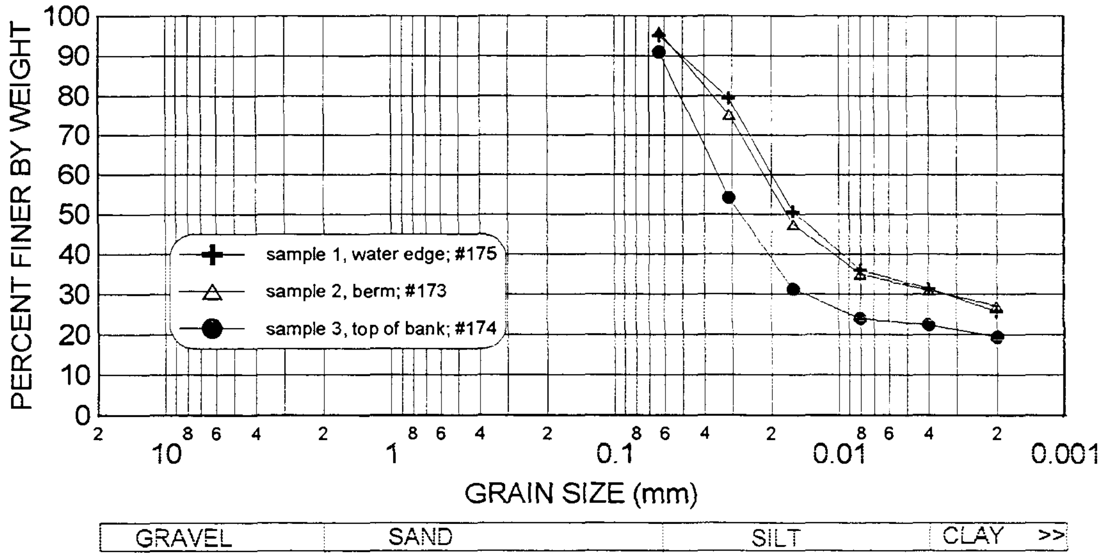
Bank: LDB (core samples from up and dn)
Pool No: 12
Sample No: 171, 170, 167, 165, 182



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

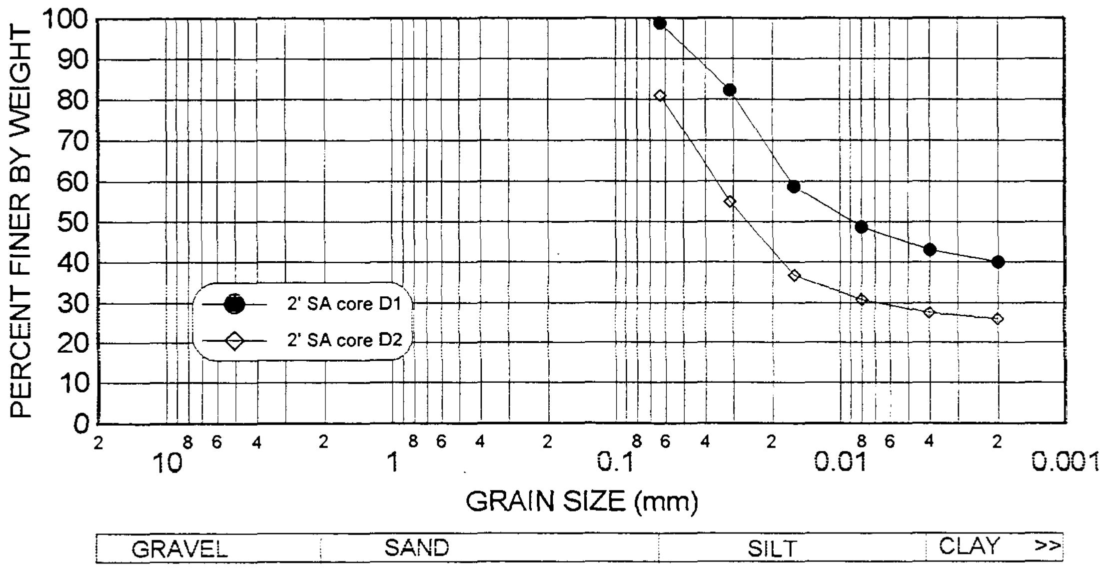
River: UMR
Site No: 16
RM: 551.9

Bank: LDB (mp)
Pool No: 13
Sample No: 175, 173, 174



River: UMR
Site No: 16
RM: 551.9

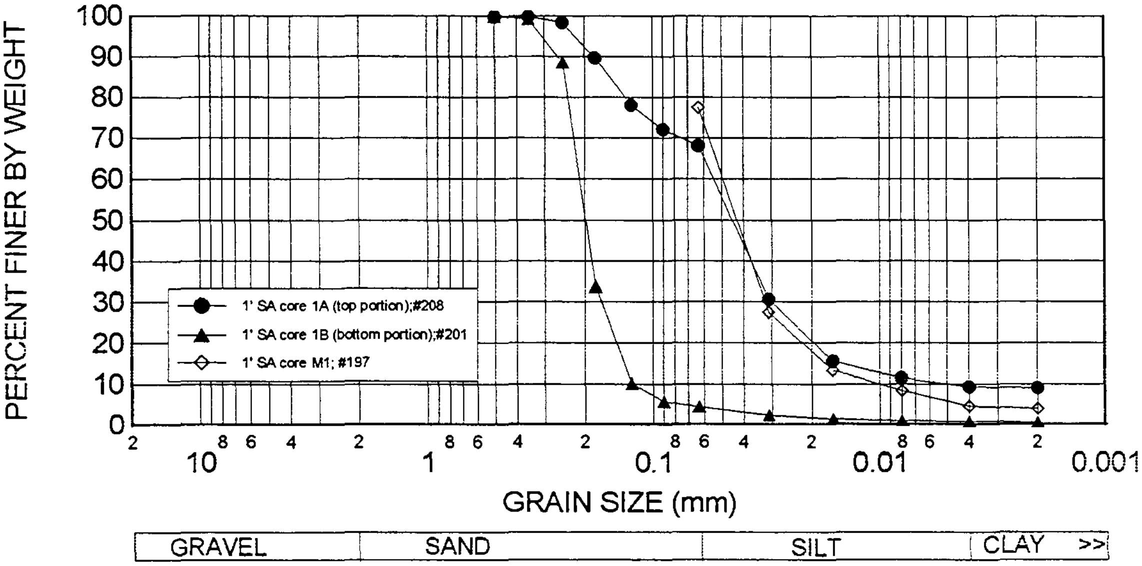
Bank: LDB (core samples from dn)
Pool No: 13
Sample No: 178, 180



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

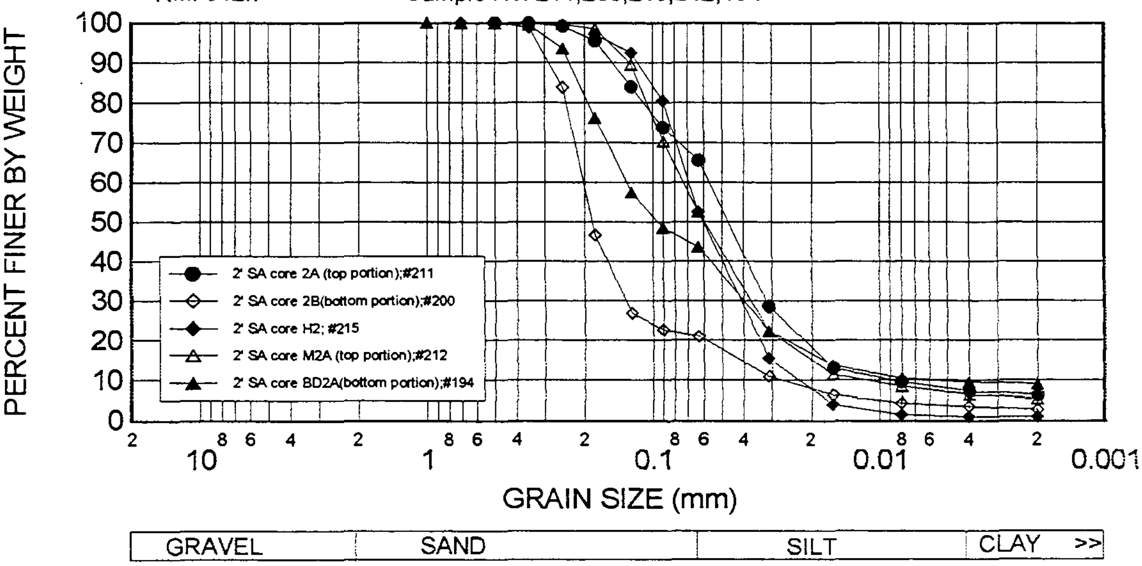
River: UMR
Site No: 17
RM: 512.7

Bank: LDB(core samples,mp and isld toe)
Pool No: 14
Sample No: 208,201,197



River: UMR
Site No: 17
RM: 512.7

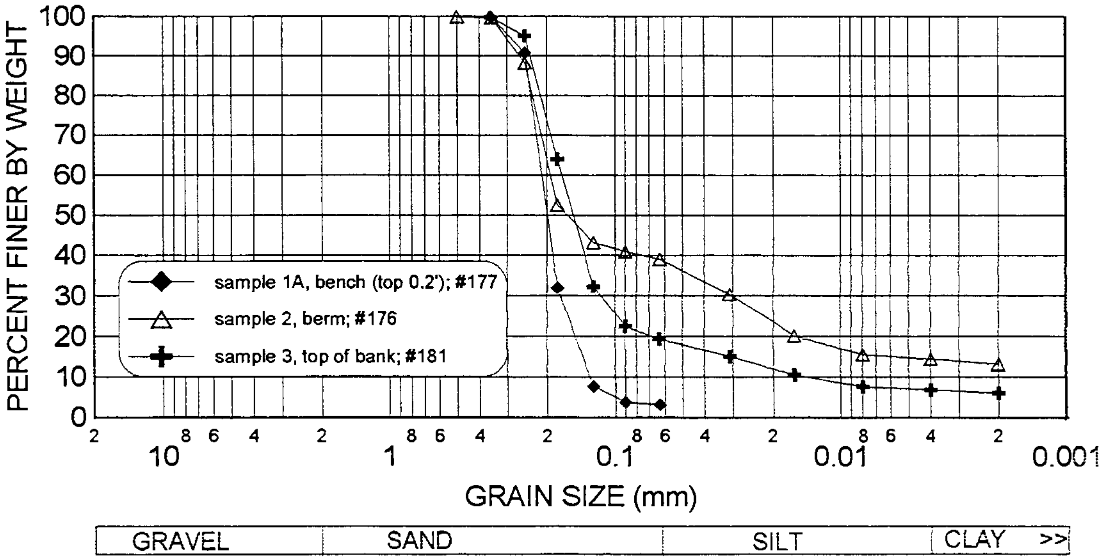
Bank: LDB(isld toe,up lmt head isld,mp and back channel dn)
Pool No: 14
Sample No: 211,200,215,212,194



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

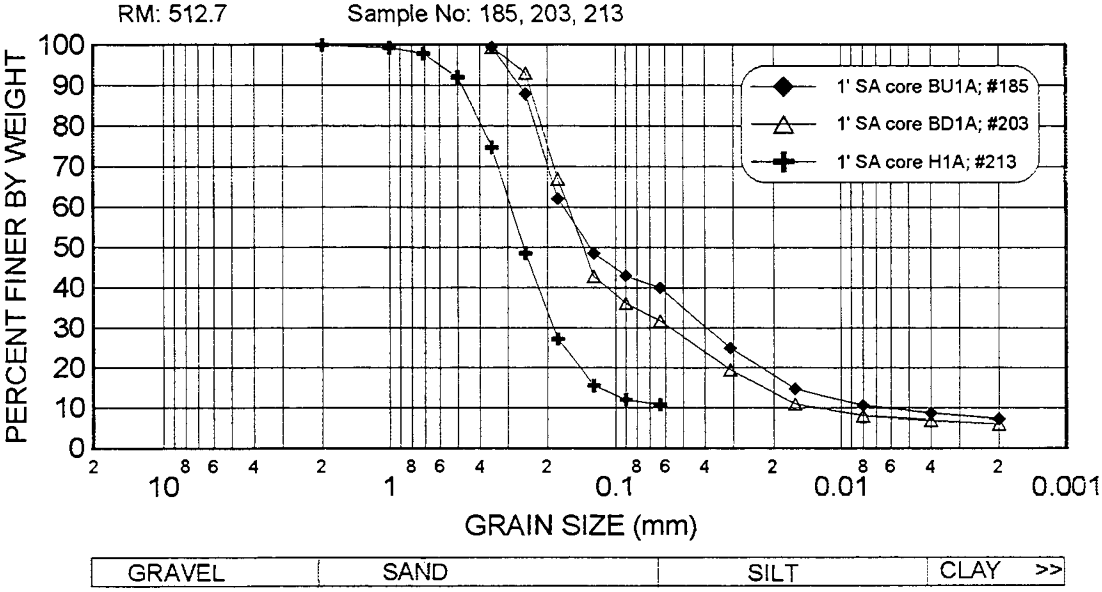
River: UMR
Site No: 17
RM: 512.7

Bank: LDB (mp)
Pool No: 14
Sample No: 177, 176, 181



River: UMR
Site No: 17
RM: 512.7

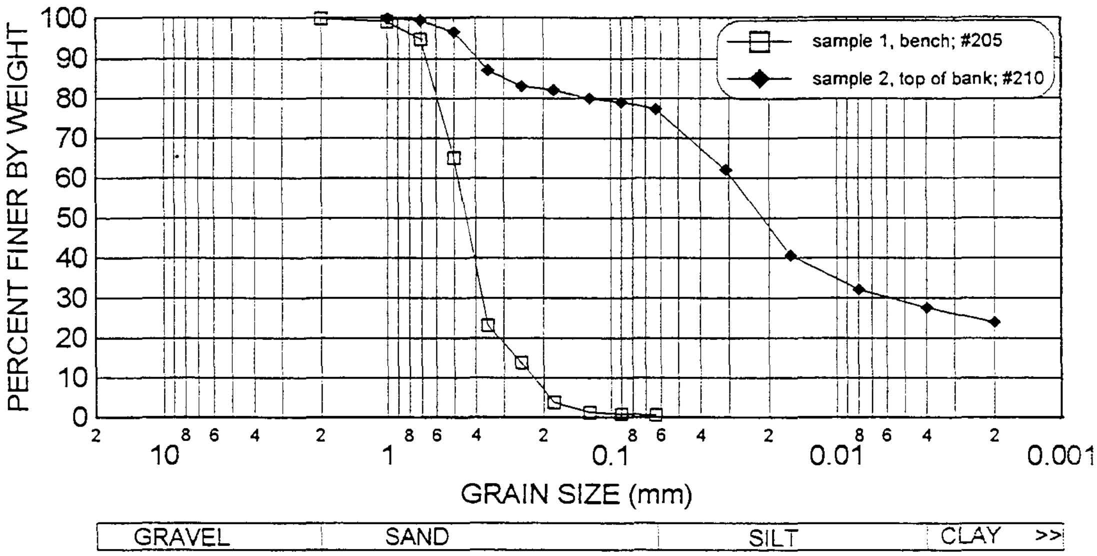
Bank: LDB (core samples from back channel and Head Island)
Pool No: 14
Sample No: 185, 203, 213



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

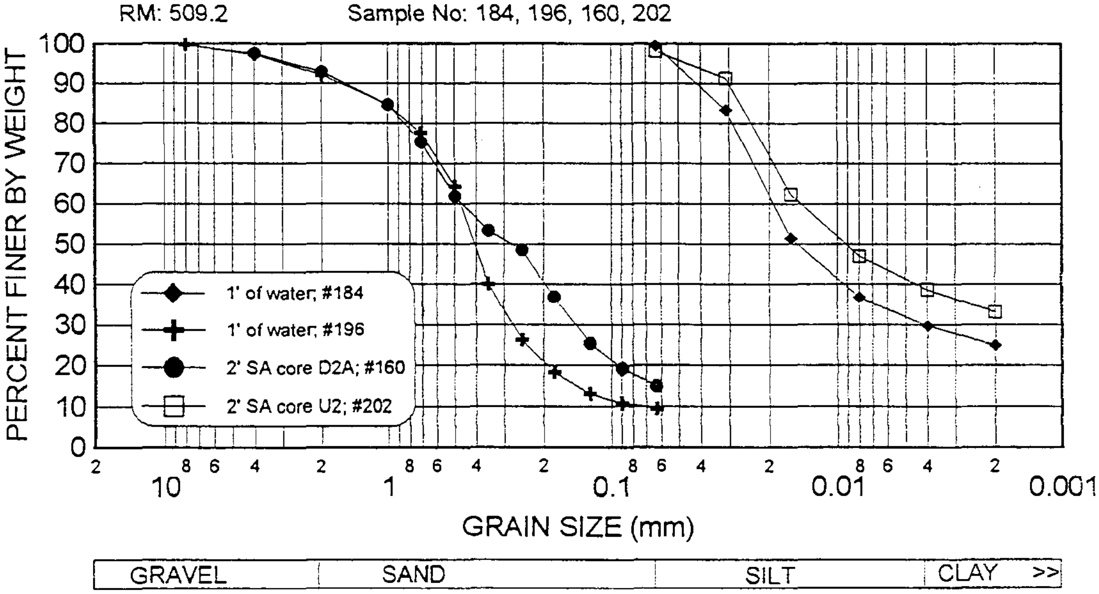
River: UMR
Site No: 18
RM: 509.2

Bank: RDB (mp)
Pool No: 14
Sample No: 205, 210



River: UMR
Site No: 18
RM: 509.2

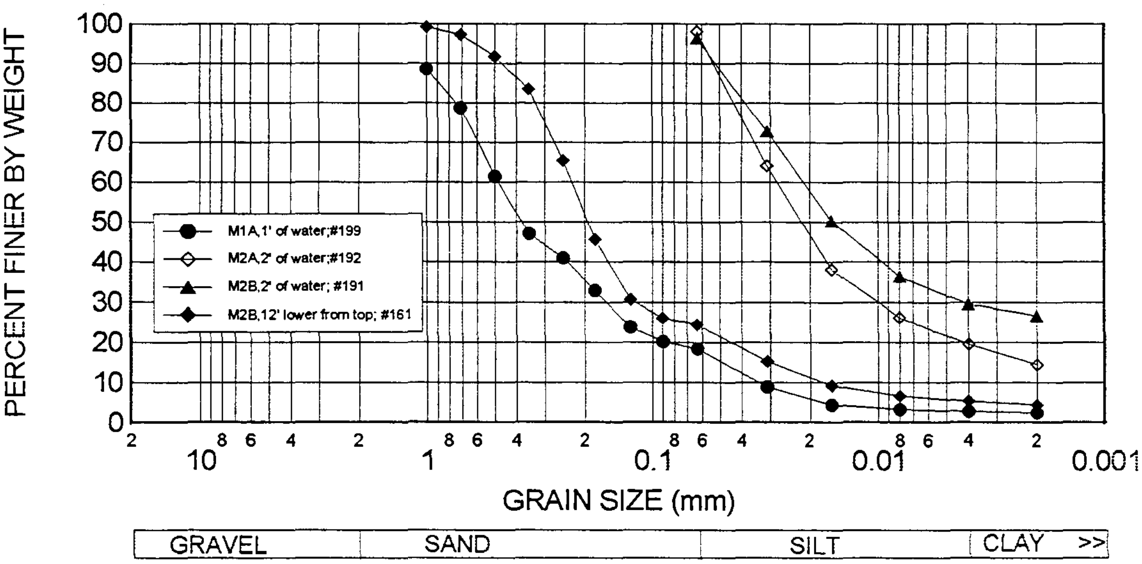
Bank: RDB (core samples from up and dn)
Pool No: 14
Sample No: 184, 196, 160, 202



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: UMR
Site No: 18
RM: 509.2

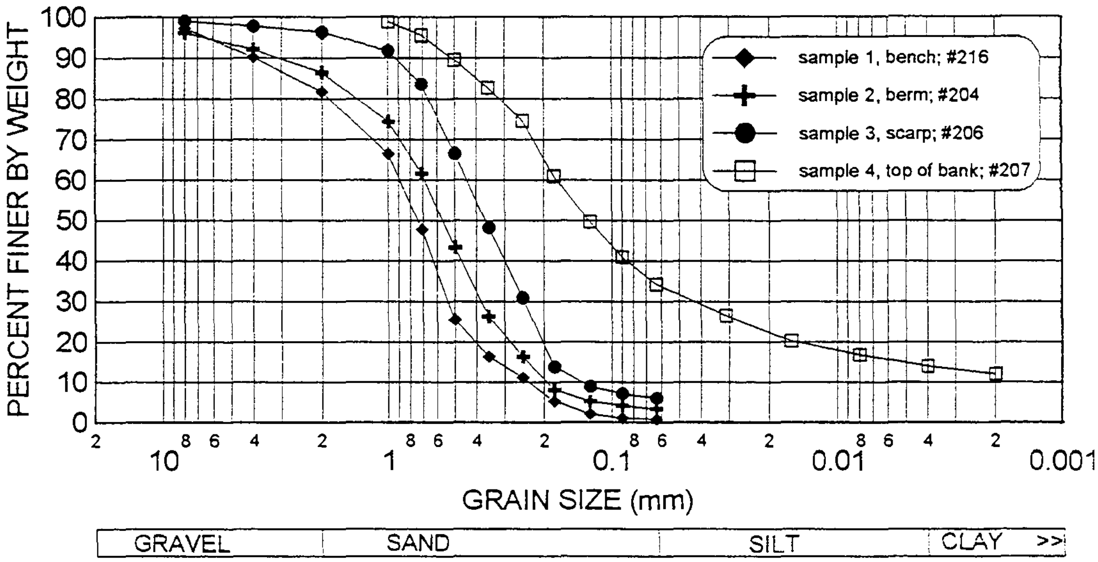
Bank: RDB(mp)
Pool No: 14
Sample No: 199,192,191,161



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

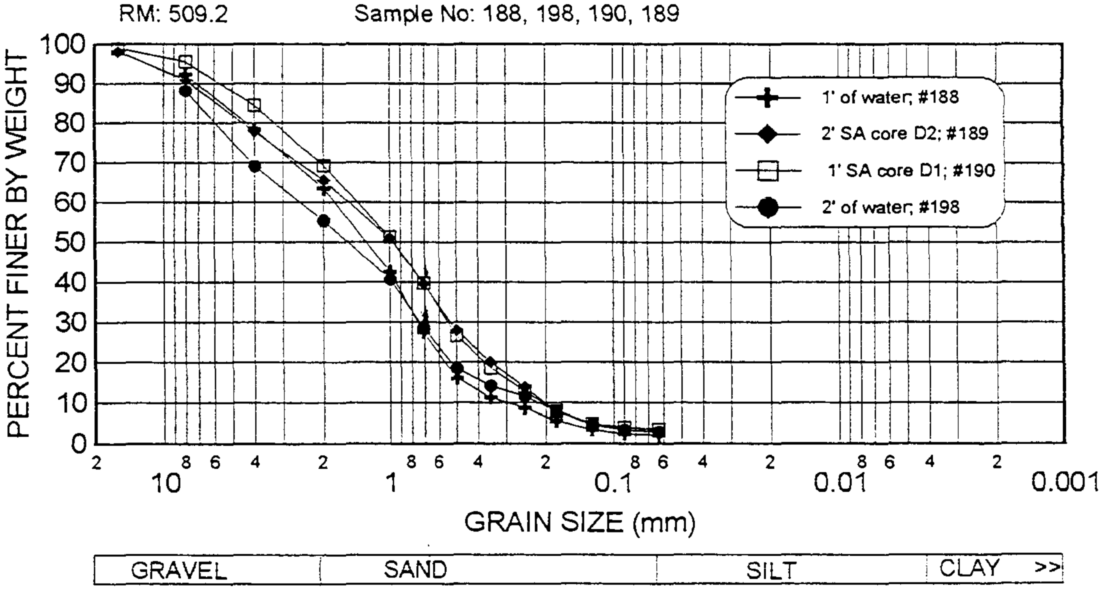
River: UMR
Site No: 19
RM: 509.2

Bank: RDB (mp)
Pool No: 14
Sample No: 216, 204, 206, 207



River: UMR
Site No: 19
RM: 509.2

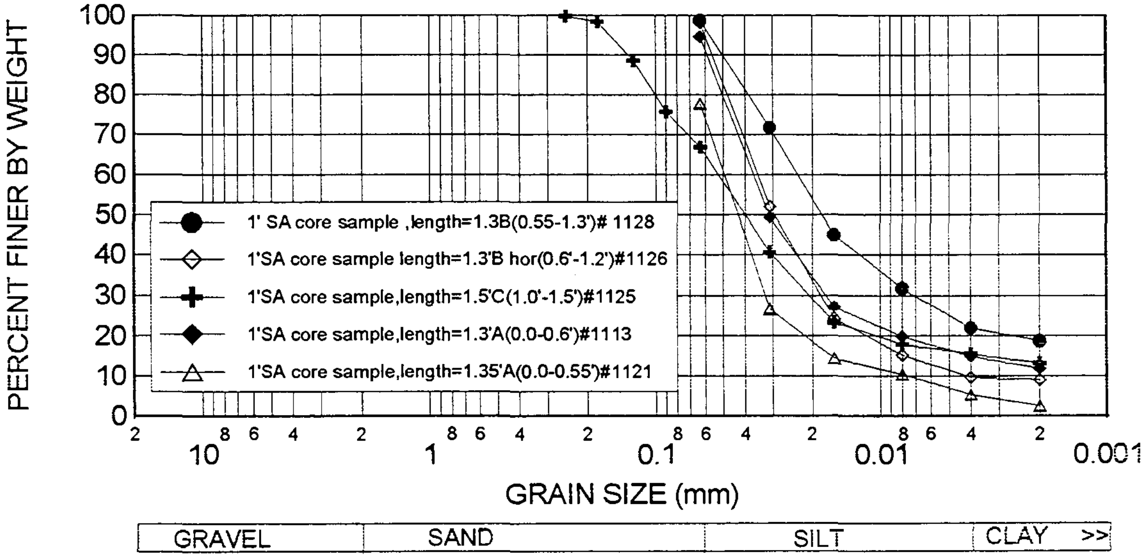
Bank: LDB (core samples from dn)
Pool No: 14
Sample No: 188, 198, 190, 189



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

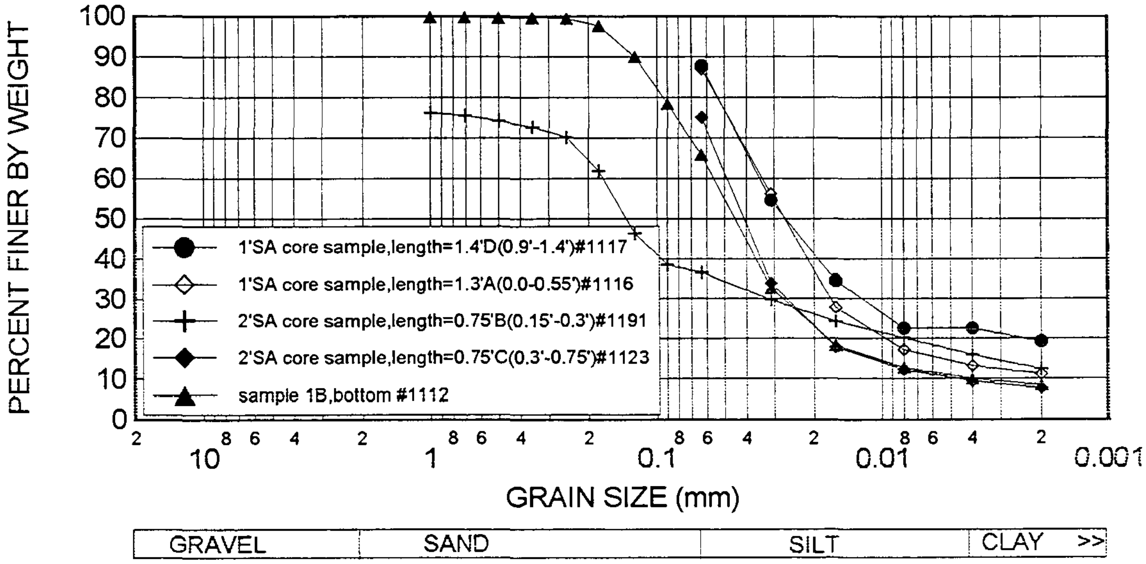
River: UMR
Site No: 21
RM: 466.7

Bank: LDB(core samples ,mp)
Pool No: 16
Sample No: 1128,1126,11251113,1121



River: UMR
Site No: 21
RM: 466.7

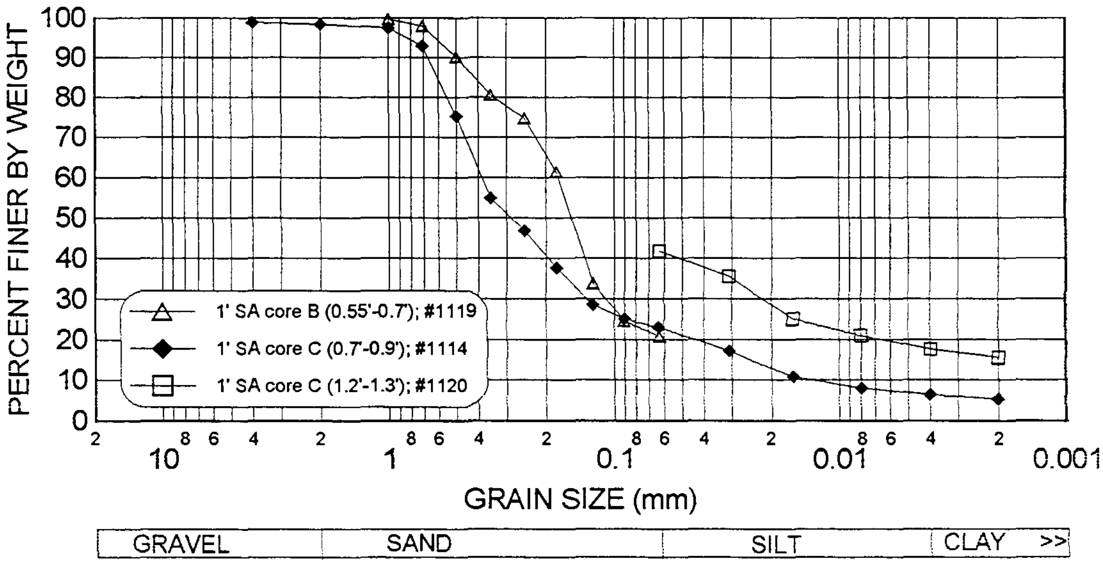
Bank: LDB(core and bottom samples,from mp,up1/3,isld toe)
Pool No: 16
Sample No: 1117,1116,1191,1123,1112



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

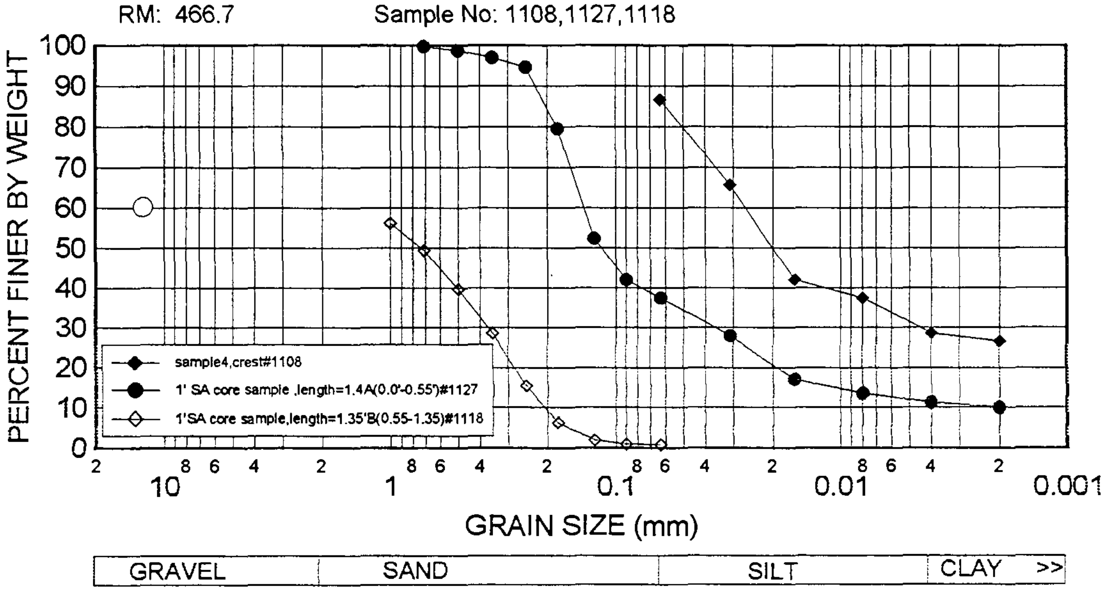
River: UMR
Site No: 21
RM: 466.7

Bank: LDB (core samples from island head and toe)
Pool No: 16
Sample No: 1119, 1114, 1120



River: UMR
Site No: 21
RM: 466.7

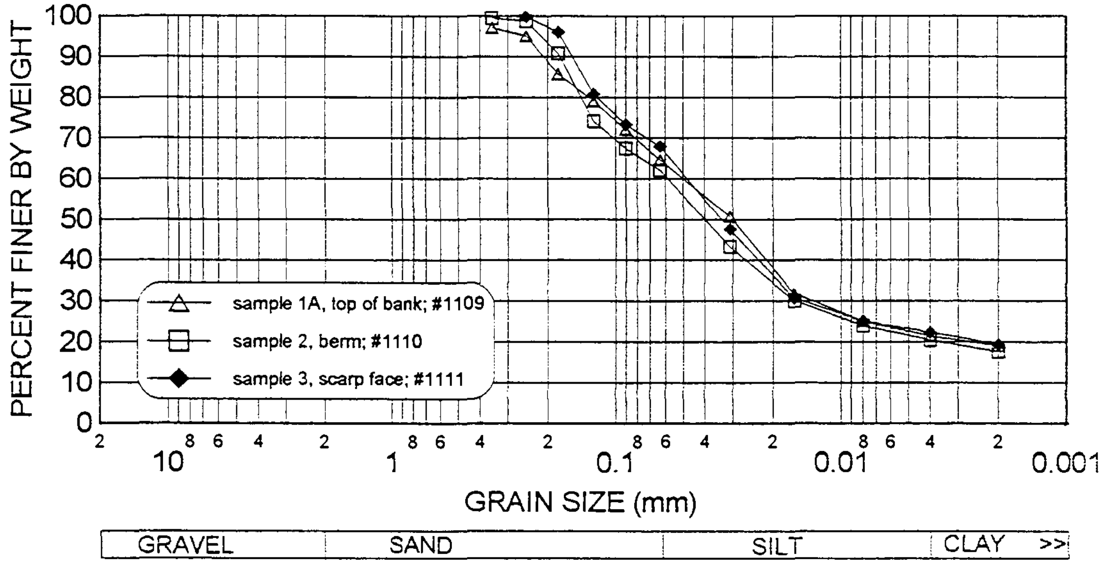
Bank: LDB
Pool No: 16
Sample No: 1108,1127,1118



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

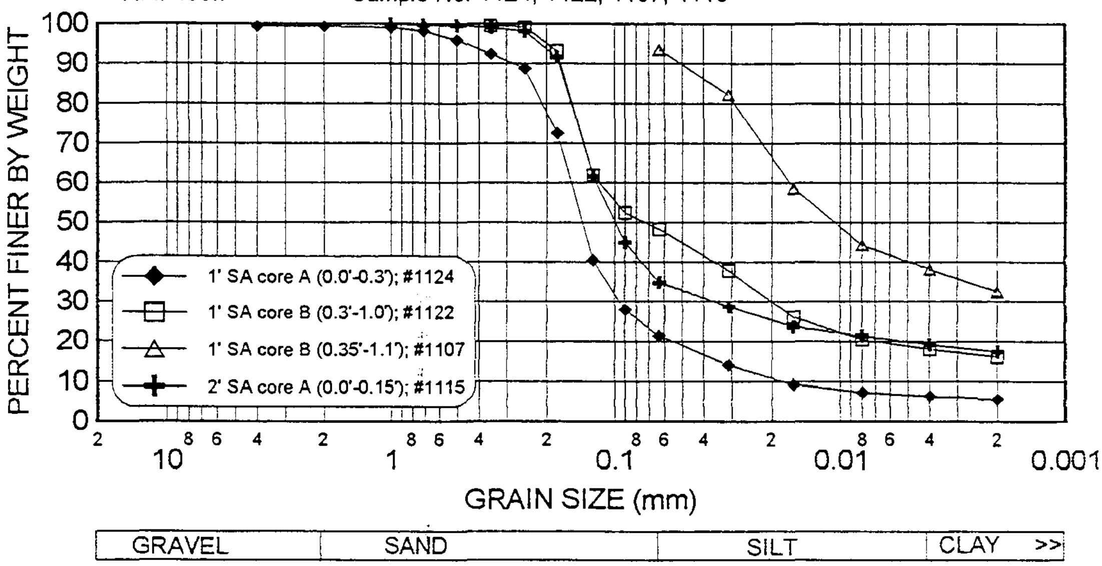
River: UMR
Site No: 21
RM: 466.7

Bank: LDB (mp)
Pool No: 16
Sample No: 1109, 1110, 1111



River: UMR
Site No: 21
RM: 466.7

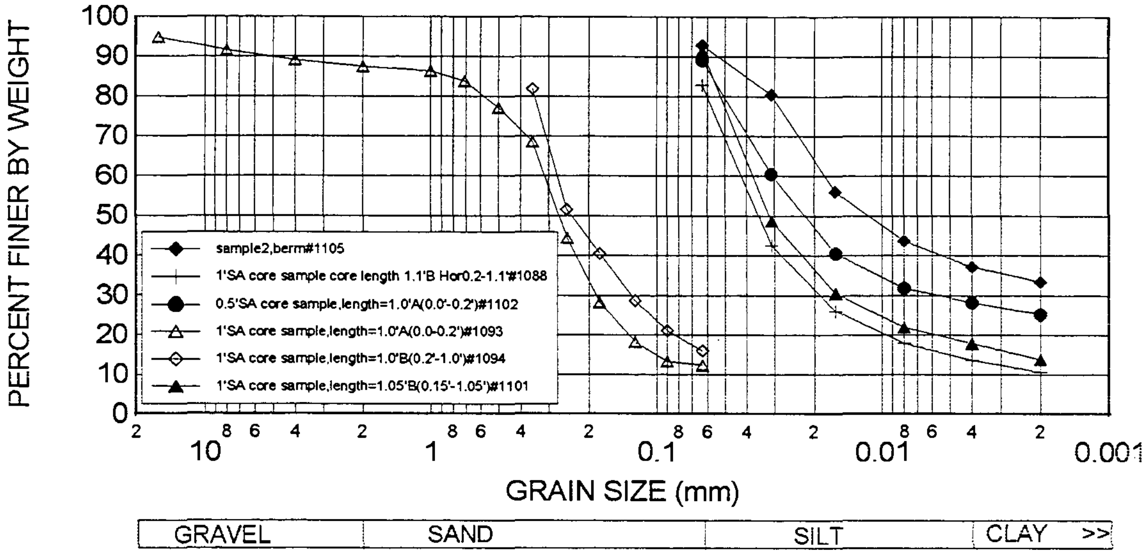
Bank: LDB (core samples from mp)
Pool No: 16
Sample No: 1124, 1122, 1107, 1115



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

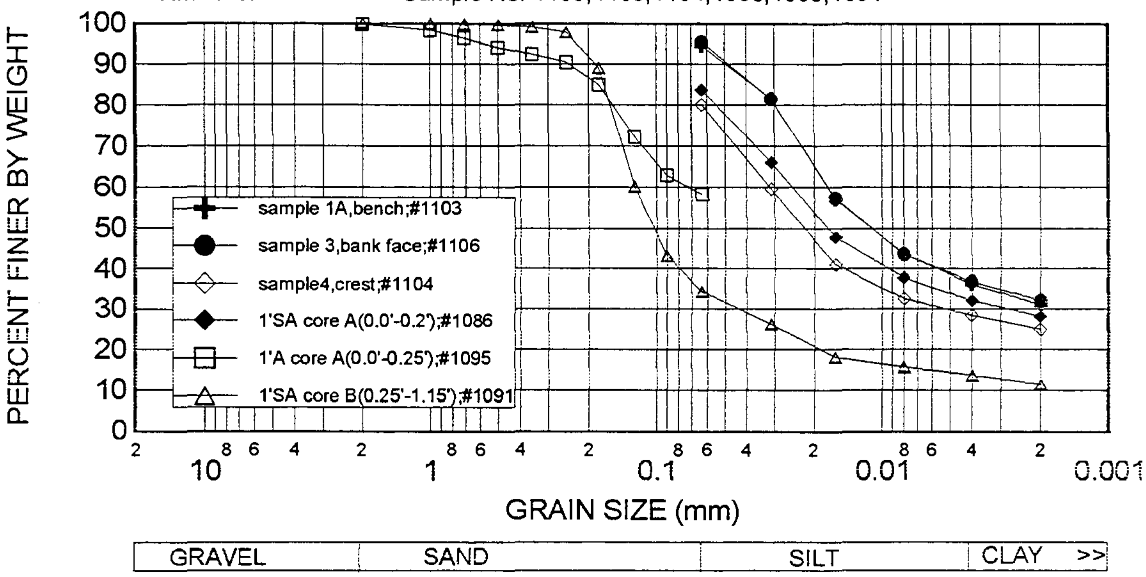
River: UMR
Site No: 22
RM: 436.4

Bank: LDB(berm and core sample from up,md dn)
Pool No: 18
Sample No: 1105,1088,1102,1093,1094,1101



River: UMR
Site No: 22
RM: 436.4

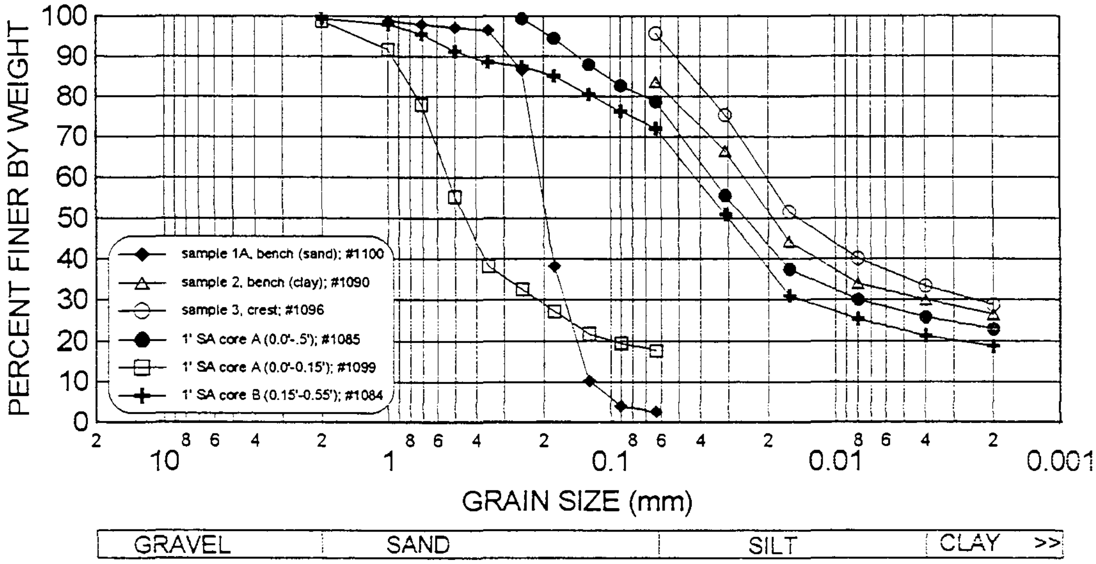
Bank: LDB(core and surface samples from mp,up)
Pool No: 18
Sample No: 1103,1106,1104,1086,1095,1091



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

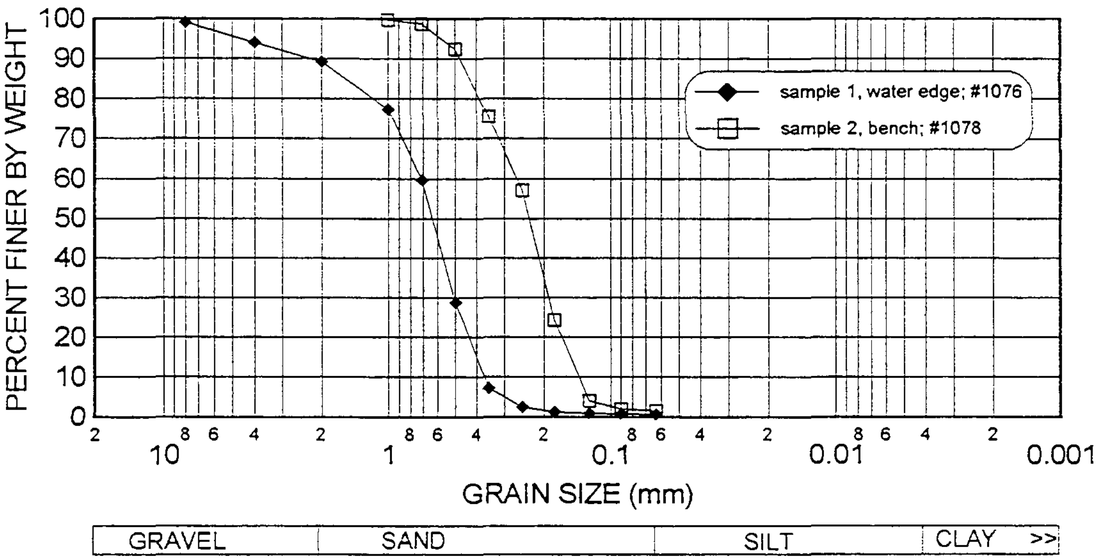
River: UMR
Site No: 23
RM: 436.4

Bank: RDB (core and surface samples from up, dn)
Pool No: 18
Sample No: 1100, 1090, 1096, 1085, 1099, 1084



River: UMR
Site No: 24
RM: 432.3

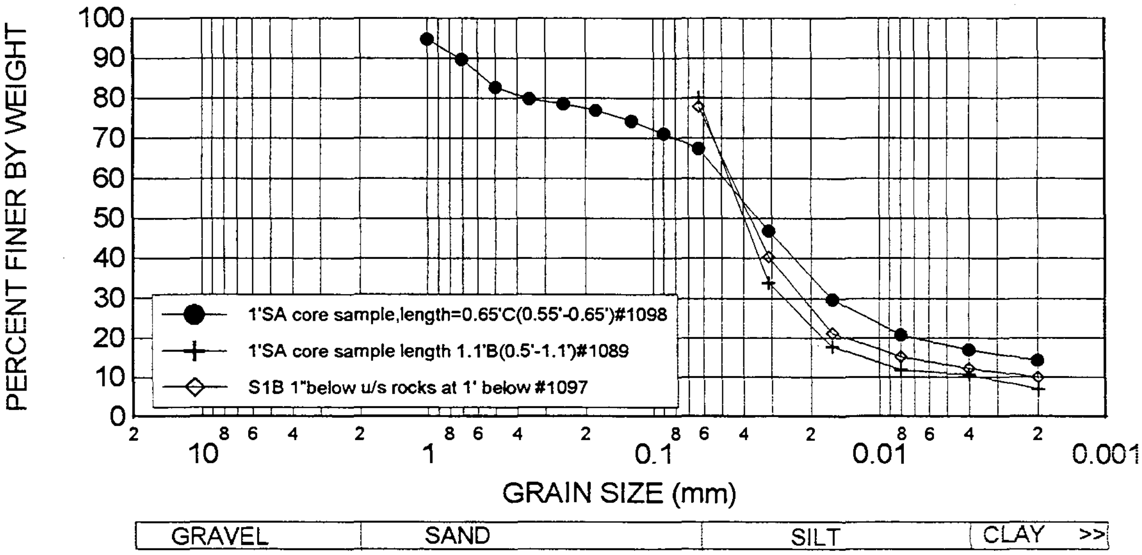
Bank: LDB (mp)
Pool No: 18
Sample No: 1076, 1078



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: UMR
Site No: 23
RM: 436.4

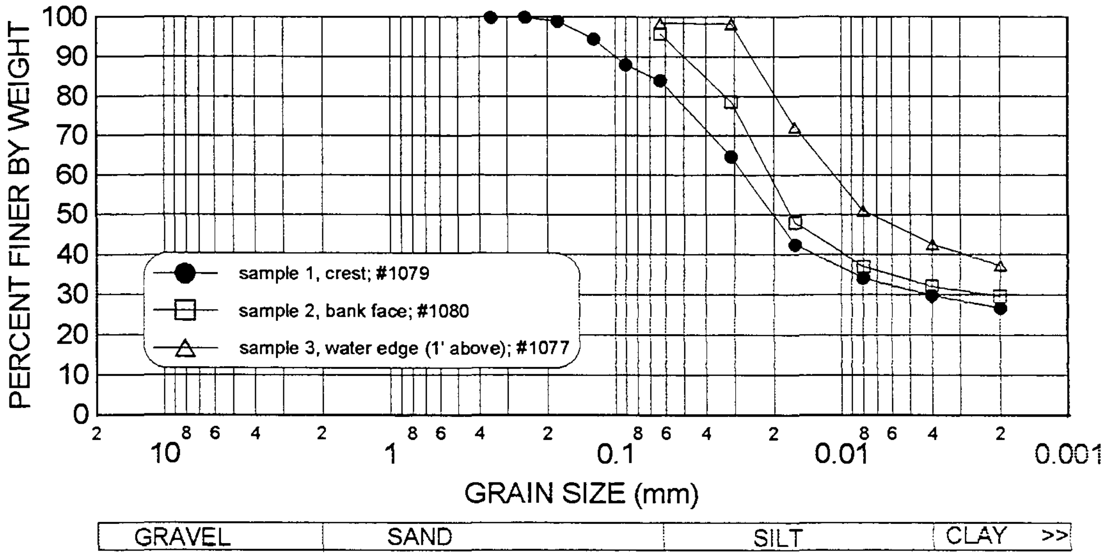
Bank: RDB(core samples from dn,up)
Pool No: 18
Sample No: 1098,1089,1097



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

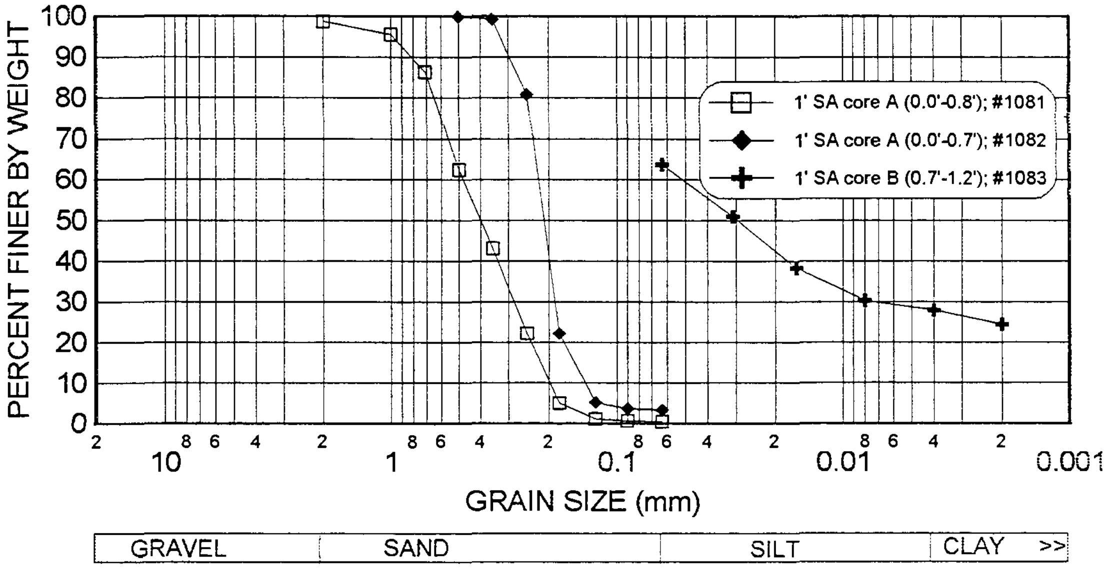
River: UMR
Site No: 25
RM: 432.3

Bank: RDB (mp)
Pool No: 18
Sample No: 1079, 1080, 1077



River: UMR
Site No: 25
RM: 432.3

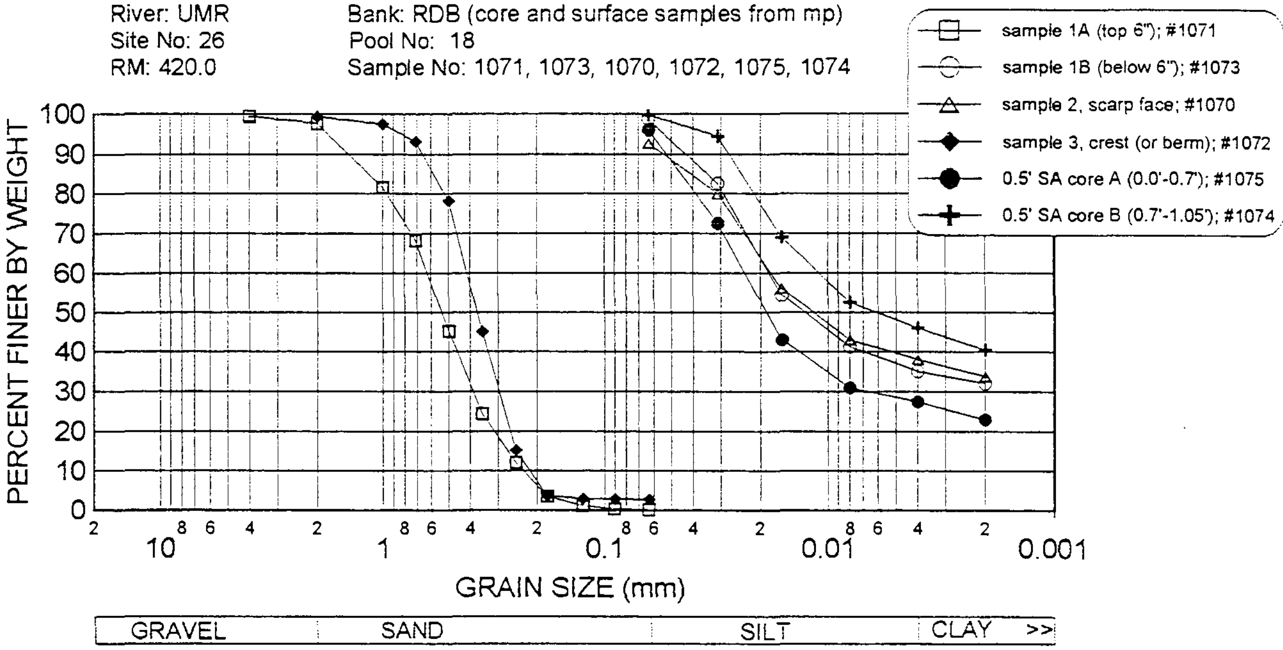
Bank: RDB (core samples from mp)
Pool No: 18
Sample No: 1081, 1082, 1083



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

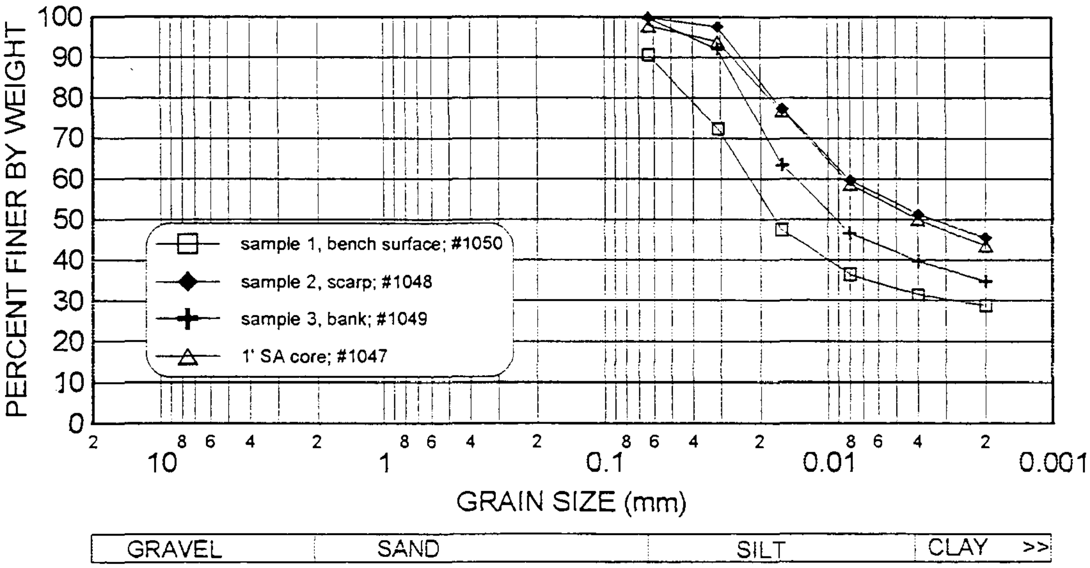
River: UMR
Site No: 26
RM: 420.0

Bank: RDB (core and surface samples from mp)
Pool No: 18
Sample No: 1071, 1073, 1070, 1072, 1075, 1074



River: UMR
Site No: 27
RM: 360.0

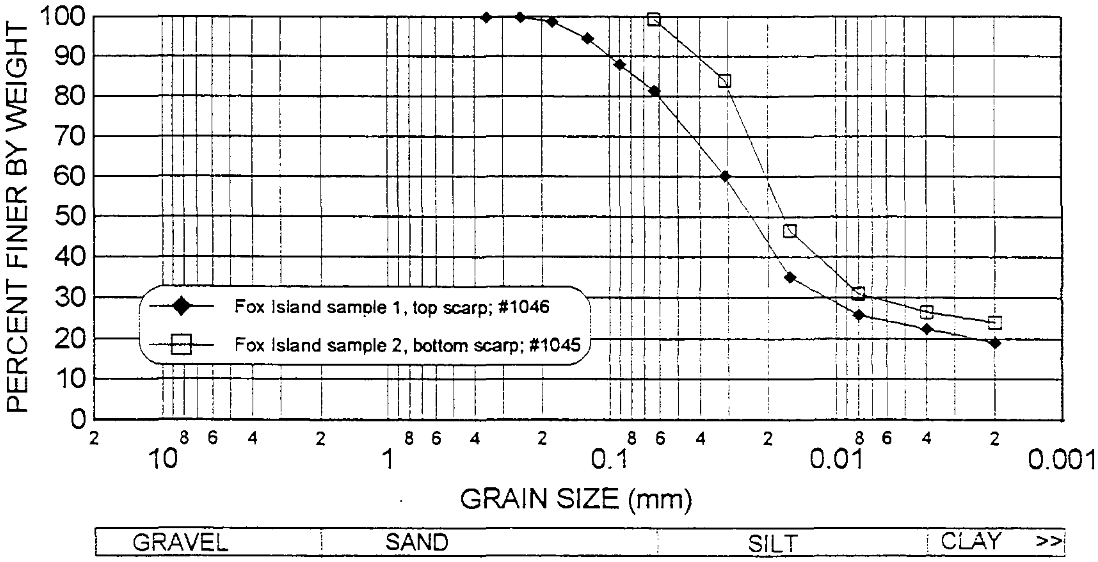
Bank: RDB (surface and core samples from mp)
Pool No: 20
Sample No: 1050, 1048, 1049, 1047



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: UMR
Site No: 28
RM: 357.6

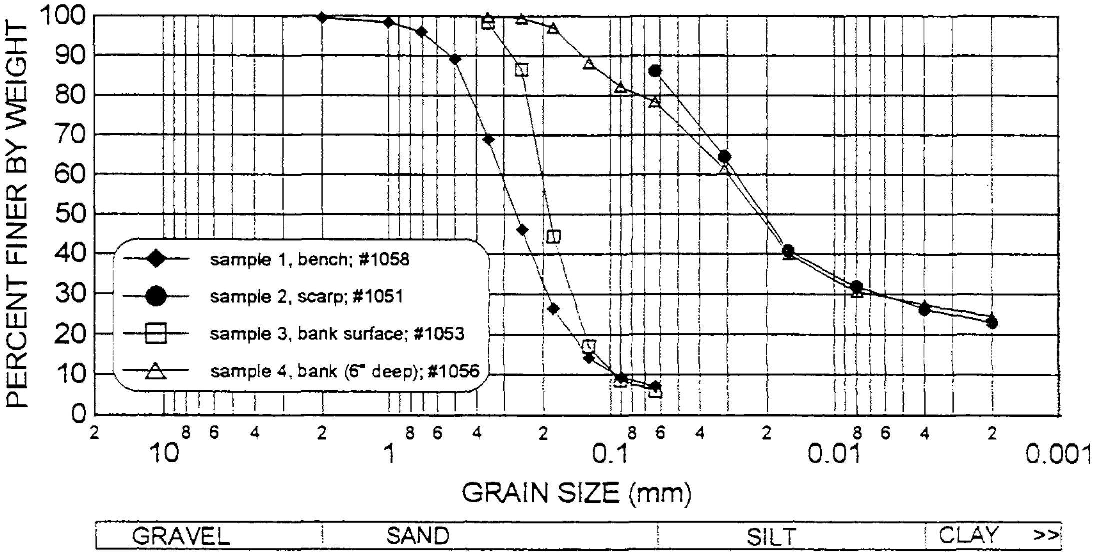
Bank: RDB (mp)
Pool No: 20
Sample No: 1046, 1045



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

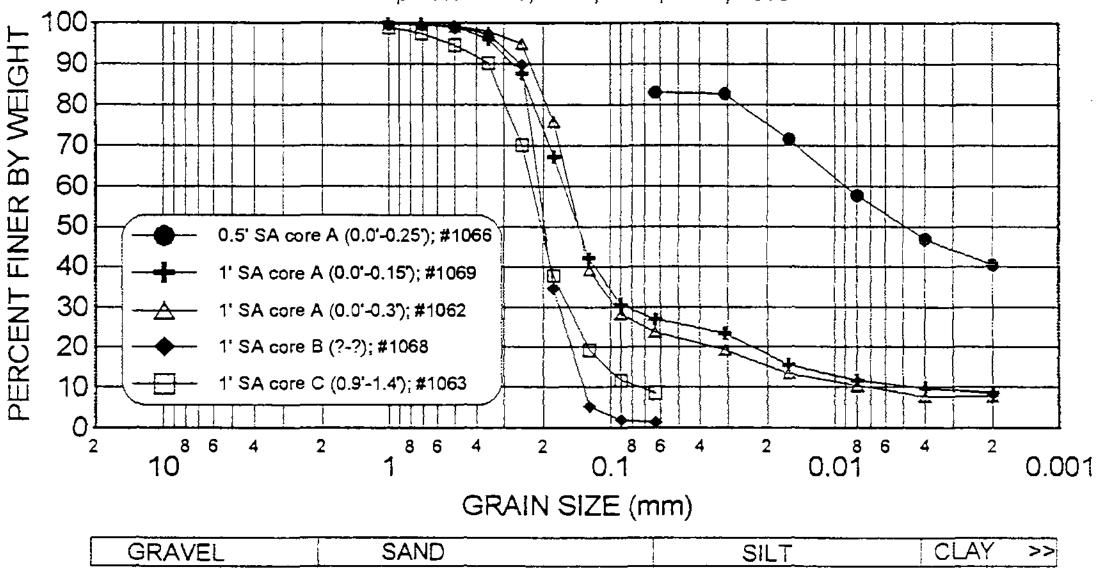
River: UMR
Site No: 29
RM: 339.3

Bank: LDB (mp)
Pool No: 21
Sample No: 1058, 1051, 1053, 1056



River: UMR
Site No: 29
RM: 339.3

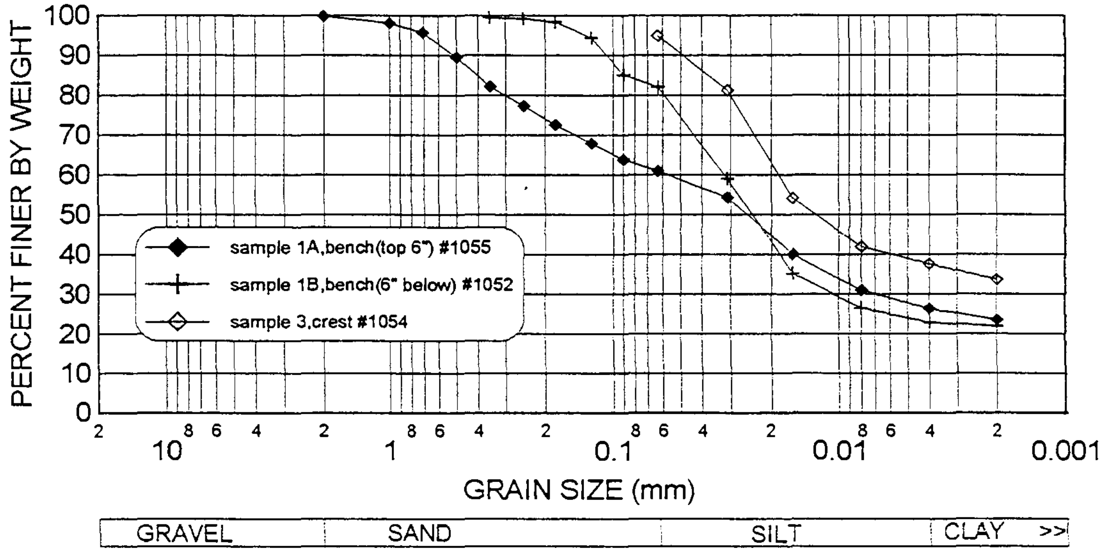
Bank: RDB (core samples from up and mp)
Pool No: 21
Sample No: 1066, 1069, 1062, 1068, 1063



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

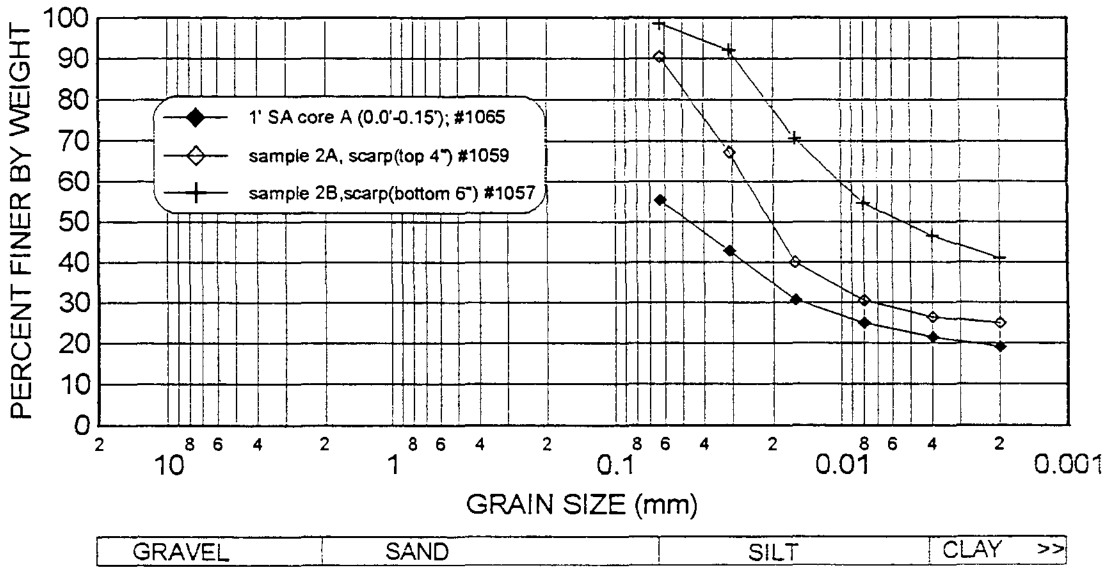
River: UMR
Site No: 30
RM: 339.3

Bank: RDB (mp)
Pool No: 21
Sample No: 1055,1052,1054



River: UMR
Site No: 30
RM: 339.3

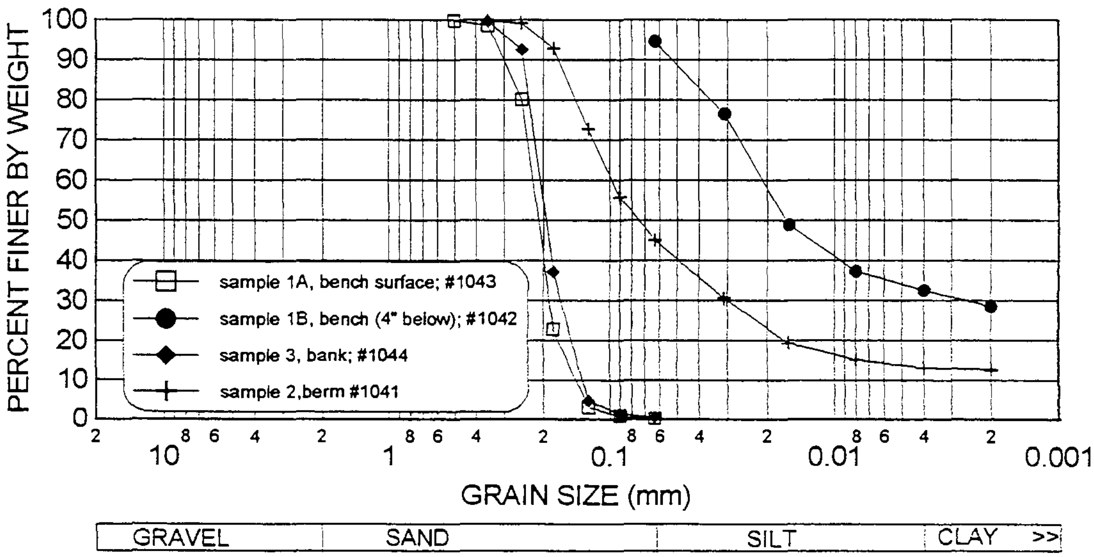
Bank: RDB (core sample from mp)
Pool No: 21
Sample No: 1065,1059,1057



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

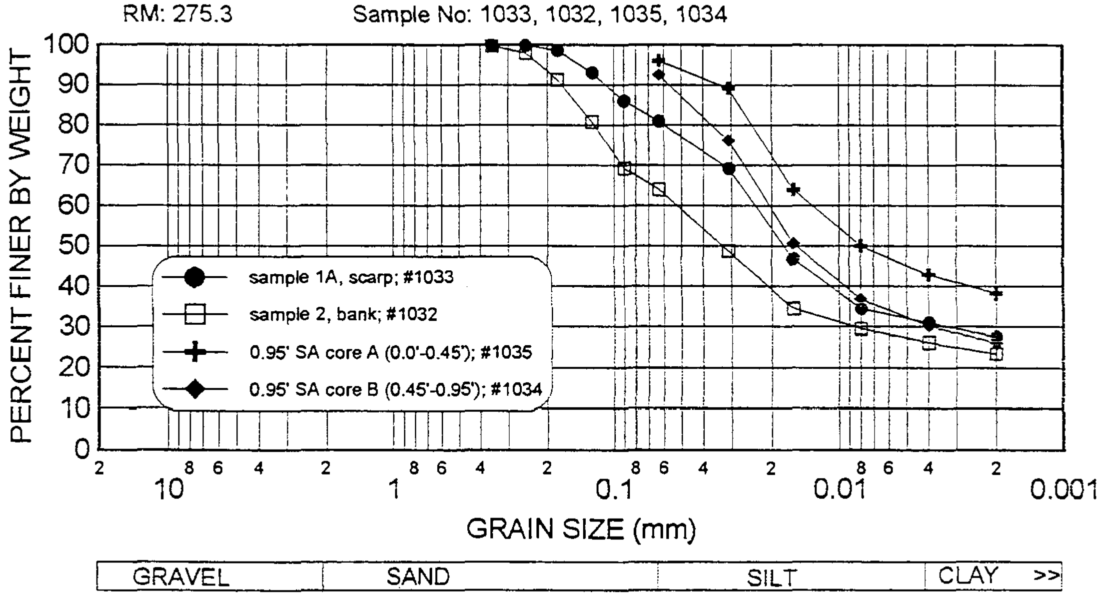
River: UMR
Site No: 31
RM: 293.0

Bank: LDB (mp)
Pool No: 23
Sample No: 1043, 1042, 1044,1041



River: UMR
Site No: 32
RM: 275.3

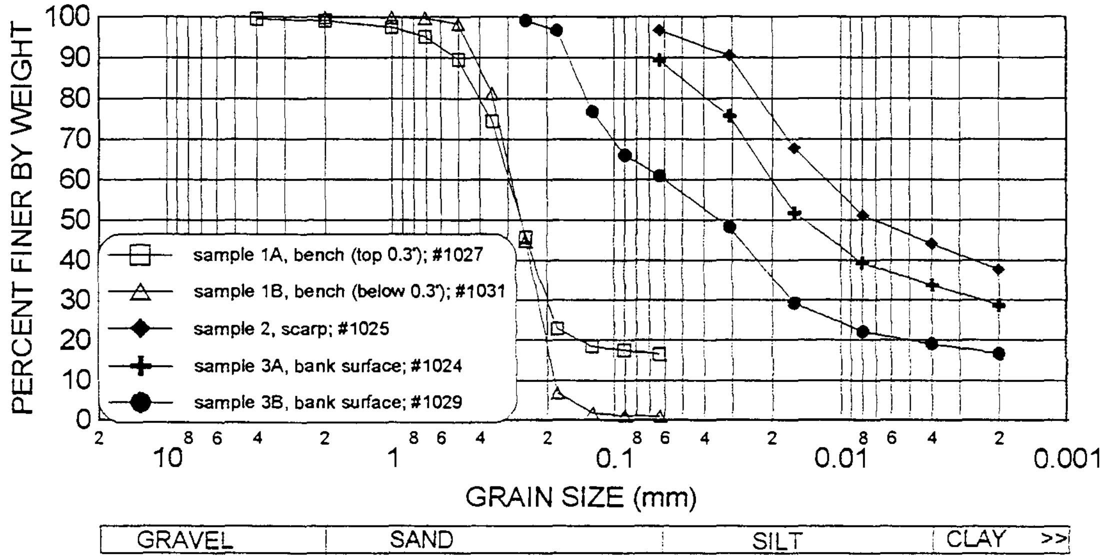
Bank: RDB (core and surface samples from mp)
Pool No: 24
Sample No: 1033, 1032, 1035, 1034



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

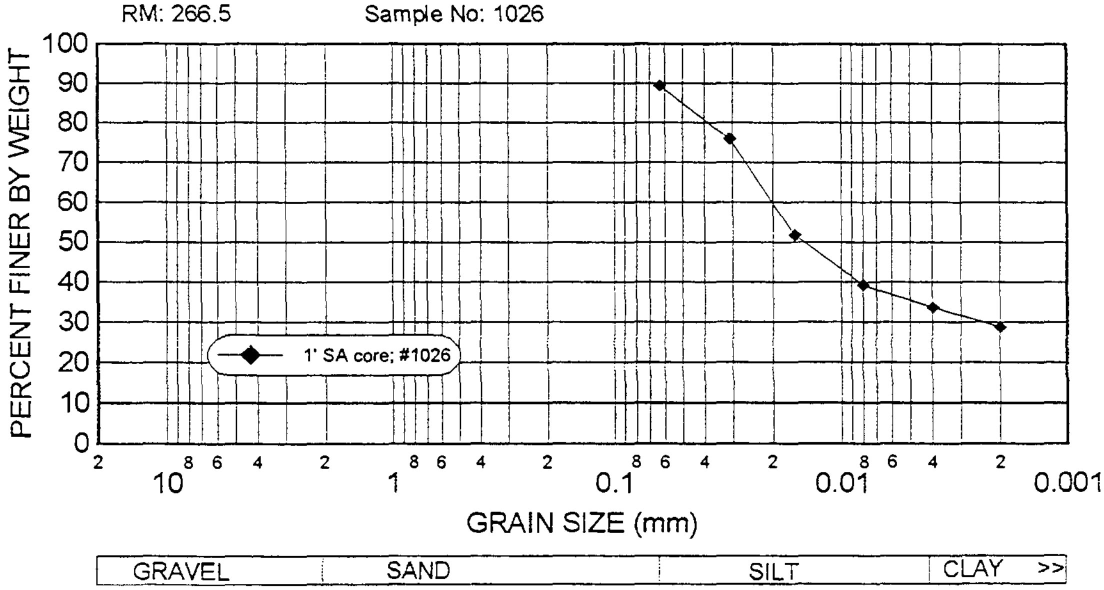
River: UMR
Site No: 33
RM: 266.5

Bank: LDB (mp)
Pool No: 25
Sample No: 1027, 1031, 1025, 1024, 1029



River: UMR
Site No: 33
RM: 266.5

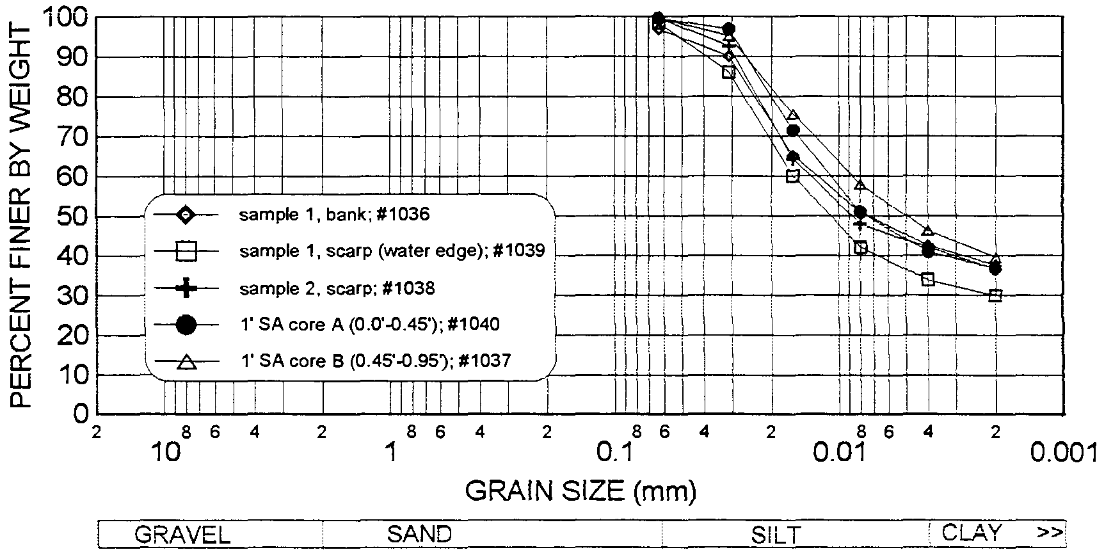
Bank: LDB (core sample from mp)
Pool No: 25
Sample No: 1026



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

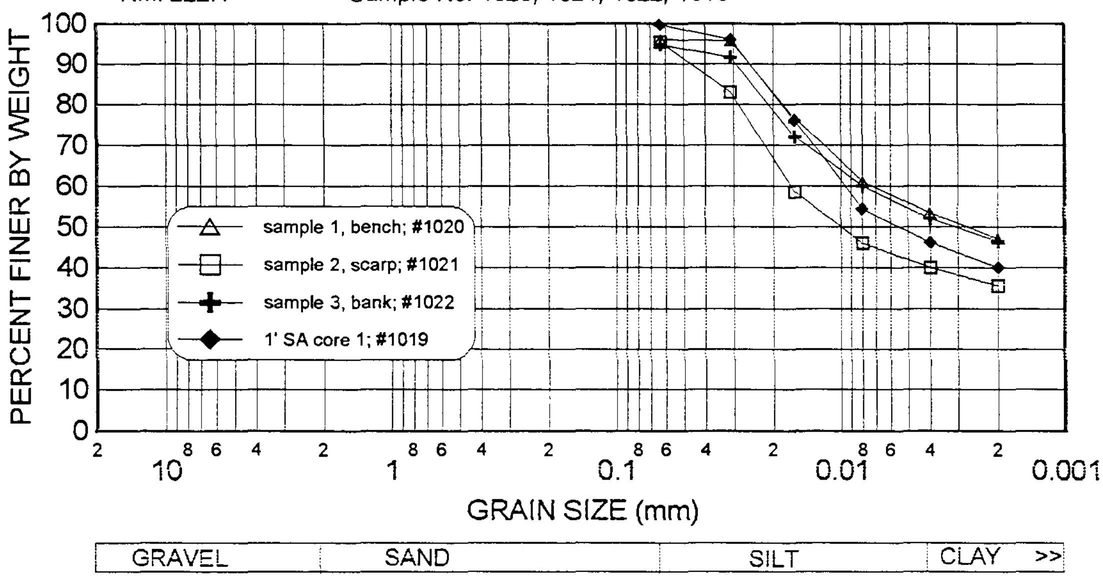
River: UMR
Site No: 34
RM: 232.2

Bank: RDB (core and surface samples from mp)
Pool No: 26
Sample No: 1036, 1039, 1038, 1040, 1037



River: UMR
Site No: 35
RM: 222.1

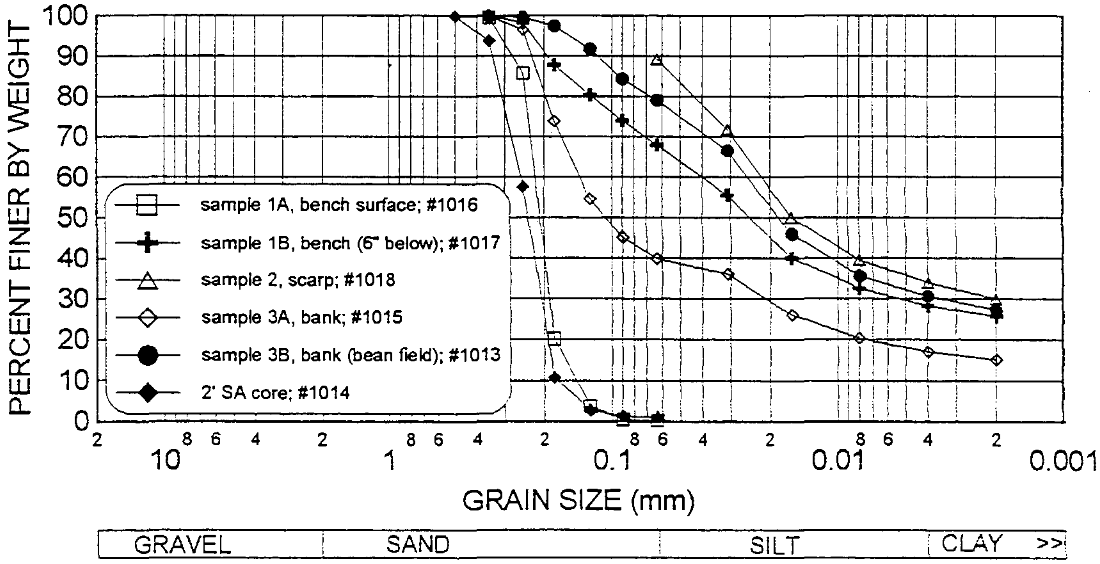
Bank: RDB (surface and core samples from mp)
Pool No: 26
Sample No: 1020, 1021, 1022, 1019



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: UMR
Site No: 36
RM: 217.5

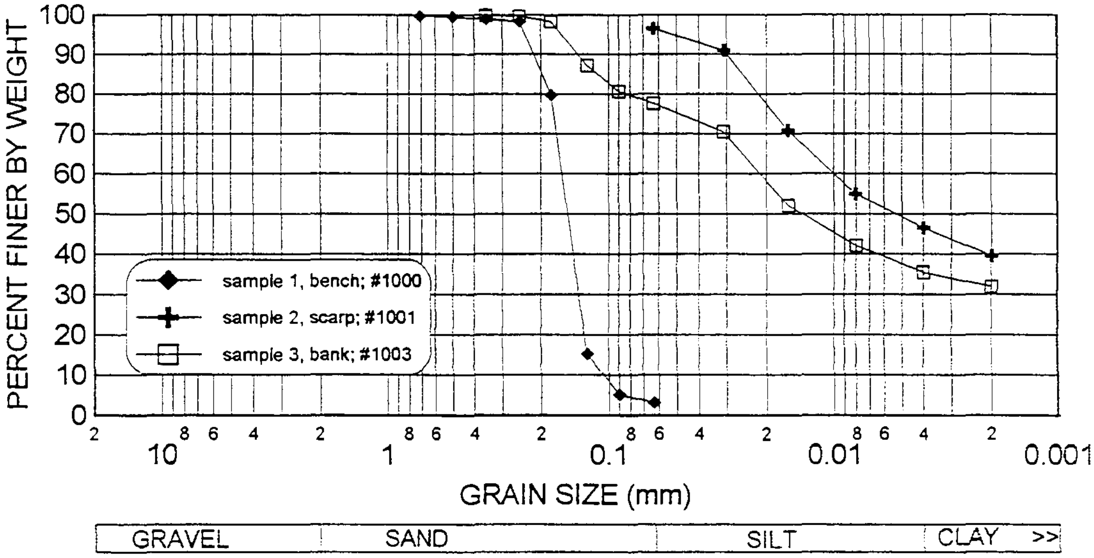
Bank: RDB (core and surface samples from mp)
Pool No: 26
Sample No: 1016, 1017, 1018, 1015, 1013, 1014



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

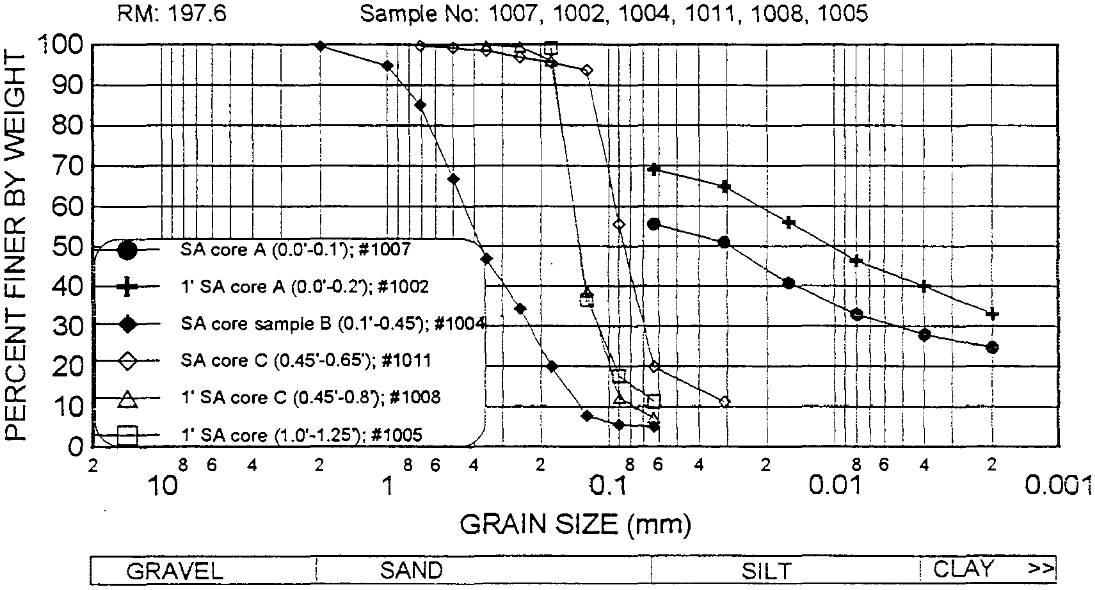
River: UMR
Site No: 37
RM: 197.6

Bank: RDB (mp)
Pool No: 27
Sample No: 1000, 1001, 1003



River: UMR
Site No: 37
RM: 197.6

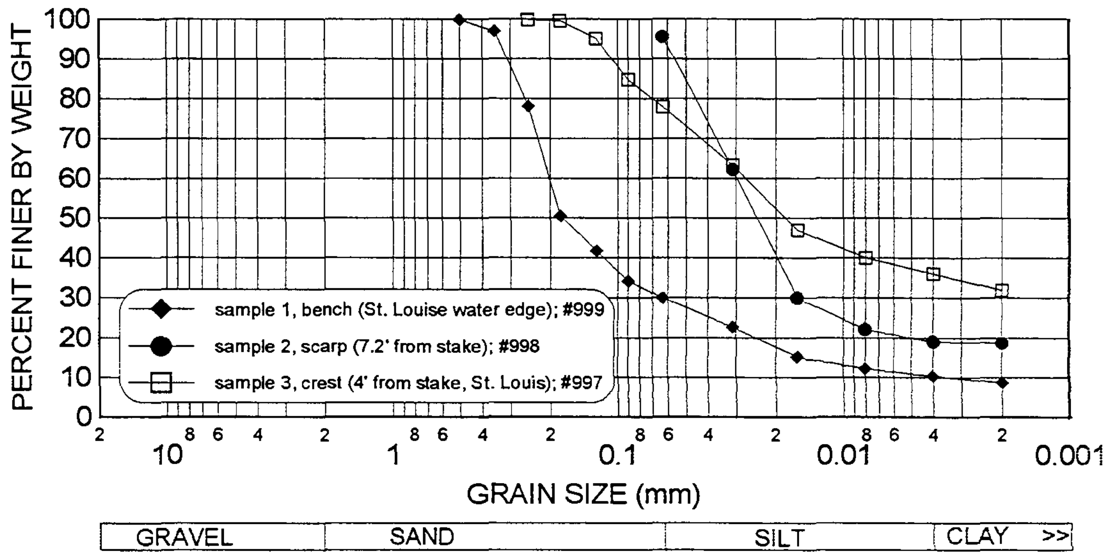
Bank: LDB (core samples from mp)
Pool No: 27
Sample No: 1007, 1002, 1004, 1011, 1008, 1005



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

River: UMR
Site No: 38
RM: 174.8

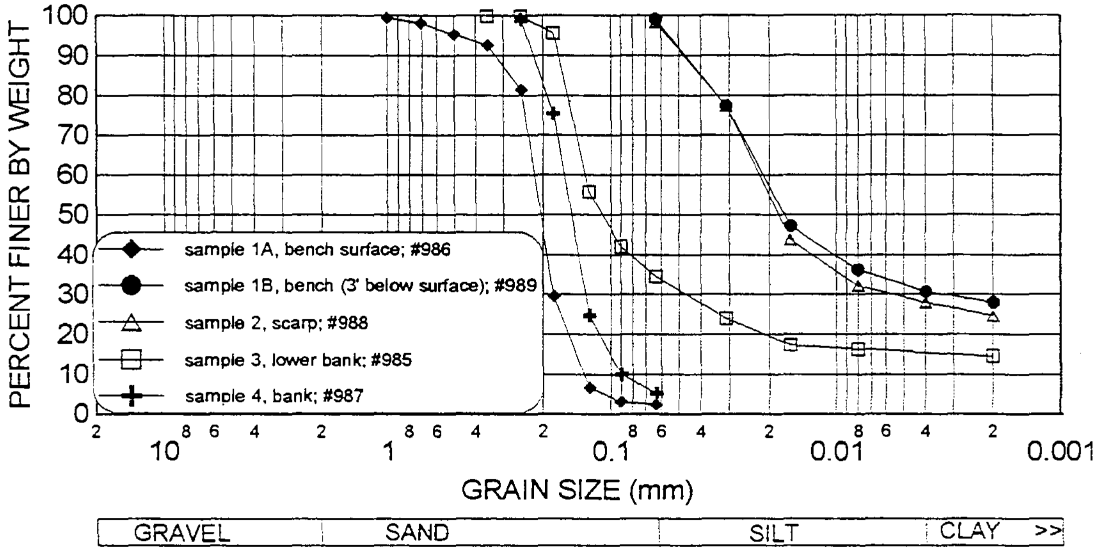
Bank: LDB (mp)
Pool No: open river
Sample No: 999, 998, 997



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

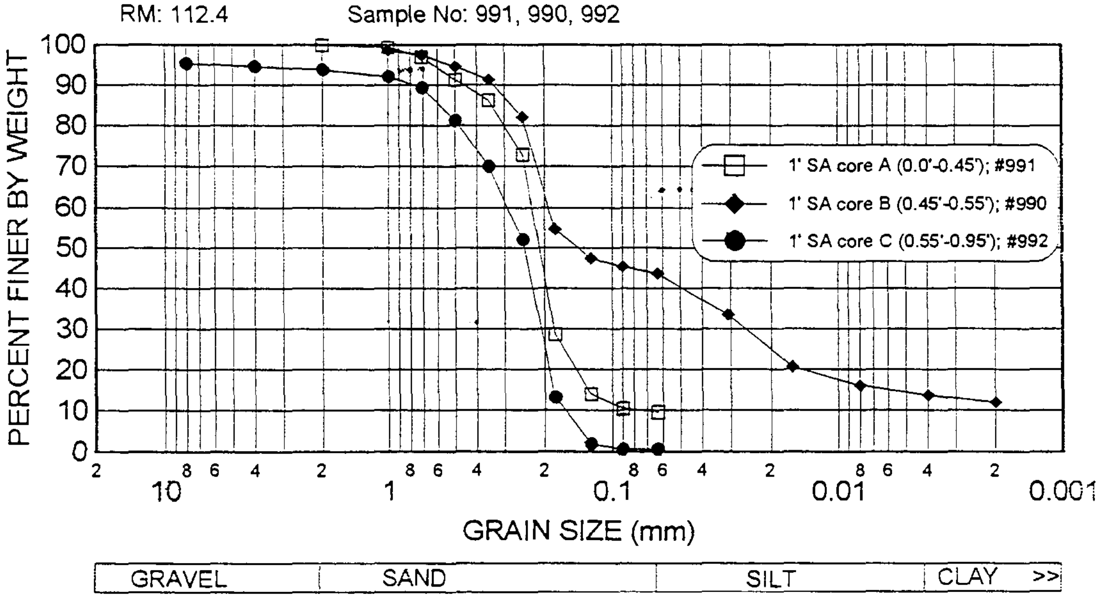
River: UMR
Site No: 39
RM: 112.4

Bank: LDB (mp)
Pool No: open river
Sample No: 986, 989, 988, 985, 987



River: UMR
Site No: 39
RM: 112.4

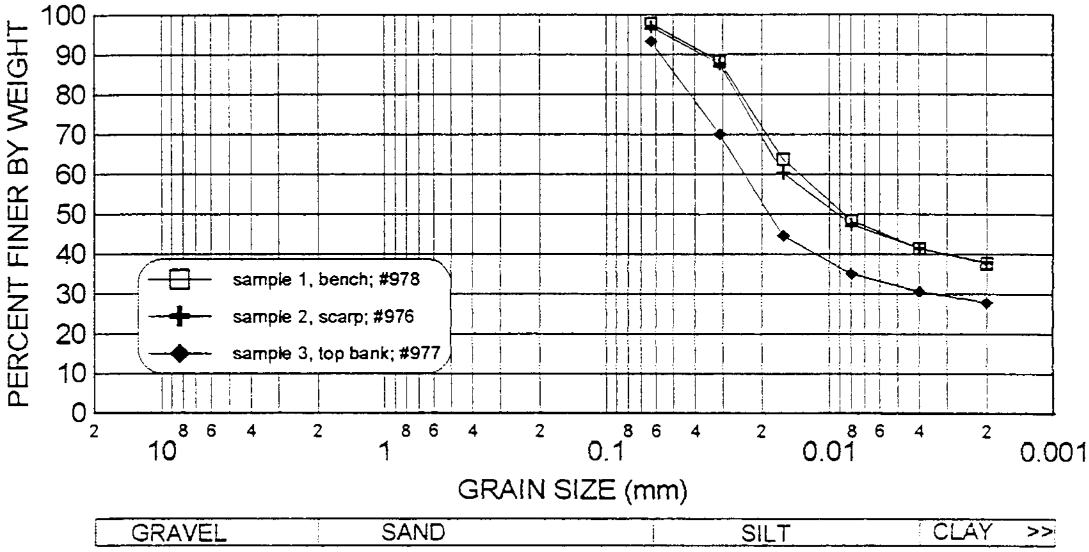
Bank: LDB (core samples from mp)
Pool No: open river
Sample No: 991, 990, 992



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

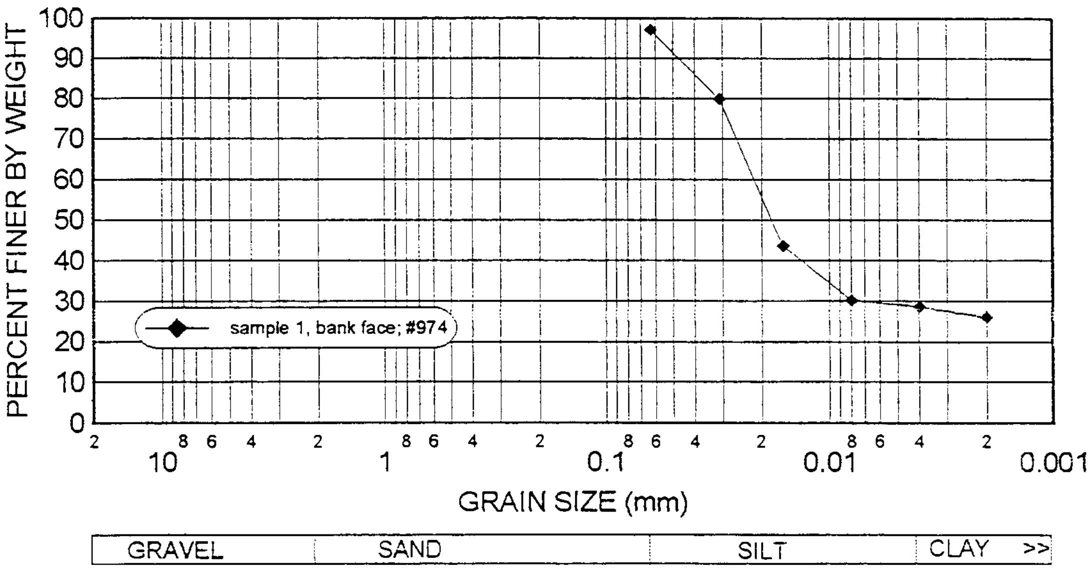
River: UMR
Site No: 40
RM: 94.1

Bank: RDB (dn)
Pool No: open river
Sample No: 978, 976, 977



River: UMR
Site No: 41
RM: 77.2

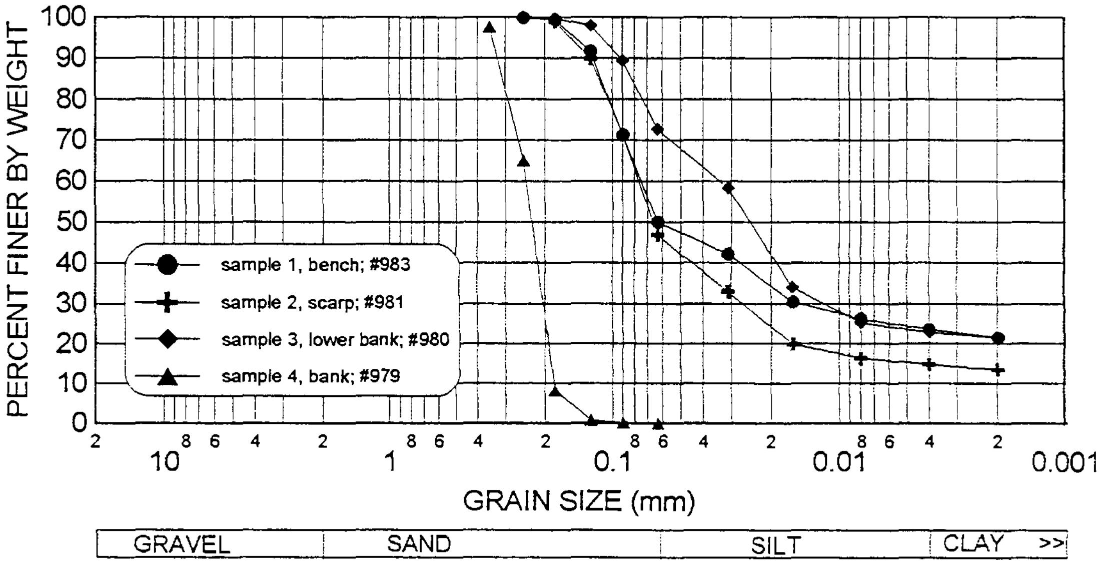
Bank: RDB (mp)
Pool No: open river
Sample No: 974



ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995

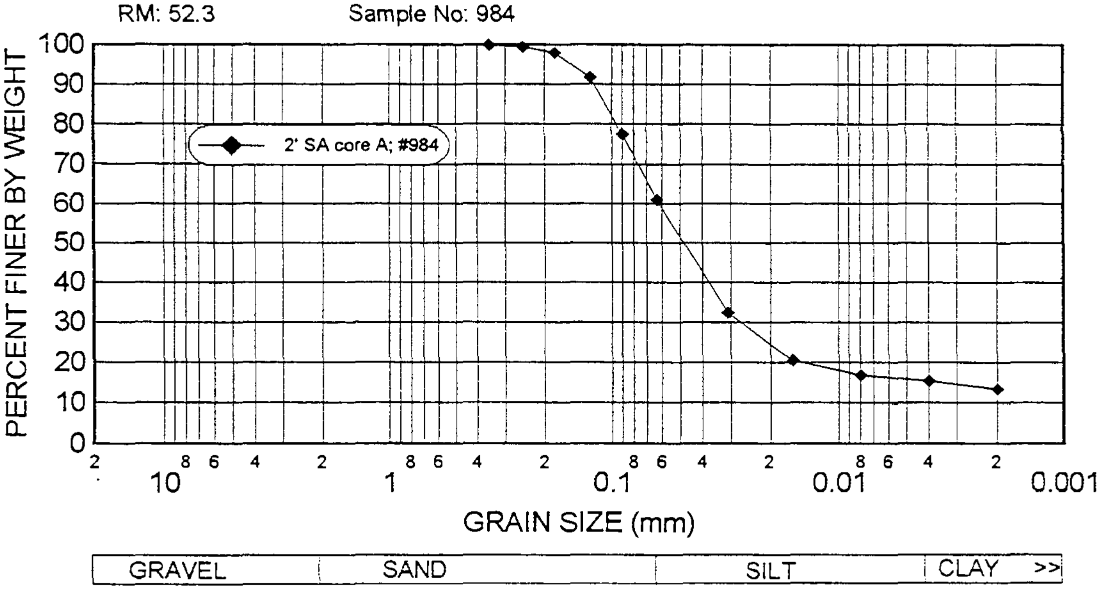
River: UMR
Site No: 42
RM: 52.3

Bank: LDB (mp)
Pool No: open river
Sample No: 983, 981, 980, 979

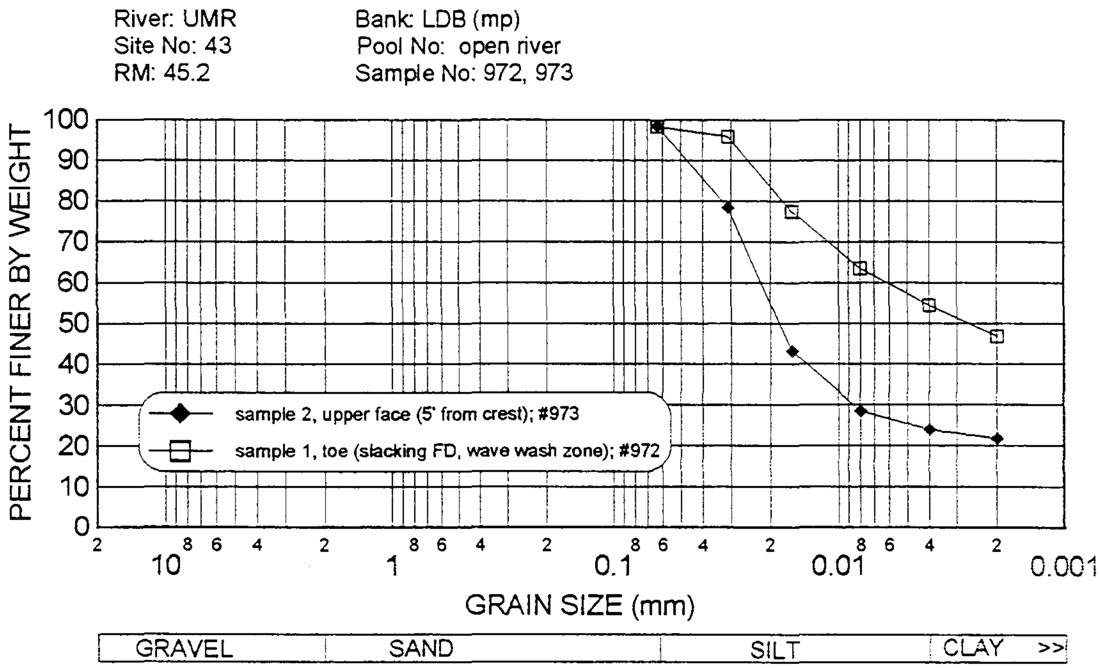


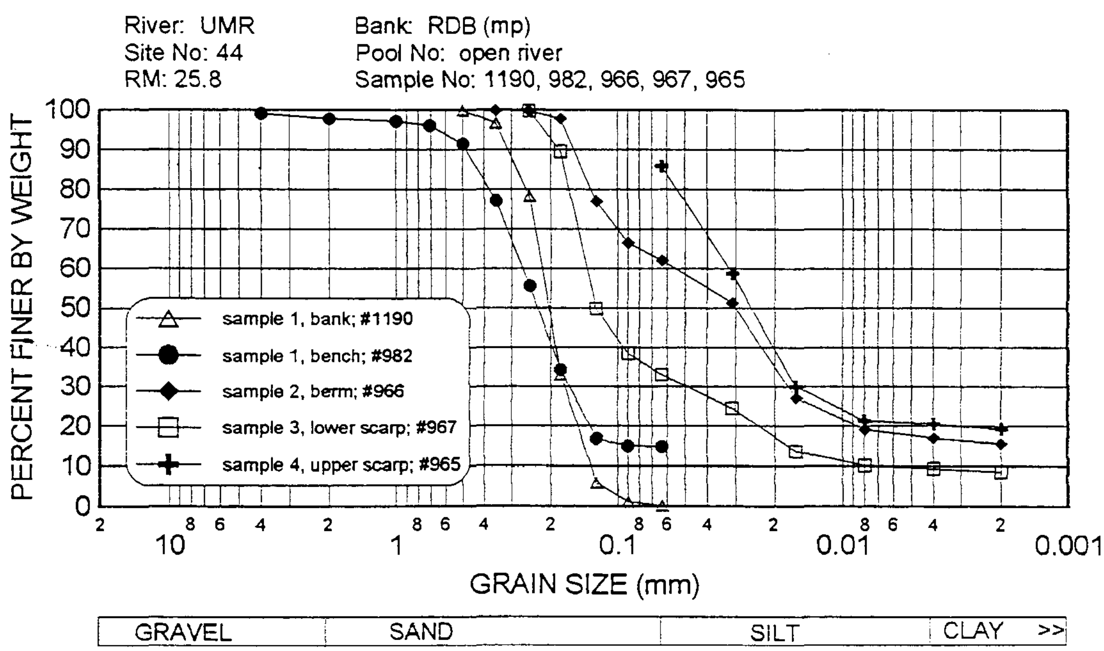
River: UMR
Site No: 42
RM: 52.3

Bank: LDB (core sample from mp)
Pool No: open river
Sample No: 984

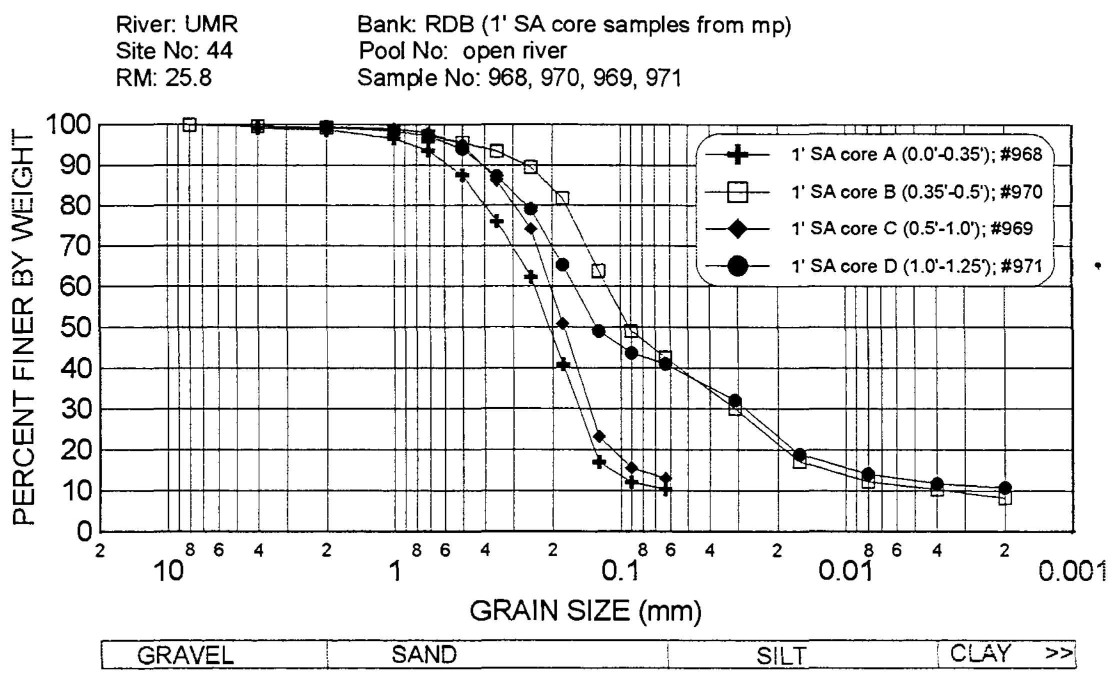


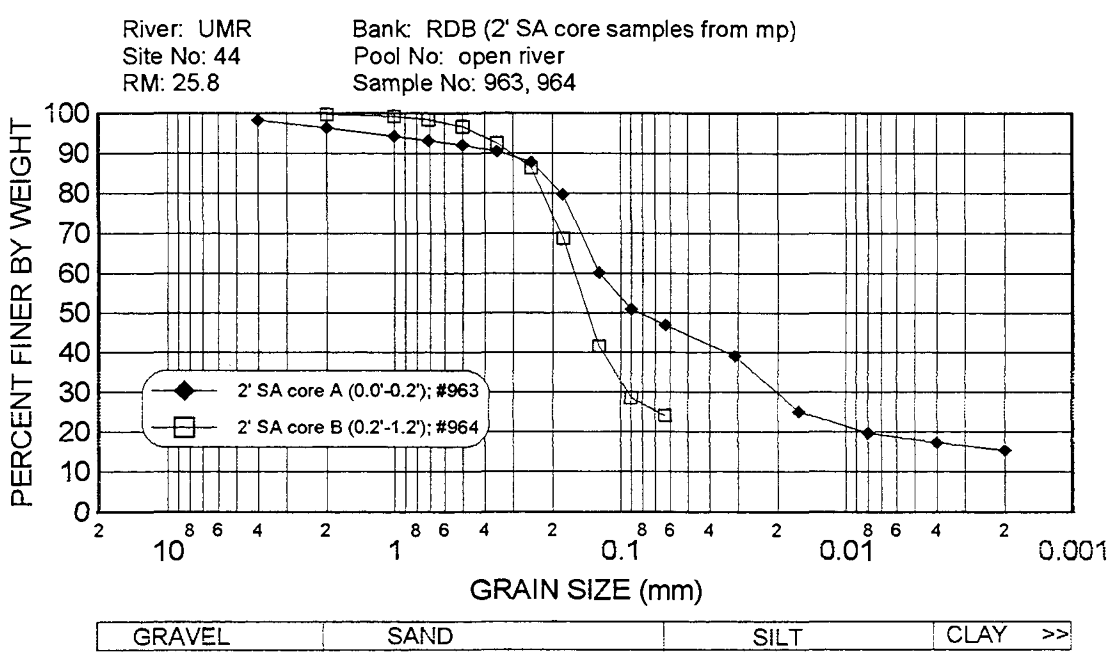
ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995





ILLINOIS STATE WATER SURVEY
BANK EROSION STUDY 1995





Appendix G.

Cross-Section and Corresponding UTM Coordinates of Selected Sites of the Illinois Waterway and Upper Mississippi River Coordinates

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

UP1 and UP2 RM 270.8 RDB

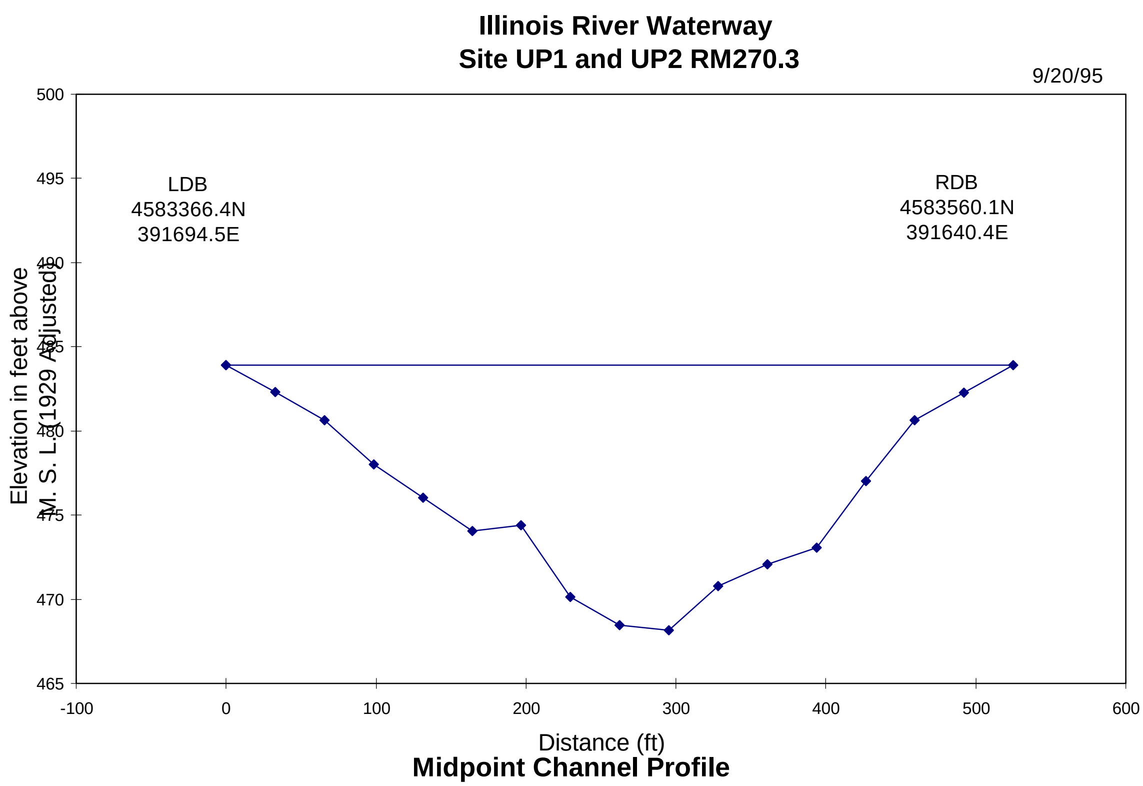
		NORTH	EAST	OPPOSITE
ILRUP1-1	MIDPOINT BANK PROFILE	4583560.1	391640.4	ILRUP1-2
ILRUP1-2	MIDPOINT PROFILE/OPPOSITE	4583366.4	391694.5	ILRUP1-1

Channel Profile Endpoints at Sites #UP1and #UP2

(A) MIDPOINT CHANNEL PROFILE (From: ILRUP1-2 To: ILRUP1-1)
Cross Section Length ~ 160m (524.9ft)

Midpoint Channel Profile RM270.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0	483.9	0
10	32.8	482.3	0.5
20	65.6	480.6	1
30	98.4	478.0	1.8
40	131.2	476.0	2.4
50	164.0	474.1	3
60	196.8	474.4	2.9
70	229.7	470.1	4.2
80	262.5	468.5	4.7
90	295.3	468.2	4.8
100	328.1	470.8	4
110	360.9	472.1	3.6
120	393.7	473.1	3.3
130	426.5	477.0	2.1
140	459.3	480.6	1
150	492.1	482.3	0.5
160	524.9	483.9	0


Illinois River Waterway
Site UP1 and UP2 RM270.3
9/20/95
LDB
4583366.4N
391694.5E
RDB
4583560.1N
391640.4E
Elevation in feet above
M. S. L. (1929 Adjusted)
500
495
490
485
480
475
470
465
-100
0
100
200
300
400
500
600
Distance (ft)
Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #UP3 RM264.3 LDB

		NORTH	EAST	OPPOSITE
ILRUP3-1	UPSTREAM SITE LIMIT	4579447.5	382564.0	N/A
ILRUP3-2	UPSTREAM BANK PROFILE	4579431.0	382534.5	N/A
ILRUP3-3	MIDPOINT BANK PROFILE	4579403.0	382481.9	ILRUP3-6
ILRUP3-4	DOWNSTREAM BANK PROFILE	4579365.5	382413.2	N/A
ILRUP3-5	DOWNSTREAM SITE LIMIT	4579336.0	382349.9	N/A
ILRUP3-6	MIDPOINT PROFILE/OPPOSITE	4579571.6	382411.7	ILRUP3-3

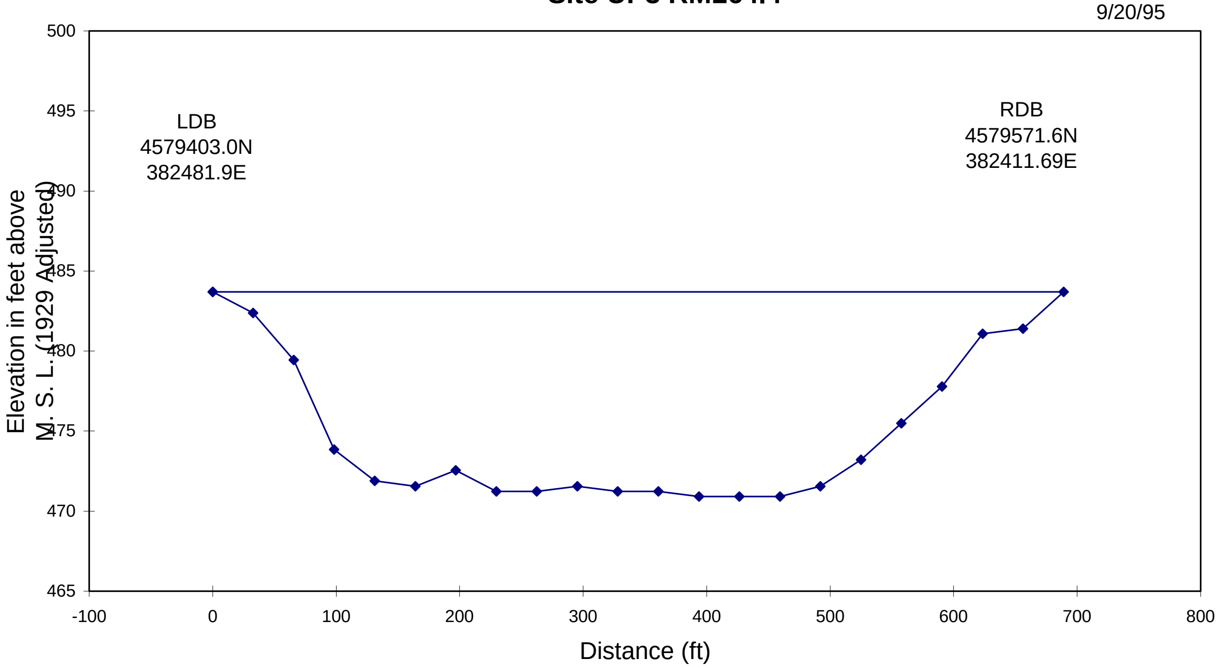
Channel Profile Endpoints at Site #UP3

(A) MIDPOINT CHANNEL PROFILE (From ILRUP3-3 to ILRUP3-6)
Cross section length ~211m (692.2ft)

Midpoint Channel Profile RM264.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	483.7	0
10	32.8	482.4	0.4
20	65.6	479.4	1.3
30	98.4	473.9	3
40	131.2	471.9	3.6
50	164.0	471.6	3.7
60	196.8	472.5	3.4
70	229.7	471.2	3.8
80	262.5	471.2	3.8
90	295.3	471.6	3.7
100	328.1	471.2	3.8
110	360.9	471.2	3.8
120	393.7	470.9	3.9
130	426.5	470.9	3.9
140	459.3	470.9	3.9
150	492.1	471.6	3.7
160	524.9	473.2	3.2
170	557.7	475.5	2.5
180	590.5	477.8	1.8
190	623.4	481.1	0.8
200	656.2	481.4	0.7
210	689.0	483.7	0

Illinois River Waterway
Site UP3 RM264.4



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #UP4 and #UP5 RM262.2 LDB

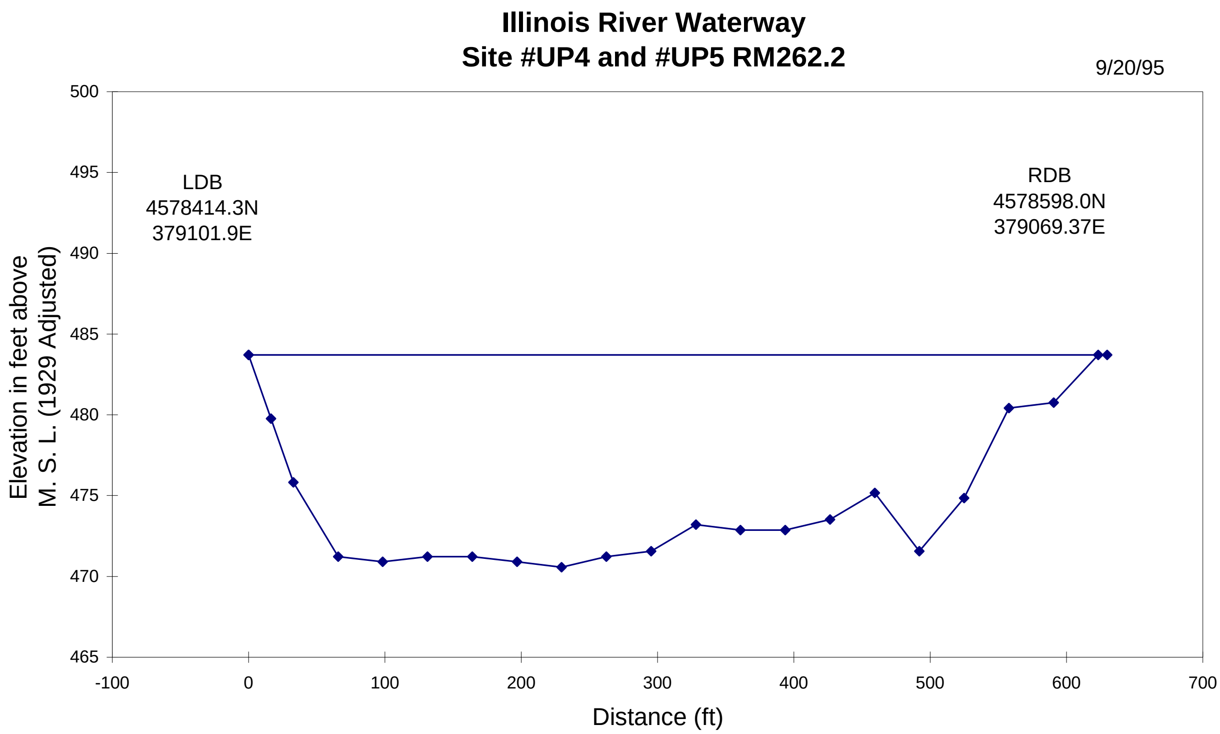
		NORTH	EAST	OPPOSITE
ILRUP4-1	UPSTREAM SITE LIMIT	4578428.5	379478.2	N/A
ILRUP4-2	UPSTREAM BANK PROFILE	4578422.6	379360.6	N/A
ILRUP4-3	MIDPOINT BANK PROFILE	4578414.3	379101.9	ILRUP4-6
ILRUP4-4	DOWNSTREAM BANK PROFILE	4578407.7	379007.4	N/A
ILRUP4-5	DOWNSTREAM SITE LIMIT	4578397.3	378915.2	N/A
ILRUP4-6	MIDPOINT PROFILE/OPPOSITE	4578598.0	379069.4	ILRUP4-3

Channel Profile Endpoints at SITES #UP4 and #UP5

(A) MIDPOINT CHANNEL PROFILE (From: ILRUP4-3 To: ILRUP4-6)
Cross Section Length ~ 192m (433.4ft)

Midpoint Channel Profile RM262.2

Distance (m)	Distance (ft)	Depth Elevaton	Depth (m)
0	0.0	483.7	0.0
5	16.4	479.8	1.2
10	32.8	475.8	2.4
20	65.6	471.2	3.8
30	98.4	470.9	3.9
40	131.2	471.2	3.8
50	164.0	471.2	3.8
60	196.8	470.9	3.9
70	229.7	470.6	4.0
80	262.5	471.2	3.8
90	295.3	471.6	3.7
100	328.1	473.2	3.2
110	360.9	472.9	3.3
120	393.7	472.9	3.3
130	426.5	473.5	3.1
140	459.3	475.2	2.6
150	492.1	471.6	3.7
160	524.9	474.8	2.7
170	557.7	480.4	1.0
180	590.5	480.7	0.9
190	623.4	483.7	0
192	629.9	483.7	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #1 RM243.1 LDB

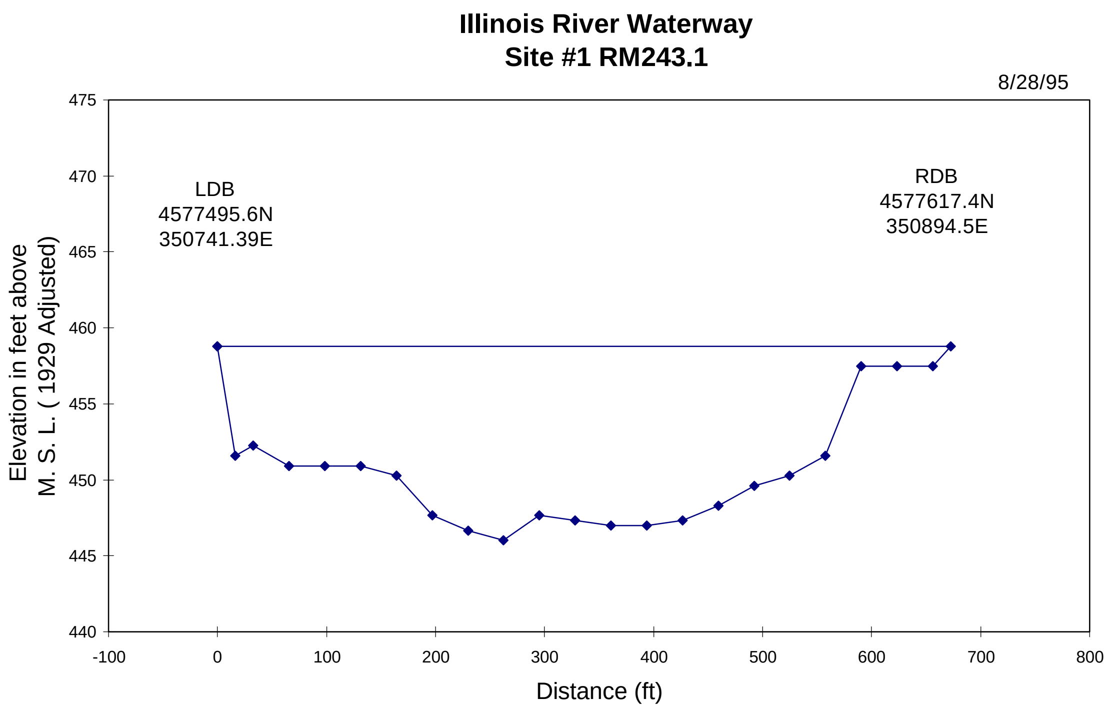
		NORTH	EAST	OPPOSITE
ILR1-1	UPSTREAM BANK PROFILE	4577258.3	351053.5	N/A
ILR1-2	MIDPOINT BANK PROFILE	4577495.6	350741.4	ILR1-3
ILR1-3	MIDPOINT PROFILE/OPPOSITE	4577617.4	350894.5	ILR1-2

Channel Profile Endpoints at Site #1

(A) MIDPOINT CHANNEL PROFILE ((From: ILR1-2 To: ILR1-3)
Cross Section Length ~205m (672.6ft)

Midpoint Channel Profile RM243.1

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	458.8	0
5	16.4	451.6	2.2
10	32.8	452.2	2
20	65.6	450.9	2.4
30	98.4	450.9	2.4
40	131.2	450.9	2.4
50	164.0	450.3	2.6
60	196.8	447.6	3.4
70	229.7	446.7	3.7
80	262.5	446.0	3.9
90	295.3	447.6	3.4
100	328.1	447.3	3.5
110	360.9	447.0	3.6
120	393.7	447.0	3.6
130	426.5	447.3	3.5
140	459.3	448.3	3.2
150	492.1	449.6	2.8
160	524.9	450.3	2.6
170	557.7	451.6	2.2
180	590.5	457.5	0.4
190	623.4	457.5	0.4
200	656.2	457.5	0.4
205	672.6	458.8	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #2 RM243.5 LBD

		NORTH	EAST	OPPOSITE
ILR2-1	MIDPOINT BANK PROFILE	4577241.0	351073.2	ILR2-2
ILR2-2	MIDPOINT PROFILE/OPPOSITE	4577442.1	351146.3	ILR2-1

Channel Profile Endpoints at Site #2

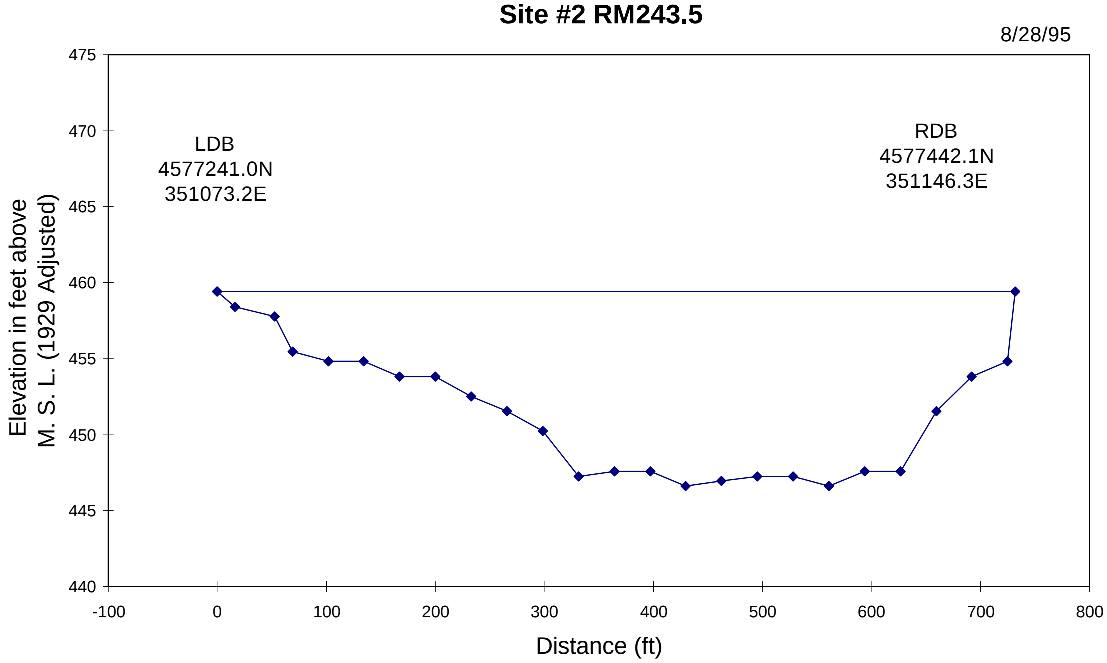
(A) MIDPOINT CHANNEL PROFILE (From: ILR2-1 To ILR2-2)

Cross Section Length ~ 223m (731.6ft)

Midpoint Channel Profile RM243.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	459.4	0
5	16.4	458.4	0.3
16	52.5	457.8	0.5
21	68.9	455.5	1.2
31	101.7	454.8	1.4
41	134.5	454.8	1.4
51	167.3	453.8	1.7
61	200.1	453.8	1.7
71	232.9	452.5	2.1
81	265.7	451.5	2.4
91	298.6	450.2	2.8
101	331.4	447.3	3.7
111	364.2	447.6	3.6
121	397.0	447.6	3.6
131	429.8	446.6	3.9
141	462.6	446.9	3.8
151	495.4	447.3	3.7
161	528.2	447.3	3.7
171	561.0	446.6	3.9
181	593.8	447.6	3.6
191	626.6	447.6	3.6
201	659.4	451.5	2.4
211	692.2	453.8	1.7
221	725.1	454.8	1.4
223	731.6	459.4	0

Illinois River Waterway
Site #2 RM243.5



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #3 RM235.7 RDB

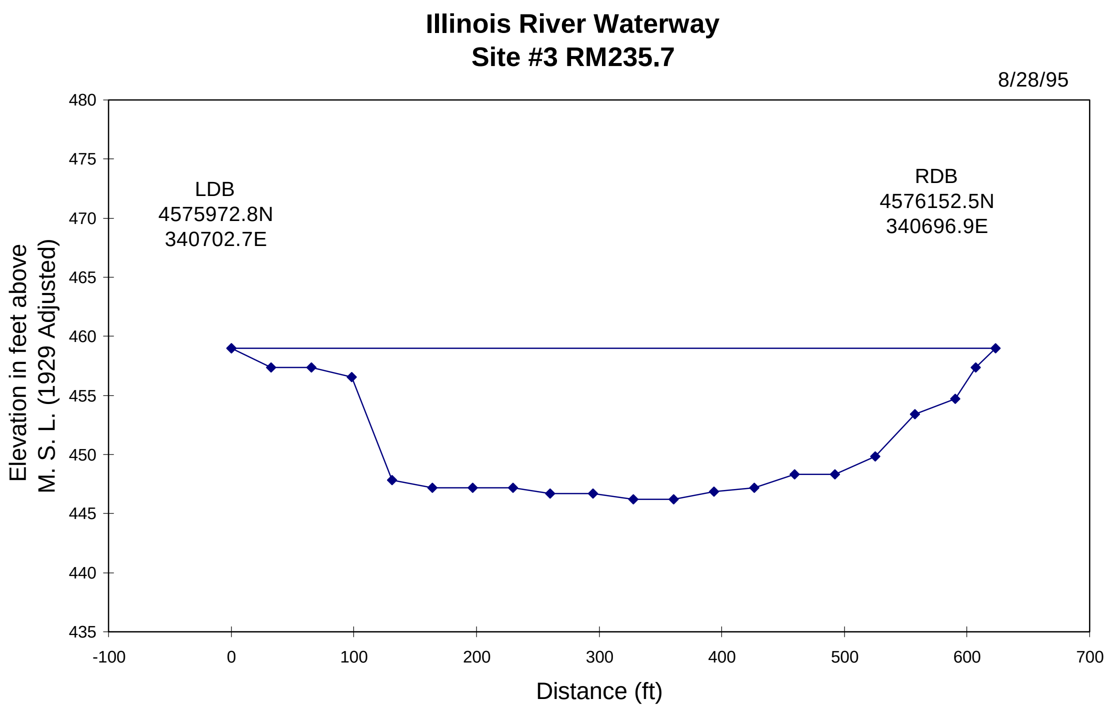
		NORTH	EAST	OPPOSITE
ILR3-1	UPSTREAM BANK PROFILE	4576162.3	340784.5	N/A
ILR3-2	MIDPOINT BANK PROFILE	4576152.8	340696.9	ILR3-4
ILR3-3	DOWNSTREAM BANK PROFILE	4576153.5	340557.6	N/A
ILR3-4	MIDPOINT PROFILE/OPPOSITE	4575972.8	340702.7	ILR3-2

Channel Profile Endpoints at Site #3

(A) MIDPOINT CHANNEL PROFILE (From: ILR3-4 To: ILR3-2)
Cross Section Length ~ 190m (623.4 ft)

Midpoint Channel Profile RM235.7

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	459.0	0
10	32.8	457.4	0.5
20	65.6	457.4	0.5
30	98.4	456.5	0.75
40	131.2	447.8	3.4
50	164.0	447.2	3.6
60	196.8	447.2	3.6
70	229.7	447.2	3.6
80	260.0	446.7	3.75
90	295.3	446.7	3.75
100	328.1	446.2	3.9
110	360.9	446.2	3.9
120	393.7	446.9	3.7
130	426.5	447.2	3.6
140	459.3	448.3	3.25
150	492.1	448.3	3.25
160	524.9	449.8	2.8
170	557.7	453.4	1.7
180	590.5	454.7	1.3
185	606.9	457.4	0.5
190	623.4	459.0	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #4 RM228.0 LDB

		NORTH	EAST	OPPOSITE
ILR4-1	UPSTREAM BANK PROFILE	4576201.9	329394.2	N/A
ILR4-2	MIDPOINT BANK PROFILE	4576183.1	329198.4	ILR4-4
ILR4-3	DOWNSTREAM BANK PROFILE	4576184.0	329002.3	N/A
ILR4-4	MIDPOINT PROFILE/OPPOSITE	4576184.0	329118.1	ILR4-2

Channel Profile Endpoints at Site #4

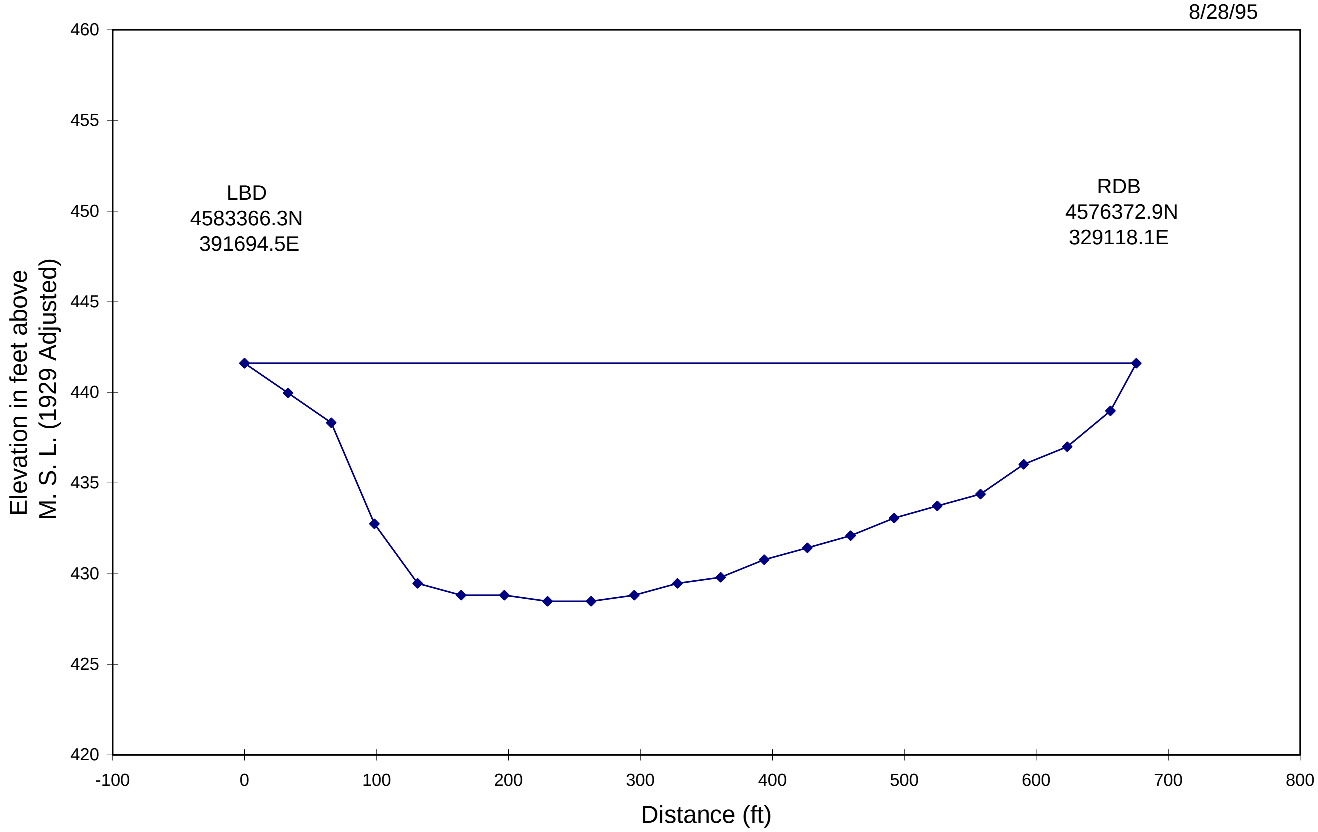
(A) MIDPOINT CHANNEL PROFILE (From: ILR4-2 To: ILR4-4)
Cross Section Length ~ 206m (675.8 ft)

Midpoint Channel Profile RM228.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	441.6	0
10	32.8	440.0	0.5
20	65.6	438.3	1
30	98.4	432.7	2.7
40	131.2	429.5	3.7
50	164.0	428.8	3.9
60	196.8	428.8	3.9
70	229.7	428.5	4
80	262.5	428.5	4
90	295.3	428.8	3.9
100	328.1	429.5	3.7
110	360.9	429.8	3.6
120	393.7	430.8	3.3
130	426.5	431.4	3.1
140	459.3	432.1	2.9
150	492.1	433.1	2.6
160	524.9	433.7	2.4
170	557.7	434.4	2.2
180	590.5	436.0	1.7
190	623.4	437.0	1.4
200	656.2	439.0	0.8
206	675.8	441.6	0

Illinois River Waterway
Site #4 RM228.0

8/28/95



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #5 RM228.75 RDB

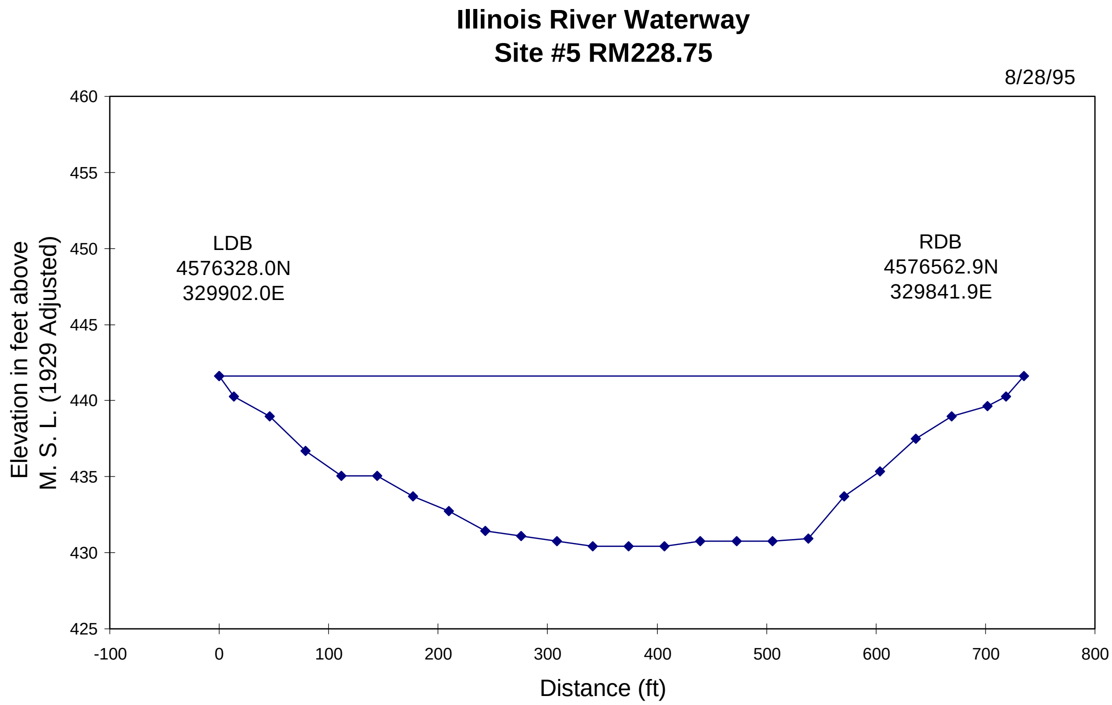
		NORTH	EAST	OPPOSITE
ILR5-1	UPSTREAM BANK PROFILE	4576590.3	329950.4	N/A
ILR5-2	MIDPOINT BANK PROFILE	4576562.9	329841.9	ILR5-4
ILR5-3	DOWNSTREAM BANK PROFILE	4576472.9	329615.9	N/A
ILR5-4	MIDPOINT PROFILE/OPPOSITE	4576328.0	329902.0	ILR5-2

Channel Profile Endpoints at Site #5

(A) MIDPOINT CHANNEL PROFILE (From: ILR5-4 To: ILR5-2)
Cross Section Length ~ 224m (734.9 ft)

Midpoint Channel Profile RM228.75

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	441.6	0
4	13.1	440.3	0.4
14	45.9	439.0	0.8
24	78.7	436.7	1.5
34	111.5	435.0	2
44	144.4	435.0	2
54	177.2	433.7	2.4
64	210.0	432.7	2.7
74	242.8	431.4	3.1
84	275.6	431.1	3.2
94	308.4	430.8	3.3
104	341.2	430.4	3.4
114	374.0	430.4	3.4
124	406.8	430.4	3.4
134	439.6	430.8	3.3
144	472.4	430.8	3.3
154	505.2	430.8	3.3
164	538.1	430.9	3.25
174	570.9	433.7	2.4
184	603.7	435.4	1.9
194	636.5	437.5	1.25
204	669.3	439.0	0.8
214	702.1	439.6	0.6
219	718.5	440.3	0.4
224	734.9	441.6	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

	Site #6 RM210.0 RDB	NORTH	EAST	OPPOSITE
ILR6-1	UPSTREAM BANK PROFILE	4573586.1	303867.0	ILR6-4
ILR6-2	MIDPOINT BANK PROFILE	4573353.5	303968.9	ILR6-5
ILR6-3	DOWNSTREAM BANK PROFILE	4573064.0	304100.8	N/A
ILR6-4	UPSTREAM PROFILE/OPPOSITE	4573644.0	303992.0	ILR6-1
ILR6-5	MIDPOINT PROFILE/OPPOSITE	4573417.0	304113.0	ILR6-2

Channel Profile Endpoints at Site #6

(A) UPSTREAM CHANNEL PROFILE (From:ILR6-4 To:ILR6-1)
Cross Section Length ~148m (485.6ft)
(B MIDPOINT CHANNEL PROFILE (From: ILR6-5 To: ILR6-2)
Cross Section Length ~165m (541.3ft.)

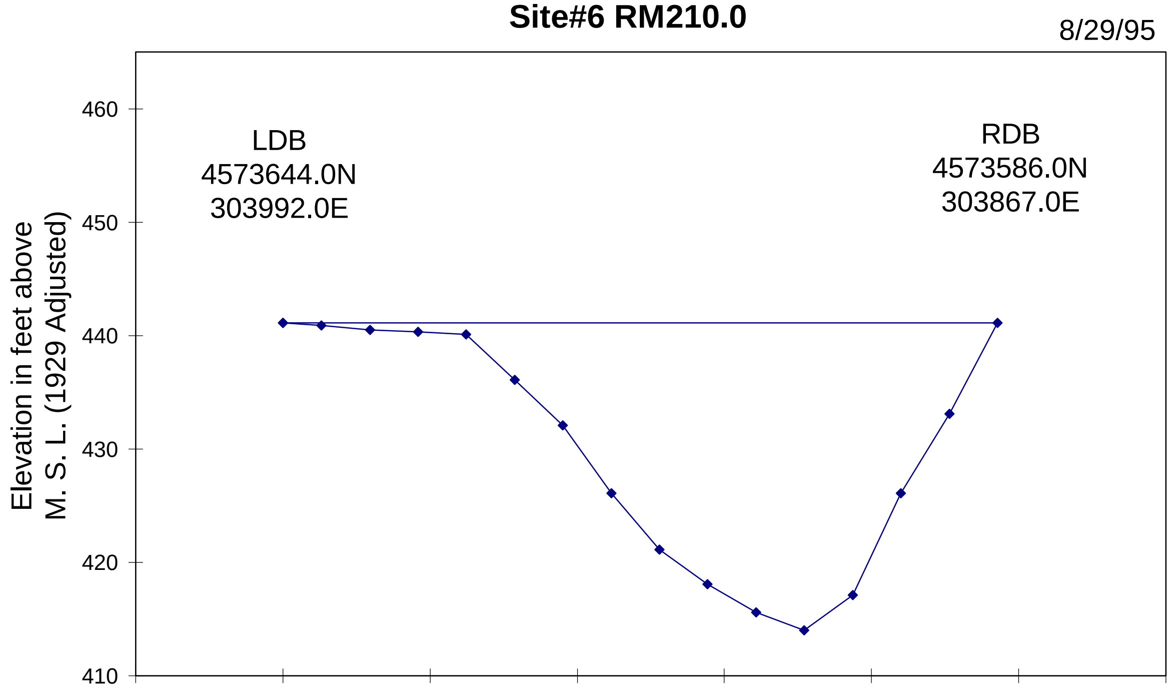
Upstream Channel Profile RM210.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	441.1	0.0
8	26.2	440.9	0.1
18	59.1	440.5	0.2
28	91.9	440.3	0.2
38	124.7	440.1	0.3
48	157.5	436.1	1.5
58	190.3	432.1	2.7
68	223.1	426.1	4.6
78	255.9	421.1	6.1
88	288.7	418.1	7.0
98	321.5	415.6	7.8
108	354.3	414.0	8.3
118	387.1	417.1	7.3
128	419.9	426.1	4.6
138	452.8	433.1	2.4
148	485.6	441.1	0.0

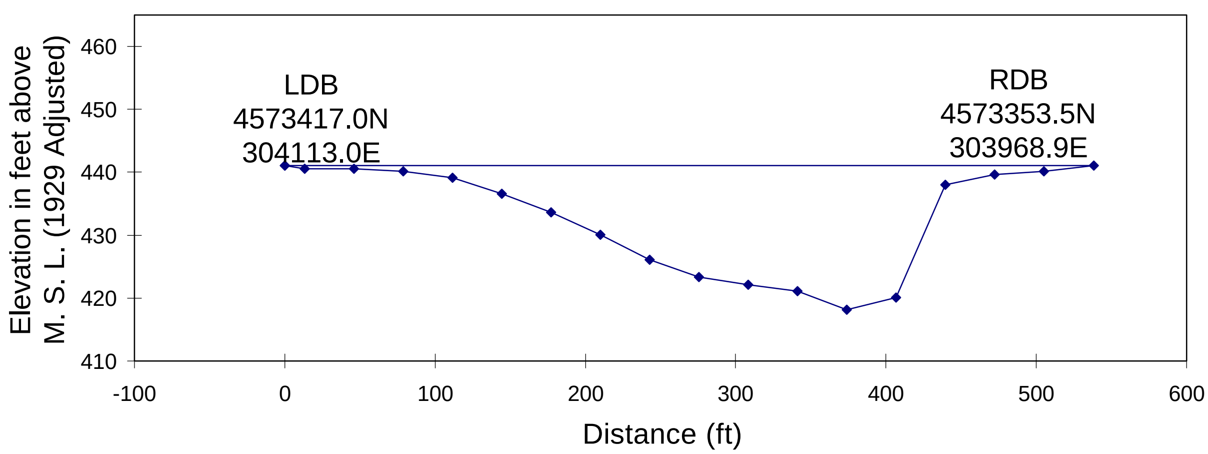
Midpoint Channel Profile RM210.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	441.1	0.0
4	13.1	440.6	0.2
14	45.9	440.6	0.2
24	78.7	440.1	0.3
34	111.5	439.1	0.6
44	144.4	436.6	1.4
54	177.2	433.6	2.3
64	210.0	430.1	3.4
74	242.8	426.1	4.6
84	275.6	423.3	5.4
94	308.4	422.1	5.8
104	341.2	421.1	6.1
114	374.0	418.1	7.0
124	406.8	420.1	6.4
134	439.6	438.0	0.9
144	472.4	439.6	0.5
154	505.2	440.1	0.3
164	538.1	441.1	0.0

Illinois River Waterway
Site#6 RM210.0



A. Upstream Channel Profile



B. Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

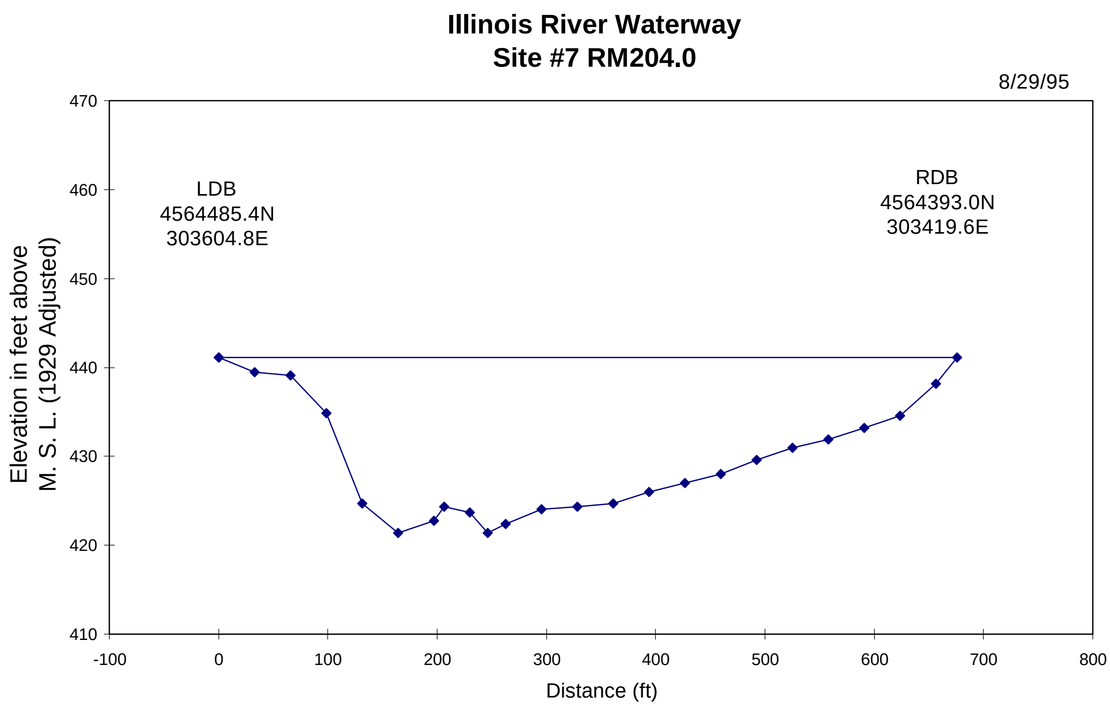
		Site #7 RM204.0 LDB	NORTH	EAST	OPPOSITE
ILR7-1	UPSTREAM BANK PROFILE		4564680.0	303515.4	N/A
ILR7-2	MIDPOINT BANK PROFILE		4564485.4	303604.8	ILR7-4
ILR7-3	DOWNSTREAM PROFILE		4564379.3	303656.6	N/A
ILR7-4	MIDPOINT PROFILE/OPPOSITE		4564396.0	303419.6	ILR7-2

Channel Profile Endpoints at Site#7

(A) MIDPOINT CHANNEL PROFILE (From: ILR-2 To: ILR7-4)
Cross section length~206m (675.8ft)

Midpoint Channal Profile RM204.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	441.1	0
10	32.8	439.5	0.5
20	65.6	439.1	0.6
30	98.4	434.9	1.9
40	131.2	424.7	5
50	164.0	421.4	6
60	196.8	422.7	5.6
63	206.7	424.4	5.1
70	229.7	423.7	5.3
75	246.1	421.4	6
80	262.5	422.4	5.7
90	295.3	424.0	5.2
100	328.1	424.4	5.1
110	360.9	424.7	5
120	393.7	426.0	4.6
130	426.5	427.0	4.3
140	459.3	428.0	4
150	492.1	429.6	3.5
160	524.9	430.9	3.1
170	557.7	431.9	2.8
180	590.5	433.2	2.4
190	623.4	434.5	2
200	656.2	438.1	0.9
206	675.8	441.1	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #8 RM184.8 LDB

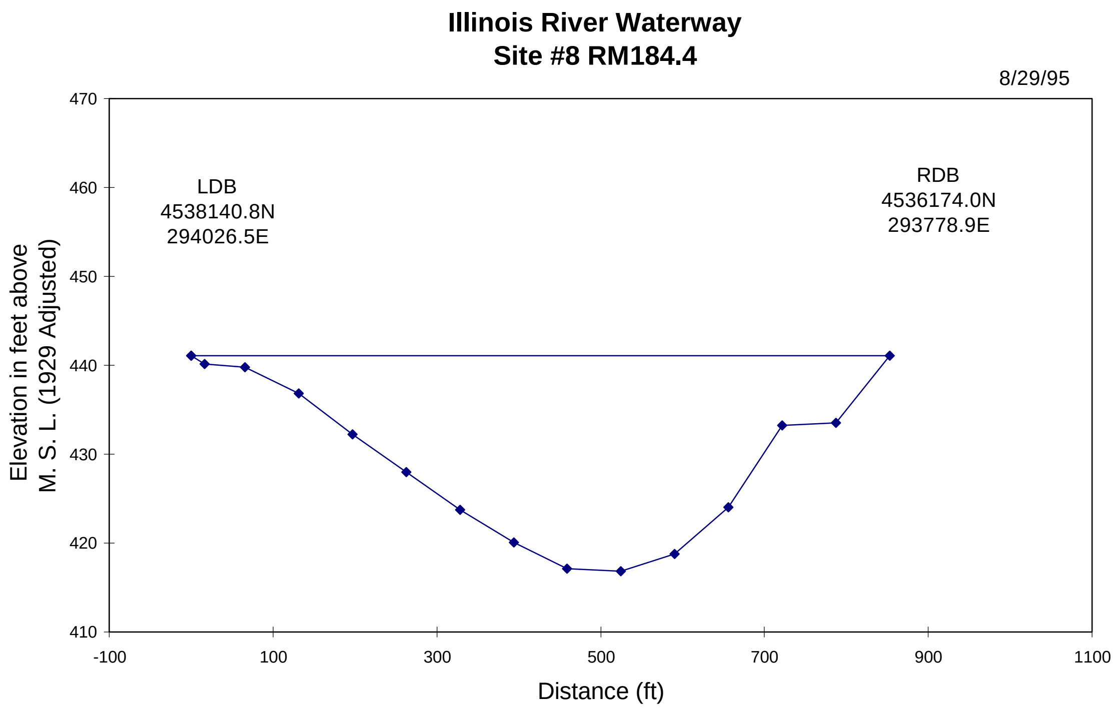
		NORTH	EAST	OPPOSITE
ILR8-1	UPSTREAM BANK PROFILE	4538463.5	294101.9	N/A
ILR8-2	MIDPOINT BANK PROFILE	4538140.8	294026.5	ILR8-4
ILR8-3	DOWNSTREAM BANK PROFILE	4538038.0	293778.9	N/A
ILR8-4	MIDPOINT PROFILE/OPPOSITE	4536174.0	293778.9	ILR8-2

Channel Profile Endpoints at Site#8

(A) MIDPOINT CHANNEL PROFILE (From: ILR8-2 To: ILR8-4)
Cross Section Length ~ 260m (853ft)

Midpoint Channel Profile RM184.4

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	441.1	0
5	16.4	440.1	0.3
20	65.6	439.8	0.4
40	131.2	436.8	1.3
60	196.8	432.2	2.7
80	262.5	428.0	4
100	328.1	423.7	5.3
120	393.7	420.1	6.4
140	459.3	417.2	7.3
160	524.9	416.8	7.4
180	590.5	418.8	6.8
200	656.2	424.0	5.2
220	721.8	433.2	2.4
240	787.4	433.6	2.3
260	853.0	441.1	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #9 RM180.0 LDB

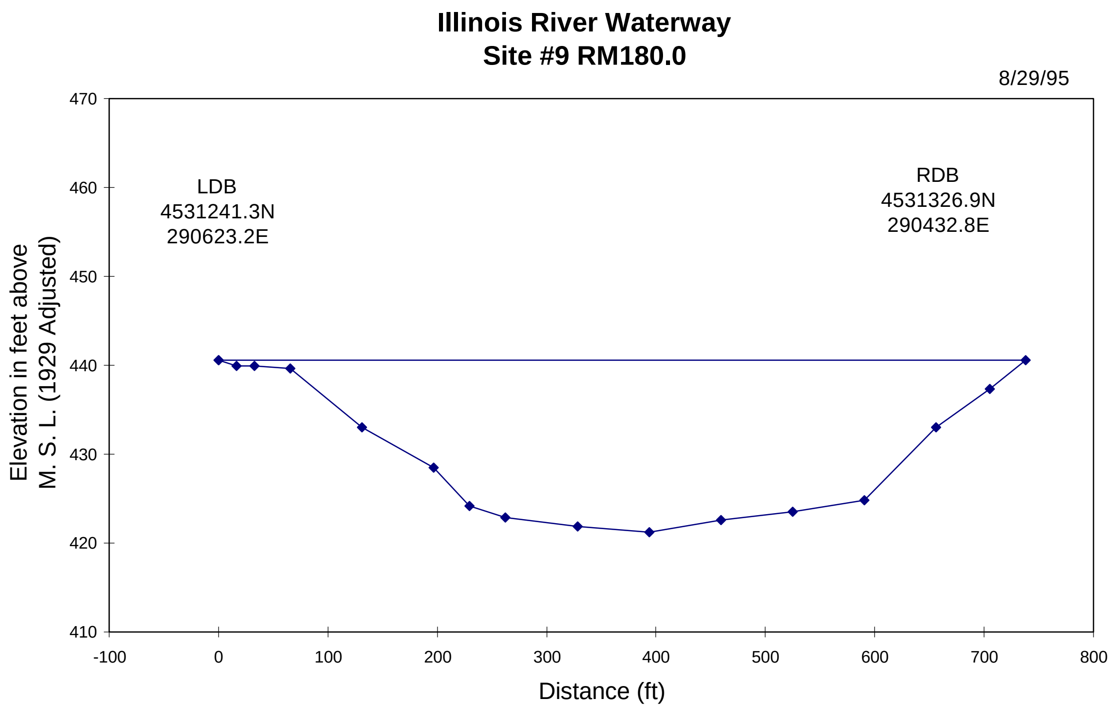
		NORTH	EAST	OPPOSITE
ILR9-1	UPSTREAM BANK PROFILE	4531428.2	290712.0	N/A
ILR9-2	MIDPOINT BANK PROFILE	4531241.3	290623.2	ILR9-4
ILR9-3	DOWNSTREAM BANK PROFILE	4531100.5	290573.4	N/A
ILR9-4	MIDPOINT PROFILE/OPPOSITE	4531326.9	290432.8	ILR9-2

Channel Profile Endpoints at Site#9

(A) MIDPOINT CHANNEL PROFILE (From: ILR9-2 To:ILR9-4)
Cross Section Length ~225m ('738.18ft)

Midpoint Channel Profile RM180.0

Distance (m)	Distance (m)	Depth Elevation	Depth (m)
0	0.0	440.6	0
5	16.4	439.9	0.2
10	32.8	439.9	0.2
20	65.6	439.6	0.3
40	131.2	433.1	2.3
60	196.8	428.5	3.7
70	229.7	424.2	5
80	262.5	422.9	5.4
100	328.1	421.9	5.7
120	393.7	421.2	5.9
140	459.3	422.6	5.5
160	524.9	423.5	5.2
180	590.5	424.9	4.8
200	656.2	433.1	2.3
215	705.4	437.3	1
225	738.2	440.6	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #10 RM160.0 RDB

		NORTH	EAST	OPPOSITE
ILR10-1	UPSTREAM BANK PROFILE	4503931.6	278707.8	N/A
ILR10-2	MIDPOINT BANK PROFILE	4503891.9	278717.2	ILR10-4
ILR10-3	DOWNSTREAM BANK PROFILE	4503756.5	278782.8	N/A
ILR10-4	MIDPOINT PROFILE/OPPOSITE	4504001.4	278967	ILR10-2

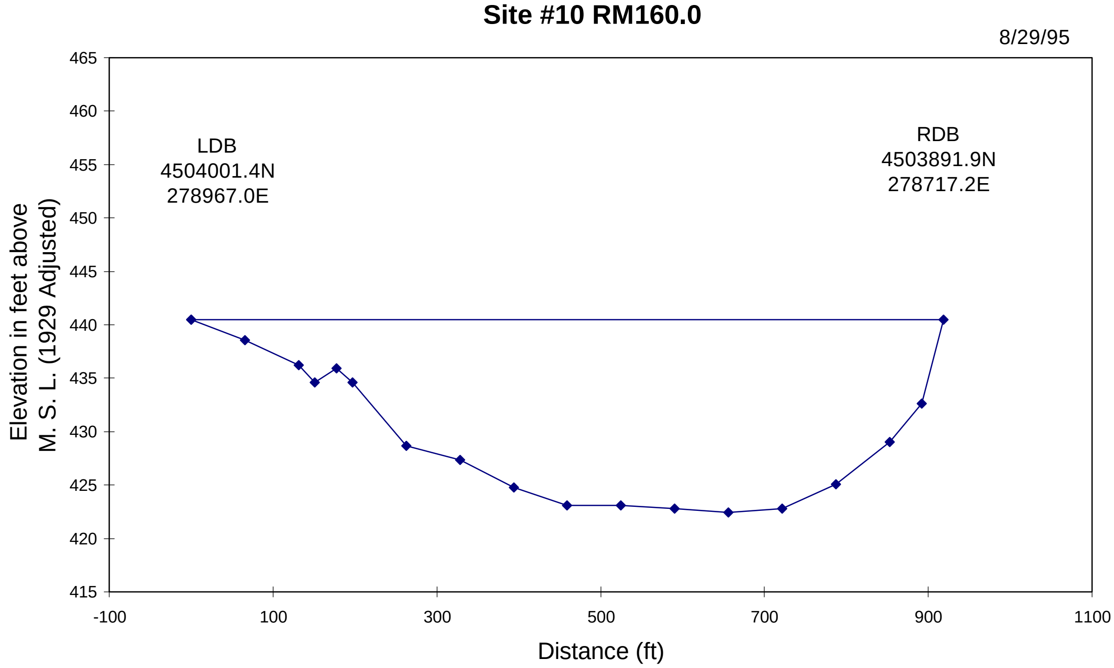
Channel Profile Endpoints

(A) MIDPOINT CHANNEL PROFILE (From: ILR10-4 To: ILR10-2)
Cross Section Length~280m (918.6ft)

Midpoint Channel Profile RM160.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	440.5	0
20	65.6	438.5	0.6
40	131.2	436.2	1.3
46	150.9	434.6	1.8
54	177.2	435.9	1.4
60	196.8	434.6	1.8
80	262.5	428.7	3.6
100	328.1	427.4	4
120	393.7	424.8	4.8
140	459.3	423.1	5.3
160	524.9	423.1	5.3
180	590.5	422.8	5.4
200	656.2	422.5	5.5
220	721.8	422.8	5.4
240	787.4	425.1	4.7
260	853.0	429.0	3.5
272	892.4	432.6	2.4
280	918.6	440.5	0

Illinois River Waterway
Site #10 RM160.0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #11 RM155.3 RDB

		NORTH	EAST	OPPOSITE
ILR11-1	UPSTREAM SITE LIMIT	4498857.0	275633.8	ILR11-6
ILR11-2	UPSTREAM BANK PROFILE	4498772.5	275555.5	N/A
ILR11-3	MIDSTREAM BANK PROFILE	4498517.0	275333.0	ILR11-7
ILR11-4	DOWNSTREAM BANK PROFILE	4498238.0	275131.0	N/A
ILR11-5	DOWNSTREAM SITE LIMIT	4498155.0	275081.0	N/A
ILR11-6	UPSTREAM SITE LIMIT	4497410.4	274998.3	ILR11-1
ILR11-7	MIDSTREAM BANK PROFILE	4498416.9	275480.2	ILR11-3

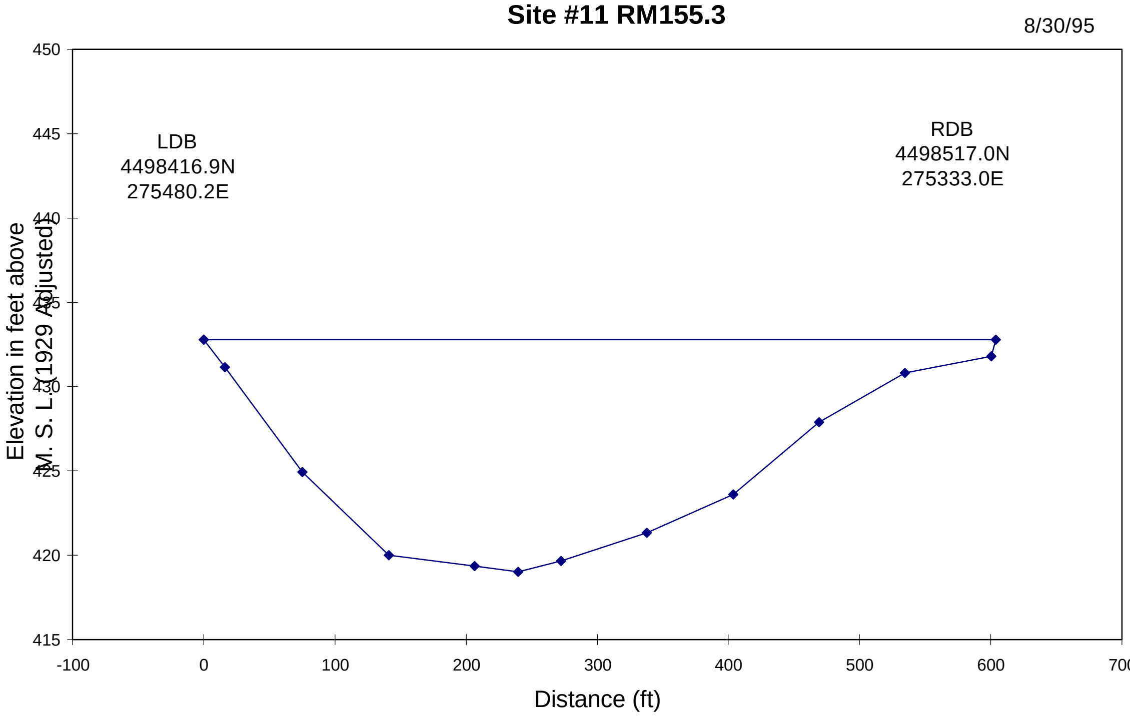
Channel Profile Endpoints at Site#11

(A) MIDPOINT CHANNEL PROFILE (From: ILR11-7 To: ILR11-3)
Cross Section Length ~ 184m (603.7ft)

Midpoint Channel Profile RM155.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	432.8	0
5	16.4	431.2	0.5
23	75.5	424.9	2.4
43	141.1	420.0	3.9
63	206.7	419.3	4.1
73	239.5	419.0	4.2
83	272.3	419.7	4
103	337.9	421.3	3.5
123	403.5	423.6	2.8
143	469.2	427.9	1.5
163	534.8	430.8	0.6
183	600.4	431.8	0.3
184	603.7	432.8	0

Illinois River Waterway
Site #11 RM155.3



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #12 RM154.5 LDB

		NORTH	EAST	OPPOSITE
ILR12-1	UPSTREAM SITE LIMIT	4497410.4	274998.3	N/A
ILR12-2	UPSTREAM BANK PROFILE	4497310.5	274987.5	N/A
ILR12-3	MIDPOINT BANK PROFILE	4496947.7	275006.4	ILR12-6
ILR12-4	DOWNSTREAM BANK PROFILE	4496477.2	275105.4	N/A
ILR12-5	DOWNSTREAM SITE LIMIT	4496385.5	275133.5	N/A
ILR12-6	MIDPOINT PROFILE/OPPOSITE	4496953.0	274840.5	ILR12-3

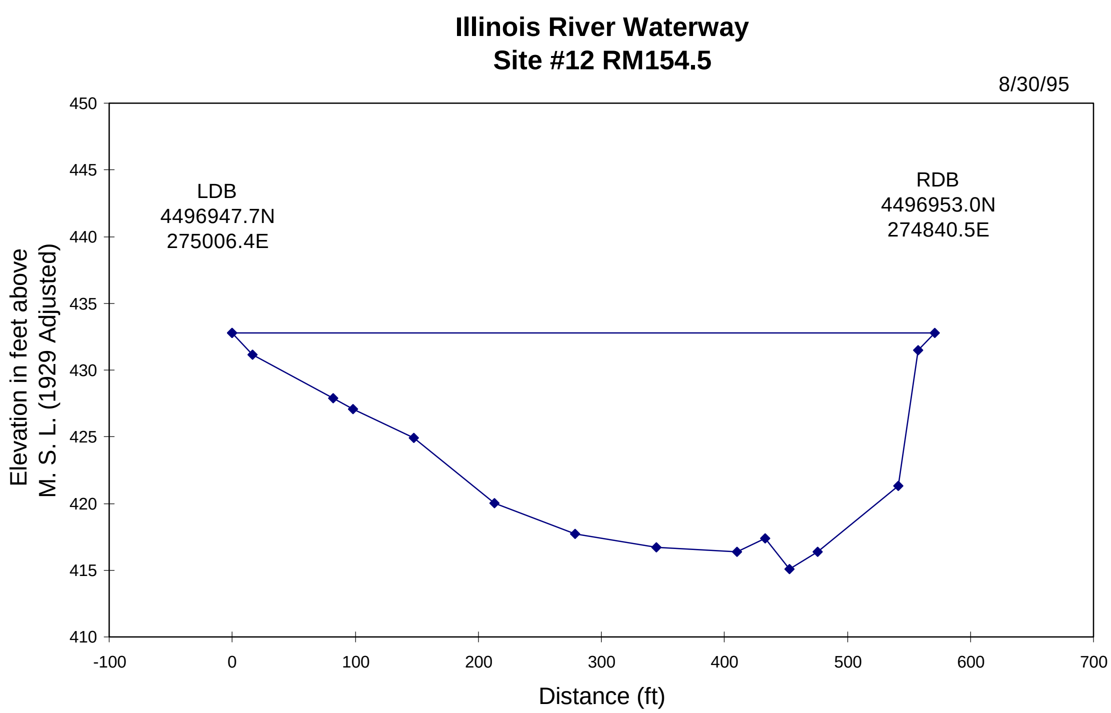
Channel Profile Endpoints at Site #12

(A) MIDPOINT CHANNEL PROFILE (From:ILR12-3 To:ILR12-6)

Cross Section Length ~174m (570.9ft)

Midpoint Channel Profile RM154.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	432.8	0
5	16.4	431.2	0.5
25	82.0	427.9	1.5
30	98.4	427.1	1.75
45	147.6	424.9	2.4
65	213.3	420.0	3.9
85	278.9	417.7	4.6
105	344.5	416.7	4.9
125	410.1	416.4	5
132	433.1	417.4	4.7
138	452.8	415.1	5.4
145	475.7	416.4	5
165	541.3	421.3	3.5
170	557.7	431.5	0.4
174	570.9	432.8	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #13 RM150.6 LDB

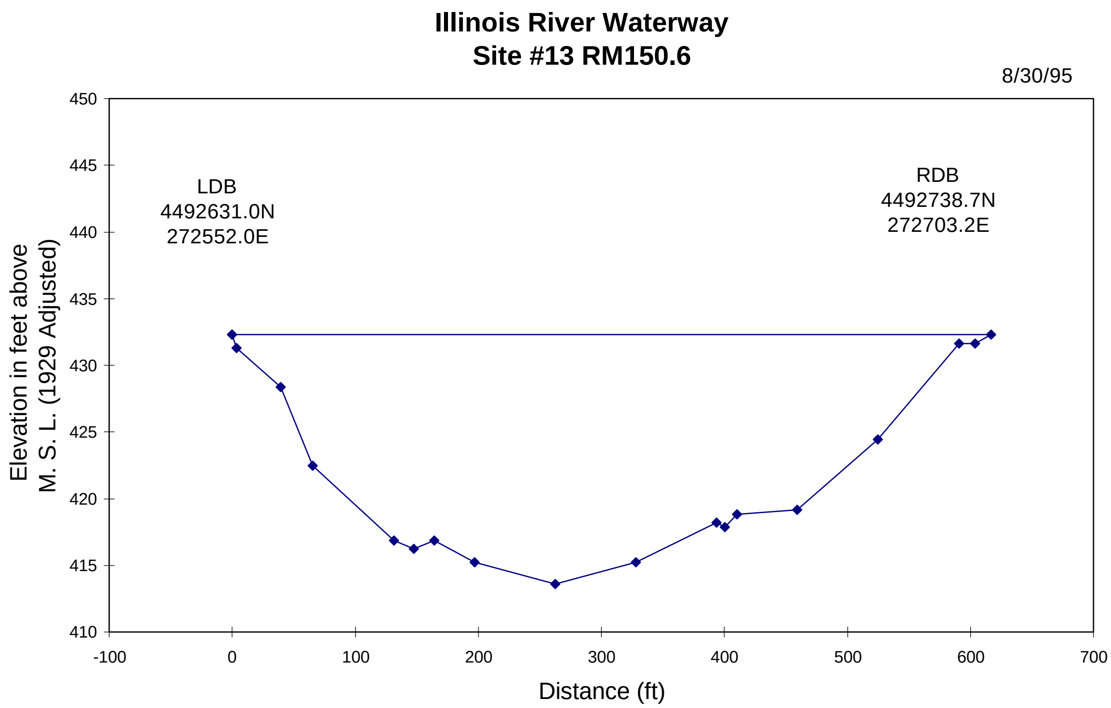
		NORTH	EAST	OPPOSITE
ILR13-1	UPSTREAM SITE LIMIT	4492518.0	272669.0	N/A
ILR13-2	UPSTREAM BANK PROFILE	4492551.0	272612.5	N/A
ILR13-3	MIDPOINT BANK PROFILE	4492631.0	272552.0	ILR13-6
ILR13-4	DOWNSTREAM BANK PROFILE	4492703.0	272508.9	N/A
ILR13-5	DOWNSTREAM SITE LIMIT	4492750.0	272494.9	N/A
ILR13-6	MIDPOINT PROFILE/OPPOSITE	4492738.7	272703.2	ILR13-3

Channel Profile Endpoints at Site#13

(A) MIDPOINT CHANNEL PROFILE (From: ILR13-3 To: ILR13-6)
Cross Section Length ~188m (616.8ft)

Midpoint Channel Profile RM150.6

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	432.3	0
1	3.3	431.3	0.3
12	39.4	428.4	1.2
20	65.6	422.5	3
40	131.2	416.9	4.7
45	147.6	416.2	4.9
50	164.0	416.9	4.7
60	196.8	415.2	5.2
80	262.5	413.6	5.7
100	328.1	415.2	5.2
120	393.7	418.2	4.3
122	400.3	417.9	4.4
125	410.1	418.8	4.1
140	459.3	419.2	4
160	524.9	424.4	2.4
180	590.5	431.6	0.2
184	603.7	431.6	0.2
188	616.8	432.3	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site#14 RM129.3 RDB

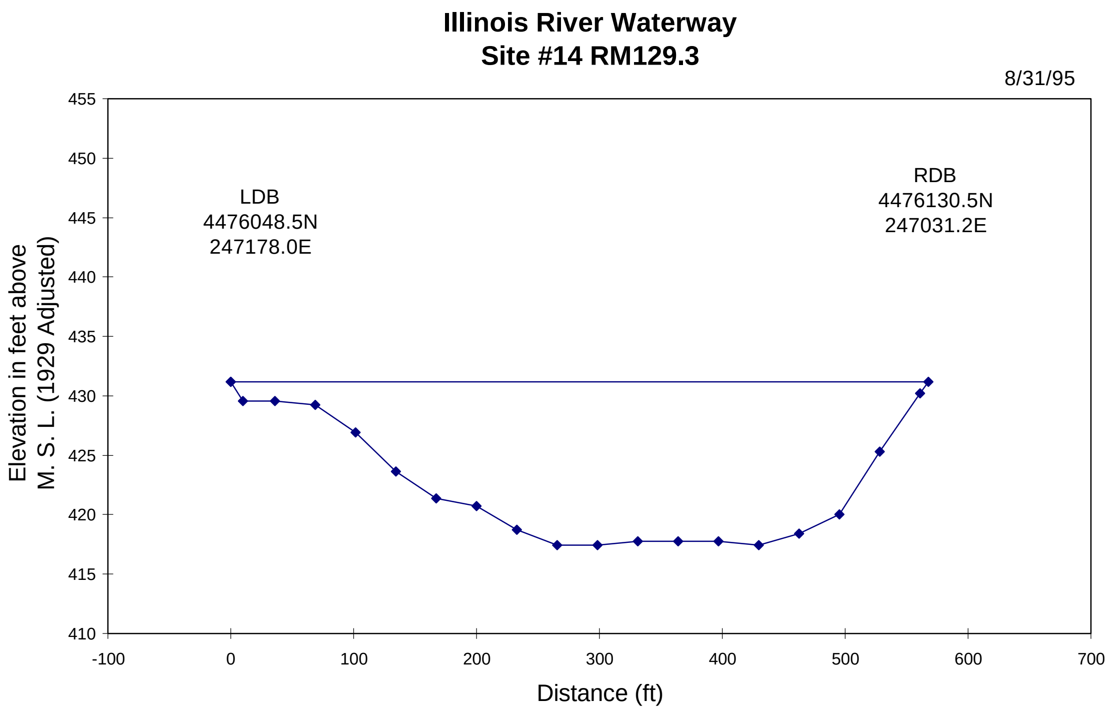
		NORTH	EAST	OPPOSITE
ILR14-1	UPSTREAM SITE LIMIT	4476372.6	247110.9	N/A
ILR14-2	UPSTREAM BANK PROFILE	4476252.9	247076.5	N/A
ILR14-3	MIDPOINT BANK PROFILE	4476130.5	247031.2	ILR14-6
ILR14-4	DOWNSTREAM BANK PROFILE	4475985.0	246954.6	N/A
ILR14-5	DOWNSTREAM SITE LIMIT	4475938.9	246927.0	N/A
ILR14-6	MIDPOINT PROFILE/OPPOSITE	4476048.5	247178.0	ILR14-3

Channel Profile Endpoints at Site#14

(A) MIDPOINT CHANNEL PROFILE (From: ILR14-6 To: ILR14-3)
Cross Section Length ~ 173m (567.6ft)

Midpoint Channel Profile RM129.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	431.2	0
3	9.9	429.6	0.5
11	36.1	429.6	0.5
21	68.9	429.2	0.6
31	101.7	426.9	1.3
41	134.5	423.7	2.3
51	167.3	421.4	3
61	200.2	420.7	3.2
71	233.0	418.7	3.8
81	265.8	417.4	4.2
91	298.6	417.4	4.2
101	331.4	417.7	4.1
111	364.2	417.7	4.1
121	397.0	417.7	4.1
131	429.8	417.4	4.2
141	462.6	418.4	3.9
151	495.4	420.0	3.4
161	528.2	425.3	1.8
171	561.0	430.2	0.3
173	567.6	431.2	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #15 RM116.5 RDB

		NORTH	EAST	OPPOSITE
ILR15-1	UPSTREAM SITE LIMIT	4461771.8	236090.6	N/A
ILR15-2	UPSTREAM BANK PROFILE	4461695.7	235960.9	N/A
ILR15-3	MIDPOINT BANK PROFILE	4461324.5	235627.9	ILR15-6
ILR15-4	DOWNSTREAM BANK PROFILE	4460601.9	235252.4	N/A
ILR15-5	DOWNSTREAM SITE LIMIT	4460482.6	235208.9	N/A
ILR15-6	MIDPOINT PROFILE/OPPOSITE	4461202.5	235807.0	ILR15-3

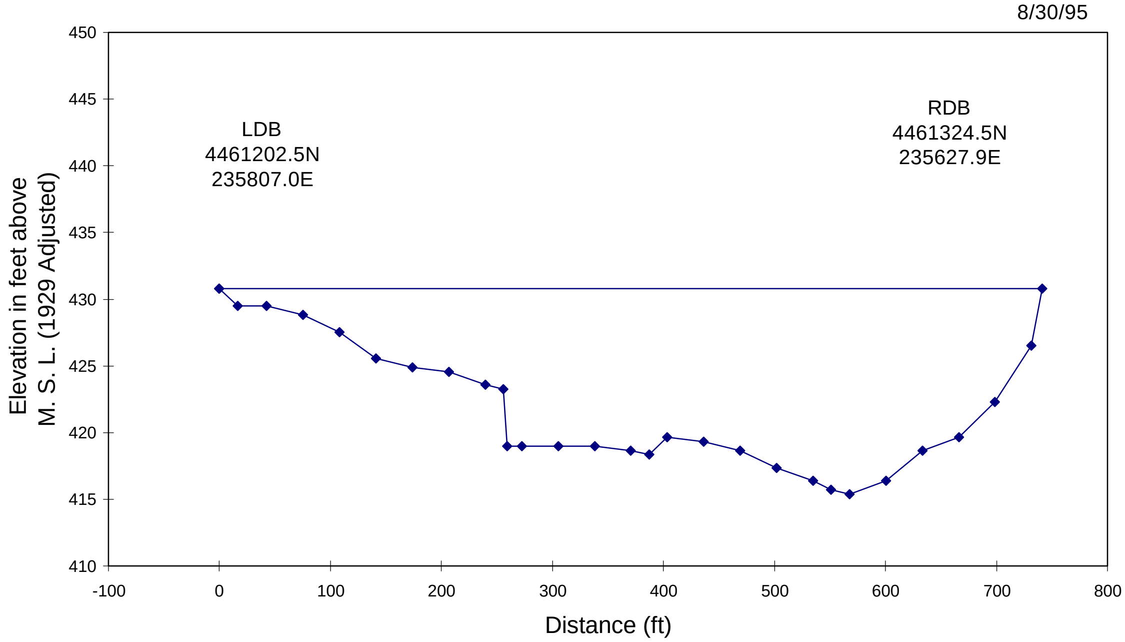
Channel Profile Endpoints at Site #15

(A) MIDPOINT CHANNEL PROFILE (From: ILR15-6 To: ILR15-3)
Cross Section Length ~226m (741.5ft)

Midpoint Channel Profile RM116.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	430.8	0
5	16.4	429.5	0.4
13	42.7	429.5	0.4
23	75.5	428.8	0.6
33	108.3	427.5	1
43	141.1	425.6	1.6
53	173.9	424.9	1.8
63	206.7	424.6	1.9
73	239.5	423.6	2.2
78	255.9	423.3	2.3
79	259.2	419.0	3.6
83	272.3	419.0	3.6
93	305.1	419.0	3.6
103	337.9	419.0	3.6
113	370.7	418.7	3.7
118	387.1	418.3	3.8
123	403.5	419.6	3.4
133	436.3	419.3	3.5
143	469.2	418.7	3.7
153	502.0	417.3	4.1
163	534.8	416.4	4.4
168	551.2	415.7	4.6
173	567.6	415.4	4.7
183	600.4	416.4	4.4
193	633.2	418.7	3.7
203	666.0	419.6	3.4
213	698.8	422.3	2.6
223	731.6	426.5	1.3
226	741.5	430.8	0

Illinois River Waterway
Site #15 RM116.5



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #16 RM109.5A LDB

		NORTH	EAST	OPPOSITE
ILR16-1	UPSTREAM SITE LIMIT	4454029.6	228584.1	N/A
ILR16-2	UPSTREAM BANK PROFILE	4454022.9	228524.5	ILR16-5
ILR16-3	MIDPOINT BANK PROFILE	4453967.3	228297.8	ILR16-6
ILR16-4	UPSTREAM SITE LIMIT	4454124.0	228261.0	N/A
ILR16-5	UPSTREAM BANK PROFILE (i)	4454170.5	228511.1	ILR16-2
ILR16-6	UPSTREAM BANK PROFILE (ii)	4454115.3	228235.6	ILR16-3

Channel Profile Endpoints at Site#16

(A) UPSTREAM CHANNEL PROFILE (From: ILR16-2 To: ILR16-5)
Cross Section Length ~150m (492.1ft)

(B) MIDPOINT CHANNEL PROFILE (From: ILR16-3 To:ILR16-6)
Cross Section Length ~162m (531.5ft)

Upstream Channel Profile RM109.5A

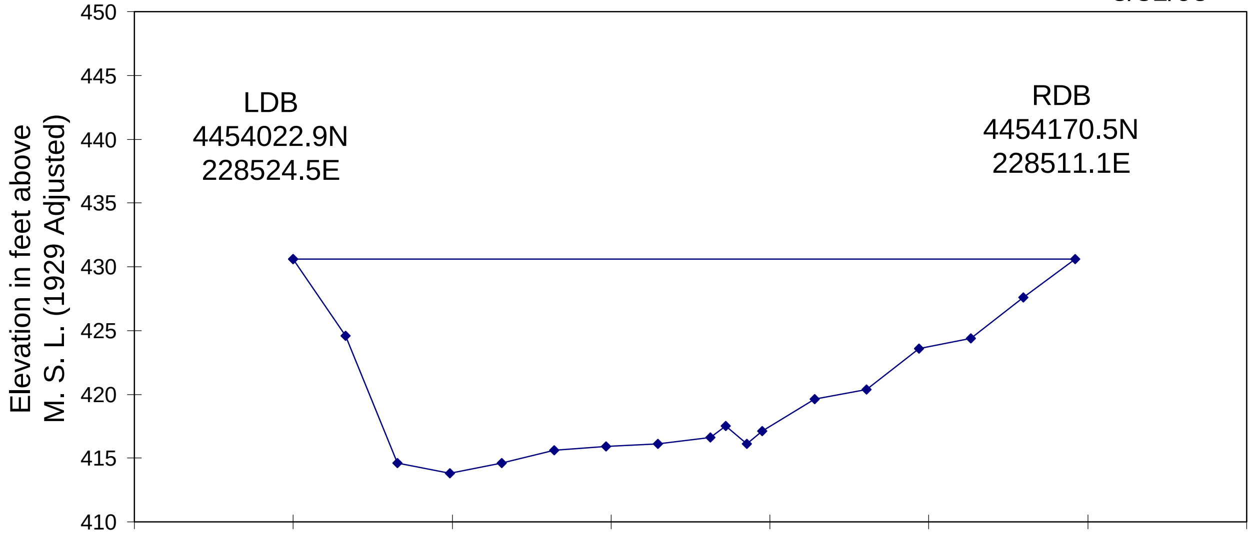
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	430.6	0.0
10	32.8	424.6	1.8
20	65.6	414.6	4.9
30	98.4	413.8	5.1
40	131.2	414.6	4.9
50	164.0	415.6	4.6
60	196.8	415.9	4.5
70	229.7	416.1	4.4
80	262.5	416.6	4.3
83	272.3	417.5	4.0
87	285.4	416.1	4.4
90	295.3	417.1	4.1
100	328.1	419.6	3.4
110	360.9	420.4	3.1
120	393.7	423.6	2.1
130	426.5	424.4	1.9
140	459.3	427.6	0.9
150	492.1	430.6	0.0

Midpoint Channel Profile RM109.5A

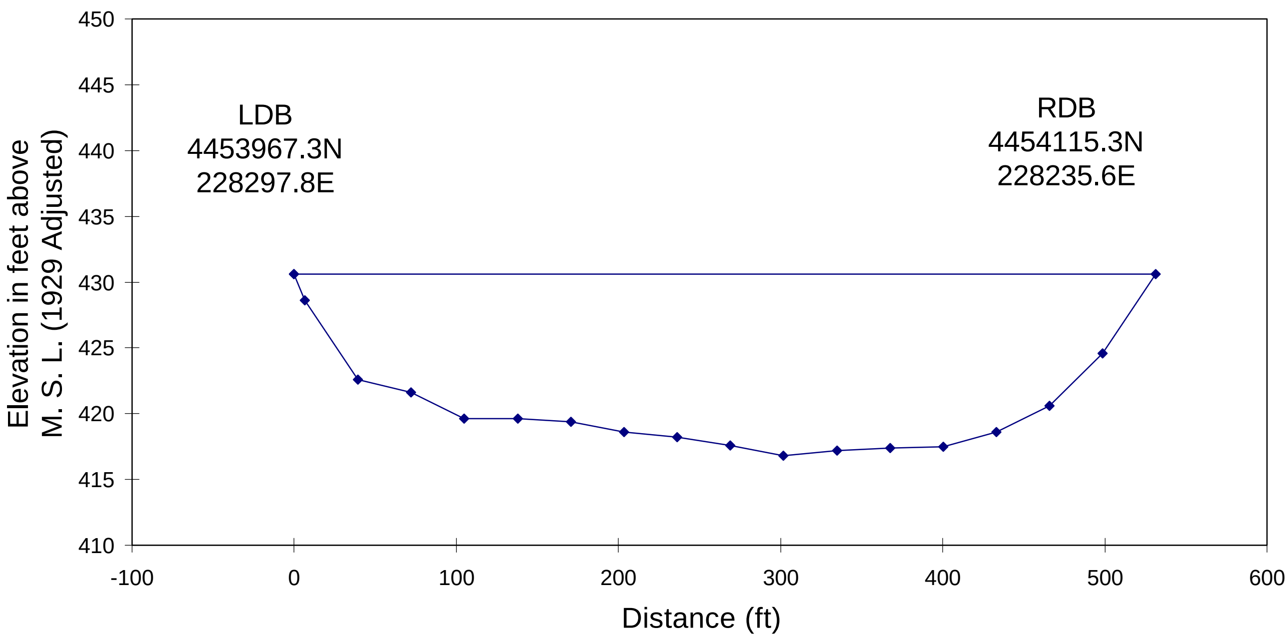
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	430.6	0.0
2	6.6	428.6	0.6
12	39.4	422.6	2.4
22	72.2	421.6	2.7
32	105.0	419.6	3.4
42	137.8	419.6	3.4
52	170.6	419.4	3.4
62	203.4	418.6	3.7
72	236.2	418.2	3.8
82	269.0	417.6	4.0
92	301.8	416.8	4.2
102	334.6	417.2	4.1
112	367.4	417.4	4.0
122	400.3	417.5	4.0
132	433.1	418.6	3.7
142	465.9	420.6	3.0
152	498.7	424.6	1.8
162	531.5	430.6	0.0

Illinois River Waterway
Site#16 RM109.5A

8/31/95



A. Upstream Channel Profile



B. Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #17 RM109.5B RDB

		NORTH	EAST	OPPOSITE
ILR17-1	MIDPOINT BANK PROFILE	4454067.1	228122.1	ILR17-4
ILR17-2	DOWNSTREAM BANK PROFILE	4453891.2	227910.2	ILR17-5
ILR17-3	DOWNSTREAM SITE LIMIT	4453867.9	227888.1	N/A
ILR17-4	MIDPOINT PROFILE/OPPOSITE	4453921.6	228203.6	ILR17-1
ILR17-5	DOWNSTREAM BANK PROFILE	4453780.1	228035.2	ILR17-2

Channel Profile Endpoints at Site#17

(A) MIDPOINT CHANNEL PROFILE (From: ILR17-4 To:ILR17-1)
Cross Section Length ~ 168m (551.2ft)

(B) DOWNSTREAM CHANNEL PROFILE (From:ILR17-5 To:ILR17-2)
Cross Section Length~170m (557.7ft)

Midpoint Channel Profile RM109.5B

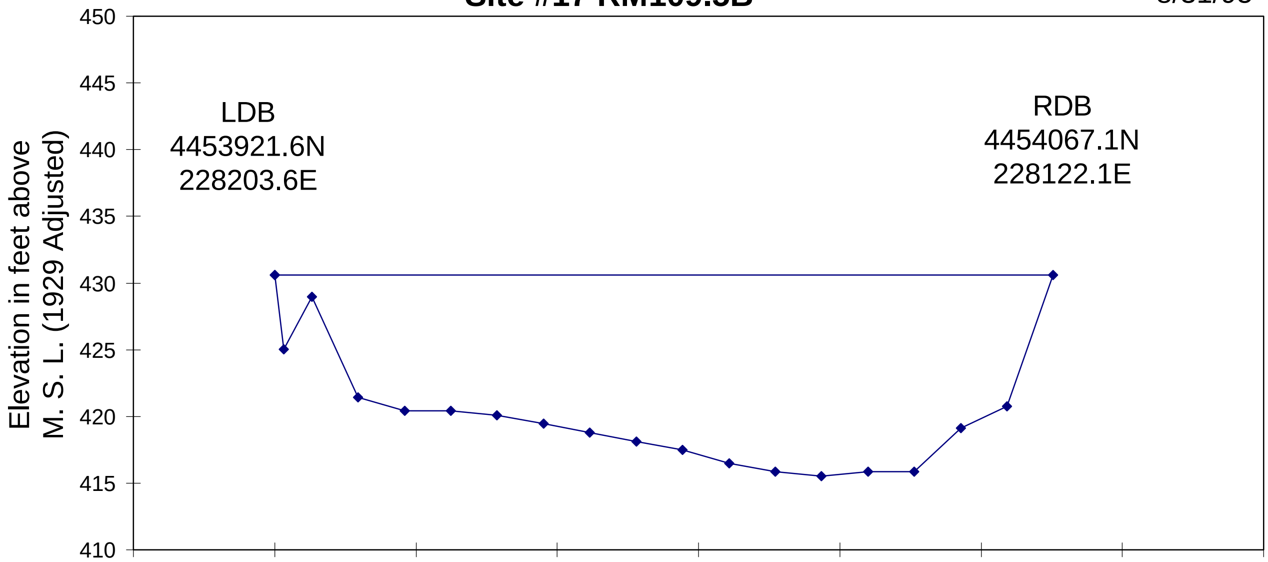
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	430.6	0
2	6.6	425.0	1.7
8	26.2	429.0	0.5
18	59.1	421.4	2.8
28	91.9	420.4	3.1
38	124.7	420.4	3.1
48	157.5	420.1	3.2
58	190.3	419.4	3.4
68	223.1	418.8	3.6
78	255.9	418.1	3.8
88	288.7	417.5	4
98	321.5	416.5	4.3
108	354.3	415.8	4.5
118	387.1	415.5	4.6
128	419.9	415.8	4.5
138	452.8	415.8	4.5
148	485.6	419.1	3.5
158	518.4	420.8	3
168	551.2	430.6	0

Downstream Channel Profile RM109.5B

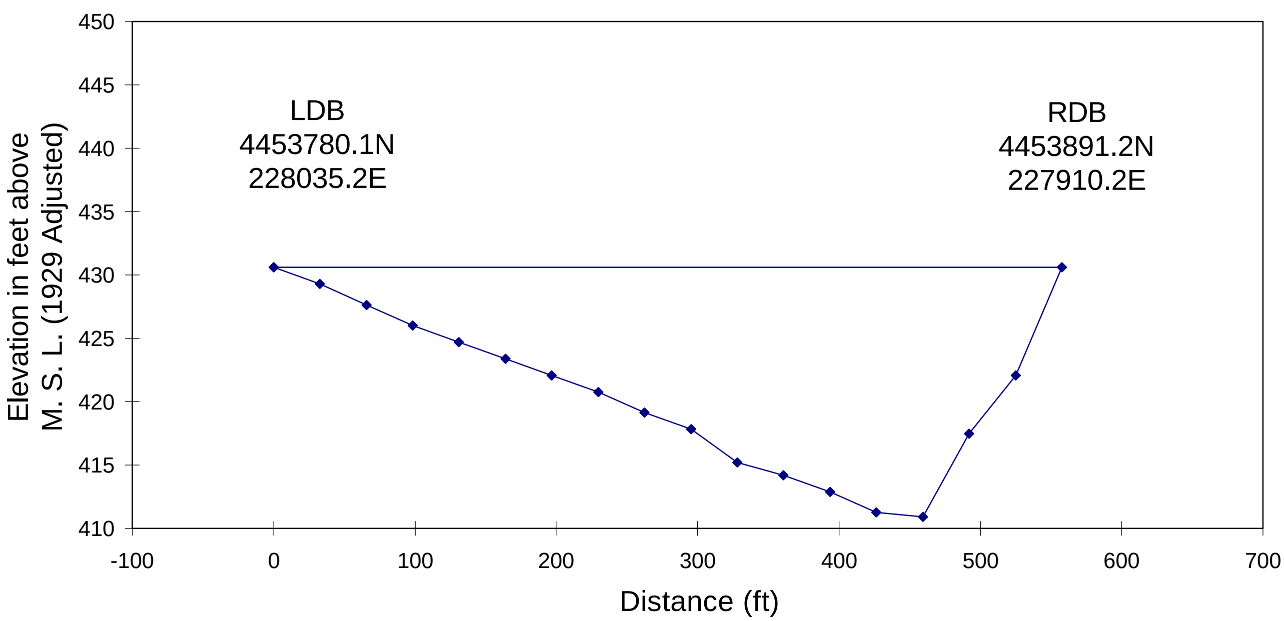
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	430.6	0
10	32.8	429.3	0.4
20	65.6	427.6	0.9
30	98.4	426.0	1.4
40	131.2	424.7	1.8
50	164.0	423.4	2.2
60	196.8	422.1	2.6
70	229.7	420.8	3
80	262.5	419.1	3.5
90	295.3	417.8	3.9
100	328.1	415.2	4.7
110	360.9	414.2	5
120	393.7	412.9	5.4
130	426.5	411.2	5.9
140	459.3	410.9	6
150	492.1	417.5	4
160	524.9	422.1	2.6
170	557.7	430.6	0

Illinois River Waterway
Site #17 RM109.5B

8/31/95



A. Midpoint Channel Profile



B. Downstream Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #18 RM94.2 RDB

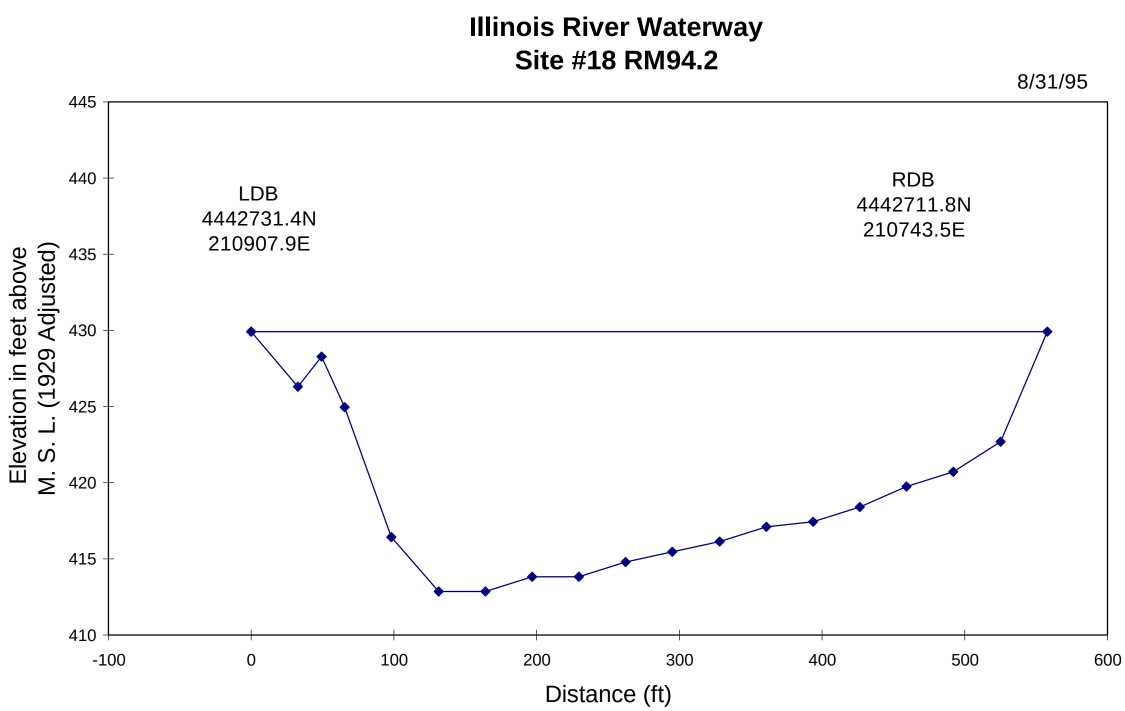
		NORTH	EAST	OPPOSITE
ILR18-1	UPSTREAM SITE LIMIT	4442789.0	210725.4	N/A
ILR18-2	UPSTREAM BANK PROFILE	4442766.4	210733.4	N/A
ILR18-3	MIDPOINT BANK PROFILE	4442711.8	210743.5	ILR18-6
ILR18-4	DOWNSTREAM BANK PROFILE	4442661.6	210745.3	N/A
ILR18-5	DOWNSTREAM SITE LIMIT	4442636.9	210749.4	N/A
ILR18-6	MIDPOINT PROFILE/OPPOSITE	4442731.4	210907.9	N/A

Channel Profile Endpoints at Site#18

(A) MIDPOINT CHANNEL PROFILE (From: ILR18-6 To:ILR18-3)
Cross Section Length ~ 170m (557.7ft)

Midpoint Channel Profile RM94.2

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	429.9	0
10	32.8	426.3	1.1
15	49.2	428.3	0.5
20	65.6	425.0	1.5
30	98.4	416.4	4.1
40	131.2	412.8	5.2
50	164.0	412.8	5.2
60	196.8	413.8	4.9
70	229.7	413.8	4.9
80	262.5	414.8	4.6
90	295.3	415.5	4.4
100	328.1	416.1	4.2
110	360.9	417.1	3.9
120	393.7	417.4	3.8
130	426.5	418.4	3.5
140	459.3	419.7	3.1
150	492.1	420.7	2.8
160	524.9	422.7	2.2
170	557.7	429.9	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #19 RM91.2 RDB

		NORTH	EAST	OPPOSITE
ILR19-1	UPSTREAM SITE LIMIT	4439736.6	207329.0	N/A
ILR19-2	UPSTREAM BANK PROFILE	4439696.7	207328.3	ILR19-6
ILR19-3	MIDPOINT BANK PROFILE	4439516.1	207343.9	ILR19-7
ILR19-4	DOWNSTREAM BANK PROFILE	4439408.5	207356.6	N/A
ILR19-5	DOWNSTREAM SITE LIMIT	4439374.9	207354.3	N/A
ILR19-6	UPSTREAM PROFILE/OPPOSITE	4439718.6	207513.4	ILR19-2
ILR19-7	MIDPOINT PROFILE/OPPOSITE	4439541.0	207511.6	ILR19-3

Channel Profile Endpoints at Site #19

(A) UPSTREAM CHANNEL PROFILE (From: ILR19-6 To: ILR19-2)
Cross Section Length ~202m (662.7ft)

(B) MIDPOINT CHANNEL PROFILE (From: ILR19-7 To: ILR19-3)
Cross Section Length ~192m (629.9ft)

Upstream Channel Profile RM91.2

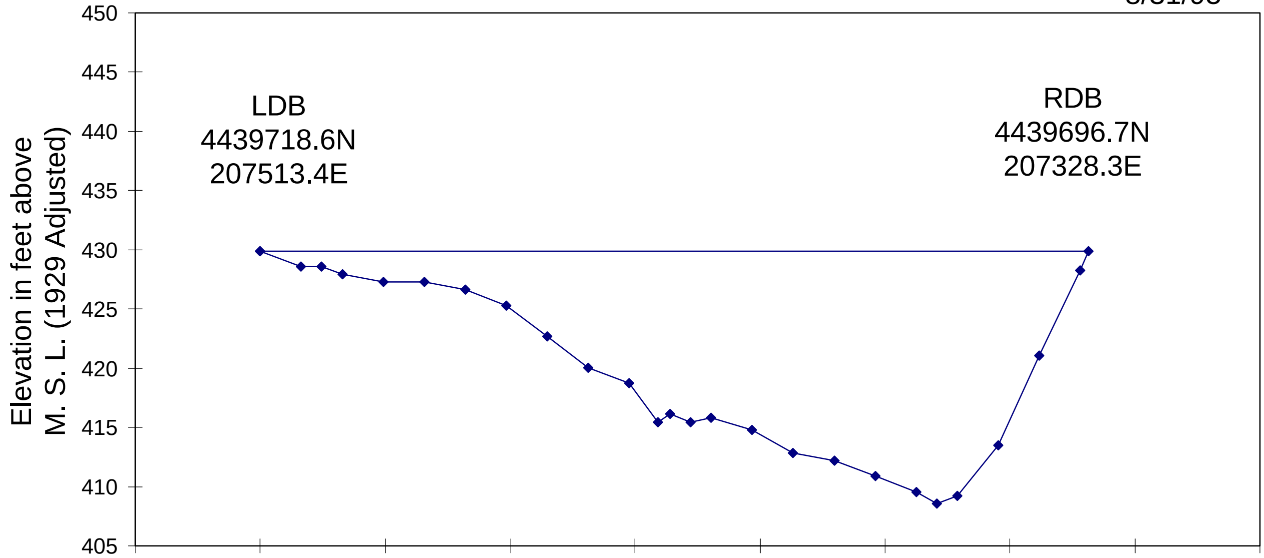
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	429.9	0
10	32.8	428.6	0.4
15	49.2	428.6	0.4
20	65.6	427.9	0.6
30	98.4	427.3	0.8
40	131.2	427.3	0.8
50	164.0	426.6	1
60	196.8	425.3	1.4
70	229.7	422.7	2.2
80	262.5	420.1	3
90	295.3	418.7	3.4
97	318.2	415.5	4.4
100	328.1	416.1	4.2
105	344.5	415.5	4.4
110	360.9	415.8	4.3
120	393.7	414.8	4.6
130	426.5	412.8	5.2
140	459.3	412.2	5.4
150	492.1	410.9	5.8
160	524.9	409.6	6.2
165	541.3	408.6	6.5
170	557.7	409.2	6.3
180	590.5	413.5	5
190	623.4	421.0	2.7
200	656.2	428.3	0.5
202	662.7	429.9	0

Midpoint Channel Profile RM91.2

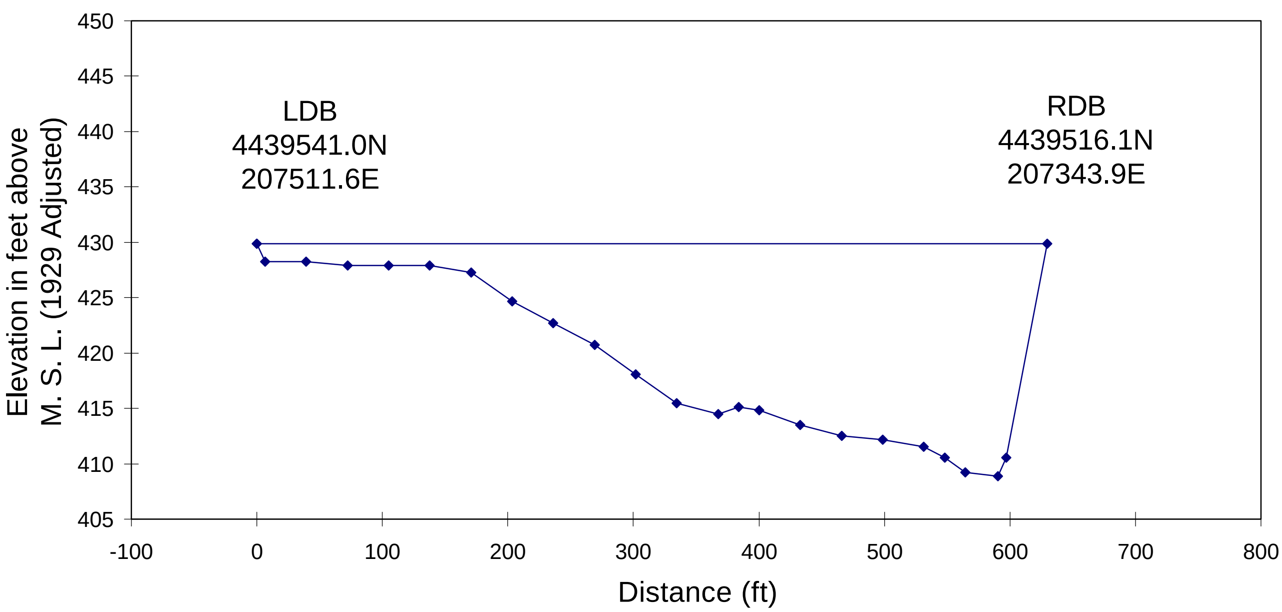
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	429.9	0
2	6.6	428.3	0.5
12	39.4	428.3	0.5
22	72.2	427.9	0.6
32	105.0	427.9	0.6
42	137.8	427.9	0.6
52	170.6	427.3	0.8
62	203.4	424.7	1.6
72	236.2	422.7	2.2
82	269.0	420.7	2.8
92	301.8	418.1	3.6
102	334.6	415.5	4.4
112	367.4	414.5	4.7
117	383.9	415.1	4.5
122	400.3	414.8	4.6
132	433.1	413.5	5
142	465.9	412.5	5.3
152	498.7	412.2	5.4
162	531.5	411.5	5.6
167	547.9	410.5	5.9
172	564.3	409.2	6.3
180	590.5	408.9	6.4
182	597.1	410.5	5.9
192	629.9	429.9	0

Illinois River Waterway
Site#19 RM91.2

8/31/95



A. Upstream Channel Profile



B. Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site 20 RM79.4 RDB

		NORTH	EAST	OPPOSITE
ILR20-1	UPSTREAM SITE LIMIT	4426424.3	197718.4	N/A
ILR20-2	UPSTREAM BANK PROFILE	4426212.0	197677.4	N/A
ILR20-3	MIDPOINT BANK PROFILE	4425894.3	197650.4	ILR20-6
ILR20-4	DOWNSTREAM BANK PROFILE	4425588.9	197637.8	ILR20-7
ILR20-5	DOWNSTREAM SITE LIMIT	4425317.4	197634.9	N/A
ILR20-6	MIDPOINT PROFILE/OPPOSITE	4425879.9	197825.8	ILR20-3
ILR20-7	DOWNSTREAM PROFILE/OPPOSITE	4425581.4	197823.7	ILR20-4

Channel Profile Endpoints at Site #20

(A) MIDPOINT CHANNEL PROFILE (From: ILR20-6 To: ILR20-3)
Cross Section Length ~177m (580.7ft)

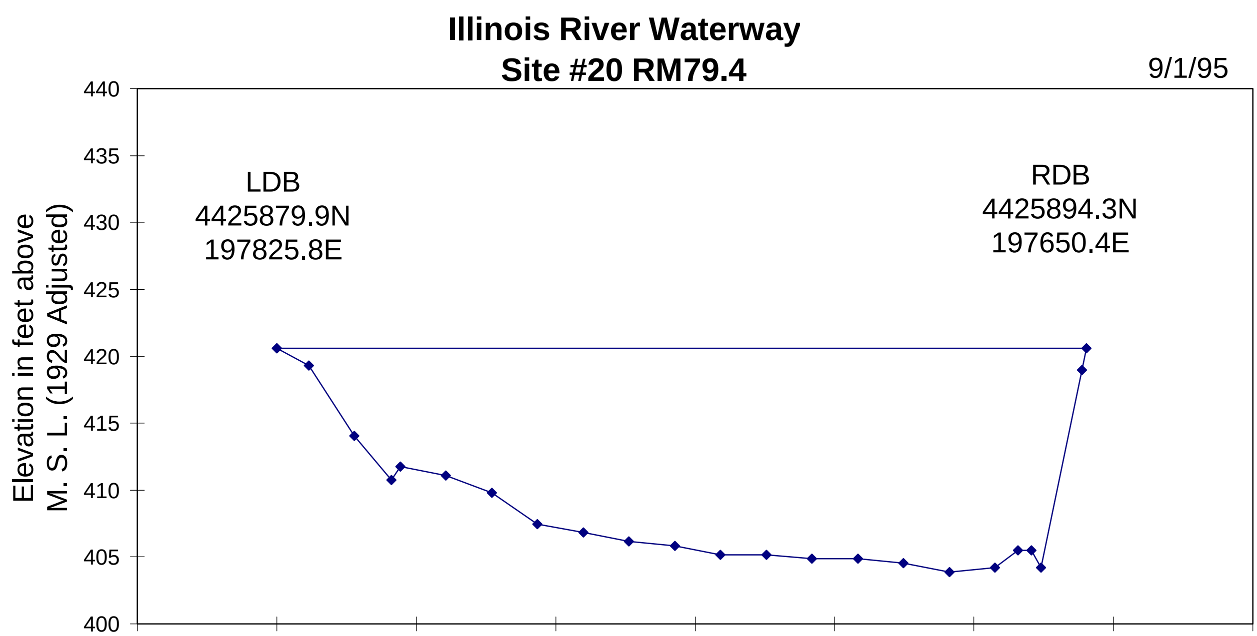
(B) DOWNSTREAM CHANNEL PROFILE (From: ILR20-7 To:ILR20-4)
Cross Section Length ~188m (616.8ft)

Midpoint Channel Profile RM79.4

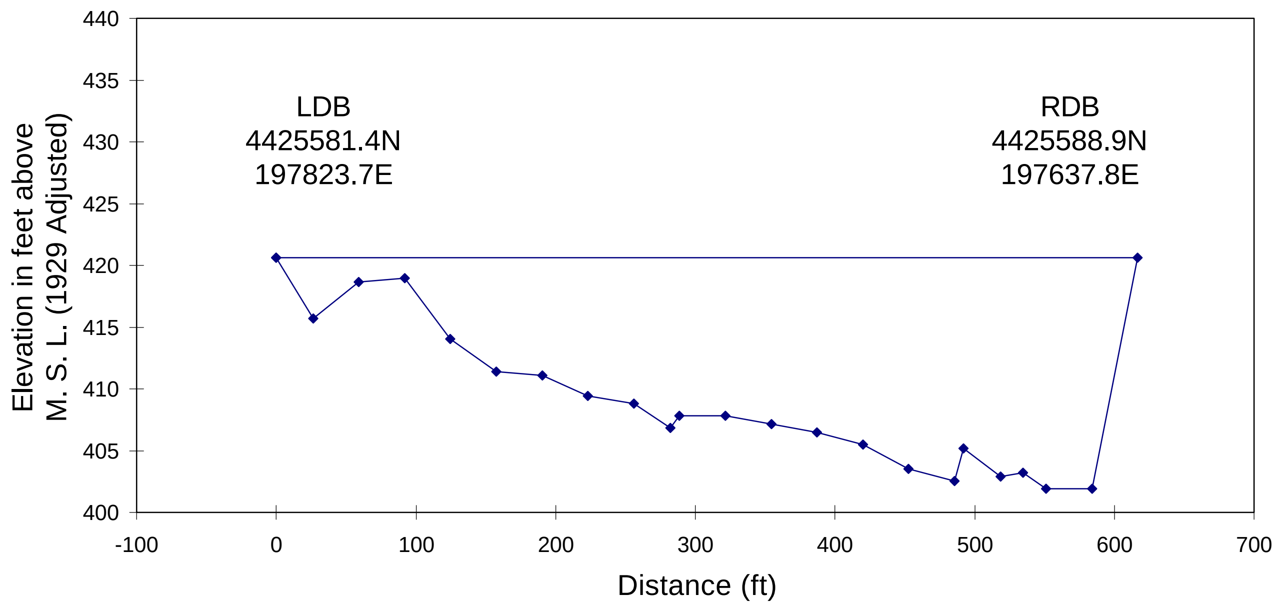
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	420.6	0.0
7	23.0	419.3	0.4
17	55.8	414.0	2.0
25	82.0	410.8	3.0
27	88.6	411.7	2.7
37	121.4	411.1	2.9
47	154.2	409.8	3.3
57	187.0	407.5	4.0
67	219.8	406.8	4.2
77	252.6	406.2	4.4
87	285.4	405.8	4.5
97	318.2	405.2	4.7
107	351.0	405.2	4.7
117	383.9	404.9	4.8
127	416.7	404.9	4.8
137	449.5	404.5	4.9
147	482.3	403.9	5.1
157	515.1	404.2	5.0
162	531.5	405.5	4.6
165	541.3	405.5	4.6
167	547.9	404.2	5.0
176	577.4	419.0	0.5
177	580.7	420.6	0.0

Downstream Channel Profile RM79.4

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	420.6	0
8	26.2	415.7	1.5
18	59.1	418.6	0.6
28	91.9	419.0	0.5
38	124.7	414.0	2
48	157.5	411.4	2.8
58	190.3	411.1	2.9
68	223.1	409.4	3.4
78	255.9	408.8	3.6
86	282.1	406.8	4.2
88	288.7	407.8	3.9
98	321.5	407.8	3.9
108	354.3	407.1	4.1
118	387.1	406.5	4.3
128	419.9	405.5	4.6
138	452.8	403.5	5.2
148	485.6	402.6	5.5
150	492.1	405.2	4.7
158	518.4	402.9	5.4
163	534.8	403.2	5.3
168	551.2	401.9	5.7
178	584.0	401.9	5.7
188	616.8	420.6	0



A. Midpoint Channel Profile



B. Downstream Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #21 RM61.5 RDB

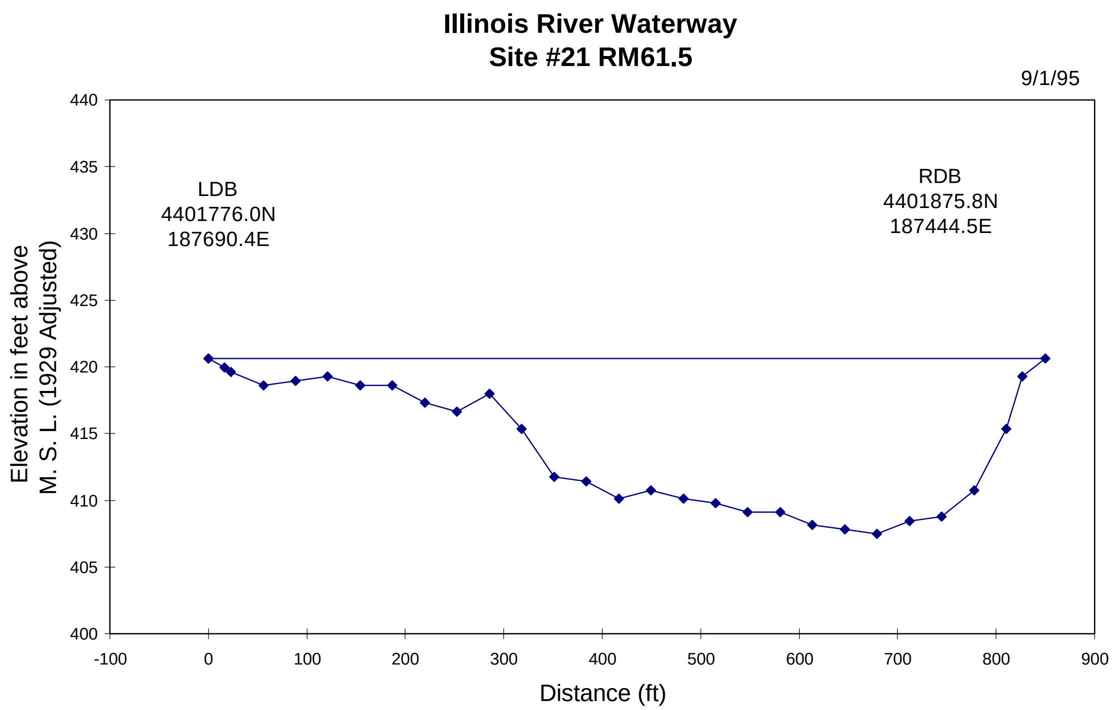
		NORTH	EAST	OPPOSITE
ILR21-1	UPSTREAM SITE LIMIT	4402080.5	187506.6	N/A
ILR21-2	UPSTREAM BANK PROFILE	4402055.2	187498.1	N/A
ILR21-3	MIDPOINT BANK PROFILE	4401875.8	187444.5	ILR21-6
ILR21-4	DOWNSTREAM BANK PROFILE	4401765.2	187415.7	N/A
ILR21-5	DOWNSTREAM SITE LIMIT	4401707.9	187399.6	N/A
ILR21-6	MIDPOINT PROFILE/OPPOSITE	4401776.0	187690.4	ILR21-3

Channel Profile Endpoints at Site #21

(A) MIDPOINT CHANNEL PROFILE (From: ILR21-6 To: ILR21-3)
Cross Section Length ~259m (849.7ft)

Midpoint Channel Profile RM61.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	420.6	0
5	16.4	419.9	0.2
7	23.0	419.6	0.3
17	55.8	418.6	0.6
27	88.6	419.0	0.5
37	121.4	419.3	0.4
47	154.2	418.6	0.6
57	187.0	418.6	0.6
67	219.8	417.3	1.0
77	252.6	416.7	1.2
87	285.4	418.0	0.8
97	318.2	415.4	1.6
107	351.0	411.7	2.7
117	383.9	411.4	2.8
127	416.7	410.1	3.2
137	449.5	410.8	3.0
147	482.3	410.1	3.2
157	515.1	409.8	3.3
167	547.9	409.1	3.5
177	580.7	409.1	3.5
187	613.5	408.1	3.8
197	646.3	407.8	3.9
207	679.1	407.5	4.0
217	711.9	408.5	3.7
227	744.7	408.8	3.6
237	777.5	410.8	3.0
247	810.4	415.4	1.6
252	826.8	419.3	0.4
259	849.7	420.6	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #22 RM45.5 RDB

		NORTH	EAST	OPPOSITE
ILR22-1	UPSTREAM BANK PROFILE	4376865.1	190864.0	N/A
ILR22-2	MIDPOINT BANK PROFILE	4376758.5	190808.6	ILR22-4
ILR22-3	DOWNSTREAM BANK PROFILE	4376663.8	190754.7	N/A
ILR22-4	MIDPOINT PROFILE/OPPOSITE	4376627.4	191049.6	ILR22-2

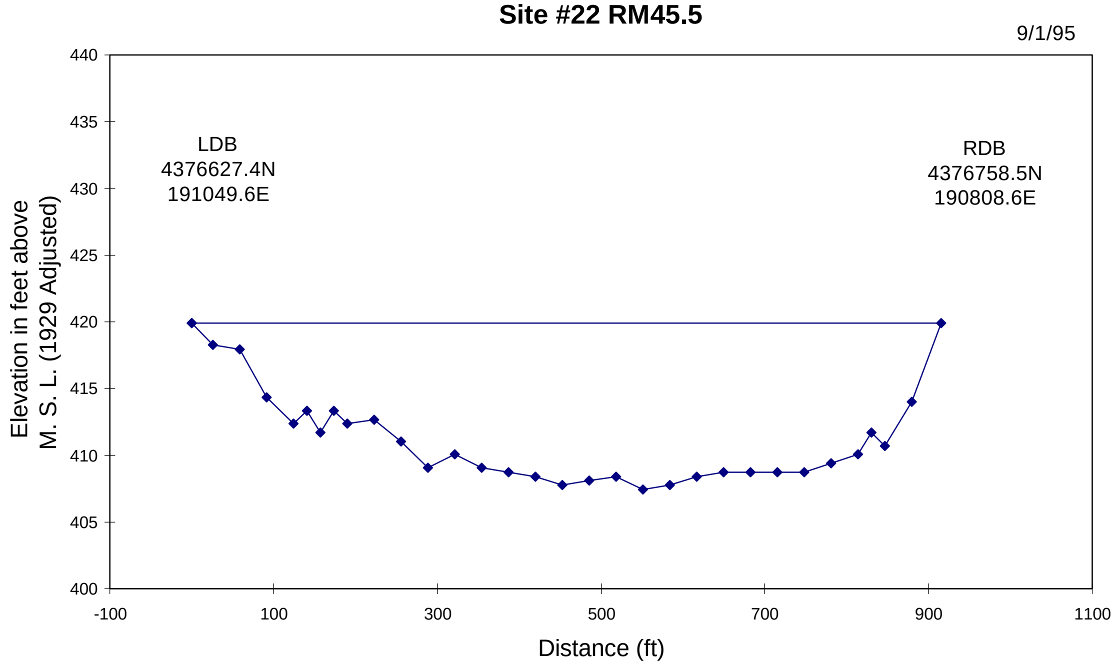
Channel Profile Endpoints at Site #22

(A) MIDPOINT CHANNEL PROFILE (From: ILR22-4 To: ILR22-2)
Cross Section Length ~279m (915.3ft)

Midpoint Channel Profile RM45.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	419.9	0
8	26.2	418.3	0.5
18	59.1	417.9	0.6
28	91.9	414.3	1.7
38	124.7	412.4	2.3
43	141.1	413.3	2.0
48	157.5	411.7	2.5
53	173.9	413.3	2.0
58	190.3	412.4	2.3
68	223.1	412.7	2.2
78	255.9	411.0	2.7
88	288.7	409.1	3.3
98	321.5	410.1	3.0
108	354.3	409.1	3.3
118	387.1	408.7	3.4
128	419.9	408.4	3.5
138	452.8	407.8	3.7
148	485.6	408.1	3.6
158	518.4	408.4	3.5
168	551.2	407.4	3.8
178	584.0	407.8	3.7
188	616.8	408.4	3.5
198	649.6	408.7	3.4
208	682.4	408.7	3.4
218	715.2	408.7	3.4
228	748.0	408.7	3.4
238	780.8	409.4	3.2
248	813.6	410.1	3.0
253	830.0	411.7	2.5
258	846.4	410.7	2.8
268	879.3	414.0	1.8
279	915.3	419.9	0

Illinois River Waterway
Site #22 RM45.5



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #23 RM23.4 RDB

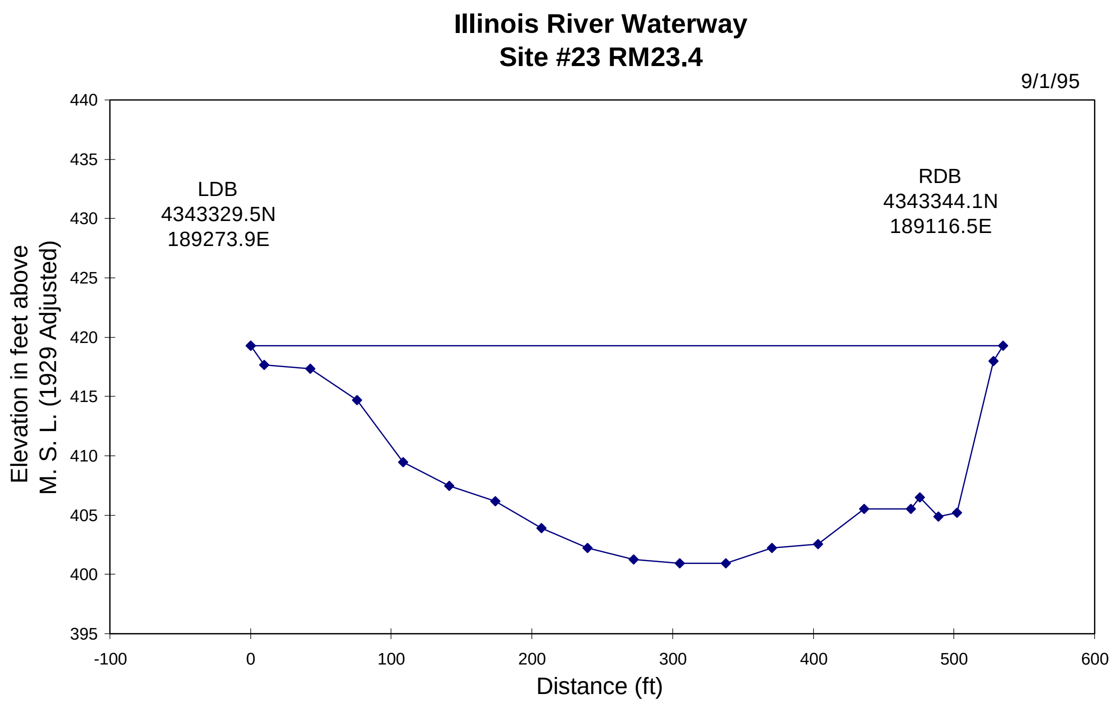
		NORTH	EAST	OPPOSITE
ILR23-1	UPSTREAM SITE LIMIT	4343555.8	189140.3	N/A
ILR23-2	UPSTREAM BANK PROFILE	4343490.3	189133.1	N/A
ILR23-3	MIDPOINT BANK PROFILE	4343344.1	189116.5	ILR23-6
ILR23-4	DOWNSTREAM BANK PROFILE	4343278.3	189105.6	N/A
ILR23-5	DOWNSTREAM SITE LIMIT	4343255.5	189100.7	N/A
ILR23-6	MIDPOINT PROFILE/OPPOSITE	4343329.5	189273.9	ILR23-3

Channel Profile Endpoints at Site #23

(A) MIDPOINT CHANNEL PROFILE (From: ILR23-6 To: ILR23-3)
Cross Section Length ~163m (534.8ft)

Midpoint Channel Profile RM23.4

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	419.3	0
3	9.8	417.7	0.5
13	42.7	417.3	0.6
23	75.5	414.7	1.4
33	108.3	409.5	3.0
43	141.1	407.5	3.6
53	173.9	406.2	4.0
63	206.7	403.9	4.7
73	239.5	402.2	5.2
83	272.3	401.3	5.5
93	305.1	400.9	5.6
103	337.9	400.9	5.6
113	370.7	402.2	5.2
123	403.5	402.6	5.1
133	436.3	405.5	4.2
143	469.2	405.5	4.2
145	475.7	406.5	3.9
149	488.8	404.9	4.4
153	502.0	405.2	4.3
161	528.2	418.0	0.4
163	534.8	419.3	0



Midpoint Channel Profile

Illinois River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #24 RM13.0 RDB

		NORTH	EAST	OPPOSITE
ILR24-1	UPSTREAM SITE LIMIT	4327657.9	189603.8	N/A
ILR24-2	UPSTREAM BANK PROFILE	4327602.4	189670.0	N/A
ILR24-3	MIDPOINT BANK PROFILE	4327529.5	189759.5	ILR24-6
ILR24-4	DOWNSTREAM BANK PROFILE	4327435.4	189870.5	N/A
ILR24-5	DOWNSTREAM SITE LIMIT	4327404.1	189903.6	N/A
ILR24-6	MIDPOINT PROFILE/OPPOSITE	4327694.8	189897.3	ILR24-3

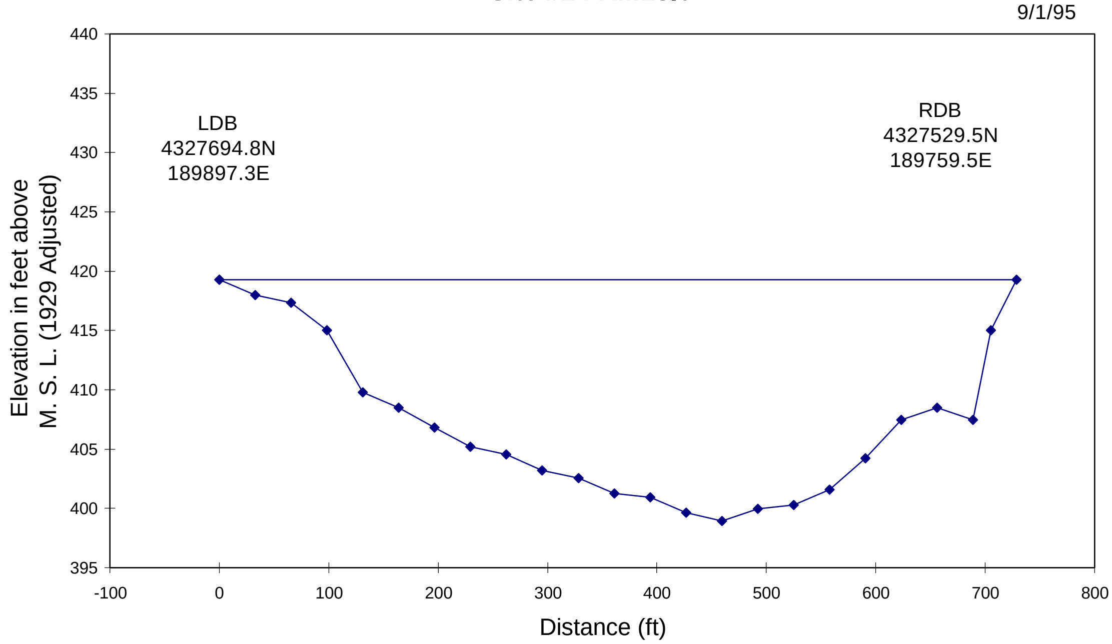
Channel Profile Endpoints at Site #24

(A) MIDPOINT CHANNEL PROFILE (From: ILR24-6 To: ILR24-3)
Cross Section Length ~222m (728.3ft)

Midpoint Channel Profile RM13.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	419.3	0
10	32.8	418.0	0.4
20	65.6	417.3	0.6
30	98.4	415.0	1.3
40	131.2	409.8	2.9
50	164.0	408.5	3.3
60	196.8	406.8	3.8
70	229.7	405.2	4.3
80	262.5	404.5	4.5
90	295.3	403.2	4.9
100	328.1	402.6	5.1
110	360.9	401.3	5.5
120	393.7	400.9	5.6
130	426.5	399.6	6
140	459.3	399.0	6.2
150	492.1	399.9	5.9
160	524.9	400.3	5.8
170	557.7	401.6	5.4
180	590.5	404.2	4.6
190	623.4	407.5	3.6
200	656.2	408.5	3.3
210	689.0	407.5	3.6
215	705.4	415.0	1.3
222	728.3	419.3	0

Illinois River Waterway
Site #24 RM13.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #1 RM825.1 RDB

		NORTH	EAST	OPPOSITE
MSR1-1	MIDPOINT BANK PROFILE	4977262.58	23388.28	MSR1-2
MSR1-2	MIDPOINT PROFILE/OPPOSITE	4977265.30	23515.70	MSR1-1

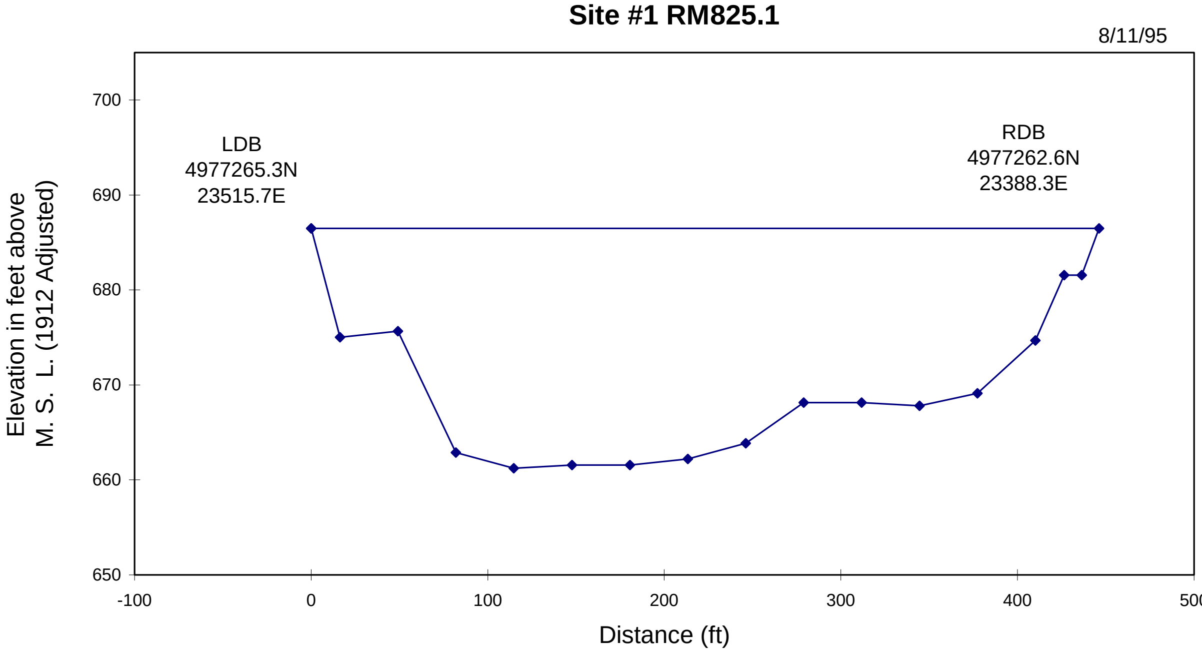
Channel Profile Endpoints at Site #1

(A) MIDPOINT CHANNEL PROFILE (From: MSR1-2 To: MSR1-1)
Cross Section Length 136m (446.2ft)

Midpoint Channel Profile RM825.1

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	686.5	0
5	16.4	675.0	3.5
15	49.2	675.7	3.3
25	82.0	662.9	7.2
35	114.8	661.2	7.7
45	147.6	661.6	7.6
55	180.4	661.6	7.6
65	213.3	662.2	7.4
75	246.1	663.9	6.9
85	278.9	668.1	5.6
95	311.7	668.1	5.6
105	344.5	667.8	5.7
115	377.3	669.1	5.3
125	410.1	674.7	3.6
130	426.5	681.6	1.5
133	436.3	681.6	1.5
136	446.2	686.5	0

Mississippi River Waterway
Site #1 RM825.1



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #2 RM791.6 RDB

		NORTH	EAST	OPPOSITE
MSR2-1	UPSTREAM SITE LIMIT	4950321.40	59070.80	N/A
MSR2-2	UPSTREAM BANK PROFILE	4950275.30	59081.20	MSR2-6
MSR2-3	MIDPOINT BANK PROFILE	4950205.00	59108.20	MSR2-7
MSR2-4	DOWNSTREAM BANK PROFILE	4950114.20	59144.50	MSR2-8
MSR2-5	DOWNSTREAM SITE LIMIT	4950043.90	59181.90	N/A
MSR2-6	UPSTREAM PROFILE/OPPOSITE	4950342.60	59304.50	MSR2-2
MSR2-7	MIDPOINT PROFILE/OPPOSITE	4950270.25	59324.25	MSR1-3
MSR2-8	DOWNSTREAM PROFILE/OPPOSITE	4950178.90	59360.50	MSR2-4

Channel Profile Endpoints at Site #2

(A) UPSTREAM CHANNEL PROFILE (From:MSR2-6 To MSR2-2)
Cross Section Length 238m (780.8ft)

(B) MIDPOINT CHANNEL PROFILE (From: MSR2-7 To: MSR2-3)
Cross Section Length 231m (750.9ft)

(C) DOWNSTREAM CHANNEL PROFILE (From:MSR2-8 To: MSR2-4)
Cross Section Length 226m (741.5ft)

Upstream Channel Profile RM791.6

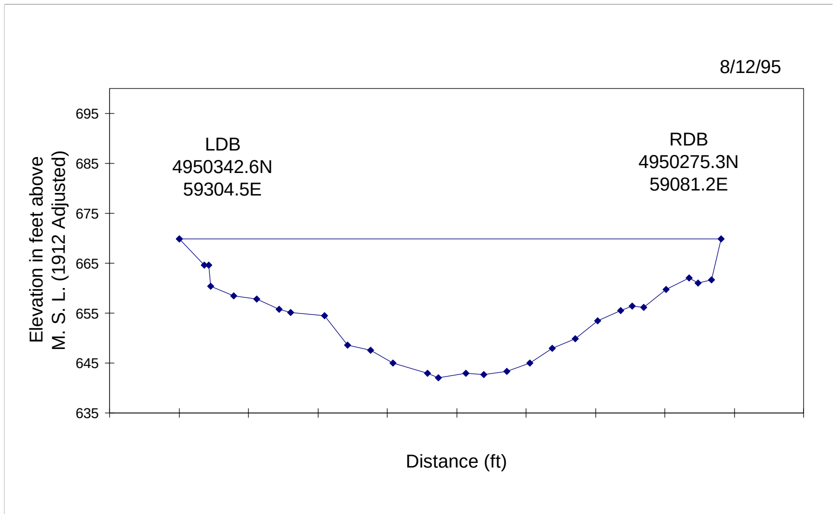
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	669.9	0
11	36.1	664.7	1.6
13	42.7	664.7	1.6
14	45.9	660.4	2.9
24	78.7	658.4	3.5
34	111.5	657.8	3.7
44	144.4	655.8	4.3
49	160.8	655.1	4.5
64	210.0	654.5	4.7
74	242.8	648.6	6.5
84	275.6	647.6	6.8
94	308.4	645.0	7.6
109	357.6	643.0	8.2
114	374.0	642.0	8.5
126	413.4	643.0	8.2
134	439.6	642.7	8.3
144	472.4	643.3	8.1
154	505.2	645.0	7.6
164	538.1	647.9	6.7
174	570.9	649.9	6.1
184	603.7	653.5	5
194	636.5	655.5	4.4
199	652.9	656.4	4.1
204	669.3	656.1	4.2
214	702.1	659.7	3.1
224	734.9	662.0	2.4
228	748.0	661	2.7
234	767.7	661.7	2.5
238	780.8	669.9	0

Midpoint Channel Profile RM791.6

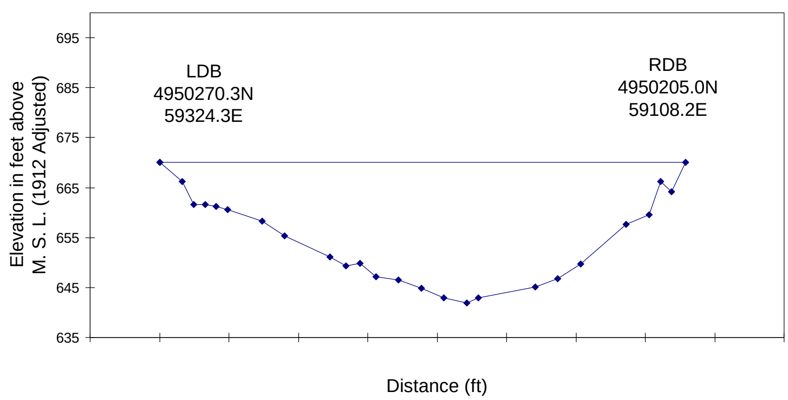
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	670.1	0
10	32.8	666.2	1.2
15	49.2	661.6	2.6
20	65.6	661.6	2.6
25	82.0	661.2	2.7
30	98.4	660.6	2.9
45	147.6	658.3	3.6
55	180.4	655.3	4.5
75	246.1	651.1	5.8
82	269.0	649.3	6.3
88	288.7	649.8	6.2
95	311.7	647.1	7
105	344.5	646.5	7.2
115	377.3	644.8	7.7
125	410.1	642.9	8.3
135	442.9	641.9	8.6
140	459.3	642.9	8.3
165	541.3	645.2	7.6
175	574.1	646.8	7.1
185	606.9	649.8	6.2
205	672.6	657.6	3.8
215	705.4	659.6	3.2
220	721.8	666.2	1.2
225	738.2	664.2	1.8
231	757.9	670.1	0

Downstream Channel Profile RM791.6

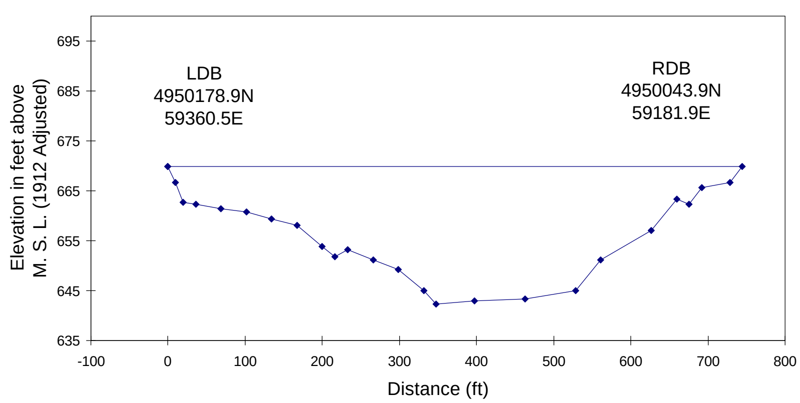
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	669.9	0
3	9.8	666.6	1
6	19.7	662.7	2.2
11	36.1	662.4	2.3
21	68.9	661.4	2.6
31	101.7	660.7	2.8
41	134.5	659.4	3.2
51	167.3	658.1	3.6
61	200.1	653.8	4.9
66	216.5	651.9	5.5
71	232.9	653.2	5.1
81	265.7	651.2	5.7
91	298.6	649.2	6.3
101	331.4	645.0	7.6
106	347.8	642.3	8.4
121	397.0	643.0	8.2
141	462.6	643.3	8.1
161	528.2	645.0	7.6
171	561.0	651.2	5.7
191	626.6	657.1	3.9
201	659.4	663.3	2
206	675.8	662.4	2.3
211	692.2	665.6	1.3
222	728.3	666.6	1
227	744.7	669.9	0



A. Upstream Channel Profile



B. Midpoint Channel Profile



C. Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #3 RM763.3 LDB

		NORTH	EAST	OPPOSITE
MSR3-1	UPSTREAM SITE LIMIT	4929954.10	95361.10	N/A
MSR3-2	UPSTREAM BANK PROFILE	4929890.95	95389.50	MSR3-5
MSR3-3	MIDPOINT BANK PROFILE	4929774.50	95448.50	MSR3-6
MSR3-4	DOWNSTREAM BANK PROFILE	4929652.42	95527.28	N/A
MSR3-5	UPSTREAM PROFILE/OPPOSITE	4929627.95	95055.78	MSR3-2
MSR3-6	MIDPOINT PROFILE/OPPOSITE	4929557.25	95169.55	MSR3-3

Channel Profile Endpoints at Site #3

(A) UPSTREAM CHANNEL PROFILE (From:MSR3-2 To:MSR3-5)
Cross Section Length 424m (1391.1ft)

(B) MIDPOINT CHANNEL PROFILE (From: MSR3-3 To: MSR3-6)
Cross Section Length 354m (1161.4ft)

Upstream Channel Profile R763.3

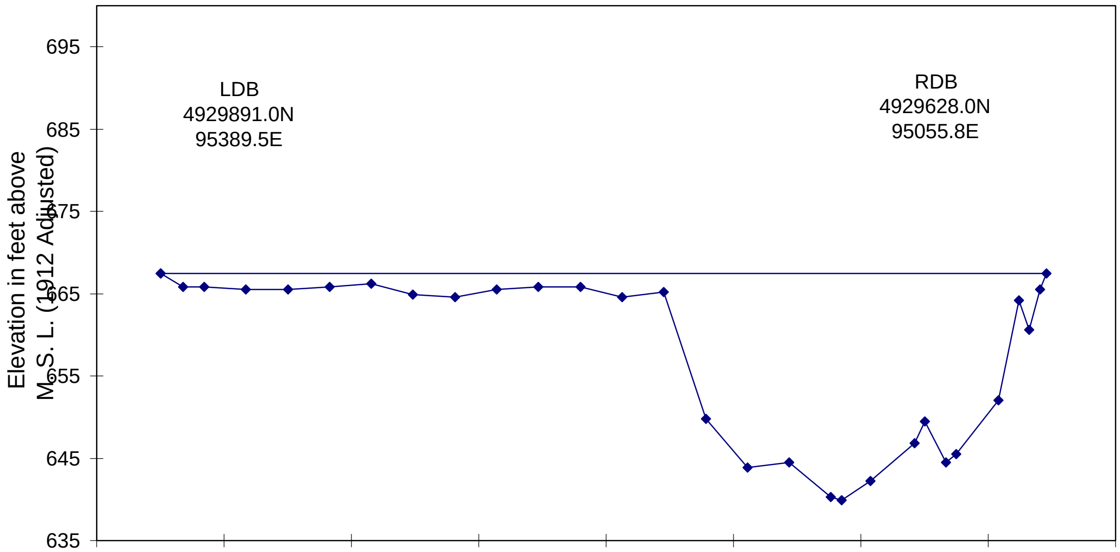
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	667.5	0.0
11	36.1	665.9	0.5
21	68.9	665.9	0.5
41	134.5	665.5	0.6
61	200.1	665.5	0.6
81	265.7	665.9	0.5
101	331.4	666.2	0.4
121	397.0	664.9	0.8
141	462.6	664.5	0.9
161	528.2	665.5	0.6
181	593.8	665.9	0.5
201	659.4	665.9	0.5
221	725.1	664.5	0.9
241	790.7	665.2	0.7
261	856.3	649.8	5.4
281	921.9	643.9	7.2
301	987.5	644.5	7.0
321	1053.1	640.3	8.3
326	1069.5	639.9	8.4
340	1115.5	642.2	7.7
361	1184.4	646.8	6.3
366	1200.8	649.5	5.5
376	1233.6	644.5	7.0
381	1250.0	645.5	6.7
401	1315.6	652.1	4.7
411	1348.4	664.2	1.0
416	1364.8	660.6	2.1
421	1381.2	665.5	0.6
424	1391.1	667.5	0.0

Midpoint Channel Profile RM763.3

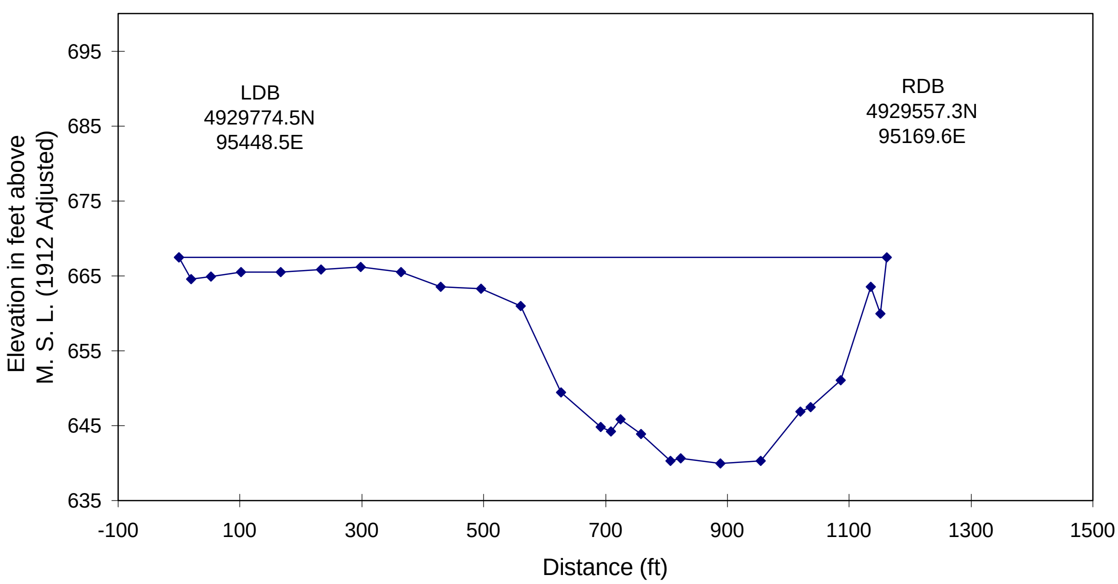
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	667.5	0.0
6	19.7	664.5	0.9
16	52.5	664.9	0.8
31	101.7	665.5	0.6
51	167.3	665.5	0.6
71	232.9	665.9	0.5
91	298.6	666.2	0.4
111	364.2	665.5	0.6
131	429.8	663.6	1.2
151	495.4	663.2	1.3
171	561.0	660.9	2.0
191	626.6	649.5	5.5
211	692.2	644.9	6.9
216	708.7	644.2	7.1
221	725.1	645.8	6.6
231	757.9	643.9	7.2
246	807.1	640.3	8.3
251	823.5	640.6	8.2
271	889.1	639.9	8.4
291	954.7	640.3	8.3
311	1020.3	646.8	6.3
316	1036.7	647.5	6.1
331	1085.9	651.1	5.0
346	1135.2	663.6	1.2
351	1151.6	660.0	2.3
354	1161.4	667.5	0.0

Mississippi River Waterway
Site #3 RM763.3

8/12/95



A. Upstream Channel Profile



B. Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #4 RM751.0 LDB

		NORTH	EAST	OPPOSITE
MSR4-1	UPSTREAM SITE LIMIT	4917328.80	107963.20	N/A
MSR4-2	UPSTREAM BANK PROFILE	4917266.70	107895.30	MSR4-6
MSR4-3	MIDPOINT BANK PROFILE	4917222.50	107836.50	MSR4-7
MSR4-4	DOWNSTREAM BANK PROFILE	4917163.40	107765.70	N/A
MSR4-5	DOWNSTREAM SITE LIMIT	4917117.00	107710.50	N/A
MSR4-6	UPSTREAM PROFILE/OPPOSITE	4917455.60	107712.90	MSR4-2
MSR4-7	MIDPOINT PROFILE/OPPOSITE	4917568.60	107479.10	MSR4-3

Channel Profile Endpoints at Site #4

(A) UPSTREAM CHANNEL PROFILE (From:MSR4-2 To MSR4-6)
Cross Section Length 275m (902.2ft)

(B) MIDPOINT CHANNEL PROFILE (From: MSR4-3 To: MSR4-7)
Cross Section Length 491m (1610.9ft)

Upstream Channel Profile RM751.0

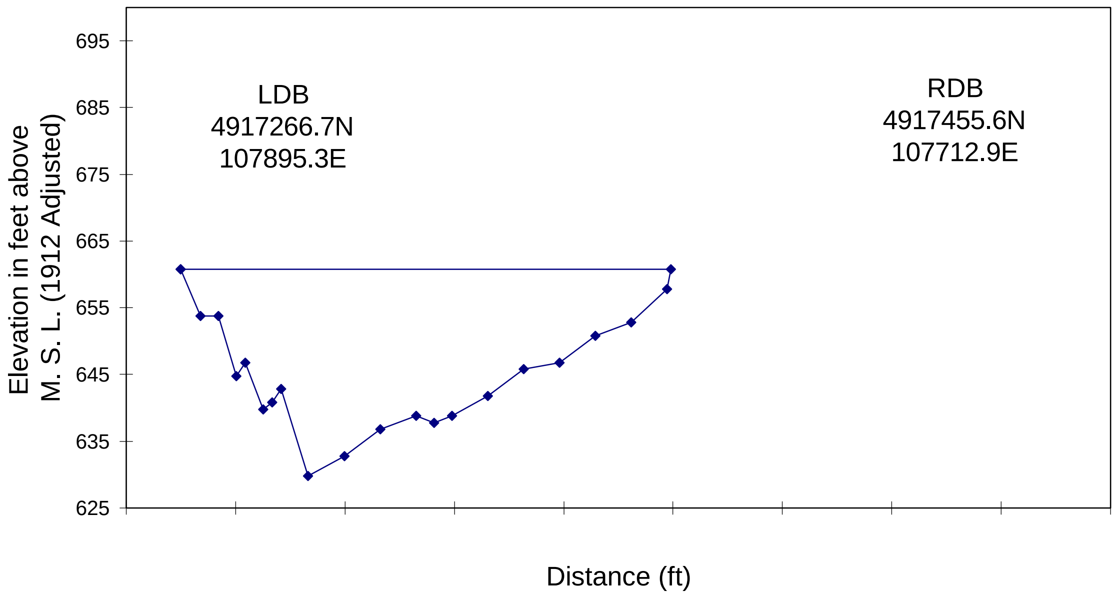
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	660.8	0.0
11	36.1	653.8	2.1
21	68.9	653.8	2.1
31	101.7	644.8	4.9
36	118.1	646.8	4.3
46	150.9	639.8	6.4
51	167.3	640.8	6.1
56	183.7	642.8	5.5
71	232.9	629.8	9.4
91	298.6	632.8	8.5
111	364.2	636.8	7.3
131	429.8	638.8	6.7
141	462.6	637.8	7.0
151	495.4	638.8	6.7
171	561.0	641.8	5.8
191	626.6	645.8	4.6
211	692.2	646.8	4.3
231	757.9	650.8	3.0
251	823.5	652.8	2.4
271	889.1	657.8	0.9
273	895.7	660.8	0.0

Midpoint Channel Profile RM751.0

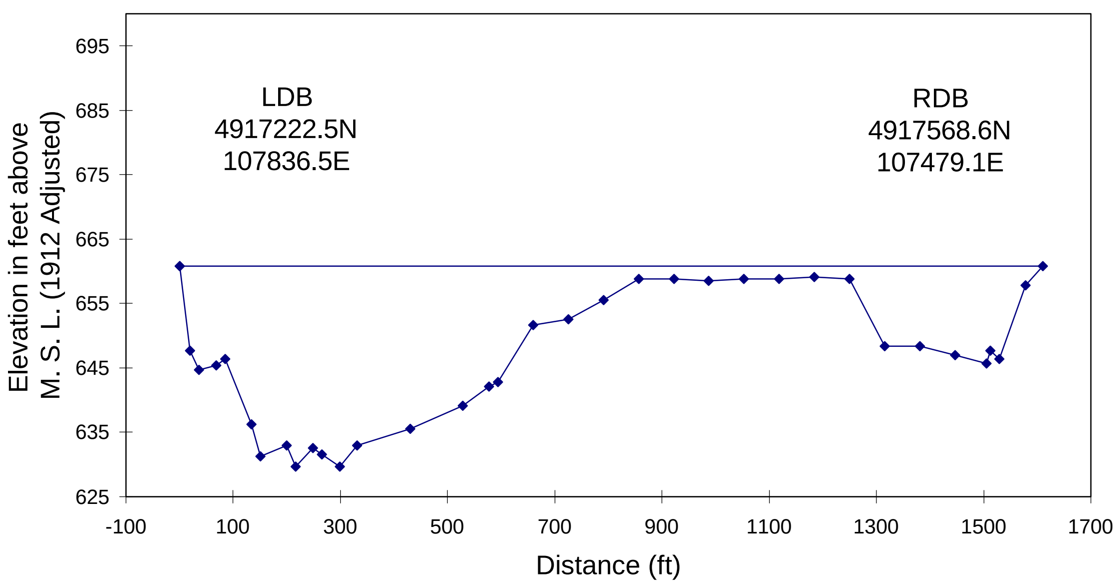
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	660.8	0
6	19.7	647.7	4
11	36.1	644.7	4.9
21	68.9	645.4	4.7
26	85.3	646.4	4.4
41	134.5	636.2	7.5
46	150.9	631.3	9
61	200.1	632.9	8.5
66	216.5	629.6	9.5
76	249.3	632.6	8.6
81	265.7	631.6	8.9
91	298.6	629.6	9.5
101	331.4	632.9	8.5
131	429.8	635.5	7.7
161	528.2	639.1	6.6
176	577.4	642.1	5.7
181	593.8	642.8	5.5
201	659.4	651.6	2.8
221	725.1	652.6	2.5
241	790.7	655.6	1.6
261	856.3	658.8	0.6
281	921.9	658.8	0.6
301	987.5	658.5	0.7
321	1053.1	658.8	0.6
341	1118.8	658.8	0.6
361	1184.4	659.2	0.5
381	1250.0	658.8	0.6
401	1315.6	648.3	3.8
421	1381.2	648.3	3.8
441	1446.8	647.0	4.2
459	1505.9	645.7	4.6
461	1512.4	647.7	4
466	1528.9	646.4	4.4
481	1578.1	657.8	0.9
491	1610.9	660.8	0

Mississippi River Waterway
Site #4 RM751.0

9/13/95



A. Upstream Channel Profile



B. Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #5 RM746.4 LDB

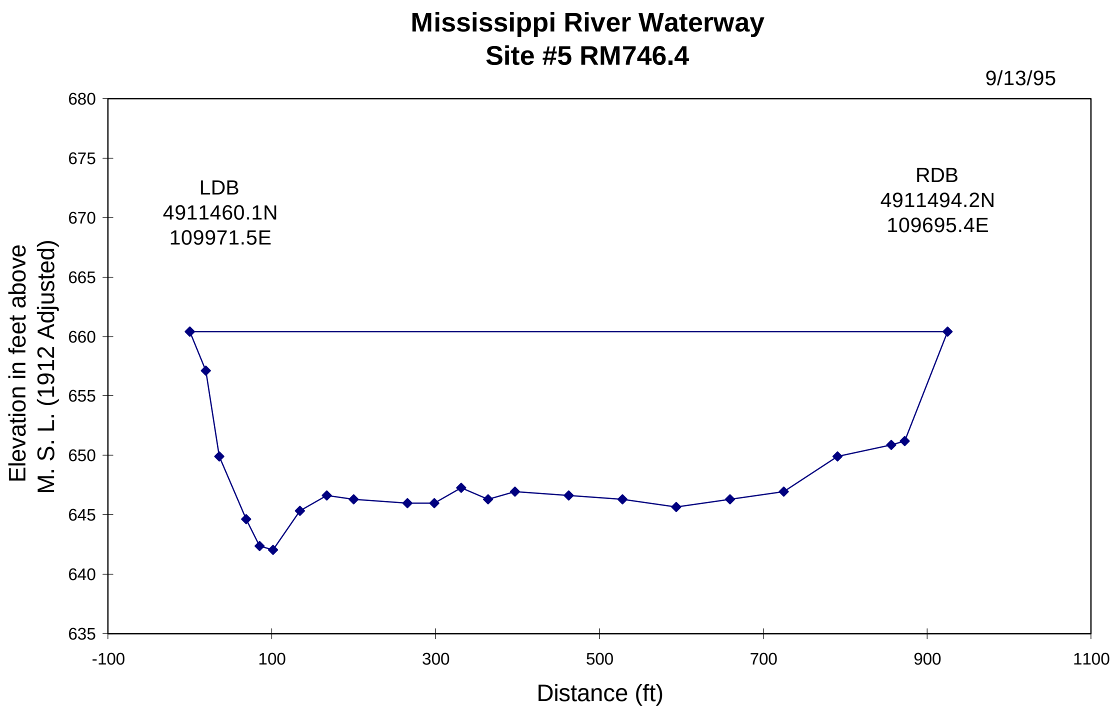
		NORTH	EAST	OPPOSITE
MSR5-1	UPSTREAM SITE LIMIT	4911635.50	109990.90	N/A
MSR5-2	UPSTREAM BANK PROFILE	4911567.25	109987.53	N/A
MSR5-3	MIDPOINT BANK PROFILE	4911460.14	109971.50	MSR5-6
MSR5-4	DOWNSTREAM BANK PROFILE	4911372.80	109945.71	N/A
MSR5-5	DOWNSTREAM SITE LIMIT	4911294.50	109932.50	N/A
MSR5-6	MIDPOINT PROFILE/OPPOSITE	4911494.20	109695.35	MSR5-3

Channel Profile Endpoints at Site #5

(A) MIDPOINT CHANNEL PROFILE (From: MSR5-3 To: MSR5-6)
Cross Section Length 282m (925.2ft)

Midpoint Channel Profile RM746.4

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	660.4	0
6	19.7	657.1	1
11	36.1	649.9	3.2
21	68.9	644.7	4.8
26	85.3	642.4	5.5
31	101.7	642.0	5.6
41	134.5	645.3	4.6
51	167.3	646.6	4.2
61	200.1	646.3	4.3
81	265.7	646.0	4.4
91	298.6	646.0	4.4
101	331.4	647.3	4.0
111	364.2	646.3	4.3
121	397.0	646.9	4.1
141	462.6	646.6	4.2
161	528.2	646.3	4.3
181	593.8	645.6	4.5
201	659.4	646.3	4.3
221	725.1	646.9	4.1
241	790.7	649.9	3.2
261	856.3	650.9	2.9
266	872.7	651.2	2.8
282	925.2	660.4	0.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #6 RM727.3 RDB

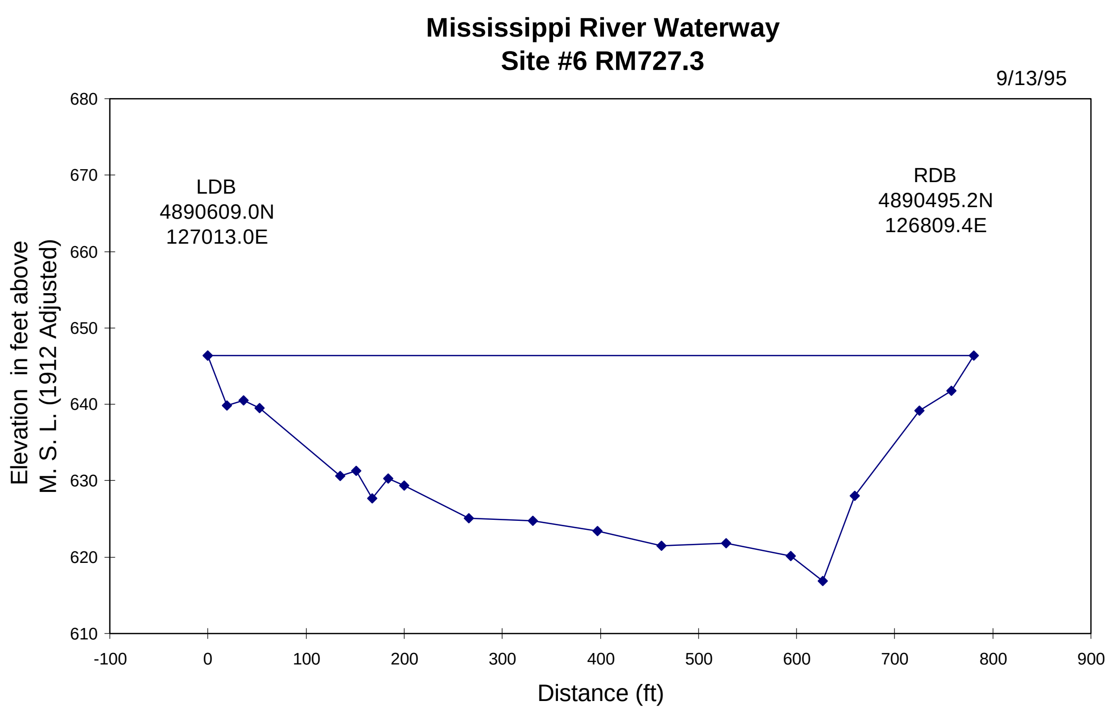
		NORTH	EAST	OPPOSITE
MSR6-1	UPSTREAM SITE LIMIT	4890824.60	126664.10	N/A
MSR6-2	UPSTREAM BANK PROFILE	4890677.95	126720.95	N/A
MSR6-3	MIDPOINT BANK PROFILE	4890495.16	126809.35	MSR6-6
MSR6-4	DOWNSTREAM BANK PROFILE	4890367.00	126879.40	N/A
MSR6-5	DOWNSTREAM SITE LIMIT	4890283.16	126932.90	N/A
MSR6-6	MIDPOINT PROFILE/OPPOSITE	4890609.00	127012.95	MSR6-3

Channel Profile Endpoints at Site #6

(A) MIDPOINT CHANNEL PROFILE (From: MSR6-6 To: MSR6-3)
Cross Section Length 238m (780.8ft)

Midpoint Channel Profile RM727.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	646.4	0
6	19.7	639.8	2
11	36.1	640.5	1.8
16	52.5	639.5	2.1
41	134.5	630.7	4.8
46	150.9	631.3	4.6
51	167.3	627.7	5.7
56	183.7	630.3	4.9
61	200.1	629.3	5.2
81	265.7	625.1	6.5
101	331.4	624.7	6.6
121	397.0	623.4	7.0
141	462.6	621.5	7.6
161	528.2	621.8	7.5
181	593.8	620.2	8.0
191	626.6	616.9	9.0
201	659.4	628.0	5.6
221	725.1	639.2	2.2
231	757.9	641.8	1.4
238	780.8	646.4	0.0



Midpoint Channel Profile

Mississippi River - UTM Coordinates and Channel Profile Endpoints

Site #8 RM677.7 RDB

		NORTH	EAST	OPPOSITE
MSR8-1	UPSTREAM SITE LIMIT	4830814.00	157038.40	N/A
MSR8-2	UPSTREAM BANK PROFILE	4830666.40	157018.43	MSR9-6
MSR8-3	MIDPOINT BANK PROFILE	4830531.00	156996.25	MSR9-7
MSR8-4	DOWNSTREAM BANK PROFILE	4830370.65	156979.70	MSR9-8
MSR8-5	DOWNSTREAM SITE LIMIT	4830300.20	157974.27	N/A

Site #9 RM677.7 LDB

		NORTH	EAST	OPPOSITE
MSR9-6	UPSTREAM PROFILE/OPPOSITE	4830598.91	157361.55	MSR8-2
MSR9-7	MIDPOINT PROFILE OPPOSITE	4830496.36	157314.85	MSR8-3
MSR9-8	DOWNSTREAM PROFILE/OPPOSITE	4830325.88	157275.47	MSR8-4

Channel Profile Endpoints at Sites #8 and #9

(A) MIDPOINT CHANNEL PROFILE (From: MSR9-7 To: MSR8-3)
Cross Section Length ~ 324m

(B) DOWNSTREAM CHANNEL PROFILE (From: MSR9-8 To: MSR8-4)
Cross Section Length ~ 303m

Midpoint Channel Profile RM677.7

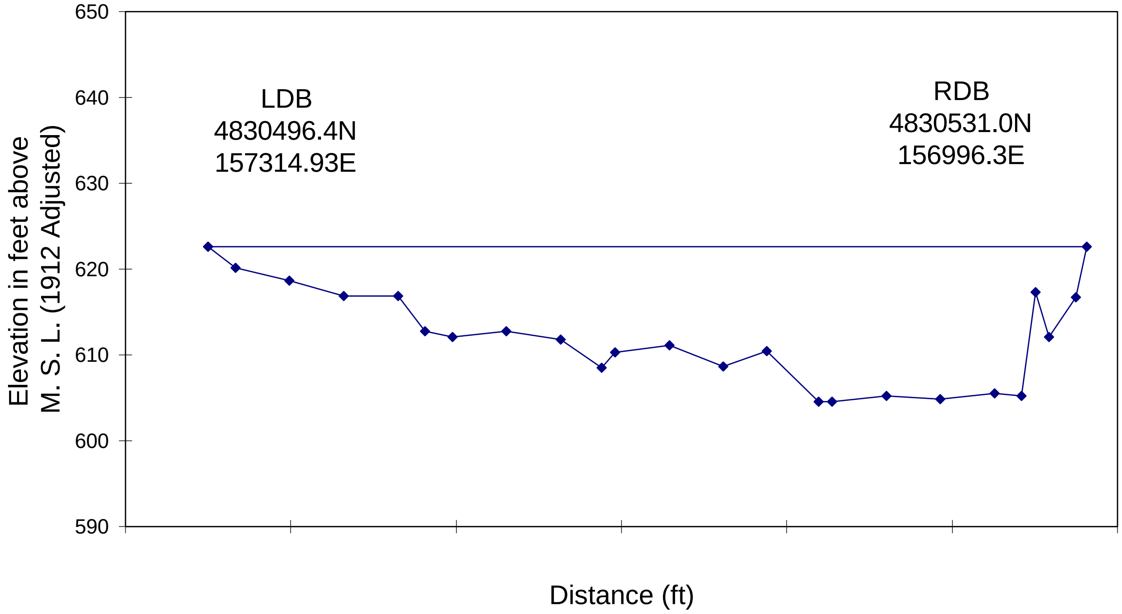
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	622.6	0
10	32.8	620.1	0.75
30	98.4	618.7	1.2
50	164.0	616.9	1.75
70	229.7	616.9	1.75
80	262.5	612.8	3
90	295.3	612.1	3.2
110	360.9	612.8	3
130	426.5	611.8	3.3
145	475.7	608.5	4.3
150	492.1	610.3	3.75
170	557.7	611.1	3.5
190	623.4	608.7	4.25
206	675.8	610.5	3.7
225	738.2	604.6	5.5
230	754.6	604.6	5.5
250	820.2	605.2	5.3
270	885.8	604.9	5.4
290	951.4	605.5	5.2
300	984.2	605.2	5.3
305	1000.6	617.4	1.6
310	1017.0	612.1	3.2
320	1049.9	616.7	1.8
324	1063.0	622.6	0

Downstream Channel Profile RM677.7

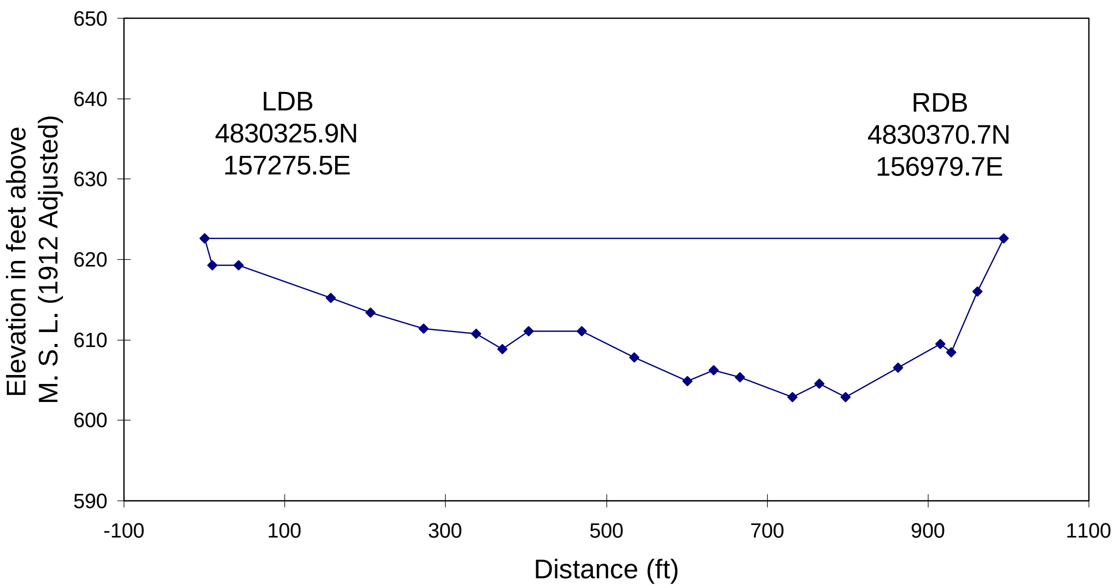
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	622.6	0
3	9.8	619.3	1
13	42.7	619.3	1
48	157.5	615.2	2.25
63	206.7	613.4	2.8
83	272.3	611.4	3.4
103	337.9	610.8	3.6
113	370.7	608.8	4.2
123	403.5	611.1	3.5
143	469.2	611.1	3.5
163	534.8	607.8	4.5
183	600.4	604.9	5.4
193	633.2	606.2	5
203	666.0	605.4	5.25
223	731.6	602.9	6
233	764.4	604.6	5.5
243	797.2	602.9	6
263	862.9	606.5	4.9
279	915.3	609.5	4
283	928.5	608.5	4.3
293	961.3	616.0	2
303	994.1	622.6	0

Mississippi River Waterway
Site #8 and #9 RM677.7

9/14/95



A. Midpoint Channel Profile



B. Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #10 RM669.0 RDB

		NORTH	EAST	OPPOSITE
MSR10-1	UPSTREAM SITE LIMIT	4820298.7	157349.2	N/A
MSR10-2	UPSTREAM BANK PROFILE	4819719.6	157405.9	MSR10-6
MSR10-3	MIDPOINT BANK PROFILE	4818771.0	157718.2	MSR10-7
MSR10-4	DOWNSTREAM BANK PROFILE	4818209.0	158075.6	N/A
MSR10-5	DOWNSTREAM SITE LIMIT	4817560.3	158588.1	MSR10-8
MSR10-6	UPSTREAM PROFILE/OPPOSITE	4819789.0	157644.0	MSR10-2
MSR10-7	MIDPOINT PROFILE/OPPOSITE	4818904.4	157999.8	MSR10-3
MSR10-8	DOWNSTREAM PROFILE/OPPOSITE	4817707.2	158829.2	MSR10-5

Channel Profile Endpoints at Site #10

(A) UPSTREAM CHANNEL PROFILE (From: MSR10-6 To: MSR10-2)
Cross Section Length ~ 265m
(B) MIDPOINT CHANNEL PROFILE (From: MSR10-7 To: MSR10-3)
Cross Section Length ~ 318m
(C) DOWNSTREAM CHANNEL PROFILE (From: MSR10-8 To: MSR10-5)
Cross Section Length ~ 284m

Upstream Channel Profile RM669.0

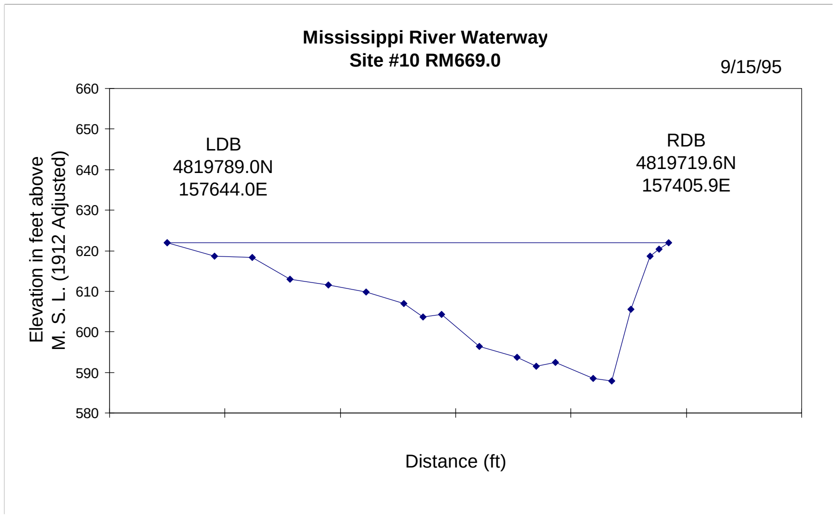
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	622.0	0
25	82.0	618.7	1
45	147.6	618.4	1.1
65	213.3	613.0	2.75
85	278.9	611.5	3.2
105	344.5	609.9	3.7
125	410.1	606.9	4.6
135	442.9	603.6	5.6
145	475.7	604.3	5.4
165	541.3	596.4	7.8
185	606.9	593.8	8.6
195	639.8	591.5	9.3
205	672.6	592.5	9
225	738.2	588.5	10.2
235	771.0	587.9	10.4
245	803.8	605.6	5
255	836.6	618.7	1
260	853.0	620.4	0.5
265	869.4	622.0	0

Midpoint Channel Profile RM669.0

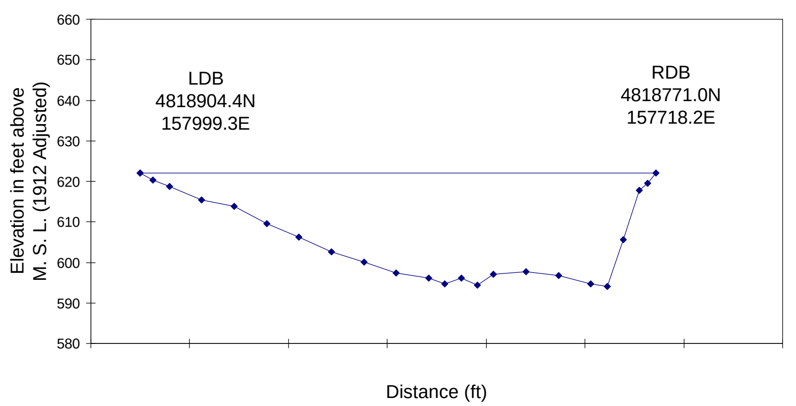
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	622.0	0
8	26.2	620.4	0.5
18	59.1	618.7	1
38	124.7	615.4	2
58	190.3	613.8	2.5
78	255.9	609.5	3.8
98	321.5	606.3	4.8
118	387.1	602.6	5.9
138	452.8	600.0	6.7
158	518.4	597.4	7.5
178	584.0	596.1	7.9
188	616.8	594.8	8.3
198	649.6	596.1	7.9
208	682.4	594.4	8.4
218	715.2	597.1	7.6
238	780.8	597.7	7.4
258	846.4	596.7	7.7
278	912.1	594.8	8.3
288	944.9	594.1	8.5
298	977.7	605.6	5
308	1010.5	617.7	1.3
313	1026.9	619.5	0.75
318	1043.3	622.0	0

Downstream Channel Profile RM669.0

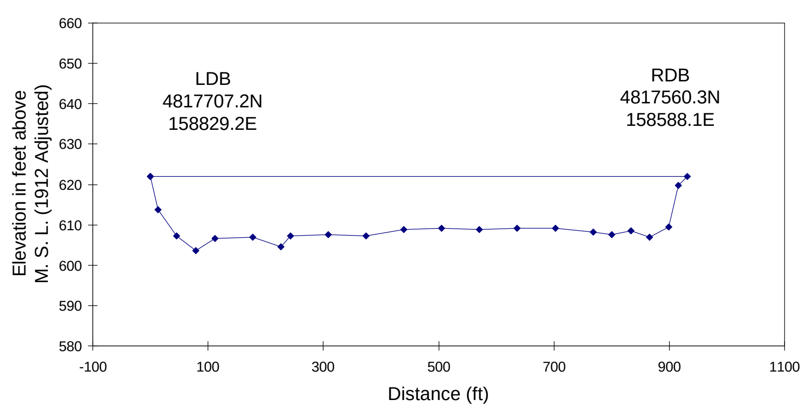
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	622.0	0
4	13.1	613.8	2.5
14	45.9	607.2	4.5
24	78.7	603.6	5.6
34	111.5	606.6	4.7
54	177.2	606.9	4.6
69	226.4	604.6	5.3
74	242.8	607.2	4.5
94	308.4	607.6	4.4
114	374.0	607.2	4.5
134	439.6	608.9	4
154	505.2	609.2	3.9
174	570.9	608.9	4
194	636.5	609.2	3.9
214	702.1	609.2	3.9
234	767.7	608.2	4.2
244	800.5	607.6	4.4
254	833.3	608.5	4.1
264	866.1	606.9	4.6
274	898.9	609.5	3.8
279	915.3	619.7	0.7
284	931.7	622.0	0



A. Upstream Channel Profile



B. Midpoint Channel Profile



C. Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #11 RM620.5 LDB

		NORTH	EAST	OPPOSITE
MSR11-1	UPSTREAM SITE LIMIT	4753801.5	165693.7	N/A
MSR11-2	UPSTREAM BANK PROFILE	4753728.3	165687.0	N/A
MSR11-3	MIDPOINT BANK PROFILE	4753628.7	165682.8	MSR11-6
MSR11-4	DOWNSTREAM BANK PROFILE	4753508.5	165675.3	N/A
MSR11-5	DOWNSTREAM SITE LIMIT	4753393.0	165651.7	N/A
MSR11-6	MIDPOINT PROFILE/OPPOSITE	4753633.6	165002.0	MSR11-3

Channel Profile Endpoints at Site #11

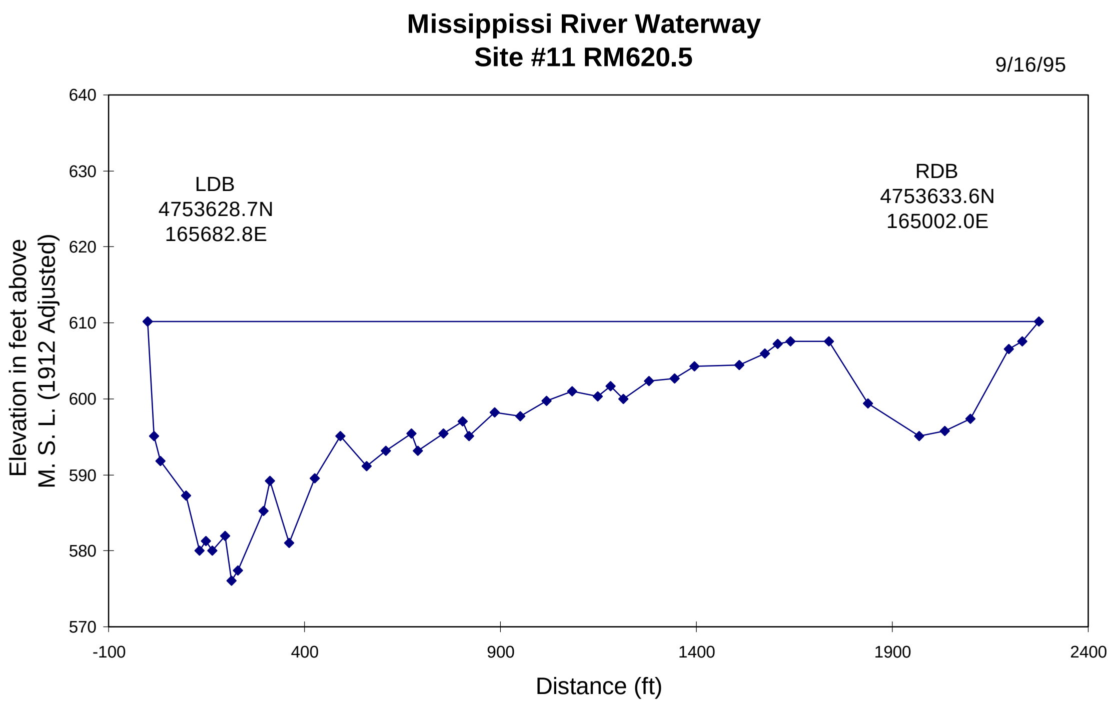
(A) MIDPOINT CHANNEL PROFILE (From: MSR11-3 To: MSR11-6)
Cross Section Length ~ 693m

Midpoint Channel Profile RM620.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	610.2	0
5	16.4	595.1	4.6
10	32.8	591.8	5.6
30	98.4	587.2	7
40	131.2	580.0	9.2
45	147.6	581.3	8.8
50	164.0	580.0	9.2
60	196.8	582.0	8.6
65	213.3	576.1	10.4
70	229.7	577.4	10
90	295.3	585.3	7.6
95	311.7	589.2	6.4
110	360.9	581.0	8.9
130	426.5	589.5	6.3
150	492.1	595.1	4.6
170	557.7	591.2	5.8
185	606.9	593.1	5.2
205	672.6	595.4	4.5
210	689.0	593.1	5.2
230	754.6	595.4	4.5
245	803.8	597.1	4
250	820.2	595.1	4.6
270	885.8	598.2	3.65
290	951.4	597.7	3.8
310	1017.0	599.7	3.2
330	1082.7	601.0	2.8

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
350	1148.3	600.4	3
360	1181.1	601.7	2.6
370	1213.9	600.0	3.1
390	1279.5	602.3	2.4
410	1345.1	602.7	2.3
425	1394.3	604.3	1.8
460	1509.2	604.5	1.75
480	1574.8	605.9	1.3
490	1607.6	607.2	0.9
500	1640.4	607.6	0.8
530	1738.8	607.6	0.8
560	1837.2	599.4	3.3
600	1968.5	595.1	4.6
620	2034.1	595.8	4.4
640	2099.7	597.4	3.9
670	2198.1	606.6	1.1
680	2230.9	607.6	0.8
693	2273.6	610.2	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #12 RM613.6 LDB

		NORTH	EAST	OPPOSITE
MSR12-1	UPSTREAM SITE LIMIT	4743233.9	166188.9	N/A
MSR12-2	UPSTREAM BANK PROFILE	4743168.3	166201.2	N/A
MSR12-3	MIDPOINT BANK PROFILE	4743051.7	166197.7	MSR12-6
MSR12-4	DOWNSTREAM BANK PROFILE	4742990.4	166192.0	N/A
MSR12-5	DOWNSTREAM SITE LIMIT	4742946.5	166184.0	N/A
MSR12-6	MIDPOINT PROFILE/OPPOSITE	4743047.6	165888.3	MSR12-3

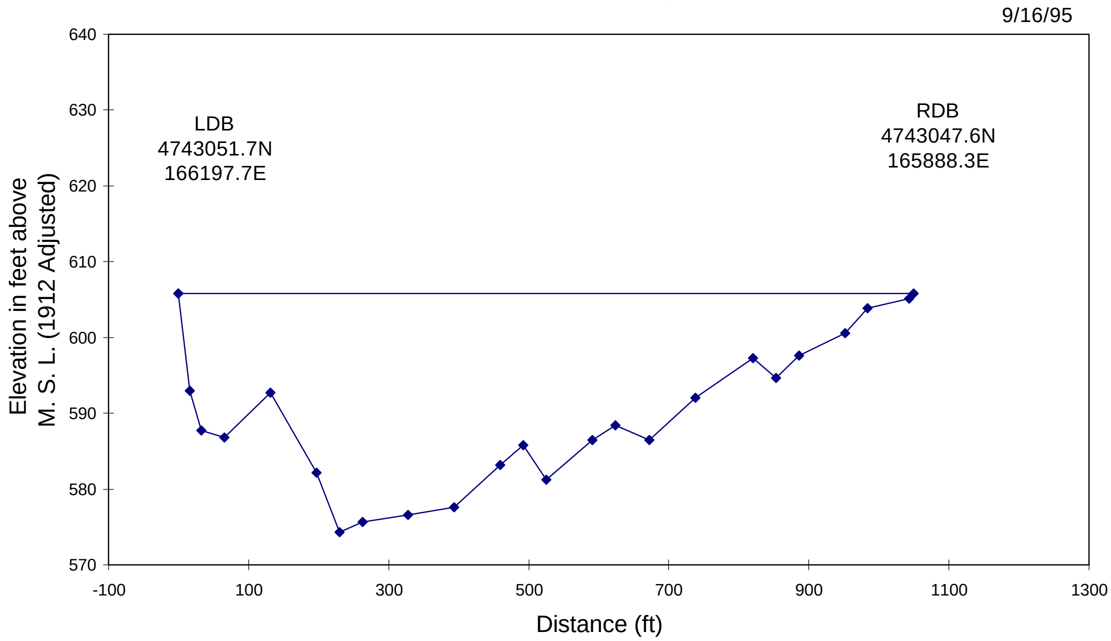
Channel Profile Endpoints at Site #12

(A) MIDPOINT CHANNEL PROFILE (From: MSR12-3 To: MSR12-6)
Cross Section Length ~ 320m

Midpoint Channel Profile RM613.6

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	605.8	0
5	16.4	593.0	3.9
10	32.8	587.8	5.5
20	65.6	586.8	5.8
40	131.2	592.7	4.0
60	196.8	582.2	7.2
70	229.7	574.3	9.6
80	262.5	575.6	9.2
100	328.1	576.6	8.9
120	393.7	577.6	8.6
140	459.3	583.2	6.9
150	492.1	585.8	6.1
160	524.9	581.2	7.5
180	590.5	586.4	5.9
190	623.4	588.4	5.3
205	672.6	586.4	5.9
225	738.2	592.0	4.2
250	820.2	597.3	2.6
260	853.0	594.6	3.4
270	885.8	597.6	2.5
290	951.4	600.6	1.6
300	984.2	603.8	0.6
318	1043.3	605.1	0.2
320	1049.9	605.8	0

Mississippi River Waterway
Site #12 RM613.6



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #14 RM607.5 RDB

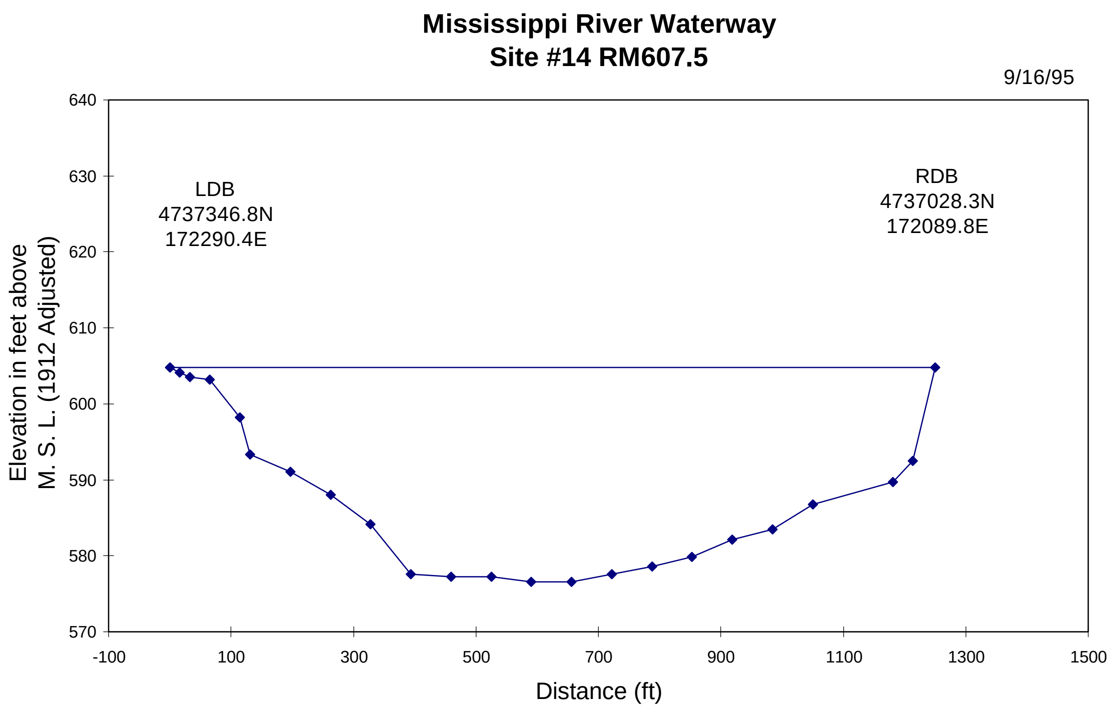
		NORTH	EAST	OPPOSITE
MSR14-1	UPSTREAM SITE LIMIT	4737267.1	171699.5	N/A
MSR14-2	UPSTREAM BANK PROFILE	4737211.1	171844.4	N/A
MSR14-3	MIDPOINT BANK PROFILE	4737028.3	172089.8	MSR14-6
MSR14-4	DOWNSTREAM BANK PROFILE	4736689.0	172420.5	N/A
MSR14-5	DOWNSTREAM SITE LIMIT	4736649.4	172589.5	N/A
MSR14-6	MIDPOINT PROFILE/OPPOSITE	4737346.8	172290.4	MSR14-3

Channel Profile Endpoints at Site #14

(A) MIDPOINT CHANNEL PROFILE (From: MSR14-6 To: MSR14-3)
Cross Section Length ~ 381m

Midpoint Channel Profile RM607.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0.0	0.0	604.8	0
5.0	16.4	604.1	0.2
10.0	32.8	603.5	0.4
20.0	65.6	603.2	0.5
35.0	114.8	598.2	2
40.0	131.2	593.3	3.5
60.0	196.8	591.0	4.2
80.0	262.5	588.1	5.1
100.0	328.1	584.1	6.3
120.0	393.7	577.6	8.3
140.0	459.3	577.2	8.4
160.0	524.9	577.2	8.4
180.0	590.5	576.6	8.6
200.0	656.2	576.6	8.6
220.0	721.8	577.6	8.3
240.0	787.4	578.6	8
260.0	853.0	579.9	7.6
280.0	918.6	582.2	6.9
300.0	984.2	583.5	6.5
320.0	1049.9	586.8	5.5
360.0	1181.1	589.7	4.6
370.0	1213.9	592.5	3.75
381.0	1250.0	604.8	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #15 RM576.0 LDB

		NORTH	EAST	OPPOSITE
MSR15-1	UPSTREAM SITE LIMIT	4707158.6	202177.2	N/A
MSR15-2	UPSTREAM BANK PROFILE	4707051.0	202265.2	N/A
MSR15-3	MIDPOINT BANK PROFILE	4706839.3	202555.5	MSR15-6
MSR15-4	DOWNSTREAM BANK PROFILE	4706652.6	203007.9	N/A
MSR15-5	DOWNSTREAM SITE LIMIT	4706534.2	203284.0	N/A
MSR15-6	MIDPOINT PROFILE/OPPOSITE	4706630.0	202398.7	MSR15-3

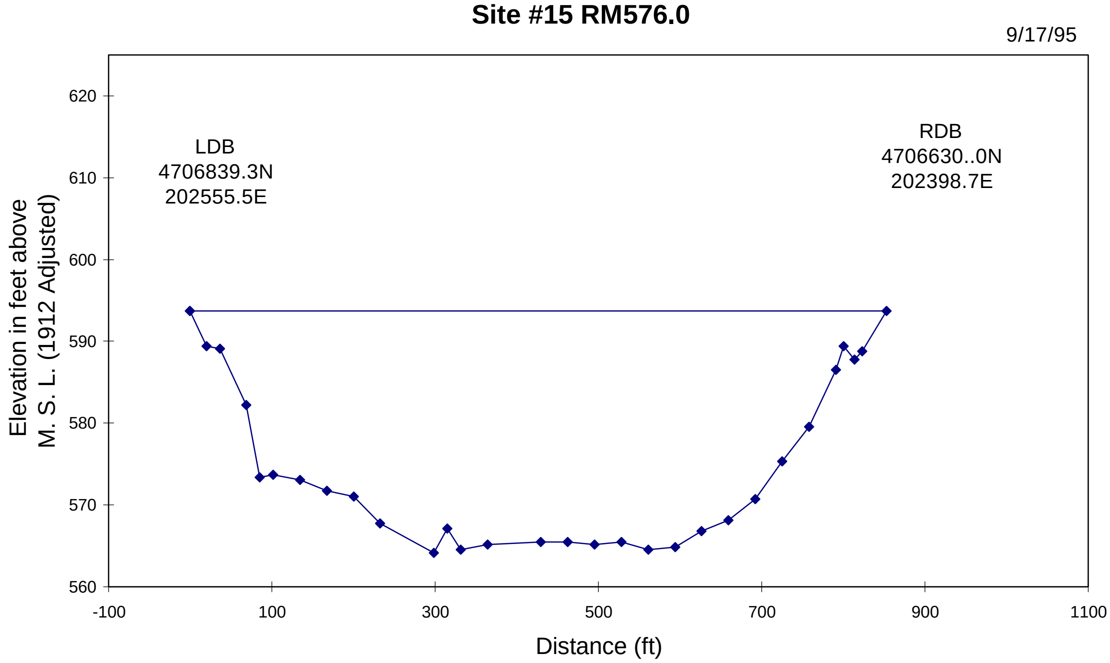
Channel Profile Endpoints at Site #15

(A) MIDPOINT CHANNEL PROFILE (From: MSR15-3 To: MSR15-6)
Cross Section Length ~ 360m

Midpoint Channel Profile RM576.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	593.7	0
6	19.7	589.4	1.3
11	36.1	589.1	1.4
21	68.9	582.2	3.5
26	85.3	573.4	6.2
31	101.7	573.7	6.1
41	134.5	573.0	6.3
51	167.3	571.7	6.7
61	200.1	571.1	6.9
71	232.9	567.8	7.9
91	298.6	564.2	9
96	315.0	567.1	8.1
101	331.4	564.5	8.9
111	364.2	565.2	8.7
131	429.8	565.5	8.6
141	462.6	565.5	8.6
151	495.4	565.2	8.7
161	528.2	565.5	8.6
171	561.0	564.5	8.9
181	593.8	564.8	8.8
191	626.6	566.8	8.2
201	659.4	568.1	7.8
211	692.2	570.7	7
221	725.1	575.3	5.6
231	757.9	579.6	4.3
241	790.7	586.5	2.2
244	800.5	589.4	1.3
248	813.6	587.8	1.8
251	823.5	588.8	1.5
260	853.0	593.7	0

Mississippi River Waterway
Site #15 RM576.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #16 RM551.9 LDB

		NORTH	EAST	OPPOSITE
MSR16-1	UPSTREAM SITE LIMIT	4678808.5	222565.3	N/A
MSR16-2	UPSTREAM BANK PROFILE	4678749.0	222574.0	N/A
MSR16-3	MIDPOINT BANK PROFILE	4678692.9	222609.3	MSR12-6
MSR16-4	DOWNSTREAM BANK PROFILE	4678637.6	222665.7	N/A
MSR16-5	DOWNSTREAM SITE LIMIT	4678604.4	222687.6	MSR16-7
MSR16-6	MIDPOINT PROFILE/OPPOSITE	4678405.1	222333.0	MSR16-3
MSR16-7	DOWNSTREAM LIMIT/OPPOSITE	4678235.7	222400.9	MSR16-5

Channel Profile Endpoints at Site #16

(A) MIDPOINT CHANNEL PROFILE (From: MSR16-3 To: MSR16-6)
Cross Section Length- (RDB taken from island) ~399m,
an additional ~215m to true RDB.

(B) DOWNSTREAM LIMIT CHANNEL PROFILE (From: MSR16-5 To: MSR16-7)
Cross Section Length - (RDB taken from island) ~466m,
an additional ~21m to true RDB.

Midpoint Channel Profile RM551.9

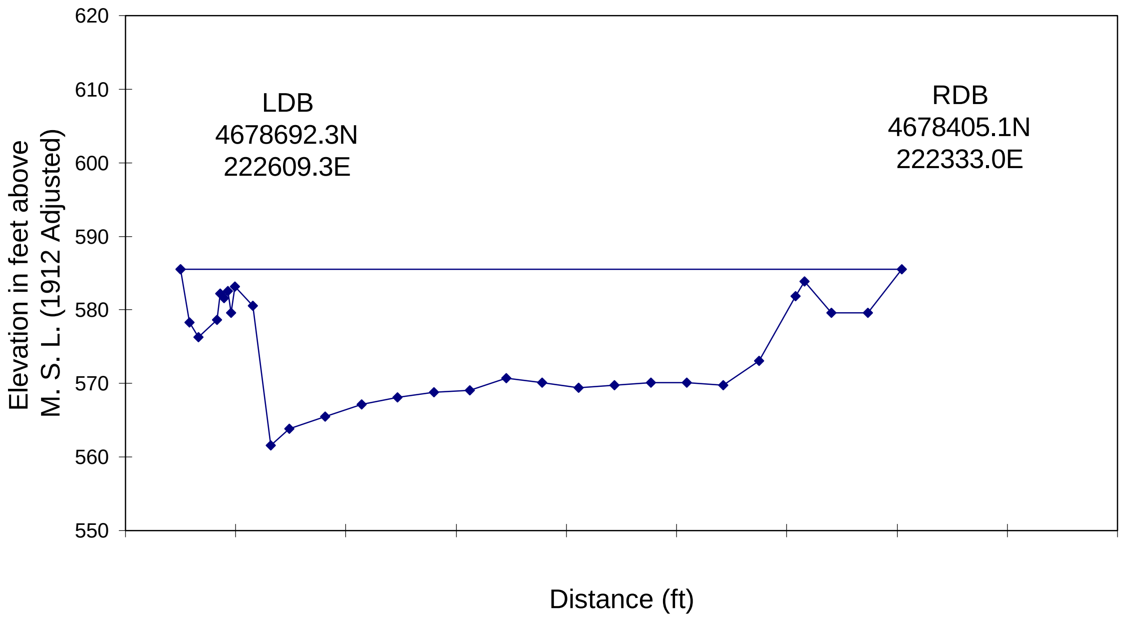
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	585.5	0
5	16.4	578.3	2.2
10	32.8	576.3	2.8
20	65.6	578.6	2.1
22	72.2	582.2	1
24	78.7	581.6	1.2
26	85.3	582.5	0.9
28	91.9	579.6	1.8
30	98.4	583.2	0.7
40	131.2	580.6	1.5
50	164.0	561.6	7.3
60	196.8	563.8	6.6
80	262.5	565.5	6.1
100	328.1	567.1	5.6
120	393.7	568.1	5.3
140	459.3	568.8	5.1
160	524.9	569.1	5
180	590.5	570.7	4.5
200	656.2	570.1	4.7
220	721.8	569.4	4.9
240	787.4	569.8	4.8
260	853.0	570.1	4.7
280	918.6	570.1	4.7
300	984.2	569.8	4.8
320	1049.9	573.0	3.8
340	1115.5	581.9	1.1
345	1131.9	583.9	0.5
360	1181.1	579.6	1.8
380	1246.7	579.6	1.8
399	1309.0	585.5	0

Downstream Channel Profile RM551.9

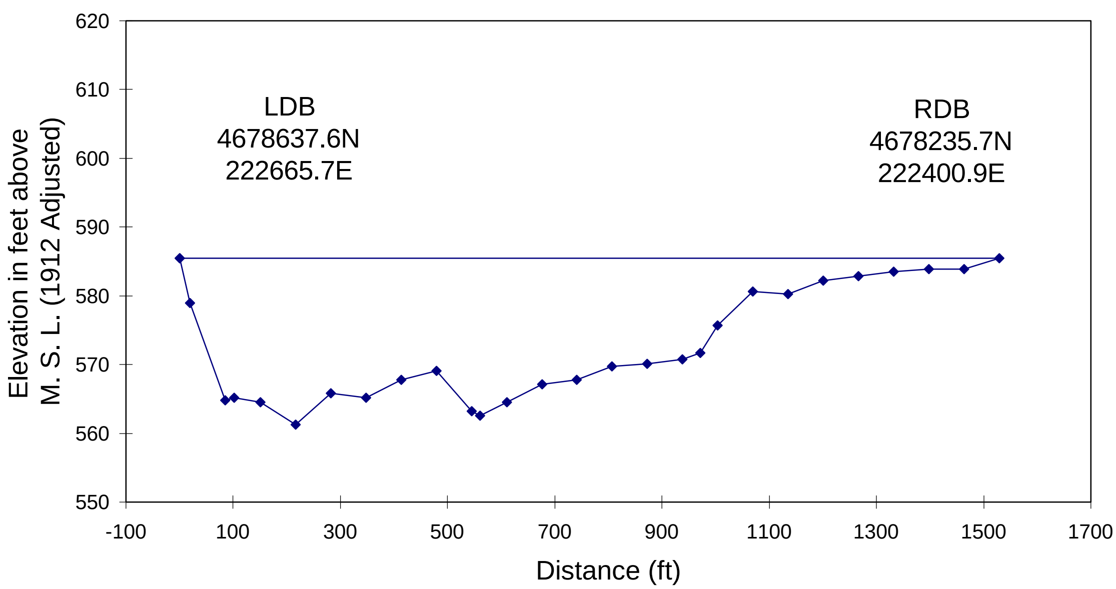
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	585.5	0
6	19.7	578.9	2
26	85.3	564.8	6.3
31	101.7	565.2	6.2
46	150.9	564.5	6.4
66	216.5	561.2	7.4
86	282.1	565.8	6
106	347.8	565.2	6.2
126	413.4	567.8	5.4
146	479.0	569.1	5
166	544.6	563.2	6.8
171	561.0	562.5	7
186	610.2	564.5	6.4
206	675.8	567.1	5.6
226	741.5	567.8	5.4
246	807.1	569.8	4.8
266	872.7	570.1	4.7
286	938.3	570.7	4.5
296	971.1	571.7	4.2
306	1003.9	575.7	3
326	1069.5	580.6	1.5
346	1135.2	580.3	1.6
366	1200.8	582.2	1
386	1266.4	582.9	0.8
406	1332.0	583.5	0.6
426	1397.6	583.9	0.5
446	1463.2	583.9	0.5
466	1528.9	585.5	0

Mississippi River Waterway
Site #16 RM551.9

9/17/95



A. Midpoint Channel Profile



B. Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #17 RM512.8 LDB

		NORTH	EAST	OPPOSITE
MSR17-1	UPSTREAM SITE LIMIT	4631163.3	231259.5	MSR17-6
MSR17-2	UPSTREAM BANK PROFILE	4631130.4	231153.6	N/A
MSR17-3	MIDPOINT BANK PROFILE	4631052.9	231037.0	MSR17-7
MSR17-4	DOWNSTREAM BANK PROFILE	4630970.0	230936.5	N/A
MSR17-5	DOWNSTREAM SITE LIMIT	4630868.6	230852.9	MSR17-8
MSR17-6	UPSTREAM LIMIT/OPPOSITE	4631676.6	230951.5	MSR17-1
MSR17-7	MIDPOINT PROFILE/OPPOSITE	4631475.0	230795.4	MSR17-3
MSR17-8	DOWNSTREAM LIMIT/OPPOSITE	4631308.4	230570.8	MSR17-5
MSR17-9	UPSTREAM BACK CHANNEL	no data, 100m upstream of MSR17-10		
MSR17-10	DOWNSTREAM BACK CHANNEL	4630922.7	231016.1	N/A

Channel Profile Endpoints at Site #17

(A) UPSTREAM CHANNEL PROFILE (From: MSR17-1 To: MSR17-6)
Cross Section Length ~ 602m

(B) MIDPOINT CHANNEL PROFILE (From: MSR17-3 To: MSR17-7)
Cross Section Length ~ 497m

(C) DOWNSTREAM CHANNEL PROFILE (From: MSR17-5 To: MSR17-8)
Cross Section Length ~ 527m

Upstream Channel Profile RM512.8

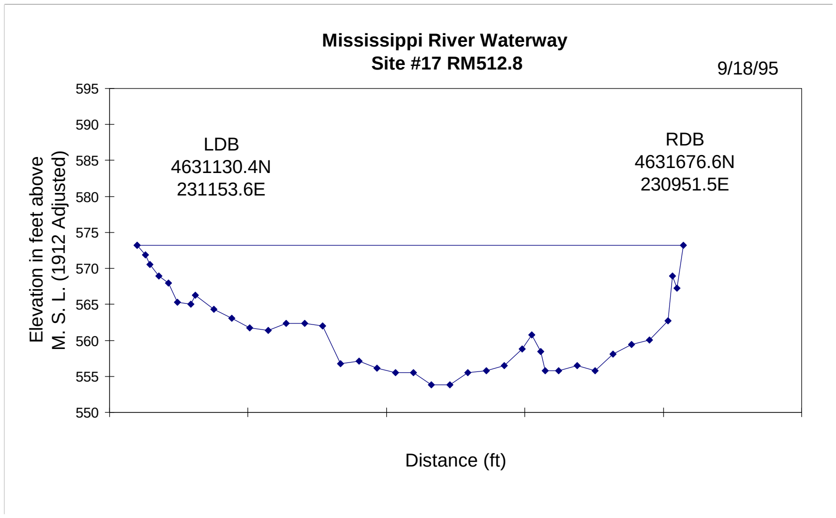
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	573.2	0
9	29.5	571.9	0.4
14	45.9	570.6	0.8
24	78.7	568.9	1.3
34	111.5	568.0	1.6
44	144.4	565.3	2.4
59	193.6	565.0	2.5
64	210.0	566.3	2.1
84	275.6	564.3	2.7
104	341.2	563.0	3.1
124	406.8	561.7	3.5
144	472.4	561.4	3.6
164	538.1	562.4	3.3
184	603.7	562.4	3.3
204	669.3	562.0	3.4
224	734.9	556.8	5
244	800.5	557.1	4.9
264	866.1	556.1	5.2
284	931.7	555.5	5.4
304	997.4	555.5	5.4
324	1063.0	553.8	5.9
344	1128.6	553.8	5.9
364	1194.2	555.5	5.4
384	1259.8	555.8	5.3
404	1325.4	556.5	5.1
424	1391.1	558.8	4.4
434	1423.9	560.7	3.8
444	1456.7	558.4	4.5
449	1473.1	555.8	5.3
464	1522.3	555.8	5.3
484	1587.9	556.5	5.1
504	1653.5	555.8	5.3
524	1719.1	558.1	4.6
544	1784.8	559.4	4.2
564	1850.4	560.1	4
584	1916.0	562.7	3.2
589	1932.4	568.9	1.3
594	1948.8	567.3	1.8
601	1971.8	573.2	0

Midpoint Channel Profile RM512.8

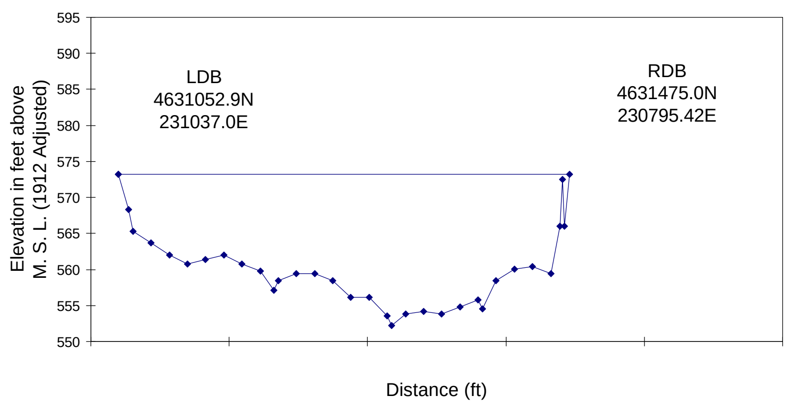
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	573.2	0
11	36.1	568.3	1.5
16	52.5	565.3	2.4
36	118.1	563.7	2.9
56	183.7	562.0	3.4
76	249.3	560.7	3.8
96	315.0	561.4	3.6
116	380.6	562.0	3.4
136	446.2	560.7	3.8
156	511.8	559.7	4.1
171	561.0	557.1	4.9
176	577.4	558.4	4.5
196	643.0	559.4	4.2
216	708.7	559.4	4.2
236	774.3	558.4	4.5
256	839.9	556.1	5.2
276	905.5	556.1	5.2
296	971.1	553.5	6
301	987.5	552.2	6.4
316	1036.7	553.8	5.9
336	1102.3	554.2	5.8
356	1168.0	553.8	5.9
376	1233.6	554.8	5.6
396	1299.2	555.8	5.3
401	1315.6	554.5	5.7
416	1364.8	558.4	4.5
436	1430.4	560.1	4
456	1496.0	560.4	3.9
476	1561.7	559.4	4.2
486	1594.5	566.0	2.2
489	1604.3	572.5	0.2
491	1610.9	566.0	2.2
497	1630.6	573.2	0

Downstream Channel Profile RM512.8

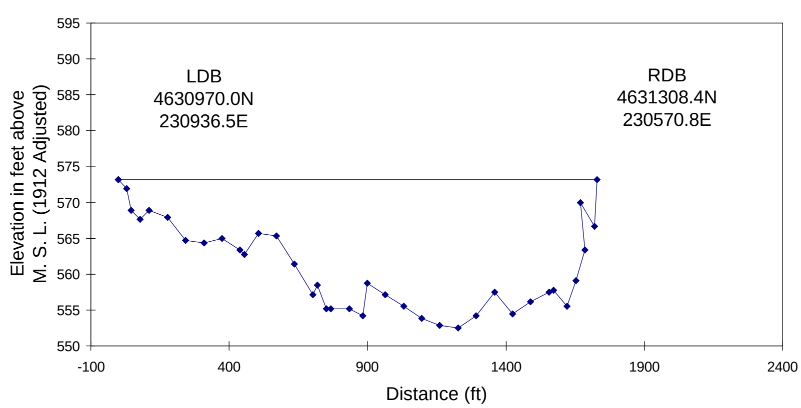
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	573.2	0
9	29.5	571.9	0.4
14	45.9	568.9	1.3
24	78.7	567.6	1.7
34	111.5	568.9	1.3
54	177.2	568.0	1.6
74	242.8	564.7	2.6
94	308.4	564.3	2.7
114	374.0	565.0	2.5
134	439.6	563.4	3
139	456.0	562.7	3.2
154	505.2	565.7	2.3
174	570.9	565.3	2.4
194	636.5	561.4	3.6
214	702.1	557.1	4.9
219	718.5	558.4	4.5
229	751.3	555.2	5.5
234	767.7	555.2	5.5
254	833.3	555.2	5.5
269	882.5	554.2	5.8
274	898.9	558.8	4.4
294	964.6	557.1	4.9
314	1030.2	555.5	5.4
334	1095.8	553.8	5.9
354	1161.4	552.9	6.2
374	1227.0	552.5	6.3
394	1292.6	554.2	5.8
414	1358.3	557.5	4.8
434	1423.9	554.5	5.7
454	1489.5	556.1	5.2
474	1555.1	557.5	4.8
479	1571.5	557.8	4.7
494	1620.7	555.5	5.4
504	1653.5	559.1	4.3
514	1686.3	563.4	3
509	1669.9	569.9	1
524	1719.1	566.6	2
527	1729.0	573.2	0



A. Upstream Channel Profile



B. Midpoint Channel Profile



C. Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #18 and Site #19 RM509.2 RDB

		NORTH	EAST	OPPOSITE
MSR18-1	UPSTREAM SITE LIMIT	4628567.5	226499.5	N/A
MSR18-2	UPSTREAM BANK PROFILE	4628499.4	226452.7	N/A
MSR18-3	MIDPOINT BANK PROFILE	4628415.1	226372.0	MSR19-1
MSR18-4	DOWNSTREAM BANK PROFILE	4628358.5	226274.3	N/A
MSR18-5	DOWNSTREAM SITE LIMIT	4628337.1	226231.5	N/A
MSR19-1	MIDPOINT PROFILE/OPPOSITE	4628120.5	226559.2	MSR18-3
MSR19-2	DOWNSTREAM PROFILE/OPPOSITE	4628039.7	226483.5	MSR18-4

Channel Profile Endpoints at Site #18 and Site #19

(A) MIDPOINT CHANNEL PROFILE (From: MSR19-1 To: MSR18.3)
Cross Section Length- 384m

(B DOWNSTREAM LIMIT CHANNEL PROFILE (From: MSR19-2 To: MSR18-4)
Cross Section Length -354m

Midpoint Channel Profile RM509.2

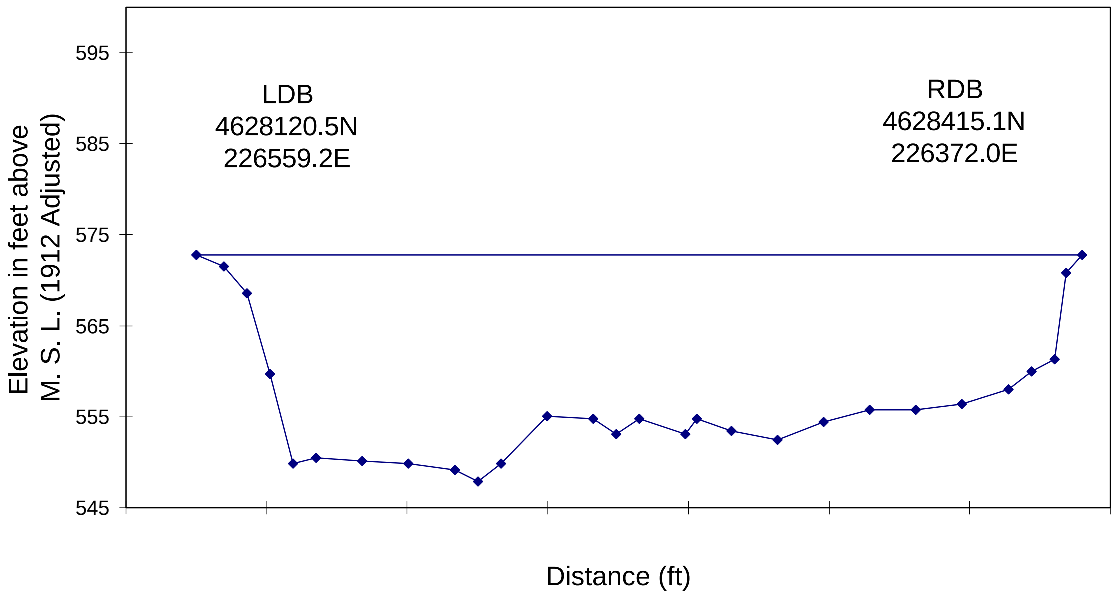
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0.0	0.0	572.8	0
12.0	39.4	571.5	0.4
22.0	72.2	568.5	1.3
32.0	105.0	559.7	4
42.0	137.8	549.8	7
52.0	170.6	550.5	6.8
72.0	236.2	550.2	6.9
92.0	301.8	549.8	7
112.0	367.4	549.2	7.2
122.0	400.3	547.9	7.6
132.0	433.1	549.8	7
152.0	498.7	555.1	5.4
172.0	564.3	554.8	5.5
182.0	597.1	553.1	6
192.0	629.9	554.8	5.5
212.0	695.5	553.1	6
217.0	711.9	554.8	5.5
232.0	761.1	553.4	5.9
252.0	826.8	552.5	6.2
272.0	892.4	554.4	5.6
292.0	958.0	555.7	5.2
312.0	1023.6	555.7	5.2
332.0	1089.2	556.4	5
352.0	1154.8	558.0	4.5
362.0	1187.6	560.0	3.9
372.0	1220.5	561.3	3.5
377.0	1236.9	570.8	0.6
384.0	1259.8	572.8	0

Downstream Channel Profile RM509.2

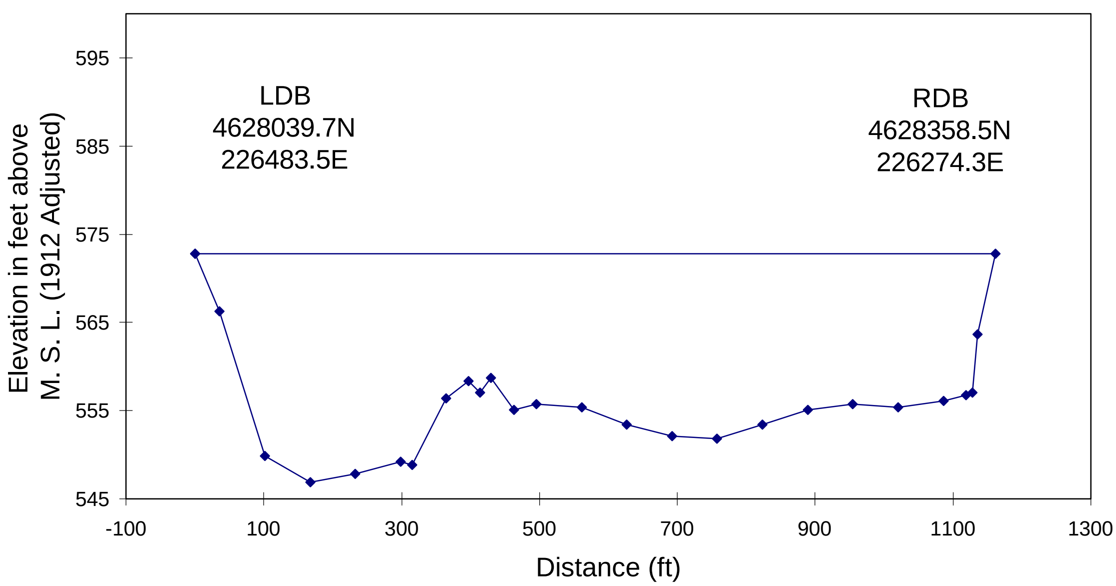
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0.0	0.0	572.8	0
11.0	36.1	566.2	2
31.0	101.7	549.8	7
51.0	167.3	546.9	7.9
71.0	232.9	547.9	7.6
91.0	298.6	549.2	7.2
96.0	315.0	548.9	7.3
111.0	364.2	556.4	5
121.0	397.0	558.4	4.4
126.0	413.4	557.1	4.8
131.0	429.8	558.7	4.3
141.0	462.6	555.1	5.4
151.0	495.4	555.7	5.2
171.0	561.0	555.4	5.3
191.0	626.6	553.4	5.9
211.0	692.2	552.1	6.3
231.0	757.9	551.8	6.4
251.0	823.5	553.4	5.9
271.0	889.1	555.1	5.4
291.0	954.7	555.7	5.2
311.0	1020.3	555.4	5.3
331.0	1085.9	556.1	5.1
341.0	1118.8	556.7	4.9
344.0	1128.6	557.1	4.8
346.0	1135.2	563.6	2.8
354.0	1161.4	572.8	0

Mississippi River Waterway
Site #18 and #19 RM509.2

9/18/95



A. Midpoint Channel Profile



B. Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #21 RM466.7 LDB

		NORTH	EAST	OPPOSITE
MSR21-1	MIDPOINT BANK PROFILE	15079619.6	587431.4	MSR21-2
MSR21-2	MIDPOINT PROFILE/OPPOSITE	15080816.7	587383.0	MSR21-1

Channel Profile Endpoints at Site #21

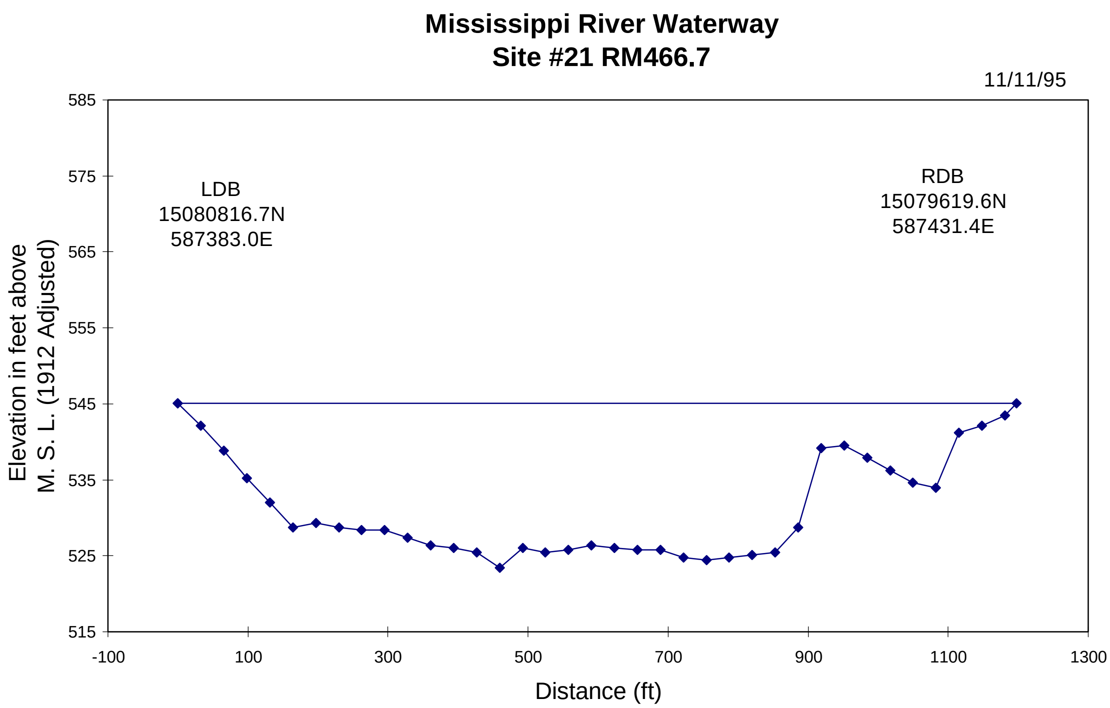
(A) MIDPOINT CHANNEL PROFILE (From: MSR21-1 To: MSR21-2)
Cross Section Length ~ 365m (1197.5ft)

Midpoint Channel Profile RM466.7

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	545.1	0
10	32.8	542.1	0.9
20	65.6	538.9	1.9
30	98.4	535.3	3
40	131.2	532.0	4
50	164.0	528.7	5
60	196.8	529.4	4.8
70	229.7	528.7	5
80	262.5	528.4	5.1
90	295.3	528.4	5.1
100	328.1	527.4	5.4
110	360.9	526.4	5.7
120	393.7	526.1	5.8
130	426.5	525.4	6
140	459.3	523.4	6.6
150	492.1	526.1	5.8
160	524.9	525.4	6
170	557.7	525.7	5.9
180	590.5	526.4	5.7
190	623.4	526.1	5.8
200	656.2	525.7	5.9
210	689.0	525.7	5.9
220	721.8	524.8	6.2
230	754.6	524.4	6.3
240	787.4	524.8	6.2
250	820.2	525.1	6.1
260	853.0	525.4	6
270	885.8	528.7	5
280	918.6	539.2	1.8
290	951.4	539.5	1.7
300	984.2	537.9	2.2

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
310	1017.0	536.2	2.7
320	1049.9	534.6	3.2
330	1082.7	533.9	3.4
340	1115.5	541.2	1.2
350	1148.3	542.1	0.9
360	1181.1	543.5	0.5
365	1197.5	545.1	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #22 RM436.4 LDB

		NORTH	EAST	OPPOSITE
MSR22-1	MIDPOINT BANK PROFILE	4566744.7	160345.8	MSR23-3
MSR22-2	DOWNSTREAM BANK PROFILE	4566618.8	160394.7	N/A

Site #23 RM436.4 RDB

MSR23-3	MIDPOINT PROFILE/OPPOSITE	4566584.2	160017.7	MSR22-1

Channel Profile Endpoints at Site #22 and Site #23

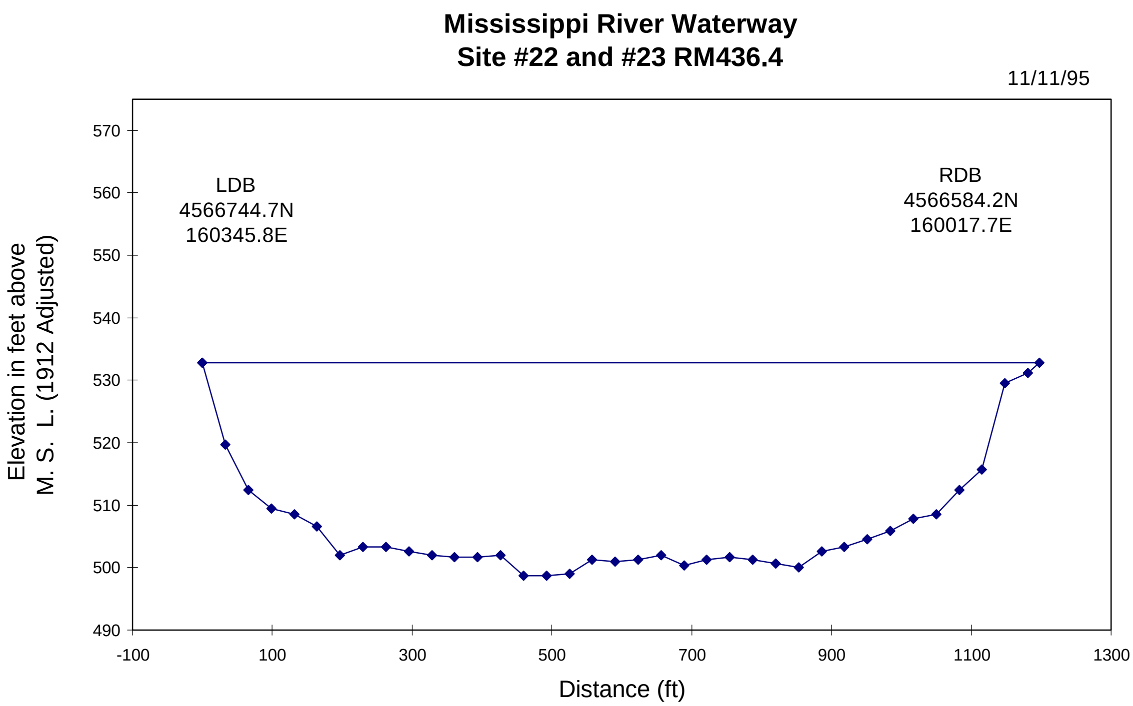
(A) MIDPOINT CHANNEL PROFILE (From: MSR22-1 To: MSR23-3)
Cross Section Length 365m (1197.5ft)

Midpoint Channel Profile RM436.4

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	532.8	0
10	32.8	519.7	4
20	65.6	512.5	6.2
30	98.4	509.5	7.1
40	131.2	508.5	7.4
50	164.0	506.6	8
60	196.8	502.0	9.4
70	229.7	503.3	9
80	262.5	503.3	9
90	295.3	502.6	9.2
100	328.1	502.0	9.4
110	360.9	501.6	9.5
120	393.7	501.6	9.5
130	426.5	502.0	9.4
140	459.3	498.7	10.4
150	492.1	498.7	10.4
160	524.9	499.0	10.3
170	557.7	501.3	9.6
180	590.5	501.0	9.7
190	623.4	501.3	9.6
200	656.2	502.0	9.4
210	689.0	500.3	9.9
220	721.8	501.3	9.6
230	754.6	501.6	9.5
240	787.4	501.3	9.6
250	820.2	500.6	9.8
260	853.0	500.0	10
270	885.8	502.6	9.2

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
280	918.6	503.3	9
290	951.4	504.6	8.6
300	984.2	505.9	8.2
310	1017.0	507.9	7.6
320	1049.9	508.5	7.4
330	1082.7	512.5	6.2
340	1115.5	515.7	5.2
350	1148.3	529.5	1
360	1181.1	531.2	0.5
365	1197.5	532.8	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #24 RM432.3 LDB

		NORTH	EAST	OPPOSITE
MSR24-1	UPSTREAM BANK PROFILE	4564687.6	164805.8	N/A
MSR24-2	MIDPOINT BANK PROFILE	4564418.0	165052.1	MSR25-4
MSR24-3	DOWNSTREAM BANK PROFILE	4564207.9	165208.0	N/A

Site #25 RM432.3 RDB

MSR25-4	MIDPOINT PROFILE/OPPOSITE	4564148.1	164691.3	MSR24-2

Channel Profile Endpoints at Site #24 and Site #25

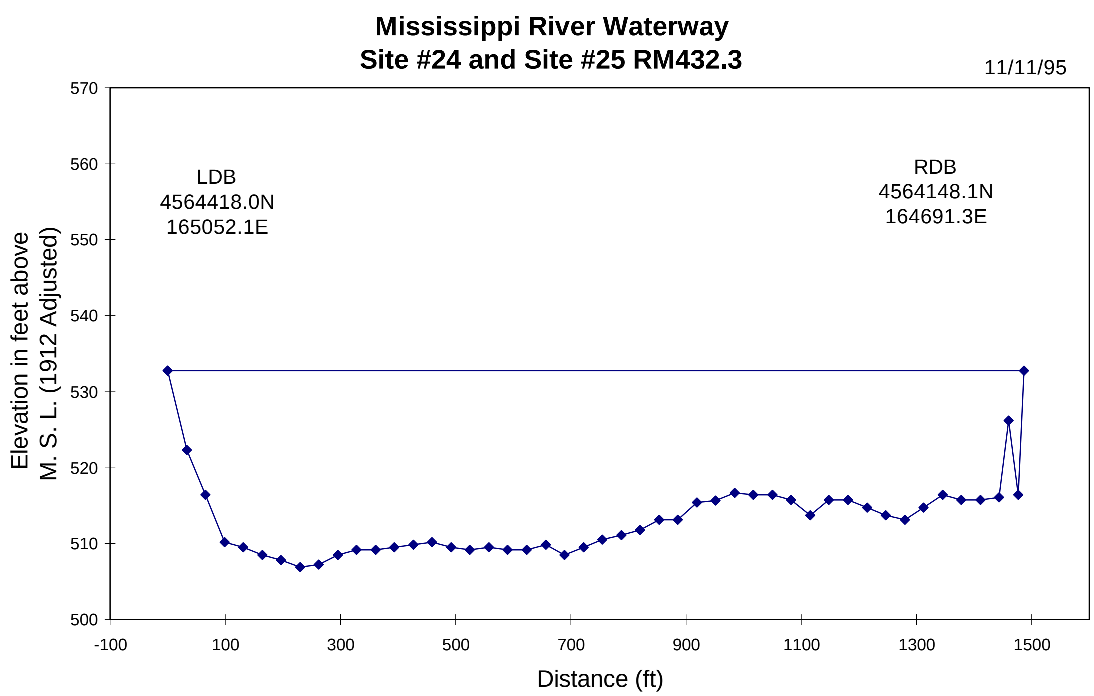
(A) MIDPOINT CHANNEL PROFILE (From: MSR24-2 To: MSR25-4)
Cross Section Length ~ 453m (1486.2ft)

Midpoint Channel Profile RM432.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	532.8	0
10	32.8	522.3	3.2
20	65.6	516.4	5
30	98.4	510.2	6.9
40	131.2	509.5	7.1
50	164.0	508.5	7.4
60	196.8	507.9	7.6
70	229.7	506.9	7.9
80	262.5	507.2	7.8
90	295.3	508.5	7.4
100	328.1	509.2	7.2
110	360.9	509.2	7.2
120	393.7	509.5	7.1
130	426.5	509.8	7
140	459.3	510.2	6.9
150	492.1	509.5	7.1
160	524.9	509.2	7.2
170	557.7	509.5	7.1
180	590.5	509.2	7.2
190	623.4	509.2	7.2
200	656.2	509.8	7
210	689.0	508.5	7.4
220	721.8	509.5	7.1
230	754.6	510.5	6.8
240	787.4	511.1	6.6
250	820.2	511.8	6.4
260	853.0	513.1	6
270	885.8	513.1	6

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
280	918.6	515.4	5.3
290	951.4	515.7	5.2
300	984.2	516.7	4.9
310	1017.0	516.4	5
320	1049.9	516.4	5
330	1082.7	515.7	5.2
340	1115.5	513.8	5.8
350	1148.3	515.7	5.2
360	1181.1	515.7	5.2
370	1213.9	514.8	5.5
380	1246.7	513.8	5.8
390	1279.5	513.1	6
400	1312.3	514.8	5.5
410	1345.1	516.4	5
420	1377.9	515.7	5.2
430	1410.7	515.7	5.2
440	1443.6	516.1	5.1
445	1460.0	526.2	2
450	1476.4	516.4	5
453	1486.2	532.8	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #26 RM420.0 RDB

		NORTH	EAST	OPPOSITE
MSR26-1	UPSTREAM BANK PROFILE	4545818.3	167479.6	N/A
MSR26-2	MIDPOINT BANK PROFILE	4545571.5	167431.0	MSR26-4
MSR26-3	DOWNSTREAM BANK PROFILE	4545408.5	167386.5	N/A
MSR26-4	MIDPOINT PROFILE/OPPOSITE	4545502.9	167982.9	MSR26-2

Channel Profile Endpoints at Site #26

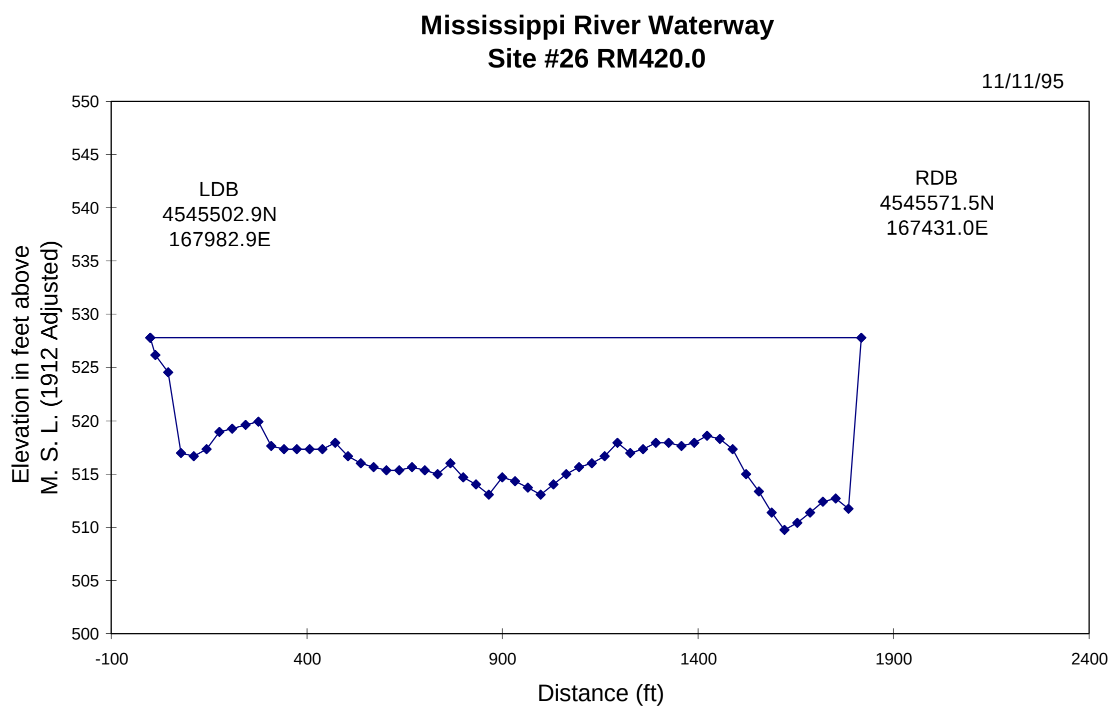
(A) MIDPOINT CHANNEL PROFILE (From: MSR26-4 To: MSR26-2)
Cross Section Length ~ 554m (1817.6ft)

Midpoint Channel Profile RM420.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	527.8	0
4	13.1	526.2	0.5
14	45.9	524.5	1
24	78.7	517.0	3.3
34	111.5	516.6	3.4
44	144.4	517.3	3.2
54	177.2	518.9	2.7
64	210.0	519.3	2.6
74	242.8	519.6	2.5
84	275.6	519.9	2.4
94	308.4	517.6	3.1
104	341.2	517.3	3.2
114	374.0	517.3	3.2
124	406.8	517.3	3.2
134	439.6	517.3	3.2
144	472.4	518.0	3
154	505.2	516.6	3.4
164	538.1	516.0	3.6
174	570.9	515.7	3.7
184	603.7	515.3	3.8
194	636.5	515.3	3.8
204	669.3	515.7	3.7
214	702.1	515.3	3.8
224	734.9	515.0	3.9
234	767.7	516.0	3.6
244	800.5	514.7	4
254	833.3	514.0	4.2
264	866.1	513.0	4.5
274	898.9	514.7	4
284	931.7	514.3	4.1

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
294	964.6	513.7	4.3
304	997.4	513.0	4.5
314	1030.2	514.0	4.2
324	1063.0	515.0	3.9
334	1095.8	515.7	3.7
344	1128.6	516.0	3.6
354	1161.4	516.6	3.4
364	1194.2	518.0	3
374	1227.0	517.0	3.3
384	1259.8	517.3	3.2
394	1292.6	518.0	3
404	1325.4	518.0	3
414	1358.3	517.6	3.1
424	1391.1	518.0	3
434	1423.9	518.6	2.8
444	1456.7	518.3	2.9
454	1489.5	517.3	3.2
464	1522.3	515.0	3.9
474	1555.1	513.4	4.4
484	1587.9	511.4	5
494	1620.7	509.8	5.5
504	1653.5	510.4	5.3
514	1686.3	511.4	5
524	1719.1	512.4	4.7
534	1751.9	512.7	4.6
544	1784.8	511.7	4.9
554	1817.6	527.8	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #27 RM360.0 RDB

		NORTH	EAST	OPPOSITE
MSR27-1	MIDPOINT BANK PROFILE	4478078.2	122879.7	MSR27-2
MSR27.2	MIDPOINT PROFILE/OPPOSITE	4477700.9	123090.7	MSR27-1

Channel Profile Endpoints at Site #27

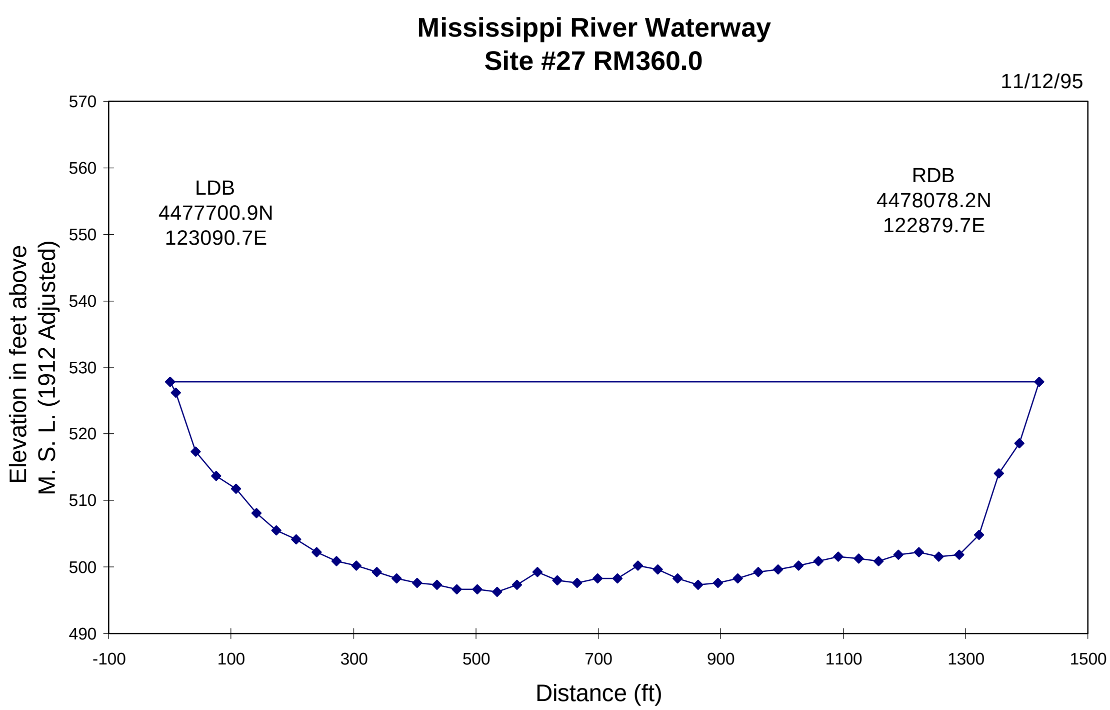
(A) MIDPOINT CHANNEL PROFILE (From: MSR26-4 To: MSR26-2)
Cross Section Length ~ 433m   (1420.5ft)

Midpoint Channel Profile RM420.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	527.8	0
3	9.8	526.2	0.5
13	42.7	517.3	3.2
23	75.5	513.7	4.3
33	108.3	511.7	4.9
43	141.1	508.1	6
53	173.9	505.5	6.8
63	206.7	504.2	7.2
73	239.5	502.2	7.8
83	272.3	500.9	8.2
93	305.1	500.2	8.4
103	337.9	499.3	8.7
113	370.7	498.3	9
123	403.5	497.6	9.2
133	436.3	497.3	9.3
143	469.2	496.6	9.5
153	502.0	496.6	9.5
163	534.8	496.3	9.6
173	567.6	497.3	9.3
183	600.4	499.3	8.7
193	633.2	497.9	9.1
203	666.0	497.6	9.2
213	698.8	498.3	9
223	731.6	498.3	9
233	764.4	500.2	8.4
243	797.2	499.6	8.6
253	830.0	498.3	9
263	862.9	497.3	9.3
273	895.7	497.6	9.2
283	928.5	498.3	9
293	961.3	499.3	8.7
303	994.1	499.6	8.6
313	1026.9	500.2	8.4

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
323	1059.7	500.9	8.2
333	1092.5	501.6	8
343	1125.3	501.2	8.1
353	1158.1	500.9	8.2
363	1190.9	501.9	7.9
373	1223.7	502.2	7.8
383	1256.5	501.6	8
393	1289.4	501.9	7.9
403	1322.2	504.8	7
413	1355.0	514.0	4.2
423	1387.8	518.6	2.8
433	1420.6	527.8	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #28 RM357.6 RDB

		NORTH	EAST	OPPOSITE
MSR28-1	UPSTREAM BANK PROFILE	4475981.0	121047.4	N/A
MSR28-2	MIDPOINT BANK PROFILE	4475472.9	120734.4	MSR28-4
MSR28-3	DOWNSTREAM BANK PROFILE	4475251.6	120629.9	N/A
MSR28-4	MIDPOINT PROFILE/OPPOSITE	4475161.4	121203.5	MSR28-2

Channel Profile Endpoints at Site #28

(A) MIDPOINT CHANNEL PROFILE (From: MSR28-4 To: MSR28-2)
Cross Section Length ~ 562m (1843.8ft)

Midpoint Channel Profile RM357.6

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0.0	0.0	482.8	0
12.0	39.4	464.8	5.5
22.0	72.2	459.5	7.1
32.0	105.0	459.5	7.1
42.0	137.8	462.5	6.2
52.0	170.6	463.4	5.9
62.0	203.4	455.2	8.4
72.0	236.2	456.6	8
82.0	269.0	456.9	7.9
92.0	301.8	457.9	7.6
102.0	334.6	458.5	7.4
112.0	367.4	459.5	7.1
122.0	400.3	461.5	6.5
132.0	433.1	466.4	5
142.0	465.9	463.8	5.8
152.0	498.7	462.1	6.3
162.0	531.5	460.5	6.8
172.0	564.3	463.1	6
182.0	597.1	463.1	6
192.0	629.9	461.1	6.6
202.0	662.7	459.5	7.1
212.0	695.5	460.2	6.9
222.0	728.3	458.5	7.4
232.0	761.1	460.2	6.9
242.0	794.0	459.2	7.2
252.0	826.8	458.9	7.3
262.0	859.6	458.9	7.3
272.0	892.4	457.9	7.6
282.0	925.2	462.5	6.2
292.0	958.0	464.1	5.7

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
302.0	990.8	463.4	5.9
312.0	1023.6	461.8	6.4
322.0	1056.4	461.1	6.6
332.0	1089.2	462.1	6.3
342.0	1122.0	462.5	6.2
352.0	1154.8	462.8	6.1
362.0	1187.6	460.8	6.7
372.0	1220.5	460.2	6.9
382.0	1253.3	462.8	6.1
392.0	1286.1	462.5	6.2
402.0	1318.9	461.1	6.6
412.0	1351.7	458.9	7.3
422.0	1384.5	461.1	6.6
432.0	1417.3	459.2	7.2
442.0	1450.1	457.5	7.7
452.0	1482.9	458.2	7.5
462.0	1515.7	459.2	7.2
472.0	1548.5	459.2	7.2
482.0	1581.3	460.2	6.9
492.0	1614.2	458.2	7.5
502.0	1647.0	457.9	7.6
512.0	1679.8	464.8	5.5
522.0	1712.6	464.1	5.7
532.0	1745.4	464.8	5.5
542.0	1778.2	462.1	6.3
552.0	1811.0	469.7	4
562.0	1843.8	482.8	0

Mississippi River Waterway
Site #28 RM357.6

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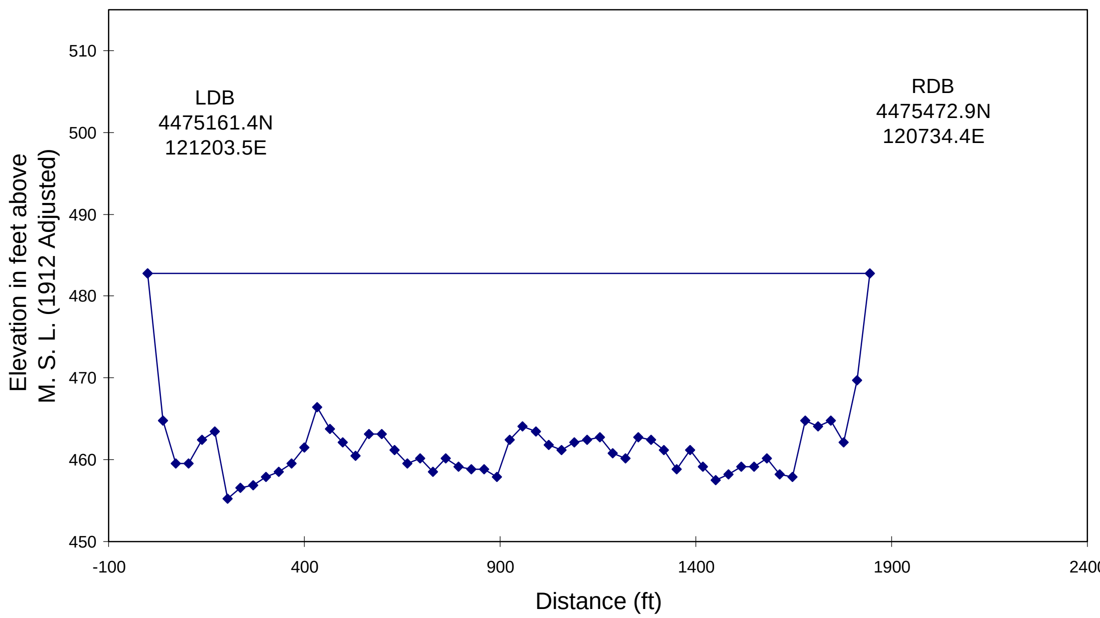


Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #29 and Site #30 RM339.4 LDB

		NORTH	EAST	OPPOSITE
MSR29-1	UPSTREAM BANK PROFILE	4447544.4	116470.2	N/A
MSR29-2	MIDPOINT BANK PROFILE	4447128.0	116477.8	MSR29-4
MSR29-3	DOWNSTREAM BANK PROFILE	4446976.4	116498.7	N/A
MSR29-4	MIDPOINT PROFILE/OPPOSITE	4447023.1	115945.0	MSR29-2
MSR30-5	MIDPOINT PROFILE/OPPOSITE	4447317.9	115918.7	N/A

Channel Profile Endpoints at Site #29

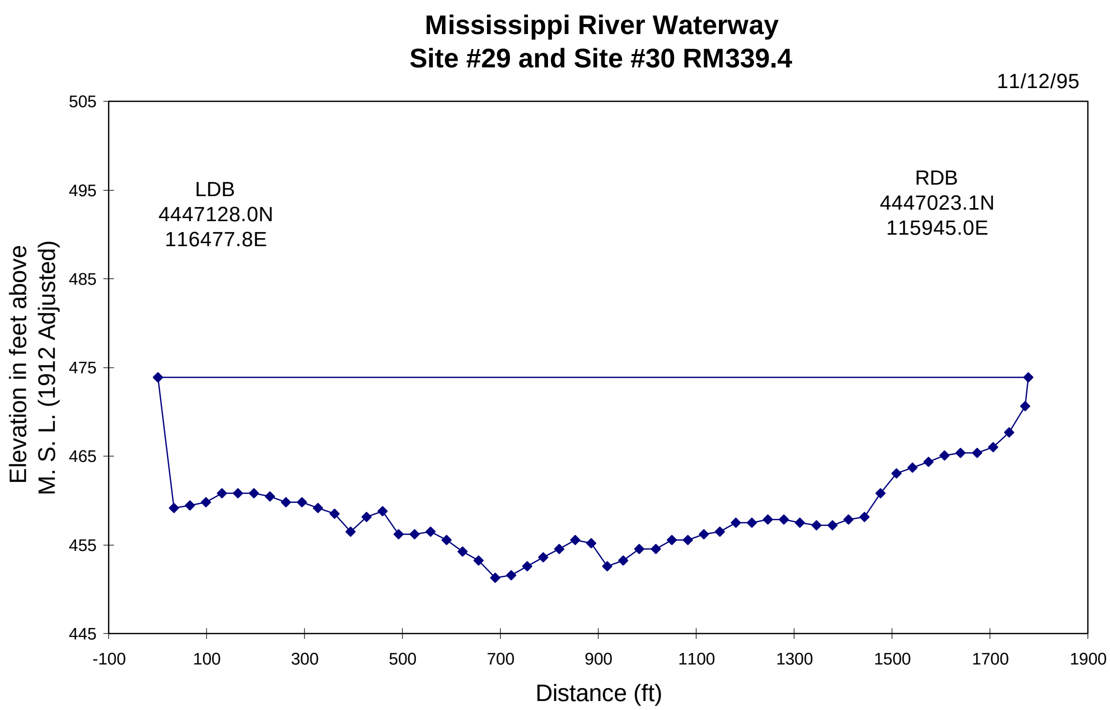
(A) MIDPOINT CHANNEL PROFILE (From: MSR29-2 To: MSR29-4)
Cross Section Length ~ 542m (1778.2ft)

Midpoint Channel Profile RM339.4

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	473.9	0
10	32.8	459.1	4.5
20	65.6	459.5	4.4
30	98.4	459.8	4.3
40	131.2	460.8	4
50	164.0	460.8	4
60	196.8	460.8	4
70	229.7	460.4	4.1
80	262.5	459.8	4.3
90	295.3	459.8	4.3
100	328.1	459.1	4.5
110	360.9	458.5	4.7
120	393.7	456.5	5.3
130	426.5	458.2	4.8
140	459.3	458.8	4.6
150	492.1	456.2	5.4
160	524.9	456.2	5.4
170	557.7	456.5	5.3
180	590.5	455.5	5.6
190	623.4	454.2	6
200	656.2	453.2	6.3
210	689.0	451.3	6.9
220	721.8	451.6	6.8
230	754.6	452.6	6.5
240	787.4	453.6	6.2
250	820.2	454.5	5.9
260	853.0	455.5	5.6
270	885.8	455.2	5.7
280	918.6	452.6	6.5

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
290	951.4	453.2	6.3
300	984.2	454.5	5.9
310	1017.0	454.5	5.9
320	1049.9	455.5	5.6
330	1082.7	455.5	5.6
340	1115.5	456.2	5.4
350	1148.3	456.5	5.3
360	1181.1	457.5	5
370	1213.9	457.5	5
380	1246.7	457.8	4.9
390	1279.5	457.8	4.9
400	1312.3	457.5	5
410	1345.1	457.2	5.1
420	1377.9	457.2	5.1
430	1410.7	457.8	4.9
440	1443.6	458.2	4.8
450	1476.4	460.8	4
460	1509.2	463.1	3.3
470	1542.0	463.7	3.1
480	1574.8	464.4	2.9
490	1607.6	465.0	2.7
500	1640.4	465.4	2.6
510	1673.2	465.4	2.6
520	1706.0	466.0	2.4
530	1738.8	467.7	1.9
540	1771.6	470.6	1
542	1778.2	473.9	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #31 RM293.0 LDB

		NORTH	EAST	OPPOSITE
MSR31-1	MIDPOINT BANK PROFILE	4386555.9	142874.2	MSR31-2
MSR31-2	MIDPOINT PROFILE/OPPOSITE	4386271.6	142462.8	MSR31-1

Channel Profile Endpoints at Site #31

(A) MIDPOINT CHANNEL PROFILE (From: MSR31-1 To: MSR31-2)
Cross Section Length ~ 500m (1640.4ft)

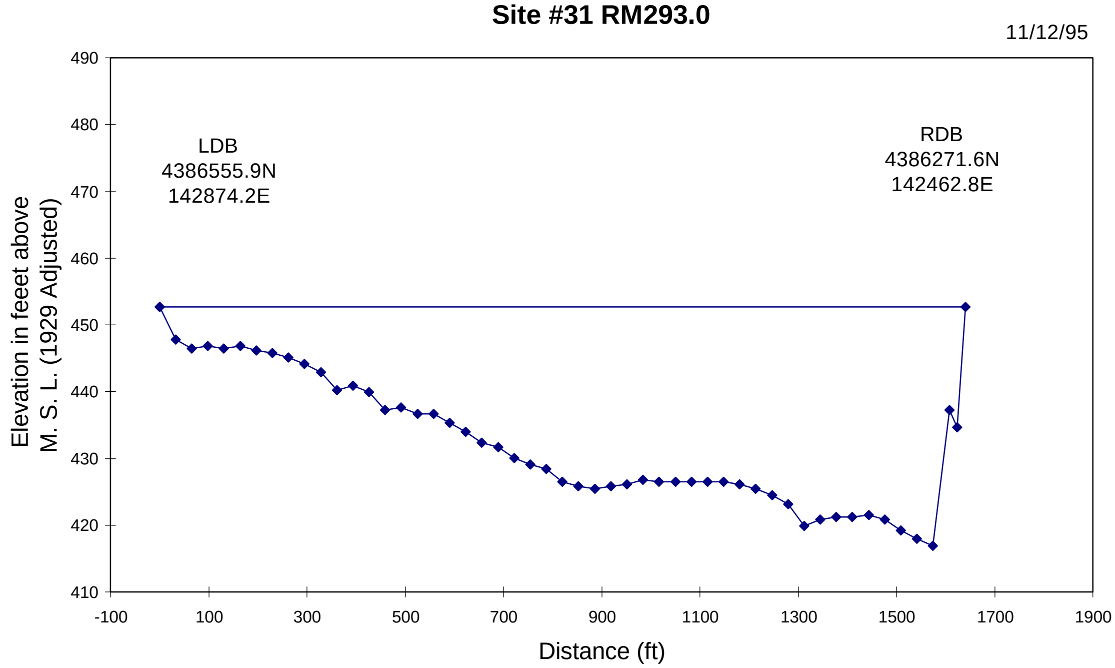
Midpoint Channel Profile RM293.0

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	452.7	0
10	32.8	447.8	1.5
20	65.6	446.5	1.9
30	98.4	446.8	1.8
40	131.2	446.5	1.9
50	164.0	446.8	1.8
60	196.8	446.1	2
70	229.7	445.8	2.1
80	262.5	445.2	2.3
90	295.3	444.2	2.6
100	328.1	442.9	3
110	360.9	440.2	3.8
120	393.7	440.9	3.6
130	426.5	439.9	3.9
140	459.3	437.3	4.7
150	492.1	437.6	4.6
160	524.9	436.6	4.9
170	557.7	436.6	4.9
180	590.5	435.3	5.3
190	623.4	434.0	5.7
200	656.2	432.4	6.2
210	689.0	431.7	6.4
220	721.8	430.1	6.9
230	754.6	429.1	7.2
240	787.4	428.4	7.4
250	820.2	426.5	8
260	853.0	425.8	8.2
270	885.8	425.5	8.3
280	918.6	425.8	8.2
290	951.4	426.1	8.1
300	984.2	426.8	7.9
310	1017.0	426.5	8
320	1049.9	426.5	8

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
330	1082.7	426.5	8
340	1115.5	426.5	8
350	1148.3	426.5	8
360	1181.1	426.1	8.1
370	1213.9	425.5	8.3
380	1246.7	424.5	8.6
390	1279.5	423.2	9
400	1312.3	419.9	10
410	1345.1	420.9	9.7
420	1377.9	421.2	9.6
430	1410.7	421.2	9.6
440	1443.6	421.5	9.5
450	1476.4	420.9	9.7
460	1509.2	419.2	10.2
470	1542.0	417.9	10.6
480	1574.8	416.9	10.9
490	1607.6	437.3	4.7
495	1624.0	434.7	5.5
500	1640.4	452.7	0

Mississippi River Waterway
Site #31 RM293.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #32 RM275.3 RDB

		NORTH	EAST	OPPOSITE
MSR32-1	UPSTREAM BANK PROFILE	4367175.1	161088.8	MSR32-3
MSR32-2	MIDPOINT BANK PROFILE	4367146.0	161137.4	N/A
MSR32-3	UPSTREAM PROFILE/OPPOSITE	4367558.4	161377.8	MSR32-1

Channel Profile Endpoints at Site #32

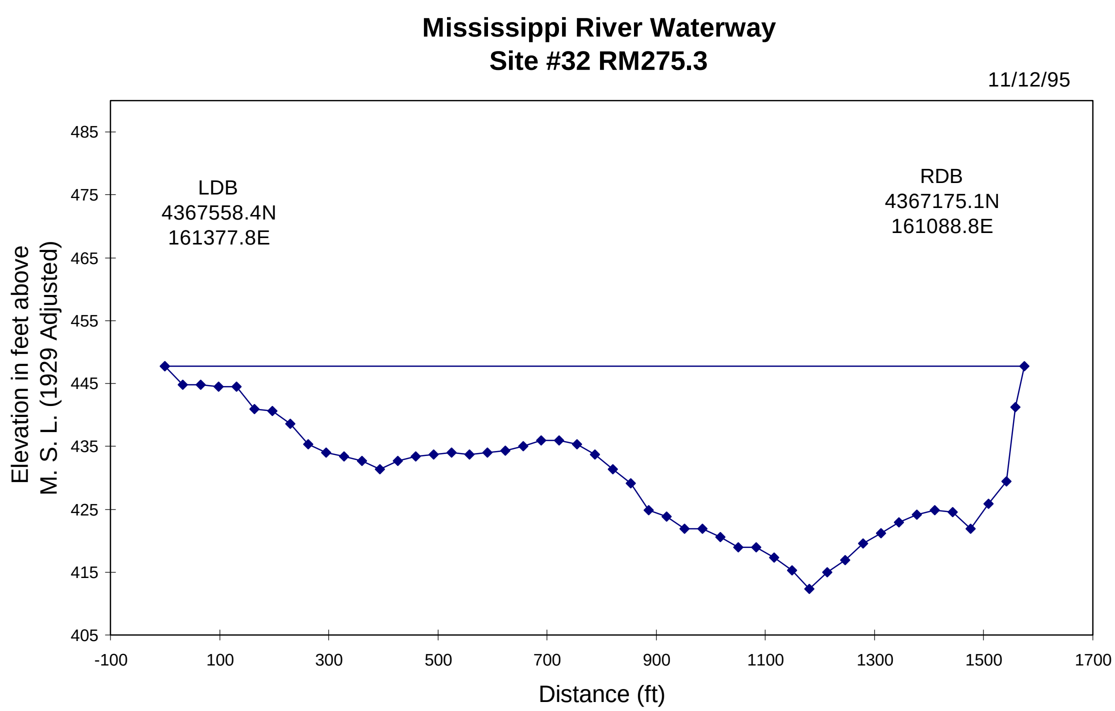
(A) UPSTREAM CHANNEL PROFILE (From: MSR32-3 To: MSR32-1)
Cross Section Length ~ 480m (1574.8ft)

Upstream Channel Profile RM275.3

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	447.8	0
10	32.8	444.8	0.9
20	65.6	444.8	0.9
30	98.4	444.5	1
40	131.2	444.5	1
50	164.0	440.9	2.1
60	196.8	440.6	2.2
70	229.7	438.6	2.8
80	262.5	435.3	3.8
90	295.3	434.0	4.2
100	328.1	433.4	4.4
110	360.9	432.7	4.6
120	393.7	431.4	5
130	426.5	432.7	4.6
140	459.3	433.4	4.4
150	492.1	433.7	4.3
160	525.0	434.0	4.2
170	557.7	433.7	4.3
180	590.5	434.0	4.2
190	623.4	434.3	4.1
200	656.2	435.0	3.9
210	689.0	436.0	3.6
220	721.8	436.0	3.6
230	754.6	435.3	3.8
240	787.4	433.7	4.3
250	820.2	431.4	5
260	853.0	429.1	5.7
270	885.8	424.8	7
280	918.6	423.9	7.3
290	951.4	421.9	7.9
300	984.2	421.9	7.9
310	1017.0	420.6	8.3

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
320	1049.9	418.9	8.8
330	1082.7	418.9	8.8
340	1115.5	417.3	9.3
350	1148.3	415.3	9.9
360	1181.1	412.4	10.8
370	1213.9	415.0	10
380	1246.7	417.0	9.4
390	1279.5	419.6	8.6
400	1312.3	421.2	8.1
410	1345.1	422.9	7.6
420	1377.9	424.2	7.2
430	1410.7	424.8	7
440	1443.6	424.5	7.1
450	1476.4	421.9	7.9
460	1509.2	425.8	6.7
470	1542.0	429.4	5.6
475	1558.4	441.2	2
480	1574.8	447.8	0



Upstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #33 RM266.5 LDB

		NORTH	EAST	OPPOSITE
MSR33-1	UPSTREAM BANK PROFILE	4358859.6	172122.5	N/A
MSR33-2	MIDPOINT BANK PROFILE	4358739.4	172293.6	MSR33-4
MSR33-3	DOWNSTREAM PROFILE	4358615.7	172479.3	N/A
MSR33-4	MIDPOINT PROFILE/OPPOSITE	4358347.7	172043.3	MSR33-2

Channel Profile Endpoints at Site #33

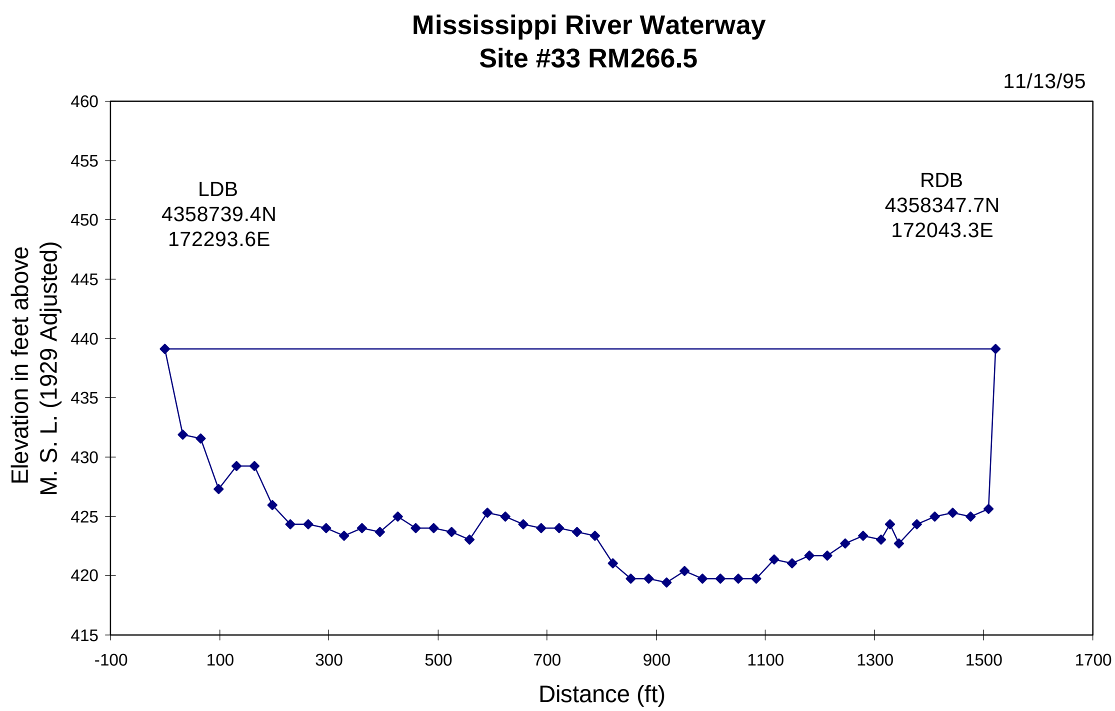
(A) MIDPOINT CHANNEL PROFILE (From: MSR33-2 To: MSR33-4)
Cross Section Length ~ 464m (1522.3ft)

Midpoint Channel Profile RM266.5

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	439.1	0
10	32.8	431.9	2.2
20	65.6	431.6	2.3
30	98.4	427.3	3.6
40	131.2	429.3	3
50	164.0	429.3	3
60	196.8	426.0	4
70	229.7	424.3	4.5
80	262.5	424.3	4.5
90	295.3	424.0	4.6
100	328.1	423.4	4.8
110	360.9	424.0	4.6
120	393.7	423.7	4.7
130	426.5	425.0	4.3
140	459.3	424.0	4.6
150	492.1	424.0	4.6
160	525.0	423.7	4.7
170	557.7	423.0	4.9
180	590.5	425.3	4.2
190	623.4	425.0	4.3
200	656.2	424.3	4.5
210	689.0	424.0	4.6
220	721.8	424.0	4.6
230	754.6	423.7	4.7
240	787.4	423.4	4.8
250	820.2	421.1	5.5
260	853.0	419.7	5.9
270	885.8	419.7	5.9
280	918.6	419.4	6
290	951.4	420.4	5.7
300	984.2	419.7	5.9

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
310	1017.0	419.7	5.9
320	1049.9	419.7	5.9
330	1082.7	419.7	5.9
340	1115.5	421.4	5.4
350	1148.3	421.1	5.5
360	1181.1	421.7	5.3
370	1213.9	421.7	5.3
380	1246.7	422.7	5
390	1279.5	423.4	4.8
400	1312.3	423.0	4.9
405	1328.7	424.3	4.5
410	1345.1	422.7	5
420	1377.9	424.3	4.5
430	1410.7	425.0	4.3
440	1443.6	425.3	4.2
450	1476.4	425.0	4.3
460	1509.2	425.6	4.1
464	1522.3	439.1	0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #34 RM232.2 RDB

		NORTH	EAST	OPPOSITE
MSR34-1	UPSTREAM BANK PROFILE	4310356.0	185090.4	N/A
MSR34-2	MIDPOINT BANK PROFILE	4310233.3	185177.2	MSR34-4
MSR34-3	DOWNSTREAM PROFILE	4310123.7	185277.3	N/A
MSR34-4	MIDPOINT PROFILE/OPPOSITE	4310934.9	186020.1	MSR34-2

Channel Profile Endpoints at Site #34

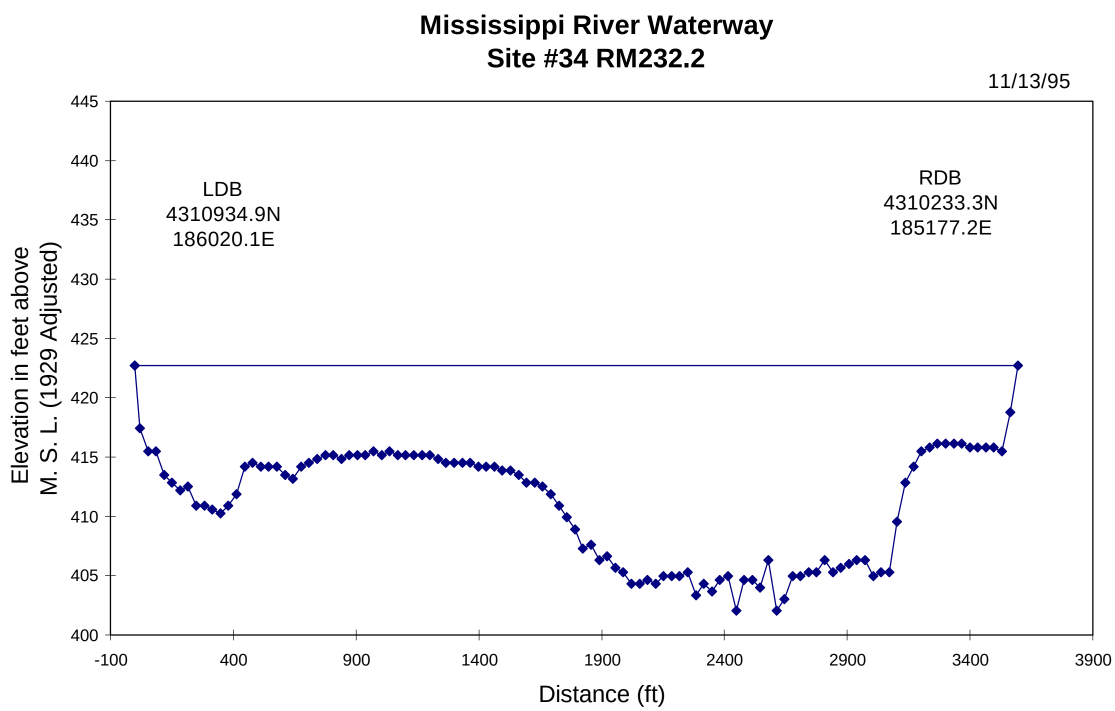
(A) MIDPOINT CHANNEL PROFILE (From: MSR34-4 To: MSR34-2)
Cross Section Length ~ 1096m (3595.8ft)

Midpoint Channel Profile RM232.2

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0.0	0.0	422.7	0
6.0	19.7	417.5	1.6
16.0	52.5	415.5	2.2
26.0	85.3	415.5	2.2
36.0	118.1	413.5	2.8
46.0	150.9	412.9	3
56.0	183.7	412.2	3.2
66.0	216.5	412.5	3.1
76.0	249.3	410.9	3.6
86.0	282.1	410.9	3.6
96.0	315.0	410.6	3.7
106.0	347.8	410.2	3.8
116.0	380.6	410.9	3.6
126.0	413.4	411.9	3.3
136.0	446.2	414.2	2.6
146.0	479.0	414.5	2.5
156.0	511.8	414.2	2.6
166.0	544.6	414.2	2.6
176.0	577.4	414.2	2.6
186.0	610.2	413.5	2.8
196.0	643.0	413.2	2.9
206.0	675.8	414.2	2.6
216.0	708.7	414.5	2.5
226.0	741.5	414.8	2.4
236.0	774.3	415.2	2.3
246.0	807.1	415.2	2.3
256.0	839.9	414.8	2.4
266.0	872.7	415.2	2.3
276.0	905.5	415.2	2.3
286.0	938.3	415.2	2.3
296.0	971.1	415.5	2.2

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
306.0	1003.9	415.2	2.3
316.0	1036.7	415.5	2.2
326.0	1069.5	415.2	2.3
336.0	1102.3	415.2	2.3
346.0	1135.2	415.2	2.3
356.0	1168.0	415.2	2.3
366.0	1200.8	415.2	2.3
376.0	1233.6	414.8	2.4
386.0	1266.4	414.5	2.5
396.0	1299.2	414.5	2.5
406.0	1332.0	414.5	2.5
416.0	1364.8	414.5	2.5
426.0	1397.6	414.2	2.6
436.0	1430.4	414.2	2.6
446.0	1463.2	414.2	2.6
456.0	1496.0	413.8	2.7
466.0	1528.9	413.8	2.7
476.0	1561.7	413.5	2.8
486.0	1594.5	412.9	3
496.0	1627.3	412.9	3
506.0	1660.1	412.5	3.1
516.0	1692.9	411.9	3.3
526.0	1725.7	410.9	3.6
536.0	1758.5	409.9	3.9
546.0	1791.3	408.9	4.2
556.0	1824.1	407.3	4.7
566.0	1856.9	407.6	4.6
576.0	1889.7	406.3	5
586.0	1922.5	406.6	4.9
596.0	1955.4	405.6	5.2
606.0	1988.2	405.3	5.3



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #35 RM222.1 RDB

		NORTH	EAST	OPPOSITE
MSR35-1	UPSTREAM SITE PROFILE	4314968.4	197376.6	N/A
MSR35-2	UPSTREAM BANK PROFILE	4315025.4	197441.6	N/A
MSR35-3	MIDPOINT BANK PROFILE	4315088.7	197507.0	MSR35-5
MSR35-4	DOWNSTREAM PROFILE	4315158.0	197574.4	N/A
MSR35-5	MIDPOINT PROFILE/OPPOSITE	4315352.1	197148.2	MSR35-3

Channel Profile Endpoints at Site #35

(A) MIDPOINT CHANNEL PROFILE (From: MSR35-5 To: MSR35-3)
Cross Section Length ~ 450m (1476.4ft)

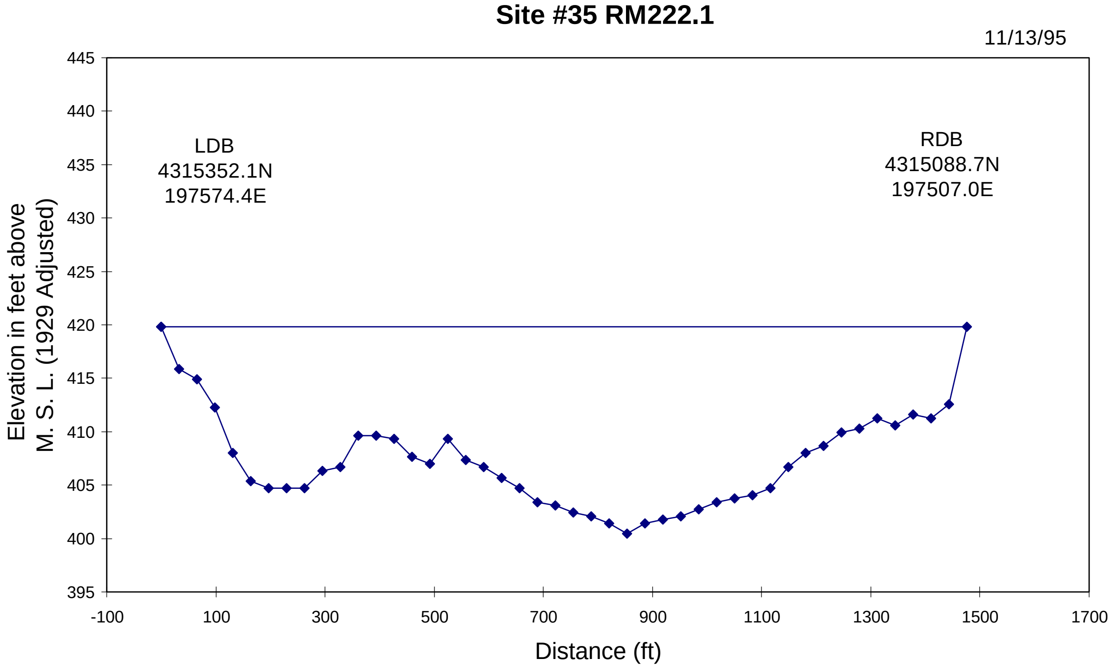
Midpoint Channel Profile RM222.1

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	419.8	0
10	32.8	415.9	1.2
20	65.6	414.9	1.5
30	98.4	412.3	2.3
40	131.2	408.0	3.6
50	164.0	405.4	4.4
60	196.8	404.7	4.6
70	229.7	404.7	4.6
80	262.5	404.7	4.6
90	295.3	406.3	4.1
100	328.1	406.7	4
110	360.9	409.6	3.1
120	393.7	409.6	3.1
130	426.5	409.3	3.2
140	459.3	407.7	3.7
150	492.1	407.0	3.9
160	524.9	409.3	3.2
170	557.7	407.3	3.8
180	590.5	406.7	4
190	623.4	405.7	4.3
200	656.2	404.7	4.6
210	689.0	403.4	5
220	721.8	403.1	5.1
230	754.6	402.4	5.3
240	787.4	402.1	5.4
250	820.2	401.4	5.6
260	853.0	400.4	5.9
270	885.8	401.4	5.6
280	918.6	401.8	5.5
290	951.4	402.1	5.4

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
300	984.2	402.7	5.2
310	1017.0	403.4	5
320	1049.9	403.7	4.9
330	1082.7	404.1	4.8
340	1115.5	404.7	4.6
350	1148.3	406.7	4
360	1181.1	408.0	3.6
370	1213.9	408.6	3.4
380	1246.7	410.0	3
390	1279.5	410.3	2.9
400	1312.3	411.3	2.6
410	1345.1	410.6	2.8
420	1377.9	411.6	2.5
430	1410.7	411.3	2.6
440	1443.6	412.6	2.2
450	1476.4	419.8	0

Mississippi River Waterway
Site #35 RM222.1



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #36 RM217.5 RDB

		NORTH	EAST	OPPOSITE
MSR36-1	MIDPOINT BANK PROFILE	4317871.9	203667.0	MSR36-2
MSR36-2	MIDPOINT PROFILE/OPPOSITE	4318689.0	203821.0	MSR36-1

Channel Profile Endpoints at Site #36

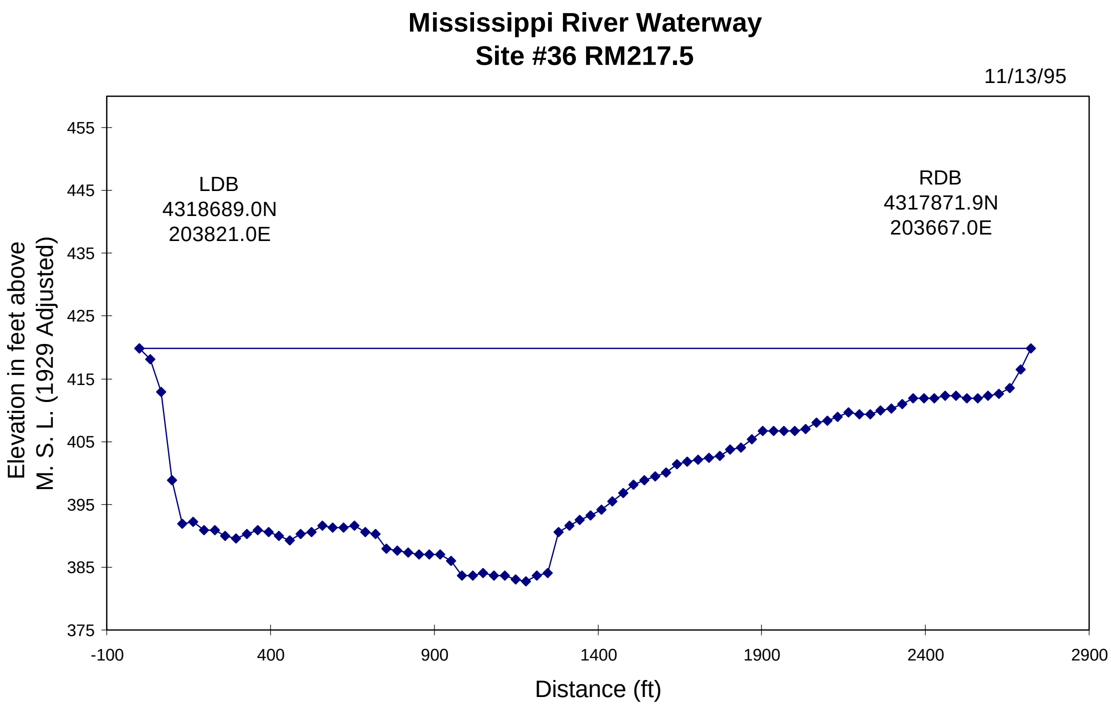
(A) MIDPOINT CHANNEL PROFILE (From: MSR36-2 To: MSR36-1)
Cross Section Length ~ 830m (2723.1ft)

Midpoint Channel Profile RM222.1

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	419.8	0.0
10	32.8	418.2	0.5
20	65.6	412.9	2.1
30	98.4	398.8	6.4
40	131.2	391.9	8.5
50	164.0	392.2	8.4
60	196.8	390.9	8.8
70	229.7	390.9	8.8
80	262.5	389.9	9.1
90	295.3	389.6	9.2
100	328.1	390.3	9.0
110	360.9	390.9	8.8
120	393.7	390.6	8.9
130	426.5	389.9	9.1
140	459.3	389.3	9.3
150	492.1	390.3	9.0
160	524.9	390.6	8.9
170	557.7	391.6	8.6
180	590.5	391.3	8.7
190	623.4	391.3	8.7
200	656.2	391.6	8.6
210	689.0	390.6	8.9
220	721.8	390.3	9.0
230	754.6	388.0	9.7
240	787.4	387.6	9.8
250	820.2	387.3	9.9
260	853.0	387.0	10.0
270	885.8	387.0	10.0
280	918.6	387.0	10.0
290	951.4	386.0	10.3
300	984.2	383.7	11.0
310	1017.0	383.7	11.0
320	1049.9	384.0	10.9

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
330	1082.7	383.7	11.0
340	1115.5	383.7	11.0
350	1148.3	383.1	11.2
360	1181.1	382.7	11.3
370	1213.9	383.7	11.0
380	1246.7	384.0	10.9
390	1279.5	390.6	8.9
400	1312.3	391.6	8.6
410	1345.1	392.6	8.3
420	1377.9	393.2	8.1
430	1410.7	394.2	7.8
440	1443.6	395.5	7.4
450	1476.4	396.8	7.0
460	1509.2	398.1	6.6
470	1542.0	398.8	6.4
480	1574.8	399.5	6.2
490	1607.6	400.1	6.0
500	1640.4	401.4	5.6
510	1673.2	401.8	5.5
520	1706.0	402.1	5.4
530	1738.8	402.4	5.3
540	1771.6	402.7	5.2
550	1804.4	403.7	4.9
560	1837.2	404.1	4.8
570	1870.1	405.4	4.4
580	1902.9	406.7	4.0
590	1935.7	406.7	4.0
600	1968.5	406.7	4.0
610	2001.3	406.7	4.0
620	2034.1	407.0	3.9
630	2066.9	408.0	3.6
640	2099.7	408.3	3.5
650	2132.5	409.0	3.3



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #37 RM197.6 RDB

		NORTH	EAST	OPPOSITE
MSR37-1	MIDPOINT BANK PROFILE	4303486.0	229747.7	MSR37-2
MSR37-2	MIDPOINT PROFILE/OPPOSITE	4303528.0	230495.7	MSR37-1

Channel Profile Endpoints at Site #37

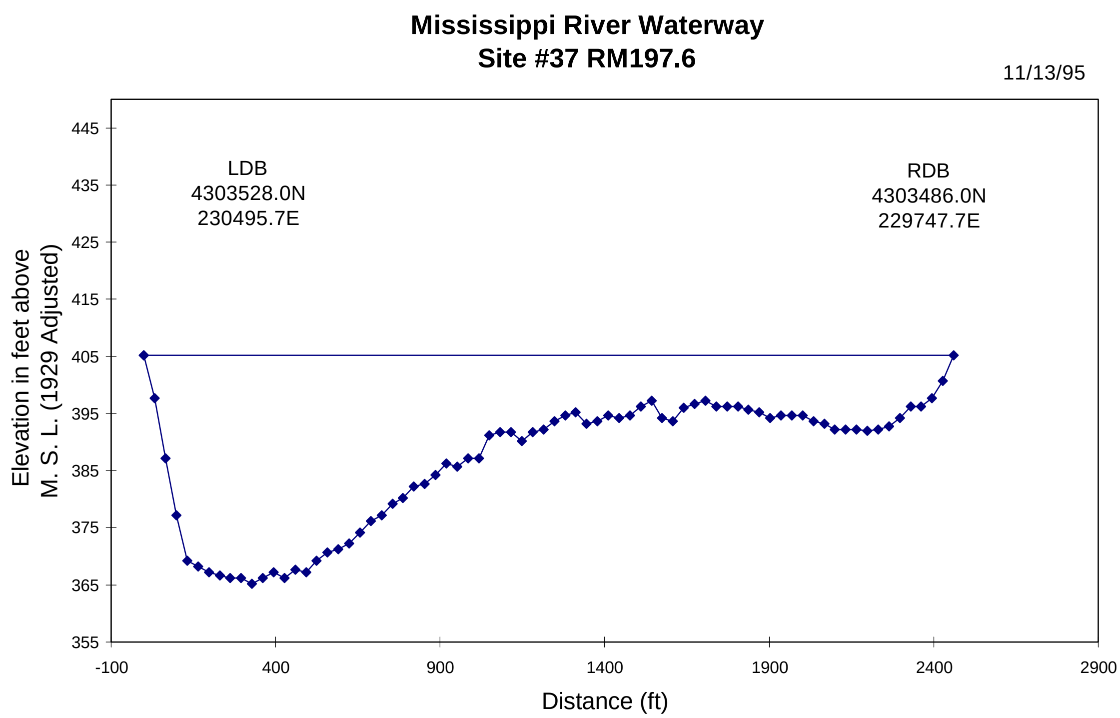
(A) MIDPOINT CHANNEL PROFILE (From: MSR37-2 To: MSR37-1)
Cross Section Length ~ 750m   (2460.6ft)

Midpoint Channel Profile RM197.6

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	405.2	0.0
10	32.8	397.7	2.3
20	65.6	387.2	5.5
30	98.4	377.2	8.5
40	131.2	369.2	11.0
50	164.0	368.2	11.3
60	196.8	367.2	11.6
70	229.7	366.7	11.7
80	262.5	366.2	11.9
90	295.3	366.2	11.9
100	328.1	365.2	12.2
110	360.9	366.2	11.9
120	393.7	367.2	11.6
130	426.5	366.2	11.9
140	459.3	367.7	11.4
150	492.1	367.2	11.6
160	524.9	369.2	11.0
170	557.7	370.7	10.5
180	590.5	371.2	10.4
190	623.4	372.2	10.1
200	656.2	374.2	9.4
210	689.0	376.2	8.8
220	721.8	377.2	8.5
230	754.6	379.2	7.9
240	787.4	380.2	7.6
250	820.2	382.2	7.0
260	853.0	382.7	6.9
270	885.8	384.2	6.4
280	918.6	386.2	5.8
290	951.4	385.7	5.9
300	984.2	387.2	5.5
310	1017.0	387.2	5.5
320	1049.9	391.2	4.3

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
330	1082.7	391.7	4.1
340	1115.5	391.7	4.1
350	1148.3	390.2	4.6
360	1181.1	391.7	4.1
370	1213.9	392.2	4.0
380	1246.7	393.7	3.5
390	1279.5	394.7	3.2
400	1312.3	395.2	3.0
410	1345.1	393.2	3.7
420	1377.9	393.7	3.5
430	1410.7	394.7	3.2
440	1443.6	394.2	3.4
450	1476.4	394.7	3.2
460	1509.2	396.2	2.7
470	1542.0	397.2	2.4
480	1574.8	394.2	3.4
490	1607.6	393.7	3.5
500	1640.4	396.0	2.8
510	1673.2	396.7	2.6
520	1706.0	397.2	2.4
530	1738.8	396.2	2.7
540	1771.6	396.2	2.7
550	1804.4	396.2	2.7
560	1837.2	395.7	2.9
570	1870.1	395.2	3.0
580	1902.9	394.2	3.4
590	1935.7	394.7	3.2
600	1968.5	394.7	3.2
610	2001.3	394.7	3.2
620	2034.1	393.7	3.5
630	2066.9	393.2	3.7
640	2099.7	392.2	4.0
650	2132.5	392.2	4.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #38 RM174.8 LDB

		NORTH	EAST	OPPOSITE
MSR38-1	UPSTREAM SITE LIMIT	4273978.0	219215.4	MSR38-4
MSR38-2	MIDPOINT BANK PROFILE	4273909.3	219145.3	N/A
MSR38-3	DOWNSTREAM SITE LIMIT	4273815.8	219049.3	N/A
MSR38-4	UPSTREAM LIMIT/OPPOSITE	4274414.6	218750.8	MSR38-1

Channel Profile Endpoints at Site #38

(A) UPSTREAM SITE CHANNEL PROFILE (From: MSR38-1 To: MSR38-4)
Cross Section Length ~ 737m* (637m + 100m) (2418.0ft)

* A barge was situated on the RDB so the profile of the last 100m to the bank was unattainable

Upstream Site Channel Profile RM174.8 **Continued**

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)	Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	392.2	0.0	280	918.6	369.2	7.0
10	32.8	382.4	3.0	290	951.4	370.2	6.7
20	65.6	376.8	4.7	300	984.2	368.6	7.2
30	98.4	375.8	5.0	310	1017.0	366.9	7.7
40	131.2	374.5	5.4	320	1049.9	367.3	7.6
50	164.0	375.1	5.2	330	1082.7	367.3	7.6
60	196.8	374.2	5.5	340	1115.5	368.9	7.1
70	229.7	375.8	5.0	350	1148.3	368.6	7.2
80	262.5	374.8	5.3	360	1181.1	367.6	7.5
90	295.3	375.8	5.0	370	1213.9	365.0	8.3
100	328.1	375.8	5.0	380	1246.7	367.3	7.6
110	360.9	375.8	5	390	1279.5	366.3	7.9
120	393.7	376.8	4.7	400	1312.3	368.9	7.1
130	426.5	378.1	4.3	410	1345.1	365.6	8.1
140	459.3	376.8	4.7	420	1377.9	364.3	8.5
145	475.7	380.7	3.5	430	1410.7	364.6	8.4
150	492.1	377.1	4.6	440	1443.6	367.6	7.5
160	524.9	371.5	6.3	450	1476.4	364.3	8.5
170	557.7	372.5	6.0	460	1509.2	363.0	8.9
180	590.5	372.8	5.9	470	1542.0	363.0	8.9
190	623.4	371.9	6.2	480	1574.8	364.6	8.4
200	656.2	371.2	6.4	490	1607.6	365.0	8.3
210	689.0	371.5	6.3	500	1640.4	366.0	8.0
220	721.8	370.9	6.5	510	1673.2	363.0	8.9
230	754.6	371.2	6.4	520	1706.0	363.7	8.7
240	787.4	370.2	6.7	530	1738.8	361.7	9.3
250	820.2	368.6	7.2	540	1771.6	361.0	9.5
260	853.0	368.9	7.1	550	1804.4	361.4	9.4
270	885.8	368.9	7.1	560	1837.2	359.4	10.0

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
570	1870.1	359.4	10.0
580	1902.9	360.0	9.8
590	1935.7	359.7	9.9
600	1968.5	357.8	10.5
610	2001.3	356.1	11.0
620	2034.1	354.8	11.4
630	2066.9	354.1	11.6
637	2089.9	350.9	12.6
737	2417.9	392.2	0.0

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
660	2165.3	392.2	4.0
670	2198.1	392.0	4.0
680	2230.9	392.2	4.0
690	2263.8	392.7	3.8
700	2296.6	394.2	3.4
710	2329.4	396.2	2.7
720	2362.2	396.2	2.7
730	2395.0	397.7	2.3
740	2427.8	400.7	1.4
750	2460.6	405.2	0.0

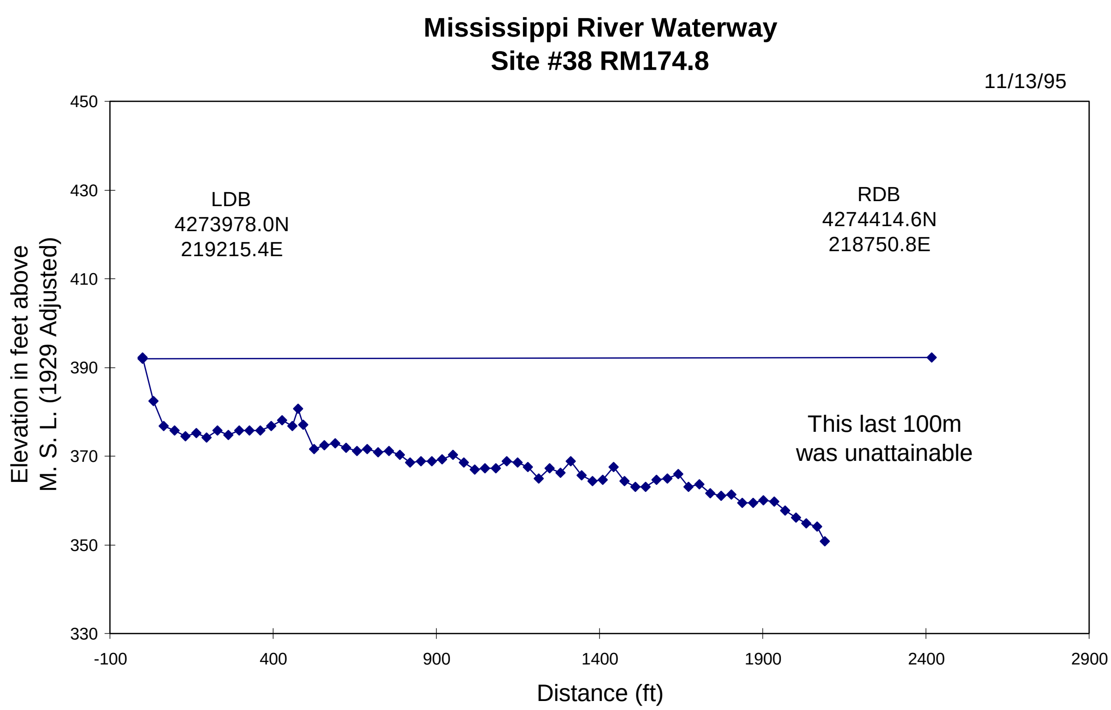
Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
660	2165.3	409.6	3.1
670	2198.1	409.3	3.2
680	2230.9	409.3	3.2
690	2263.8	410.0	3.0
700	2296.6	410.3	2.9
710	2329.4	410.9	2.7
720	2362.2	411.9	2.4
730	2395.0	411.9	2.4
740	2427.8	411.9	2.4
750	2460.6	412.3	2.3
760	2493.4	412.3	2.3
770	2526.2	411.9	2.4
780	2559.0	411.9	2.4
790	2591.8	412.3	2.3
800	2624.6	412.6	2.2
810	2657.4	413.6	1.9
820	2690.3	416.5	1.0
830	2723.1	419.8	0.0

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
616.0	2021.0	404.3	5.6
626.0	2053.8	404.3	5.6
636.0	2086.6	404.7	5.5
646.0	2119.4	404.3	5.6
656.0	2152.2	405.0	5.4
666.0	2185.0	405.0	5.4
676.0	2217.8	405.0	5.4
686.0	2250.6	405.3	5.3
696.0	2283.4	403.3	5.9
706.0	2316.2	404.3	5.6
716.0	2349.1	403.7	5.8
726.0	2381.9	404.7	5.5
736.0	2414.7	405.0	5.4
746.0	2447.5	402.0	6.3
756.0	2480.3	404.7	5.5
766.0	2513.1	404.7	5.5
776.0	2545.9	404.0	5.7
786.0	2578.7	406.3	5
796.0	2611.5	402.0	6.3
806.0	2644.3	403.0	6

816.0	2677.1	405.0	5.4
826.0	2709.9	405.0	5.4
836.0	2742.7	405.3	5.3
846.0	2775.6	405.3	5.3
856.0	2808.4	406.3	5
866.0	2841.2	405.3	5.3
876.0	2874.0	405.6	5.2
886.0	2906.8	406.0	5.1
896.0	2939.6	406.3	5
906.0	2972.4	406.3	5
916.0	3005.2	405.0	5.4
926.0	3038.0	405.3	5.3
936.0	3070.8	405.3	5.3
946.0	3103.6	409.6	4
956.0	3136.4	412.9	3
966.0	3169.3	414.2	2.6
976.0	3202.1	415.5	2.2
986.0	3234.9	415.8	2.1
996.0	3267.7	416.1	2
1006.0	3300.5	416.1	2
1016.0	3333.3	416.1	2
1026.0	3366.1	416.1	2
1036.0	3398.9	415.8	2.1
1046.0	3431.7	415.8	2.1
1056.0	3464.5	415.8	2.1
1066.0	3497.3	415.8	2.1
1076.0	3530.1	415.5	2.2
1086.0	3562.9	418.8	1.2
1096.0	3595.8	422.7	0



Upstream Limit Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #39 RM112.4 LDB

		NORTH	EAST	OPPOSITE
MSR39-1	MIDPOINT BANK PROFILE	4201278.3	247518.8	MSR39-2
MSR39-2	MIDPOINT PROFILE/OPPOSITE	4200472.8	247100.4	MSR39-1

Channel Profile Endpoints at Site #39

(A) MIDPOINT CHANNEL PROFILE (From: MSR39-1 To: MSR39-2)
Cross Section Length ~ 738m (2421.2ft)

Midpoint Channel Profile RM112.4

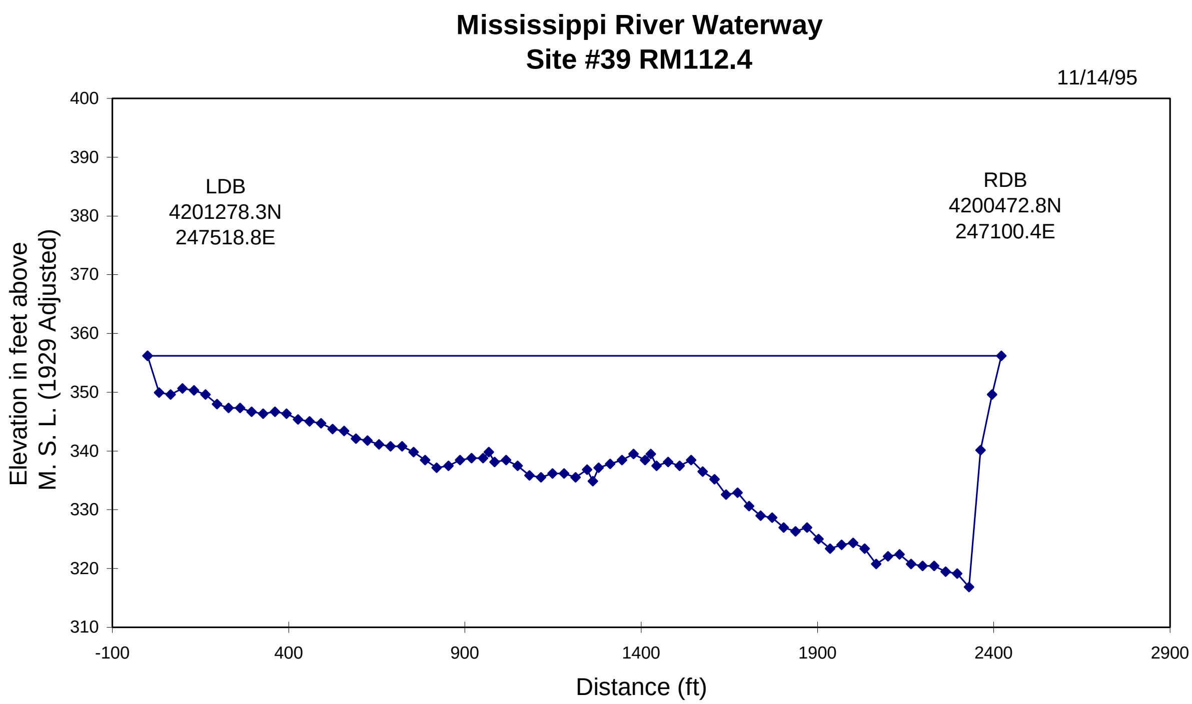
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	356.2	0.0
10	32.8	350.0	1.9
20	65.6	349.6	2.0
30	98.4	350.6	1.7
40	131.2	350.3	1.8
50	164.0	349.6	2.0
60	196.8	348.0	2.5
70	229.7	347.3	2.7
80	262.5	347.3	2.7
90	295.3	346.7	2.9
100	328.1	346.4	3.0
110	360.9	346.7	2.9
120	393.7	346.4	3.0
130	426.5	345.4	3.3
140	459.3	345.0	3.4
150	492.1	344.7	3.5
160	524.9	343.7	3.8
170	557.7	343.4	3.9
180	590.5	342.1	4.3
190	623.4	341.8	4.4
200	656.2	341.1	4.6
210	689.0	340.8	4.7
220	721.8	340.8	4.7
230	754.6	339.8	5.0
240	787.4	338.5	5.4
250	820.2	337.2	5.8
260	853.0	337.5	5.7
270	885.8	338.5	5.4
280	918.6	338.8	5.3
290	951.4	338.8	5.3
295	967.8	339.8	5
300	984.2	338.2	5.5
310	1017.0	338.5	5.4

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
320	1049.9	337.5	5.7
330	1082.7	335.9	6.2
340	1115.5	335.5	6.3
350	1148.3	336.2	6.1
360	1181.1	336.2	6.1
370	1213.9	335.5	6.3
380	1246.7	336.8	5.9
385	1263.1	334.9	6.5
390	1279.5	337.2	5.8
400	1312.3	337.8	5.6
410	1345.1	338.5	5.4
420	1377.9	339.5	5.1
430	1410.7	338.5	5.4
435	1427.1	339.5	5.1
440	1443.6	337.5	5.7
450	1476.4	338.2	5.5
460	1509.2	337.5	5.7
470	1542.0	338.5	5.4
480	1574.8	336.5	6.0
490	1607.6	335.2	6.4
500	1640.4	332.6	7.2
510	1673.2	332.9	7.1
520	1706.0	330.6	7.8
530	1738.8	329.0	8.3
540	1771.6	328.6	8.4
550	1804.4	327.0	8.9
560	1837.2	326.3	9.1
570	1870.1	327.0	8.9
580	1902.9	325.0	9.5
590	1935.7	323.4	10.0
600	1968.5	324.0	9.8
610	2001.3	324.4	9.7
620	2034.1	323.4	10.0

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
630	2066.9	320.8	10.8
640	2099.7	322.1	10.4
650	2132.5	322.4	10.3
660	2165.3	320.8	10.8
670	2198.1	320.4	10.9
680	2230.9	320.4	10.9
690	2263.8	319.5	11.2
700	2296.6	319.1	11.3
710	2329.4	316.8	12.0
720	2362.2	340.1	4.9
730	2395.0	349.6	2.0
738	2421.2	356.2	0.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #40 RM94.2 RDB

		NORTH	EAST	OPPOSITE
MSR40-1	MIDPOINT BANK PROFILE	4181768.2	264819.2	N/A
MSR40-2	DOWNSTREAM BANK PROFILE	4181673.9	264830.7	MSR40-3
MSR40-3	DOWNSTREAM PROFILE/OPPOSITE	4182056.2	265403.3	MSR40-2

Channel Profile Endpoints at Site #40

(A) DOWNSTREAM CHANNEL PROFILE (From: MSR40-3 To: MSR40-2)
Cross Section Length ~ 690m (2263.8ft)

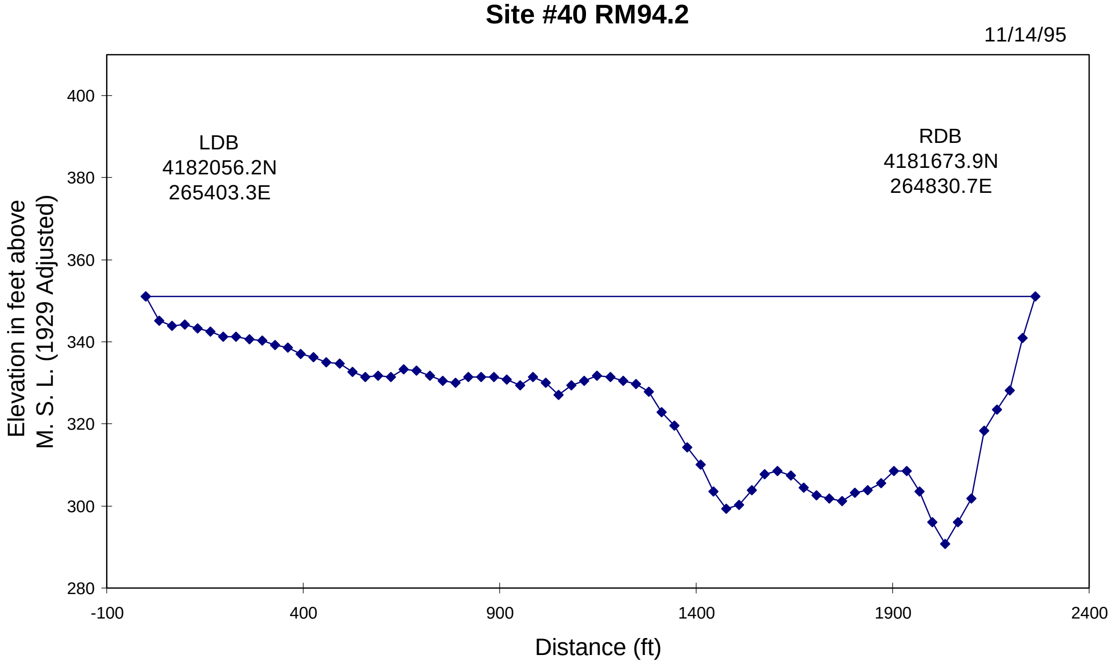
Downstream Channel Profile RM94.2 / **Continued**

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)	Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	351.1	0.0	320	1049.9	327.2	7.3
10	32.8	345.2	1.8	330	1082.7	329.4	6.6
20	65.6	343.9	2.2	340	1115.5	330.4	6.3
30	98.4	344.2	2.1	350	1148.3	331.7	5.9
40	131.2	343.2	2.4	360	1181.1	331.4	6.0
50	164.0	342.6	2.6	370	1213.9	330.4	6.3
60	196.8	341.3	3.0	380	1246.7	329.8	6.5
70	229.7	341.3	3.0	390	1279.5	327.8	7.1
80	262.5	340.6	3.2	400	1312.3	322.9	8.6
90	295.3	340.3	3.3	410	1345.1	319.6	9.6
100	328.1	339.3	3.6	420	1377.9	314.4	11.2
110	360.9	338.6	3.8	430	1410.7	310.1	12.5
120	393.7	337.0	4.3	440	1443.6	303.5	14.5
130	426.5	336.3	4.5	450	1476.4	299.3	15.8
140	459.3	335.0	4.9	460	1509.2	300.2	15.5
150	492.1	334.7	5.0	470	1542.0	303.9	14.4
160	524.9	332.7	5.6	480	1574.8	307.8	13.2
170	557.7	331.4	6.0	490	1607.6	308.4	13.0
180	590.5	331.7	5.9	500	1640.4	307.5	13.3
190	623.4	331.4	6.0	510	1673.2	304.5	14.2
200	656.2	333.4	5.4	520	1706.0	302.5	14.8
210	689.0	333.1	5.5	530	1738.8	301.9	15.0
220	721.8	331.7	5.9	540	1771.6	301.2	15.2
230	754.6	330.4	6.3	550	1804.4	303.2	14.6
240	787.4	330.1	6.4	560	1837.2	303.9	14.4
250	820.2	331.4	6.0	570	1870.1	305.5	13.9
260	853.0	331.4	6.0	580	1902.9	308.4	13.0
270	885.8	331.4	6.0	590	1935.7	308.4	13.0
280	918.6	330.8	6.2	600	1968.5	303.5	14.5
290	951.4	329.4	6.6	610	2001.3	296.0	16.8
300	984.2	331.4	6.0	620	2034.1	290.7	18.4
310	1017.0	330.1	6.4	630	2066.9	296.0	16.8

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
640	2099.7	301.9	15.0
650	2132.5	318.3	10.0
660	2165.3	323.5	8.4
670	2198.1	328.1	7.0
680	2230.9	340.9	3.1
690	2263.8	351.1	0.0

Mississippi River Waterway
Site #40 RM94.2



Downstream Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #41 RM77.2 RDB

		NORTH	EAST	OPPOSITE
MSR41-1	MIDPOINT BANK PROFILE	4163801.9	277330.8	MSR41-2
MSR41-2	MIDPOINT PROFILE/OPPOSITE	4163626.8	277943.8	MSR41-1

Channel Profile Endpoints at Site #41

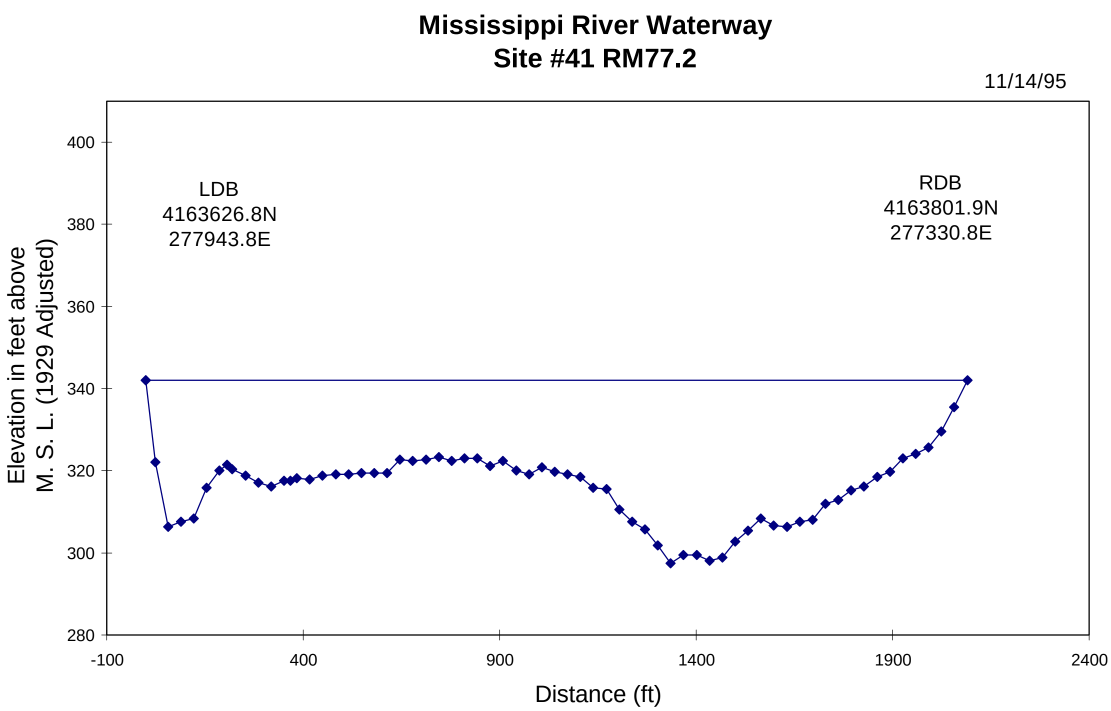
(A) MIDPOINT CHANNEL PROFILE (From: MSR41-2 To: MSR41-1)
Cross Section Length ~ 637m (2089.9ft)

Midpoint Channel Profile RM77.2

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	342.1	0.0
7	23.0	322.1	6.1
17	55.8	306.3	10.9
27	88.6	307.7	10.5
37	121.4	308.3	10.3
47	154.2	315.9	8.0
57	187.0	320.1	6.7
63	206.7	321.4	6.3
67	219.8	320.4	6.6
77	252.6	318.8	7.1
87	285.4	317.2	7.6
97	318.2	316.2	7.9
107	351.0	317.5	7.5
112	367.4	317.5	7.5
117	383.9	318.2	7.3
127	416.7	317.8	7.4
137	449.5	318.8	7.1
147	482.3	319.1	7.0
157	515.1	319.1	7.0
167	547.9	319.5	6.9
177	580.7	319.5	6.9
187	613.5	319.5	6.9
197	646.3	322.7	5.9
207	679.1	322.4	6.0
217	711.9	322.7	5.9
227	744.7	323.4	5.7
237	777.5	322.4	6.0
247	810.4	323.1	5.8
257	843.2	323.1	5.8
267	876.0	321.1	6.4
277	908.8	322.4	6.0
287	941.6	320.1	6.7
297	974.4	319.1	7

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
307	1007.2	320.8	6.5
317	1040.0	319.8	6.8
327	1072.8	319.1	7.0
337	1105.6	318.5	7.2
347	1138.4	315.9	8.0
357	1171.2	315.5	8.1
367	1204.1	310.6	9.6
377	1236.9	307.7	10.5
387	1269.7	305.7	11.1
397	1302.5	301.7	12.3
407	1335.3	297.5	13.6
417	1368.1	299.4	13.0
427	1400.9	299.4	13.0
437	1433.7	298.1	13.4
447	1466.5	298.8	13.2
457	1499.3	302.7	12
467	1532.1	305.4	11.2
477	1564.9	308.3	10.3
487	1597.7	306.7	10.8
497	1630.6	306.3	10.9
507	1663.4	307.7	10.5
517	1696.2	308.0	10.4
527	1729.0	311.9	9.2
537	1761.8	312.9	8.9
547	1794.6	315.2	8.2
557	1827.4	316.2	7.9
567	1860.2	318.5	7.2
577	1893.0	319.8	6.8
587	1925.8	323.1	5.8
597	1958.6	324.1	5.5
607	1991.4	325.7	5.0
617	2024.3	329.6	3.8
627	2057.1	335.5	2.0
637	2089.9	342.1	0.0



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #42 RM52.3 LDB

		NORTH	EAST	OPPOSITE
MSR42-1	MIDPOINT BANK PROFILE	4132843.2	278235.9	MSR42-2
MSR42-2	MIDPOINT PROFILE/OPPOSITE	4133241.7	277858.7	MSR42-1

Channel Profile Endpoints at Site #42

(A) MIDPOINT CHANNEL PROFILE (From: MSR42-1 To: MSR42-2)
Cross Section Length ~ 550m (1804.4ft)

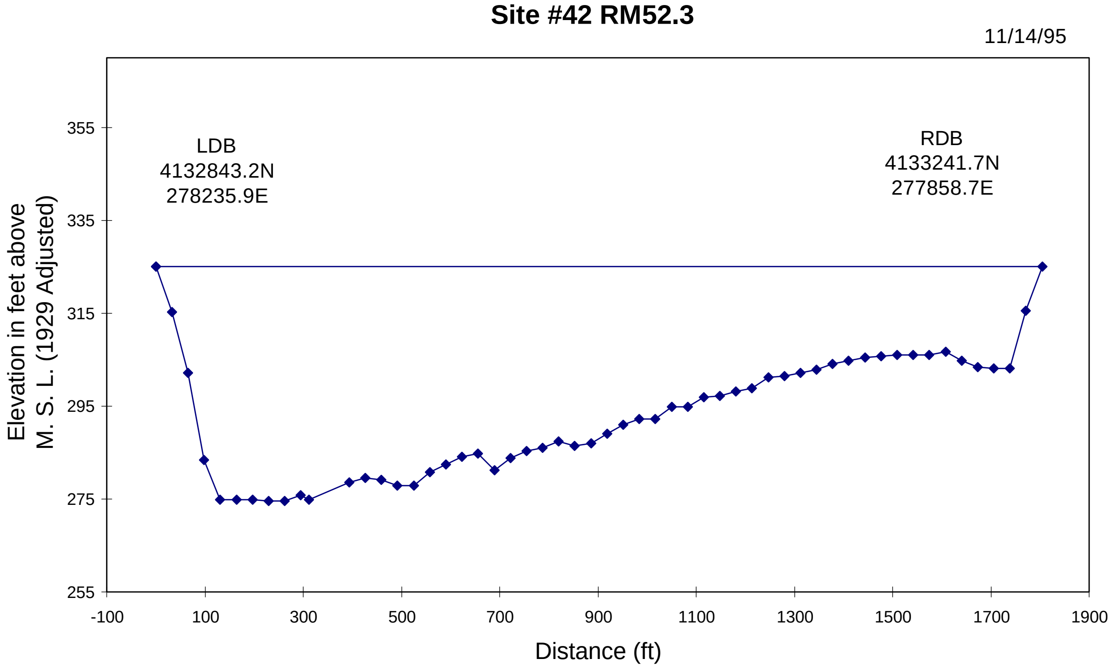
Midpoint Channel Profile RM77.2

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	325.1	0.0
10	32.8	315.3	3.0
20	65.6	302.1	7.0
30	98.4	283.4	12.7
40	131.2	274.9	15.3
50	164.0	274.9	15.3
60	196.8	274.9	15.3
70	229.7	274.6	15.4
80	262.5	274.6	15.4
90	295.3	275.9	15.0
95	311.7	274.9	15.3
120	393.7	278.5	14.2
130	426.5	279.5	13.9
140	459.3	279.2	14.0
150	492.1	277.9	14.4
160	524.9	277.9	14.4
170	557.7	280.8	13.5
180	590.5	282.4	13.0
190	623.4	284.1	12.5
200	656.2	284.7	12.3
210	689.0	281.1	13.4
220	721.8	283.8	12.6
230	754.6	285.4	12.1
240	787.4	286.1	11.9
250	820.2	287.4	11.5
260	853.0	286.4	11.8
270	885.8	287.0	11.6
280	918.6	289.0	11.0
290	951.4	291.0	10.4
300	984.2	292.3	10.0
310	1017.0	292.3	10.0
320	1049.9	294.9	9.2
330	1082.7	294.9	9.2

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
350	1148.3	297.2	8.5
360	1181.1	298.2	8.2
370	1213.9	298.9	8.0
380	1246.7	301.2	7.3
390	1279.5	301.5	7.2
400	1312.3	302.1	7.0
410	1345.1	302.8	6.8
420	1377.9	304.1	6.4
430	1410.7	304.8	6.2
440	1443.6	305.4	6.0
450	1476.4	305.7	5.9
460	1509.2	306.1	5.8
470	1542.0	306.1	5.8
480	1574.8	306.1	5.8
490	1607.6	306.7	5.6
500	1640.4	304.8	6.2
510	1673.2	303.4	6.6
520	1706.0	303.1	6.7
530	1738.8	303.1	6.7
540	1771.6	315.6	2.9
550	1804.4	325.1	0.0

Mississippi River Waterway
Site #42 RM52.3



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #43 RM45.2 LDB

		NORTH	EAST	OPPOSITE
MSR43-1	MIDPOINT BANK PROFILE	4124089.9	282134.9	MSR43-2
MSR43-2	MIDPOINT PROFILE/OPPOSITE	4124406.2	281682.5	MSR43-1

Channel Profile Endpoints at Site #43

(A) MIDPOINT CHANNEL PROFILE (From: MSR43-1 To: MSR43-2)
Cross Section Length ~ 552m (1811.0ft)

Midpoint Channel Profile RM45.2

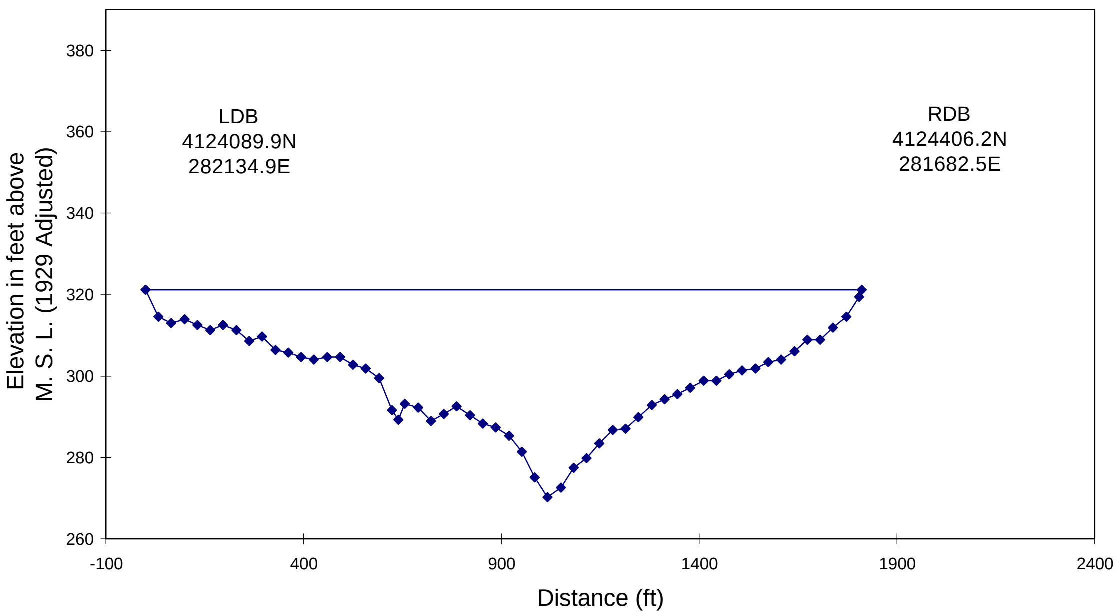
Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	321.1	0.0
10	32.8	314.5	2.0
20	65.6	312.9	2.5
30	98.4	313.9	2.2
40	131.2	312.6	2.6
50	164.0	311.3	3.0
60	196.8	312.6	2.6
70	229.7	311.3	3
80	262.5	308.6	3.8
90	295.3	309.6	3.5
100	328.1	306.3	4.5
110	360.9	305.7	4.7
120	393.7	304.7	5.0
130	426.5	304.0	5.2
140	459.3	304.7	5.0
150	492.1	304.7	5.0
160	524.9	302.7	5.6
170	557.7	301.7	5.9
180	590.5	299.4	6.6
190	623.4	291.6	9.0
195	639.8	289.3	9.7
200	656.2	293.2	8.5
210	689.0	292.2	8.8
220	721.8	288.9	9.8
230	754.6	290.6	9.3
240	787.4	292.6	8.7
250	820.2	290.3	9.4
260	853.0	288.3	10.0
270	885.8	287.3	10.3
280	918.6	285.3	10.9
290	951.4	281.4	12.1
300	984.2	275.2	14.0
310	1017.0	270.2	15.5

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
320	1049.9	272.5	14.8
330	1082.7	277.5	13.3
340	1115.5	279.8	12.6
350	1148.3	283.4	11.5
360	1181.1	286.7	10.5
370	1213.9	287.0	10.4
380	1246.7	289.9	9.5
390	1279.5	292.9	8.6
400	1312.3	294.2	8.2
410	1345.1	295.5	7.8
420	1377.9	297.2	7.3
430	1410.7	298.8	6.8
440	1443.6	298.8	6.8
450	1476.4	300.4	6.3
460	1509.2	301.4	6.0
470	1542.0	301.7	5.9
480	1574.8	303.4	5.4
490	1607.6	304.0	5.2
500	1640.4	306.0	4.6
510	1673.2	309.0	3.7
520	1706.0	309.0	3.7
530	1738.8	311.9	2.8
540	1771.6	314.5	2.0
550	1804.4	319.5	0.5
552	1811.0	321.1	0.0

Mississippi River Waterway
Site #43 RM45.2

11/14/95



Midpoint Channel Profile

Mississippi River Waterway - UTM Coordinates and Channel Profile Endpoints

Site #44 RM25.8 RDB

		NORTH	EAST	OPPOSITE
MSR44-1	MIDPOINT BANK PROFILE	4098657.5	293525.4	MSR44-2
MSR44-2	MIDPOINT PROFILE/OPPOSITE	4099114.3	293982.2	MSR44-1

Channel Profile Endpoints at Site #44

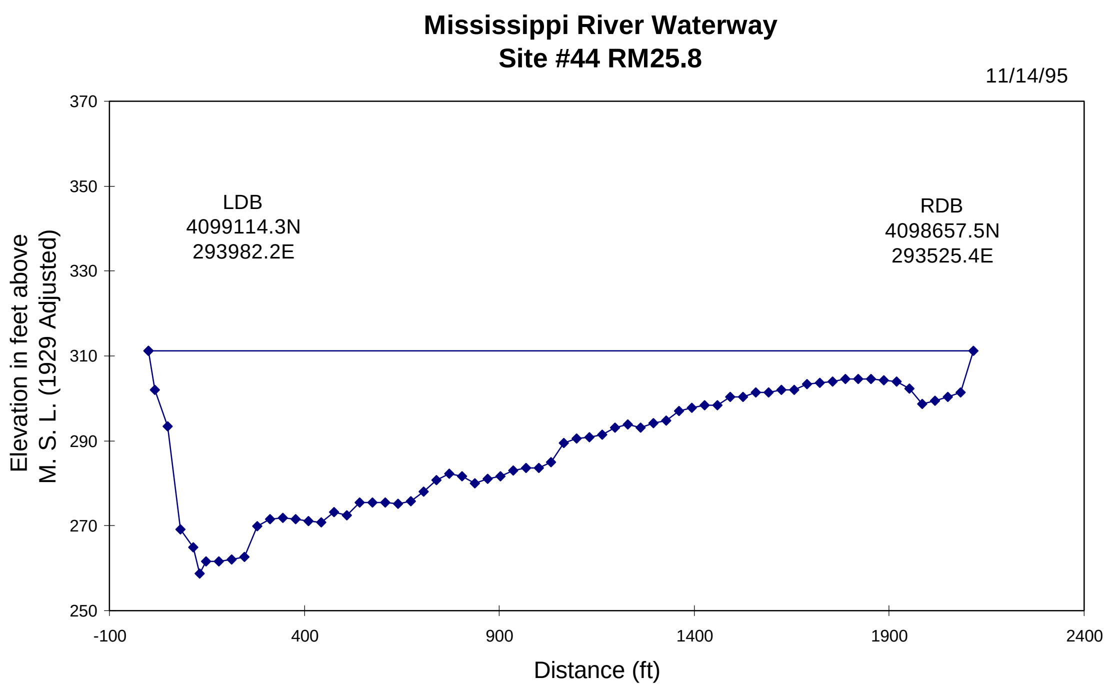
(A) MIDPOINT CHANNEL PROFILE (From: MSR44-2 To: MSR44-1)
Cross Section Length ~ 645m (2116.1ft)

Midpoint Channel Profile RM25.8

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
0	0.0	311.2	0.0
5	16.4	302.0	2.8
15	49.2	293.5	5.4
25	82.0	269.2	12.8
35	114.8	264.9	14.1
40	131.2	258.7	16
45	147.6	261.7	15.1
55	180.4	261.7	15.1
65	213.3	262.0	15
75	246.1	262.6	14.8
85	278.9	269.9	12.6
95	311.7	271.5	12.1
105	344.5	271.8	12.0
115	377.3	271.5	12.1
125	410.1	271.2	12.2
135	442.9	270.8	12.3
145	475.7	273.1	11.6
155	508.5	272.5	11.8
165	541.3	275.4	10.9
175	574.1	275.4	10.9
185	606.9	275.4	10.9
195	639.8	275.1	11.0
205	672.6	275.8	10.8
215	705.4	278.1	10.1
225	738.2	280.7	9.3
235	771.0	282.3	8.8
245	803.8	281.7	9.0
255	836.6	280.0	9.5
265	869.4	281.0	9.2
275	902.2	281.7	9.0
285	935.0	283.0	8.6
295	967.8	283.6	8.4
305	1000.6	283.6	8.4

Continued

Distance (m)	Distance (ft)	Depth Elevation	Depth (m)
315	1033.5	285.0	8
325	1066.3	289.5	6.6
335	1099.1	290.5	6.3
345	1131.9	290.9	6.2
355	1164.7	291.5	6.0
365	1197.5	293.2	5.5
375	1230.3	293.8	5.3
385	1263.1	293.2	5.5
395	1295.9	294.1	5.2
405	1328.7	294.8	5.0
415	1361.5	297.1	4.3
425	1394.3	297.7	4.1
435	1427.1	298.4	3.9
445	1460.0	298.4	3.9
455	1492.8	300.4	3.3
465	1525.6	300.4	3.3
475	1558.4	301.4	3
485	1591.2	301.4	3.0
495	1624.0	302.0	2.8
505	1656.8	302.0	2.8
515	1689.6	303.3	2.4
525	1722.4	303.7	2.3
535	1755.2	304.0	2.2
545	1788.0	304.6	2.0
555	1820.8	304.6	2.0
565	1853.7	304.6	2.0
575	1886.5	304.3	2.1
585	1919.3	304.0	2.2
595	1952.1	302.3	2.7
605	1984.9	298.7	3.8
615	2017.7	299.4	3.6
625	2050.5	300.4	3.3
635	2083.3	301.4	3.0
645	2116.1	311.2	0.0



Midpoint Channel Profile

Appendix H.

Mississippi River Geomorphology Report

MISSISSIPPI RIVER EROSION STUDY
SOIL PROFILE DESCRIPTIONS-SAMPLING TUBE CORES

SITE NAME: ST1 **RM825.5 Site 1** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Late Wisconsinan outwash terrace.
POSITION IN LANDSCAPE: Along shoulder slope of terrace 200' above water's edge.
PARENT MATERIALS: Mississippi River outwash.
WATER TABLE: Below bottom of core.
SURFACE ELEVATION: approx 850.0'
USGS 7.5 MIN.QUADRANGLE: Inver Grove Heights, MN.
SLOPE: 25-30%
VEGETATION: Mixed hardwood forest.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.0', 152cm.
PHOTOGRAPHED: Color slide of area.
DATE DESCRIBED: 9/11/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very steep sloped, very coarse grained late glacial outwash terrace, boulder lag armoring the channel margin. Unstable slope along outer meander bend.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-1.0 0-30	SP A	10YR 2/2-very dark brown; sandy loam; weak medium granular structure; friable; common fine roots; few granules (fine gravel); noncalcareous; clear boundary.
1.0-3.75 30-114	SP Bw	7.5YR 4/6-strong brown; sandy loam; weak medium subangular blocky structure; friable; common fine roots; few granules and small well rounded pebbles (fine gravel); noncalcareous; clear boundary.
3.75-5.0 114-152	SP C	10YR 6/4-light yellowish brown; sandy loam (fine medium sand); single grain; loose; few granules and small well rounded pebbles (fine gravel); noncalcareous.

SITE NAME: ST2T **RM805**
GEOMORPHIC SURFACE: Mississippi River late Holocene island
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below bottom of core.
SURFACE ELEVATION: approx 680.0'
USGS 7.5 MIN.QUADRANGLE: Diamond Bluff West, WI-MN.
SLOPE: 0%
VEGETATION: Silver maples
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 3.3', 100cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/11/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Brief stop at this location. A quick test core was advanced. Late Holocene deposit capped by about two feet of recent historical deposits.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.0 0-60	SM-ML C	10YR 4/4-3/3-dark yellowish brown to dark brown; loam (silt and sand); weak medium platy structure; friable; historical flood laminae of silt and sand; noncalcareous; abrupt boundary.
2.0-2.6 60-80	SM A	10YR 2/2-very dark brown; loam; moderate medium granular structure; friable; common fine roots; noncalcareous; clear boundary.
2.6-3.3 80-100	SP-SM Bw	10YR 4/4-dark yellowish brown; sandy loam; single grain; loose; noncalcareous.

SITE NAME: ST3T **RM801**
GEOMORPHIC SURFACE: Mississippi River late Holocene surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below bottom of core.
SURFACE ELEVATION: approx 680.0'
USGS 7.5 MIN.QUADRANGLE: Diamond Bluff West, WI-MN.
SLOPE: 0%
VEGETATION: Silver maples
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 1.3', 40cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/11/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Brief stop at this location. A quick test core was advanced. Recent historical alluvium recorded in this shallow core.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-1.3 0-40	SM-ML C	10YR 4/4-3/3-dark yellowish brown to dark brown; loam (silt and sand); weak medium platy structure; friable; historical flood laminae of silt and sand; noncalcareous.

SITE NAME: ST4a&b **RM791.7 Site 2** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Mississippi River very late Holocene surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 3.4', 103cm.
SURFACE ELEVATION: approx 675.0'
USGS 7.5 MIN.QUADRANGLE: Red Wing, WI-MN.
SLOPE: 0%
VEGETATION: Silver maples
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: B/W print and color slide of ST4.
DATE DESCRIBED: 9/11-12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Historical alluvium recorded in this core capping the surface. Very late Holocene deposits lie below. A weak thin buried AC horizon exists beginning at 37.0", 94cm. Below this unit is calcareous flood laminae containing partially decomposed gastropod shells. Outer meander bend.

DEPTH (FT)	**USCS SOIL CLASSIFICATION**	**SOIL/GEOLOGIC**

(CM)	USDA HORIZON DESIGNATION	DESCRIPTION
0-0.33 0-10	SP C	10YR 4/4-dark yellowish brown; medium sand; single grain; loose; historical sand deposit; noncalcareous; abrupt boundary.
0.33-2.0 10-60	SP Bw	7.5YR 4/4-brown; loamy sand (medium sand with minor silt); weak medium subangular blocky structure; friable to loose; weak B horizon; noncalcareous; gradual boundary.
2.0-3.1 60-94	SP C	10YR 4/4-dark yellowish brown; fine medium sand; single grain; loose; noncalcareous. abrupt boundary.
3.1-3.2 94-97.5	SP-SM ACb	N2/0-3/0-black to very dark gray; sandy loam; massive to single grain; friable to loose; charcoal flecks and black organic material; noncalcareous; abrupt boundary.
3.2-3.4 97.5-104	SP Cb	7.5YR 4/4-brown; medium sand; single grain; nonsticky; saturated; common coarse prominent mottles; noncalcareous; abrupt boundary.
3.4-3.6 104-109	SP C2b	10YR 4/2-dark grayish brown; medium sand; single grain; nonsticky; saturated; mottles along sand bedding planes; shell fragments; calcareous; abrupt boundary.
3.6-5.8 109-177	SM Cg3b	10YR 4/1-3/1-dark gray to very dark gray; silt loam to loam (silty fine sand); massive; sticky; common medium distinct mottles; common to many fine roots; charcoal unit from 4.1' to 4.3', 126cm-130cm; gleyed; calcareous; abrupt boundary.
5.8-10.2 177-310	ML Cg4b	N3/0-very dark gray; silt loam (silt); massive; sticky; common fine roots; laminae of silt and very fine sand, less than 0.1' (few mm's) thick; shell fragments; gleyed; some units calcareous, others noncalcareous.

SITE NAME: ST5T **RM791.7 Site 2**
GEOMORPHIC SURFACE: Mississippi River very late Holocene surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 1.9', 58cm.
SURFACE ELEVATION: approx 675.0'
USGS 7.5 MIN.QUADRANGLE: Red Wing, WI-MN.
SLOPE: 0%
VEGETATION: Silver maples
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.0', 152cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Recent flood deposit caps the top 0.4', 13cm. A very weak soil in apparent very late Holocene to early historic deposit lies below. Weak organic enrichment occurs from 0.8' to 1.0', 25cm-30cm. Calcareous flood laminae containing partially decomposed gastropod shells. Adjacent particle size sample #2.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.4 0-13	SP C	10YR 6/4-light yellowish brown; medium sand; single grain; loose; recent historical sand deposit; erosion surface at the contact with the lower horizon; noncalcareous; abrupt boundary.
0.4-0.6 13-18	SP C2	10YR 6/4-light yellowish brown; medium sand; single grain; loose; common medium distinct mottles along bedding planes; mottles highly oxidized and concretionary; noncalcareous; abrupt boundary.
0.6-0.8 18-25	SP C3	10YR 4/1-dark gray; fine medium sand; single grain; loose; thin bedded sand laminae; many medium distinct mottles along bedding planes; some silty sand laminae; noncalcareous. abrupt boundary.
0.8-1.0 25-30	SM ACb	10YR2/1-black; loam (silty sand); moderate medium subangular blocky; friable; charcoal flecks and black organic material; many fine roots and root holes; noncalcareous; abrupt boundary.
1.0-5.0 30-152	ML Cgb	10YR 3/1-very dark gray; silt loam (silty very fine sand); massive; sticky to nonsticky; saturated; common medium distinct mottles; common fine roots; becoming gleyed 10YR4/1 massive silt with common shell fragments; calcareous.

SITE NAME: ST6a&b **RM763.4 Site 3** Left descending bank, midpoint.

GEOMORPHIC SURFACE: Chippewa River tributary fan capped by historical alluvium and spoil.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mixed dredge spoil and historical alluvium.
WATER TABLE: 1.7', 52cm.
SURFACE ELEVATION: approx 675.0'
USGS 7.5 MIN.QUADRANGLE: Wabasha North, MN-WI.
SLOPE: 0%
VEGETATION: Silver maples
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 4.5', 138cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Sandy dredge spoil caps recent historical flood laminae. The native pre-settlement soil was not encountered. Just below the Chippewa River confluence.

DEPTH **(FT)** **(CM)**	**USCS SOIL CLASSIFICATION** **USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.9 0-27	SP C	10YR 7/3-very pale brown; medium coarse sand with few granules (sand with fine gravel); single grain; loose; dredge spoil; noncalcareous; abrupt boundary.
0.9-1.2 27-35.5	SM 2C	10YR 5/4-yellowish brown; loam (silty fine sand); massive; slightly sticky; common medium distinct mottles; historical alluvium; saturated; noncalcareous; abrupt boundary.
1.2-2.7 35.5-81	SP 2C2	10YR 5/4-yellowish brown; medium sand; single grain; nonsticky; historical alluvium; saturated; noncalcareous; abrupt boundary.
2.7-3.0 81-91	SM 2Cg3	N4/0-dark gray; loam (silty sand); massive; sticky; common fine roots and organic material; thick bedded flood lamina 0.5" 1.0cm thick; noncalcareous; abrupt boundary.
3.0-4.5 91-138	SP 2Cg4	medium coarse sand; saturated; no recovery

SITE NAME: ST7 **RM763.4 Site 3** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Chippewa River tributary fan capped by historical alluvium and spoil.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mixed dredge spoil and historical alluvium.
WATER TABLE: 1.9', 58cm.
SURFACE ELEVATION: approx 675.0'
USGS 7.5 MIN.QUADRANGLE: Wabasha North, MN-WI.
SLOPE: 0%
VEGETATION: Silver maples
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 3.6', 110cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Sandy dredge spoil caps recent historical flood laminae. The native pre-settlement soil was not encountered. ST7 is about 4.5' upslope from ST6a&b.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.2 0-6	SP C	10YR 7/3-very pale brown; medium sand; single grain; loose; dredge spoil; noncalcareous; abrupt boundary.
0.2-0.4 6-11	SM C2	10YR 4/4-dark yellowish brown; loam (silty sand); massive; friable; dredge spoil; noncalcareous; abrupt boundary.
0.4-0.9 11-28	SP C3	10YR 7/3-very pale brown; medium sand; single grain; loose; dredge spoil; noncalcareous; abrupt boundary.
0.9-1.2 28-35	SM-ML 2Cg	10YR4/1-dark gray; loam (sandy silt); massive; friable; historical flood laminae; common medium distinct mottles along bedding planes; common fine roots; noncalcareous; abrupt boundary.
1.2-2.3 35-70	SP 2C2	10YR 4/4-dark yellowish brown; coarse sand; nonsticky; few granules (fine gravel); few coarse prominent mottles; saturated; noncalcareous; abrupt boundary.
2.3-3.3 70-100	SM-ML 2C3	N3/0-very dark gray; loam (sandy silt); massive; sticky; organic material interbedded with flood alluvium; noncalcareous; abrupt boundary.
3.3-3.6 100-110	SP 2C4	10YR 7/2-light gray; coarse sand; single grain; nonsticky; noncalcareous.

SITE NAME: ST8a&b **RM751.1 Site 4** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Mid to late Holocene Mississippi River levee.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium and Holocene alluvium.
WATER TABLE: 5.3', 163cm.
SURFACE ELEVATION: approx 665.0'
USGS 7.5 MIN.QUADRANGLE: Alma, WI-MN.
SLOPE: 0%
VEGETATION: Mixed hardwoods and silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 6.7', 203cm.
PHOTOGRAPHED: Color slides, B/W prints of core and location. Power plant in background.
DATE DESCRIBED: 9/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Historical flood deposits caps the surface to about 0.7', 22cm. At least six paleosols were recognized below ranging in age from very late Holocene-early historic to mid-late Holocene. Two miles downstream from L&D 4. Archaeological site is nearby, and high buried archaeological potential in this levee deposit. Upstream power plant has sheet piling.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.7 0-22	SP C	10YR 5/3-yellowish brown; fine sand; single grain; loose; common fine roots; historical alluvium; pH 6.0; noncalcareous; abrupt boundary.
0.7-1.0 22-29	ML A	10YR 3/1-very dark gray; silt loam (silt); moderate medium granular structure; friable; common fine roots; pH 6.5; noncalcareous; abrupt boundary.
1.0-2.0 29-58	SP BC	10YR 6/4-light yellowish brown; fine sand; single grain; loose; common medium distinct mottles; few organic inclusions from above horizon; noncalcareous; abrupt boundary.
2.0-2.3 58-69	SM-ML Ab	10YR2/2-very dark brown; loam (fine sandy silt); weak medium subangular blocky structure; friable; common fine roots; noncalcareous; clear boundary.
2.3-3.0 69-91	SP BCb	10YR 6/4-light yellowish brown; fine medium sand; single grain; loose; common medium distinct mottles; few organic inclusions from above horizon; noncalcareous; abrupt boundary.
3.0-3.4 91-103	SM-ML Ab2	10YR2/2-very dark brown; loam (fine sandy silt); moderate medium subangular blocky structure; friable; common fine roots and root holes; few medium faint mottles; noncalcareous; clear boundary.

3.4-3.8 103-115	SP BCb2	10YR 6/4-light yellowish brown; fine medium sand; single grain; loose; common medium distinct mottles; few organic inclusions from above horizon (krotovina); noncalcareous; clear boundary.
3.8-4.1 115-125	SM ACb3	10YR 3/3-dark brown; loam to sandy loam (silty sand); weak medium subangular blocky structure; friable; noncalcareous; abrupt boundary.
4.1-5.6 125-170	SP Cb3	10YR 4/4-dark yellowish brown; medium sand; single grain; loose; common medium to coarse prominent mottles; few weak organic enriched units less than 0.1' thick; noncalcareous; clear boundary.
5.6-5.8 170-175	SM Ab4	10YR 3/3-2/2-dark brown to very dark brown; loam to sandy loam (silty fine medium sand); massive; sticky; saturated; noncalcareous; abrupt boundary.
5.8-6.3 175-191	SP BCb4	10YR 3/3-4/4-dark brown to dark yellowish brown; medium sand; single grain; nonsticky; saturated; noncalcareous; abrupt boundary.
6.3-6.5 191-198	ML Ab5	10YR3/1-2/2-very dark gray to very dark brown; silt loam (silt); moderate medium subangular blocky breaking to moderate medium granular structure; sticky; saturated; noncalcareous; abrupt boundary.
6.5-6.7 198-203	SM Cgb5	10YR 4/1-dark gray; loam to sandy loam (silty sand); massive; slightly sticky; saturated; common medium distinct mottles; noncalcareous.

SITE NAME: ST9 **RM746.4 Site 5** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Old dredge spoil site, over an apparent late Holocene surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Dredge spoil.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 665.0'
USGS 7.5 MIN.QUADRANGLE: Weaver, MN-WI.
SLOPE: 0%
VEGETATION: Silver maples, poison ivy.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.0', 60cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Old dredge spoil site, hole cave-in occurred at 2.0'. Large dredge spoil storage area.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.0 0-60	SP C	10YR 7/3-very pale brown; medium coarse sand; single grain; loose; dredge spoil; few granules (fine gravel); noncalcareous.

SITE NAME: ST10 **RM746.4 Site 5** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Old dredge spoil site, apparently over a late Holocene surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Dredge spoil and historical alluvium.
WATER TABLE: At or near the surface.
SURFACE ELEVATION: approx. 665.0'.
USGS 7.5 MIN.QUADRANGLE: Weaver, MN-WI.
SLOPE: 0%
VEGETATION: Silver maples, poison ivy.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.0', 152cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Old dredge spoil site, on beach next to middle stake. Large dredge storage area.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.3 0-10	SP C	10YR 7/3-very pale brown; medium coarse sand with few granules (sand with fine gravel); single grain; nonsticky; dredge spoil; saturated; noncalcareous; abrupt boundary.
0.3-4.4 10-135	SM 2Cg	N4/0-dark gray; loam (silty medium fine sand); massive; slightly sticky; historical alluvium; saturated; gleyed; noncalcareous; abrupt boundary.
4.4-5.0 135-152	ML-CL 2ACgb	N3/0-very dark gray; silty clay loam (clayey silt); massive; sticky; very late Holocene to historic alluvium; saturated; gleyed; noncalcareous.

SITE NAME: ST11 **RM727.4 Site 6** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Mid to late Holocene Mississippi River levee.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River Holocene alluvium.
WATER TABLE: 5.3', 160cm.
SURFACE ELEVATION: approx. 650.0'
USGS 7.5 MIN.QUADRANGLE: Winona West, MN. Quadrangle not stocked.
SLOPE: 0%
VEGETATION: Ash and silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.0', 213cm.
PHOTOGRAPHED: Color slides of site activity.
DATE DESCRIBED: 9/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Lateral bank erosion with minor surface erosion. About 1 mile downstream of L&D 5A. High buried archaeological potential in this levee deposit. Description is complimented with a bank profile exposure.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.3 0-10	SM A	10YR 2/2-very dark brown; loam (silty sand to sandy silt); moderate medium granular structure; friable; many fine roots and root holes; noncalcareous; abrupt boundary.
0.3-1.8 10-53	SP C	10YR 7/3-very pale brown; coarse sand; single grain; loose; laminae of cross-bedded coarse sand, medium sand and some very coarse sand with granules (fine gravel); few fine faint mottles along bedding planes; pH 6.0; noncalcareous; abrupt boundary.
1.8-2.3 53-69	SM Ab	10YR 2/2-very dark brown; loam (silty sand to sandy silt); moderate medium subangular blocky breaking to moderate medium granular structure; friable; many fine and coarse roots and root holes; few fine faint mottles; pH 6.5; noncalcareous; abrupt boundary.
2.3-2.8 69-86	SP-SM Bwb	7.5YR 5/4-brown; sandy loam (fine medium sand with minor silt); weak medium subangular blocky structure; very friable; common fine root holes; noncalcareous; abrupt boundary.
2.8-3.3 86-100	SM ACb2	10YR 2/3-very dark brown; loam (silty sand); moderate medium subangular blocky structure; friable; many fine roots; common medium distinct mottles; medium sand inclusions in horizon; noncalcareous; abrupt boundary.
3.3-4.2	ML	10YR 2/2-very dark brown; silt loam (silt); moderate

100-127	Ab3	medium subangular blocky structure; friable; many fine root holes common fine roots and worm casts; thick buried A horizon excellent for RC date; few fine faint mottles; noncalcareous; gradual boundary.
4.2-7.0 127-213	ML BCgb3	10YR 4/2-dark grayish brown; silt loam to loam (silt to sandy silt); weak medium subangular blocky structure to massive; sticky; many medium distinct mottles; gleyed; noncalcareous.

SITE NAME: ST12 **RM727.4 Site 7** Left descending bank, midpoint (opposite bank).
GEOMORPHIC SURFACE: Probable very late Holocene Mississippi River surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River Holocene alluvium.
WATER TABLE: Within 1.0' of the surface.
SURFACE ELEVATION: approx. 650.0'
USGS 7.5 MIN.QUADRANGLE: Winona West, MN.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.1', 64cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Core advanced on beach near water's edge. Deposits are all relatively recent. Undetermined if older Holocene surfaces lie east away from the bank under the spoil material. Probable very late Holocene surface below 1.5'.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.8 0-24	SP C	10YR 7/3-very pale brown; medium sand; single grain; loose; dredge spoil; noncalcareous; abrupt boundary.
0.8-1.5 24-46	ML Cg	5Y 4/1-dark gray; silt loam (silt); massive; slightly sticky; common to many fine and medium roots; common medium distinct mottles; gleyed; noncalcareous; gradual boundary.
1.5-1.8 46-56	ML-CL ACgb	N2/0-3/0-black to very dark gray; silty clay loam (clayey silt); massive; sticky; many fine roots; organic enriched clayey silt; gleyed; noncalcareous; abrupt boundary.
1.8-2.1 56-64	SP Cb	7.5YR 3/6-strong dark brown; coarse sand; single grain; nonsticky; highly oxidized, common coarse prominent mottles; noncalcareous.

SITE NAME: ST13 **RM677.7 Site 8** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Mid to late Holocene Mississippi River levee.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River Holocene alluvium.
WATER TABLE: 5.9', 180cm.
SURFACE ELEVATION: approx. 625.0'
USGS 7.5 MIN.QUADRANGLE: Genoa, WI-MN-IA.
SLOPE: 0%
VEGETATION: Red maple and silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 9.2', 280cm.
PHOTOGRAPHED: Color slides, and B/W prints.
DATE DESCRIBED: 9/14/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Historical alluvium caps the surface, below lies late Holocene levee deposits with two buried soils. Site is about 1.5 miles downstream of L&D 8. Power plant is just upstream. PSA/PSS contact seen in photos.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.3 0-132	SM-ML C	10YR 2/2-3/3-6/3-very dark brown, dark brown and pale brown; loam, silt loam and sandy loam (silty sand, and silt); weak medium subangular blocky breaking to moderate medium granular, and weak medium platy structure; friable; few fine roots and root holes; few fine faint mottles; historical flood laminae; some units noncalcareous other calcareous; abrupt boundary.
4.3-4.8 132-147	ML Ab	10YR 2/2-3/1very dark brown to very dark gray; silt loam (silt); moderate medium subangular blocky structure breaking to moderate medium granular; friable; many fine root holes common fine roots; common medium distinct mottles; noncalcareous; clear boundary.
4.8-5.2 147-157	ML BCb	10YR 3/2-very dark grayish brown; silt loam (silt); weak to moderate medium subangular blocky structure; friable; many fine root holes; common medium distinct mottles;; noncalcareous; clear boundary.
5.2-6.0 157-183	ML Cb	10YR 3/2-4/2-very dark grayish brown to dark grayish brown; silt loam (silt); massive; sticky; few fine root holes; common medium distinct mottles;; noncalcareous; abrupt boundary.
6.0-6.2 183-189	ML Ab2	10YR 2/2-2/3-very dark brown; silt loam (silt); moderate medium subangular blocky breaking to

		moderate medium granular structure; friable; many fine roots and root holes; common medium distinct mottles; noncalcareous; abrupt boundary.
6.2-6.6 189-201	ML Bwb2	10YR 3/2-very dark grayish brown; silt loam (silt); moderate medium subangular blocky structure; friable; many fine root holes; common medium distinct mottles; noncalcareous; abrupt boundary.
6.6-9.2 201-280	SM-SP Cb2	10YR 4/2-dark grayish brown; silt loam to sandy loam (silt to silty sand); massive to single grain; sticky to nonsticky; coarsening with depth becoming saturated medium sand by 7.9', 240cm; common medium distinct mottles; noncalcareous.

SITE NAME: ST14 **RM677.5 Site 9** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Probable late to very Holocene Mississippi River surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Dredge spoil and Mississippi River Holocene alluvium.
WATER TABLE: At or near the surface.
SURFACE ELEVATION: approx. 625.0'
USGS 7.5 MIN.QUADRANGLE: Genoa, WI-MN-IA.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.5', 76cm.
PHOTOGRAPHED: Color slides, and B/W prints.
DATE DESCRIBED: 9/14/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Profile near water's edge on beach terrace, sediment is reworked. Spoil caps the surface of this young Holocene surface. Site is opposite side (east) of Site 8. Photos show historical/native (PSA/PSS) soil contact at Site 8. Site is about 1.5 miles downstream of L&D 8. Power plant is just upstream. ST14, 15, and 16 taken at the same site.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.8 0-25	SP C	10YR 7/3-very pale brown; medium coarse sand; single grained; nonsticky; few granules (fine gravel) spoil material; noncalcareous; abrupt boundary.
0.8-1.2 25-36	SP-SM C2	10YR 7/3-very pale brown; loamy sand (medium coarse sand with minor silt); single grain; nonsticky; laminae of coarse sand, silty coarse sand, and silty sand; laminae 0.25"-0.5" (0.5-1.0cm) thick; few granules (fine gravel) reworked spoil material; noncalcareous; abrupt boundary.
1.2-2.5 36-76	SP C3	10YR 7/3-very pale brown; coarse sand; single grain; nonsticky; few granules (fine gravel) reworked clean sand spoil material; noncalcareous.

SITE NAME: ST15 **RM677.5 Site 9** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Probable late to very Holocene Mississippi River surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Dredge spoil and Mississippi River Holocene alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 625.0'
USGS 7.5 MIN.QUADRANGLE: Genoa, WI-MN-IA.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 1.5', 46cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/14/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Profile further away (east) from ST14 and channel margin. Site is about 1.5 miles downstream of L&D 8. Power plant is just upstream.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.25 0-8	SP-SM AC	10YR 3/3-dark brown; loamy sand (sand with minor silt); weak medium granular structure; friable; weak AC horizon developed in spoil material; noncalcareous; abrupt boundary.
0.25-1.5 8-46	SP C	10YR 7/3-very pale brown; fine medium sand; single grain; end with hole cave-in; loose; noncalcareous.

SITE NAME: ST16 **RM677.5 Site 9** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Probable late to very Holocene Mississippi River surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Dredge spoil and historical Mississippi River alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 625.0'
USGS 7.5 MIN.QUADRANGLE: Genoa, WI-MN-IA.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.0', 60cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/14/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Profile further away (east) from ST14,ST15 and channel margin. Site is about 1.5 miles downstream of L&D 8. Power plant is just upstream. The surface is capped by post-spoil deposition historical alluvium. That is, historical alluvium has accumulated after the dredge material was deposited.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-1.33 0-41	ML C	10YR 3/3-dark brown; silt loam (silt); weak medium granular structure; very friable; many fine roots and root holes; silt highly enriched with partially decomposed organic material (silver maple leaves); noncalcareous; abrupt boundary.
0.25-1.5 8-46	SP C	10YR 7/3-very pale brown; medium sand; single grain; loose; spoil material; noncalcareous.

SITE NAME: ST17 **RM669.5 Site 10** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene Mississippi River to historic surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Dredge spoil and historical Mississippi River alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 620.0'
USGS 7.5 MIN.QUADRANGLE: DeSoto, WI-IA.
SLOPE: 0%
VEGETATION: Silver maples, grass, wild grape, and ash.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 4.0', 122cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Soil pit to 1.6' (48cm), then sampling tube core. About the upper 2.0 feet is composed of interbedded dredge spoil and historical alluvium. Below is historical alluvium to 4.0 feet (122cm). Sampling tubes 17, 18, 19 and 20 were advanced at this site.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.25 0-8	SP-SM AC	10YR 3/3-dark brown; loamy sand (sand with minor silt); weak medium granular structure; friable; historical alluvium; many fine roots and root holes; calcareous; abrupt boundary.
0.25-1.6 8-48	SP C	10YR 6/4-light yellowish brown; medium sand; single grain; loose; spoil; noncalcareous; abrupt boundary.
1.6-1.8 48-53	ML C2	10YR 2/2-very dark brown; silt loam (silt); massive; friable; historical alluvium; calcareous; abrupt boundary.
1.8-1.9 53-58	SP C3	10YR 8/2-white; medium sand; single grain; loose; spoil; calcareous; abrupt boundary.
1.9-3.3 58-102	ML C4	10YR 3/2-very dark grayish brown; silt loam (silt); massive; friable; historical alluvium; few fine faint mottles; calcareous; abrupt boundary.
3.3-4.0 102-122	SM C5	10YR 3/2-very dark grayish brown; loam (silty sand) massive; friable; historical alluvium; common medium distinct mottles; weakly calcareous.

SITE NAME: ST18 **RM669.5 Site 10** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene Mississippi River to historic surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Reworked dredge spoil and historical Mississippi River alluvium.
WATER TABLE: 0.8', 24cm.
SURFACE ELEVATION: approx. 620.0'
USGS 7.5 MIN.QUADRANGLE: DeSoto, WI-IA.
SLOPE: 0%
VEGETATION: Silver maples, grass, wild grape, and ash.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.8', 178cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Located on the beach downslope from ST17, about 1.0' from the stake. Reworked dredge spoil is on the surface and below lie a fine grained poorly drained deposit. Sampling tubes 17, 18, 19 and 20 were advanced at this site.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.33 0-10	SP C	10YR 7/3-very pale brown; medium sand; single grain; loose; reworked spoil; noncalcareous; abrupt boundary.
0.33-2.5 10-76	ML 2Cg	10YR 3/1-4/1-very dark gray to dark gray; silt loam (silt); massive; sticky; flood laminae 1/8 to 1/4 inch (0.3cm-0.6cm) thick; saturated; gleyed; common medium distinct mottles; noncalcareous; abrupt boundary.
2.5-2.7 76-81	ML 2ACgb	N3/0-very dark gray; silt loam (silt); moderate medium subangular blocky; sticky; organic enriched; native wetland soil horizon; many medium distinct mottles; saturated; gleyed; noncalcareous; abrupt boundary.
2.7-5.8 81-178	ML 2Cg2b	N3/0-4/0-very dark gray to dark gray; silt loam (silt); weak medium subangular blocky structure to massive; sticky; many medium distinct mottles; saturated; gleyed; noncalcareous.

SITE NAME: ST19a&b **RM669.5 Site 10** Right descending bank, north 1/4 point.
GEOMORPHIC SURFACE: Very late Holocene Mississippi River to historic surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical, and very late Holocene Mississippi River alluvium.
WATER TABLE: 5.5', 167cm.
SURFACE ELEVATION: approx. 620.0'
USGS 7.5 MIN.QUADRANGLE: DeSoto, WI-IA.
SLOPE: 0%
VEGETATION: Silver maples, grass, wild grape, and ash.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.8', 178cm.
PHOTOGRAPHED: Color slide of ST19 and "Monitor".
DATE DESCRIBED: 9/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Located upstream from the midpoint of site 10. Two cores (a&b) were advanced at this location. Historical alluvium caps a fine grained wetland soil. Sampling tubes 17, 18, 19 and 20 were advanced at this site.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.8 0-25	ML C	10YR 3/3-dark brown; silt loam (silt); weak medium granular structure; friable; common fine roots and root holes; historical alluvium; strongly calcareous; abrupt boundary.
0.8-2.3 25-69	SP C2	10YR 6/4-light yellowish brown; medium sand; single grain; loose; historical alluvium; strongly calcareous; abrupt boundary.
2.3-4.3 69-130	ML ACb	10YR 3/3-dark brown; silt loam (silt); weak medium subangular blocky; sticky; few fine root holes; native soil; common medium distinct mottles; noncalcareous; gradual boundary.
4.3-7.2 130-218	SM Cgb	10YR 3/3-4/2-dark brown to dark grayish brown; loam (silty sand); massive; sticky; many medium distinct mottles; saturated; noncalcareous; abrupt boundary.
7.2-7.5 218-229	ML ACgb2	N3/0-very dark gray; silt loam to silty clay loam (silt to clayey silt); massive; sticky; organic enrichment; fine grained channel fill; gleyed; noncalcareous.

SITE NAME: ST20 **RM669.5 Site 10** Right descending bank, north 1/4 point.
GEOMORPHIC SURFACE: Very late Holocene Mississippi River to historic surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical, and very late Holocene Mississippi River alluvium.
WATER TABLE: 0.9', 27cm.
SURFACE ELEVATION: approx. 620.0'
USGS 7.5 MIN.QUADRANGLE: DeSoto, WI-IA.
SLOPE: 0%
VEGETATION: Silver maples, grass, wild grape, and ash.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 4.5', 137cm.
PHOTOGRAPHED: Color slide.
DATE DESCRIBED: 9/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Located downslope from ST19a&b. Historical alluvium caps a fine grained wetland soil. Sampling tubes 17, 18, and 19 were advanced at this site.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.25 0-8	SP C	10YR 4/4-light yellowish brown; medium sand; single grain; loose; reworked historical alluvium; calcareous; abrupt boundary.
0.25-0.8 8-25	ML ACb	10YR 3/2-dark brown; silt loam (silt); weak medium subangular blocky breaking to moderate medium granular; sticky; few fine root holes; native soil; common medium distinct mottles; noncalcareous; gradual boundary.
0.8-3.5 25-107	SM Cgb	10YR 3/3-4/2-dark brown to dark grayish brown; loam (silty sand); massive; sticky; many medium distinct mottles; saturated; noncalcareous; abrupt boundary.
3.5-4.5 107-137	ML-CL ACgb2	N3/0-4/0-very dark gray; silt loam to silty clay loam (silt to clayey silt); massive; sticky; organic enrichment; fine grained channel fill; gleyed; noncalcareous.

SITE NAME: ST21T **RM636.0** Left descending bank.
GEOMORPHIC SURFACE: Late Holocene Mississippi River island capped by thick historical alluvium.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 615.0'
USGS 7.5 MIN.QUADRANGLE: Prairie du Chien, IA-WI.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 4.0', 122cm.
PHOTOGRAPHED: Color slide.
DATE DESCRIBED: 9/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium at this location, silver maple root crowns buried. Low buried archaeological potential.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.0 0-122	ML C	10YR 6/4-3/3-light yellowish brown and dark brown; silt loam (silt); massive; sticky; historical flood laminae thick bedded; calcareous.

SITE NAME: ST22T **RM621.4** Left descending bank.
GEOMORPHIC SURFACE: Late Holocene Mississippi River island capped by thick historical alluvium.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 615.0'
USGS 7.5 MIN.QUADRANGLE: Guttenberg, IA-WI.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.9', 180cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium at this location, silver maple root crowns buried. Low buried archaeological potential. Native A horizon appears to be eroded.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-5.6 0-170	SP-SM C	10YR 7/3-6/3-very pale brown to pale brown; medium sand to loam (silty sand); massive; friable; laminae of historical alluvium of medium sand and silty sand; calcareous; abrupt boundary.
5.6-5.9 170-180	ML ABb	10YR 3/3-dark brown; silt loam (silt); weak medium subangular blocky; sticky; many fine root holes and few fine roots; native soil; few fine faint mottles; noncalcareous.

SITE NAME: ST23 **RM620.5 Site 11** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Late Holocene Mississippi River island capped by thick historical alluvium.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium and very late Holocene alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 615.0'
USGS 7.5 MIN.QUADRANGLE: Guttenberg, IA-WI.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.8', 236cm.
PHOTOGRAPHED: B/W vertical print of ST23 with "Monitor" in background.
DATE DESCRIBED: 9/16/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium over a very poorly drained very late Holocene soil. Low buried archaeological potential.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.8 0-25	SP C	10YR 7/3-very pale brown; medium sand; single grain; loose; historical alluvium, probable 1993 deposit; weakly calcareous; abrupt boundary.
0.8-1.1 25-33	SM AC	10YR 2/3-very dark brown; loam (silty sand); weak medium subangular blocky breaking to weak medium granular structure; very friable; many fine roots and root holes; weak A horizon developed in historical deposit; weakly calcareous; clear boundary.
1.1-2.5 33-76	SP C	10YR 4/4-6/4-dark yellowish brown to light yellowish brown; loamy sand (sand with minor silt); single grain; loose; historical alluvium; noncalcareous; abrupt boundary.
2.5-2.8 76-84	SM AC2	10YR 2/3-very dark brown; loam (silty sand); weak medium subangular blocky breaking to weak medium granular structure; very friable; few fine roots and root holes; noncalcareous; abrupt boundary.
2.8-4.0 84-122	SP C2	10YR 6/4-light yellowish brown-dry; medium sand; single grain; loose; historical alluvium; noncalcareous; abrupt boundary.
4.0-4.3 122-130	ML C3	10YR 3/3-dark brown; silt loam (silt); weak medium subangular blocky structure; friable; common fine roots and root holes; few fine faint mottles; historical alluvium; strongly calcareous; abrupt boundary.

4.3-6.5 130-197	SM-SP C4	10YR 3/3-very dark brown; sandy loam to loam (silty sand); massive; sticky; common medium distinct mottles; mottling along bedding planes; historical alluvium; upper portion calcareous, lower noncalcareous; abrupt boundary.
6.5-7.8 197-236	ML ACgb	N2/0-3/0-black to very dark gray; silt loam (silt) massive; sticky; native A horizon; common medium distinct mottles in upper part of horizon, gleyed lower part; noncalcareous.

SITE NAME: ST24 **RM620.5 Site 11** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Late Holocene Mississippi River island capped by thick historical alluvium.
POSITION IN LANDSCAPE: Flat lying downslope from ST23, near channel margin.
PARENT MATERIALS: Reworked recent sand, historical alluvium and very late Holocene alluvium.
WATER TABLE: At or near the surface.
SURFACE ELEVATION: approx. 615.0'
USGS 7.5 MIN.QUADRANGLE: Guttenberg, IA-WI.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.2', 66cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/16/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Reworked sand capping historical alluvium and native soil. Low buried archaeological potential.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.3 0-10	SP C	10YR 4/4-dark yellowish brown; medium sand; single grain; loose; reworked historical alluvium; calcareous; abrupt boundary.
0.3-2.0 10-61	SM C2	N3/0-very dark gray; loam (silty sand); massive; sticky; gleyed; calcareous; abrupt boundary.
2.0-2.2 10-66	ML-CL ACgb	N2/0-3/0-black to very dark gray; silt loam to silty clay loam (silt to clayey silt); massive; sticky; native A horizon; gleyed; noncalcareous.

SITE NAME: ST25 **RM613.6 Site 12** Left descending bank, midpoint.
GEOMORPHIC SURFACE: The historical deposits capping a mapped EMHOL2.
POSITION IN LANDSCAPE: Flat lying, 6.0 feet from bank.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: 4.1', 125cm.
SURFACE ELEVATION: approx. 610.0'
USGS 7.5 MIN.QUADRANGLE: Guttenberg, IA-WI.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.8', 239cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/16/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium over a mapped mid Holocene surface. The mid Holocene surface probably lies further inland from this near-channel location. Earlier work was conducted at the nearby Ackerman's cut (1984). Buried soils and Woodland pottery were identified in a bank exposure, no site number is assigned. Site 13 is across the channel at the right descending bank.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.3 0-10	SP C	10YR 6/4-light yellowish brown; medium sand; single grain; loose; post-spoil historical alluvial deposit; noncalcareous; abrupt boundary.
0.3-0.7 10-20	ML C2	10YR 3/3-dark brown; silt loam (silt); weak medium granular structure; friable; few fine roots and root holes; weak historical laminae 0.25" thick; post-spoil historical alluvial deposit; noncalcareous; clear boundary.
0.7-6.2 20-188	SP C3	10YR 7/3-very pale brown; medium sand; single grain; loose; spoil; noncalcareous; abrupt boundary.
6.2-7.8 188-239	ML Cg	N3/0-very dark gray; silt loam (silt); massive; sticky; common medium roots; gleyed; strongly calcareous.

SITE NAME: ST26 **RM607.5 Site 14** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Turkey River fan composed of thick historical alluvium, mapped as EMHOL2.
POSITION IN LANDSCAPE: Flat lying, four feet from bank edge.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: 9.5', 291cm.
SURFACE ELEVATION: approx. 605.0'
USGS 7.5 MIN.QUADRANGLE: Turkey River, IA-WI.
SLOPE: 0%
VEGETATION: Silver maples, weeds.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: Took a B/W print and color slide of location, barges on right.
DATE DESCRIBED: 9/16/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical deposits, location is near the boundary of TRIFAN and EMHOL2. Earlier work in 1984 showed thick historical deposits here. Low buried archaeological potential.

DEPTH (FT) (CM)	USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION	SOIL/GEOLOGIC DESCRIPTION
0-10.2 0-310	ML-SM C	10YR 4/4-3/3-dark yellowish brown and dark brown; silt loam and loam (silt, clayey silt and very fine sandy silt); weak medium platy structure to massive; friable to sticky; thick bedded historical laminae becoming mottled by 200cm and gleyed by 250cm; calcareous.

SITE NAME: ST27 **RM576.0 Site 15** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: 7.2', 220cm.
SURFACE ELEVATION: approx. 595.0'
USGS 7.5 MIN.QUADRANGLE: Menominee, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: Color slide of location with the river and barge behind trees.
DATE DESCRIBED: 9/17/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium. Island 228 is a barge mooring area. Archaeological sites 11JD124 and 11JD126 are nearby.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-6.2 0-190	ML C	10YR 3/3-dark brown; silt loam (silt); weak medium platy structure to massive; friable; thick and thin bedded historical alluvium; calcareous upper unit, noncalcareous lower; abrupt boundary.
6.2-7.2 190-220	ML C2	10YR 3/3-dark brown; silt loam (silt); weak medium subangular blocky structure to massive; friable; common fine roots; calcareous; abrupt boundary.
7.2-10.2 220-310	SM Cg	N4/0-dark gray; loam (fine sandy silt); massive; sticky; few fine roots; gleyed; noncalcareous; abrupt boundary.

SITE NAME: ST28T **RM576.0 Site 15** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, near channel margin.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: At or near the surface.
SURFACE ELEVATION: approx. 595.0'
USGS 7.5 MIN.QUADRANGLE: Menominee, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 3.0', 91cm.
PHOTOGRAPHED: B/W shot of exposed root bank and barge.
DATE DESCRIBED: 9/17/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium. Island 228 is a barge mooring area. Archaeological sites 11JD124 and 11JD126 are nearby. Core is downslope from ST27 next to the water's edge.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.1 0-3	SP C	10YR 6/3-pale brown; medium sand; single grain; loose; reworked recent historical deposit; noncalcareous; abrupt boundary.
0.1-2.2 3-66	ML C2	10YR 3/3-dark brown; silt loam (silt); massive; sticky; historical deposit; calcareous; abrupt boundary.
2.2-3.0 66-91	SM Cg	N4/0-dark gray; loam (fine sandy silt); massive; sticky to nonsticky; gleyed; calcareous.

SITE NAME: ST29a&b **RM551.6 Site 16** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Historical deposits, over late Holocene surface, LAHOL.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium, very late Holocene alluvium.
WATER TABLE: 6.7', 205cm.
SURFACE ELEVATION: approx. 590.0'
USGS 7.5 MIN.QUADRANGLE: Green Island IA-IL.
SLOPE: 0%
VEGETATION: Silver maples, nettles.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: Vertical color slide of location with stakes, and tube in foreground. Took B/W shot looking along the bank noting the old stumps probably marking the PSS.
DATE DESCRIBED: 9/17/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium, overlying a poorly drained very late Holocene surface. Well developed paleosol on nearby Kingston terrace Mile 549.6 at the Savanna depot. It may be related to site 11CA44.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.3 0-130	ML-SM C	10YR 3/3-4/4-dark brown to dark yellowish brown; silt loam to loam (silt and fine sandy silt); weak medium platy structure to massive; friable; laminae of historical alluvium, laminae vary in thickness; few medium distinct mottles along lower part of horizon; calcareous; abrupt boundary.
4.3-4.9 130-150	ML ACb	10YR 3/3-dark brown; silt loam (silt); moderate medium subangular blocky breaking to moderate medium granular structure; friable; many fine roots and worm holes; common medium distinct mottles; noncalcareous; gradual boundary.
4.9-10.2 150-310	ML Cb	10YR 3/3-4/4-dark brown to dark yellowish brown; silt loam (silt); massive; sticky; common medium distinct mottles, few medium Fe concretions; noncalcareous.

SITE NAME: ST30 **RM512.7 Site 17** Left descending bank, west side of island, upstream 1/4.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, upper end of island.
PARENT MATERIALS: Historical alluvium and very late Holocene alluvium.
WATER TABLE: 5.2', 159cm.
SURFACE ELEVATION: approx. 575.0'
USGS 7.5 MIN.QUADRANGLE: Clinton, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples, nettles, grass.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/18/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium. Small island just down from Beaver Island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-3.9 0-120	ML C	10YR 3/3-4/4-dark brown to dark yellowish brown; silt loam (silt); weak medium platy structure to massive; friable; few fine roots; thick and thin bedded historical alluvium, few very fine sand laminae; calcareous upper unit, noncalcareous lower; gradual boundary.
3.9-4.4 120-135	ML ACb	10YR 3/3-dark brown; silt loam (silt); moderate medium subangular blocky breaking to moderate medium granular structure; friable; common to many fine roots; few fine faint mottles; noncalcareous; abrupt boundary.
4.4-6.6 135-200	SM C	10YR 6/3 - 10YR 4/1-pale brown and dark gray; loam and sandy loam (silt, silty sand and fine medium sand); massive to single grain; sticky to nonsticky; laminae of gleyed silt and medium fine sand; 2 sand lamina 3.0" thick; oxidized root casts; noncalcareous; abrupt boundary.
6.6-7.9 200-240	ML Cg	10YR 4/1 - N3/0-dark to very dark gray; silt loam (silt); massive; sticky; common coarse prominent mottles, few coarse Fe concretions; calcareous.

SITE NAME: ST31 **RM512.7 Site 17** Left descending bank, east side of island, upstream 1/4.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, upper end of island.
PARENT MATERIALS: Historical alluvium and very late Holocene alluvium.
WATER TABLE: 6.2', 190cm.
SURFACE ELEVATION: approx. 575.0'
USGS 7.5 MIN.QUADRANGLE: Clinton, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples, nettles, grass.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/18/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium. Profile similar to ST30. Small island just down from Beaver Island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.2 0-130	SP C	10YR 7/3-very pale brown; medium fine sand; single grain; loose; few fine roots; historical alluvium; noncalcareous; abrupt boundary.
4.2-4.9 130-150	ML ACb	10YR 3/3-dark brown; silt loam (silt); moderate medium granular structure; friable; many fine roots; common medium distinct mottles; noncalcareous; abrupt boundary.
4.9-7.9 150-240	SM Cg	10YR 5/4 - N3/0-yellowish brown and very dark gray; loam and sandy loam (silt, silty sand and medium sand); massive to single grain; sticky to nonsticky; laminae of thick and thin bedded gleyed calcareous silt and noncalcareous medium sand.

SITE NAME: ST32 **RM512.7 Site 17** left descending bank, midpoint.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, west side center of island.
PARENT MATERIALS: Historical alluvium and very late Holocene alluvium.
WATER TABLE: 5.6', 171cm.
SURFACE ELEVATION: approx. 575.0'
USGS 7.5 MIN.QUADRANGLE: Clinton, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples, nettles, grass.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED:
DATE DESCRIBED: 9/18/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium. Profile similar to ST30, ST31. Small island just down from Beaver Island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.5 0-75	SP C	10YR 7/3-very pale brown; medium and fine sand; single grain; loose; few fine and medium roots; laminae of fine and medium sand, historical alluvium; noncalcareous; abrupt boundary.
2.5-6.2 75-190	ML C2	10YR 3/3-dark brown; silt loam (silt); weak medium granular structure; friable; few to common fine roots; historical silt laminae; some units calcareous others noncalcareous; gradual boundary.
6.2-6.9 190-210	ML ACb	10YR 3/3-dark brown; silt loam (silt); moderate medium subangular blocky structure; sticky; many fine roots; noncalcareous; gradual boundary.
6.9-9.2 210-280	ML Cb	10YR 3/3-4/4-dark brown to dark yellowish brown; silt loam (silt); massive; sticky; silt flood laminae 0.12" thick; noncalcareous; gradual boundary.
9.2-10.2 280-310	ML ACgb2	10YR 4/1-dark gray; silt loam (silt, to clayey silt); massive; sticky; laminae of calcareous and noncalcareous silt, some laminae organic enriched.

SITE NAME: ST33 **RM466.7 Site 21** left descending bank, midpoint.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, north side center of island, narrow valley reach.
PARENT MATERIALS: Historical alluvium and very late Holocene/historical alluvium.
WATER TABLE: 6.0', 183cm.
SURFACE ELEVATION: approx. 550.0'
USGS 7.5 MIN.QUADRANGLE: Montpelier, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples, nettles, grass.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: 2 B/W shots of location, ST33 and water's edge sampling.
DATE DESCRIBED: 10/2/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium, 10 feet from bank scarp. Small island just across from Andalusia Island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.3 0-130	SM C	10YR 3/3-4/4-6/4-dark brown, dark yellowish brown, and light yellowish brown; loam (silt and very fine sand); weak medium granular and weak medium platy structure; friable; common medium roots and root holes; laminae of silt and very fine sand, historical alluvium; few medium distinct mottles, common coarse carbonate concretions at horizon boundary; calcareous; abrupt boundary.
4.3-5.2 130-160	ML Ab	10YR 3/3-2/2-dark to very dark brown; silt loam (silt); massive; sticky; common medium distinct mottles; calcareous; gradual boundary.
5.2-7.9 160-240	ML Cgb	N3/0-dark gray; silt loam (silt); massive; sticky; gleyed; calcareous.

SITE NAME: ST34 **RM466.9 Site 21** left descending bank, upper end.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, head of the island, narrow valley reach.
PARENT MATERIALS: Historical alluvium and very late Holocene/historical alluvium.
WATER TABLE: 4.1', 125cm.
SURFACE ELEVATION: approx. 550.0'
USGS 7.5 MIN.QUADRANGLE: Montpelier, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples, nettles, grass, poison ivy.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: B/W shot of location near ST34 where water's edge sampling occurred.
DATE DESCRIBED: 10/2/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium, upper end of island, severe erosion. Small island just across from Andalusia Island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.6 0-140	SM C	10YR 3/3-4/4-6/4-dark brown, dark yellowish brown, and light yellowish brown; loam (silt and very fine sand); weak medium granular and weak medium platy structure; friable; many medium roots and root holes in upper 3.0 feet; laminae of silt and very fine sand, historical alluvium; few medium distinct mottles, common coarse carbonate concretions at horizon boundary; calcareous; abrupt boundary.
4.6-5.1 140-155	ML ACgb	10YR 3/1-very dark gray; silt loam (silt); massive; sticky; common medium distinct mottles; calcareous; gradual boundary.
5.1-7.2 155-220	ML Cgb	N3/0-very dark gray; silt loam (silt); weak medium subangular blocky structure to massive; sticky; few fine roots; gleyed; calcareous; abrupt boundary.
7.2-7.9 220-240	SP Cg2b	10YR 4/1-dark gray; medium sand; single grain; loose; noncalcareous.

SITE NAME: ST35a&b **RM466.3 Site 21** left descending bank, downstream end.
GEOMORPHIC SURFACE: Historical deposits, mid channel island, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying, downstream end of the island, narrow valley reach.
PARENT MATERIALS: Historical alluvium and very late Holocene/historical alluvium.
WATER TABLE: 3.1', 95cm.
SURFACE ELEVATION: approx. 550.0'
USGS 7.5 MIN.QUADRANGLE: Montpelier, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/2/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium, lower end of island, root crown exposure and severe erosion. Small island just across from Andalusia Island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.6 0-140	SM C	10YR 3/3-4/4-6/4-dark brown, dark yellowish brown, and light yellowish brown; loam (silt and very fine sand); weak medium granular and weak medium platy structure; friable; many medium roots and root holes in upper 3.0 feet; laminae of silt and very fine sand, historical alluvium; few medium distinct mottles, common coarse carbonate concretions at horizon boundary; calcareous; abrupt boundary.
4.6-4.9 140-150	ML ACgb	10YR 3/1-very dark gray; silt loam (silt); massive; sticky; common medium distinct mottles; calcareous; gradual boundary.
4.9-7.9 150-240	ML Cgb	N3/0-very dark gray; silt loam (silt); weak medium subangular blocky structure to massive; sticky; gleyed; calcareous.

SITE NAME: ST36 **RM436.4 Site 22** left descending bank, upper section.
GEOMORPHIC SURFACE: Historical deposits, early to mid Holocene surface EMHOL1.
POSITION IN LANDSCAPE: Flat lying, near channel margin.
PARENT MATERIALS: Historical alluvium and Holocene alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 535.0'
USGS 7.5 MIN.QUADRANGLE: Toolesboro, IA-IL.
SLOPE: 0%
VEGETATION: Grass.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: 2 slides of site and orange erosion pins.
DATE DESCRIBED: 10/3/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium, over an early Holocene surface. Just downstream from lock and dam, cultural material found from 11MC124. PSS is just about at the pool's water level elevation.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-6.2 0-190	ML C	10YR 3/3-4/4-dark brown, and dark yellowish brown; silt loam (silt); weak medium platy structure to massive; friable; common to many medium roots and root holes; laminae of silt historical alluvium; few fine faint mottles; calcareous; abrupt boundary.
6.2-7.1 190-215	ML ABb	10YR 2/2-3/3-very dark brown to dark brown; silt loam (silt); moderate medium subangular blocky breaking to moderate medium granular structure; friable; many fine root holes; noncalcareous; clear boundary.
7.1-7.9 215-240	ML-CL Btb	10YR3/3-dark brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; many fine root holes; few argillans; noncalcareous.

SITE NAME: ST37a&b **RM436.4 Site 22** left descending bank, upper section.
GEOMORPHIC SURFACE: Early to mid Holocene surface EMHOL1, capped by late Holocene..
POSITION IN LANDSCAPE: Flat lying, behind levee about 150 away from channel margin.
PARENT MATERIALS: Holocene alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 530.0'
USGS 7.5 MIN.QUADRANGLE: Toolesboro, IA-IL.
SLOPE: 0%
VEGETATION: Ag field (37a) and elm, ash and silver maple forest (37b).
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 3.6', 110cm.
PHOTOGRAPHED: 2 slides of site and orange erosion pins.
DATE DESCRIBED: 10/3/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Late Holocene alluvium, over an early Holocene surface. Just downstream from lock and dam, cultural material found from 11MC124. PSS is just about at the pool's water level elevation. Good place for radiocarbon dates.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.7 0-20	ML A	10YR 2/1-black; silt loam (silt); moderate medium granular structure; friable; common to many fine roots; noncalcareous; clear boundary.
0.7-1.8 20-55	ML-CL AB	10YR2/2-very dark brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common fine roots; noncalcareous; clear boundary.
1.8-2.6 55-80	ML-CL Bw-Bt	10YR 3/3-4/4-dark brown to dark yellowish brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; very friable; many fine root holes; common medium distinct mottles; noncalcareous; abrupt boundary.
2.6-3.3 80-100	ML ABb	10YR2/2-very dark brown; silt loam to silty clay loam (silt to clayey silt); moderate fine to medium columnar structure; friable; common fine roots and root holes; noncalcareous; clear boundary.
3.3-3.6 100-110	ML-CL ABtb	10YR2/2-very dark brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; noncalcareous.

SITE NAME: ST38 **RM436.4 Site 23** right descending bank.
GEOMORPHIC SURFACE: Late Holocene island capped by PSA, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical and Holocene alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 535.0'
USGS 7.5 MIN.QUADRANGLE: Toolesboro, IA-IL.
SLOPE: 0%
VEGETATION: Silver maple forest.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/3/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Late Holocene alluvium, capped by historical alluvium on Keg Island. Just downstream from lock and dam, cultural material found from 11MC124.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.9 0-150	ML C	10YR 3/3-4/4-dark brown, and dark yellowish brown; silt loam (silt); weak medium platy structure to massive; friable; common to many medium roots and root holes; laminae of silt historical alluvium; calcareous upper unit noncalcareous below; abrupt boundary.
4.9-5.4 150-165	ML Ab	10YR 2/2-3/3-very dark brown to dark brown; silt loam (silt); weak medium subangular blocky breaking to moderate medium granular structure; friable; many fine root holes; noncalcareous; clear boundary.
5.4-5.9 165-180	ML Bwb	10YR 2/2-3/3-very dark brown to dark brown; silt loam to silty clay loam (silt to clayey silt); moderate medium subangular blocky structure; friable; weak flood laminae, mottling along laminae plates; noncalcareous; clear boundary.
5.9-7.5 180-230	ML ABwb	10YR3/3-2/2-dark to very dark brown; silt loam to silty clay loam (silt to clayey silt); moderate medium subangular blocky structure; friable; few argillans; common medium distinct mottles, few fine Fe concretions; few organic enriched flood laminae; noncalcareous; clear boundary.
7.5-7.9 230-240	ML Cb	10YR4/3-dark brown; silt loam (silt); massive; friable; noncalcareous.

SITE NAME: ST39 **RM432.3 Site 25** right descending bank, midpoint.
GEOMORPHIC SURFACE: Historical island, mapped as PSA.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 535.0'
USGS 7.5 MIN.QUADRANGLE: Joy, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: 2 B/W of classic PSA, a color slide and a B/W shot of ST39 location.
DATE DESCRIBED: 10/3/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Thick historical alluvium at a PSA island. This is across from a Savanna terrace near New Boston where site 24 is located.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.6 0-80	SP C	10YR 6/4-light yellowish brown; medium and fine sand; single grain; loose; historical alluvium, apparent 1993 flood deposit; calcareous; abrupt boundary.
2.6-7.9 80-240	ML C2	10YR 4/4-3/3-2/2-dark yellowish brown, dark brown and very dark brown; silt loam (silt); massive; friable; calcareous.

SITE NAME: ST40 **RM420.0 Site 26** right descending bank, midpoint.
GEOMORPHIC SURFACE: Spoil capped late Holocene island with PSA, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium and spoil.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 530.0'
USGS 7.5 MIN.QUADRANGLE: Oquawka, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.9', 90cm.
PHOTOGRAPHED: B/W of eroded spoil note tree root crowns.
DATE DESCRIBED: 10/3/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Historical alluvium overlying coarse sandy dredge spoil.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.8 0-25	ML C	10YR 3/3-4/4-dark brown and dark yellowish brown; silt loam (silt); weak medium platy structure to massive; friable; historical alluvial laminae; calcareous; abrupt boundary.
0.8-2.9 25-90	SP C2	10YR 7/3-very pale brown; medium and coarse sand; single grain; loose; common granules; noncalcareous.

SITE NAME: ST41 **RM420.0 Site 26** right descending bank, midpoint.
GEOMORPHIC SURFACE: Late Holocene island with PSA, mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical alluvium.
WATER TABLE: 60cm.
SURFACE ELEVATION: approx. 525.0'
USGS 7.5 MIN.QUADRANGLE: Oquawka, IA-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: Color slide of erosion pin installation.
DATE DESCRIBED: 10/3/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Historical alluvium, downslope away from dredge spoil and channel margin near a mid island wetland filled with PSA.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.6 0-80	ML-SM C	10YR 3/3-dark brown; loam to silt loam (silt and very fine sand); weak medium platy structure; friable; historical alluvial laminae; calcareous; gradual boundary.
2.6-7.9 80-240	ML-SM C2	10YR 4/1-dark gray; silt loam to loam (silt, clayey silt, and fine sand); massive and single grain; massive to loose; laminae of historical silt, clayey silt and fine sand; common fine and medium roots and root holes; gleyed; calcareous.

SITE NAME: ST42 **RM360.0 Site 27** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene Mississippi River to historic surface, LAHOL.
POSITION IN LANDSCAPE: Flat lying, about 1.0 mile downstream of Des Moines R. confluence.
PARENT MATERIALS: Historical Mississippi River/Des Moines River alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 490.0'
USGS 7.5 MIN.QUADRANGLE: Warsaw IL-MO.
SLOPE: 0%
VEGETATION: Grass.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 8.2', 250cm.
PHOTOGRAPHED: B/W print and color slide erosion pins and bank.
DATE DESCRIBED: 10/4/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Located just downstream of Des Moines River confluence. Thick bedded historical alluvium. Impressive area of desiccated slump blocks calving into the channel. The hot dry summer conditions has accelerated this erosional process erosion.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-8.2 0-250	ML-SM C	10YR 6/4-3/3-light yellowish brown and dark brown; loam and silt loam (silt and very fine sand); massive; very friable; historical flood laminae of alternating thick bedded dark brown silt and thin bedded very fine sand; calcareous.

SITE NAME: ST43 **RM339.3 Site 29** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Late Holocene Mississippi River Island mapped as ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Historical Mississippi River alluvium.
WATER TABLE: 10.2', 310cm.
SURFACE ELEVATION: approx. 480.0'
USGS 7.5 MIN.QUADRANGLE: Long Island IL-MO.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.7', 325cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/5/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Located across the upper end of Long Island. Entire profile is thick and thin bedded historical alluvium, medium calcareous sand at the base of the profile.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-9.5 0-290	ML-SM C	10YR 7/3-4/4-3/3-very pale brown, dark yellowish brown and dark brown; loam and silt loam (silt and very fine sand); massive; friable; historical flood laminae of alternating thick and thin bedded dark brown silt and very fine sand; common medium distinct mottles below 200cm, gleyed below 250cm, calcareous; abrupt boundary.
9.5-10.7 290-325	SP C2	10YR 7/3-very pale brown; medium sand; single grain; loose; common coarse prominent mottles; calcareous.

SITE NAME: ST44 **RM339.3 Site 30** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Early to mid Holocene Mississippi River surface, EMHOL2.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 475.0'
USGS 7.5 MIN.QUADRANGLE: La Grange-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: One slide, 2 B/W of ST44, Site 30 location looking downstream.
DATE DESCRIBED: 10/5/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Located across from Site 29 and ST43 on the Missouri side of the valley. Area is mapped as FANCO but, below the 480' contour lies the early to mid Holocene surface identified in the field. Somewhat poorly to poorly drained surface. Should be re-mapped as EMHOL2.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.6 0-140	ML C	10YR 3/3-2/2-dark brown, and very dark brown; silt loam (silt); weak medium platy structure to massive; friable; common medium roots and root holes; laminae of thin bedded silt historical alluvium; calcareous; abrupt boundary.
4.6-5.4 140-165	ML-CL ABb	N2/0-black; silty clay loam (clayey silt); moderate medium subangular blocky structure; sticky; noncalcareous; clear boundary.
5.4-6.6 165-200	ML-CL Btg1b	N3/0-very dark gray; silty clay loam (clayey silt); moderate medium subangular blocky structure; sticky; few argillans; few fine faint mottles, gleyed; noncalcareous; clear boundary.
6.6-7.9 200-240	ML-CL Btg2b	10YR4/1-dark gray; silty clay loam (clayey silt); massive; sticky; many medium distinct mottles, gleyed; common argillans; noncalcareous.

SITE NAME: ST45 **RM312.5** Right descending bank.
GEOMORPHIC SURFACE: Late Holocene Mississippi River lateral accretion ridge, LAHOL1.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 4.3', 130cm.
SURFACE ELEVATION: approx. 465.0'
USGS 7.5 MIN.QUADRANGLE: Marblehead-MO-IL.
SLOPE: 0%
VEGETATION: Fallow ag field.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/5/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Lateral accretion ridge at the Bay de Charles. Spot core taken while waiting for group. Protected by artificial levee, no PSA. Fining upward sequence.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.7 0-20	ML Ap	10YR 3/3-dark brown; silt loam (silt); weak medium granular structure; friable; common fine roots; probably some historical alluvium mixed into this horizon; noncalcareous; abrupt boundary.
0.7-1.1 20-35	ML-CL AB	10YR 3/2-very dark grayish brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable to sticky; many fine roots; noncalcareous; clear boundary.
1.1-2.0 35-60	ML Bw	10YR 4/3-dark brown; silt loam (silt); moderate medium subangular blocky structure; friable; common to many medium distinct mottles; noncalcareous; gradual boundary.
2.0-7.9 60-240	ML-SM C	10YR 4/3-dark brown; silt loam to loam (silt to silty sand); massive; sticky; late Holocene flood laminae, few gleyed clayey silt laminae; common to many medium distinct mottles, common medium Fe concretions; noncalcareous.

SITE NAME: ST46 **RM292.4** Right descending bank.
GEOMORPHIC SURFACE: Early to mid Holocene Mississippi River flood basin, mapped as EMHOL1.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 1.3', 40cm.
SURFACE ELEVATION: approx. 455.0'
USGS 7.5 MIN.QUADRANGLE: Ashburn-MO-IL.
SLOPE: 0%
VEGETATION: Fallow ag field.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 5.9', 180cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/6/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Early to mid Holocene fine grained, very poorly drained flood basin, just south of Saverton. Nearby Gilbert island is a good study location.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.2 0-5	ML C	10YR 3/2-very dark grayish brown; silt loam (silt); weak medium granular structure; friable; common fine roots; thin historical alluvial deposit; noncalcareous; abrupt boundary.
0.2-1.3 5-40	ML-CL ABtg	10YR 3/1-very dark gray; silty clay loam (clayey silt); moderate medium subangular blocky structure; sticky; common medium distinct mottles, gleyed; noncalcareous; gradual boundary.
1.3-5.9 40-180	CL Cg	N3/0-very dark gray; silty clay; massive; sticky; common medium distinct mottles, gleyed; noncalcareous.

SITE NAME: ST47 **RM275.3 Site 32** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River alluvium,LAHOL.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 1.5', 46cm.
SURFACE ELEVATION: approx. 450.0'
USGS 7.5 MIN.QUADRANGLE: Pleasant Hill West-MO-IL.
SLOPE: 0%
VEGETATION: Weeds and wetland plants.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 9.2', 280cm.
PHOTOGRAPHED: B/W shot of ST47 location with Dan and Miss. R. channel in background.
DATE DESCRIBED: 10/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very late to historic fine grained deposit, wetland soil. Core taken away from the channel margin.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-3.6 0-110	ML C	10YR 3/3-4/2-dark brown and dark grayish brown; silt loam (silt); weak to moderate medium platy structure; friable; common fine roots; few fine faint mottles along plate faces; historical alluvial deposit; calcareous; gradual boundary.
3.6-8.2 110-250	ML Cgb	N3/0-very dark gray; silt loam (silt); massive; sticky; few fine faint mottles, gleyed; weakly calcareous; abrupt boundary.
8.2-9.2 250-280	CL Cg2b	N3/0-very dark gray; silty clay; massive; sticky; few fine faint mottles, gleyed; weakly calcareous.

SITE NAME: ST48 **RM275.3 Site 32** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River alluvium,LAHOL.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 1.8', 56cm.
SURFACE ELEVATION: approx. 450.0'
USGS 7.5 MIN.QUADRANGLE: Pleasant Hill West-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples, weeds.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 280cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very late to historic fine grained deposit, wetland soil, core taken about 10.0 feet from the channel margin.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-3.9 0-120	ML C	10YR 3/3-4/2-dark brown, and dark grayish brown; silt loam (silt); weak medium platy structure to massive; friable; laminae of historical very fine sand and silt which vary in thickness; few fine faint mottles; calcareous; abrupt boundary.
3.9-4.9 120-150	ML-CL ACgb	N2/0-3/0-black to very dark gray; silty clay loam (clayey silt); massive; sticky; few to common charcoal fragments; gleyed; weakly calcareous; gradual boundary.
4.9-5.4 150-165	ML-CL BCgb	N3/0-very dark gray; silty clay loam (clayey silt); weak medium subangular blocky structure; sticky; gleyed; noncalcareous; gradual boundary.
5.4-7.9 165-240	ML-CL Cgb	N3/0-very dark gray; silty clay loam (clayey silt); massive; sticky; noncalcareous.

SITE NAME: Bank exposure **RM266.8 Observation** Left descending bank.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River alluvium, ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below base of profile.
SURFACE ELEVATION: approx. 445.0'
USGS 7.5 MIN.QUADRANGLE: Annada-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 8.6', 262cm.
PHOTOGRAPHED: 2 color slides of bank profile, and one of erosion pins.
DATE DESCRIBED: 10/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very late to historic fine grained deposit on Slim Island. The description is of a bank profile exposure. Three erosion pins were installed at this location.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.2 0-128	ML C	10YR 7/3-4/4-very pale brown and dark yellowish brown; silt loam (silt); weak medium platy structure to massive; friable; few to common root holes; laminae of historical very fine sand and silt which vary in thickness; calcareous; abrupt boundary.
4.2-6.5 128-198	ML ACgb	10YR 3/3-dark brown; silt loam (silt); moderate medium subangular blocky, moderate medium platy breaking to moderate medium granular structure; friable; common medium distinct mottles; noncalcareous; gradual boundary.
6.5-8.6 198-262	ML-CL ACgb2	10YR 3/1-very dark gray; silty clay loam (clayey silt); weak medium subangular blocky structure; friable; common medium distinct mottles, gleyed; noncalcareous.

SITE NAME: ST49 **RM266.5 Site 33** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River alluvium, ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below base of profile.
SURFACE ELEVATION: approx. 445.0'
USGS 7.5 MIN.QUADRANGLE: Annada-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 9.2', 280cm.
PHOTOGRAPHED: B/W shot of location with Mike on the left.
DATE DESCRIBED: 10/12/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very late to historic fine grained deposit on Coon Island. A well developed buried A horizon occurs at 210cm. A good study island.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-6.2 0-190	ML C	10YR 7/3-4/4-3/3-very pale brown, dark yellowish brown, and dark brown; silt loam (silt); weak medium platy structure; friable; laminae of historical very fine sand and silt which vary in thickness, mostly thick bedded; calcareous; abrupt boundary.
6.2-6.9 190-210	ML ACb	10YR 2/2-3/3-very dark brown to dark brown; silt loam (silt); moderate medium subangular blocky breaking to moderate medium granular structure; friable; common to many fine root holes, and worm casts; few laminae observed; noncalcareous; gradual boundary.
6.9-8.2 210-250	ML Ab2	10YR 2/2-very dark brown; silt loam (silt); moderate medium subangular blocky breaking to moderate medium granular structure; friable; many fine roots; noncalcareous; gradual boundary.
8.2-9.2 250-280	ML Cb2	10YR 3/3-dark brown; silt loam (silt); massive; friable; very thin laminae of silt and clayey silt; many fine roots; noncalcareous.

SITE NAME: ST50 **RM232.2 Site 34** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River alluvium,LAHOL.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 7.1', 216cm.
SURFACE ELEVATION: approx. 425.0'
USGS 7.5 MIN.QUADRANGLE: Winfield-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 12.5', 380cm.
PHOTOGRAPHED:
DATE DESCRIBED: 10/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very late to historic fine grained deposits. Thick historical deposits capping the surface.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-10.5 0-320	ML C	10YR 4/4-3/3-dark yellowish brown, and dark brown; silt loam (silt); weak medium platy structure; friable; laminae of historical very fine sand and silt thick and thin bedded; common to many medium distinct mottles below 6.0'; calcareous; abrupt boundary.
10.5-12.5 320-380	ML ACgb	N3/0-very dark gray; silt loam to silty clay loam (silt to clayey silt); massive; sticky; some organic material and charcoal; gleyed; noncalcareous.

SITE NAME: ST51 **RM222.1 Site 35** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River alluvium, ISLAN.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 9.2', 280cm.
SURFACE ELEVATION: approx. 425.0'
USGS 7.5 MIN.QUADRANGLE: Grafton-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: B/W shot of PSA bank and slumping silver maples.
DATE DESCRIBED: 10/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Very late to historic fine grained deposits. Thick historical deposits capping the surface.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-8.9 0-270	ML C	10YR 4/4-3/3-dark yellowish brown, and dark brown; silt loam (silt); weak medium platy structure to massive; friable; common medium and fine root and root holes, and worm casts; laminae of historical very fine sand, silt, and clayey silt, thick and thin bedded; calcareous; abrupt boundary.
8.9-10.2 270-310	ML-CL ACgb	N3/0-very dark gray; silty clay loam (clayey silt); massive; sticky; some organic material and charcoal fragments; gleyed; calcareous.

SITE NAME: ST52 **RM217.5 Site 36** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Very late Holocene to historic Mississippi River surface.
POSITION IN LANDSCAPE: Flat lying, just downstream from Illinois River confluence.
PARENT MATERIALS: Mississippi/Illinois River alluvium.
WATER TABLE: 6.2', 190cm.
SURFACE ELEVATION: approx. 425.0'
USGS 7.5 MIN.QUADRANGLE: Grafton-MO-IL.
SLOPE: 0%
VEGETATION: Weeds.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: Several slides were taken nearby particularly of confluence.
DATE DESCRIBED: 10/13/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Historic fine, medium, and coarse grained deposits.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-5.9 0-180	ML C	10YR 3/3-dark brown (dry); silt loam (silt); massive; very friable; laminae of historical silt which vary in thickness; few fine faint mottles; calcareous; gradual boundary.
5.9-6.6 180-200	ML-SM C2	10YR3/3-dark brown; silt loam and loam (silty fine sand); massive; friable; common medium distinct mottles; calcareous; abrupt boundary.
6.6-7.2 200-220	SM-SP C3	10YR 4/4-dark yellowish brown; sandy loam (fine sand); single grain; loose; calcareous; abrupt boundary.
7.2-7.9 220-240	SP C4	10YR 4/4-dark yellowish brown; fine medium sand; single grain; loose; calcareous.

SITE NAME: ST53 **RM197.6 Site 37** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Historic Mississippi River surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below base of profile.
SURFACE ELEVATION: approx. 410.0'
USGS 7.5 MIN.QUADRANGLE: Wood River-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 7.9', 240cm.
PHOTOGRAPHED: Took slide of levee breach area behind ST53.
DATE DESCRIBED: 10/14/1995
DESCRIBED BY: Jeff Anderson
REMARKS: This is disturbed area where construction has been going on repairing the levee break. Across the channel is Shell Oil docking area. Disturbed reworked fill and thick bedded PSA. About 1.5 miles upstream of the confluence with the Missouri River.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.6 0-140	ML C	10YR 6/4-4/4-light yellowish brown and dark yellowish brown (dry); silt loam (silt and very fine sand); massive; very friable; laminae of historical silt and very fine sand thick and thin bedded; common fine roots, root holes, and worm holes; calcareous; abrupt boundary.
4.6-5.9 140-180	ML C2	10YR2/2-very dark brown; silt loam (silt); weak medium subangular blocky breaking to moderate medium granular structure; friable; common fine roots and worm holes; appears to be reworked topsoil (A horizon); calcareous; abrupt boundary.
5.9-7.9 180-240	ML C3	10YR 3/3-4/4-4/2-dark brown, dark yellowish brown, and dark grayish brown; silt loam (silt and very fine sand); weak medium platy structure; friable; few fine faint mottles; laminae of recent historical deposits; strongly calcareous.

SITE NAME: ST54 **RM174.8 Site 38** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Mississippi River Late Holocene surface capped by PSA.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: Below base of profile.
SURFACE ELEVATION: approx. 410.0'
USGS 7.5 MIN.QUADRANGLE: Cahokia-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 9.2', 280cm.
PHOTOGRAPHED: Several slides and B/W shots of location and recent flood deposits.
DATE DESCRIBED: 10/14/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Extremely thick bedded silt and sand historical deposits.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-6.6 0-200	ML C	10YR 6/4-5/4-light yellowish brown and yellowish brown (dry); silt loam (silt and very fine sand); massive; very friable; laminae of historical silt and very fine sand thick and thin bedded; individual flood units several inches thick; calcareous; abrupt boundary.
6.6-9.2 200-280	SP C2	10YR7/3-very pale brown; medium sand; single grain; loose; calcareous.

SITE NAME: ST55a&b **Observation site RM134.1** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Mississippi River Late Holocene surface capped by PSA.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 16.0', 488cm.
SURFACE ELEVATION: approx. 380.0'
USGS 7.5 MIN.QUADRANGLE: Bloomsdale-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 20.0', 610cm.
PHOTOGRAPHED: Several slides and B/W shots of location and recent flood deposits.
DATE DESCRIBED: 10/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Extremely thick bedded silt and sand historical deposits. Slide shows massive flood debris including a "Century 21" sign in the debris. CCC riprap is in pictures and erosion of about 150' of bank erosion has occurred since riprap placement. Two cores taken to extend profile.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-4.9 0-150	ML C	10YR 3/3-4/4-dark brown and dark yellowish brown (dry); silt loam (silt and very fine sand); weak medium platy structure to massive; friable; laminae of historical silt and very fine sand, thick and thin bedded; few fine faint mottles along bedding planes; common to many root and worm holes in upper 2.0'; calcareous; gradual boundary.
4.9-6.2 150-190	ML C2	10YR2/2-very dark brown; silt loam to silty clay loam (silt to clayey silt); massive; friable; historical flood laminae; strongly calcareous; abrupt boundary.
6.2-11.5 190-350	ML-CL C3	10YR 2/2-very dark brown; silty clay loam (clayey silt); weak medium platy structure to massive; sticky; historical flood laminae; strongly calcareous; abrupt boundary.
11.5-12.5 350-381	ML C4	10YR 3/2-3/3-very dark grayish brown to dark brown; silt loam (silt); weak medium platy structure to massive; sticky; few fine faint mottles along bedding planes; strongly calcareous; abrupt boundary.
12.5-15.5 381-472	ML C5	10YR-3/3-dark brown; silt loam (silt and very fine sand); weak medium platy structure to massive; sticky; strongly calcareous; abrupt boundary .
15.5-16.5	ML-CL	10YR 2/2-3/1-very dark brown to very dark gray;

472-488	C6	silty clay loam (clayey silt); massive; sticky; strongly calcareous; abrupt boundary.
16.5-20.0 488-610	ML Cg7	N3/0-2/0-very dark gray to black; silt loam (silt, clayey silt and very fine sand); weak medium platy structure to massive; sticky; thick bedded historical laminae; gleyed; strongly calcareous.

SITE NAME: ST56 **Site 39 RM112.4** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Mississippi River Late Holocene surface capped by PSA.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River alluvium.
WATER TABLE: 1.0', 30cm.
SURFACE ELEVATION: approx. 370.0'
USGS 7.5 MIN.QUADRANGLE: Chester-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 3.9', 120cm.
PHOTOGRAPHED: Took slide of bank profile with project team for scale, took slide and B/W of green plastic "Purex" bottle.
DATE DESCRIBED: 10/15/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Extremely thick bedded silt and very fine sand historical deposits. A "Purex" brand plastic bottle is buried below 20.45' of historical alluvium.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-1.6 0-50	SP C	10YR 5/4-yellowish brown; medium sand; single grain; loose; reworked sand; calcareous; abrupt boundary.
1.6-2.3 50-70	ML-CL C2	N3/0-very dark gray; silty clay loam (clayey silt); massive; sticky; historical flood laminae; gleyed; calcareous; abrupt boundary.
2.3-3.9 70-120	SP-GP C3	10YR 5/4-yellowish brown; gravelly sand; single grain; loose; historical flood laminae; sand and pebbles; calcareous.

SITE NAME: ST57 **Site 40 RM94.1** Right descending bank, downstream 1/4.
GEOMORPHIC SURFACE: Mississippi River Late Holocene surface capped by PSA.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River historical alluvium.
WATER TABLE: 1.1', 34cm.
SURFACE ELEVATION: approx. 360.0'
USGS 7.5 MIN.QUADRANGLE: Rockwood-MO-IL.
SLOPE: 0%
VEGETATION: Silver maples.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: Took slides of barge and erosion pin location with David and Dan.
DATE DESCRIBED: 10/16/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Extremely thick bedded silt and sand historical deposits. Fuel oil in some of the historical deposits.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.5 0-76	ML C	10YR 3/2-very dark grayish brown; silt loam and silty clay loam (silt and clayey silt); weak medium platy structure to massive; friable; laminae of historical silt and clayey silt about 1/4" thick; strongly calcareous; gradual boundary.
2.5-5.0 76-152	ML-CL C2	N3/0-very dark gray; silty clay loam (clayey silt); massive; sticky; historical flood laminae; gleyed; strongly calcareous; abrupt boundary.
5.0-7.5 152-229	ML C3	10YR 3/1-very dark gray; silt loam and very fine sand (silt and very fine sand); massive; sticky to loose; historical flood laminae; strongly calcareous; abrupt boundary.
7.5-10.2 229-310	ML-CL C4	N3/0-very dark gray; silty clay loam (clayey silt); massive; sticky; fuel oil smell in this horizon; calcareous.

SITE NAME: ST58/bank exposure **Site 41 RM77.2** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Holocene alluvial fan and footslope.
POSITION IN LANDSCAPE: Midfan.
PARENT MATERIALS: Reworked loess and colluvium.
WATER TABLE: Below bottom of core/profile.
SURFACE ELEVATION: approx. 360.0'
USGS 7.5 MIN.QUADRANGLE: Neelys Landing-MO-IL.
SLOPE: 15-20%
VEGETATION: Hardwoods, hickory.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 20.0', 610cm.
PHOTOGRAPHED: Took a slide and B/W to begin two rolls of profile.
DATE DESCRIBED: 10/16/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Eroded late Wisconsinan to early Holocene fan, eroded during high magnitude flows. Barge smears are observed about 20-25 feet above the current water surface. Reworked loess and gravelly chert colluvium/alluvium.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-0.3 0-10	ML-GM A	10YR 4/4-dark yellowish brown (dry); silt loam (gravelly silt); moderate medium granular structure; friable; many fine root and worm holes; noncalcareous; clear boundary.
0.3-0.8 10-25	ML-GM E	10YR6/3-pale brown (dry); silt loam (gravelly silt); massive; friable; core refusal from gravel; noncalcareous; clear boundary.
0.8-2.5 25-75	ML-GM Bt	7.5YR 6/4-light brown; silty clay loam (gravelly clayey silt); weak medium subangular blocky structure to massive; friable; noncalcareous; abrupt boundary.
2.3-3.0 75-91	GW C	10YR 4/4-dark yellowish brown; gravel; single grained; loose; noncalcareous; abrupt boundary.
3.0-4.0 91-122	ML-GM C2	10YR-6/4-light yellowish brown; silt loam (gravelly silt); massive; nonsticky; noncalcareous; abrupt boundary .
4.0-5.0 122-152	GW C3	10YR 4/4-dark yellowish brown; gravel; single grained; loose; noncalcareous; abrupt boundary.
5.0-8.0 152-244	ML C4	10YR 4/4-dark yellowish brown; silt loam (silt); massive; friable; reworked loess; noncalcareous; abrupt boundary.

8.0-10.0 244-305	GW C5	10YR 4/4-dark yellowish brown; gravel; single grained; loose; noncalcareous; abrupt boundary.
10.0-20.0 305-610	ML C6	10YR 4/4-dark yellowish brown; silt loam (silt); massive; friable; reworked loess; noncalcareous.

SITE NAME: ST59 **Site 42 RM52.3** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Mississippi River Late Holocene surface capped by PSA.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River historical alluvium.
WATER TABLE: Below depth of core.
SURFACE ELEVATION: approx. 330.0'
USGS 7.5 MIN.QUADRANGLE: Cape Girardeau-MO-IL.
SLOPE: 0%
VEGETATION: Weeds.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 10.2', 310cm.
PHOTOGRAPHED: Took slides of slump block falling into the channel.
DATE DESCRIBED: 10/17/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Extremely thick bedded silt, clayey silt, very fine and medium sand historical deposits.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-1.5 0-45	ML-SM C	10YR 4/4-4/2-3/1-dark yellowish brown, dark grayish brown, and very dark gray; silt loam, silty clay loam, and loam (silt, fine sandy silt, and clayey silt); massive; friable; laminae of thick bedded historical silt, clayey silt and very fine sand; strongly calcareous; gradual boundary.
1.5-2.1 45-65	ML-CL C2	N3/0-very dark gray; silty clay loam (clayey silt); weak medium platy structure to massive; sticky; historical flood laminae; gleyed; strongly calcareous; abrupt boundary.
2.1-3.0 65-90	ML C3	10YR 4/2-dark grayish brown; silt loam (silt); massive; sticky; historical flood silt laminae; gleyed; strongly calcareous; abrupt boundary.
3.0-10.2 90-310	ML-SM C4	10YR 4/1-dark gray; silt loam, silty clay loam, and loam (silt, clayey silt, and very fine and medium sand); massive to single grained; sticky to loose; thick bedded laminae; strongly calcareous.

SITE NAME: Bank exposure/ST60 **Site 43 RM45.2** Left descending bank, midpoint.
GEOMORPHIC SURFACE: Holocene alluvial fan over Wisconsinan loess, over basal Loveland(?) loess and shale.
POSITION IN LANDSCAPE: Midfan.
PARENT MATERIALS: Reworked loess and colluvium.
WATER TABLE: Below bottom of exposure/core.
SURFACE ELEVATION: approx. 360.0'
USGS 7.5 MIN.QUADRANGLE: Thebes-MO-IL.
SLOPE: 5-10%
VEGETATION: Hardwoods, hickory.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 26.5', 808cm.
PHOTOGRAPHED: Took a slide of profile.
DATE DESCRIBED: 10/17/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Eroded Wisconsinan to early Holocene fan. Unclear what age the basal deposits are. Well developed multiple paleosols are recognized in the profile. Needs further study to determine if the buried soils are Wisconsinan or Holocene. Initial thought is that the buried soils are Wisconsinan aged based on the relatively high degree of paleosol profile development, and the basal highly oxidized unit over shale is Loveland loess (Sangamon soil). However, this Illinoian(?) loess could be too low stratigraphically.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-1.0 0-30	ML EB	5YR 5/4-reddish brown; silt loam (silt); weak medium subangular blocky structure; friable; many fine root and worm holes; A horizon is eroded; noncalcareous; clear boundary.
1.0-1.5 30-46	ML-CL Bt	5YR4/4-reddish brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common argillans; noncalcareous; clear boundary.
1.5-2.5 46-76	ML EBb	5YR 5/4-reddish brown; silt loam (silt); moderate medium subangular blocky structure; friable; many fine root and worm holes; A horizon is eroded or oxidized/altered; noncalcareous; clear boundary.
2.5-5.5 76-168	ML-CL Btb	5YR4/4-reddish brown; silty clay loam (clayey silt); strong medium to coarse subangular blocky structure; friable; common argillans, many silans, few Mn smears; noncalcareous; clear boundary.
5.5-8.0 168-244	ML BCb	5YR 5/4-reddish brown; silt loam (silt); weak medium subangular blocky structure; friable; common silans; noncalcareous; abrupt boundary.

8.0-10.0 244-305	ML-CL ABtb2	7.5YR 3/3-dark brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common silans, few argillans; noncalcareous; abrupt boundary.
10.0-14.0 305-427	ML-CL Btb2	7.5YR 4/4-brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common silans and argillans; noncalcareous; clear boundary.
14.0-16.0 427-488	ML-CL ABtb3	7.5YR 3/3-dark brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common silans, few argillans; noncalcareous; abrupt boundary.
16.0-18.0 488-549	ML-CL Btb3	7.5YR 4/4-brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common silans and argillans; noncalcareous; clear boundary.
18.0-20.5 549-625	ML Cb3	7.5YR 4/4-brown; silt loam (silt); massive; friable; noncalcareous; abrupt boundary.
20.5-22.0 625-671	ML-CL ABtb4	7.5YR 3/3-dark brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; common silans, few argillans; noncalcareous; abrupt boundary.
22.0-24.0 671-732	ML-SM 2BCb4	7.5YR 4/4-brown; silt loam to loam (silt to silty sand); moderate medium subangular blocky structure; friable; alluvial unit; calcareous; abrupt boundary.
24.0-25.0 732-762	SM 2Cb4	7.5YR 4/4-brown; loam (silty sand); massive to single grained; friable; alluvial laminae of silt and fine sand; common medium distinct mottles; calcareous; abrupt boundary.
25.0-26.5 762-808	ML-CL 3ABtb5	2.5YR4/4-reddish brown; silty clay loam (clayey silt); moderate medium subangular blocky structure; friable; many fine root holes; common argillans; Sangamon soil(?); noncalcareous; refusal from shale bedrock at 26.5'.

SITE NAME: ST61a&b **Site 44 RM25.8** Right descending bank, midpoint.
GEOMORPHIC SURFACE: Mississippi River historical surface.
POSITION IN LANDSCAPE: Flat lying.
PARENT MATERIALS: Mississippi River historical alluvium.
WATER TABLE: 40cm, 1.3'.
SURFACE ELEVATION: approx. 320.0'
USGS 7.5 MIN.QUADRANGLE: Cache-MO-IL.
SLOPE: 0%
VEGETATION: Weeds.
METHODOLOGY: JMC sampling tube core (1.0" or 1.5" ID).
DEPTH OF CORE, TRENCH, BORING, OR SOIL PIT: 2.6', 80cm.
PHOTOGRAPHED: Took 2 slides and 2 B/W of Site 44 area. One shot is of buried duck blind in bank, and note plastic bottle is 13.21 feet from the dune top.
DATE DESCRIBED: 10/17/1995
DESCRIBED BY: Jeff Anderson
REMARKS: Extremely thick bedded silt and very fine sand historical deposits. A plastic bottle is buried and ST61 is 22.02 feet below PSA dune top, plastic bottle is 13.21 feet below the dune top. Refusal from gravel below medium sand. Thick bedded silt and sand lie above the core, or upper 22.02 feet.

DEPTH (FT) (CM)	**USCS SOIL CLASSIFICATION USDA HORIZON DESIGNATION**	**SOIL/GEOLOGIC DESCRIPTION**
0-2.6 0-80	SP C	10YR 6/3-pale brown; medium sand; single grain; loose; reworked sand; calcareous; refusal from coarser gravel below.

Appendix I.

Field Survey Data Base

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	UP1	UP1	UP1	UP2
DATE	18-Sep-95	18-Sep-95	18-Sep-95	18-Sep-95
TIME	04:15 PM	03:30 PM	04:00 PM	04:30 PM
RIVER	IL	IL	IL	IL
RIVER MILE @ MIDPOINT	270.3	270.3	270.3	270.3
UTM X		391640.4		391694.5
UTM Y		4583560.1		4583366.4
BANK PROFILE TYPE	up	mp	dn	mp
RDB/LDB	RDB	RDB	RDB	LDB
POOL NAME	Marseilles Pool	Marseilles Pool	Marseilles Pool	Marseilles Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	n	n	n	n
ARCHEOLOGICAL SITE	n	n		n
SORROUNDING STRUCTURES	d/s of Dresden dam	d/s of Dresden dam	d/s of Dresden dam	d/s of Dresden island L&D.u/s of R.R. draw bridge
COMMERCIAL TRAFFIC LEVEL				
RECREATIONAL TRAFFIC LEVEL				H
ESTIMATED DISTANCE TO THE SAILING LINE	187.5'	187.5'	187.5'	281.3'
LAND USE ON BANK CREST	G(Weeds)	G(Weeds)	G(Weeds)	G(Weeds)
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds)	G(Weeds)	G(Weeds)	G(Weeds)
TYPE OF VEGETATION AT SCARP FACE		bare face, 4' tall	G(Weeds)	W(small trees..1 to 2 yrs. old. Medium diameter.. 6")
TYPE OF VEGETATION AT BENCH	NO	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		NO		Tree roots cover the scarp face.
OVERLAND DRAINAGE AT THE SITE		NO	NO	NO
BANK EROSION TYPE	B, L, FD, P, W, RT	?	Scarp	Scarp. FD, P, W, RT
SCARP HEIGHT	19.1'	11.0'	5.3'	
SCARP SLOPE	1.05H:1V	0.23H:1V	0.38H:1V	
SCARP SOIL TYPE	ML	ML (Dredge material)	ML	GP (boulders)
BERM HEIGHT	6.4'	1.2'	1.9'	7.1'
BERM WIDTH	10'	1.0'	2.0'	31.4'
BERM SOIL TYPE	ML	SM	SM	GP (boulders)
UNDER WATER SLOPE	6.72H:1V	7.63H:1V	9.01H:1V	10.99H:1V
BENCH SEDIMENT TYPE	Uniform sand	Uniform sand	Uniform sand	GP (Rocks)
SUBAQUOUS BENCH DESCRIPTION	Gravel & Sand filled	Sandy		Sandy

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	UP3	UP3
DATE	19-Sep-95	20-Sep-95
TIME	08:20 AM	07:30 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	264.3	264.3
UTM X	382564.0	382481.9
UTM Y	4579447.5	4579403.0
BANK PROFILE TYPE	up	mp
RDB/LDB	LDB	LDB
POOL NAME	Marseilles Pool	Marseilles Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE	n	n
SORROUNDING STRUCTURES	d/s of a boat ramp approx. 100'	Boat ramps, Docks, Trailer park at top of bank.
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL	H	H
ESTIMATED DISTANCE TO THE SAILING LINE	250'	250'
LAND USE ON BANK CREST		Trailer park
TYPE OF VEGETATION ON TOP OF BANK	W(Tall trees)G(grass)	Mowed lawn with trees(Oak,Hickory,Hardwoods)
TYPE OF VEGETATION AT SCARP FACE	A(some vines, Old Field)	Bare scarp, weedy berm, sandy bench
TYPE OF VEGETATION AT BENCH	NO	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' from top	2' to 3' exposed roots at scarp
OVERLAND DRAINAGE AT THE SITE	NO	NONE
BANK EROSION TYPE	FD, P, TR, W	F, C, S, B, L, P, W, R & T
SCARP HEIGHT	3.5'	3.5'
SCARP SLOPE	0.17H:1V	0.86H:1V
SCARP SOIL TYPE	ML	ML
BERM HEIGHT	2.3'	1.6'
BERM WIDTH	8.9'	2.5'
BERM SOIL TYPE	ML	ML
UNDER WATER SLOPE	21.74H:1V	21.74H:1V
BENCH SEDIMENT TYPE	Uniform sand	Sand
SUBAQUOUS BENCH DESCRIPTION	Mildly sloping, Sandy	Mildly sloping, Sandy

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	UP3	UP4
DATE	20-Sep-95	20-Sep-95
TIME	08:00 AM	10:30 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	264.3	262.1
UTM X	382349.9	379478.2
UTM Y	4579336.0	4578428.5
BANK PROFILE TYPE	dn	up
RDB/LDB	LDB	LDB
POOL NAME	Marseilles Pool	Marseilles Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE	n	n
SORROUNDING STRUCTURES	Boat docks, rock piles along bank.Camp trailer park at top of bank.	Fleeting area
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL	H	
ESTIMATED DISTANCE TO THE SAILING LINE	250'	250'
LAND USE ON BANK CREST	Trailer park	A(Corn)
TYPE OF VEGETATION ON TOP OF BANK	Mowed grass & hardwoods	G(Weeds)W(Ash)
TYPE OF VEGETATION AT SCARP FACE	Bare scarp, weedy berm/bench, sandy bench	Bare scarp, sandy bench & berm
TYPE OF VEGETATION AT BENCH	NONE	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' to 3' exposed roots in scarp area	3' exposed roots
OVERLAND DRAINAGE AT THE SITE	NONE	Yes. Rilling at scarp
BANK EROSION TYPE	F, C, S, B, L, P, W, R & T	F, C, B, L, P, W, R & T
SCARP HEIGHT	2.5'	5.2'
SCARP SLOPE	0.60H:1V	0.48H:1V
SCARP SOIL TYPE	ML	SM
BERM HEIGHT	4.1'	1.1'
BERM WIDTH	14.5'	2.0'
BERM SOIL TYPE	ML	SM
UNDER WATER SLOPE	20.83H:1V	7.52H:1V
BENCH SEDIMENT TYPE	Contaminated sediment, Rock piles, boulders in water	1.5" sand over SM
SUBAQUOUS BENCH DESCRIPTION	Mildly sloping sandy bench. contaminated sediment	Sandy bench & berm

SITE NUMBER	UP4	UP4
DATE	20-Sep-95	20-Sep-95
TIME	10:00 AM	10:20 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	262.1	262.1
UTM X	379101.9	378915.2
UTM Y	4578414.3	4578397.3
BANK PROFILE TYPE	mp	dn
RDB/LDB	LDB	LDB
POOL NAME	Marseilles Pool	Marseilles Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE	n	n
SORROUNDING STRUCTURES	Mooring & Fleeting area (Left bank only)	Barge fleeting area,1000' d/s of a parked barge
COMMERCIAL TRAFFIC LEVEL		?
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	250'	250'
LAND USE ON BANK CREST	A(Corn)	Navigable channel
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds) & 1 tree in vicinity of Midpoint	A(OLD FIELD. 6-8')
TYPE OF VEGETATION AT SCARP FACE	Bare scarp, some weeds on berm. Bare sandy bench.	Not much. Bare face
TYPE OF VEGETATION AT BENCH	NONE	Not observed
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1 tree near MP with 3' root exposure	NO
OVERLAND DRAINAGE AT THE SITE	Yes..rilling at scarp	NO
BANK EROSION TYPE	F, C, B, L, P, W, R & T	F, B, W, P, FD, R & T
SCARP HEIGHT	6.5'	5.4'
SCARP SLOPE	0.54H:1V	0.796H:1V
SCARP SOIL TYPE	SM	ML (Top), MH (Bottom)
BERM HEIGHT	0.5'	3.2'
BERM WIDTH	1.0'	9.8'
BERM SOIL TYPE	SM	MH
UNDER WATER SLOPE	12.50H:1V	10.20H:1V
BENCH SEDIMENT TYPE	1.5" sand over SM	SC, CH
SUBAQUOUS BENCH DESCRIPTION	Sandy bench over silt/clay	

SITE NUMBER	UP5	1
DATE	20-Sep-95	28-Aug-95
TIME	11:00 AM	12:45 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	262.1	242.0
UTM X	379069.4	351053.5
UTM Y	4578598.0	4577258.3
BANK PROFILE TYPE	mp	up
RDB/LDB	RDB	LDB
POOL NAME	Marseilles Pool	Marseilles Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE	no	
SORROUNDING STRUCTURES	Fleeting area across river on LT bank	
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	300'	250'
LAND USE ON BANK CREST	A(Corn)	W (Tall Ash?)
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds)W(Trees)	y
TYPE OF VEGETATION AT SCARP FACE	Bare scarp & bench	Yes
TYPE OF VEGETATION AT BENCH	NONE	NO.Gravel Bank,debris exposed root system for many live trees.soil washed away
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' to 3' exposed roots	Top 1/3
OVERLAND DRAINAGE AT THE SITE	Yes..rilling at top of scarp	No clear drainage
BANK EROSION TYPE	F, C, S, B, L, P, W, R & T	ML
SCARP HEIGHT	2.8'	10.0'
SCARP SLOPE	0.46H:1V	0.80H:1V
SCARP SOIL TYPE	ML/SC	
BERM HEIGHT	4.8'	
BERM WIDTH	12.7'	
BERM SOIL TYPE	ML/SC	Consolidated clay
UNDER WATER SLOPE	26.00:1V	40.65:1V
BENCH SEDIMENT TYPE	ML/SC	Gravel
SUBAQUOUS BENCH DESCRIPTION	Flat, silty/clay bench	No bench

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	1	2
DATE	28-Aug-95	28-Aug-95
TIME	10:45 AM	11:45 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	242.8	243.4
UTM X	350741.4	351073.2
UTM Y	4577495.6	4577241.0
BANK PROFILE TYPE	mp	mp
RDB/LDB	LDB	LDB
POOL NAME	Marseilles Pool	Marseilles Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE		
SORROUNDING STRUCTURES	u/s of Four star Marina, 0.3 mile. u/s of a delta	Across the river there is a Barge terminal
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL	M To H	M to H
ESTIMATED DISTANCE TO THE SAILING LINE	406'	250'
LAND USE ON BANK CREST	W (Tall Oak 10 to 30 Ft.) A (Soybean Field)	W (Oak 30'-40')
TYPE OF VEGETATION ON TOP OF BANK	W (tall Oak)	G (small weeds)
TYPE OF VEGETATION AT SCARP FACE	W (2 to 3 Yrs. old Maple Tree)	Grass roots, no yearly trees
TYPE OF VEGETATION AT BENCH	Yes. 4 To 6 Yrs. Old Trees	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Yes. average 3'2" depth root system.Seems has been Exposed several Yrs.	Covers whole height of the bank
OVERLAND DRAINAGE AT THE SITE	Bank drainage, d/s of main transect	Clear moist layer at bottom of steep face
BANK EROSION TYPE	S,B,L,R&T.Weathering	P,S,R & T
SCARP HEIGHT	12.5'	6.0'
SCARP SLOPE	0.53H:1V	0.53H:1V
SCARP SOIL TYPE	Clay silt, silt consolidated	SC
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	GC	SW, SP
UNDER WATER SLOPE	6.06:1V	17.24H:1V
BENCH SEDIMENT TYPE	Coarse sand,gravel	Fine sand.5" to 8", silt underneath
SUBAQUOUS BENCH DESCRIPTION		Mildly sloping, sandy

SITE NUMBER	3	3
DATE	28-Aug-95	28-Aug-95
TIME	04:00 PM	04:13 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	236.0	235.7
UTM X	340784.5	340696.9
UTM Y	4576162.3	4576152.8
BANK PROFILE TYPE	up	mp
RDB/LDB	RDB	RDB
POOL NAME	Starved Rock	Starved Rock
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Spoil site, levee	
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE		
SORROUNDING STRUCTURES	Sheehan Island	Sheehan Island
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL	H	H
ESTIMATED DISTANCE TO THE SAILING LINE	125'	125'
LAND USE ON BANK CREST	W (Cottonwood. dia 10")	
TYPE OF VEGETATION ON TOP OF BANK	G (some weeds)	
TYPE OF VEGETATION AT SCARP FACE	G (some 1-2 yrs old bushes)	
TYPE OF VEGETATION AT BENCH	N	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Trees fell half way, stabilized and regrew	
OVERLAND DRAINAGE AT THE SITE	No obvious drainage	
BANK EROSION TYPE	W, L, SL	W, S, B, undercut
SCARP HEIGHT	17.8'	15.0'
SCARP SLOPE	0.10H:1V	0.40H:1V
SCARP SOIL TYPE	GC	
BERM HEIGHT		5.0'
BERM WIDTH		6.0'
BERM SOIL TYPE	SM	
UNDER WATER SLOPE	50.00H:1V	8.00:1V
BENCH SEDIMENT TYPE	GP	
SUBAQUOUS BENCH DESCRIPTION	There is a rework zone (berm).	

SITE NUMBER	3
DATE	28-Aug-95
TIME	03:20 PM
RIVER	IL
RIVER MILE @ MIDPOINT	235.8
UTM X	340557.6
UTM Y	4576153.5
BANK PROFILE TYPE	dn
RDB/LDB	RDB
POOL NAME	Starved Rock
GEOMORPHIC CHARACTER	STRAIGHT REACH
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	
ARCHEOLOGICAL SITE	
SORROUNDING STRUCTURES	From Nav. chart there is a lake behind it, Sheehan Island
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	125'
LAND USE ON BANK CREST	W (Maple, Elm, Locust.Sparse wood.Dia=3"-6".trees has exposed roots)
TYPE OF VEGETATION ON TOP OF BANK	
TYPE OF VEGETATION AT SCARP FACE	NONE
TYPE OF VEGETATION AT BENCH	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	5' from top
OVERLAND DRAINAGE AT THE SITE	No obvious drainage
BANK EROSION TYPE	W, L, SL
SCARP HEIGHT	13.5'
SCARP SLOPE	0.089H:1V
SCARP SOIL TYPE	ML
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	SM
UNDER WATER SLOPE	12.05H:1V
BENCH SEDIMENT TYPE	GP, Shells
SUBAQUOUS BENCH DESCRIPTION	Fine sand, shells..seems from bank

SITE NUMBER	4
DATE	28-Aug-95
TIME	06:25 PM
RIVER	IL
RIVER MILE @ MIDPOINT	228.1
UTM X	329394.2
UTM Y	4576201.9
BANK PROFILE TYPE	up
RDB/LDB	LDB
POOL NAME	Peoria Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	
ARCHEOLOGICAL SITE	y
SORROUNDING STRUCTURES	d/s of Starved Rock L&D; spoil site across the river
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	Wave impact can be severe
ESTIMATED DISTANCE TO THE SAILING LINE	362.5'
LAND USE ON BANK CREST	W (dia>1')
TYPE OF VEGETATION ON TOP OF BANK	W
TYPE OF VEGETATION AT SCARP FACE	Yes
TYPE OF VEGETATION AT BENCH	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed root system can demonstrate how much erosion has been..but trees survived and established protection system
OVERLAND DRAINAGE AT THE SITE	Fairly extended bank erosion site
BANK EROSION TYPE	P(above tree line),W,R&T
SCARP HEIGHT	2.8'
SCARP SLOPE	3.21H:1V
SCARP SOIL TYPE	ML
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	
UNDER WATER SLOPE	18.18H:1V
BENCH SEDIMENT TYPE	Clay bottom, covered with shells
SUBAQUOUS BENCH DESCRIPTION	Beach is mild slope..has gravel and shells (mussel site)

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	4	4	5
DATE	28-Aug-95	28-Aug-95	28-Aug-95
TIME	06:40 PM	07:00 PM	07:40 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	228.0	228.0	229.0
UTM X	329198.4	329002.3	329950.4
UTM Y	4576183.1	4576184.0	4576590.3
BANK PROFILE TYPE	mp	dn	up
RDB/LDB	LDB	LDB	RDB
POOL NAME	Peoria Pool	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	n	n	
ARCHEOLOGICAL SITE	n	n	y
SORROUNDING STRUCTURES	N/A	N/A	d/s of a dock
COMMERCIAL TRAFFIC LEVEL			H
RECREATIONAL TRAFFIC LEVEL			H
ESTIMATED DISTANCE TO THE SAILING LINE	362.5'	362.5'	437.5'
LAND USE ON BANK CREST	G,W (25' wooded behind this..Trees have exposed roots.)	G & W (Maple)	A (Corn)
TYPE OF VEGETATION ON TOP OF BANK	G	G,W(Maple)	G (high weeds. 5')
TYPE OF VEGETATION AT SCARP FACE	G, W	G	G (Weeds)
TYPE OF VEGETATION AT BENCH	G	None	None
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed roots	Exposed roots..3-4' exposure	Weeds
OVERLAND DRAINAGE AT THE SITE	No specific OB drainage noted	Piping features noted in upper half of bank	
BANK EROSION TYPE	?		
SCARP HEIGHT	8'	7'	6.6'
SCARP SLOPE	10H:1V	5H:1V	0.697H:1V
SCARP SOIL TYPE	SM	SC	SC
BERM HEIGHT	3'	0.5'	2.6'
BERM WIDTH	12'	10'	17.7'
BERM SOIL TYPE	SM	SC	
UNDER WATER SLOPE	21.28H:1V	25.64H:1V	21.74H:1V
BENCH SEDIMENT TYPE	Silt & clay at least 18" thick	SC	Fine sand
SUBAQUOUS BENCH DESCRIPTION			

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	5	5
DATE	28-Aug-95	28-Aug-95
TIME	07:25 PM	07:30 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	228.8	228.50
UTM X	329841.9	329615.9
UTM Y	4576562.9	4576472.9
BANK PROFILE TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	INSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE	y	y
SORROUNDING STRUCTURES	d/s of dock, approx. 500'	N/A
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL	Can be severe	H
ESTIMATED DISTANCE TO THE SAILING LINE	437.5'	375'
LAND USE ON BANK CREST	A (Corn)	A (Corn)
TYPE OF VEGETATION ON TOP OF BANK	G (high weeds. 5')	G,W(Maple)
TYPE OF VEGETATION AT SCARP FACE		G,W(Maple)
TYPE OF VEGETATION AT BENCH	NO	Weeds. No submerged or emergent vegetation
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Weeds..no trees	Exposed roots..3-4' exposure
OVERLAND DRAINAGE AT THE SITE	Piping features, 1-2' wide 10" high hole	Piping features noted in bank..approx. 1/3 to 1/2 down from top
BANK EROSION TYPE		
SCARP HEIGHT		5.0'
SCARP SLOPE		0.96H:1V
SCARP SOIL TYPE	SC	SM
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE		SM
UNDER WATER SLOPE	23.81H:1V	17.24H:1V
BENCH SEDIMENT TYPE	Fine sand	Sand to first bench
SUBAQUOUS BENCH DESCRIPTION	Mild slope	6" bench at base of slope

SITE NUMBER	6	6
DATE	29-Aug-95	29-Aug-95
TIME	10:35 AM	10:40 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	210.0	210.0
UTM X	303867.0	303968.9
UTM Y	4573586.1	4573353.5
BANK PROFILE TYPE	up	mp
RDB/LDB	RDB	RDB
POOL NAME	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	CROSS OVER	CROSS OVER
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE		n
SORROUNDING STRUCTURES	d/s from entrance of Spring Lake	N/A
COMMERCIAL TRAFFIC LEVEL	?	
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	268.8'	268.8'
LAND USE ON BANK CREST	A (20' inside is corn field)	A (Corn)
TYPE OF VEGETATION ON TOP OF BANK	Yes	G,W(Maple)
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	G,W(Maple)
TYPE OF VEGETATION AT BENCH		Smartweed on shore..20' from WE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Some	Exposed roots..3-4' exposure
OVERLAND DRAINAGE AT THE SITE	n	None noted
BANK EROSION TYPE	RS, W, Tractive force	
SCARP HEIGHT	2.0'; 8.6'	5'
SCARP SLOPE	0.20H:1V; 0.30H:1V	5H:1V
SCARP SOIL TYPE	CL	CL
BERM HEIGHT	2.4'	2.5'
BERM WIDTH	7.9'	10'
BERM SOIL TYPE	OH	OH
UNDER WATER SLOPE	6.10H:1V	16.13H:1V
BENCH SEDIMENT TYPE	OH	OH
SUBAQUOUS BENCH DESCRIPTION		Fine sand over silty clay material.No vegetation except trees with exposed roots

SITE NUMBER	6	7	7
DATE	29-Aug-95	29-Aug-95	29-Aug-95
TIME	11:15 AM	12:15 PM	12:00 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	209.7	203.8	203.8
UTM X	304100.8	303515.4	303604.8
UTM Y	4573064.0	4564680.0	4564485.4
BANK PROFILE TYPE	dn	up	mp
RDB/LDB	RDB	LDB	LDB
POOL NAME	Peoria Pool	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	CROSS OVER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	n	n	n
ARCHEOLOGICAL SITE			n
SORROUNDING STRUCTURES	Big trees?	None. Outside of red buoy	N/A
COMMERCIAL TRAFFIC LEVEL		M	
RECREATIONAL TRAFFIC LEVEL		H	
ESTIMATED DISTANCE TO THE SAILING LINE	437.5'	437.5'	437.5'
LAND USE ON BANK CREST	W (silver maple)	Levee. Weeds < 1'	Levee/Dike
TYPE OF VEGETATION ON TOP OF BANK	G (weeds)	G (weeds)	G (Grass..Foxtail..Fesc?)
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	G (weeds)	G (Grass..Foxtail..Fesc?)W (Willows)
TYPE OF VEGETATION AT BENCH	None	NO	Grasses & weeds within 15' of edge of water
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		Not much	Generally not exposed
OVERLAND DRAINAGE AT THE SITE	None noted	n	None noted
BANK EROSION TYPE		W, P, Flood	W, F, R & T, L
SCARP HEIGHT		1.6'	4.3'
SCARP SLOPE		0.63H:1V	0.81H:1V
SCARP SOIL TYPE	CL	Clay, sand	Silts,sands & gravels
BERM HEIGHT			5.3'
BERM WIDTH			40.0'
BERM SOIL TYPE	CL	Silt, clay	Silt, sand & gravel
UNDER WATER SLOPE	14.93H:1V	23.26H:1V	23.26H:1V
BENCH SEDIMENT TYPE	Clay hard bottom, many newly deposited fines?	Soft fines over hard clay	Silt, sand & gravel
SUBAQUOUS BENCH DESCRIPTION			Wavewashed gravel at shore very muddy out in water

SITE NUMBER	7	8	8
DATE	29-Aug-95	29-Aug-95	29-Aug-95
TIME	12:45 PM	02:45 PM	02:30 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	203.5	184.9	184.8
UTM X	303656.6	294101.9	294026.5
UTM Y	4564379.3	4538463.5	4538140.8
BANK PROFILE TYPE	dn	up	mp
RDB/LDB	LDB	LDB	LDB
POOL NAME	Peoria Pool	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE		Natural	Natural
WINGDAM PRESENT OR NOT	n	n	n
ARCHEOLOGICAL SITE			
SORROUNDING STRUCTURES	tree lines land ? about 20'	Babbs Slough	Fallen tree u/s of midpoint site
COMMERCIAL TRAFFIC LEVEL	M		
RECREATIONAL TRAFFIC LEVEL	H		
ESTIMATED DISTANCE TO THE SAILING LINE	500'	437.5'	375'
LAND USE ON BANK CREST	Levee	W (d > 2")	G, W (Maple)
TYPE OF VEGETATION ON TOP OF BANK	G (weeds)	G (weeds)	G,W
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	Fine young root System..covered bank	Scarp feature. No vegetation
TYPE OF VEGETATION AT BENCH	NO	NONE	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		Depth covered upto bench..approx 3'	Exposed roots right at scarp roots not exposed at top of bank
OVERLAND DRAINAGE AT THE SITE	n	Piping along W.E.	Some piping evident
BANK EROSION TYPE			W, P, L, R & T, C
SCARP HEIGHT	2.5'	2.9'	5'
SCARP SLOPE	1.40H:1V	0.07H:1V	0.20H:1V
SCARP SOIL TYPE	Clay, SAND	Sandy	Silt, Clay
BERM HEIGHT	4.5'	1.5'	0.7'
BERM WIDTH	36.4'	3.8'	2.0'
BERM SOIL TYPE	Sandy	Clay	Silty clay
UNDER WATER SLOPE	20.41H:1V	71.43H:1V	83.33H:1V
BENCH SEDIMENT TYPE	Clay hard bottom	Fine clay..approx. 10"?	Silty clay
SUBAQUOUS BENCH DESCRIPTION			Shallow silt/clay bench..very muddy

SITE NUMBER	8	9	9
DATE	29-Aug-95	29-Aug-95	29-Aug-95
TIME	03:05 PM	03:50 PM	03:45 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	184.7	179.9	179.8
UTM X	294017.6	290712.0	290623.2
UTM Y	4538038.0	4531428.2	4531241.3
BANK PROFILE TYPE	dn	up	mp
RDB/LDB	LDB	LDB	LDB
POOL NAME	Peoria Pool	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE			Natural
WINGDAM PRESENT OR NOT			n
ARCHEOLOGICAL SITE			
SORROUNDING STRUCTURES			N/A
COMMERCIAL TRAFFIC LEVEL	?		
RECREATIONAL TRAFFIC LEVEL	?		
ESTIMATED DISTANCE TO THE SAILING LINE	343.8'	312.5'	312.5'
LAND USE ON BANK CREST	W	W (Forest. Large trees > 1.5')G (Weed)	W, G (Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	Exposed fine roots		G,W
TYPE OF VEGETATION AT SCARP FACE		G (weeds 1')	roots exposed..2-3' trees falling over
TYPE OF VEGETATION AT BENCH		NONE	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		Not obvious	Exposed roots..2-3'..trees falling over
OVERLAND DRAINAGE AT THE SITE	n	n	n
BANK EROSION TYPE		W, P	R & T, P, W
SCARP HEIGHT	5.2'		2.5'
SCARP SLOPE	0.48H:1V		8.00
SCARP SOIL TYPE	Clay		Sandy silt
BERM HEIGHT			2.5
BERM WIDTH			?
BERM SOIL TYPE	Clay		Silty sand/sandy silt
UNDER WATER SLOPE	47.62H:1V	21.28H:1V	15.87H:1V
BENCH SEDIMENT TYPE	Silt	Fines, some sand	Sand/silty sand
SUBAQUOUS BENCH DESCRIPTION			Sandy..gently sloping to 88' and then steep drop

SITE NUMBER	9	10
DATE	29-Aug-95	29-Aug-95
TIME	04:05 PM	06:25 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	179.7	160.0
UTM X	290573.4	278707.8
UTM Y	4531100.5	4503931.6
BANK PROFILE TYPE	dn	up
RDB/LDB	LDB	RDB
POOL NAME	Peoria Pool	Peoria Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE	n	
SORROUNDING STRUCTURES	u/s Peoria Lake	1000' u/s Kickapoo Creek.d/s of drawbridge(Peoria)Fleeting on RDb(u/s about 1000')
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL		H
ESTIMATED DISTANCE TO THE SAILING LINE	312.5'	437.5'
LAND USE ON BANK CREST	W (Forest)	W (maple d>1')
TYPE OF VEGETATION ON TOP OF BANK	G (weeds)	Root System
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	Root System
TYPE OF VEGETATION AT BENCH	NO	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed roots on sandy beach	exposed young roots still exist
OVERLAND DRAINAGE AT THE SITE	Very wet sand beach..sink easily	Dry.Piping? perhaps not seen holes
BANK EROSION TYPE		W, R & T
SCARP HEIGHT		1.0'
SCARP SLOPE		0.70H:1V
SCARP SOIL TYPE	SW	Clay
BERM HEIGHT		0.7'
BERM WIDTH		1.9'
BERM SOIL TYPE	SW	Clay
UNDER WATER SLOPE	14.08H:1V	15.02H:1V
BENCH SEDIMENT TYPE	MH	sandy
SUBAQUOUS BENCH DESCRIPTION	Very thick sediment. Mostly fines	Sandy

SITE NUMBER	10	10	11
DATE	29-Aug-95	29-Aug-95	30-Aug-95
TIME	06:20 PM	06:45 PM	11:00 AM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	160.0	160.0	155.3
UTM X		278782.8	275633.8
UTM Y		4503756.5	4498857.0
BANK PROFILE TYPE	mp	dn	up
RDB/LDB	RDB	RDB	RDB
POOL NAME	Peoria Pool	Peoria Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	n	n	
ARCHEOLOGICAL SITE			
SORROUNDING STRUCTURES	Kickapoo Creek (d/s)	Fleet (u/s at LDB)	
COMMERCIAL TRAFFIC LEVEL	H	H	
RECREATIONAL TRAFFIC LEVEL	H	H	?
ESTIMATED DISTANCE TO THE SAILING LINE	437.5'	437.5'	356'
LAND USE ON BANK CREST	G, W (maple, elm,mulberry)	W (dia> 1')	W
TYPE OF VEGETATION ON TOP OF BANK	G (Sparse),W	NO	Y
TYPE OF VEGETATION AT SCARP FACE	W	Root System	Yes
TYPE OF VEGETATION AT BENCH	N/A	NONE	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed at scarp..vertical scarp	Exposed	?
OVERLAND DRAINAGE AT THE SITE	Yes.Piping conduits	Piping(Clear)	Nearshore sand is moist
BANK EROSION TYPE	P, W, R & T	P, W, R & T, C	W, R & T
SCARP HEIGHT	1.2'	1.8'	
SCARP SLOPE	0.83H:1V	0.56H:1V	
SCARP SOIL TYPE	SM	Clay	Clayish
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE	SM	Clay	Sand
UNDER WATER SLOPE	5.59H:1V	10.53H:1V	11.24H:1V
BENCH SEDIMENT TYPE	Silt/clay	Fines	Silt,clay
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	11	11
DATE	30-Aug-95	30-Aug-95
TIME	08:15 AM	11:30 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	155.3	155.3
UTM X	275333.0	275081.0
UTM Y	4498517.0	4498155.0
BANK PROFILE TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE	n	
SORROUNDING STRUCTURES	N/A	500' u/s dock structure
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	356'	356'
LAND USE ON BANK CREST	G,W (Silver Maple, Cottonweed, Mulberry, Popler)	
TYPE OF VEGETATION ON TOP OF BANK	G (Sparse weeds),W	G (weeds)
TYPE OF VEGETATION AT SCARP FACE	G (no trees)	None?
TYPE OF VEGETATION AT BENCH	N/A	Yes
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed roots..1-3' exposure	
OVERLAND DRAINAGE AT THE SITE	None noted in MP reach.Desication cracking in bench area	None
BANK EROSION TYPE	W, R & T	
SCARP HEIGHT		0.8'
SCARP SLOPE	N/A	0.50H:1V
SCARP SOIL TYPE	SM	
BERM HEIGHT	8'	4.5'
BERM WIDTH	50'	21.2'
BERM SOIL TYPE	SM, SC	S
UNDER WATER SLOPE	11.12H:1V	9.00H:1V
BENCH SEDIMENT TYPE	SC	Hard clay, silt
SUBAQUOUS BENCH DESCRIPTION	Sandy beach with several mini scarps.	

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	12	12	12
DATE	30-Aug-95	30-Aug-95	30-Aug-95
TIME	08:45 AM	09:40 AM	10:40 AM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	154.4	154.4	154.4
UTM X	274998.3	275006.4	275133.0
UTM Y	4497410.4	4496947.7	4496385.5
BANK PROFILE TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	Lagrange Pool	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE		Natural	
WINGDAM PRESENT OR NOT		n	
ARCHEOLOGICAL SITE		n	
SORROUNDING STRUCTURES	Power plant across the river	N/A	across the river is loading dock
COMMERCIAL TRAFFIC LEVEL			
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE	343.8'	343.8'	343.8'
LAND USE ON BANK CREST	W (d > 10")	G,W (Willows/Maples)	W
TYPE OF VEGETATION ON TOP OF BANK	G (weeds)	G,W (Willows/Maples)	G (Tall weeds)
TYPE OF VEGETATION AT SCARP FACE	G (weeds)?	G	G (Tall weeds)?
TYPE OF VEGETATION AT BENCH		N/A	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed roots?	Exposure at large scarp..2-3'	Some but not near the WE now
OVERLAND DRAINAGE AT THE SITE	Moist bank soil	Some piping noted	
BANK EROSION TYPE		R & T, P, W	
SCARP HEIGHT		1.5'- 2'	
SCARP SLOPE		2H:1V	
SCARP SOIL TYPE	P, W	SM	
BERM HEIGHT		11'	
BERM WIDTH		106'	
BERM SOIL TYPE	Clay	SM	Clay
UNDER WATER SLOPE	16.95H:1V	16.95H:1V	9.00H:1V
BENCH SEDIMENT TYPE	Fine silt over clay	SC	
SUBAQUOUS BENCH DESCRIPTION	Cracks in weed zone are much deeper than shore zone.	Wide weed covered bench	

SITE NUMBER	13	13	13
DATE	30-Aug-95	30-Aug-95	30-Aug-95
TIME	12:15 PM	12:10 PM	12:45 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	150.6	150.5	150.5
UTM X	272669.0	272552.0	272494.9
UTM Y	4492518.0	4492631.0	4492750.0
BANK PROFILE TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	Lagrange Pool	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT		n	
ARCHEOLOGICAL SITE		n	n
SORROUNDING STRUCTURES	N/A	none	none
COMMERCIAL TRAFFIC LEVEL			?
RECREATIONAL TRAFFIC LEVEL			?
ESTIMATED DISTANCE TO THE SAILING LINE	562.5'	375'	375'
LAND USE ON BANK CREST	W (Large Woods, Sparse Veg.)	G, W (Cottonwood, Silver Maple)	W (about 30' inside).Weeds sparse
TYPE OF VEGETATION ON TOP OF BANK	Not much	G (mostly weeds)	some
TYPE OF VEGETATION AT SCARP FACE	NO	G (weeds)	G (weeds)
TYPE OF VEGETATION AT BENCH	NONE	N/A	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Fallen trees..no trees directly near bank line	Root exposure at high scarp only	NO
OVERLAND DRAINAGE AT THE SITE		Yes.Piping scarp	None observed
BANK EROSION TYPE		F, B, P, W, R & T	W, R & T
SCARP HEIGHT	3.3'	4.3'	1.2'
SCARP SLOPE	0.09H:1V	Vertical	0.58H:1V
SCARP SOIL TYPE		ML	Hard Clay
BERM HEIGHT	1.0'	1.5'	5.1'
BERM WIDTH	2.9'	6.0'	13.6'
BERM SOIL TYPE		SM	
UNDER WATER SLOPE	2.90H:1V	8.00H:1V	2.67H:1V
BENCH SEDIMENT TYPE		ML	
SUBAQUOUS BENCH DESCRIPTION		Underwater sand	

SITE NUMBER	14	14	14
DATE	30-Aug-95	30-Aug-95	30-Aug-95
TIME	04:15 PM	04:15 PM	04:45 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	129.3	129.3	129.2
UTM X	247110.9	247031.2	246927.0
UTM Y	4476372.6	4476130.5	4475938.9
BANK PROFILE TYPE	up	mp	dn
RDB/LDB	RDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	INSIDE BEND	INSIDE BEND	INSIDE BEND
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT		n	
ARCHEOLOGICAL SITE		y*	
SORROUNDING STRUCTURES		N/A	none
COMMERCIAL TRAFFIC LEVEL	?		?
RECREATIONAL TRAFFIC LEVEL	Heavy		?
ESTIMATED DISTANCE TO THE SAILING LINE	275'	275'	250'
LAND USE ON BANK CREST	G (Sparse Weeds) W (inside)	G,W (Silver Maple)	W
TYPE OF VEGETATION ON TOP OF BANK	Not much	G,W	G (weeds)
TYPE OF VEGETATION AT SCARP FACE	Exposed tree roots	NONE	G (Sparse weeds)
TYPE OF VEGETATION AT BENCH	NONE	N/A	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Yes?	Exposed roots..2-3'	Yes?
OVERLAND DRAINAGE AT THE SITE	None observed	Yes.Some piping noted	None observed
BANK EROSION TYPE	W, R & T	W, P, L, R & T	W, R & T
SCARP HEIGHT		1.3'	2.1'
SCARP SLOPE		0.38H:1V	2.62H:1V
SCARP SOIL TYPE	Clay	SC	Clay?
BERM HEIGHT		4.1'	1.9'
BERM WIDTH		10.5'	8.7'
BERM SOIL TYPE			
UNDER WATER SLOPE	10.10H:1V	7.87H:1V	14.49H:1V
BENCH SEDIMENT TYPE			
SUBAQUOUS BENCH DESCRIPTION		Micro piping, bare/no vegetation. Wave induced scarps (small)	

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	15	15	15	16
DATE	30-Aug-95	30-Aug-95	30-Aug-95	31-Aug-95
TIME	06:35 PM	06:45 PM	07:10 PM	11:05 AM
RIVER	IL	IL	IL	IL
RIVER MILE @ MIDPOINT	116.9	116.5	116.3	109.8
UTM X	236090.6	235627.9	235208.9	228584.1
UTM Y	4461771.8	4461324.5	4460482.6	4454029.6
BANK PROFILE TYPE	up	mp	dn	up
RDB/LDB	RDB	RDB	RDB	LDB
POOL NAME	Lagrange Pool	Lagrange Pool	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	OUTSIDE BEND	INSIDE BEND
BANK TYPE		Natural		Natural
WINGDAM PRESENT OR NOT		n		
ARCHEOLOGICAL SITE		n		y
SORROUNDING STRUCTURES	Levee?	N/A	Has riprap for a section of the levee	no
COMMERCIAL TRAFFIC LEVEL			?	?
RECREATIONAL TRAFFIC LEVEL	?		?	?
ESTIMATED DISTANCE TO THE SAILING LINE	375'	438'	344'	281.3'
LAND USE ON BANK CREST	G (mowed)		G (mowed)	W
TYPE OF VEGETATION ON TOP OF BANK		W	G (Tall Grass..6')	NO
TYPE OF VEGETATION AT SCARP FACE	G (tall grass..6')	G (weeds)	G (Tall Grass..6')	G (young weeds)
TYPE OF VEGETATION AT BENCH	NONE	N/A	NONE	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NONE	NONE	NONE	Yes?
OVERLAND DRAINAGE AT THE SITE	Levee.None observed	None observed	None observed	
BANK EROSION TYPE	Flood, W, P	R & T, P, W	Flood, W, P, B	
SCARP HEIGHT	2.5'	2.7'	2.0'	4.9'
SCARP SLOPE	0.28H:1V	0.04H:1V	0.45H:1V	0.41H:1V
SCARP SOIL TYPE		ML/CL		Clay
BERM HEIGHT	7.0'	2.5'	8.1'	3.4'
BERM WIDTH	24.5'	7.9'	22.9'	13.3'
BERM SOIL TYPE				
UNDER WATER SLOPE	8.10H:1V	9.52H:1V	10.99H:1V	6.99H:1V
BENCH SEDIMENT TYPE				
SUBAQUOUS BENCH DESCRIPTION		Sandy..bare..no significant scarp		

SITE NUMBER	16	16	17
DATE	31-Aug-95	31-Aug-95	31-Aug-95
TIME	10:25 AM	10:38 AM	10:00 AM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	109.5	109.2	109.4
UTM X	228297.8		
UTM Y	4453967.3		
BANK PROFILE TYPE	mp	dn	up
RDB/LDB	LDB	LDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	INSIDE BEND	INSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural		
WINGDAM PRESENT OR NOT	n		
ARCHEOLOGICAL SITE	n	y	
SORROUNDING STRUCTURES	N/A	no	no
COMMERCIAL TRAFFIC LEVEL		?	?
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE	250'	250'	262.5'
LAND USE ON BANK CREST	W,G (Silver Maple)	W (Silver Maple)	W
TYPE OF VEGETATION ON TOP OF BANK	G,W	Yes	Yes
TYPE OF VEGETATION AT SCARP FACE	NONE	NONE	G (weeds)?
TYPE OF VEGETATION AT BENCH	N/A		NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed roots..3-3.5'	Exposed roots at crest line	NONE
OVERLAND DRAINAGE AT THE SITE	Yes.Piping in large scarp area		
BANK EROSION TYPE	F, C, L, P, W, R & T		Prop. wash, Flood
SCARP HEIGHT	3.1'	3.9'	
SCARP SLOPE	0.26H:1V	0.49H:1V	
SCARP SOIL TYPE	ML		Clay
BERM HEIGHT	4.0'		
BERM WIDTH	9.2'		
BERM SOIL TYPE			
UNDER WATER SLOPE	8.50H:1V	14.49H:1V	4.29H:1V
BENCH SEDIMENT TYPE			
SUBAQUOUS BENCH DESCRIPTION	Silt/clay, No vegetation, small scarps with piping, steep underwater slope		

SITE NUMBER	17	17
DATE	31-Aug-95	31-Aug-95
TIME	09:15 AM	10:30 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	109.5	109.6
UTM X	228122.1	227888.1
UTM Y	4454067.1	4453867.9
BANK PROFILE TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE	n	
SORROUNDING STRUCTURES	N/A	
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	287.5'	312.5'
LAND USE ON BANK CREST	G,W (Silver Maple, Cottonwood)	W
TYPE OF VEGETATION ON TOP OF BANK	G,W	Yes
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	G (Sparse weeds)
TYPE OF VEGETATION AT BENCH	N/A	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed roots..3'	Some. Not uniform
OVERLAND DRAINAGE AT THE SITE	Piping in bench and berm area.	No
BANK EROSION TYPE	P, W, R & T	
SCARP HEIGHT	1.5'	3.0'
SCARP SLOPE	1.00	0.47H:1V
SCARP SOIL TYPE	SC(upper scarp)ML(Scarp at W.E.)	Clay
BERM HEIGHT	5'	3.7'
BERM WIDTH	25'	10.2'
BERM SOIL TYPE		
UNDER WATER SLOPE	3.50H:1V	4.00H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION	10' wide, clay/silt,small scarplet at berm interface, scarp @ W.E., steep sub-aquious slope	

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	18	18
DATE	31-Aug-95	31-Aug-95
TIME	02:40 PM	02:15 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	94.3	94.2
UTM X	210725.4	210743.5
UTM Y	4442789.0	4442711.8
BANK PROFILE TYPE	up	mp
RDB/LDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	CROSS OVER	INSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT		n
ARCHEOLOGICAL SITE		n
SORROUNDING STRUCTURES	Sugar Creek	N/A
COMMERCIAL TRAFFIC LEVEL	?	
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	250'	162.5'
LAND USE ON BANK CREST	G (Dense Weeds)	W,G (Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	Yes	G,W
TYPE OF VEGETATION AT SCARP FACE	NO	G (weeds)*
TYPE OF VEGETATION AT BENCH	NONE	N/A
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Young roots, cover scrap face	2-3' of exposure at scarp
OVERLAND DRAINAGE AT THE SITE	No	Yes.Overbank drainage,erosion at scarp (minor),piping in scarp
BANK EROSION TYPE	F, P, W	F, B, L, C, P, W, R & T
SCARP HEIGHT	1.7'	2.1'
SCARP SLOPE	0.47H:1V	0.24H:1V
SCARP SOIL TYPE	Clay	ML
BERM HEIGHT	1.6'	1.2'
BERM WIDTH	5.5'	4.0'
BERM SOIL TYPE		
UNDER WATER SLOPE	7.35H:1V	8.55H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		bare..starts flat & then very steep out 8'

SITE NUMBER	18	19
DATE	31-Aug-95	31-Aug-95
TIME	02:20 PM	03:05 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	94.0	91.2
UTM X	210749.4	207329.0
UTM Y	4442636.9	4439736.6
BANK PROFILE TYPE	dn	up
RDB/LDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	INSIDE BEND	OUTSIDE BEND
BANK TYPE		Spoil
WINGDAM PRESENT OR NOT		
ARCHEOLOGICAL SITE		
SORROUNDING STRUCTURES	Sugar Creek u/s	d/s is barge piling
COMMERCIAL TRAFFIC LEVEL		?
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	281.3'	312.5'
LAND USE ON BANK CREST	W	G (Weeds 2' tall dense)
TYPE OF VEGETATION ON TOP OF BANK	Yes	Not much
TYPE OF VEGETATION AT SCARP FACE	Yes	NO
TYPE OF VEGETATION AT BENCH		None but Algae has grown on shoreline
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed root system along bank crest	single dead tree root
OVERLAND DRAINAGE AT THE SITE		4' above W.E. moisture line
BANK EROSION TYPE		Not obvious
SCARP HEIGHT	1.7'	
SCARP SLOPE	0.88H:1V	
SCARP SOIL TYPE	Clay	Clay
BERM HEIGHT	2.9'	
BERM WIDTH	9.5'	
BERM SOIL TYPE		
UNDER WATER SLOPE	12.99H:1V	4.76H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	19	19
DATE	31-Aug-95	31-Aug-95
TIME	04:00 PM	04:30 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	91.2	91.1
UTM X	207343.9	207354.3
UTM Y	4439516.1	4439374.9
BANK PROFILE TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE	n	
SORROUNDING STRUCTURES	Downstream Terminal fleeting area at this site	d/s. barge terminal
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	312.5'	312.5'
LAND USE ON BANK CREST	W(Mulberry, silver maple, Walnut)G(weeds on failure face & top of bank)	G (Weed 1')
TYPE OF VEGETATION ON TOP OF BANK	G,W	Root System
TYPE OF VEGETATION AT SCARP FACE	G,W	NO
TYPE OF VEGETATION AT BENCH	N/A	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	3-4' exposed roots	about 1'
OVERLAND DRAINAGE AT THE SITE	Piping features noted	2' above W.E. moist line
BANK EROSION TYPE	F, C, B, L, P, W, R & T	In channel erosion, W
SCARP HEIGHT	1.6'	
SCARP SLOPE	1.13H:1V	
SCARP SOIL TYPE	ML	Clay
BERM HEIGHT	2.6'	
BERM WIDTH	5.7'	
BERM SOIL TYPE		
UNDER WATER SLOPE	8.34H:1V	10.00H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION	?	

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	20	20	20
DATE	31-Aug-95	31-Aug-95	31-Aug-95
TIME	07:40 PM	07:15 PM	07:20 PM
RIVER	IL	IL	IL
RIVER MILE @ MIDPOINT	79.4	79.4	79.4
UTM X	197718.4	197650.4	197634.9
UTM Y	4426424.3	4425894.3	4425317.4
BANK PROFILE TYPE	up	mp	dn
RDB/LDB	RDB	RDB	RDB
POOL NAME	Lagrange Pool	Lagrange Pool	Lagrange Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	
WINGDAM PRESENT OR NOT		n	
ARCHEOLOGICAL SITE		n	
SORROUNDING STRUCTURES	d/s of Lagrange L&D	Upstream of Lagrange L&D	d/s Lagrange Pool, 1 mile
COMMERCIAL TRAFFIC LEVEL			?
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE	312.5'	312.5'	312.5'
LAND USE ON BANK CREST		A(Road, then crops)	Weeds
TYPE OF VEGETATION ON TOP OF BANK		G (weeds)	NO
TYPE OF VEGETATION AT SCARP FACE		G (weeds)	?
TYPE OF VEGETATION AT BENCH	NONE	N/A	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Collapsed tree.1 or 2..not too much	NONE..no trees at MP	NONE
OVERLAND DRAINAGE AT THE SITE		Yes..rilling above scarp piping	No
BANK EROSION TYPE		F, C, B, L, P, W, R & T	Scarps
SCARP HEIGHT		5'	7.2'
SCARP SLOPE		1.00	0.71H:1V
SCARP SOIL TYPE		SM	
BERM HEIGHT		4	
BERM WIDTH		10	
BERM SOIL TYPE			
UNDER WATER SLOPE	5.38H:1V	15.87H:1V	0.994H:1V
BENCH SEDIMENT TYPE			
SUBAQUOUS BENCH DESCRIPTION		?	

SITE NUMBER	21	21
DATE	01-Sep-95	01-Sep-95
TIME	11:00 AM	10:45 AM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	61.7	61.7
UTM X	187506.6	187444.5
UTM Y	4402080.5	4401875.8
BANK PROFILE TYPE	up	mp
RDB/LDB	RDB	RDB
POOL NAME	Alton Pool	Alton Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE		Natural
WINGDAM PRESENT OR NOT		y
ARCHEOLOGICAL SITE		n
SORROUNDING STRUCTURES	d/s. Draw bridge. Power line	Wing Dam.Bridge (see Nav. Charts)
COMMERCIAL TRAFFIC LEVEL	?	
RECREATIONAL TRAFFIC LEVEL	?	
ESTIMATED DISTANCE TO THE SAILING LINE	237.5'	237.5'
LAND USE ON BANK CREST	W (silver Maple 10')	G, W (Silver Maple, Willow)
TYPE OF VEGETATION ON TOP OF BANK	G (weeds)	G,W
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	G
TYPE OF VEGETATION AT BENCH	NONE	N/A
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NONE	Minor root exposure in 18" scarp. Small amount in 5'scarp
OVERLAND DRAINAGE AT THE SITE	NONE	Some piping.No other OB drainage noted.
BANK EROSION TYPE	P (lower bank), Flood(higher bank),W (rework on shore)	L, P, W, R & T, F
SCARP HEIGHT		2.4'
SCARP SLOPE		0.42H:1V
SCARP SOIL TYPE	Mixed clay sand	ML
BERM HEIGHT		3.1'
BERM WIDTH		5.0'
BERM SOIL TYPE		
UNDER WATER SLOPE	10.53H:1V	7.35H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	21	22
DATE	01-Sep-95	01-Sep-95
TIME	10:40 AM	01:00 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	61.4	46.5
UTM X	187399.6	190864.0
UTM Y	4401707.9	4376865.1
BANK PROFILE TYPE	dn	up
RDB/LDB	RDB	RDB
POOL NAME	Alton Pool	Alton Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE		
WINGDAM PRESENT OR NOT		
ARCHEOLOGICAL SITE		
SORROUNDING STRUCTURES	d/s is a drawbridge.Wing Dam across	
COMMERCIAL TRAFFIC LEVEL	?	
RECREATIONAL TRAFFIC LEVEL	?	
ESTIMATED DISTANCE TO THE SAILING LINE	375.0'	687.5'
LAND USE ON BANK CREST	W (Willows very dense)	G (weeds) A (beans field on crest 30' in)
TYPE OF VEGETATION ON TOP OF BANK	G (weeds..5'..very dense)	G (weeds)
TYPE OF VEGETATION AT SCARP FACE	G (weeds)	G (weeds)
TYPE OF VEGETATION AT BENCH	NO	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NONE	Some, not very dense
OVERLAND DRAINAGE AT THE SITE	Yes.Piping;Flow clear.	Yes.Bank drainage
BANK EROSION TYPE		F, P, W
SCARP HEIGHT	2.5'	
SCARP SLOPE	1H:1V	
SCARP SOIL TYPE	Clay	Clay
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE		
UNDER WATER SLOPE	9.52H:1V	6.49H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	22	22
DATE	01-Sep-95	01-Sep-95
TIME	12:50 PM	01:30 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	45.1	45.0
UTM X	190808.6	190754.7
UTM Y	4376758.5	4376663.8
BANK PROFILE TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	Alton Pool	Alton Pool
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE	n	
SORROUNDING STRUCTURES	None	None
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	312.5'	375'
LAND USE ON BANK CREST	A (Soy Beans)	A (Beans)
TYPE OF VEGETATION ON TOP OF BANK	G, W (Silver Maple, Willow)	W?
TYPE OF VEGETATION AT SCARP FACE	G,W	G (weeds)
TYPE OF VEGETATION AT BENCH	NONE	NONE
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' exposure in some areas	Dead trees..no exposed root
OVERLAND DRAINAGE AT THE SITE	Some piping features.none other noted.	Yes
BANK EROSION TYPE	C, L, P, W, R & T	scarp face
SCARP HEIGHT	1.0'	0.7'
SCARP SLOPE	0.50H:1V	0.14H:1V
SCARP SOIL TYPE	ML	Clay
BERM HEIGHT	1.1'	
BERM WIDTH	4.5'	
BERM SOIL TYPE		
UNDER WATER SLOPE	6.99H:1V	5.50H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION	Very soft sediment..silty clay, clay/silt 12" thick.soft neatly deposited sed.	

SITE NUMBER	23	23
DATE	01-Sep-95	01-Sep-95
TIME	04:30 PM	04:20 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	23.5	23.4
UTM X	189140.3	189116.5
UTM Y	4343555.8	4343344.1
BANK PROFILE TYPE	up	mp
RDB/LDB	RDB	RDB
POOL NAME	Alton Pool	Alton Pool
GEOMORPHIC CHARACTER	CROSS OVER	CROSS OVER
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT		n
ARCHEOLOGICAL SITE	n	n
SORROUNDING STRUCTURES	end of island	None
COMMERCIAL TRAFFIC LEVEL	?	
RECREATIONAL TRAFFIC LEVEL	Heavy	
ESTIMATED DISTANCE TO THE SAILING LINE	225.0'	187.5'
LAND USE ON BANK CREST	W (Silver Maple, Cottonwoods,Locus?)	G,W(Silver Maple, Elm, Cottonwood)
TYPE OF VEGETATION ON TOP OF BANK	G (5' weeds) A (OLD FIELD, grape)	G (Ragweed)
TYPE OF VEGETATION AT SCARP FACE	?	G (Ragweed)
TYPE OF VEGETATION AT BENCH	Algae	N/A
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Not here but slightly d/s..200'..has 4' root exposure	Roots exposed in failing bank above scarp
OVERLAND DRAINAGE AT THE SITE	Relative open space.tall trees at crest or slightly below crest.	Yes.rilling of upper bank.
BANK EROSION TYPE	F, W, P	C, L, F, W, R & T, OB drainage
SCARP HEIGHT		3.5'
SCARP SLOPE		1.26H:1V
SCARP SOIL TYPE	Clay	ML
BERM HEIGHT		0.9'
BERM WIDTH		2.0'
BERM SOIL TYPE		
UNDER WATER SLOPE	12.50H:1V	5.00H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		Bare bench relatively steep.

SITE NUMBER	23	24
DATE	01-Sep-95	01-Sep-95
TIME	04:45 PM	06:30 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	23.3	13.0
UTM X	189100.7	189603.8
UTM Y	4343255.5	4327657.9
BANK PROFILE TYPE	dn	up
RDB/LDB	RDB	RDB
POOL NAME	Alton Pool	Alton Pool
GEOMORPHIC CHARACTER	INSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT		
ARCHEOLOGICAL SITE		
SORROUNDING STRUCTURES	island side. Up of confluence	
COMMERCIAL TRAFFIC LEVEL	Heavy	Heavy
RECREATIONAL TRAFFIC LEVEL	Heavy	Heavy
ESTIMATED DISTANCE TO THE SAILING LINE	250'	437.5'
LAND USE ON BANK CREST	W	G (weeds) A (OLD FIELD)
TYPE OF VEGETATION ON TOP OF BANK	G (weeds) A (OLD FIELD,2')	G (weeds) A (OLD FIELD)
TYPE OF VEGETATION AT SCARP FACE	G (weeds in the upper bank..4')	A (OLD FIELD..in the upper bank)G (weeds)
TYPE OF VEGETATION AT BENCH	Algae	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Not here. Some rots stick out from bank at u/s 7' from crest..about 1"d	Vegetation covered upper bank
OVERLAND DRAINAGE AT THE SITE	Lower bank wet surface	Lower bank moist clay
BANK EROSION TYPE	F, P, W	F, P, W, R & T
SCARP HEIGHT	9.5'	5.6'
SCARP SLOPE	0.34H:1V	0.95H:1V
SCARP SOIL TYPE	Clay	Clay
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE		
UNDER WATER SLOPE	5.26H:1V	15.87H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		

FIELD DATA SUMMARY FOR SELECTED SITES FROM THE ILLINOIS RIVER

SITE NUMBER	24	24
DATE	01-Sep-95	01-Sep-95
TIME	06:00 PM	06:15 PM
RIVER	IL	IL
RIVER MILE @ MIDPOINT	13.0	13.0
UTM X	189759.5	189903.6
UTM Y	4327529.5	4327404.1
BANK PROFILE TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	Alton Pool	Alton Pool
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	
ARCHEOLOGICAL SITE		y
SORROUNDING STRUCTURES	d/s Hardy's landing	
COMMERCIAL TRAFFIC LEVEL		?
RECREATIONAL TRAFFIC LEVEL	?	?
ESTIMATED DISTANCE TO THE SAILING LINE	437.5'	437.5'
LAND USE ON BANK CREST	yes?	G(Weeds) W (tall trees)
TYPE OF VEGETATION ON TOP OF BANK	Yes	G (weeds), root
TYPE OF VEGETATION AT SCARP FACE	Yes	some
TYPE OF VEGETATION AT BENCH	Algae	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' from crest. mature	Young fine roots..2' from crest
OVERLAND DRAINAGE AT THE SITE	Wet line.2.5' above W.E.	
BANK EROSION TYPE	F, P, W	
SCARP HEIGHT	4.9'	2.0'
SCARP SLOPE	0.35H:1V	0.05H:1V
SCARP SOIL TYPE	Clay sample #1	
BERM HEIGHT	1.9'	3.1'
BERM WIDTH	3.4'	3.6'
BERM SOIL TYPE		
UNDER WATER SLOPE	11.40H:1V	25.00H:1V
BENCH SEDIMENT TYPE		
SUBAQUOUS BENCH DESCRIPTION		

FIELD/LAB DATA SUMMARY FOR SELECTED SITES FROM UPPER MISSISSIPPI RIVER

SITE NUMBER	1	2
DATE	11-Sep-95	12-Sep-95
TIME	12:30 PM	09:50 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	825.5	791.7
UTM X	23388.3	59070.8
UTM Y	4977262.6	4950321.4
BANK SECTION TYPE	mp	up
RDB/LDB	RDB	RDB
POOL NAME	POOL 2	POOL 4
GEOMORPHIC CHARACTER	OUTSIDE BEND*	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	d/s of a side channel (day marker 825.6)	d/s of ? slough
COMMERCIAL TRAFFIC LEVEL	H	H
RECREATIONAL TRAFFIC LEVEL	H	H
ESTIMATED DISTANCE TO THE SAILING LINE	281.3'	375'
LAND USE ON BANK CREST		
TYPE OF VEGETATION ON TOP OF BANK	W(Tall Trees..Species?)	Wild Flowers
TYPE OF VEGETATION AT SCARP FACE	G(Sparse weeds)	NO.Debris, weed roots and tree roots cover the first (Top) Scarp
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NONE	Approx. 2'
OVERLAND DRAINAGE AT THE SITE	Yes..Overland	NO
BANK EROSION TYPE	SP, L, W, FD	Scarp, R & T, W
SCARP HEIGHT	n/a	1.23
SCARP SLOPE	n/a	0.946
SCARP SOIL TYPE	SP	Scarp.Clay
BERM HEIGHT	n/a	9.4
BERM WIDTH	n/a	1.97
BERM SOIL TYPE	NO Berm	NO Berm
UNDER WATER SLOPE	0.2	5.319
BENCH SEDIMENT TYPE	?	SM
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	2	2
DATE	11-Sep-95	12-Sep-95
TIME	07:00 PM	10:50 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	791.7	791.5
UTM X		59181.9
UTM Y		4950043.9
BANK SECTION TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	POOL 4	POOL 4
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT		n
ARCHEOLOGICAL SITE		n
SURROUNDING STRUCTURES		
COMMERCIAL TRAFFIC LEVEL	H	H
RECREATIONAL TRAFFIC LEVEL	H	H
ESTIMATED DISTANCE TO THE SAILING LINE	375'	356.3'
LAND USE ON BANK CREST		W(Species?)
TYPE OF VEGETATION ON TOP OF BANK	G,W(High trees 1.5')	W(Species?)
TYPE OF VEGETATION AT SCARP FACE	NO	NO
TYPE OF VEGETATION AT BENCH	NO	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Root zone (fine dense root) covers down upto top sand beach and bench (50%)	2.6' high..5.5' inward
OVERLAND DRAINAGE AT THE SITE	Runoff	NO
BANK EROSION TYPE	Scarp, W, R & T	R & T
SCARP HEIGHT	0.74	n/a
SCARP SLOPE	1.48	n/a
SCARP SOIL TYPE	Major scarp face, Clay	
BERM HEIGHT	0.99	n/a
BERM WIDTH	5.5	n/a
BERM SOIL TYPE		NO Berm
UNDER WATER SLOPE	0.146	6.67H:1V
BENCH SEDIMENT TYPE	Sand over clay	SM
SUBAQUOUS BENCH DESCRIPTION		

FIELD/LAB DATA SUMMARY FOR SELECTED SITES FROM UPPER MISSISSIPPI RIVER

SITE NUMBER	3	3	3
DATE	12-Sep-95	12-Sep-95	12-Sep-95
TIME	08:20 AM	04:00 PM	04:30 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	763.4	763.4	763.2
UTM X	95361.1		95527.3
UTM Y	4929954.1		4929652.4
BANK SECTION TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	POOL 4	POOL 4	POOL 4
GEOMORPHIC CHARACTER	STRAIGHT REACH*	STRAIGHT REACH*	STRAIGHT REACH*
BANK TYPE			
WINGDAM PRESENT OR NOT	n	n	n
ARCHEOLOGICAL SITE	n	n	n
SURROUNDING STRUCTURES	d/s of Chippewa River	d/s of Chippewa River mouth	d/s of Chippewa River mouth
COMMERCIAL TRAFFIC LEVEL			
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE	843.8'	843.8'	712.5'
LAND USE ON BANK CREST	W(Elm, Silver Maple, Cottonwood..d, 1')	W(Silver Maple d=1' approx.)	W(Sparse?) G & Vegetation
TYPE OF VEGETATION ON TOP OF BANK	G(Grass..sparse)		G, A(Oat field)
TYPE OF VEGETATION AT SCARP FACE	Grapes		Grapes
TYPE OF VEGETATION AT BENCH	NO	Floating aquatic weeds	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Yes..2.5'		5'..(half of Bank Height)
OVERLAND DRAINAGE AT THE SITE	NO	NO	NO
BANK EROSION TYPE	FD, R & T	FD, R & T, W	FD, R & T
SCARP HEIGHT	2.58	1.26	n/a
SCARP SLOPE	1.518	1.4	n/a
SCARP SOIL TYPE	Uniform sand	Well graded sand	Uniform sand
BERM HEIGHT	6.11	n/a	26.6
BERM WIDTH	24.6	n/a	3.87
BERM SOIL TYPE	NO Berm	NO Berm	NO Berm
UNDER WATER SLOPE	0.285	0.1	0.2
BENCH SEDIMENT TYPE		Uniformly graded sand	Uniform sand
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	4	4	4
DATE	12-Sep-95	12-Sep-95	13-Sep-95
TIME	07:40 PM	07:00 PM	09:55 AM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	751.1	751.1	751.1
UTM X	107963.2		107710.5
UTM Y	4917328.8		4917117.0
BANK SECTION TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	POOL 5	POOL 5	POOL 5
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT			n
ARCHEOLOGICAL SITE			
SURROUNDING STRUCTURES	?	?	d/s of steel pile sheeting for structure
COMMERCIAL TRAFFIC LEVEL			H
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE	562.5'	562.5'	562.5'
LAND USE ON BANK CREST	G(Weeds), W(Species?)		W(Elm, Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G(Grass)	W(Dense Oak field)	Grapes
TYPE OF VEGETATION AT SCARP FACE	Few Grape Vine	Roots from weeds & trees	Grape Vines
TYPE OF VEGETATION AT BENCH	Unable to observe	Unable to observe	bench?
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Yes..covers whole bank height	Yes..covers whole bank height	Yes..covers whole bank height
OVERLAND DRAINAGE AT THE SITE	NO	NO	NO
BANK EROSION TYPE	NO	W, R & T, P	Yes
SCARP HEIGHT	4.2	3.91	4.3
SCARP SLOPE	2.47	1.955	1
SCARP SOIL TYPE		S. C	Sandy clay silt mixture
BERM HEIGHT	1.3	1.45	1.15
BERM WIDTH	4.3	4.5	6.9
BERM SOIL TYPE		SC	NO Berm
UNDER WATER SLOPE	0.198	0.187	0.169
BENCH SEDIMENT TYPE	SM	SM	Uniform sand over top surface
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	5
DATE	13-Sep-95
TIME	11:45 AM
RIVER	UMR
RIVER MILE @ MIDPOINT	746.5
UTM X	109990.9
UTM Y	4911635.5
BANK SECTION TYPE	up
RDB/LDB	LDB
POOL NAME	POOL 5
GEOMORPHIC CHARACTER	OUTSIDE BEND
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	
ARCHEOLOGICAL SITE	
SURROUNDING STRUCTURES	d/s of entrance to Pomme De Terre?? slough
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	468.8'
LAND USE ON BANK CREST	
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds.not tall)
TYPE OF VEGETATION AT SCARP FACE	Yes..Weeds..not tall
TYPE OF VEGETATION AT BENCH	Unable to observe
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Whole face covered
OVERLAND DRAINAGE AT THE SITE	
BANK EROSION TYPE	
SCARP HEIGHT	4.04
SCARP SLOPE	2.24
SCARP SOIL TYPE	
BERM HEIGHT	0.86
BERM WIDTH	2.4
BERM SOIL TYPE	
UNDER WATER SLOPE	0.161
BENCH SEDIMENT TYPE	
SUBAQUOUS BENCH DESCRIPTION	

SITE NUMBER	5	5
DATE	13-Sep-95	13-Sep-95
TIME	11:10 AM	12:10 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	746.4	746.3
UTM X		109932.5
UTM Y		4911294.5
BANK SECTION TYPE	mp	dn
RDB/LDB	LDB	LDB
POOL NAME	POOL 5	POOL 5
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT		
ARCHEOLOGICAL SITE		
SURROUNDING STRUCTURES	d/s of entrance to Pomme De Terre?? slough	?
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	375'	375'
LAND USE ON BANK CREST	G(Weeds)	
TYPE OF VEGETATION ON TOP OF BANK	Sparse small Veg. covered by very fine rootmat, algae and wet soil at bottom	
TYPE OF VEGETATION AT SCARP FACE	Sparse small Veg. covered by very fine rootmat, algae and wet soil at bottom	
TYPE OF VEGETATION AT BENCH	Unable to observe..very strong current	Yes..tall weed?
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Covered whole scarp face	
OVERLAND DRAINAGE AT THE SITE	NO	
BANK EROSION TYPE	RW, W, P	RW , W , P
SCARP HEIGHT	1.41	3.2
SCARP SLOPE	2.82	1.104
SCARP SOIL TYPE	Sand	
BERM HEIGHT	0.64	0.84
BERM WIDTH	1.4	2.7
BERM SOIL TYPE		
UNDER WATER SLOPE	0.186	0.156
BENCH SEDIMENT TYPE	Graded sand	A finer sand
SUBAQUOUS BENCH DESCRIPTION		Sandy bench

SITE NUMBER	6	6	6
DATE	13-Sep-95	13-Sep-95	13-Sep-95
TIME	05:40 PM	04:15 PM	06:10 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	727.4	727.4	727.4
UTM X	126664.1		126932.9
UTM Y	4890824.6		4890283.2
BANK SECTION TYPE	up	mp	dn
RDB/LDB	RDB	RDB	RDB
POOL NAME	POOL 6	POOL 6	POOL 6
GEOMORPHIC CHARACTER	STRAIGHT REACH*	STRAIGHT REACH*	STRAIGHT REACH*
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT		n	n
ARCHEOLOGICAL SITE		n	n
SURROUNDING STRUCTURES	d/s of L&D 5A approx. 1 mile	d/s of L&D 5A approx. 1 mile	d/s of L&D 5A approx. 1 mile
COMMERCIAL TRAFFIC LEVEL		H	H
RECREATIONAL TRAFFIC LEVEL		H	H
ESTIMATED DISTANCE TO THE SAILING LINE	468.8'	468.8'	468.8'
LAND USE ON BANK CREST		W(Species?)	
TYPE OF VEGETATION ON TOP OF BANK	Poison Ivy	Poison Ivy 6"..oat field 1.5'	
TYPE OF VEGETATION AT SCARP FACE	Debris. Medium root webs (d=2" approx.)	Root webs covered	Root webs covered
TYPE OF VEGETATION AT BENCH	Floating aquatic Veg.	Unable to observe	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Yes..1'	Yes..2.8'. Covers whole face	Covers scarp height 2'
OVERLAND DRAINAGE AT THE SITE	NO	NO	
BANK EROSION TYPE	W , R & T , FD , P	W , R & T , FD, P	
SCARP HEIGHT	0.92	3.34	2.9
SCARP SLOPE	1.314	2.23	1.61
SCARP SOIL TYPE	Clay	Clay layer (1') under top sand layer (1.5')	
BERM HEIGHT	1.91	1.86	0.3
BERM WIDTH	7.4	9.1	1.9
BERM SOIL TYPE	Clay	Clay Mixture	
UNDER WATER SLOPE	0.153	0.237	0.145
BENCH SEDIMENT TYPE	Uniform sand	Uniform sand	Uniform sand
SUBAQUOUS BENCH DESCRIPTION		Clay layer then sand bench	Sandy bench

SITE NUMBER	7	8	8
DATE	13-Sep-95	14-Sep-95	14-Sep-95
TIME	04:45 PM	05:30 PM	03:30 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	727.4	677.7	677.7
UTM X	127013.0	157038.4	
UTM Y	4890609.0	4830814.0	
BANK SECTION TYPE	mp	up	mp
RDB/LDB	LDB	RDB	RDB
POOL NAME	POOL 6	POOL 9	POOL 9
GEOMORPHIC CHARACTER	STRAIGHT REACH*	STRAIGHT REACH*	STRAIGHT REACH*
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	n		n
ARCHEOLOGICAL SITE	n		n
SURROUNDING STRUCTURES	d/s of L&D 5A? approx. 1 mile	Thief Slough?	d/s of L&D 9, d/s of Thief slough, d/s of Green Day Mark 677.7
COMMERCIAL TRAFFIC LEVEL	H		Y?
RECREATIONAL TRAFFIC LEVEL	Y?		Y?
ESTIMATED DISTANCE TO THE SAILING LINE	2156.3'	281.3'	281.3'
LAND USE ON BANK CREST			Very Dense Cane, W(behind..species?)
TYPE OF VEGETATION ON TOP OF BANK	Yes?		Very dense Cane
TYPE OF VEGETATION AT SCARP FACE	Root webs covered	NO	Yes. Very dense Cane
TYPE OF VEGETATION AT BENCH	NO	Tree?(From sketch)	Layers of floating aquatic Veg. washed ashore
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Covers whole bank face	NO	NO
OVERLAND DRAINAGE AT THE SITE	NO	NO	NO, Fairly uniform erosion
BANK EROSION TYPE	W , R & T , FD , P	Scarp. Fall	W , R & T , FD , B
SCARP HEIGHT	3.26	2.47	0.88
SCARP SLOPE	1.417	4.117	8.8
SCARP SOIL TYPE		Dry clay, wet silt layers	Clayish
BERM HEIGHT	4.19	2.9	3.4
BERM WIDTH	10.7	11.7	11
BERM SOIL TYPE	Sand Run?	Silt-Sand	Clayish
UNDER WATER SLOPE	0.175	0.214	0.163
BENCH SEDIMENT TYPE	Uniform sand	Silty sand, fine sand	SC
SUBAQUOUS BENCH DESCRIPTION	Sandy bench	Silty sand bench	Sandy bench

SITE NUMBER	8	9
DATE	14-Sep-95	14-Sep-95
TIME	05:00 PM	04:20 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	677.3	677.5
UTM X	157974.3	157314.9
UTM Y	4830300.2	4830598.9
BANK SECTION TYPE	dn	mp
RDB/LDB	RDB	LDB
POOL NAME	POOL 9	POOL 9
GEOMORPHIC CHARACTER	STRAIGHT REACH*	STRAIGHT REACH*
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT		n
ARCHEOLOGICAL SITE		n
SURROUNDING STRUCTURES	d/s of L&D 9, d/s of Thief slough, d/s of Green Day Mark 677.2	d/s of L&D 8, across site 8 behind is thief slough
COMMERCIAL TRAFFIC LEVEL		Y?
RECREATIONAL TRAFFIC LEVEL		Y?
ESTIMATED DISTANCE TO THE SAILING LINE	487.5'	1875'
LAND USE ON BANK CREST	Very Dense Cane, W(50'..species?)	W(Species?), Grapes, Sparse Cane
TYPE OF VEGETATION ON TOP OF BANK	Very dense Cane	G(Weeds), Grapes
TYPE OF VEGETATION AT SCARP FACE	NO	Root covered. Grapes on scarp
TYPE OF VEGETATION AT BENCH	Layers of floating aquatic Veg. washed ashore	No..sand beach
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO	Covers the scarp face
OVERLAND DRAINAGE AT THE SITE		NO
BANK EROSION TYPE	W, P	W , L , FD
SCARP HEIGHT	3.83	2.77
SCARP SLOPE	12.77	2.308
SCARP SOIL TYPE		SP
BERM HEIGHT	2.07	2.1
BERM WIDTH	12.5	10.2
BERM SOIL TYPE		Sand with coarse gravel, SP
UNDER WATER SLOPE	0.138	0.171
BENCH SEDIMENT TYPE	Clayish sand	Uniform sand
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	10	10
DATE	15-Sep-95	15-Sep-95
TIME	11:00 AM	10:00 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	670.0	669.5
UTM X	157349.2	
UTM Y	4820298.7	
BANK SECTION TYPE	up	mp
RDB/LDB	RDB	RDB
POOL NAME	POOL 9	POOL 9
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND*
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y?	n
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	1000' above a slough entrance. Wing Dams at opposite site	Bank protection (Submerged Wing Dams)
COMMERCIAL TRAFFIC LEVEL	?	
RECREATIONAL TRAFFIC LEVEL	?	
ESTIMATED DISTANCE TO THE SAILING LINE	375'	468.8'
LAND USE ON BANK CREST	G(Weeds)	W(Species?)
TYPE OF VEGETATION ON TOP OF BANK	Dense Cane	Medium dense Cane
TYPE OF VEGETATION AT SCARP FACE	NO..but with cane root	NO
TYPE OF VEGETATION AT BENCH	A lot of washed shore Veg.	Some aquatic Veg. washed ashore
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Covers the scarp face	About 10', not consistent.
OVERLAND DRAINAGE AT THE SITE	NO	NO
BANK EROSION TYPE	C, LS. FD , W , P	FD , W , P
SCARP HEIGHT	1.33	0.64
SCARP SLOPE	2.66	1.28
SCARP SOIL TYPE	Clay, Silt	Clay, Silt
BERM HEIGHT	2.01	1.8
BERM WIDTH	12.3	8
BERM SOIL TYPE	Clay, Silt	Clay, Silt
UNDER WATER SLOPE	0.081	0.112
BENCH SEDIMENT TYPE	Silty sand	Uniform silty sand
SUBAQUOUS BENCH DESCRIPTION		Sand & Clay mix?

SITE NUMBER	10	11
DATE	15-Sep-95	16-Sep-95
TIME	11:35 AM	09:15 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT		620.5
UTM X	158588.1	165693.7
UTM Y	4817560.3	4753801.5
BANK SECTION TYPE	dn	up
RDB/LDB	RDB	LDB
POOL NAME	POOL 9	POOL 10
GEOMORPHIC CHARACTER	OUTSIDE BEND	CROSS OVER
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	y
ARCHEOLOGICAL SITE		n
SURROUNDING STRUCTURES	u/s of Big Slough?	u/s of Wing Dam
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	468.8'	6468.8'
LAND USE ON BANK CREST	G(Weeds)	Poison Ivy, Grapes, Cane
TYPE OF VEGETATION ON TOP OF BANK	Cane	Poison Ivy, Grapes, Cane
TYPE OF VEGETATION AT SCARP FACE	Roots from weeds & trees	Yes. mixed with root webs
TYPE OF VEGETATION AT BENCH	Some aquatic Veg. washed ashore	Yes..submerged Vegetation (type?)
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Covers bank height from top 2'	Yes..3', ? covers sand scarp
OVERLAND DRAINAGE AT THE SITE	NO	NO
BANK EROSION TYPE	C, B. FD , W , P	FD , W , Structure (Wing Dam)
SCARP HEIGHT	2.82	1.24
SCARP SLOPE	14.1	4.13
SCARP SOIL TYPE	Clay, Silt	Sand below drap
BERM HEIGHT	n/a	2.56
BERM WIDTH	n/a	13.2
BERM SOIL TYPE	Clay, Silt	
UNDER WATER SLOPE	0.128	0.13
BENCH SEDIMENT TYPE	Fine sand	Uniform sand
SUBAQUOUS BENCH DESCRIPTION	Very fine sand bench	

SITE NUMBER	11
DATE	16-Sep-95
TIME	08:40 AM
RIVER	UMR
RIVER MILE @ MIDPOINT	620.5
UTM X	
UTM Y	
BANK SECTION TYPE	mp
RDB/LDB	LDB
POOL NAME	POOL 10
GEOMORPHIC CHARACTER	CROSS OVER
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	y
ARCHEOLOGICAL SITE	n
SURROUNDING STRUCTURES	u/s of L&D 10(@RM 615.7).Wing Dam field..fairly long one, extend to Red Buoy
COMMERCIAL TRAFFIC LEVEL	H
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	6468.8'
LAND USE ON BANK CREST	W(Species?...on the back), Poison Ivy
TYPE OF VEGETATION ON TOP OF BANK	?
TYPE OF VEGETATION AT SCARP FACE	Roots & Vines extent to form a drap about 2.5'
TYPE OF VEGETATION AT BENCH	Yes..submerged Vegetation (type?)
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Covers the sand scarp and berm. Medium density
OVERLAND DRAINAGE AT THE SITE	NO
BANK EROSION TYPE	F. C. Plus structure (Wing Dam) , P , F
SCARP HEIGHT	3.29
SCARP SLOPE	2.742
SCARP SOIL TYPE	Sand
BERM HEIGHT	2.26
BERM WIDTH	6
BERM SOIL TYPE	Clay
UNDER WATER SLOPE	0.149
BENCH SEDIMENT TYPE	SM, Uniform fine sand on top
SUBAQUOUS BENCH DESCRIPTION	Sandy bench

SITE NUMBER	11	12
DATE	16-Sep-95	16-Sep-95
TIME	09:00 AM	01:30 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	620.5	613.6
UTM X	165651.7	166188.9
UTM Y	4753393.0	4743233.9
BANK SECTION TYPE	dn	up
RDB/LDB	LDB	LDB
POOL NAME	POOL 10	POOL 11
GEOMORPHIC CHARACTER	CROSS OVER	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y?	n
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	dike	d/s of Cassville slough.Seems also a mooring area at u/s of the island
COMMERCIAL TRAFFIC LEVEL	H	H
RECREATIONAL TRAFFIC LEVEL		H
ESTIMATED DISTANCE TO THE SAILING LINE	6468.8'	4593.8'
LAND USE ON BANK CREST	W(d, 1.5' or 2'. 40 to 50 Yrs. old)	G(very sparse grass)
TYPE OF VEGETATION ON TOP OF BANK	Vines, Poison Ivy	G(Young weeds not dense..root webs, W(old trees..Silver Maple)
TYPE OF VEGETATION AT SCARP FACE	Vines, Poison Ivy	NO
TYPE OF VEGETATION AT BENCH	Yes..submerged Vegetation (type?)	Not seen..very wavy surface
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1" - 2" vine and root web	Fine web covers top 2'
OVERLAND DRAINAGE AT THE SITE	NO	Yes..possible due to return flood
BANK EROSION TYPE	Scarp & berm. FD , W , Structure (Wing Dam)	FD , W , P , R & T
SCARP HEIGHT	n/a	0.43
SCARP SLOPE	n/a	4.3
SCARP SOIL TYPE	SM	ML
BERM HEIGHT	3.24	1.78
BERM WIDTH	6.1	7.3
BERM SOIL TYPE	SM	MH
UNDER WATER SLOPE	0.09	0.012
BENCH SEDIMENT TYPE	Uniform fine sand	MH
SUBAQUOUS BENCH DESCRIPTION	Sandy bench	NO Bench

SITE NUMBER	12	12
DATE	16-Sep-95	16-Sep-95
TIME	01:10 PM	12:40 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	613.4	612.5
UTM X		166184.0
UTM Y		4742946.5
BANK SECTION TYPE	mp	dn
RDB/LDB	LDB	LDB
POOL NAME	POOL 11	POOL 11
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE		n
SURROUNDING STRUCTURES	Just d/s from Ackerman's Cut	d/s of Cassville slough.**
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL		H
ESTIMATED DISTANCE TO THE SAILING LINE	4968.8'	6843.8'
LAND USE ON BANK CREST	G, W(Silver Maple)	?
TYPE OF VEGETATION ON TOP OF BANK	G, W(Silver Maple)	Bare
TYPE OF VEGETATION AT SCARP FACE	Exposed roots/Poison Ivy	NO
TYPE OF VEGETATION AT BENCH	NO	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' - 2' exposed roots	Grass?
OVERLAND DRAINAGE AT THE SITE	Slough outlet just U.S. of site...4 small sloughs cut through this erosion reach	Yes when water return from high water
BANK EROSION TYPE	C, W, R & T, minor P	FD , W , P , R & T
SCARP HEIGHT	1.9	1.63
SCARP SLOPE	1.9	1.63
SCARP SOIL TYPE	SM	Clay, Silt mixture
BERM HEIGHT	NONE	0.53
BERM WIDTH	NONE	5.3
BERM SOIL TYPE	SM	Clay, CL, MH
UNDER WATER SLOPE	0.0333	0.288
BENCH SEDIMENT TYPE	ML	Clay, CL, MH?
SUBAQUOUS BENCH DESCRIPTION	NO Bench	NO Bench

SITE NUMBER	13	14
DATE	16-Sep-95	16-Sep-95
TIME	01:00 PM	02:25 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	613.6	607.5
UTM X	165888.3	171699.5
UTM Y	4743047.6	4737267.1
BANK SECTION TYPE	mp	up
RDB/LDB	RDB	RDB
POOL NAME	POOL 11	POOL 11
GEOMORPHIC CHARACTER	INSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y	n
ARCHEOLOGICAL SITE		n
SURROUNDING STRUCTURES	Wing Dams u/s & d/s. Shore control point 50' u/s	d/s of local ferry landing..about 600' barge fleeting area from here down
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL		H
ESTIMATED DISTANCE TO THE SAILING LINE	2437.5'	656.3'
LAND USE ON BANK CREST	G, W(Silver Maple)	Very dense cane
TYPE OF VEGETATION ON TOP OF BANK	G, W(Silver Maple)	Very dense Cane
TYPE OF VEGETATION AT SCARP FACE	G, W(Silver Maple)	NO
TYPE OF VEGETATION AT BENCH	N/A	Some aquatic Veg. washed ashore
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' - 2' exposed roots	NO
OVERLAND DRAINAGE AT THE SITE	NO	NO
BANK EROSION TYPE	W, R & T	F, C, L, W, R & T, P, FD
SCARP HEIGHT	n/a	2.52
SCARP SLOPE	n/a	8.4
SCARP SOIL TYPE	SM	MH
BERM HEIGHT	1.9	3.51
BERM WIDTH	14	12
BERM SOIL TYPE	SC	MH
UNDER WATER SLOPE	0.133	0.129
BENCH SEDIMENT TYPE	SM	PT
SUBAQUOUS BENCH DESCRIPTION	Flat & gently sloping Sandy bench	Stepped bench & berm area

SITE NUMBER	14
DATE	16-Sep-95
TIME	02:25 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	607.5
UTM X	
UTM Y	
BANK SECTION TYPE	mp
RDB/LDB	RDB
POOL NAME	POOL 11
GEOMORPHIC CHARACTER	INSIDE BEND
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	y
ARCHEOLOGICAL SITE	n
SURROUNDING STRUCTURES	Fleeting Area. Wing Dams both u/s and d/s of this area.
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	656.3'
LAND USE ON BANK CREST	G, W(Boxelder & Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G(Grassy),W
TYPE OF VEGETATION AT SCARP FACE	G(Grassy)
TYPE OF VEGETATION AT BENCH	N/A
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' - 3' exposed roots
OVERLAND DRAINAGE AT THE SITE	Yes..Small gullies in vertical scarp every 15'+/-
BANK EROSION TYPE	C, L, P, W, R & T, B/S
SCARP HEIGHT	3.2
SCARP SLOPE	3.2
SCARP SOIL TYPE	CL/ML
BERM HEIGHT	3.1
BERM WIDTH	12
BERM SOIL TYPE	CL/ML
UNDER WATER SLOPE	0.147
BENCH SEDIMENT TYPE	CL
SUBAQUOUS BENCH DESCRIPTION	Stepped bench & berm area

SITE NUMBER	14
DATE	16-Sep-95
TIME	02:30 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	607.5
UTM X	172589.5
UTM Y	4736649.4
BANK SECTION TYPE	dn
RDB/LDB	RDB
POOL NAME	POOL 11
GEOMORPHIC CHARACTER	INSIDE BEND
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	n
ARCHEOLOGICAL SITE	n
SURROUNDING STRUCTURES	Mooring/Fleeting area
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	656.3'
LAND USE ON BANK CREST	G, W(Willow,Silver Maple...mostly grassy)
TYPE OF VEGETATION ON TOP OF BANK	G,W
TYPE OF VEGETATION AT SCARP FACE	G/Bare
TYPE OF VEGETATION AT BENCH	N/A
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' - 3' exposed roots
OVERLAND DRAINAGE AT THE SITE	Yes..small erosion rills at vertical scarp
BANK EROSION TYPE	C, L, P, W, R & T, B/S
SCARP HEIGHT	1.2
SCARP SLOPE	1
SCARP SOIL TYPE	CL/ML
BERM HEIGHT	1.7
BERM WIDTH	9
BERM SOIL TYPE	CL/ML
UNDER WATER SLOPE	0.0985
BENCH SEDIMENT TYPE	SC/ML/CL
SUBAQUOUS BENCH DESCRIPTION	Stepped bench & berm area. Sandy surface washed by waves & Fleeting area

SITE NUMBER	15
DATE	17-Sep-95
TIME	10:30 AM
RIVER	UMR
RIVER MILE @ MIDPOINT	576.0
UTM X	202177.2
UTM Y	4707158.6
BANK SECTION TYPE	up
RDB/LDB	LDB
POOL NAME	POOL 12
GEOMORPHIC CHARACTER	INSIDE BEND
BANK TYPE	Revetted
WINGDAM PRESENT OR NOT	y
ARCHEOLOGICAL SITE	?
SURROUNDING STRUCTURES	Wing Dams u/s of site. Fleeting area, riprap bank
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	3937.5'
LAND USE ON BANK CREST	G, W(Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G,W
TYPE OF VEGETATION AT SCARP FACE	G/Bare
TYPE OF VEGETATION AT BENCH	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	
OVERLAND DRAINAGE AT THE SITE	Some rilling of upper top of bank
BANK EROSION TYPE	F, C, S, B, L, P, W, R & T
SCARP HEIGHT	n/a
SCARP SLOPE	n/a
SCARP SOIL TYPE	SC/ML
BERM HEIGHT	4.8
BERM WIDTH	16.5
BERM SOIL TYPE	SC/ML
UNDER WATER SLOPE	0.092
BENCH SEDIMENT TYPE	Sand over SL/ML
SUBAQUOUS BENCH DESCRIPTION	Wide sandy bench

SITE NUMBER	15	15
DATE	17-Sep-95	17-Sep-95
TIME	10:00 AM	10:00 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	576.0	576.0
UTM X		203284.0
UTM Y		4706534.2
BANK SECTION TYPE	mp	dn
RDB/LDB	LDB	LDB
POOL NAME	POOL 12	POOL 12
GEOMORPHIC CHARACTER	INSIDE BEND	STRAIGHT REACH
BANK TYPE	Revetted	Natural
WINGDAM PRESENT OR NOT	y	n
ARCHEOLOGICAL SITE	y	n
SURROUNDING STRUCTURES	Wing Dams u/s of end of site. Fleeting area, riprap bank	Barge Fleeting area
COMMERCIAL TRAFFIC LEVEL		H
RECREATIONAL TRAFFIC LEVEL		H
ESTIMATED DISTANCE TO THE SAILING LINE	3937.5'	3937.5'
LAND USE ON BANK CREST	G, W(Silver Maple, Poison Ivy)	G, W(Species?)
TYPE OF VEGETATION ON TOP OF BANK	G,W	Medium dense Cane
TYPE OF VEGETATION AT SCARP FACE	Bare	NO
TYPE OF VEGETATION AT BENCH	N/A	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' exposed roots	3' over..very fine web covers
OVERLAND DRAINAGE AT THE SITE	Minor rilling at scarp area	NO
BANK EROSION TYPE	F, S, B, L, P, W, R & T	Mooring , P , W , FD
SCARP HEIGHT	1.6	n/a
SCARP SLOPE	1.6	n/a
SCARP SOIL TYPE	SM/SC	MH
BERM HEIGHT	3.6	4.22
BERM WIDTH	20	16.7
BERM SOIL TYPE	SM/SC	MH
UNDER WATER SLOPE	0.116	0.059
BENCH SEDIMENT TYPE	Sand on silt & clay	SM
SUBAQUOUS BENCH DESCRIPTION	Wide sandy bench	Fine Sand & silty bench

FIELD/LAB DATA SUMMARY FOR SELECTED SITES FROM UPPER MISSISSIPPI RIVER

SITE NUMBER	16
DATE	17-Sep-95
TIME	04:30 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	551.9
UTM X	222565.3
UTM Y	4678808.5
BANK SECTION TYPE	up
RDB/LDB	LDB
POOL NAME	POOL 13
GEOMORPHIC CHARACTER	INSIDE BEND
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	y
ARCHEOLOGICAL SITE	n
SURROUNDING STRUCTURES	d/s of Wing Dams
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	187.5'
LAND USE ON BANK CREST	G, W(Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G,W
TYPE OF VEGETATION AT SCARP FACE	NO
TYPE OF VEGETATION AT BENCH	N/A
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' - 2' exposed roots..upstream & downstream of site
OVERLAND DRAINAGE AT THE SITE	Yes..rilling at bank crest
BANK EROSION TYPE	F, C, S, B, L, P, W, R & T
SCARP HEIGHT	0.1
SCARP SLOPE	0.1
SCARP SOIL TYPE	SC/ML
BERM HEIGHT	1.5
BERM WIDTH	4.5
BERM SOIL TYPE	SC/ML
UNDER WATER SLOPE	0.286
BENCH SEDIMENT TYPE	SC/ML
SUBAQUOUS BENCH DESCRIPTION	NO Bench

SITE NUMBER	16	16
DATE	17-Sep-95	17-Sep-95
TIME	04:00 PM	04:10 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	551.9	551.9
UTM X		222687.6
UTM Y		4678604.4
BANK SECTION TYPE	mp	dn
RDB/LDB	LDB	LDB
POOL NAME	POOL 13	POOL 13
GEOMORPHIC CHARACTER	INSIDE BEND	INSIDE BEND?
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y	y
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	Wing Dam 1000' d/s	Wing Dam 1000' d/s
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	187.5'	187.5'
LAND USE ON BANK CREST	G(Grass), W(Silver Maple)	G(Weeds..dense approx. 2'), W(2' Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G,W	G(Weeds..dense 2')
TYPE OF VEGETATION AT SCARP FACE	G,W(Silver maple)	NO
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' - 2' exposed roots	Exposed root 4'
OVERLAND DRAINAGE AT THE SITE	Yes..rilling in upper scarp area	NO
BANK EROSION TYPE	F, C, S, B, P, W, R & T	FD , W , R & T , P
SCARP HEIGHT	1	n/a
SCARP SLOPE	Varies..vertical scarps & sloping berms	n/a
SCARP SOIL TYPE	ML	SM
BERM HEIGHT	n/a	n/a
BERM WIDTH	n/a	n/a
BERM SOIL TYPE	ML	ML, SL
UNDER WATER SLOPE	n/a	0.146
BENCH SEDIMENT TYPE	ML	MH
SUBAQUOUS BENCH DESCRIPTION	NO Bench	NO Bench

SITE NUMBER	17	17
DATE	18-Sep-95	18-Sep-95
TIME	11:45 AM	11:30 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	512.7	512.7
UTM X	231259.5	
UTM Y	4631163.3	
BANK SECTION TYPE	uplmt	up1/4
RDB/LDB	LDB	LDB
POOL NAME	POOL 14	POOL 14
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y	y
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	Between Wing Dams	Between Wing Dams
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	2625'	
LAND USE ON BANK CREST	G, W(Silver Maple, Cottonwood)	G, W(Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	W(Trees), Exposed roots	Trees extending out to water edge..dead trees falling into water
TYPE OF VEGETATION AT SCARP FACE	NO	W(Silver Maple)
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	2' - 3' exposed roots	Exposed root 2'
OVERLAND DRAINAGE AT THE SITE	Yes..Piping features	
BANK EROSION TYPE	L, B, P, W, R & T	P,W,R & T
SCARP HEIGHT	1.6	n/a
SCARP SLOPE	1.6	n/a
SCARP SOIL TYPE	Silty/Clay	Silty/Clay soil
BERM HEIGHT	2.3	4
BERM WIDTH	8.5	19
BERM SOIL TYPE	Sand over silty clay	Silty clay soil
UNDER WATER SLOPE	0.127	0.083
BENCH SEDIMENT TYPE	Sand over silty clay	Sand over silty clay
SUBAQUOUS BENCH DESCRIPTION	Flat sandy bench	Flat sandy bench

SITE NUMBER	17	17
DATE	18-Sep-95	18-Sep-95
TIME	11:00 AM	12:00 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	512.7	512.7
UTM X		
UTM Y		
BANK SECTION TYPE	up1/3	mp
RDB/LDB	LDB	LDB
POOL NAME	POOL 14	POOL 14
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y	y
ARCHEOLOGICAL SITE	n	?
SURROUNDING STRUCTURES	u/s & d/s Wing Dams	Between Wing Dams
COMMERCIAL TRAFFIC LEVEL	N?	
RECREATIONAL TRAFFIC LEVEL	Yes..Fishing Boat	
ESTIMATED DISTANCE TO THE SAILING LINE		2625'
LAND USE ON BANK CREST	W(Species?),Grape Vines	G, W(Silver Maple, Willow)
TYPE OF VEGETATION ON TOP OF BANK	Grape vines	G,W
TYPE OF VEGETATION AT SCARP FACE	A(Oat Field.Sparse), garpe vine	Trees extending out in bunches.Erosion between trees
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	4" at scarp	Exposed root 2'
OVERLAND DRAINAGE AT THE SITE	NO	Yes..some rilling features
BANK EROSION TYPE	FD , W , P (Very high ground water..soft bench)	P, W, R & T. Velocity scour around tree roots.
SCARP HEIGHT	n/a	n/a
SCARP SLOPE	n/a	n/a
SCARP SOIL TYPE	Uniform sand	Silt & Sand
BERM HEIGHT	n/a	2.5
BERM WIDTH	n/a	7
BERM SOIL TYPE	Uniform fine sand	Sand over silty clay
UNDER WATER SLOPE	n/a	0.097
BENCH SEDIMENT TYPE	SC	Sand over silty clay
SUBAQUOUS BENCH DESCRIPTION	Sandy bench with many fallen trees	Gradually sloping underwater Sandy bench

SITE NUMBER	17	17
DATE	18-Sep-95	18-Sep-95
TIME	12:20 PM	11:45 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	512.7	512.7
UTM X		230852.9
UTM Y		4630868.6
BANK SECTION TYPE	dn1/4	dnlmt
RDB/LDB	LDB	LDB
POOL NAME	POOL 14	POOL 14
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	y	y
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	u/s & d/s Wing Dams	u/s & d/s Wing Dams
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE		
LAND USE ON BANK CREST	G, W(Silver Maple)	G,W(Some trees..Species?)
TYPE OF VEGETATION ON TOP OF BANK	G,W	G(Grass)
TYPE OF VEGETATION AT SCARP FACE	W(Silver Maple)	G(Grass)
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Exposed root 2'	NO
OVERLAND DRAINAGE AT THE SITE	Yes..Piping features	NO
BANK EROSION TYPE	P, W, R & T	W..Stable site
SCARP HEIGHT	n/a	
SCARP SLOPE	n/a	?
SCARP SOIL TYPE	Silty/Clay	Sandy
BERM HEIGHT	1.7	
BERM WIDTH	6.2	
BERM SOIL TYPE	Sand over silty clay	Sandy
UNDER WATER SLOPE	0.145	18.51H:1V
BENCH SEDIMENT TYPE	Sand over silty clay	Sandy
SUBAQUOUS BENCH DESCRIPTION	Sandy bench	Sandy bench

SITE NUMBER	17	18
DATE	18-Sep-95	18-Sep-95
TIME	11:15 AM	03:30 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	512.7	509.2
UTM X		226499.5
UTM Y		4628567.5
BANK SECTION TYPE	dnbkch	up
RDB/LDB	LDB	RDB
POOL NAME	POOL 14	POOL 14
GEOMORPHIC CHARACTER	BACK CHANNEL	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	?	n
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	Approx. 800' wide of back channel	closing structure behind island
COMMERCIAL TRAFFIC LEVEL	N?	
RECREATIONAL TRAFFIC LEVEL	Several Fishing Boat	
ESTIMATED DISTANCE TO THE SAILING LINE		
LAND USE ON BANK CREST	G(Weed)	G, W(Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds)	G,W
TYPE OF VEGETATION AT SCARP FACE	A(Oat field..2' tall Veg.)	Bare face
TYPE OF VEGETATION AT BENCH		NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO	Exposed root 3'
OVERLAND DRAINAGE AT THE SITE	NO	Some rilling in scarp area
BANK EROSION TYPE	Acretion site, stable. Some W, P, erosion	F, C, S, B, L, P, W, R & T
SCARP HEIGHT		?
SCARP SLOPE		?
SCARP SOIL TYPE	ML	SC/ML
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	NO	SC/ML
UNDER WATER SLOPE	15.15H:1V	5.49H:1V
BENCH SEDIMENT TYPE	MH, CH	SC/ML
SUBAQUOUS BENCH DESCRIPTION	Very soft bench with silt-sand mixture	Silty/clay bench

SITE NUMBER	18	18
DATE	18-Sep-95	18-Sep-95
TIME	02:45 PM	03:45 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	509.2	509.2
UTM X		226231.5
UTM Y		4628337.1
BANK SECTION TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	POOL 14	POOL 14
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	n	n
ARCHEOLOGICAL SITE	n	n
SURROUNDING STRUCTURES	closing structure behind island	closing structure behind island
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	1875'	
LAND USE ON BANK CREST	G, W(Silver Maple)	G, W(Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G,W	W(Silver Maple)
TYPE OF VEGETATION AT SCARP FACE	G,W(Silver maple)	W(Silver Maple)
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1' - 2' exposed roots	1' exposure
OVERLAND DRAINAGE AT THE SITE	NO	NO
BANK EROSION TYPE	W, R & T	W, R & T
SCARP HEIGHT	?	?
SCARP SLOPE	?	?
SCARP SOIL TYPE	Sand, Silt & Clay	Sand
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	Sand	Sand
UNDER WATER SLOPE	7.04H:1V	8.55H:1V
BENCH SEDIMENT TYPE	Sand	Sand
SUBAQUOUS BENCH DESCRIPTION	Sandy bench	Gently sloping Sandy bench

SITE NUMBER	19
DATE	18-Sep-95
TIME	04:00 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	509.2
UTM X	226559.2
UTM Y	4628120.5
BANK SECTION TYPE	mp
RDB/LDB	LDB
POOL NAME	POOL 14
GEOMORPHIC CHARACTER	STRAIGHT REACH
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	
ARCHEOLOGICAL SITE	
SURROUNDING STRUCTURES	closing structure behind island?
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	750'
LAND USE ON BANK CREST	I
TYPE OF VEGETATION ON TOP OF BANK	G,W
TYPE OF VEGETATION AT SCARP FACE	Bare scarp
TYPE OF VEGETATION AT BENCH	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Minor..0' - 6'
OVERLAND DRAINAGE AT THE SITE	NO
BANK EROSION TYPE	F, DS, C, S, B, L, P, W, R & T
SCARP HEIGHT	?
SCARP SLOPE	?
SCARP SOIL TYPE	SC
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	SM
UNDER WATER SLOPE	7.46H:1V
BENCH SEDIMENT TYPE	SP
SUBAQUOUS BENCH DESCRIPTION	Gently sloping Sandy bench

SITE NUMBER	19
DATE	18-Sep-95
TIME	04:10 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	509.2
UTM X	226483.5
UTM Y	4628039.7
BANK SECTION TYPE	dn
RDB/LDB	LDB
POOL NAME	POOL 14
GEOMORPHIC CHARACTER	STRAIGHT REACH
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	
ARCHEOLOGICAL SITE	n
SURROUNDING STRUCTURES	closing structure behind island?
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	750'
LAND USE ON BANK CREST	I
TYPE OF VEGETATION ON TOP OF BANK	G,W(Hackberry, boxelder, Silver Maple)
TYPE OF VEGETATION AT SCARP FACE	G,W
TYPE OF VEGETATION AT BENCH	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Minor..0' - 1'
OVERLAND DRAINAGE AT THE SITE	NO
BANK EROSION TYPE	F, D, C, S, B, L, P, W, R & T
SCARP HEIGHT	?
SCARP SLOPE	?
SCARP SOIL TYPE	SC
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	SM
UNDER WATER SLOPE	5.75H:1V
BENCH SEDIMENT TYPE	SP
SUBAQUOUS BENCH DESCRIPTION	Sandy bench..20' +/- wide

SITE NUMBER	21	21
DATE	02-Oct-95	02-Oct-95
TIME	12:30 PM	01:10 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	466.9	466.7
UTM X		
UTM Y		
BANK SECTION TYPE	Tip	up
RDB/LDB	ISLAND	LDB/I
POOL NAME	POOL 16	POOL 16
GEOMORPHIC CHARACTER	Island	STRAIGHT REACH
BANK TYPE	Natural	Revetted
WINGDAM PRESENT OR NOT	Yes	Yes
ARCHEOLOGICAL SITE	NO	
SURROUNDING STRUCTURES	Wingdam	Upstream wingdam (short)
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	468.8'	937.5'
LAND USE ON BANK CREST	G	
TYPE OF VEGETATION ON TOP OF BANK	G(Grass),W(Old Trees)	??G(Grass)
TYPE OF VEGETATION AT SCARP FACE	W(Silver Maple)	W(Maple)
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	??	Moderate
OVERLAND DRAINAGE AT THE SITE	NO	
BANK EROSION TYPE	FD, W, P	FD
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	MH	Sand / SSP (Stone slope protection)
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE		Sand
UNDER WATER SLOPE	3.39H:1V	11.11H:1V
BENCH SEDIMENT TYPE	SM	Sand. Stone
SUBAQUOUS BENCH DESCRIPTION	Sand mostly over silts..fine sand..sand & silt	

SITE NUMBER	21	21	21
DATE	02-Oct-95	02-Oct-95	02-Oct-95
TIME	01:55 PM	12:40 PM	01:50 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	466.8	466.7	466.5
UTM X		587431.4	
UTM Y		15079619.6	
BANK SECTION TYPE	up1/3	mp	dn1/4
RDB/LDB	RDB	LDB	LDB
POOL NAME	POOL 16	POOL 16	POOL 16
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT		NO	NO
ARCHEOLOGICAL SITE		NO	NO
SURROUNDING STRUCTURES		Island	
COMMERCIAL TRAFFIC LEVEL	N	H	
RECREATIONAL TRAFFIC LEVEL	L	H	
ESTIMATED DISTANCE TO THE SAILING LINE	1031.3'	1031.3'	750'
LAND USE ON BANK CREST		G(Weed)	
TYPE OF VEGETATION ON TOP OF BANK	Dense vines, Oak field	G(weeds)	Brush?, G(Grass)
TYPE OF VEGETATION AT SCARP FACE	Dense vines, Oak field	Roots, Vines, W(Silver maple..d approx. 1.5')	G(PI, Jewel weed)
TYPE OF VEGETATION AT BENCH	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO	Roots cover whole scarp face	Severe
OVERLAND DRAINAGE AT THE SITE	NO	NO	NO
BANK EROSION TYPE	FD , W , P	FD , W , P	
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE	OL, CL	ML, CL	Sand /Silt
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE	CH	MH	Sand
UNDER WATER SLOPE	14.49H:1V	19.61H:1V	14.71H:1V
BENCH SEDIMENT TYPE	OH, CH	SM, SC	Sand
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	21	21	22
DATE	02-Oct-95	02-Oct-95	03-Oct-95
TIME	02:45 PM	02:10 PM	09:30 AM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	466.7	466.3	436.4
UTM X			
UTM Y			
BANK SECTION TYPE	dn1/3	End	uplmt
RDB/LDB	LDB	LDB	LDB
POOL NAME	POOL 16	POOL 16	POOL 18
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	NO	NO	NO
ARCHEOLOGICAL SITE	NO	NO	NO
SURROUNDING STRUCTURES	Back of island	??	Downstream of L&D 17
COMMERCIAL TRAFFIC LEVEL	N		H
RECREATIONAL TRAFFIC LEVEL	L		H
ESTIMATED DISTANCE TO THE SAILING LINE	1031.3'	281.3'	1312.5'
LAND USE ON BANK CREST	W(Tall Silver Maple)		G(dense grass), W(Woods. d approx. 1.5'. Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G(Sparse weeds..1')	G(Grass)	G(Dense grass)
TYPE OF VEGETATION AT SCARP FACE	G(Sparse weeds), W(Silver Maple)		NO
TYPE OF VEGETATION AT BENCH	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Covered, 1' tall		NONE
OVERLAND DRAINAGE AT THE SITE	NO	NO	NO
BANK EROSION TYPE	B		PG. RT , W , P , FD
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE	ML	Sand /Silt	CL, CM
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE	NO BERM	2' sand over rock	NO BERM
UNDER WATER SLOPE	10.64H:1V	13.00H:1V	8.62H:1V
BENCH SEDIMENT TYPE	CH, OH	Sand	SM, SC
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	22	22	22
DATE	03-Oct-95	03-Oct-95	03-Oct-95
TIME	10:00 AM	10:05 AM	10:26 AM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	436.4	436.1	436.4
UTM X		160345.8	160394.7
UTM Y		4566744.7	4566618.8
BANK SECTION TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	POOL 18	POOL 18	POOL 18
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	NO	NO	NO
ARCHEOLOGICAL SITE	NO	NO	NO
SURROUNDING STRUCTURES	Mooring area, bare cables laying around	Downstream of L&D 17	Mooring area
COMMERCIAL TRAFFIC LEVEL		H	
RECREATIONAL TRAFFIC LEVEL		H	
ESTIMATED DISTANCE TO THE SAILING LINE	656.3'	656.3'	1125'
LAND USE ON BANK CREST	G, W(Silver Maple), grapevine, foxtail ground cherry	W(Silver Maple..d , 1.5')	G, W(Silver Maple)
TYPE OF VEGETATION ON TOP OF BANK	G,W	W(1' Oak field)	
TYPE OF VEGETATION AT SCARP FACE	NO	W(Sparse oak field)	
TYPE OF VEGETATION AT BENCH	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Old exposure	Not much..several stick out	
OVERLAND DRAINAGE AT THE SITE		NO	
BANK EROSION TYPE		B, L. RT , W , P , FD	
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE		ML	
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE		MH	
UNDER WATER SLOPE	6.85H:1V	8.85H:1V	2.40H:1V
BENCH SEDIMENT TYPE		CH, OH	
SUBAQUOUS BENCH DESCRIPTION			Steep drop off at water line

SITE NUMBER	22	23	23
DATE	03-Oct-95	03-Oct-95	03-Oct-95
TIME		11:25 AM	11:55 AM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	436.4	436.4	436.4
UTM X			
UTM Y			
BANK SECTION TYPE	dnlmt	up	dn
RDB/LDB	LDB	RDB	RDB
POOL NAME	POOL 18	POOL 18	POOL 18
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	NO	NO	NO
ARCHEOLOGICAL SITE	NO	NO	NO
SURROUNDING STRUCTURES		Downstream of L&D 17	
COMMERCIAL TRAFFIC LEVEL		H	M?
RECREATIONAL TRAFFIC LEVEL		H	M
ESTIMATED DISTANCE TO THE SAILING LINE	1125'	2250'	2250'
LAND USE ON BANK CREST	W(Silver Maple)	G(Grass), W(Tall Trees)	G, W(Simple cottonwood)
TYPE OF VEGETATION ON TOP OF BANK	W(Silver Maple)	W(d , 1'..Oak field. Very dense)	G(Old fields..grass, weeds)
TYPE OF VEGETATION AT SCARP FACE		NO clear bank face	G(Grass, Weeds)
TYPE OF VEGETATION AT BENCH	Veg. on top of bank..root on bench	Duck weeds along shore line	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Severe	NO	NO
OVERLAND DRAINAGE AT THE SITE		NO	Yes..soil peds?? polygons
BANK EROSION TYPE		W , LS , P , RT , FD	FD, W, P
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE		ML, CL	MH
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE		MH, CH	SM, ML
UNDER WATER SLOPE	4.83H:1V	14.71H:1V	6.90H:1V
BENCH SEDIMENT TYPE		Surface: uniform sand	SM, ML
SUBAQUOUS BENCH DESCRIPTION	Long sloping bench	Two segments of bench..sand & clay bench	??

SITE NUMBER	24	24	24
DATE	03-Oct-95	03-Oct-95	03-Oct-95
TIME	12:25 PM	12:30 PM	01:20 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	432.3	432.3	432.3
UTM X	164805.8		165208.0
UTM Y	4564687.6		4564207.9
BANK SECTION TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	POOL 18	POOL 18	POOL 18
GEOMORPHIC CHARACTER	OUTSIDE BEND	OUTSIDE BEND	OUTSIDE BEND
BANK TYPE	Nat, Rev	Natural	Nat, Rev
WINGDAM PRESENT OR NOT	NO	NO	NO
ARCHEOLOGICAL SITE	NO	NO	NO
SURROUNDING STRUCTURES		New Boston	
COMMERCIAL TRAFFIC LEVEL			
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE		937.5'	
LAND USE ON BANK CREST		A Narrow Ridge	Natural
TYPE OF VEGETATION ON TOP OF BANK			W(Locust trees)
TYPE OF VEGETATION AT SCARP FACE			
TYPE OF VEGETATION AT BENCH	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		Some dead roots..in general there isn't any	Severe but old
OVERLAND DRAINAGE AT THE SITE			
BANK EROSION TYPE		Deflation , RT , W , FD	
SCARP HEIGHT			approx. 40 to 50'
SCARP SLOPE			
SCARP SOIL TYPE			
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE			
UNDER WATER SLOPE	6.29H:1V	6.62H:1V	5.21H:1V
BENCH SEDIMENT TYPE			
SUBAQUOUS BENCH DESCRIPTION			Sandy bench

FIELD/LAB DATA SUMMARY FOR SELECTED SITES FROM UPPER MISSISSIPPI RIVER

SITE NUMBER	25	26	26
DATE	03-Oct-95	03-Oct-95	03-Oct-95
TIME	02:00 PM	04:22 PM	
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	432.3	420.0	420.0
UTM X		167479.6	
UTM Y		4545818.3	
BANK SECTION TYPE	mp	up	mp
RDB/LDB	RDB	RDB	RDB
POOL NAME	POOL 18	POOL 18	POOL 18
GEOMORPHIC CHARACTER	INSIDE BEND	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	NO	Yes	Yes
ARCHEOLOGICAL SITE		NO	NO
SURROUNDING STRUCTURES	Island		Wing dams
COMMERCIAL TRAFFIC LEVEL			
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE	1312.5'		3993.8'
LAND USE ON BANK CREST	W(Woods..d , 1.5'..dense oak field..3'-4' dense)		W(Silver Maple, Cotton Wood)
TYPE OF VEGETATION ON TOP OF BANK	Some..moderate	G(Pl/Grass)	Grape Vine, Sparse
TYPE OF VEGETATION AT SCARP FACE	NO	NO	NO.sand
TYPE OF VEGETATION AT BENCH	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO..drap of root web though	Severe	Yes, from top 6'
OVERLAND DRAINAGE AT THE SITE	NO		NO
BANK EROSION TYPE	FD , P , W		FD , W , P(Seepage)
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE	CL		Sand
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE			ML
UNDER WATER SLOPE	2.98H:1V	7.69H:1V	9.52H:1V
BENCH SEDIMENT TYPE	CL		Uniform sand
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	26	27	28
DATE	03-Oct-95	04-Oct-95	04-Oct-95
TIME		03:05 PM	04:00 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	420.0	360.0	357.6
UTM X	167386.5	122879.7	120734.4
UTM Y	4545408.5	4478078.2	4475251.6
BANK SECTION TYPE	dn	mp	mp
RDB/LDB	RDB	RDB	RDB
POOL NAME	POOL 18	POOL 20	POOL 20
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	Yes	NO	?
ARCHEOLOGICAL SITE	NO	?	?
SURROUNDING STRUCTURES		Mooring area. Warsaw is across the river terminals across the river	
COMMERCIAL TRAFFIC LEVEL		H	
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE		937.5'	468.8'
LAND USE ON BANK CREST	W(Silver Maple, Cotton Wood)	G(Loosely spaced grass), W(Woods..d , 1.5')	
TYPE OF VEGETATION ON TOP OF BANK	Grape Vine, Sparse	W(Young Maples, Cottonwoods..d approx. 2'), A(oat field)	
TYPE OF VEGETATION AT SCARP FACE	NO.sand	NO	
TYPE OF VEGETATION AT BENCH	NO	Duck weeds along shore line	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		Maple roots..2' from top	
OVERLAND DRAINAGE AT THE SITE		NO	
BANK EROSION TYPE		L, LS, & FD. Tow induced vel. , W , P	
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE		CL, ML	
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE		CL, ML	
UNDER WATER SLOPE	5.00H:1V	8.40H:1V	6.00:1V
BENCH SEDIMENT TYPE		ML	
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	29	29
DATE	05-Oct-95	05-Oct-95
TIME	10:10 AM	10:00 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	339.4	339.3
UTM X	116470.2	
UTM Y	4447544.4	
BANK SECTION TYPE	up	mp
RDB/LDB	LDB	LDB
POOL NAME	POOL 21	POOL 21
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	Yes	Yes
ARCHEOLOGICAL SITE	NO	NO
SURROUNDING STRUCTURES	Wing dams off island	Wing dams
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	4312.5'	4500'
LAND USE ON BANK CREST	W(Silver Maple, Cotton Wood, Elm)	G, W
TYPE OF VEGETATION ON TOP OF BANK	W(Silver Maples, Cottonwoods, dense Oak field..d , 2')	G,W
TYPE OF VEGETATION AT SCARP FACE	G(small weeds)	G,W
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	4' deep..7-9' out..trunk on crest edge	Silver Maples, Cottonwood roots??
OVERLAND DRAINAGE AT THE SITE	NO	Yes..some
BANK EROSION TYPE	F, PG, B, L, SL, C. FD , P , W or all equal	P , W / B / FD / SL
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	CL, OL	Sandy Silt (ML)
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	NO BERM	Sandy silt (ML)
UNDER WATER SLOPE	7.00H:1V	7.35H:1V
BENCH SEDIMENT TYPE	NO	Sandy, Silt, Clay, SM, MH
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	29	30
DATE	05-Oct-95	05-Oct-95
TIME	10:45 AM	11:30 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	339.3	339.3
UTM X	116498.7	115945.0
UTM Y	4446976.4	4447023.1
BANK SECTION TYPE	dn	mp
RDB/LDB	LDB	RDB
POOL NAME	POOL 21	POOL 21
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	Yes	?
ARCHEOLOGICAL SITE	NO	NO
SURROUNDING STRUCTURES	Wing dams just downstream	
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE		975'
LAND USE ON BANK CREST	W(Silver Maple..approx..1.5'-2'in diameter), Grapevine	G, W
TYPE OF VEGETATION ON TOP OF BANK		G,W
TYPE OF VEGETATION AT SCARP FACE	G(Grass), Grape vine	G,W
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	Severe.. 3' from crest (2.5-6')	See sketch??
OVERLAND DRAINAGE AT THE SITE	Yes..flows from seepage causes rill erosion	Yes..some
BANK EROSION TYPE	P (Seepage) rill erosion. P , W , FD	P , W , B / FD / SL
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	SM, SC	Silt & Clay
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	CL, OL	Silt & Clay
UNDER WATER SLOPE	13.70H:1V	9.43H:1V
BENCH SEDIMENT TYPE	SP	Silt & Clay & fine sand
SUBAQUOUS BENCH DESCRIPTION	Long sloping beach	

SITE NUMBER	31	32
DATE	06-Oct-95	12-Oct-95
TIME	11:40 AM	10:35 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	293.0	275.3
UTM X	142874.2	161137.4
UTM Y	4386555.9	4367146.0
BANK SECTION TYPE	mp	mp
RDB/LDB	LDB	RDB
POOL NAME	POOL 23	POOL 24
GEOMORPHIC CHARACTER	INSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	?	Yes?
ARCHEOLOGICAL SITE	?	NO
SURROUNDING STRUCTURES	Riprap u/s, d/s..this stretch has erosion	Barge tie off area
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	1125'	468.8'
LAND USE ON BANK CREST	W	W(Oak field, Silver Maples, Cottonwood, Ash)
TYPE OF VEGETATION ON TOP OF BANK	W	G(Weeds)
TYPE OF VEGETATION AT SCARP FACE	Tree roots	NO
TYPE OF VEGETATION AT BENCH	NO	NOT SEEN
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	3-4'	
OVERLAND DRAINAGE AT THE SITE	NO	NO
BANK EROSION TYPE	F, W..accretion	W , RT , FD , SL , P
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	Sand	Silt & Clay. ML & MH
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	CL	Silt & Clay. ML & MH. (Berm in water)
UNDER WATER SLOPE	10.82H:1V	6.29H:1V
BENCH SEDIMENT TYPE	Uniform sand	
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	33	34	35
DATE	12-Oct-95	13-Oct-95	13-Oct-95
TIME	02:10 PM	10:55 AM	02:15 PM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	266.5	232.2	222.1
UTM X	172293.6	185177.2	197376.6
UTM Y	4358739.4	4310233.3	4314968.4
BANK SECTION TYPE	mp	mp	up
RDB/LDB	LDB	RDB	RDB
POOL NAME	POOL 25	POOL 26	POOL 26
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural	Natural
WINGDAM PRESENT OR NOT	NO	Yes?	NO
ARCHEOLOGICAL SITE	NO	NO	
SURROUNDING STRUCTURES	NO..Coon island side	Out of chute of island #508	
COMMERCIAL TRAFFIC LEVEL			H
RECREATIONAL TRAFFIC LEVEL			H
ESTIMATED DISTANCE TO THE SAILING LINE	3375'	1031.3'	3468.8'
LAND USE ON BANK CREST	G(Dense Weeds 2-3'), W(Silver Maple)	W(Silver Maple)	W(Silver Maple, Black Berry)
TYPE OF VEGETATION ON TOP OF BANK	W(Oak field), Vine structure	W, Poison ivy and some grape vines	W(moderate)
TYPE OF VEGETATION AT SCARP FACE	NO	Bare face with sparse weeds	
TYPE OF VEGETATION AT BENCH	NOT SEEN	NO	Debris. No submerged
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO	1' covers top	
OVERLAND DRAINAGE AT THE SITE	NO	NO	
BANK EROSION TYPE	Scarp. P , W , FD	FD , P	FD, W, SL, P
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE	ML	MH	ML
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE	ML	No Berm	
UNDER WATER SLOPE	6.94H:1V	8.85H:1V	7.75H:1V
BENCH SEDIMENT TYPE	Sand	CH/CL	
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	35	35
DATE	13-Oct-95	13-Oct-95
TIME	02:00 PM	02:45 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	222.1	221.1
UTM X		197574.4
UTM Y		4315158.0
BANK SECTION TYPE	mp	dn
RDB/LDB	RDB	RDB
POOL NAME	POOL 26	POOL 26
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	NO	NO
ARCHEOLOGICAL SITE	NO	
SURROUNDING STRUCTURES	Island	Close to Navigation Channel
COMMERCIAL TRAFFIC LEVEL	H	H
RECREATIONAL TRAFFIC LEVEL	H	H
ESTIMATED DISTANCE TO THE SAILING LINE	3468.8'	2625'
LAND USE ON BANK CREST	W	
TYPE OF VEGETATION ON TOP OF BANK	Grape Vines	Vine structure
TYPE OF VEGETATION AT SCARP FACE	NO. Some failed trees & roots	Dense Grape Vines
TYPE OF VEGETATION AT BENCH	NO. Submerged. Emerged Veg. live trees	debris. Mostly d/s direction
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		
OVERLAND DRAINAGE AT THE SITE	NO	Yes. From the site
BANK EROSION TYPE	Scarp, Bench. FD , W , P	FD, W, SL, P
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	ML?, CL	MH
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	No Berm	CH, MH
UNDER WATER SLOPE	8.40H:1V	10.31H:1V
BENCH SEDIMENT TYPE	Clay, CL	Sand
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	36	37
DATE	13-Oct-95	14-Oct-95
TIME	03:50 PM	09:45 AM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	217.5	197.6
UTM X	203667.0	229747.7
UTM Y	4317871.9	4303486.0
BANK SECTION TYPE	mp	mp
RDB/LDB	RDB	RDB
POOL NAME	POOL 26	POOL 27
GEOMORPHIC CHARACTER	Confluence/OUTSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	NO	Yes
ARCHEOLOGICAL SITE		NO
SURROUNDING STRUCTURES	Confluence buoy	Below two small islands. Wing Dam. Above a Mooring structure
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	1875'	1875'
LAND USE ON BANK CREST	A(Beans)	W, G(Weeds)
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds)	W(Dense Oak field..3-4')
TYPE OF VEGETATION AT SCARP FACE	NO	Not much. Bare face
TYPE OF VEGETATION AT BENCH	Floated in beds	Some small debris. No submerged Veg.
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO	NO
OVERLAND DRAINAGE AT THE SITE	Yes	Yes. From the site. 1-2' wide
BANK EROSION TYPE	Scarp, Undercut, Bench. FD , W , SL, Overland Flow	SL, P, B, W, RT, FD. FD between barge & Bank
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	ML	ML, CL
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	No Berm	ML, CL
UNDER WATER SLOPE	13.16H:1V	8.70H:1V
BENCH SEDIMENT TYPE	Sand	Sand
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	38
DATE	14-Oct-95
TIME	02:00 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	174.8
UTM X	219145.3
UTM Y	4273909.3
BANK SECTION TYPE	mp
RDB/LDB	LDB
POOL NAME	OPEN WATER
GEOMORPHIC CHARACTER	STRAIGHT REACH
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	NO
ARCHEOLOGICAL SITE	
SURROUNDING STRUCTURES	Fleeting area; but not close to shore. Stump field on Nav. Chart
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	1312.5'
LAND USE ON BANK CREST	
TYPE OF VEGETATION ON TOP OF BANK	
TYPE OF VEGETATION AT SCARP FACE	
TYPE OF VEGETATION AT BENCH	
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	
OVERLAND DRAINAGE AT THE SITE	
BANK EROSION TYPE	
SCARP HEIGHT	
SCARP SLOPE	
SCARP SOIL TYPE	Silt Blocks
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	
UNDER WATER SLOPE	7.09H:1V
BENCH SEDIMENT TYPE	Sand?
SUBAQUOUS BENCH DESCRIPTION	

SITE NUMBER	39
DATE	15-Oct-95
TIME	04:30 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	112.4
UTM X	247518.8
UTM Y	4201278.3
BANK SECTION TYPE	mp
RDB/LDB	LDB
POOL NAME	OPEN WATER
GEOMORPHIC CHARACTER	OUTSIDE BEND?
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	Yes
ARCHEOLOGICAL SITE	NO
SURROUNDING STRUCTURES	Wing Dam field. both u/s & d/s failed wooden dike and recently loaded riprap
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	1500'
LAND USE ON BANK CREST	W(Young Maple, Large Cottonwoods)
TYPE OF VEGETATION ON TOP OF BANK	G(Weeds)
TYPE OF VEGETATION AT SCARP FACE	Some grow on top part of scarp
TYPE OF VEGETATION AT BENCH	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO
OVERLAND DRAINAGE AT THE SITE	NO
BANK EROSION TYPE	FD , P , W (RT). SL
SCARP HEIGHT	
SCARP SLOPE	
SCARP SOIL TYPE	ML, MH
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	ML, MH
UNDER WATER SLOPE	5.81H:1V
BENCH SEDIMENT TYPE	Sand
SUBAQUOUS BENCH DESCRIPTION	

SITE NUMBER	40
DATE	16-Oct-95
TIME	12:05 PM
RIVER	UMR
RIVER MILE @ MIDPOINT	94.2
UTM X	
UTM Y	
BANK SECTION TYPE	up
RDB/LDB	RDB
POOL NAME	OPEN WATER
GEOMORPHIC CHARACTER	OUTSIDE BEND
BANK TYPE	Natural
WINGDAM PRESENT OR NOT	Yes
ARCHEOLOGICAL SITE	
SURROUNDING STRUCTURES	u/s of a Wing Dam
COMMERCIAL TRAFFIC LEVEL	
RECREATIONAL TRAFFIC LEVEL	
ESTIMATED DISTANCE TO THE SAILING LINE	937.5'
LAND USE ON BANK CREST	W(Willows. d approx. 1')
TYPE OF VEGETATION ON TOP OF BANK	G(Sparse Weeds)
TYPE OF VEGETATION AT SCARP FACE	NO
TYPE OF VEGETATION AT BENCH	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1.5' high dead tree stump
OVERLAND DRAINAGE AT THE SITE	Yes
BANK EROSION TYPE	Scarp, Berm. Higher ground, Drainage, P, Lower L/W contact. W = RT = Prop. wash
SCARP HEIGHT	
SCARP SLOPE	
SCARP SOIL TYPE	ML, MH
BERM HEIGHT	
BERM WIDTH	
BERM SOIL TYPE	ML, MH
UNDER WATER SLOPE	2.05H:1V
BENCH SEDIMENT TYPE	ML, MH
SUBAQUOUS BENCH DESCRIPTION	

SITE NUMBER	40	41
DATE	16-Oct-95	16-Oct-95
TIME	11:15 AM	03:30 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	94.1	77.2
UTM X	264830.7	277330.8
UTM Y	4181673.9	4163801.9
BANK SECTION TYPE	dn	mp
RDB/LDB	RDB	RDB
POOL NAME	OPEN WATER	OPEN WATER
GEOMORPHIC CHARACTER	OUTSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	Yes	Yes
ARCHEOLOGICAL SITE		
SURROUNDING STRUCTURES	d/s of a Wing Dam	d/s of Noname Island, Wing Dam field (from chart)
COMMERCIAL TRAFFIC LEVEL	H	
RECREATIONAL TRAFFIC LEVEL	H	H
ESTIMATED DISTANCE TO THE SAILING LINE	937.5'	750'
LAND USE ON BANK CREST	W(Willows. d approx. 1')	
TYPE OF VEGETATION ON TOP OF BANK	G(Sparse Weeds)	G(Sparse Weeds)
TYPE OF VEGETATION AT SCARP FACE	NO	NO
TYPE OF VEGETATION AT BENCH	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	1.5' high dead tree stump	NO
OVERLAND DRAINAGE AT THE SITE	Yes	Yes
BANK EROSION TYPE	Scarp, Berm. Upper Bank, Drainage, P, Lower Bank. W, RT, P, SL, B	FD , Overland Flow , ?
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	ML, MH	Silt
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE	ML, MH	Silt
UNDER WATER SLOPE	14.71H:1V	5.81H:1V
BENCH SEDIMENT TYPE	ML, MH	Pebbles, Gravels
SUBAQUOUS BENCH DESCRIPTION		

SITE NUMBER	42	42	42
DATE	17-Oct-95	17-Oct-95	17-Oct-95
TIME			07:50 AM
RIVER	UMR	UMR	UMR
RIVER MILE @ MIDPOINT	52.3	52.3	52.3
UTM X		278235.9	
UTM Y		4132843.2	
BANK SECTION TYPE	up	mp	dn
RDB/LDB	LDB	LDB	LDB
POOL NAME	OPEN WATER	OPEN WATER	OPEN WATER
GEOMORPHIC CHARACTER	STRAIGHT REACH	STRAIGHT REACH	STRAIGHT REACH
BANK TYPE	Revetted	Revetted	Revetted
WINGDAM PRESENT OR NOT	Yes	Yes	Yes
ARCHEOLOGICAL SITE	NO	NO	NO
SURROUNDING STRUCTURES	u/s of a Wing Dam..approx. 1000'	u/s of a Wing Dam..approx. 1000'	u/s of a Wing Dam..approx. 1000'
COMMERCIAL TRAFFIC LEVEL			
RECREATIONAL TRAFFIC LEVEL			
ESTIMATED DISTANCE TO THE SAILING LINE		1500'	
LAND USE ON BANK CREST	Revetment; some dredge	Revetment; some dredge	Revetment; some dredge
TYPE OF VEGETATION ON TOP OF BANK	NO	NO	NO
TYPE OF VEGETATION AT SCARP FACE			
TYPE OF VEGETATION AT BENCH	NO	NO	NO
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE	NO	NO	NO
OVERLAND DRAINAGE AT THE SITE	Yes	Yes	Yes
BANK EROSION TYPE	Scarp, B. FD , W , Overland Flow	Scarp, B. FD , W , Overland Flow	Scarp, B. FD , W , Overland Flow
SCARP HEIGHT			
SCARP SLOPE			
SCARP SOIL TYPE			
BERM HEIGHT			
BERM WIDTH			
BERM SOIL TYPE			MH, ML
UNDER WATER SLOPE	7.41H:1V	10.87H:1V	5.88H:1V
BENCH SEDIMENT TYPE	Sand?	Sand	Sand?
SUBAQUOUS BENCH DESCRIPTION			

SITE NUMBER	43	44
DATE	17-Oct-95	17-Oct-95
TIME	11:10 AM	02:30 PM
RIVER	UMR	UMR
RIVER MILE @ MIDPOINT	45.2	25.8
UTM X	282134.9	293525.4
UTM Y	4124089.9	4098657.5
BANK SECTION TYPE	mp	mp
RDB/LDB	LDB	RDB
POOL NAME	OPEN WATER	OPEN WATER
GEOMORPHIC CHARACTER	OUTSIDE BEND	STRAIGHT REACH
BANK TYPE	Natural	Natural
WINGDAM PRESENT OR NOT	NO	Yes
ARCHEOLOGICAL SITE		NO
SURROUNDING STRUCTURES	d/s of a power line	Below a Wing Dam..approx. 0.2 mile.
COMMERCIAL TRAFFIC LEVEL		
RECREATIONAL TRAFFIC LEVEL		
ESTIMATED DISTANCE TO THE SAILING LINE	750'	937.5'
LAND USE ON BANK CREST		W(Silver Maple, Cottonwoods, Willow)
TYPE OF VEGETATION ON TOP OF BANK		G(Thin dry grass)
TYPE OF VEGETATION AT SCARP FACE		NO
TYPE OF VEGETATION AT BENCH		Debris facing d/s. Debris in water on bank face
EXTENT OF TREE ROOT EXPOSURE ON BANK FACE		Approx. 4' right on edge
OVERLAND DRAINAGE AT THE SITE		NO. Sand on top for Flood '93
BANK EROSION TYPE		Scarp, Berm & Sand Benches
SCARP HEIGHT		
SCARP SLOPE		
SCARP SOIL TYPE	Silt	ML, MH. Mostly Silt
BERM HEIGHT		
BERM WIDTH		
BERM SOIL TYPE		Silt
UNDER WATER SLOPE	5.38H:1V	7.58H:1V
BENCH SEDIMENT TYPE	Rock Bed	Sand
SUBAQUOUS BENCH DESCRIPTION		

Appendix J.

Navigation Charts Marked with 1995 Field Survey Bank Conditions
(On file with the Rock Island District, U.S. Army Corps of Engineers)

Interim Report For The Upper Mississippi River - Illinois Waterway System Navigation Study

Bank Erosion Field Survey Report

Bank Condition Mapping

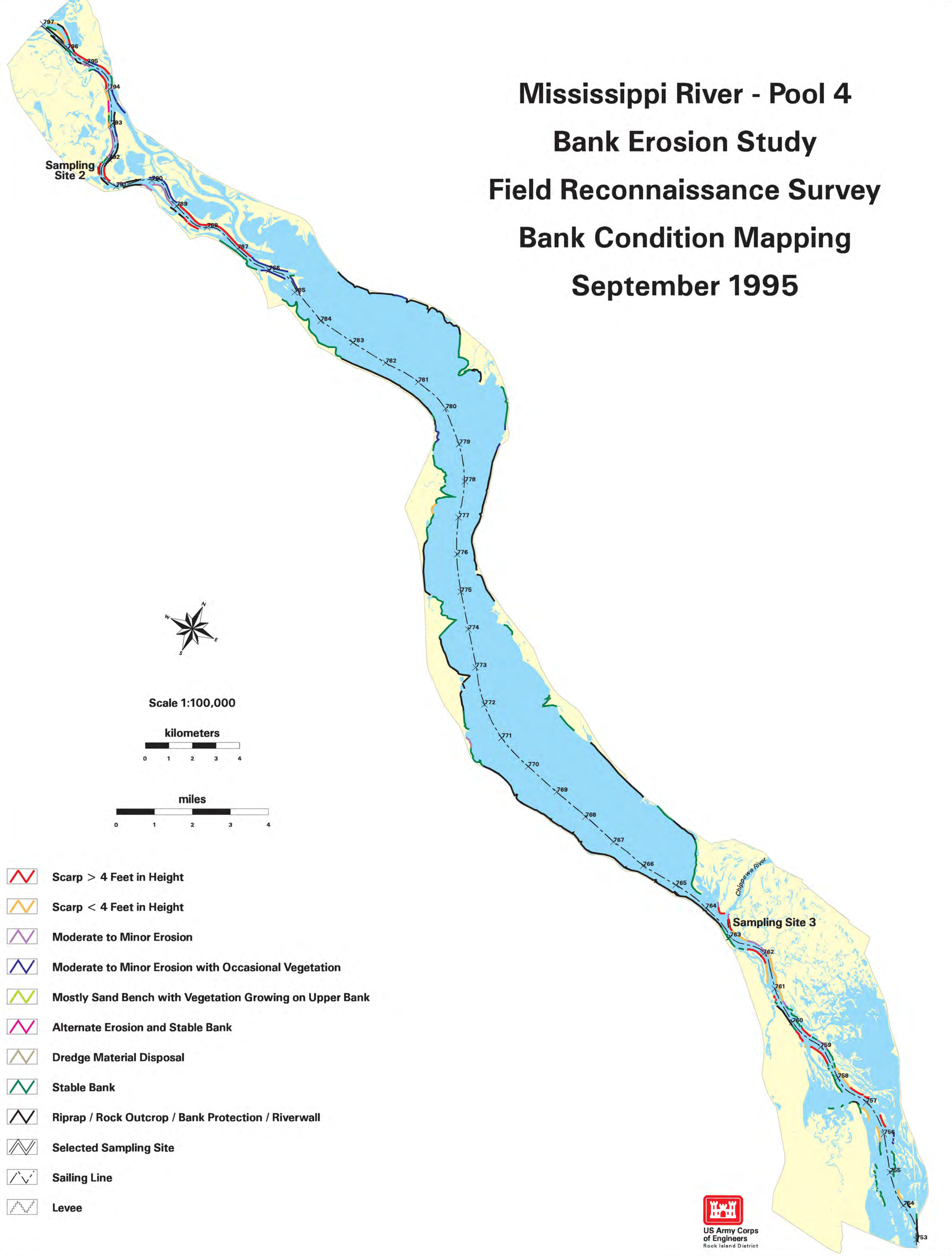
Appendix J

November 1997

US Army Corps
of Engineers

St. Paul District
Rock Island District
St. Louis District

Mississippi River - Pool 4
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995



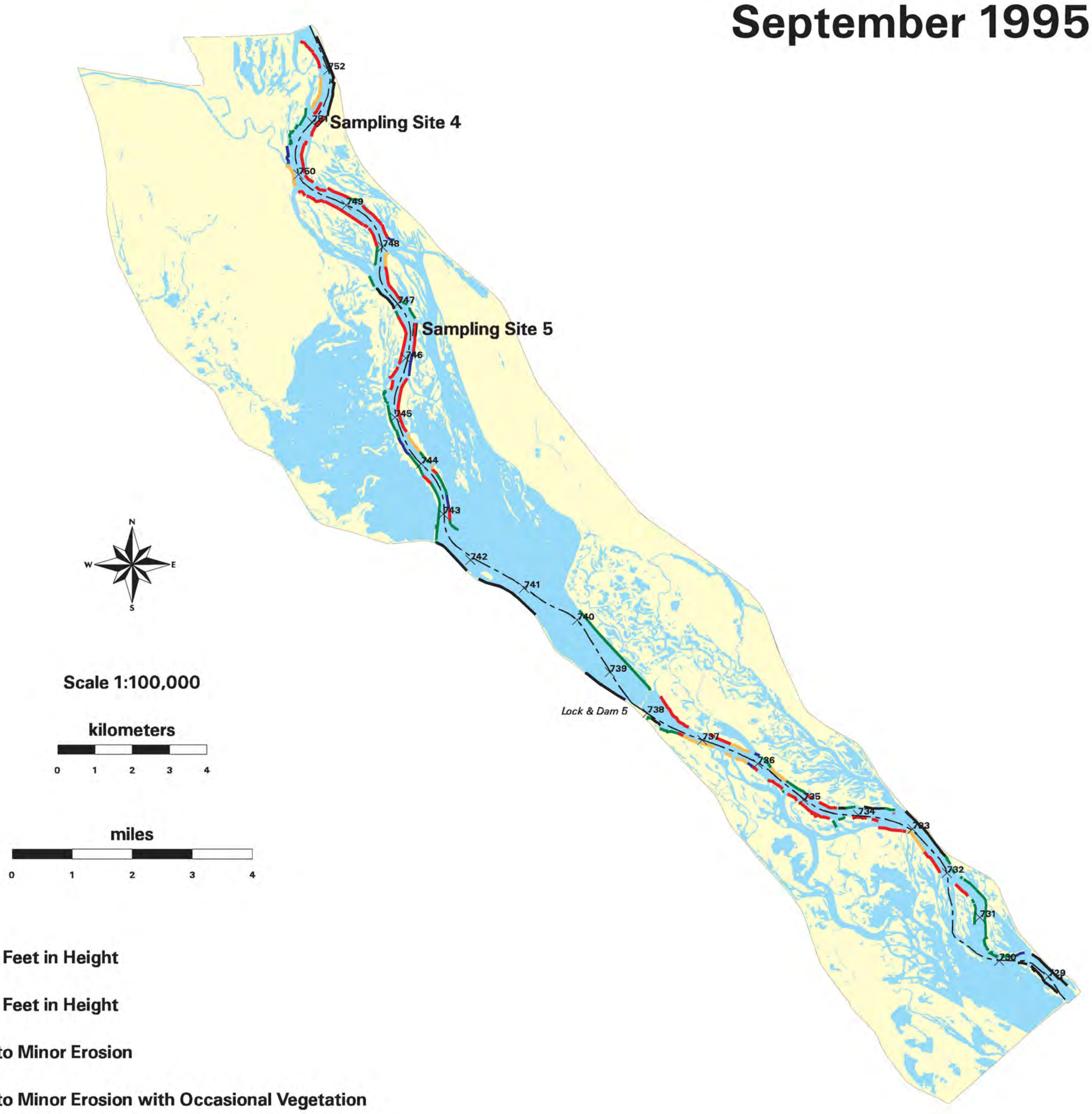
Mississippi River - Pools 5 and 5a

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

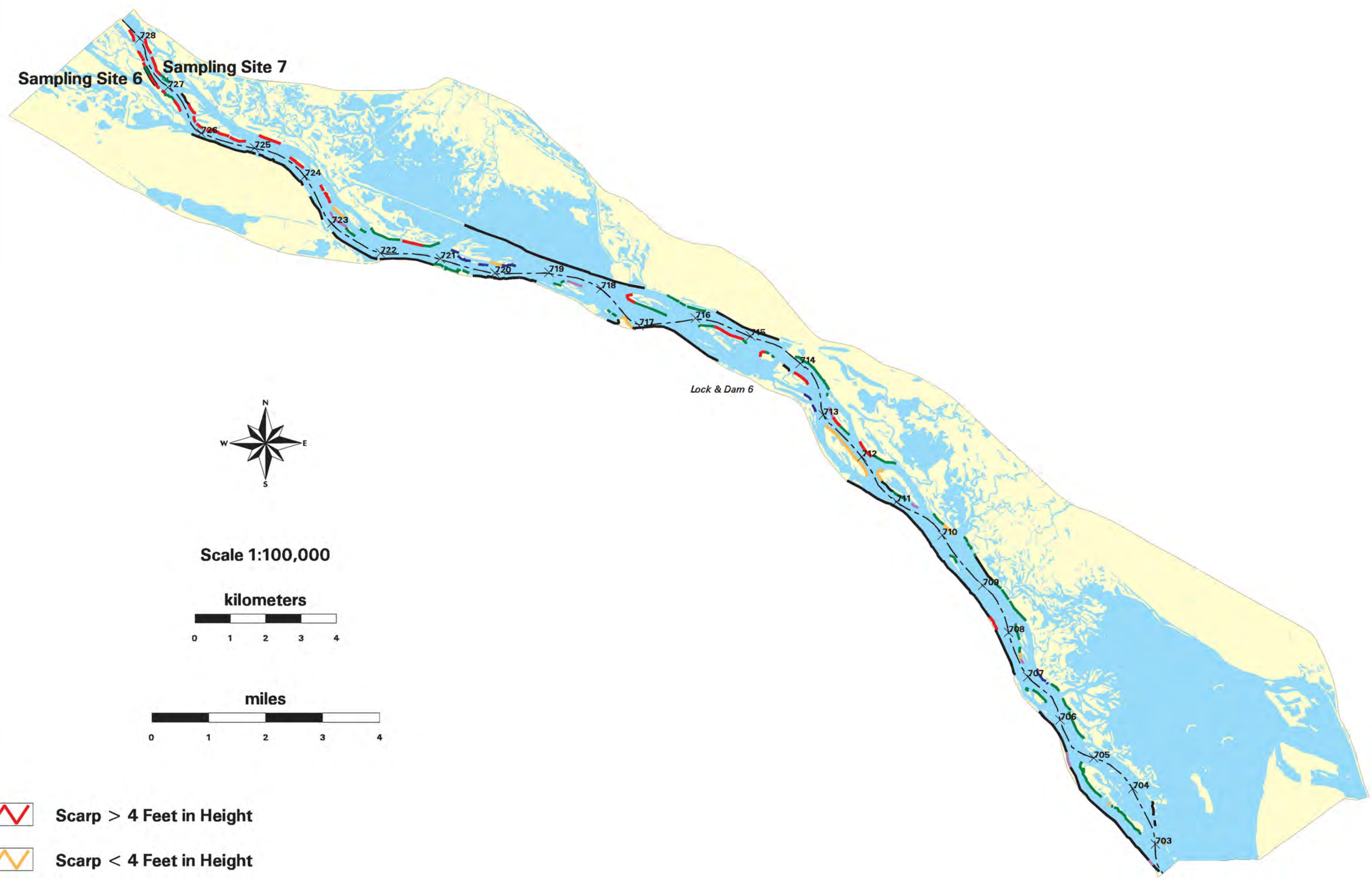
Mississippi River - Pools 6 and 7

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

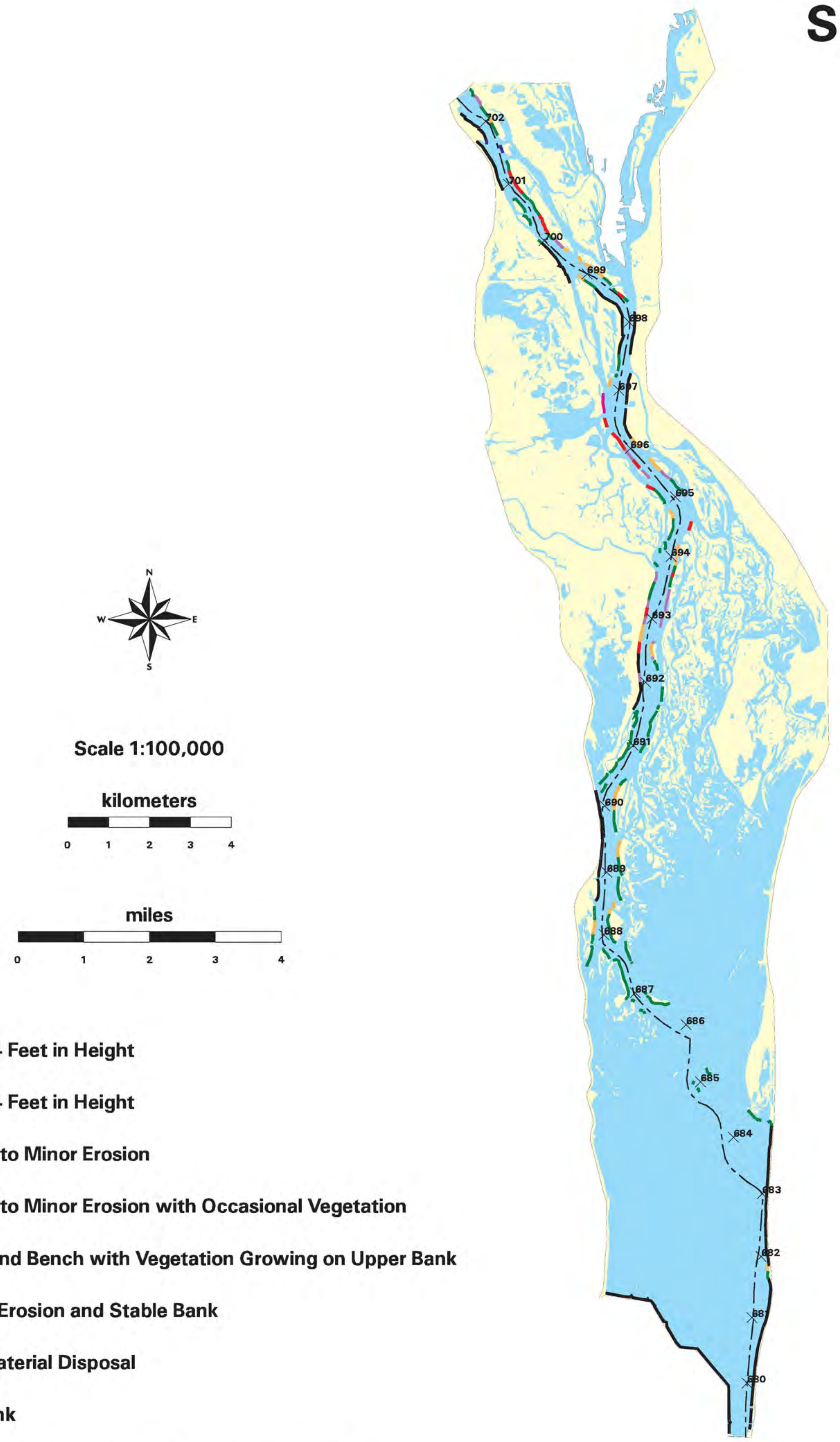
September 1995



- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

Mississippi River - Pool 8
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995



Scarp > 4 Feet in Height

Scarp < 4 Feet in Height

Moderate to Minor Erosion

Moderate to Minor Erosion with Occasional Vegetation

Mostly Sand Bench with Vegetation Growing on Upper Bank

Alternate Erosion and Stable Bank

Dredge Material Disposal

Stable Bank

Riprap / Rock Outcrop / Bank Protection / Riverwall

Selected Sampling Site

Sailing Line

Levee

US Army Corps of Engineers
Rock Island District

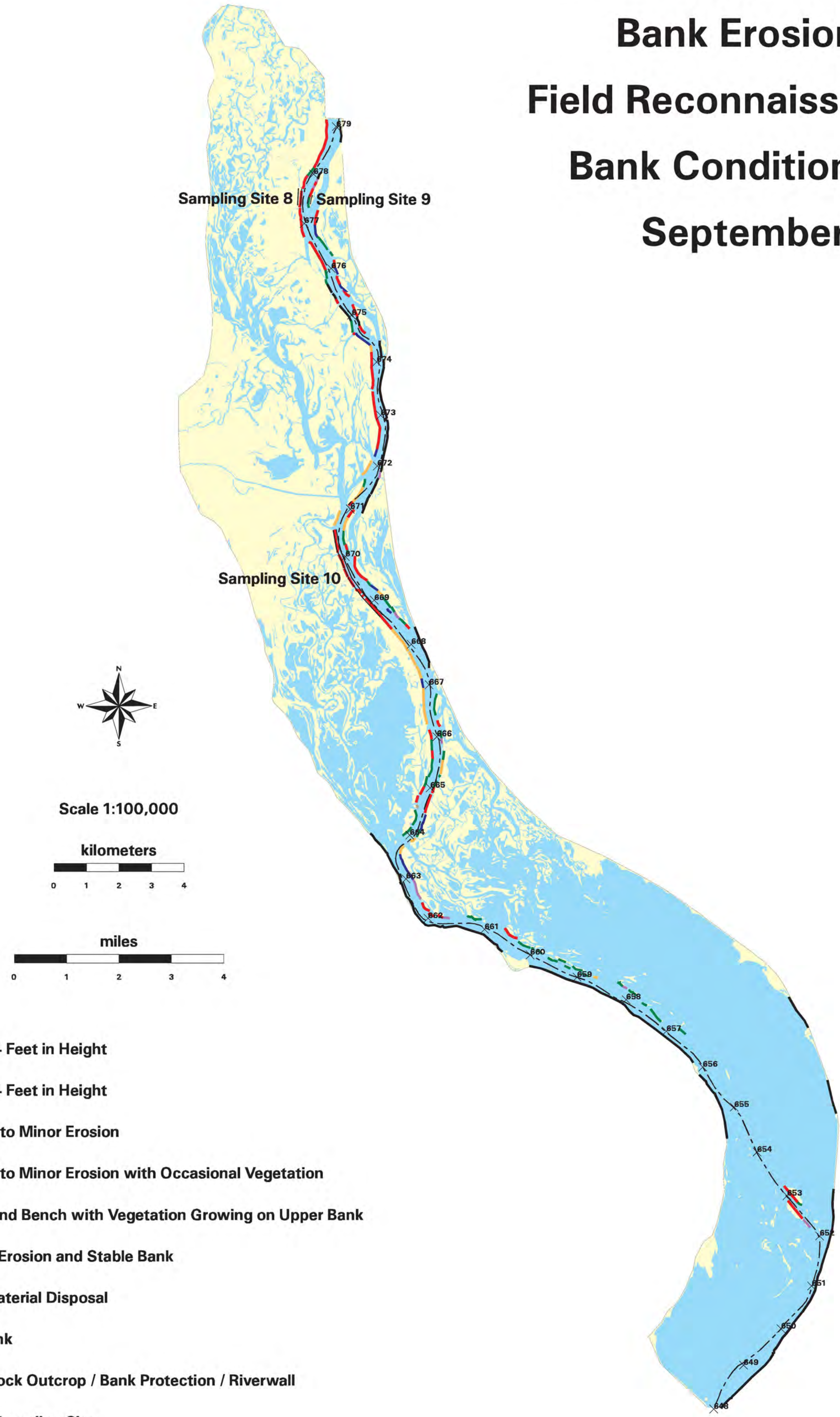
Mississippi River - Pool 9

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

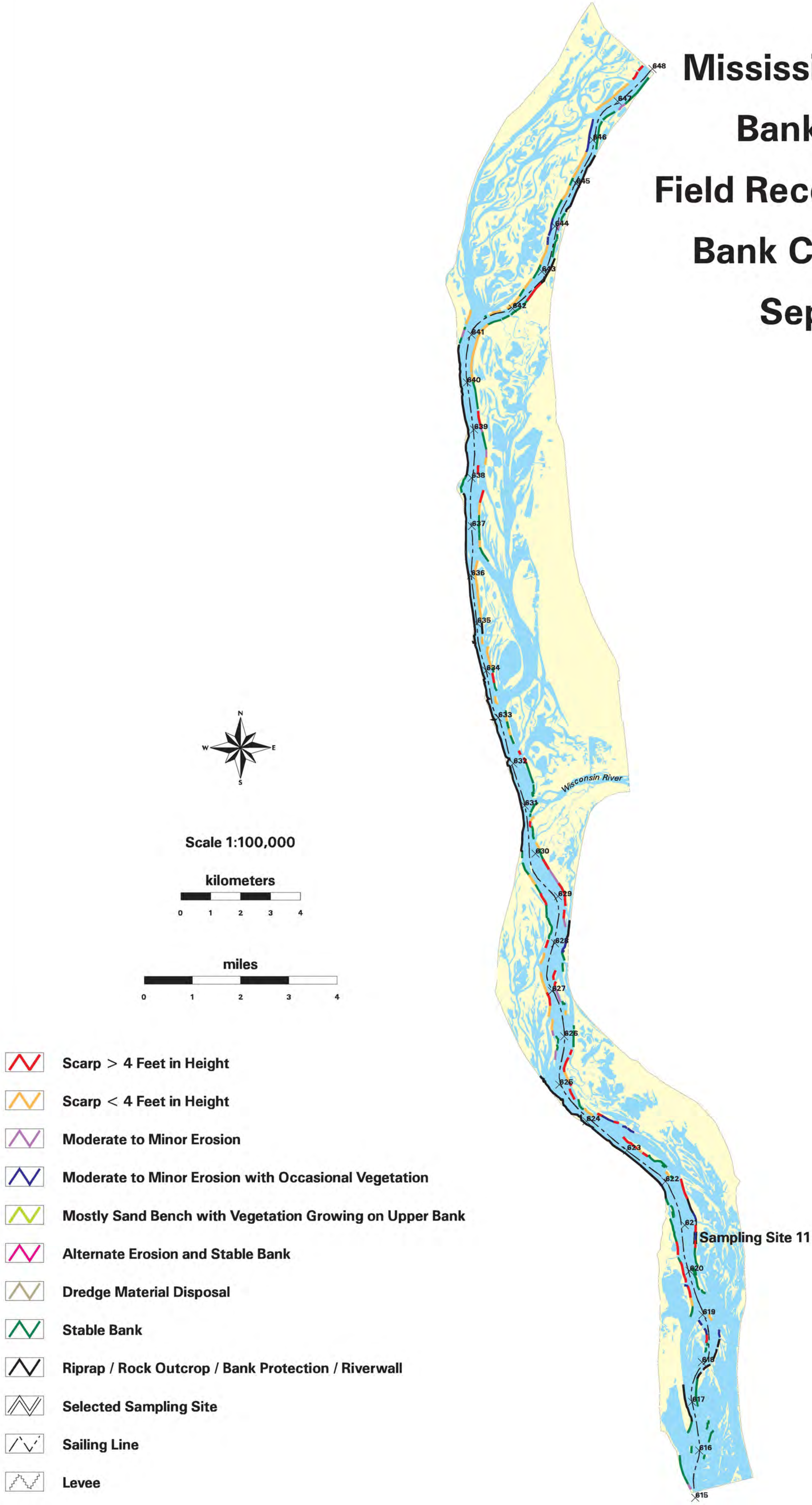
Mississippi River - Pool 10

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



US Army Corps of Engineers
Rock Island District

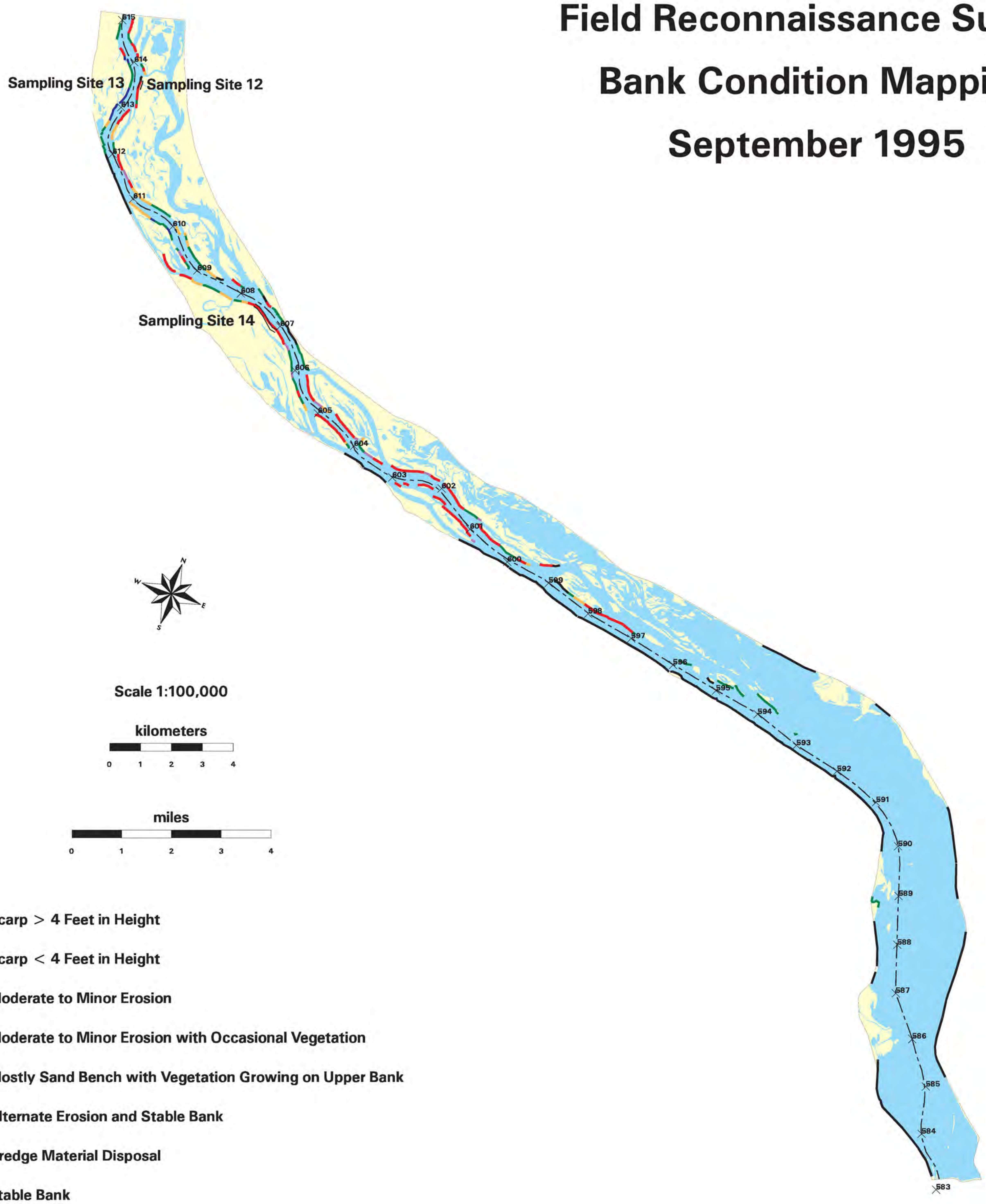
Mississippi River - Pool 11

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



Scarp > 4 Feet in Height

Scarp < 4 Feet in Height

Moderate to Minor Erosion

Moderate to Minor Erosion with Occasional Vegetation

Mostly Sand Bench with Vegetation Growing on Upper Bank

Alternate Erosion and Stable Bank

Dredge Material Disposal

Stable Bank

Riprap / Rock Outcrop / Bank Protection / Riverwall

Selected Sampling Site

Sailing Line

Levee

US Army Corps of Engineers
Rock Island District

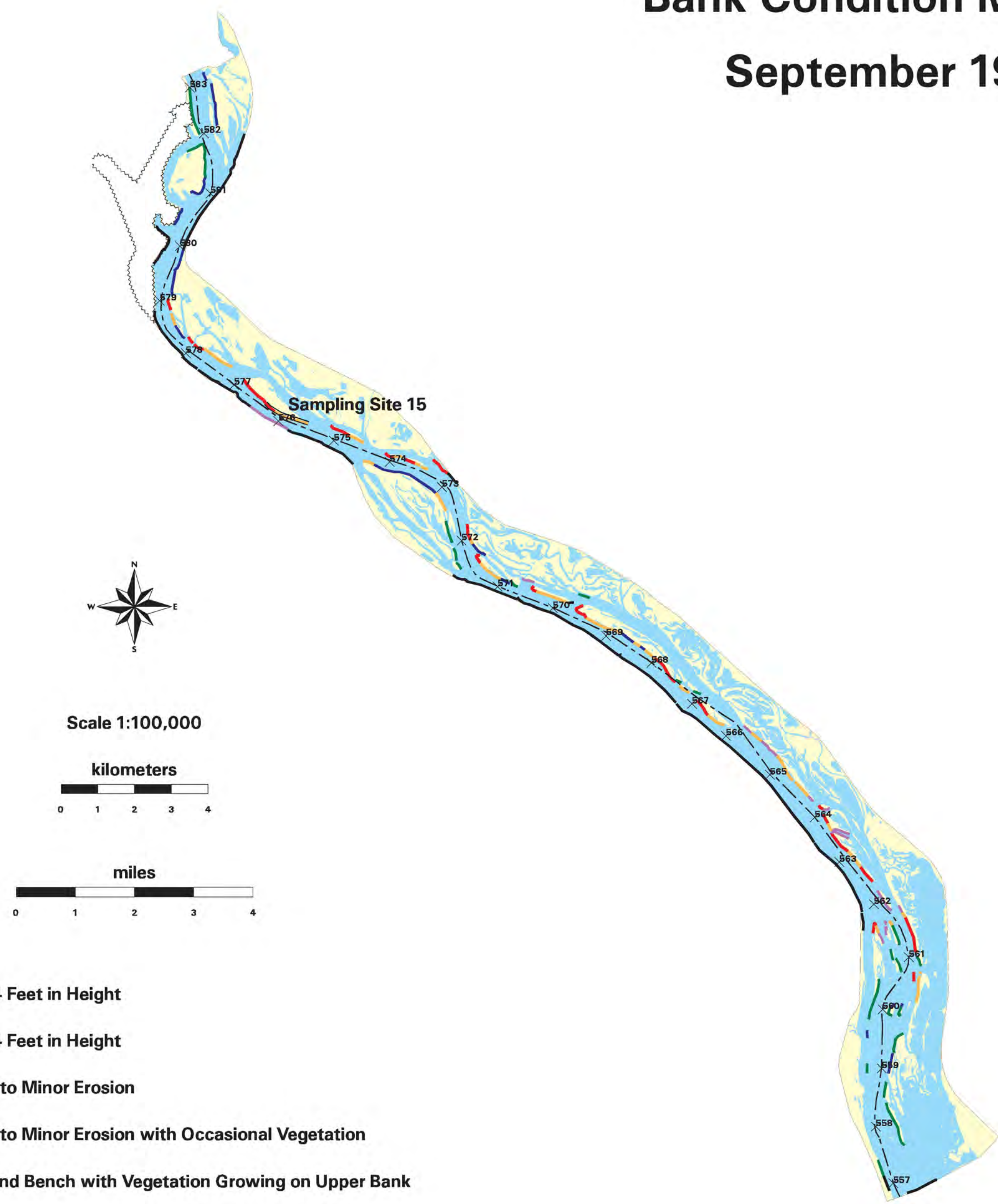
Mississippi River - Pool 12

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

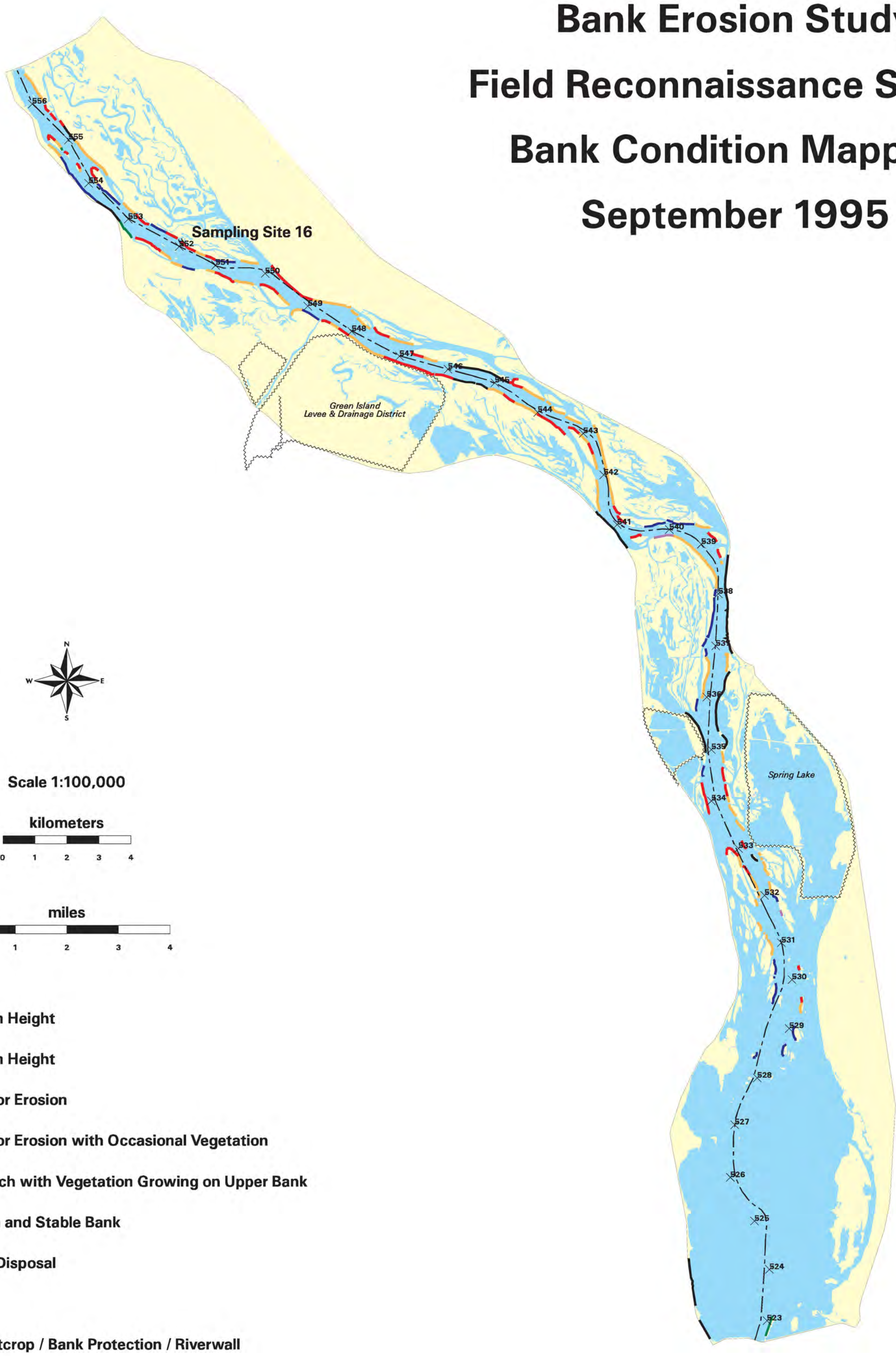
Mississippi River - Pool 13

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



N
W E
S

Scale 1:100,000

kilometers

0 1 2 3 4

miles

0 1 2 3 4

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District

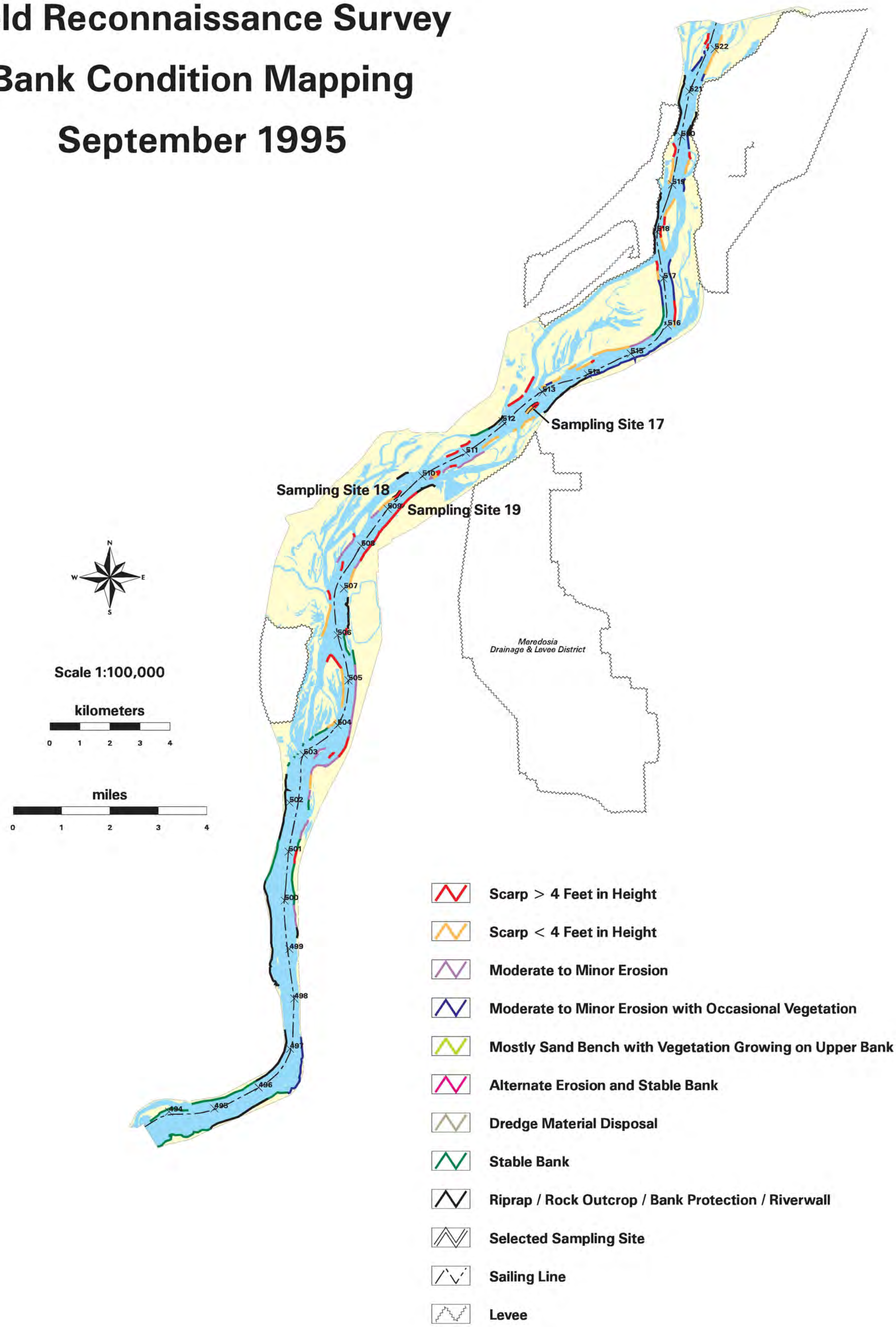
Mississippi River - Pool 14

Bank Erosion Study

Field Reconnaissance Survey

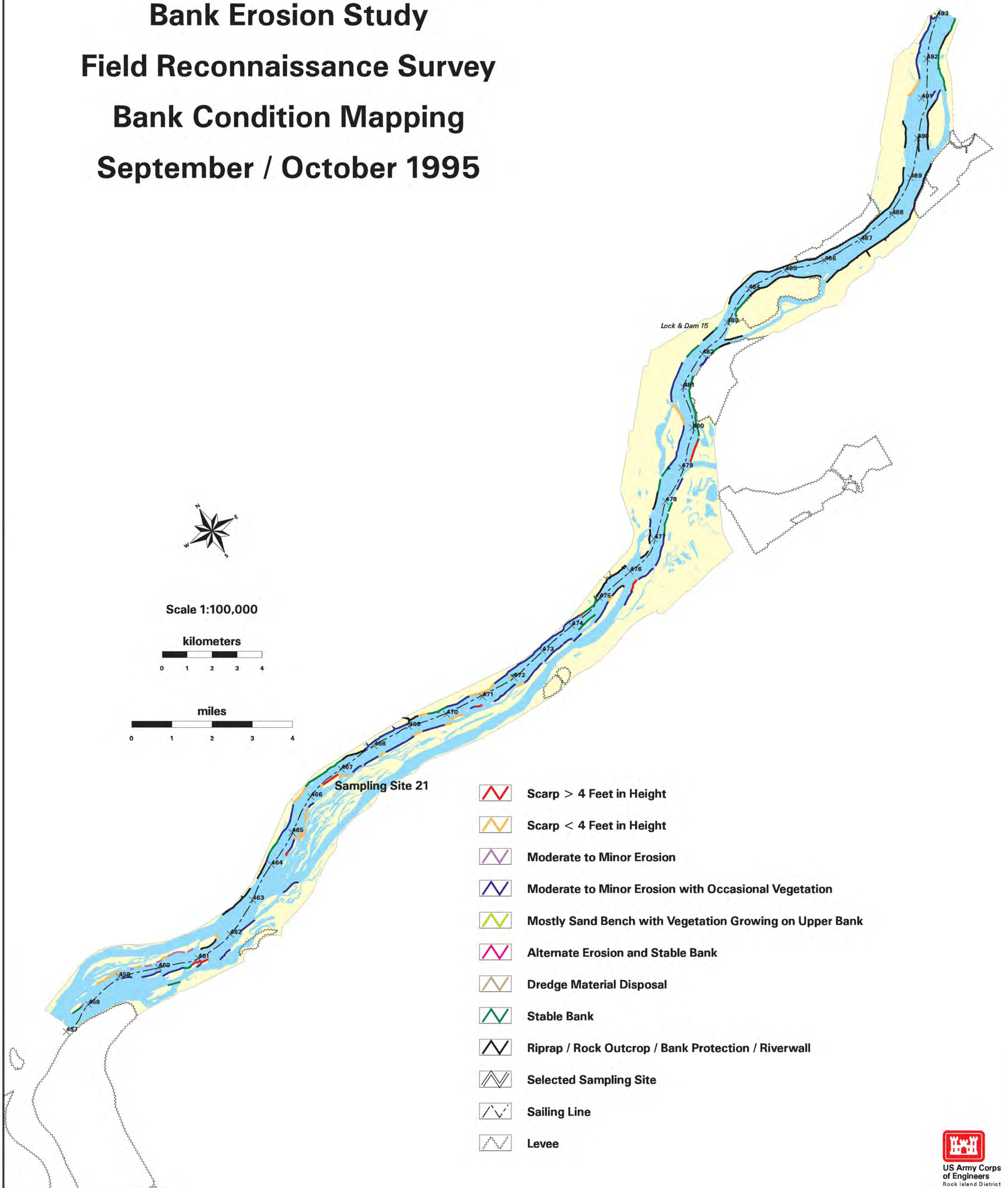
Bank Condition Mapping

September 1995



US Army Corps of Engineers
Rock Island District

Mississippi River - Pools 15 and 16
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September / October 1995



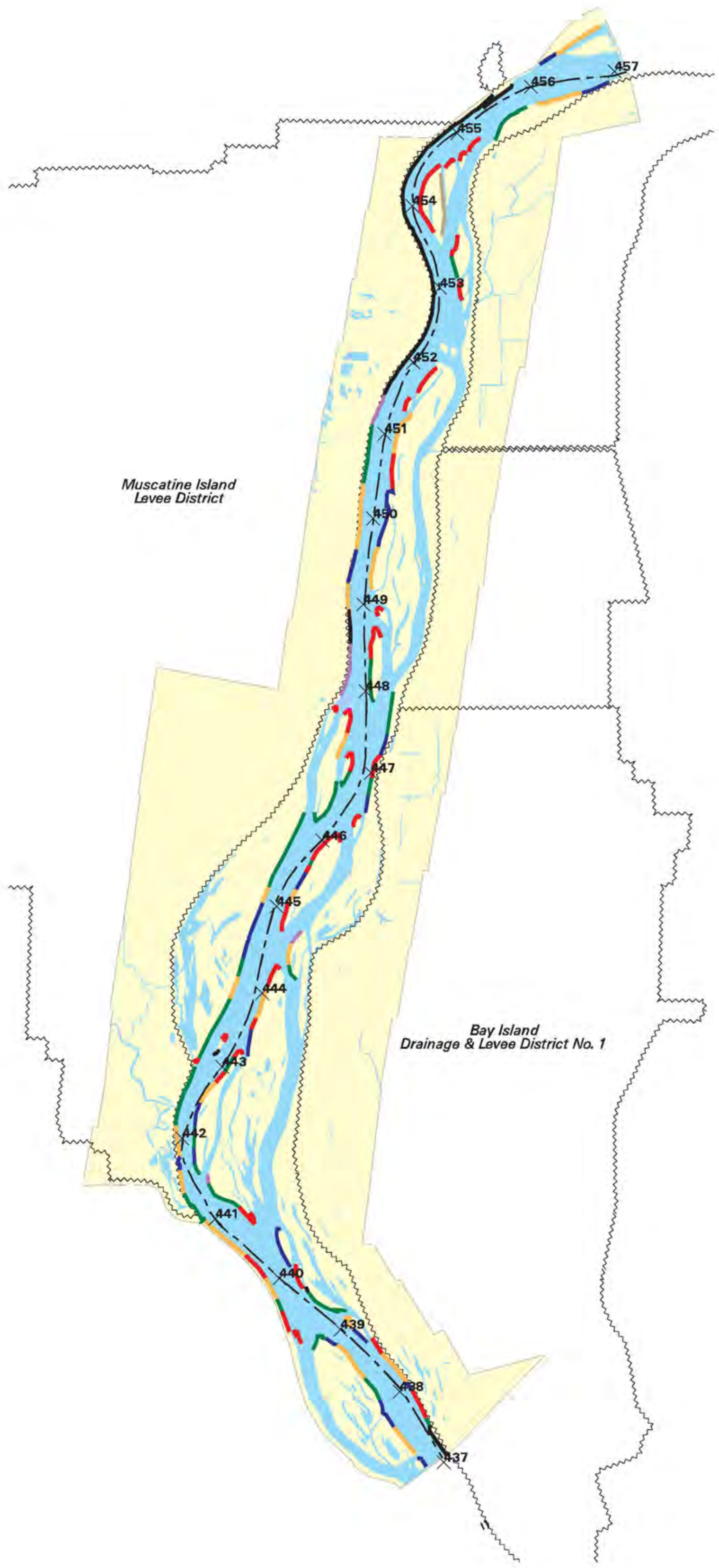
Mississippi River - Pool 17

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

October 1995



N
W E
S

Scale 1:100,000

kilometers

0 1 2 3 4

miles

0 1 2 3 4

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District

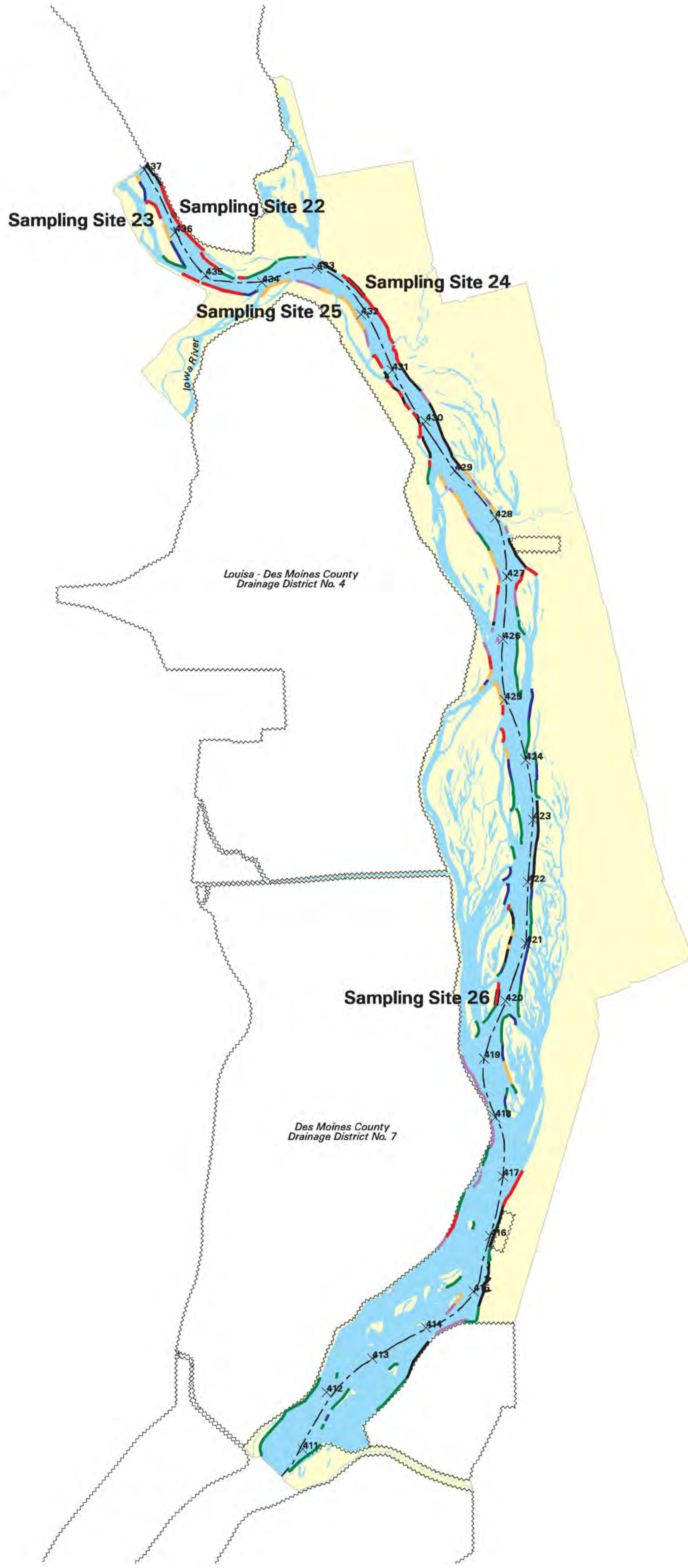
Mississippi River - Pool 18

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

October 1995



N
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Scale 1:100,000

kilometers

0 1 2 3 4

miles

0 1 2 3 4

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District

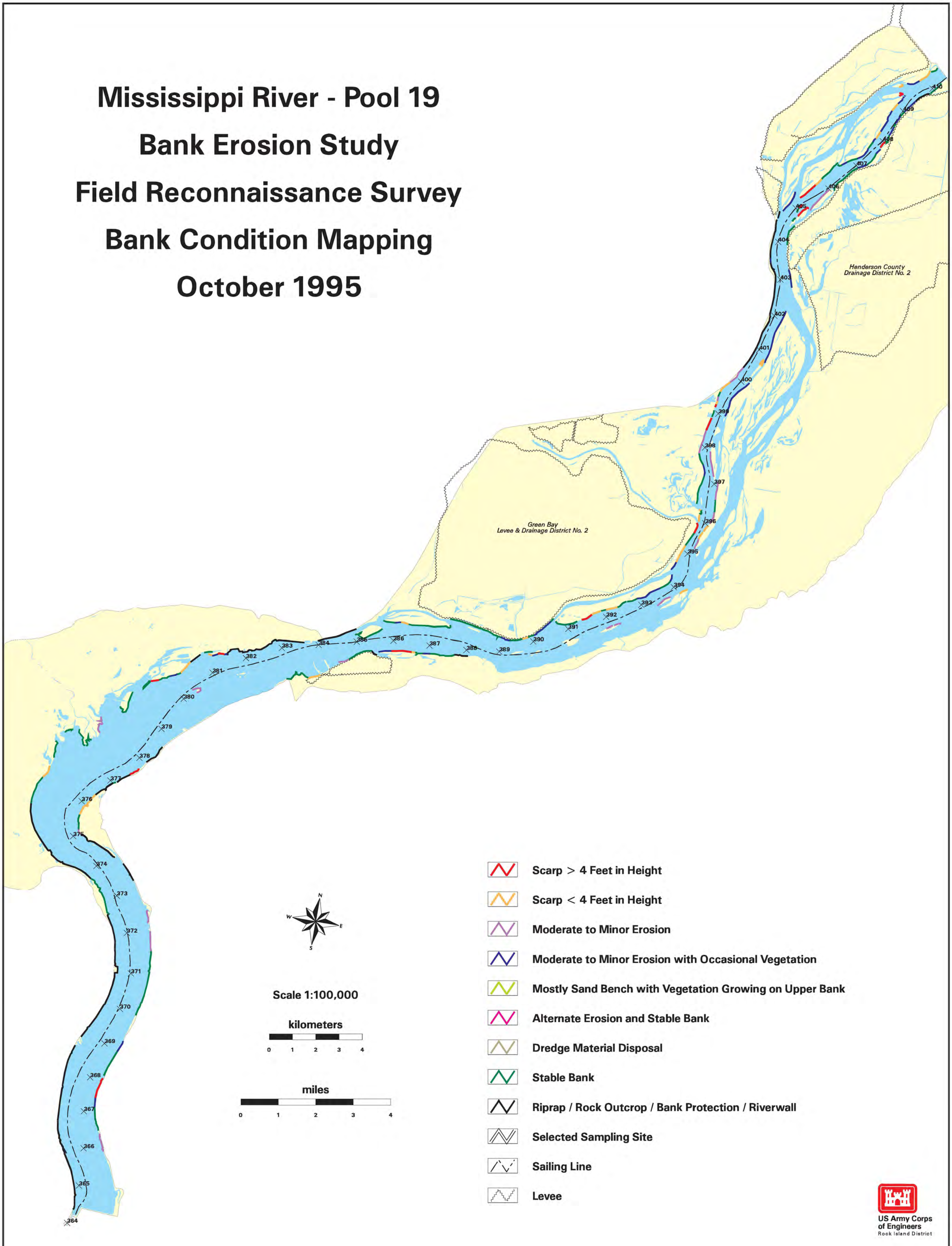
Mississippi River - Pool 19

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

October 1995



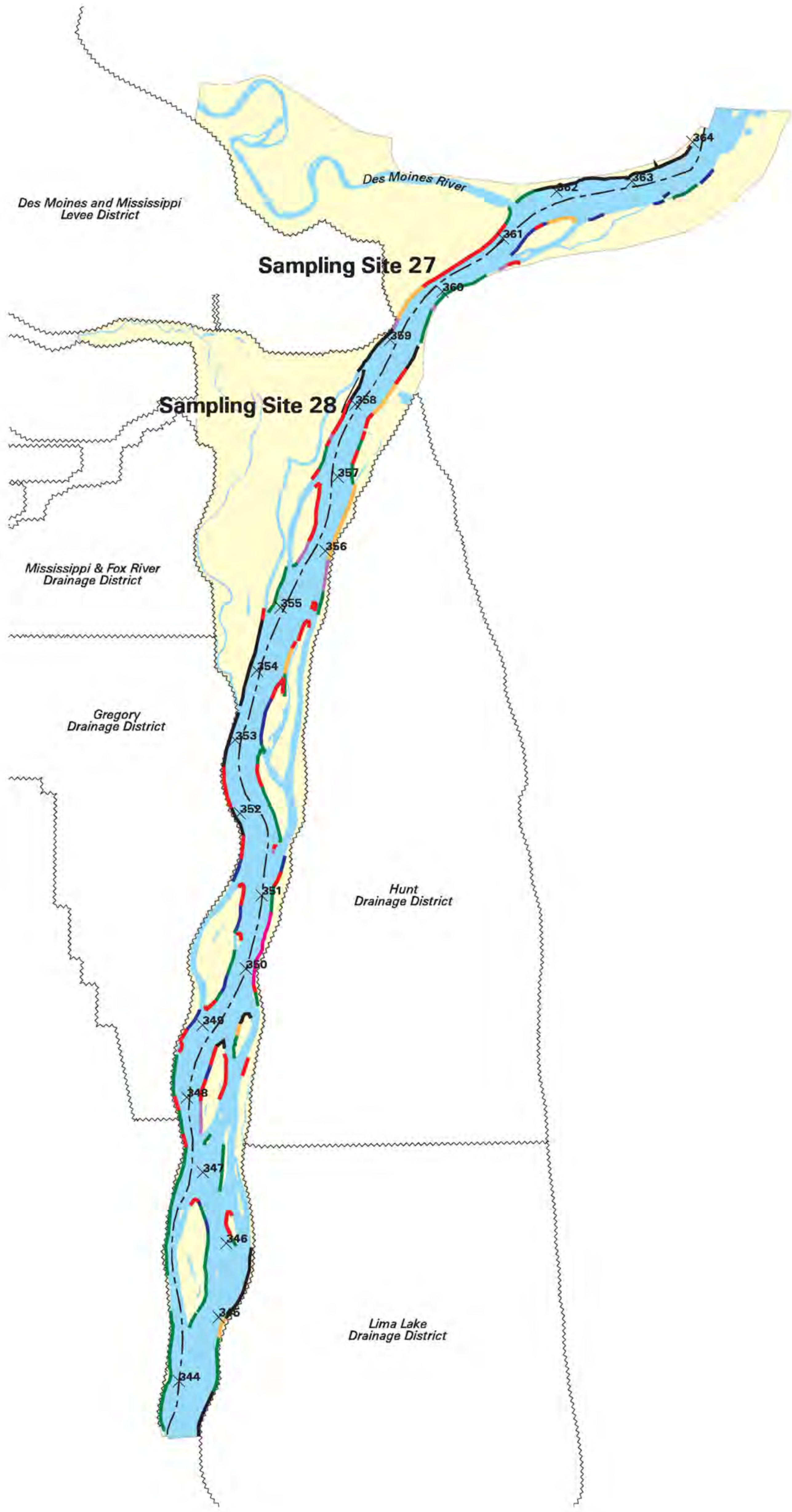
Mississippi River - Pool 20

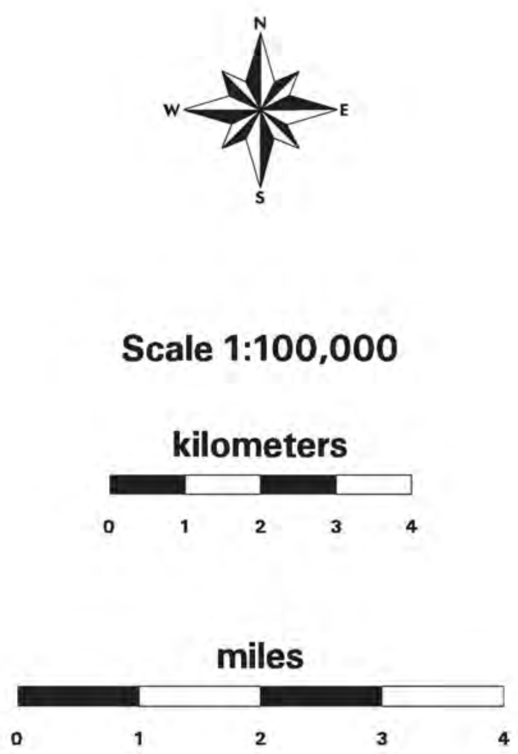
Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

October 1995





- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

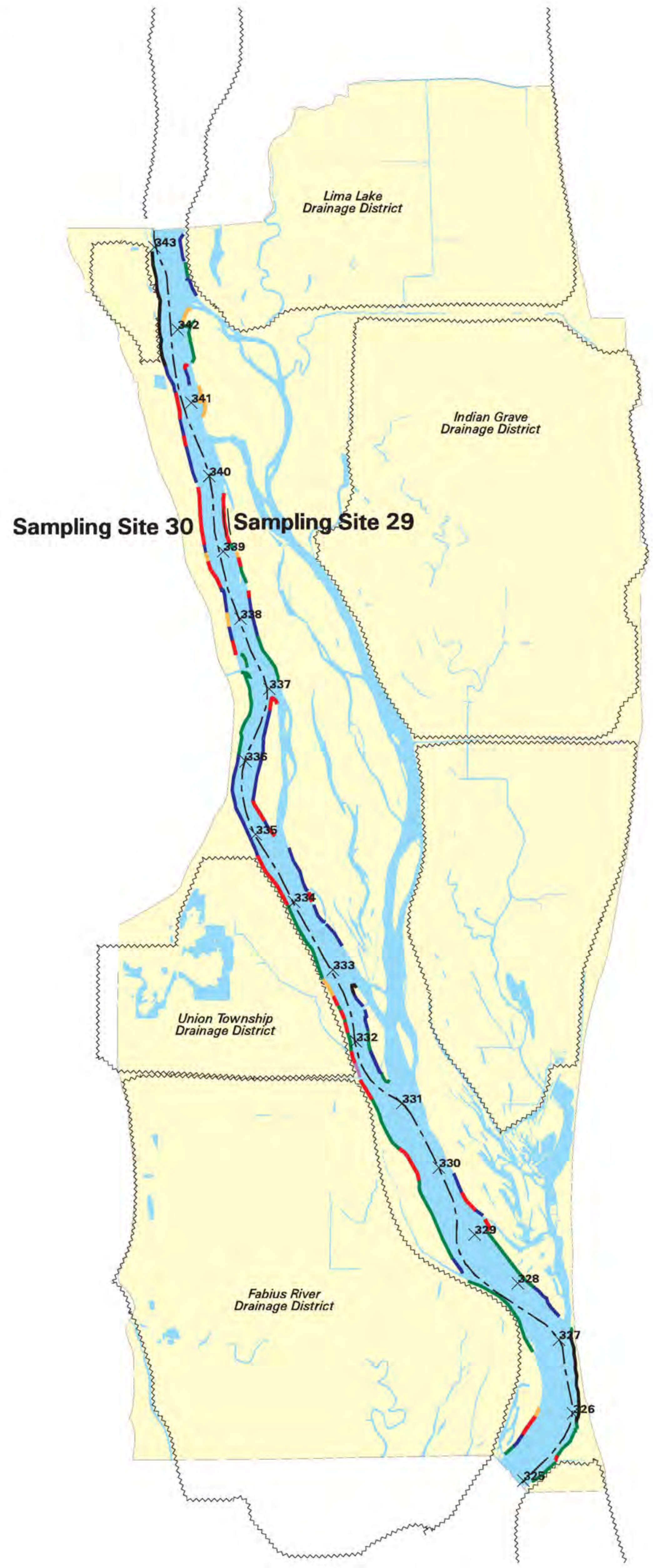
Mississippi River - Pool 21

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

October 1995



Scale 1:100,000

kilometers

0 1 2 3 4

miles

0 1 2 3 4

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

Mississippi River - Pool 22

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

October 1995

Scarp > 4 Feet in Height

Scarp < 4 Feet in Height

Moderate to Minor Erosion

Moderate to Minor Erosion with Occasional Vegetation

Mostly Sand Bench with Vegetation Growing on Upper Bank

Alternate Erosion and Stable Bank

Dredge Material Disposal

Stable Bank

Riprap / Rock Outcrop / Bank Protection / Riverwall

Selected Sampling Site

Sailing Line

Levee

US Army Corps of Engineers
Rock Island District

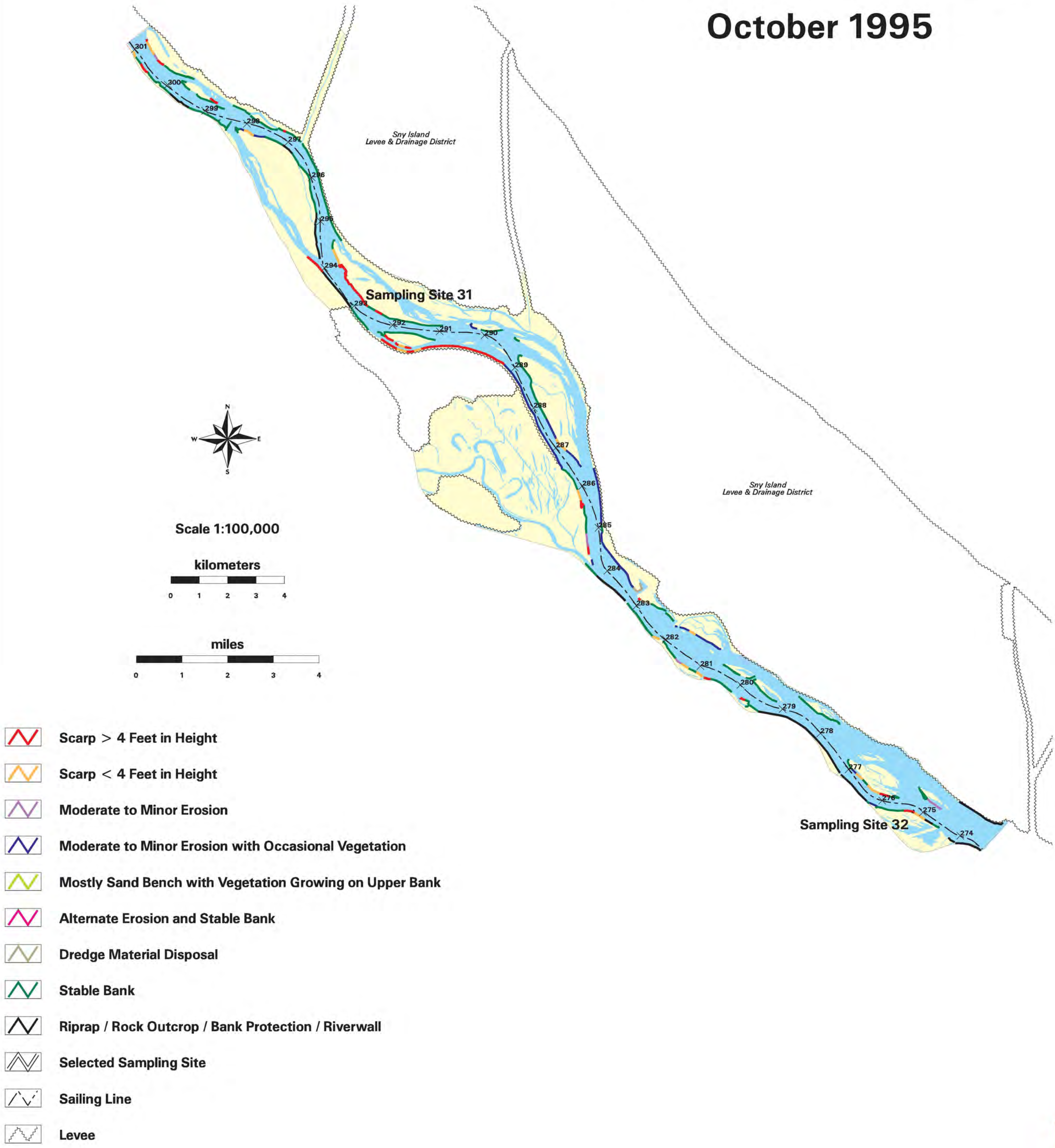
Mississippi River - Pool 24

Bank Erosion Study

Field Reconnaissance Survey

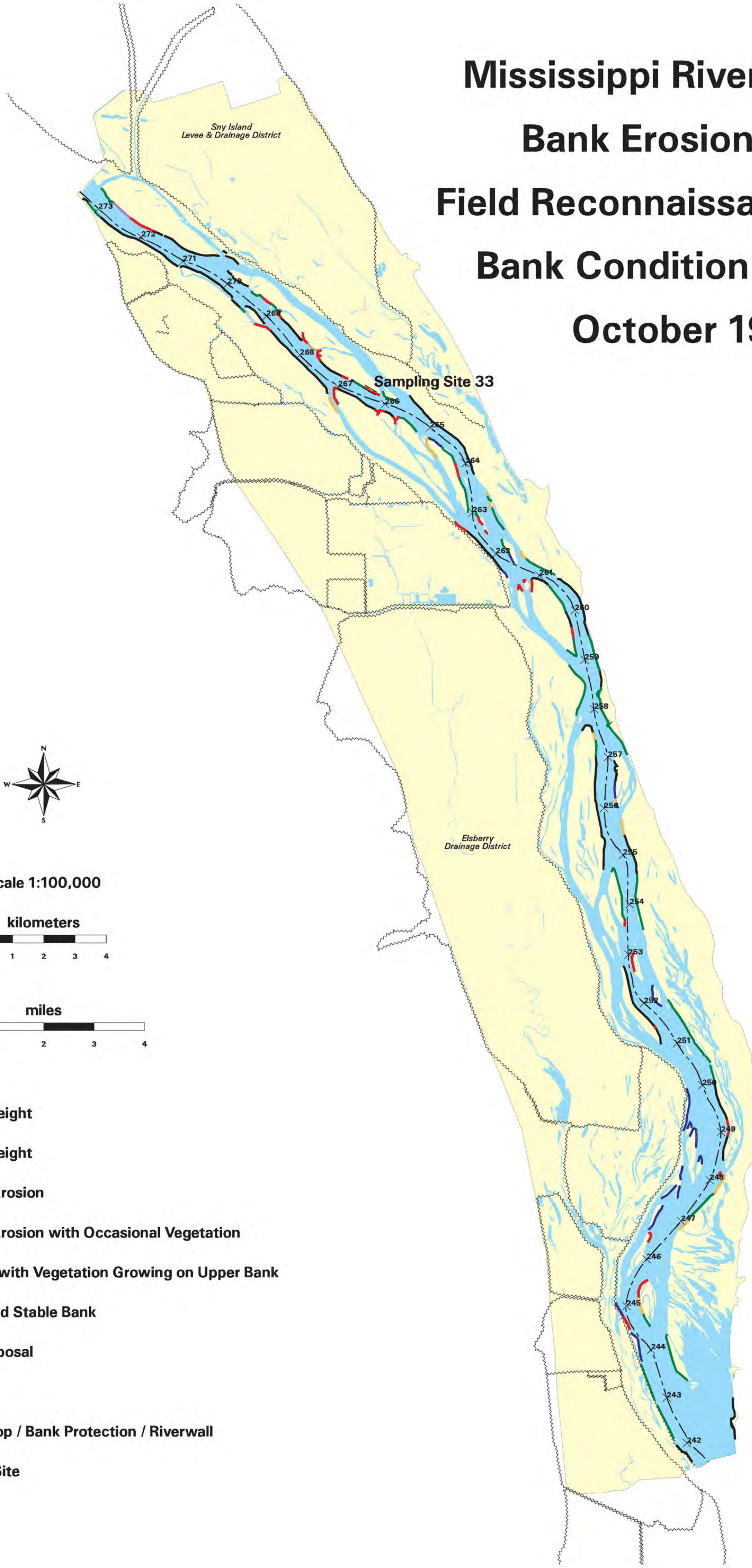
Bank Condition Mapping

October 1995



US Army Corps of Engineers
Rock Island District

Mississippi River - Pool 25
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
October 1995



Scale 1:100,000

kilometers

0 1 2 3 4

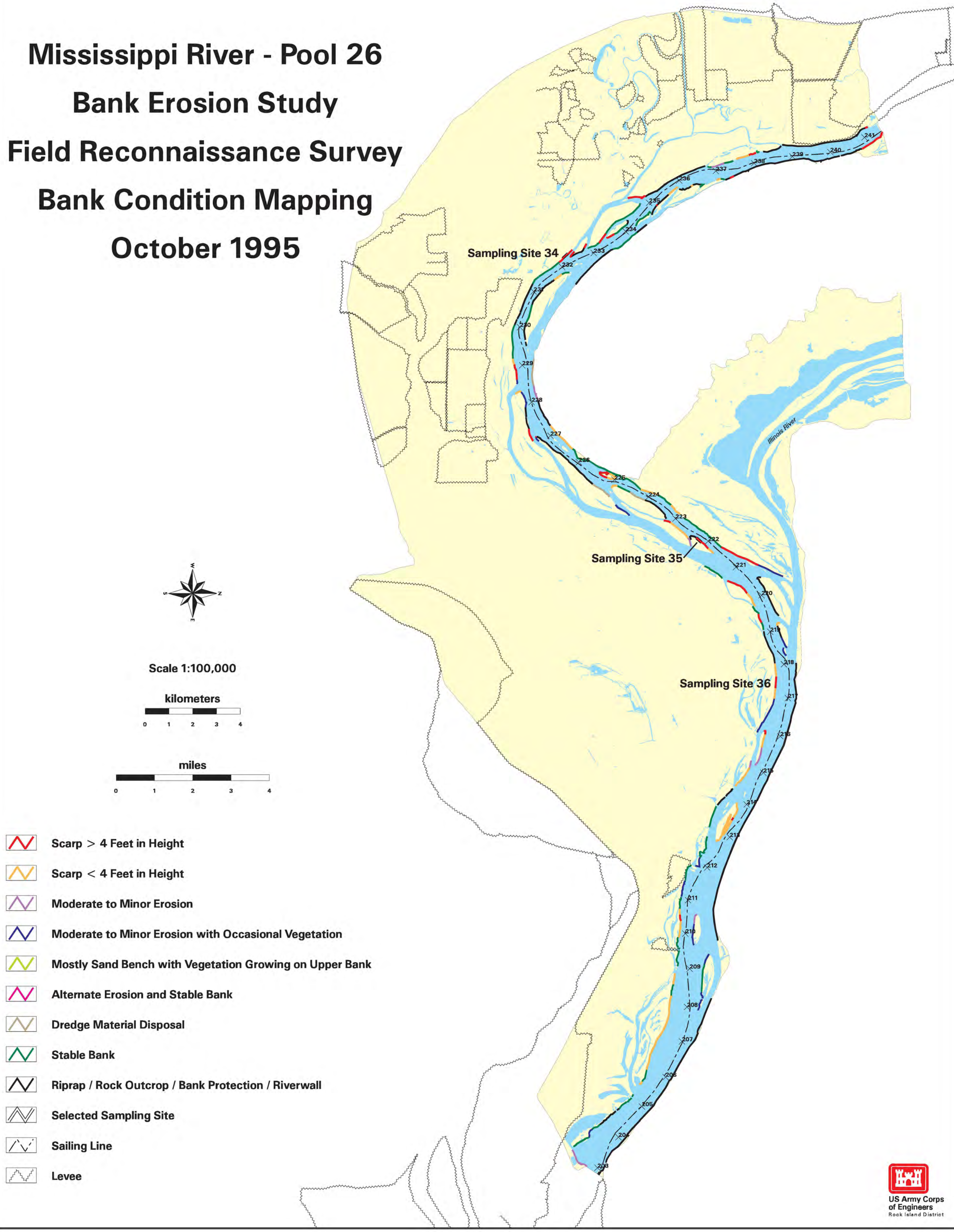
miles

0 1 2 3 4

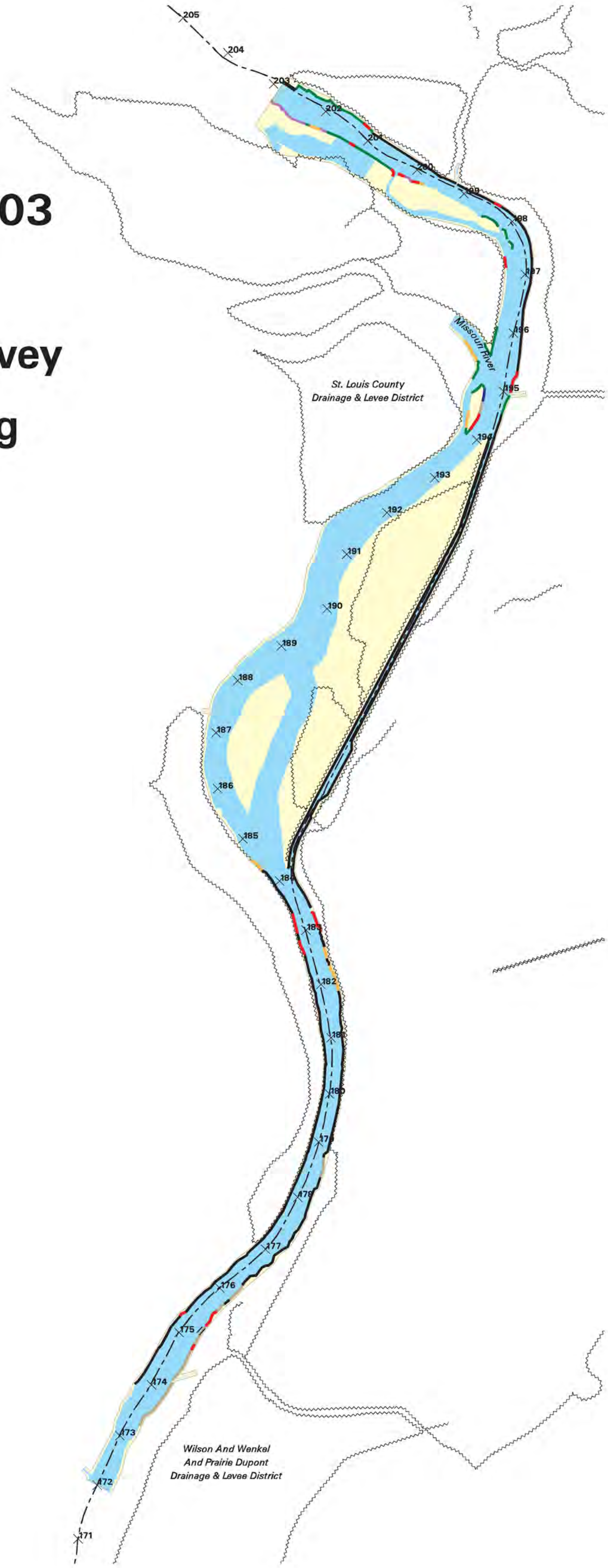
- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District

Mississippi River - Pool 26
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
October 1995



Open River, Mile 172 to 203
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995



Scale 1:100,000

kilometers

0 1 2 3 4

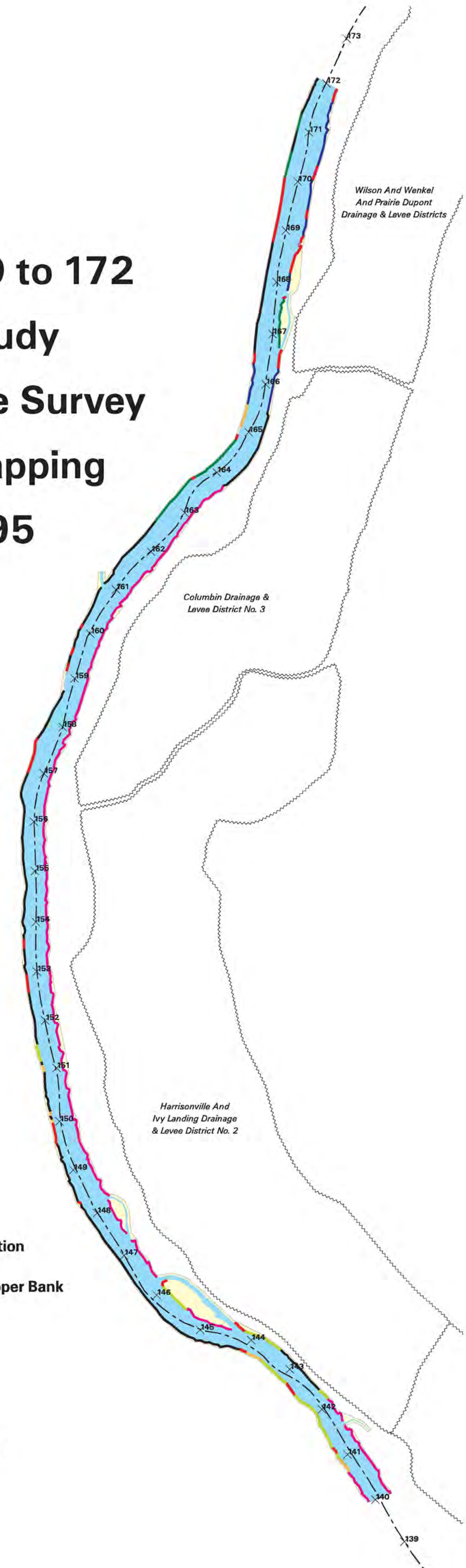
miles

0 1 2 3 4

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Eddy Scour and Deposition Between Wingdams
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District
St. Paul District
St. Louis District

Open River, Mile 140 to 172
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995



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Scale 1:100,000

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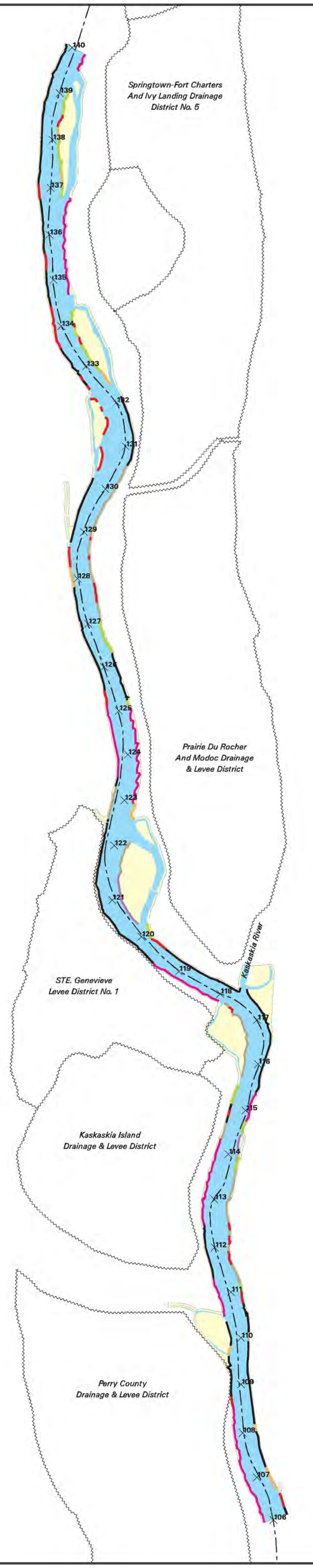
- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Eddy Scour and Deposition Between Wingdams
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District
St. Paul District
St. Louis District

Open River, Mile 106 to 140
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995



Scale 1:100,000

kilometers

0 1 2 3 4

miles

0 1 2 3 4

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Eddy Scour and Deposition Between Wingdams
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District
St. Paul District
St. Louis District

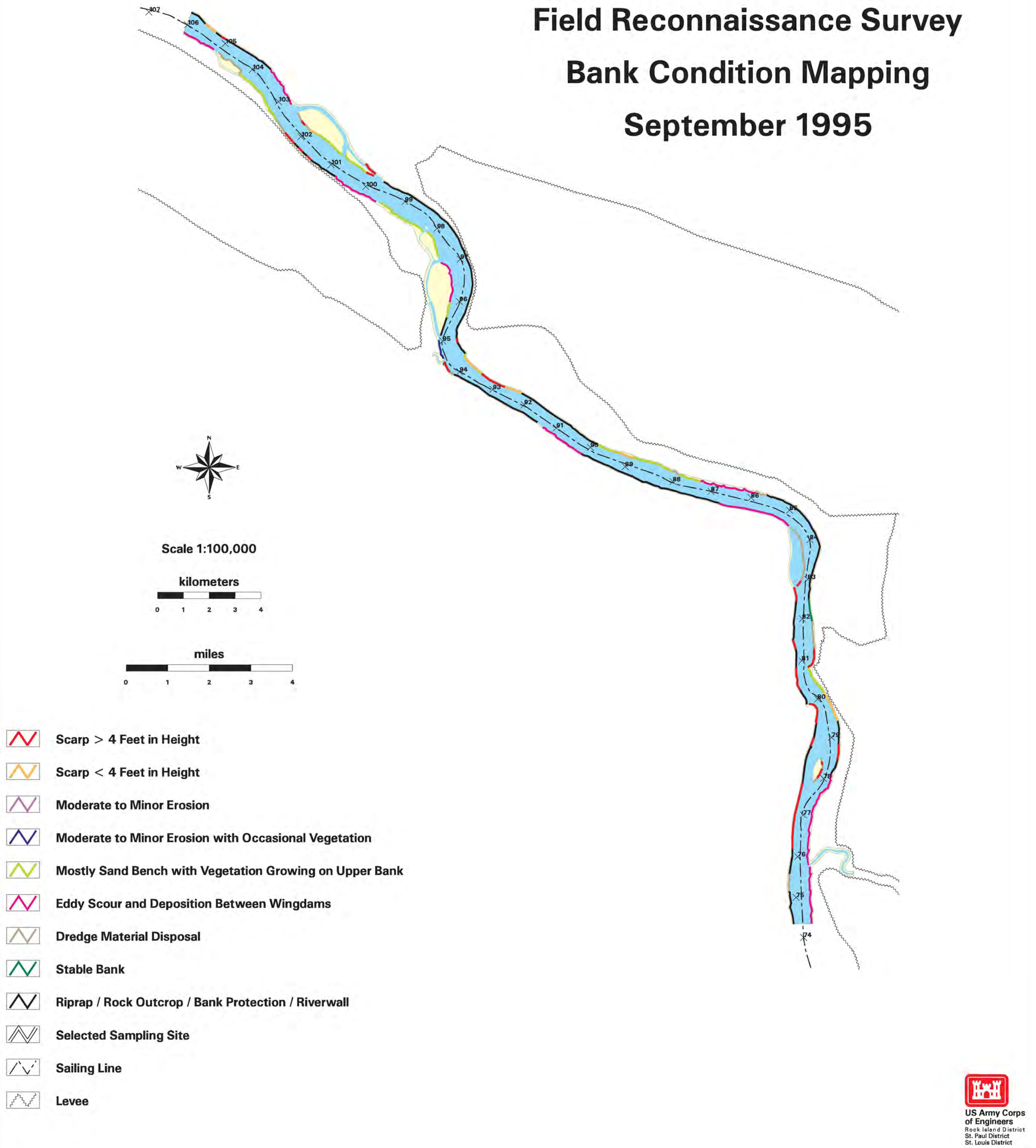
Open River, Mile 74 to 106

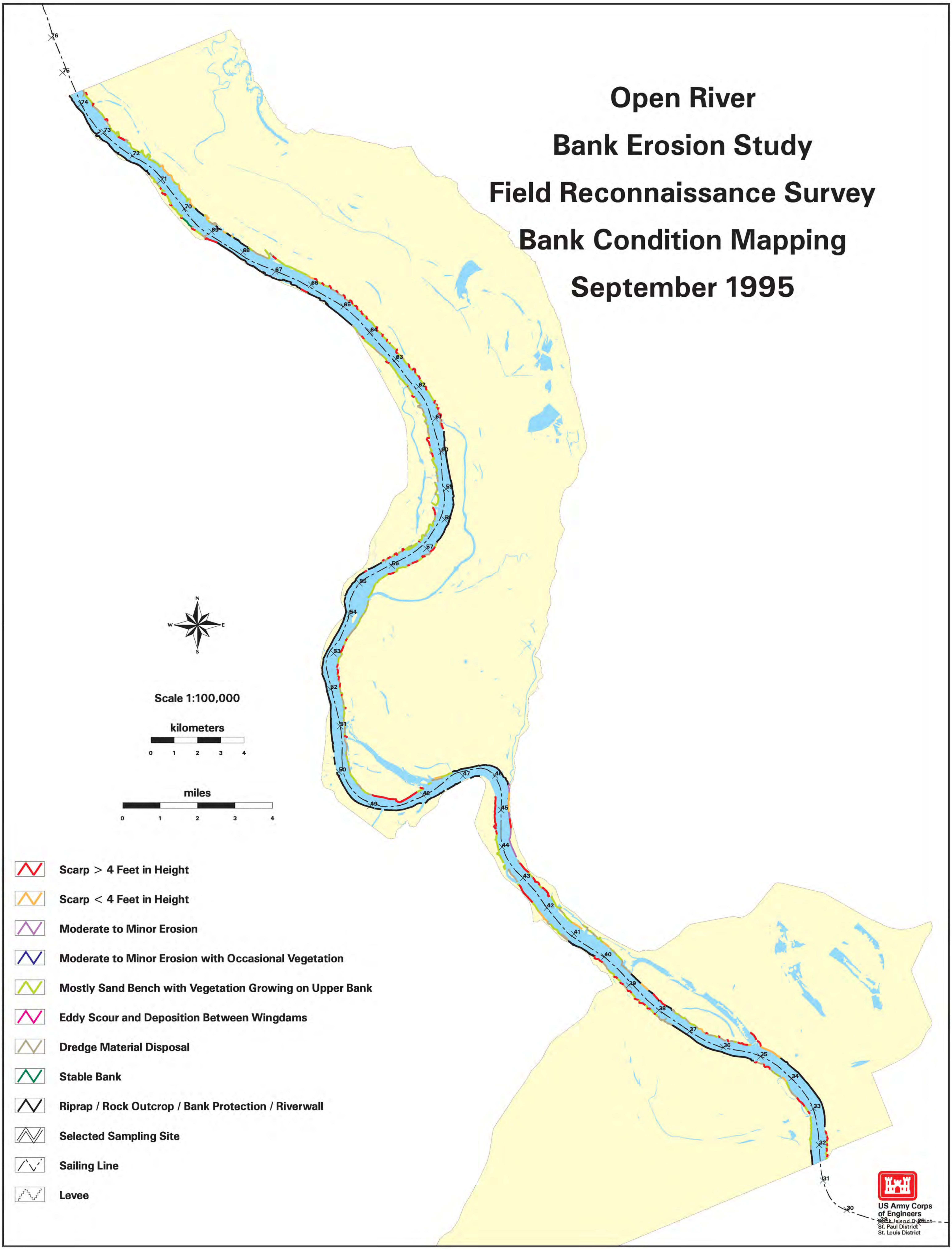
Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995




Open River
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995
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Scale 1:100,000
kilometers
0 1 2 3 4
miles
0 1 2 3 4
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Eddy Scour and Deposition Between Wingdams
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps
of Engineers
St. Paul District
St. Louis District

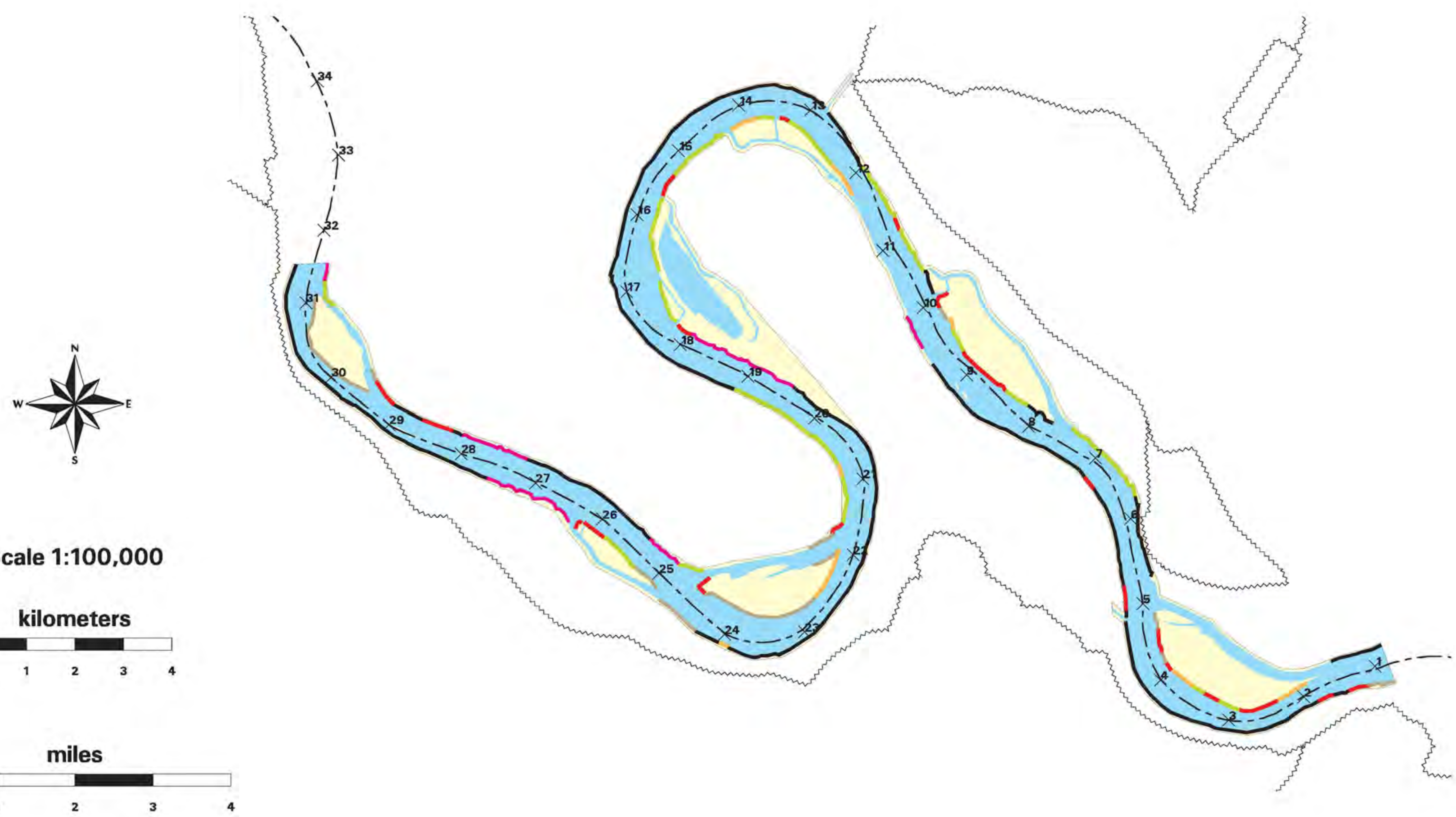
Open River, Mile 1 to 31

Bank Erosion Study

Field Reconnaissance Survey

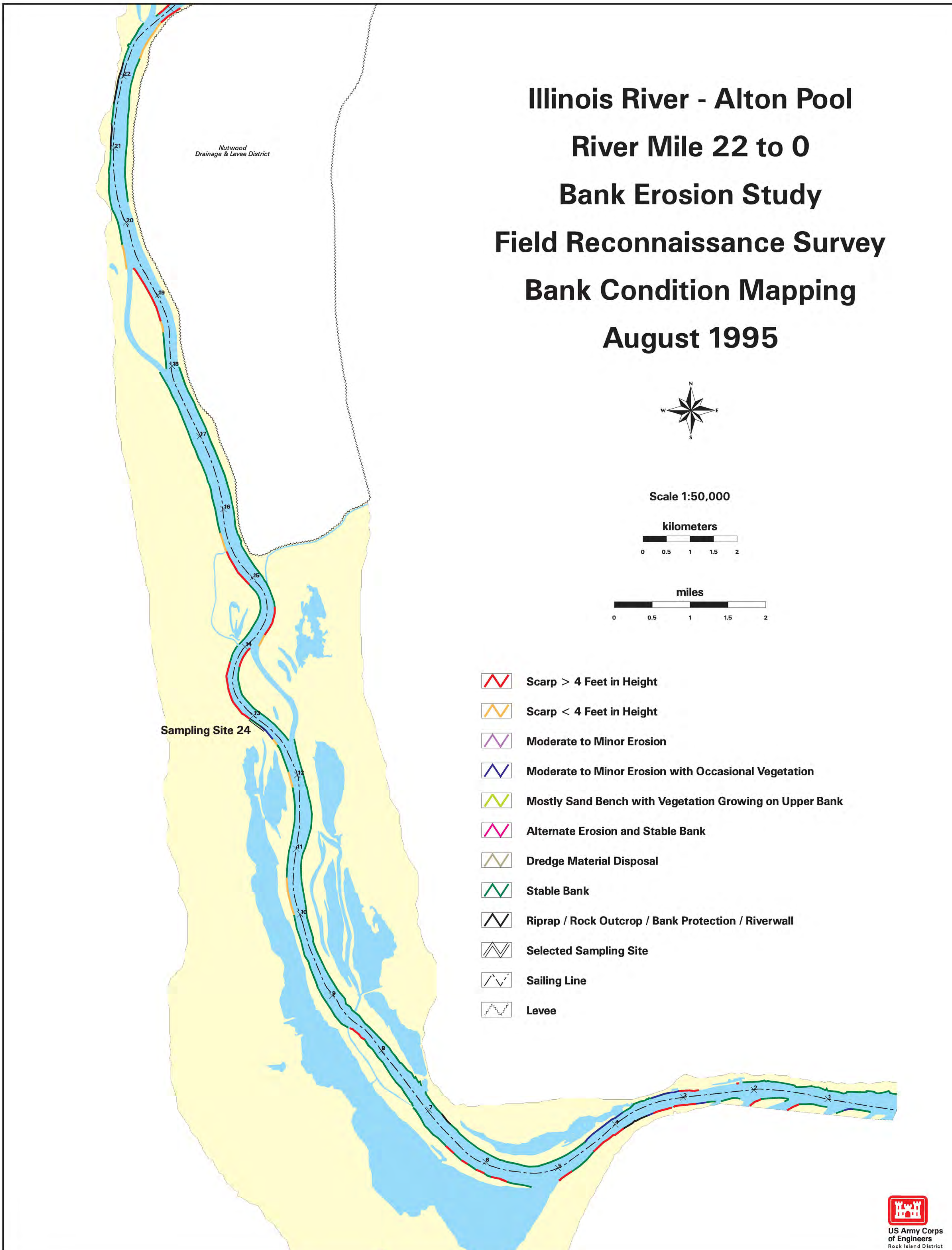
Bank Condition Mapping

September 1995



- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Eddy Scour and Deposition Between Wingdams
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District
St. Paul District
St. Louis District


Illinois River - Alton Pool
River Mile 22 to 0
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
Nutwood Drainage & Levee District
Sampling Site 24
N
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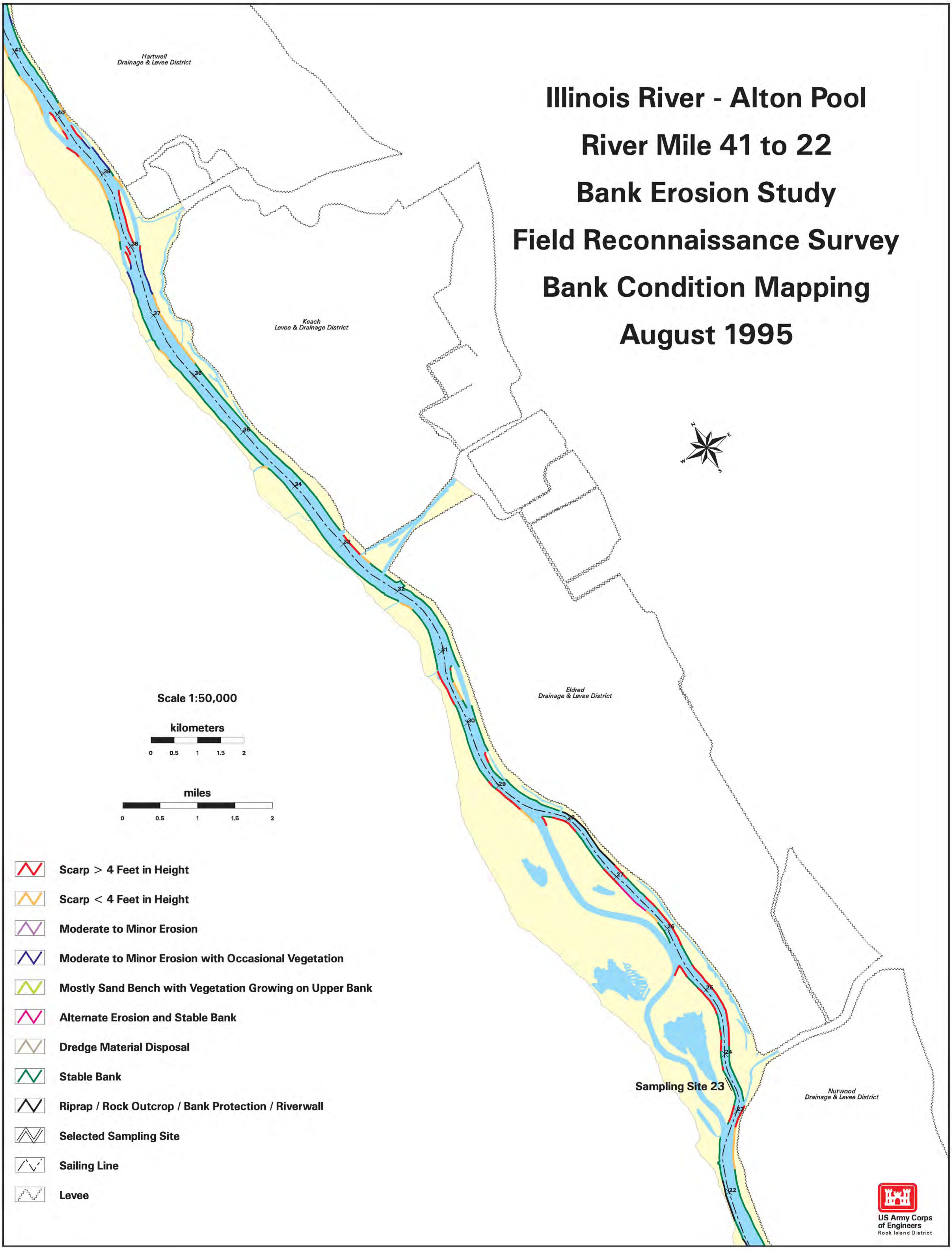
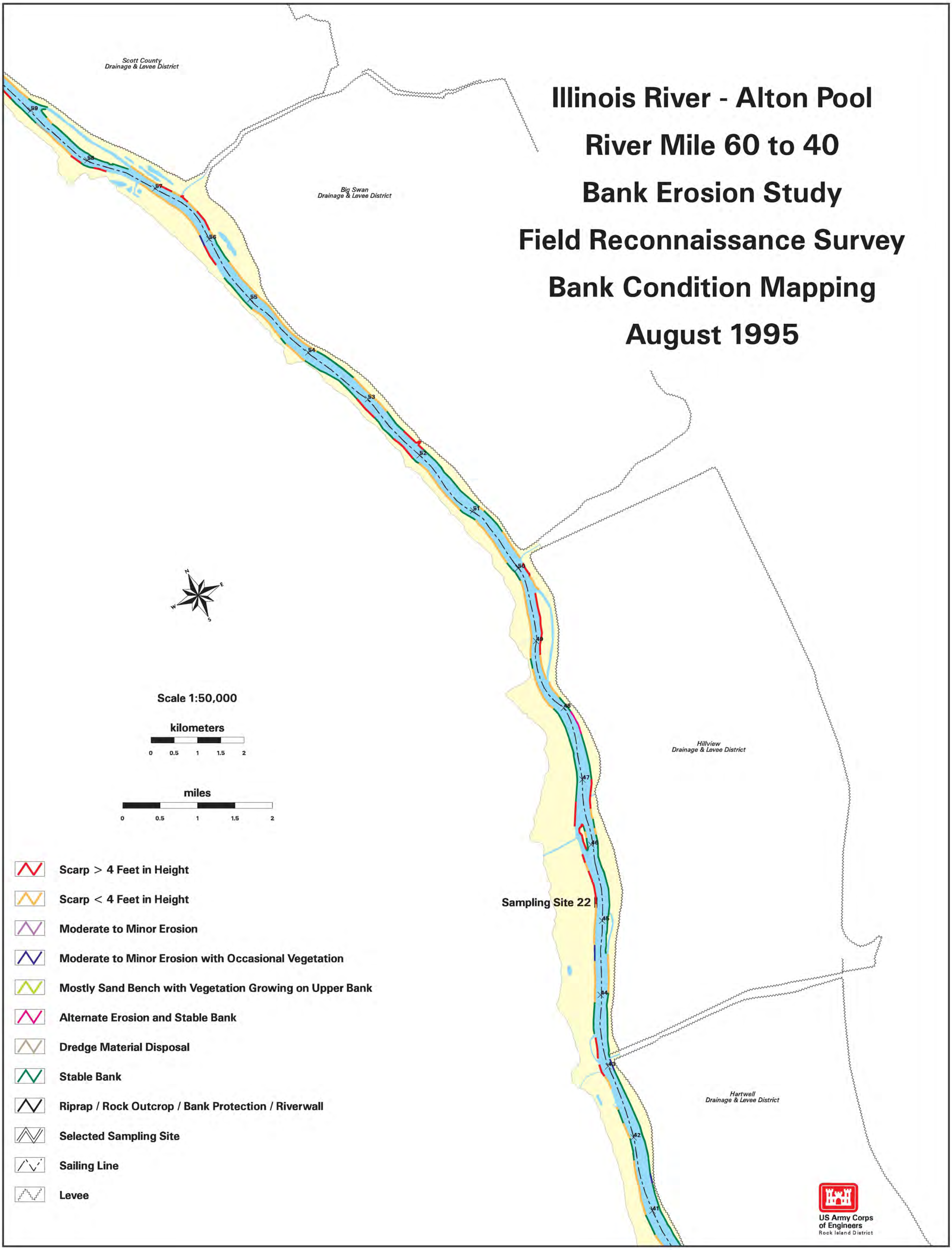
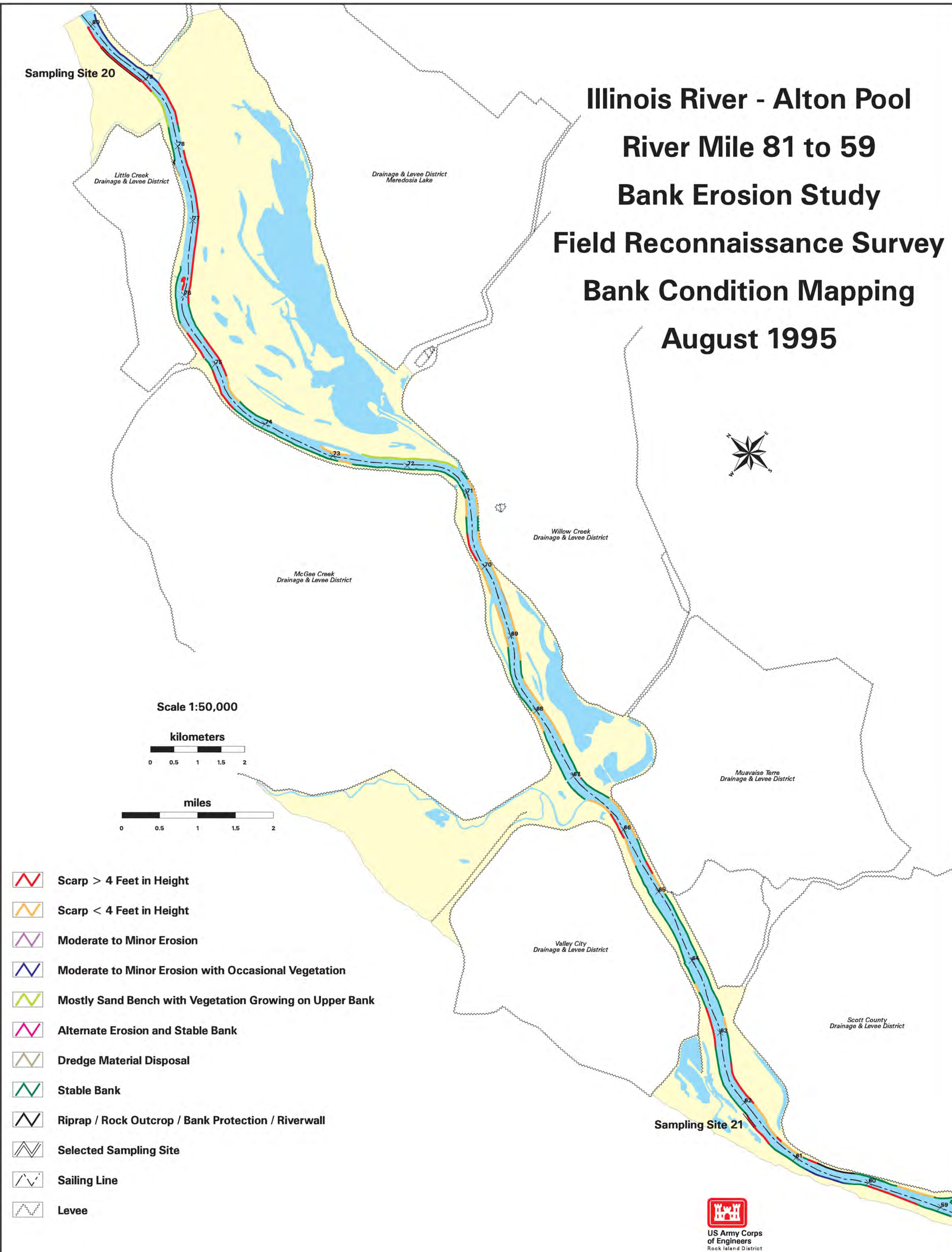
W
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District

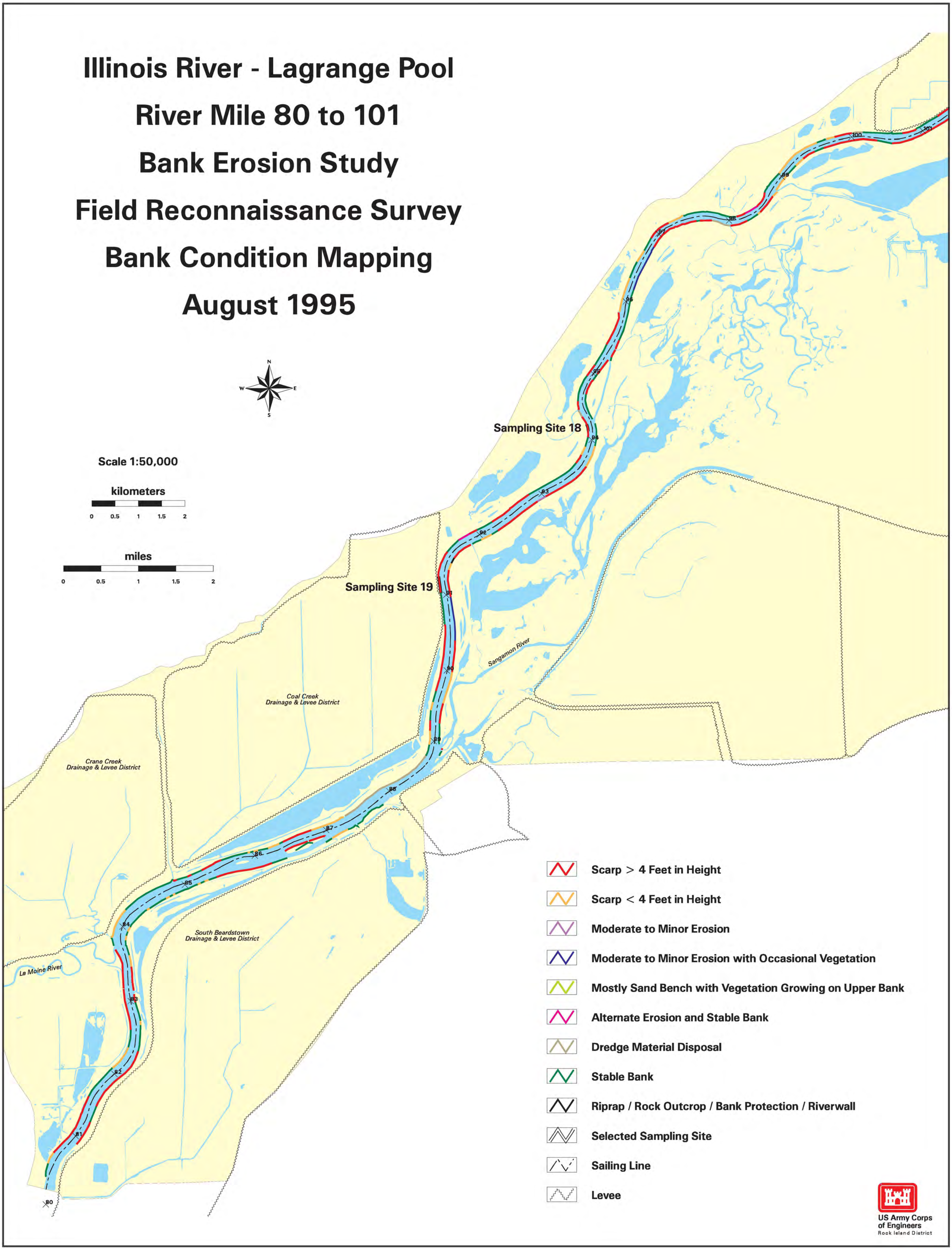

Illinois River - Alton Pool
River Mile 41 to 22
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
Hartwell
Drainage & Levee District
Keach
Levee & Drainage District
Eldred
Drainage & Levee District
Nutwood
Drainage & Levee District
Sampling Site 23
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps
of Engineers
Rock Island District



Illinois River - Alton Pool
River Mile 60 to 40
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
Scott County Drainage & Levee District
Big Swan Drainage & Levee District
Hillview Drainage & Levee District
Hartwell Drainage & Levee District
Sampling Site 22
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District



Illinois River - Alton Pool
River Mile 81 to 59
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
Sampling Site 20
Sampling Site 21
Little Creek Drainage & Levee District
Drainage & Levee District Meredosia Lake
Willow Creek Drainage & Levee District
McGee Creek Drainage & Levee District
Muavaise Terre Drainage & Levee District
Valley City Drainage & Levee District
Scott County Drainage & Levee District
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District


Illinois River - Lagrange Pool
River Mile 80 to 101
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
N
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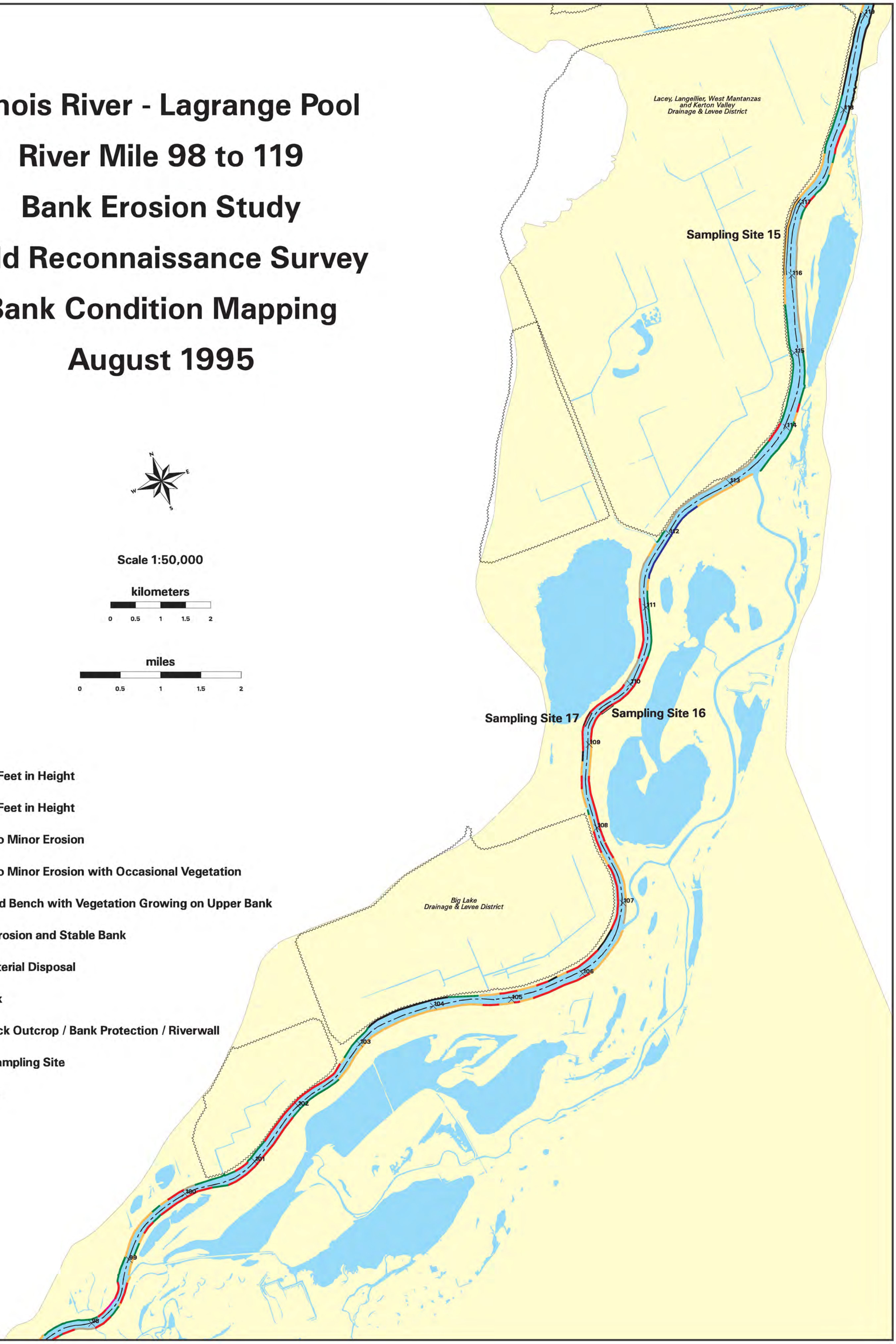
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Sampling Site 18
Sampling Site 19
Sangamon River
Coal Creek
Drainage & Levee District
Crane Creek
Drainage & Levee District
South Beardstown
Drainage & Levee District
La Moine River
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps
of Engineers
Rock Island District

Illinois River - Lagrange Pool
River Mile 98 to 119
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995



Scale 1:50,000

kilometers

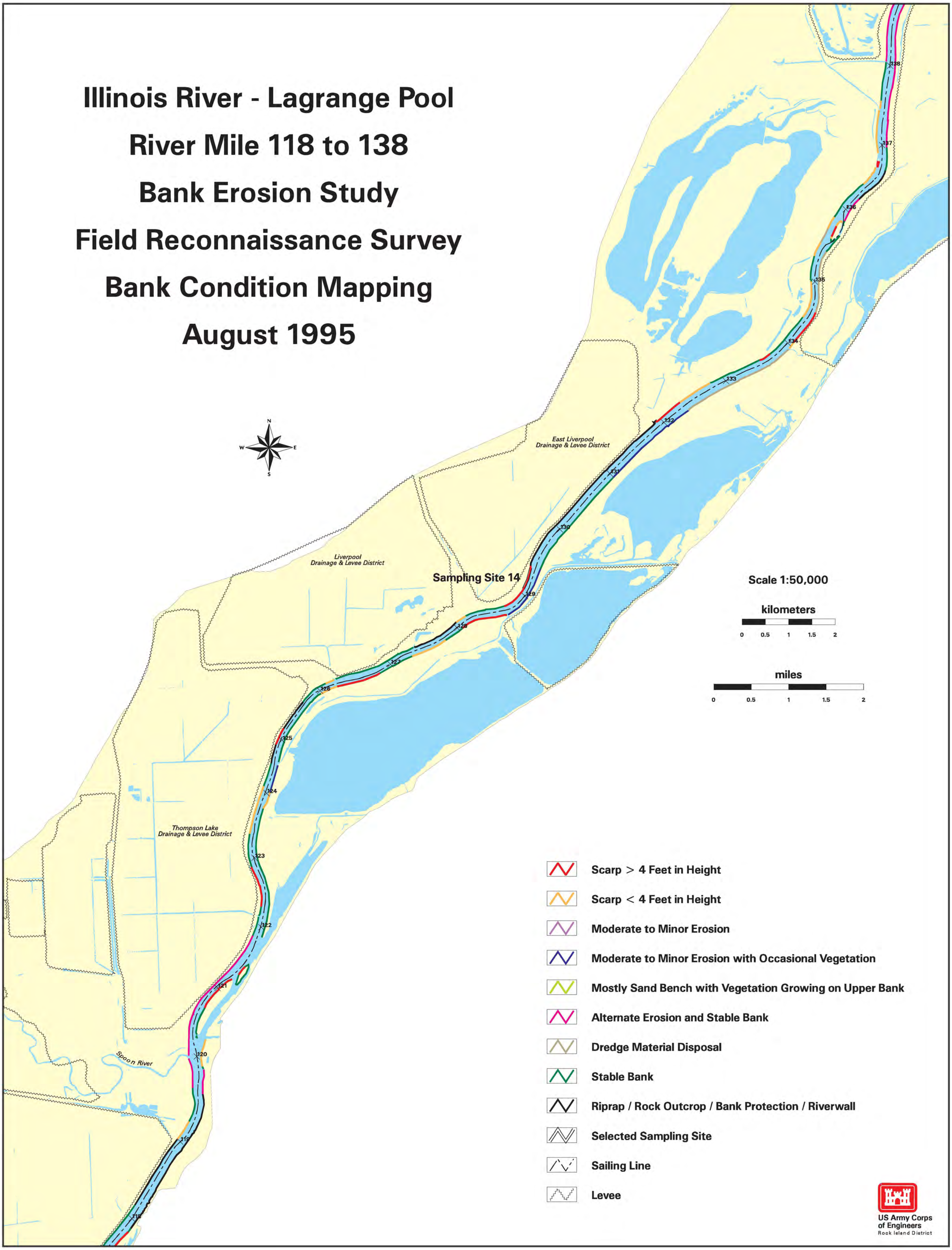
0 0.5 1 1.5 2

miles

0 0.5 1 1.5 2

- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District


Illinois River - Lagrange Pool
River Mile 118 to 138
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
N
W
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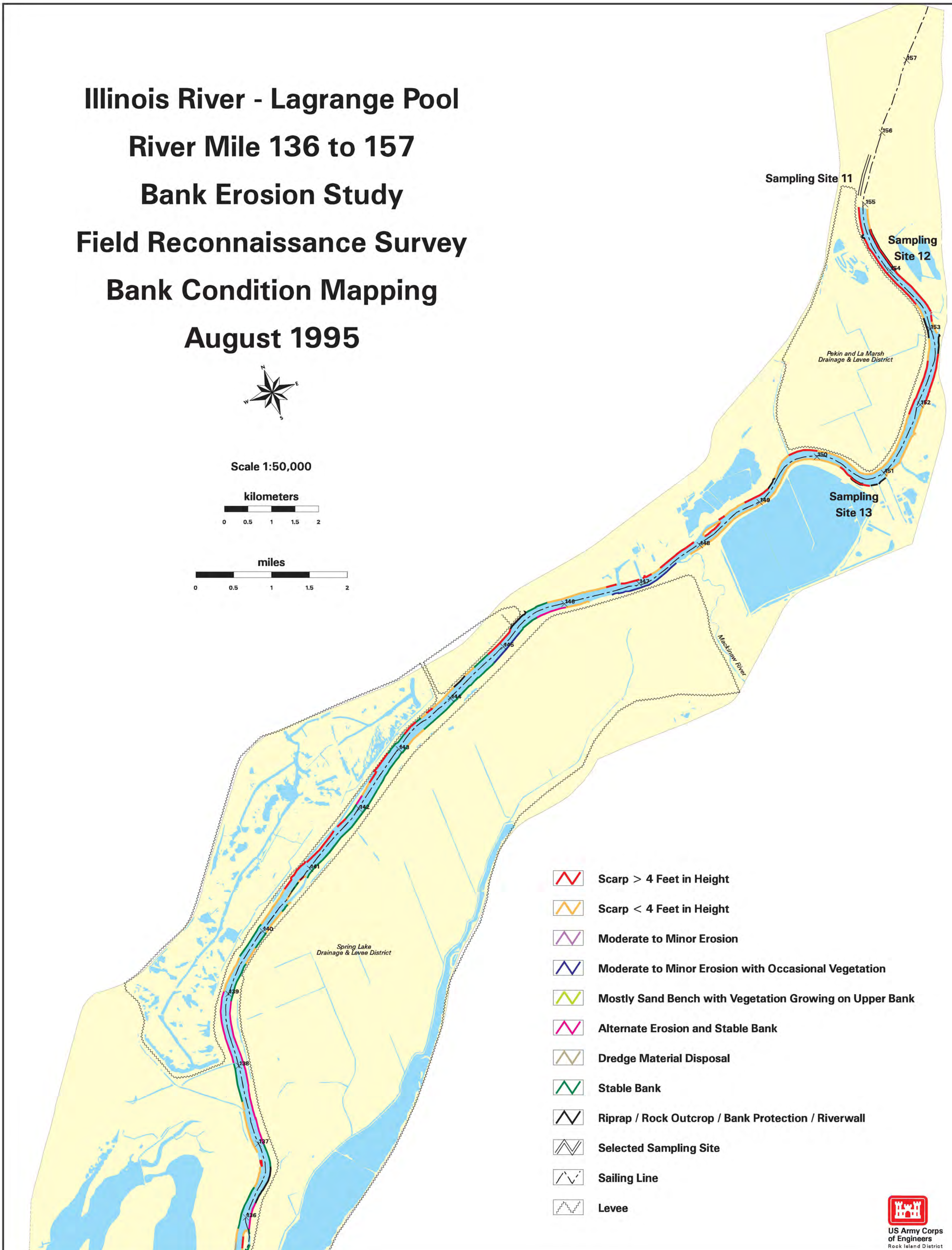
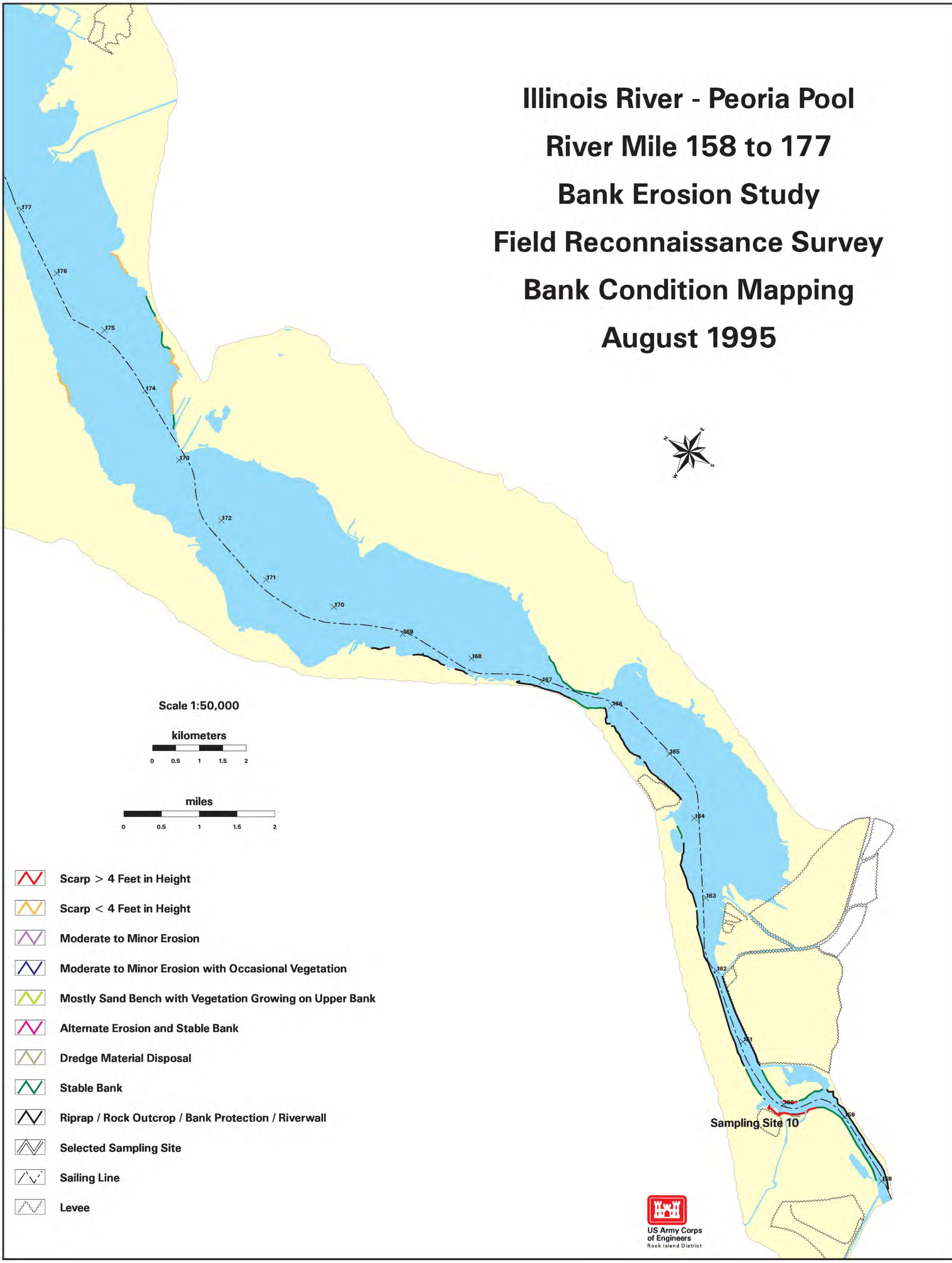
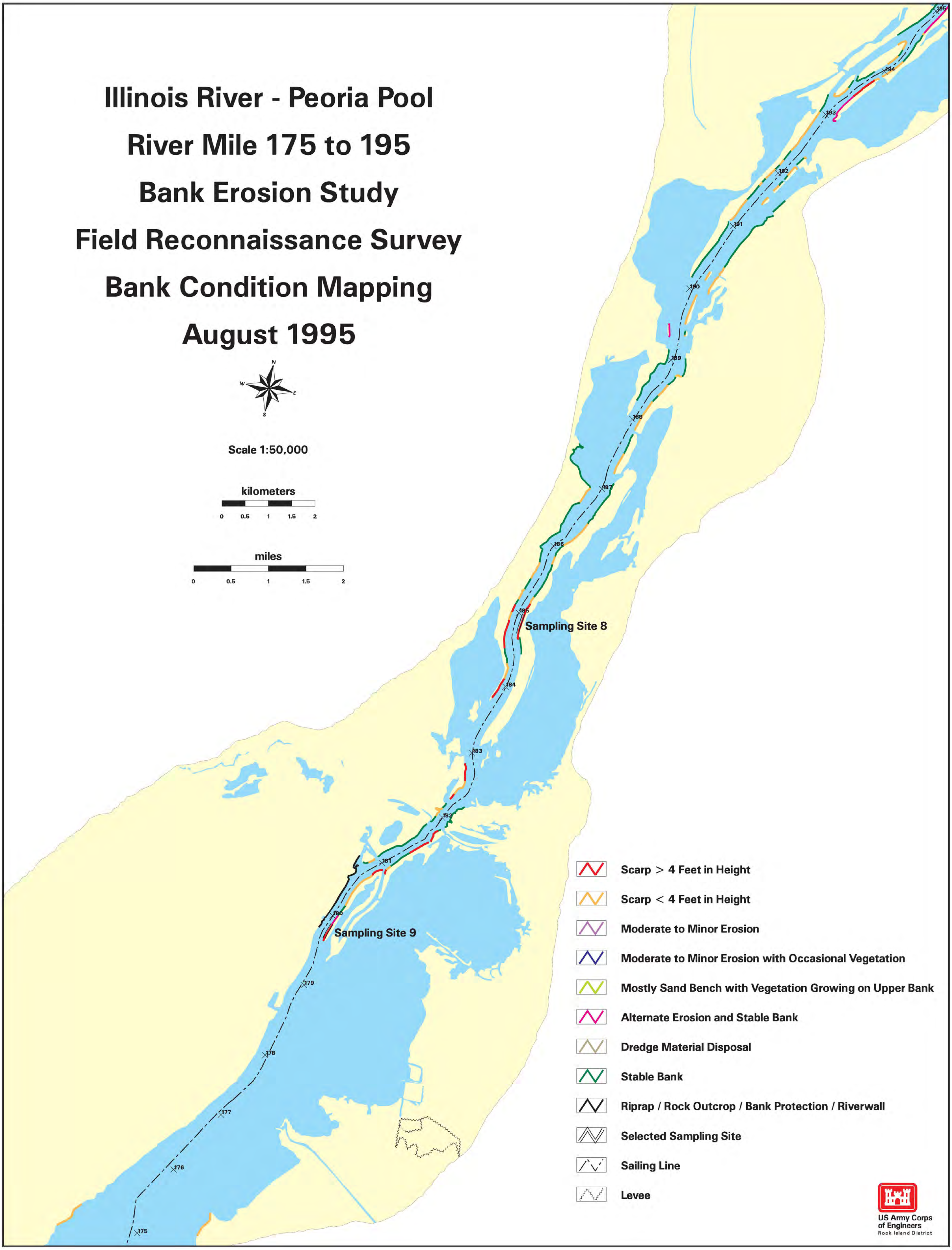
East Liverpool Drainage & Levee District
Liverpool Drainage & Levee District
Sampling Site 14
Thompson Lake Drainage & Levee District
Spoon River
138
137
136
135
134
133
132
131
130
129
128
127
126
125
124
123
122
121
120
119
118
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District

Illinois River - Lagrange Pool
River Mile 136 to 157
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995





Illinois River - Peoria Pool
River Mile 158 to 177
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
177
176
175
174
173
172
171
170
169
168
167
166
165
164
163
162
161
160
159
158
Sampling Site 10
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District


Illinois River - Peoria Pool
River Mile 175 to 195
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
N
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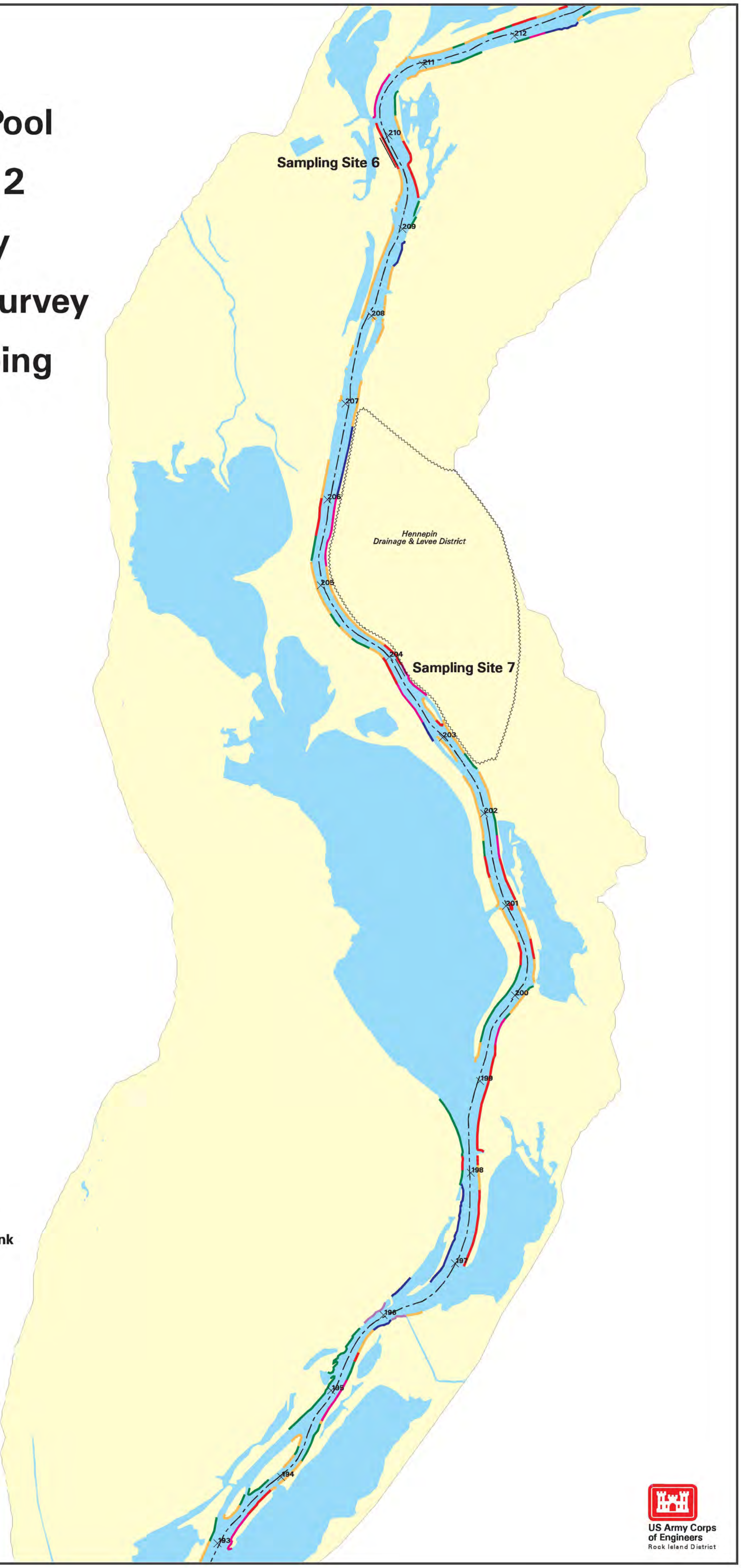
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Sampling Site 8
Sampling Site 9
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District

Illinois River - Peoria Pool
River Mile 193 to 212
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995



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Scale 1:50,000

kilometers

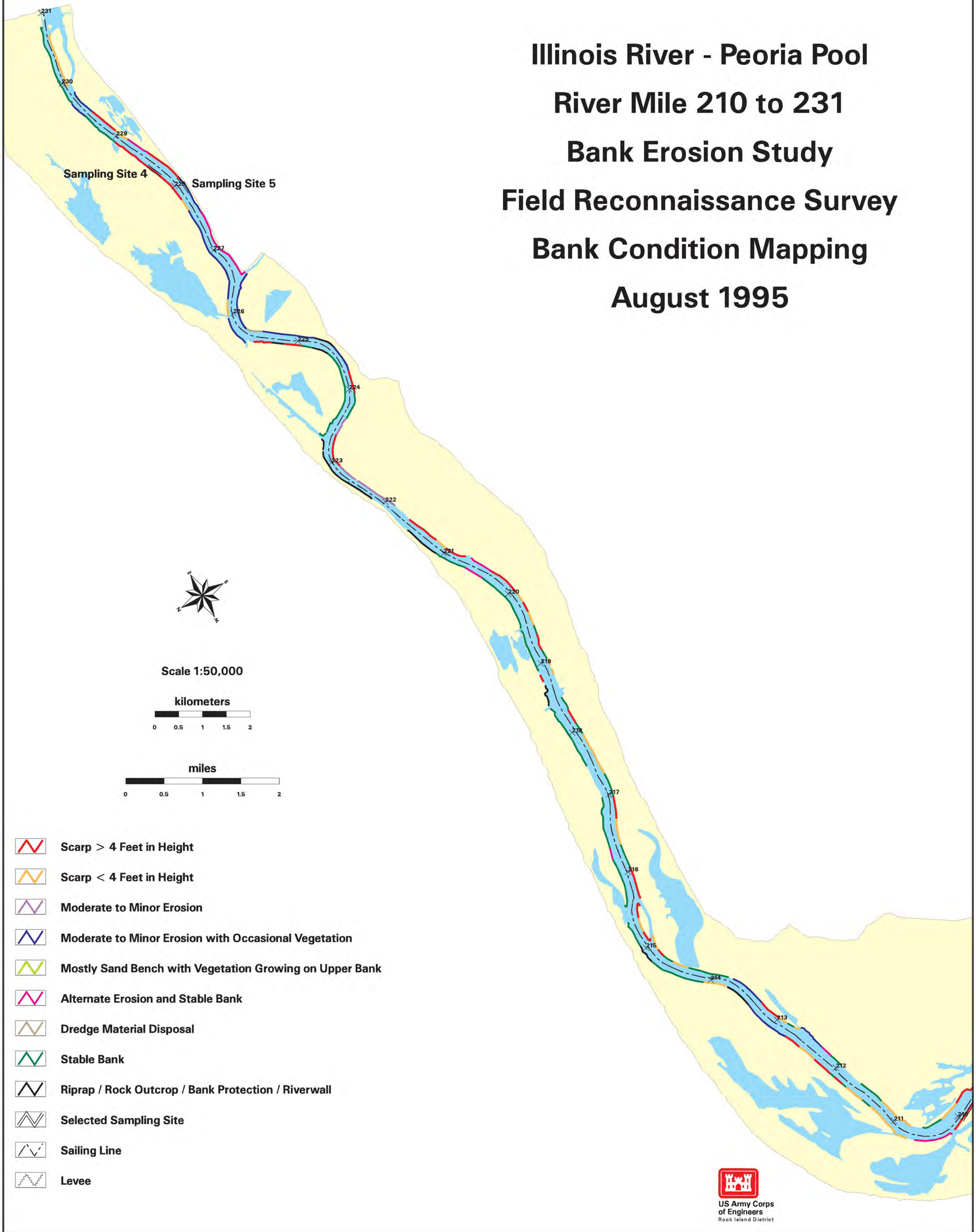
0 0.5 1 1.5 2

miles

0 0.5 1 1.5 2

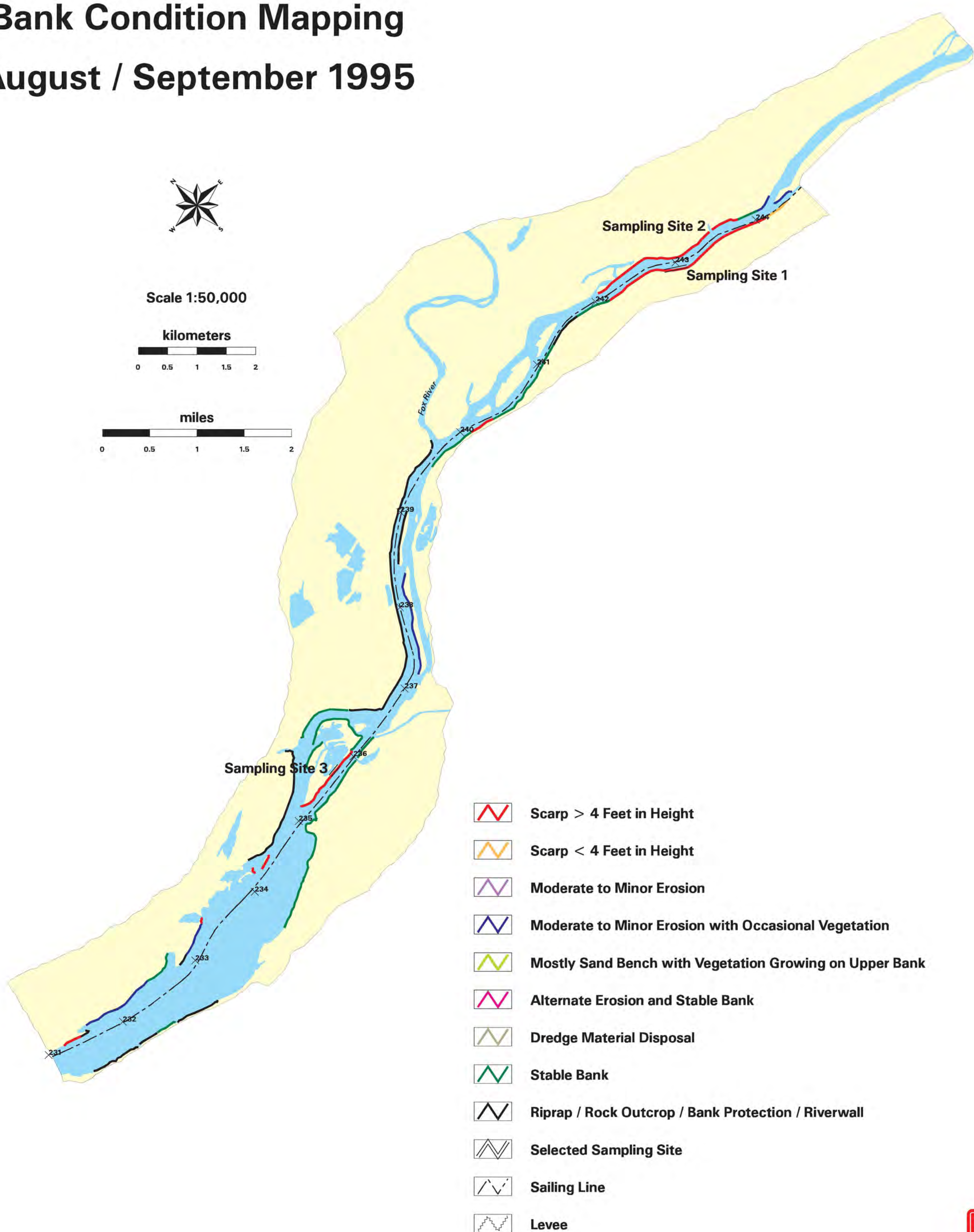
- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps
of Engineers
Rock Island District



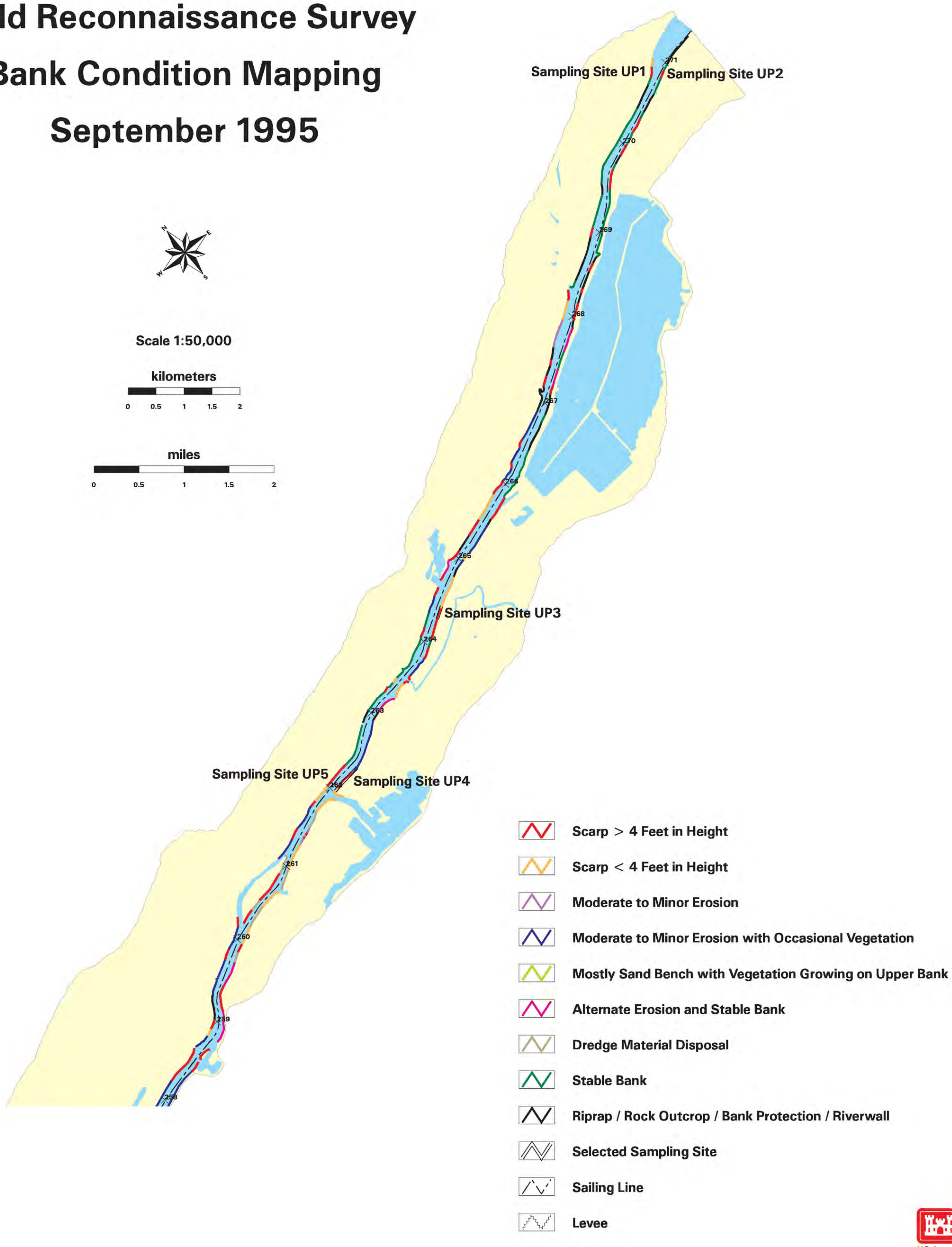
Illinois River - Peoria Pool
River Mile 210 to 231
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August 1995
Sampling Site 4
Sampling Site 5
231
230
229
227
226
224
223
222
221
220
219
218
217
216
215
214
213
212
211
Scale 1:50,000
kilometers
0 0.5 1 1.5 2
miles
0 0.5 1 1.5 2
Scarp > 4 Feet in Height
Scarp < 4 Feet in Height
Moderate to Minor Erosion
Moderate to Minor Erosion with Occasional Vegetation
Mostly Sand Bench with Vegetation Growing on Upper Bank
Alternate Erosion and Stable Bank
Dredge Material Disposal
Stable Bank
Riprap / Rock Outcrop / Bank Protection / Riverwall
Selected Sampling Site
Sailing Line
Levee
US Army Corps of Engineers
Rock Island District

Illinois River - Starved Rock Pool
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
August / September 1995



US Army Corps
of Engineers
Rock Island District

Illinois River - Upper Marseilles Pool
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995



US Army Corps of Engineers
Rock Island District

Illinois River - Lower Marseilles Pool
Bank Erosion Study
Field Reconnaissance Survey
Bank Condition Mapping
September 1995

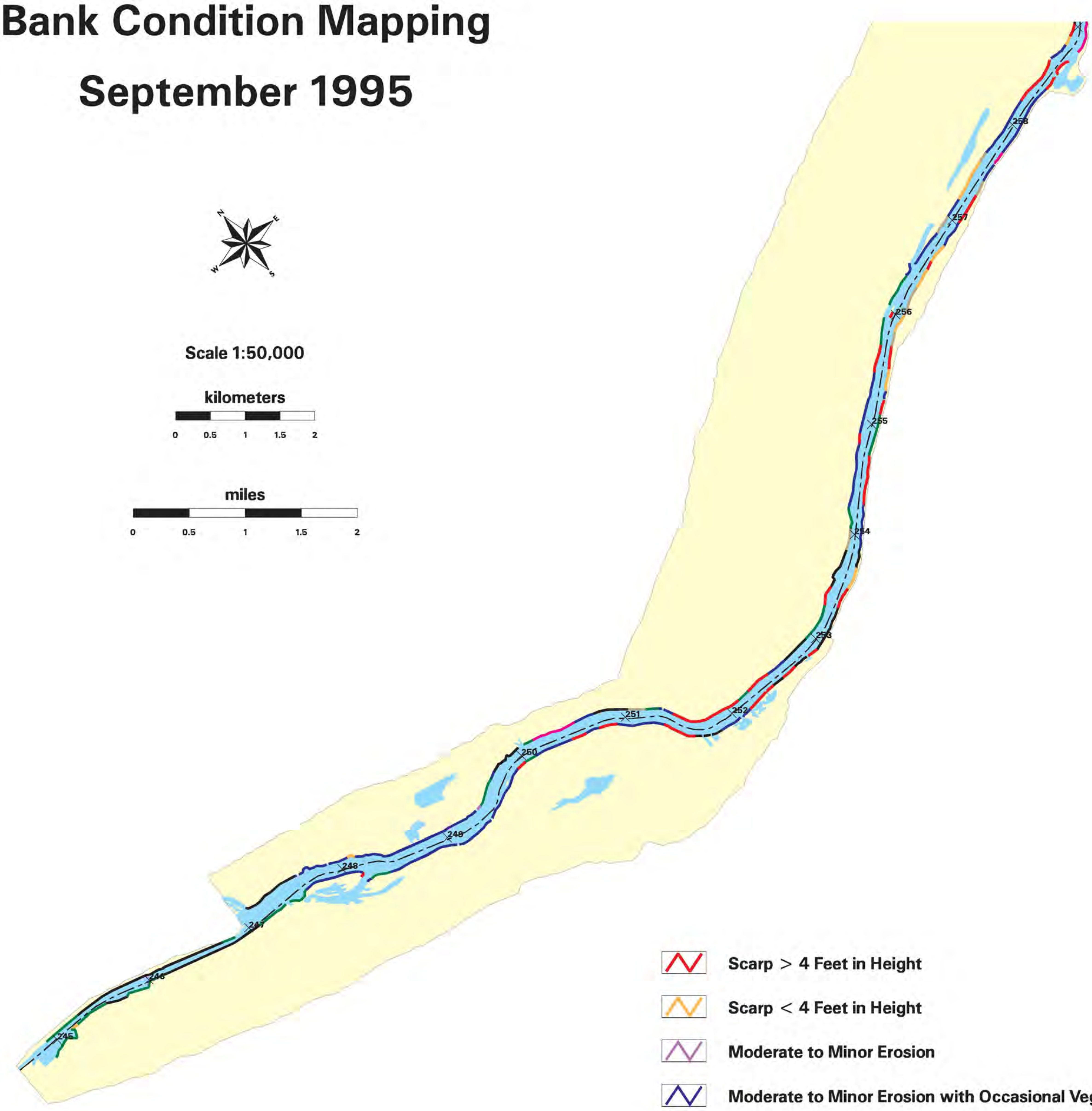
Scale 1:50,000

kilometers

0 0.5 1 1.5 2

miles

0 0.5 1 1.5 2



- Scarp > 4 Feet in Height
- Scarp < 4 Feet in Height
- Moderate to Minor Erosion
- Moderate to Minor Erosion with Occasional Vegetation
- Mostly Sand Bench with Vegetation Growing on Upper Bank
- Alternate Erosion and Stable Bank
- Dredge Material Disposal
- Stable Bank
- Riprap / Rock Outcrop / Bank Protection / Riverwall
- Selected Sampling Site
- Sailing Line
- Levee

US Army Corps of Engineers
Rock Island District

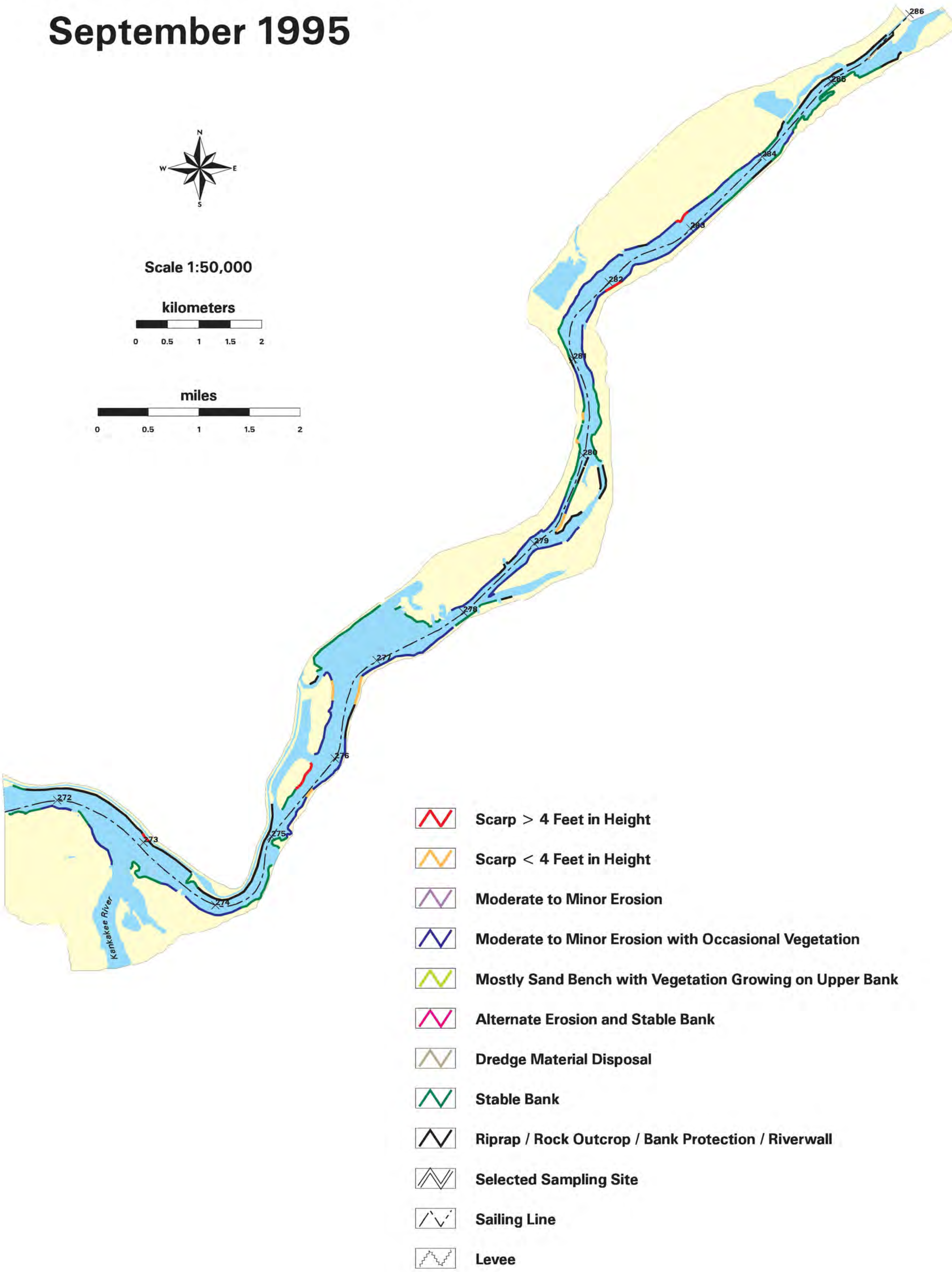
Illinois River - Dresden Island Pool

Bank Erosion Study

Field Reconnaissance Survey

Bank Condition Mapping

September 1995



US Army Corps of Engineers
Rock Island District

Appendix K.

Photographs of Study Sites on the Illinois Waterway (Photographs of the Mississippi River Sites are on file with the Rock Island District, U.S. Army Corps of Engineers)

Site UP1, RDB of RM 270.3, Looking upstream

Site UP1, RDB of RM 270.3, Looking downstream

Site UP1, RDB of RM 270.3, Site overview

Site UP2, LDB of RM 270.3, Looking upstream

Site UP2, LDB of RM 270.3, Site view

Site UP2, LDB of RM 270.3, Scarp face with sample mark #3 and a sample bag

Site UP3, LDB of RM 264.3, Site view with a booth on top of bank

Site UP3, LDB of RM 264.3, Site view

Site UP3, LDB of RM 264.3, Exposed tree roots

Site UP4, LDB of RM 262.1, Looking upstream from downstream section

Site UP4, LDB of RM 262.1, Mid-section with Mike Cox taking notes

Site UP4, LDB of RM 262.1, Scarp face with sample mark #2

Site UP5, RDB of RM 262.1, Site view

Site UP5, RDB of RM 262.1

Site UP5, RDB of RM 262.1

Site 1, LDB of RM 242.9, Site view with Mike Spoor taking samples and Nani Bhowmik taking notes

Site 1, LDB of RM 242.9, Looking downstream

Site 1, LDB of RM 242.9, Bank materials at scarp face

Site 2, LDB of RM 243.4, Site view with crews taking data

Site 2, LDB of RM 242.4, Looking upstream

Site 2, LDB of RM 243.4, Looking downstream

Site 3, RDB of RM 235.8, Site view

Site 3, RDB of RM 235.8, Looking downstream

Site 3, RDB of RM 235.8, Site view with Mike Spoor and Jim Slowikowski measuring underwater bed profile

Site 4, LDB of RM 228.1, Site view with Dan Johnson filling in data sheet

Site 4, LDB of RM 228.1, Site view with the sign for each midsection

Site 4, LDB of RM 228.1, Downstream section view with exposed tree roots

No Site-specific Photos were taken at Site 5

Site 6, RDB of RM 210.0, Site view with soil sampling location

Site 6, RDB of RM 210.0, Looking upstream

Site 6, RDB of RM 210.0, Looking downstream with a work barge passing the site and the SWS Monitor at the downstream limit


Site 7, LDB of RM 203.8, Scarp face at upper portion of the bank

Site 7, LDB of RM 203.8, Looking upstream

Site 7, LDB of RM 203.8, Looking downstream


Site 8, LDB of RM 184.8, Site view


Site 8, LDB of RM 184.8, Site view

Site 8, LDB of RM 184.8, Downstream section view

Site 9, LDB of RM 179.8, Looking upstream

Site 9, LDB of RM 179.8, Mid-section view with an old monument.

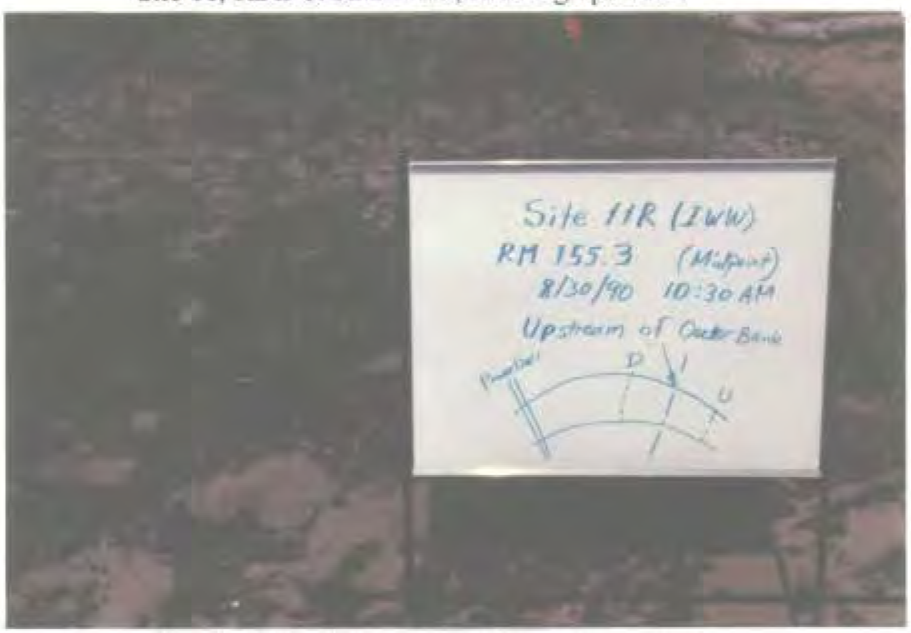
Site 9, LDB of RM 179.8, Downstream section view

Site 10, RDB of RM 160.0, Mid-section view with Dan Johnson and Tatsuaki Nakato

Site 10, RDB of RM 160.0, Close up of mid-section with Dan Johnson writing notes and the Monitor at the upstream section

Site 10, RDB of RM 160.0, Downstream section view

Site 11, RDB of RM 155.3, Looking upstream



Site 11, RDB of RM 155.3, Mid-section with sign

Site 11, RDB of RM 155.3, Looking upstream

Site 12, LDB of RM 154.4, Mid-section view with Dan Johnson and Tatsuaki Nakato taking data

Site 12, LDB of RM 154.4, Upstream section with Mike Cox, Mike Spoor, and David Soong on site

Site 12, LDB of RM 154.4, Downstream section with turkey vulture in sight

Site 13, LDB of RM 150.6, Mid-section view

Site 13, LDB of RM 150.6, Looking upstream

Site 13, LDB of RM 150.6, Looking downstream

Site 14, RDB of RM 129.3, Site view of the mid-section

Site 14, RDB of RM 129.3, Site view of the mid-section

Site 14, RDB of RM 129.3, View of upstream limit

Site 15, RDB of RM 116.5, Downstream section view

Site 15, RDB of RM 116.5, Looking upstream

Site 15, RDB of RM 116.5, Looking downstream

Site 16, LDB of RM 109.5, Mid-section view

Site 16, LDB of RM 109.5, Scarp face at 100' upstream

Site 16, LDB of RM 109.5, Looking downstream

Site 17, RDB of RM 109.5, Mid-section view

Site 18, RDB of RM 94.3, Site view

Site 18, RDB of RM 94.3, Mass collapsed on site

Site 18, RDB of RM 94.3, Looking upstream

Site 19, RDB of RM 91.2, An overview of mid-section

Site 19, RDB of RM 91.2, A closer view of bank conditions

Site 19 RDB of RM 91.2 Downstream section view

Site 20, RDB of RM 79.4, Looking upstream

Site 20, RDB of RM 79.4, Looking downstream

Site 20. RDB of RM 79.4, Sampling location of the bench where ground water showed up at the sampling hole

Site 21, RDB of RM 61.7, Upstream section view

Site 21, RDB of RM 61.7, Mid-section view

Site 21, RDB or RM 61.7, Downstream section view

Site 22, RDB of RM 45.1, Upstream section view

Site 22, RDB of RM 45.1, Mid-section view

Site 22, RDB of RM 45.1, Looking downstream from mid-section

Site 23, RDB of RM 45.1, Mid-section view

Site 23, RDB of RM 23.5, Looking upstream from mid-section

Site 23, RDB of RM 23.5, Looking downstream from mid-section

Site 24, RDB of RM 13.1, Mid-section view

Site 24, RDB of RM 13.1, Mid-section view with crew working

Site 24, RDB of RM 13.1, Downstream section view