

Technical Report M9

**ENVIRONMENTAL AND NAVIGATION IMPROVEMENT
STUDY OF WOLF ISLAND
MISSISSIPPI RIVER
MILES 936.5 TO 929**

By

Robert D. Davinroy

David C. Gordon

Aron M. Rhoads

Edward Riff

DISTRIBUTION STATEMENT A

Approved for Public Release
Distribution Unlimited

Prepared For
U.S. Army Corps of Engineers
Mississippi River Valley Division
&
Memphis District

**Reproduced From
Best Available Copy**

In cooperation with
Missouri Department of Conservation
and the U.S. Fish and Wildlife Service

June 2000

DTIC QUALITY INSPECTED 4

20000703 091

REPORT DOCUMENTATION PAGEForm Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) xx-06-2000		2. REPORT TYPE Final Report		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE Environmental and Navigation Improvement Study of Wolf Island Mississippi River Miles 936.5 to 929 Volume : ()				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
				5d. PROJECT NUMBER	
6. AUTHOR(S) Davintro, Robert D. Gordon, David C. Rhoads, Aron M. Riiff, Edward H.				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US Army Corps of Engineers St. Louis District Applied River Engineering Ctr Foot of Arsenal Street St. Louis, Missouri 63118				8. PERFORMING ORGANIZATION REPORT NUMBER Technical Report M9	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers Mississippi River Valley Division P.O. Box 80 Vicksburg, MS 39181				10. SPONSOR/MONITOR'S ACRONYM(S) U.S. ACE	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT A Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES Available at the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161					
14. ABSTRACT An environmental and navigation study of Wolf Island, Miles 936.5 to 929, Lower Mississippi River, was conducted by the U.S. Army Corps of Engineers. The study was initiated in order to evaluate sedimentation trends in a major side channel of the Mississippi River and to access evaluate structural design alternative impacts. The goal was to maintain or improve the existing navigation channel through the study reach. Ensure that the side channel would not capture additional flows and eventually become the main channel, and preserve vital fisheries habitat within the side channel. A hydraulic micro model was used for this analysis. The model contained scales of 1 inch=600 feet horizontal and 1 inch=50 feet vertical. A team of various representatives from the U.S. Army Corps of Engineers Mississippi Valley Division, Memphis District, St. Louis District, Missouri Department of Conservation, Kentucky Department of Natural Resources, and the U.S. Fish and Wildlife Service participated and formulated ideas in the model study					
15. SUBJECT TERMS Wolf Island; Mississippi River, Micro Model; Fisheries; Navigation Channel; Side Channel; Environmental					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Unclassified Unlimited	18. NUMBER OF PAGES 52	19a. NAME OF RESPONSIBLE PERSON Robert D. Davintro
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code) 314-263-4714

FOREWORD

This report is dedicated to a fellow comrade and friend, Mr. Robert Rentchler, who was taken away from this earth in 1999. Bob was a tremendous individual who always had a way of taking the positive, lighter views on matters of importance, from river engineering and water control, to farming and cooking. Bob's sense of humor and enthusiasm will never be forgotten.

Bob supplied important input to this particular report. Bob conducted a sediment classification study on Wolf Island Bar, Mississippi River Mile 935. Through sediment sampling and observations made during low water, Bob was able to make a determination of the materials located in this reach of river. These results were vital to the calibration of the Wolf Island Micro Model and are discussed later in this report.

Bob will be forever remembered as a great contributor to the channel improvement team. He will be deeply missed by us here in the St. Louis District as well as other districts within the Mississippi Valley Division.

INTRODUCTION

An environmental and navigation improvement study of the Mississippi River at Wolf Island, between Miles 937 and 929, was conducted by the Mississippi Valley Division, in cooperation with the Memphis District.

The study was conducted in 1999 in order to evaluate past, present, and future conditions of the Mississippi River in the vicinity of Wolf Island Bar, between Miles 937 and 929.

The study was performed by Mr. Robert Davinroy, Mr. David Gordon, Mr. Edward Riiff, and Mr. Aron Rhoads of the St. Louis District.

Personnel also involved and overseeing the study included:

Mississippi River Valley Division: Mr. Steve Cobb, Dr. Don Williams, Mr. Steve Ellis, and Mr. Clarence Thomas.

Memphis District: Mr. Darian Chasteen, Mr. James Gutshall, Mr. Derrick Smith, Mr. Wayne Max. and Mr. John Rumancik

Personnel from other agencies who participated in a group meeting at the Applied River Engineering Center in St. Louis included:

Mr. Mark Boone, Mr. David Herzog, and Mr. Mark Haas of the Missouri Department of Conservation, Ms. Martie Barber and Mr. Paul Rister of the Kentucky Department of Natural Resources, and Mr. Jim Widlak and Mr. Ron Nassar of the U.S. Fish and Wildlife Service.

TABLE OF CONTENTS

FOREWORD	1
INTRODUCTION	2
TABLE OF CONTENTS	3
BACKGROUND	4
1. Problem Description	4
2. Study Purpose and Goals	5
MICRO MODEL DESCRIPTION	6
1. Scales and Bed Materials	6
2. Appurtenances	6
MICRO MODEL TESTS	7
1. Calibration and Verification	7
A. Design Hydrograph	7
B. Prototype Surveys	7
2. Base Test	10
3. Design Alternative Tests	13
RESULTS AND CONCLUSIONS	21
1. Summary of Model Tests	21
2. Interpretation of Model Test Results	23
LIST OF PLATES	24
FOR MORE INFORMATION	26

BACKGROUND

This report details the investigation of an environmental and navigation improvement study of the Lower Mississippi River at Wolf Island, between Miles 936.5 to 929. A hydraulic micro model was used to evaluate the sediment response in both the main channel and side channel of the Mississippi River in this vicinity.

1. Problem Description

Plate 1 is a map depicting the characteristics, configuration, and nomenclature of the Lower Mississippi River through this particular study reach. The Memphis District constructed both a rock closure dike and longitudinal main channel dike in 1995 in an effort to maintain sufficient channel conveyance in the navigation channel, between Miles 936 and 929. Discharge measurements and flow split calculations were conducted between the period July 1981 through September 1998. Plate 2 is a summary of this data. The data showed that the average flow split over this period of time was approximately 38 percent in the main channel and 62 percent in the side channel. One major concern by Memphis District personnel and the MVD Channel Improvement team was that the relatively large percentage of captured flow in the secondary side channel (greater than 60 % at stages between 30 and 40 ft.) was encouraging the development of a future, permanent cutoff from the main channel. If this event were to occur, a tremendous amount of future dredging and channel improvement works would be required in order to maintain a new navigation channel.

Another concern was that an extremely difficult navigation alignment had developed in the main channel between Miles 936 and 935. A channel sweep hydrographic survey collected in the study reach in November 1993 and March

1994 (Plate 9) showed the navigation channel and the channel thalweg along Columbus Revetment (left descending bank), near Mile 936, made a sharp, 90 degree turn toward the right descending bank along Wolf Island Revetment. The main channel had become excessively narrow at Mile 935. Downbound tows were having a difficult and dangerous time transiting through this area. Currents at Mile 936 off the left descending bank were such that tows were being forced toward the Wolf Island side channel away from the main channel.

In 1990, a team of engineers and biologist conducted sediment sampling along the upstream portion of Wolf Island. The team discovered that the exposed Wolf Island Bar was armored, consisting of a cemented layer of coarse cobbles and gravel. These coarse materials were conglomerated with fine sands, silts, and clays (Plates 3 through 7). Upon further study of morphological maps, the team determined that this material was a result of a former bed planform of the Ohio River. The Ohio River today is located approximately 15 miles upstream of Wolf Island.

2. Study Purpose and Goals

The study was performed to examine the effects of various design alternatives or measures to maintain existing flow conveyance and address improvement in the navigation channel crossing, between Miles 936 and 935. The goal was to ensure that any positive measures upon the navigation channel realized from a particular alternative would not adversely change the bed conditions within the side channel. The Wolf Island Side Channel has been considered important fisheries habitat for the Lower Mississippi River.

MICRO MODEL DESCRIPTION

1. Scales and Bed Materials

Plate 8 is a photograph of the Wolf Island hydraulic micro model used in this study. The scales were 1 inch = 600 feet, or 1:7200 horizontal, 1 inch = 50 feet, or 1:600 vertically, for a 12:1 distortion ratio. This distortion supplied the necessary forces required for the simulation of sediment transport conditions similar to the prototype. The bed material was granular plastic urea, Type II, with a specific gravity of 1.23.

2. Appurtenances

The model was constructed according to detailed aerial photographs of the Mississippi River. Flow was controlled via an electronic/computer interface and mechanical control valve. Stages and resultant bed configurations were surveyed with a 3-dimensional laser scanner. Structures were set with a three-dimensional digitizer. Slope was controlled by rotational jacks located within the hydraulic flume.

MICRO MODEL TESTS

1. Calibration and Verification

The calibration/verification of the micro model involved the adjustment of water discharge, sediment load, time scale, entrance conditions, and slope. These parameters were adjusted until the measured bed response of the model was similar to the prototype.

A. Design Hydrograph

A repeatable, sinusoidal discharge hydrograph was run throughout this model study which represented that hydrograph where normal sediment transport would be expected to occur in the prototype. In this particular study, the high stage of the hydrograph was +15 feet LWRP, while the low stage was -5 feet LWRP. Because of the constant variation experienced in the prototype, this discharge response was used to theoretically analyze the average expected sediment response that could be expected to occur during any given year.

B. Prototype Surveys

Several prototype surveys (1993/94, 1996, 1997, and 1998) were used to determine the general bed characteristics that have existed in the prototype over the years (Plates 9 through 14). Generally, only slight trend change differences were observed between the surveys from pre and post construction of the closing structure and longitudinal dike at the upper end of Wolf Island Chute. In the earliest 1993/94 survey, taken prior to construction, the bathymetric trends

observed within both the main channel and the side channel were very similar to later post construction surveys. With the exception of the development of the localized scour holes formed downstream of the two notches in the closure structure and some slight deepening trends observed within the main channel, the trends were very similar.

Within the side channel, the survey showed that there was a tendency for two smaller channels or "guts" to develop off both the left and right descending bank of the upper end of the channel. In addition, the occurrence of a high bar (+10 feet to +20 feet LWRP) developed off the lower right bank of Wolf Island Side Channel near Mile 932 and also off the left descending bank near Mile 930. A re-developing, relatively high, single and double channel development trend (single in 1993-94 and 1997, double in 1996 and 1997) was observed between the two high bars at the lower end of the side channel. These channels generally re-connected with the main channel between Miles 931 and 929.

Within the main channel, a similar, deep scour hole was observed off the left descending bank at the upper end of the study reach, between Miles 937 and 936.5 in all surveys, with depths between -60 feet and -90 feet LWRP. At approximately Mile 936.4, a shallow crossing trend in the main channel appeared in all surveys between 1993 and 1997, with depths between -10 feet and -20 feet LWRP. In the 1998 survey, the channel was slightly deeper in this area, with depths between -20 feet and -30 feet LWRP.

Between Miles 934 and 932, the channel developed along the outside of the right descending bank of the bend in all surveys. In the pre construction survey of 1993-94, depths along this area were generally between -10 feet and -30 feet LWRP, with the exception of a deeper scour hole that occurred near Mile 934.9, with depths between -30 feet and -40 feet LWRP. In the post construction surveys, average depths along the outside of the bend were slightly deeper, with depths of -30 feet and -40 feet LWRP much more frequently observed.

Between Mile 932 and 931, a crossing with depths between -15 feet and -20 feet LWRP was observed in 1993/94, while depths were generally deeper (-20 feet to -25 feet LWRP) in the post construction surveys. Between Miles 931 and 929, near the end of the study reach, the channel developed off the left descending bluff bar, with depths between -30 feet and -60 feet LWRP, observed in all surveys. There was no apparent tendency for this bank to migrate laterally to the north, and the bankline alignment generally remained the same on all surveys.

C. ADCP Plan View Velocities

Plates 15 and 16 are plan view velocity vectors maps generated from Acoustic Doppler Current Profile (ADCP) data, obtained in the Mississippi River in 1996 and 1998, respectfully. Velocity data was extracted from profile information and plotted as plan view directional vectors at a depth of 5.28 feet. Results indicated the following:

Velocities were generally greater through the right descending notch than the left descending notch in 1996. In addition, more velocity was noted in the channel below the right notch as compared to the left channel. Some erroneous data was located near Mile 933. Downstream of Mile 932, higher velocities were noted along the left descending bank. The flow pattern seemed to split near Mile 932, with velocities directed along two basic directions, one path along and adjacent to the left descending bank, and the other path along the right descending high bar bank toward the navigation channel.

In 1998, velocities were generally similar through both the right and left notches. Associated flow through the side channel seemed to be evenly distributed down the two channels below the notches. Near Mile 932, there was a considerable

amount of erroneous data that did not clearly define the proper direction of the velocities.

2. Base Test

Plate 17 shows the resultant bed configuration of the micro model base test. The base test was developed from the simulation of successive design hydrographs until bed stability was reached and a similar bed response was achieved as compared with the prototype surveys. Results of the base test and comparison to the prototype indicated the following trends:

The micro model was calibrated using 1996, 1997, and 1998 hydrographic surveys of the Mississippi River as well as channel sweep surveys collected within the side channel of Wolf Island.

Of vital importance to the calibration of the model was the knowledge of possible non-erosive areas within the study reach. In 1990, a field inspection by MVD engineers revealed that an abundant amount of conglomerated cobbles, gravel, and coarse sand existed throughout the surrounding bar of Wolf Island adjacent to the main channel, as discussed previously. The combined effect of armoring was apparent. Morphology conducted by Fisk revealed that this entire area at one time was inhabited by the Ohio River, thus explaining the existence of the relatively larger, coarser material (Rentschler 1999).

As a result, the bar in the model in the vicinity of the field inspection, off the left descending bank between Miles 935.5 and 934.5, was molded out of clay.

Entrance conditions of the model began at approximately Mile 937.5. At Mile 936.5, off the left descending bank at Columbus Revetment, the thalweg developed in the model, with depths between -30 feet and -50 feet LWRP. This

scour hole pattern followed the general trend of the prototype surveys, although in the prototype the scour hole extended approximately 0.5 miles further downstream to Mile 935.8. Between Mile 935.8 and 934.2, a crossing developed in the model, with depths between -10 feet and -20 feet LWRP. Between Mile 935.8 and Mile 935.5, the shallowest area of the crossing developed, with depths near -10 feet LWRP. This same shoaling trend was evident in the prototype surveys.

From Mile 935 to 932, the thalweg developed against the right descending bank. Depths through this segment of the model ranged between -20 feet and -60 feet LWRP. Depths in the prototype were generally less, between -20 feet and -30 feet LWRP. Between Mile 932 and 931, a crossing developed in both the model and the prototype. Depths in the model were slightly shallower than the prototype. Between Mile 932 and the exit conditions of the model, the channel was located against the left descending bank, with depths in both the model and the prototype between -30 feet to -40 feet LWRP.

The general upstream approach trends of the side channel were very similar between the model and prototype. Depths in the model were higher than the prototype by 0 to 10 feet, but the relative distribution pattern of the sediment was very similar. A bar formation was established off the left descending bank directly above the closure and extended approximately 2000 feet in breadth across the channel. Beyond this point, a shallower approach channel to the right closure notch was defined in both the model and the prototype.

At the closure structure, since direct elevations defining centerline depths of the two notches were impossible to obtain in the field because of the dangerous velocity conditions that existed, the invert of the notches in the model were calibrated by trial and error. In order for downstream sediment trends in the model to develop similar to the prototype, the left notch was completely shut off, while the right notch was degraded to -14 feet LWRP. During the calibration, it

was observed that the right notch was the dominant notch carrying the majority of the bed load through the side channel. Enabling the left notch to dominate during calibration as an experiment caused major deposition in the side channel along the left descending bank.

Downstream of the closure structure, between Mile 934.1 and 932, trends in both the model and the prototype were similar. Below the left notch, scour hole depths between -20 feet and -30 feet LWRP developed against the left descending bank similar to what was observed in the prototype surveys. A left channel extended along the left descending to approximately Mile 932. Between 932 and 931.8, there was a tendency for shoaling in this channel. Between 931.8 and 930.8, this channel was redefined, similar to what was observed in the prototype.

Below the right notch, a scour hole with depths between -50 feet and -60 feet LWRP developed in the model similar to the prototype. Flow below the notch deflected off the right descending bank, near Mile 933.5, and then crossed over to join the channel off the left descending bank, near Mile 932.5.

Between the left and right notches, the 20 foot scour depth that formed directly below the closure structure extended somewhat farther downstream in the model than the prototype. The hydrographic surveys and bathymetry obtained from the multi-swath indicated that this localized downstream scour in this area was a periodic trend tendency. In some particular years, deposition apparently builds up directly downstream against the structure.

Against the right descending bank of the side channel between Mile 933.6 and 933.1, a channel formed in the model to depths near -10 feet LWRP.

3. Design Alternative Tests

A number of alternative design plans were tested in this study. The effectiveness of each plan was evaluated by comparing results to the base test.

Alternative 1. Closure Structure Right Notch to -30 feet LWRP, Left Notch

Closed. Plate 18 shows the resultant bed configuration of Alternative 1. Test results indicated the following observed trends:

Depths increased just upstream of the closure structure approaching the right notch between 0 and 5 feet. A scour hole developed upstream of the closure in front of the right notch due to the increase of flow through the notch. The scour hole downstream of the right notch decreased approximately 10 feet in depth. The overall effect of the degradation of the right notch in the vicinity of the closure structure was an increase in approach depth and a slight decrease in exit depths.

Directly upstream of the left notch, deposition was similar to the base test. Downstream of the notch, depths and trends in the "gut" along the left descending bank were similar to the base test.

At Mile 931, off the left descending bank, depths increased by approximately 10 feet. The overall general flow and sediment response within the side channel was similar to the prototype.

Just downstream of the right notch, off the right descending side channel bank of Wolf Island, depths increased by approximately 10 feet.

Alternative 2. Closure Structure Right Notch at -2 feet LWRP and Left Notch at -10 feet LWRP. Plate 19 shows the resultant bed configuration of Alternative 1. Test results indicated the following observed trends:

The scour hole below the left descending notch increased in depths by approximately 10 feet as compared to the base test. The flow and sediment load increased through the notch as compared to the base test. The channel below the notch, along the left descending bank, filled in with sediment by approximately 10 to 20 feet. Once this bar was completely formed, flow was then directed more toward the center of the side channel. A scour hole eventually developed as a result of this change off the right descending high bar, near Mile 932.

Scour below the left notch decreased by approximately 20 to 30 feet. The flow and sediment load decreased through this notch as compared to the base test. Scour against the left descending bank near Mile 933.3 increased approximately 10 feet. This was a result of the depositional trend change below the left notch forcing more flow toward the center and right descending side of the side channel.

In the main channel, at the upper end of the model, scour developed along the left descending bank, to depths between -50 feet and -60 feet LWRP, against Columbus Revetment similar to the base test. The crossing at Mile 935.5 deepened slightly, with depths near -20 feet LWRP. From Mile 934 to the end of the model, the trends were essentially the same as observed in the base test.

Alternative 3. Closure Structure Right Notch Closed, Left to -30 feet LWRP
Plate 20 shows the resultant bed configuration of Alternative 3. Results indicated the following trends:

Within the side channel, scour developed directly below the left notch, with depths near -30 feet LWRP. More flow and sediment were observed moving through the notch as compared to the base test. Between Miles 933 and 931.5, the channel along the left descending bank filled with sediment as a result of this increased load, to depths between 0 and +10 feet LWRP. Once the high bar formed, along the left descending bank, more flow was then forced against the right descending high bar, and a large scour hole developed near Mile 932. A new channel was thus formed, with depths between -20 feet and -30 feet LWRP.

Scour below the right notch was less than the base test, with depths between -20 feet and -30 feet LWRP. Flow below the notch, instead of crossing over to the left descending side of the channel as in the base test, was redirected toward the new channel formed off the right descending high bar near Mile 932.

The scour and depositional trends that occurred in the main channel as a result of this alternative were very similar to the trends that occurred in the base test.

Alternative 4. Closure Structure Right Notch Raised to -2 feet LWRP, Left Notch Lowered to -10 feet LWRP, New Middle Notch Added to -2 feet LWRP. Plate 21 shows the resultant bed configuration of Alternative 4. Results indicated the following trends:

Within the side channel, scour developed directly below the left notch, with depths near -30 feet LWRP. The channel along the left descending bank filled in with sediment, to depths near 0 feet LWRP.

Scour developed downstream of the middle notch to depths between -20 feet and -30 feet LWRP. A middle channel formed below this notch, with depths developed near -10 feet LWRP.

Scour developed directly below the right notch, with depths between -30 feet and -40 feet LWRP. Flow was directed through the notch and then against the right descending bank, where it then deflected off the island and back toward the middle channel formed by the middle notch.

Within the main channel, scour developed against the left descending bank at the upper end of the model as in the base test. The crossing between Miles 936 and 935 became deeper than the base test, with depths near -20 feet LWRP.

Generally, other trends in the main channel were similar to the base test. The crossing near Mile 931.5 was slightly deeper (approximately 10 feet) than the base test.

Alternative 5. Closure Structures Restored To Original Design Grade

Closure Structures Between Island 266 and Sweeney Islands. Plate 22

shows the resultant bed configuration of Alternative 5. Test results indicated the following trends:

Within the side channel, the scour trends below both notches were very similar to the base test. A channel was developed along the left descending bank below the left notch. Depths were generally the same as in the base test, between -10 feet and -20 feet LWRP, except near Mile 930.8, where depths were deeper than the base test, between -20 and -30 feet LWRP.

A channel was developed below the right notch similar to the base test. Flow was directed toward right descending bank of Wolf Island near Mile 933.5, and then was directed back across the side channel and joined the left channel, near Mile 932.4.

In the main channel, scour developed off the left descending bank against Columbus Revetment, between Miles 937 and 936, to depths between -30 feet and -50 feet LWRP.

Trends in the crossing near Mile 935.5 were similar to the base test, with depths between -10 feet and -20 feet LWRP. Below Mile 935, the trends developed in Alternative 5 in the main channel were generally similar to the trends of the base test.

Alternative 6. Bendway Weirs at -20 feet LWRP. Plate 23 shows the resultant bed configuration of Alternative 6. Results indicated the following trends:

In the main channel, between Mile 937 and 936, scour was developed off the end of the weirs, with depths between -30 feet and -50 feet LWRP. Deposition occurred within the weir field, to depths between -20 feet and -30 feet LWRP. Directly below the weir field, against the left descending side of the channel, a depositional ridge developed, to depths near -10 feet LWRP. Adjacent to this ridge, in the center of the main channel through the crossing at Mile 935.5, adequate navigation depths were maintained, with depths between -20 feet and -30 feet LWRP.

Below Mile 935, the trends developed in Alternative 6 in the main channel were generally similar to the trends of the base test.

Within the side channel, the observed trends were very similar to the base test, and no major changes were noted.

Alternative 7. Extend Existing Longitudinal Dike 1200 Feet. Plate 24 shows the resultant bed configuration of Alternative 7. Results indicated the following trends:

Scour developed of the end of Columbus Revetment near the upper end of the model, to depths between -30 feet and -50 feet LWRP, similar to the base test. At the downstream crossing, between Miles 936 and 935, depths increased substantially as compared to the base test. Along the first 2000 feet of the longitudinal dike adjacent to the main channel, depths were between -30 feet and -60 feet LWRP, an increase of between 20 feet to 50 feet as compared to the base test.

From Mile 935 to the end of the model, the trends developed in Alternative 7 were very similar to the trends observed in the base test.

Within the side channel, near Mile 935, depths were generally greater than the base test as a result of the dike extension, between -20 feet and -30 feet LWRP. Scour below the left notch was similar to the base test, with depths near -20 feet LWRP.

Below the notch, the channel along the left descending bank was developed that was similar to the base test.

Scour below the right notch was slightly less than the base test, with depths between -30 feet and -40 feet LWRP. Below the notch, a channel developed against the right descending bank of Wolf Island and the crossed over to the left descending channel, which was very similar to what was observed in the base test.

Alternative 8. New Left Descending Dike Adjacent to Navigation Channel, 500 Feet in Length, to 0 feet LWRP. Plate 25 shows the resultant bed configuration of Alternative 8. Results indicated the following trends:

Scour developed off the end of Columbus Revetment near the upper end of the model, to depths between -30 feet and -50 feet LWRP, similar to the base test. From the dike location near Mile 935.9 to upstream point of the longitudinal dike, depths along the left descending side of the channel increased approximately 10 feet as compared to the base test, with depths near -20 feet LWRP. In the center of the navigation channel along this same stretch, depths were generally shallower than the base test, with depths near -10 feet LWRP.

From Mile 935 to the end of the model, the trends developed in Alternative 7 were very similar to the trends observed in the base test, although the crossing near Mile 931.5 was approximately 10 feet deeper than the base test.

Alternative 9. Closure Dike Removed. Plate 26 shows the resultant bed configuration of Alternative 8. Results indicated the following trends:

Scour developed off the end of Columbus Revetment near the upper end of the model, to depths between -30 feet and -50 feet LWRP, similar to the base test. Depths were generally shallower in the crossing near Mile 935 as compared to the base test, with most depths near -10 feet LWRP. Depths along the outside of the bend, between Miles 935 and 933.2, were much shallower than the base test, in some areas by as much as 50 feet, with depths between -10 feet and -20 feet LWRP.

Between Miles 932 and 931, within the crossing, depths were generally shallower than the base test, with depths between -10 feet and -20 feet LWRP. From Below the crossing, the scour along the outside of the bend against the left descending high bank bar was shallower by approximately 10 feet. A bar

developed to depths near 0 feet LWRP at Mile 929.3, which was between 10 feet and 20 feet higher than the base test.

Within the side channel, the scour holes below the former location of the closure structure filled in with sediment, to depths near 0 feet LWRP. The deeper channel along the left descending bank disappeared. A dominant, relatively shallow channel formed in the middle of the side channel, replacing the higher middle bar of the base test, to depths near 0 feet LWRP. Flow was evenly distributed through the entire side channel as a result of these changes. The channel along the left descending bank observed in the base test filled in with sediment, to depths between 0 and +10 feet LWRP. A scour hole still developed against the right descending bank of Wolf Island Bar similar to what was observed in the base test, to depths near -20 feet LWRP.

RESULTS AND CONCLUSIONS

1. Summary of Model Tests

- All closure structure alternatives showed that the relationship between the two notches was sensitive and inter-dependent. The left notch, when compromised, had a tendency to dominate the transport of sediment within the side channel. The more the left notch dominated, the more flow and sediment was distributed through this notch and the more the tendency for the channel along the left descending bank to fill in with sediment. This depositional trend below the left notch ultimately caused a new channel to develop further downstream on the opposite side of the side channel, against the right descending lower high bar of Wolf Island, near Mile 932.
- Alternative 6 showed that placement of 4 upstream angled weirs, located along the left descending bank between Miles 936.9 and 936.5, combined with the closure structure of the base test, improved navigation depths and widths through the crossing, between Miles 936 and 935. Conditions within the side channel remained similar to the base test.
- Alternative 7 showed that an extension of the existing longitudinal structure, combined with the closure structure of the base test, made an improvement to the channel crossing, between Miles 936 and 935. Trends within the side channel, with conditions of the closure structure left as in the base test, displayed similar trends as compared to the base test.
- Alternative 8 showed that placement of a new dike at 0 LWRP at the entrance to the side channel made some minor improvement to the navigation channel directly downstream of the dike. However, shallow depths were still observed in the middle of the crossing, between Miles 936 and

935.5. In addition, the location of this dike, which extended out into the existing navigation channel, posed a possible safety hazard to downbound tows navigating through this reach.

- Alternative 9 showed that complete removal of the closure structure, with the longitudinal dike left in place, tended to dramatically change the trends within the side channel. The side channel flow distribution trend changed from two distinct channels along the left and right descending banks, as observed in the base test, to one dominant, much shallower channel along the entire width of the side channel. In addition, navigation depths within the main channel were considerably less than the base test. This alternative showed the critical functionality of the closure structure for maintaining the existing depth diversity within the side channel.
- Alternative 5 showed that the closure structure, with the restored original notches, combined with the longitudinal structure, maintained the trends as observed in the base test.
- All alternatives tested showed that additional measures would be required to improve the crossing in the main channel, between Miles 936 and 935. As previously discussed, Alternatives 6, 7, and 8 showed improvements to this crossing.
- None of the tests seemed to show any significant tendency for increased depth and associate lateral migration downstream along the left descending high bar bank of the main channel, between Miles 931 and 929. There was initial concern that improvements generated in the main channel for increased crossing depths would possibly increase depths further downstream along this area. This trend was not evident. Improvements to the crossing seemed to be directly related with local structural measures made near the crossing and had no negative effect further downstream.

2. Interpretation of Model Test Results

In the interpretation and evaluation of the results of the tests conducted, it should be noted that the results of these model tests were qualitative in nature. Any hydraulic model, whether physical or numerical, is subject to biases introduced as a result of the inherent complexities that exist in the prototype. Anomalies in actual hydrographic events, such as prolonged periods of high or low flows, are not reflected in these results, nor are any unknown, complex physical phenomena, such as the existence of underlying rock formations or other non-erosive variables.

A field sedimentation study revealed that an abundant amount of coarse bed material existed throughout the upper end of Wolf Island Bar and also within the navigation channel. This should be taken into consideration if measures for construction are eventually pursued.

LIST OF PLATES

Plates 1 through 26 will follow:

- Plate 1. Location and Vicinity map
- Plate 2. Split Flow Measurements
- Plate 3. Sediment Reconnaissance Team
- Plate 4. Sediment Reconnaissance
- Plate 5. Sediment Reconnaissance
- Plate 6. Sediment Reconnaissance
- Plate 7. Hard Erode Areas
- Plate 8. Wolf Island Micro Model
- Plate 9. 1993 and 1994 Prototype Survey
- Plate 10. 1996 Prototype Survey
- Plate 11. 1997 Prototype Survey
- Plate 12. 1997 Channel Sweep Survey
- Plate 13. 1998 Prototype Survey
- Plate 14. 1998 Channel Sweep Survey
- Plate 15. Acoustic Doppler Profile Vectors at 5.28 ft. depth
- Plate 16. Acoustic Doppler Profile Vectors at 5.28 ft. depth
- Plate 17. Base Test
- Plate 18. Alternative 1
- Plate 19. Alternative 2
- Plate 20. Alternative 3

Plate 21. Alternative 4

Plate 22. Alternative 5

Plate 23. Alternative 6

Plate 24. Alternative 7

Plate 25. Alternative 8

Plate 26. Alternative 9

FOR MORE INFORMATION

For more information about micro modeling or the Applied River Engineering Center, please contact Robert Davinroy, David Gordon or Edward Riiff at:

Applied River Engineering Center
U.S. Army Corps of Engineers – St. Louis District
Hydrologic and Hydraulics Branch
Foot of Arsenal Street
St. Louis, Mo. 63118

Phone:

(314) 263-4714 or (314) 263-4230

Fax. (314) 263-4166

E-mail:

Robert.D.Davinroy@mvs02.usace.army.mil

David.Gordon@mvs02.usace.army.mil

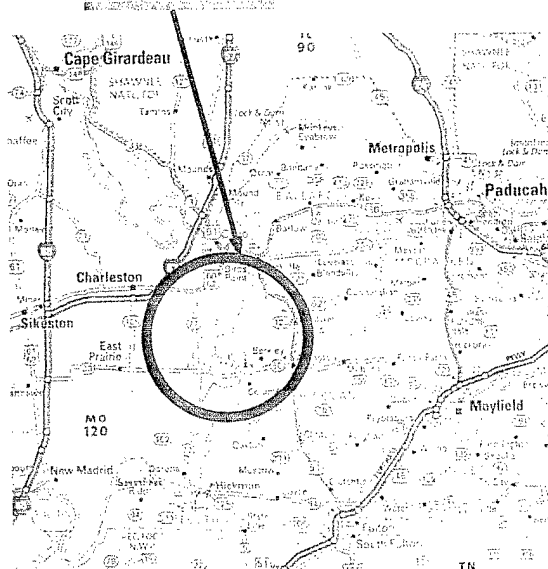
Edward.H.Riiff@mvs02.usace.army.mil

Or you can visit us on the World Wide Web at:

<http://www.mvs.usace.army.mil/river/river.htm>



STUDY
REACH



**U.S ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI**

PREPARED BY: D. Gordon
CHECKED BY: R. Dewberry

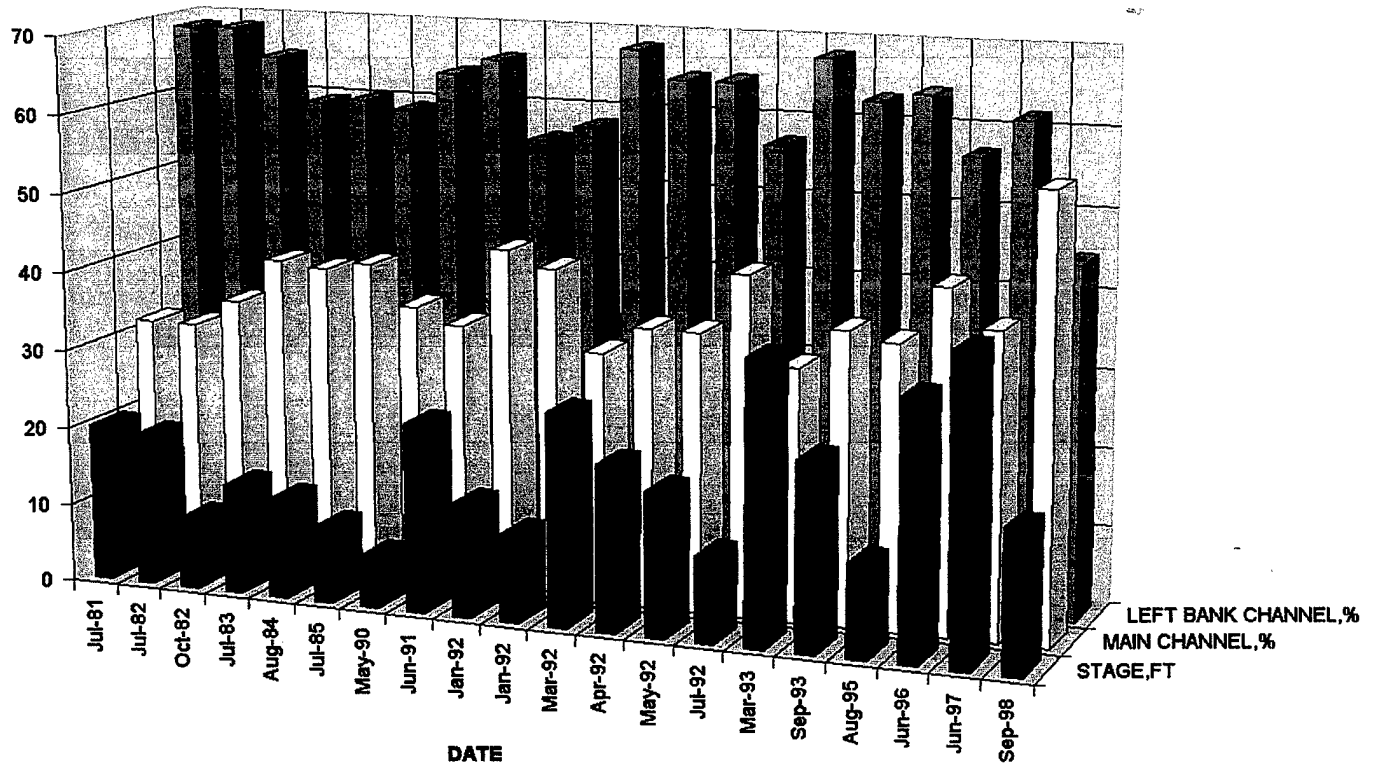
**WOLF ISLAND MICROMODEL STUDY
RIVER MILES 936 TO 929.5**

LOCATION AND VICINITY MAP

PLATE NO.

1

WOLF ISLAND, MILE 933



U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

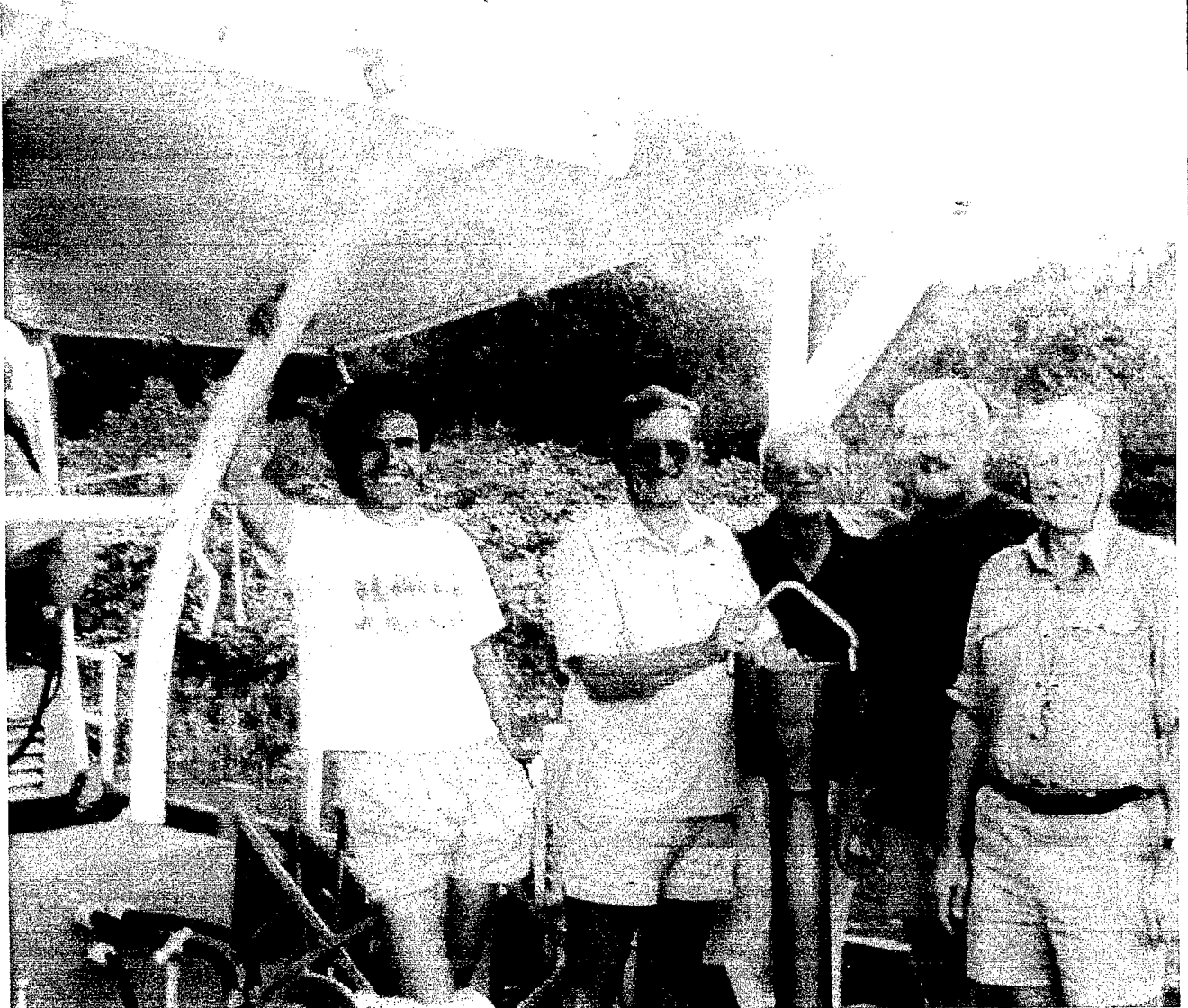
PREPARED BY: A. RHODES
CHECKED BY: R. DAVINROY
DATE: MAY, 1999

WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5

SPLIT FLOW MEASUREMENTS

PLATE NO.

2



**U.S ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI**

PREPARED BY: D. Gordon
CHECKED BY: R. Devroy

**WOLF ISLAND MICROMODEL STUDY
RIVER MILES 936 TO 929.5**

SEDIMENT RECONNAISSANCE TEAM

PLATE NO.

3



PREPARED BY: D. Gordon
CHECKED BY: R. Davhroy

**U.S ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI**

**WOLF ISLAND MICROMODEL STUDY
RIVER MILES 936 TO 929.5**

SEDIMENT RECONNAISSANCE

PLATE NO.

4



U.S ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

PREPARED BY: D. Gordon
CHECKED BY: R. Daverroy

WOLF ISLAND MICROMODEL STUDY
RIVER MILES 936 TO 929.5

SEDIMENT RECONNAISSANCE

PLATE NO.

5



PREPARED BY: D. Gordon
CHECKED BY: R. Daveray

**U.S ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI**

**WOLF ISLAND MICROMODEL STUDY
RIVER MILES 936 TO 929.5**

SEDIMENT RECONNAISSANCE

PLATE NO.

6

MISSOURI

KENTUCKY

Known Gravel Areas

WOLF ISLAND BAR

WOLF ISLAND

0 500 1000 1500 2000 2400

U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 93.6 TO 929.5
HARD ERODE AREAS

2400 1800 1200 600 0 1200 2400

STATE NO. 7

WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5
HARD ERODE AREAS

2400	1800	1200	600	0	1200	2400
------	------	------	-----	---	------	------

SECTION FILE PROCEDURE DOW PLATE NO	1
--	---

PLATE NO. _____

10



PREPARED BY: R. DAVENPORT
DRAWN BY: E. DUFF
CHECKED BY: R. DAVENPORT
DATE: 11/1/55

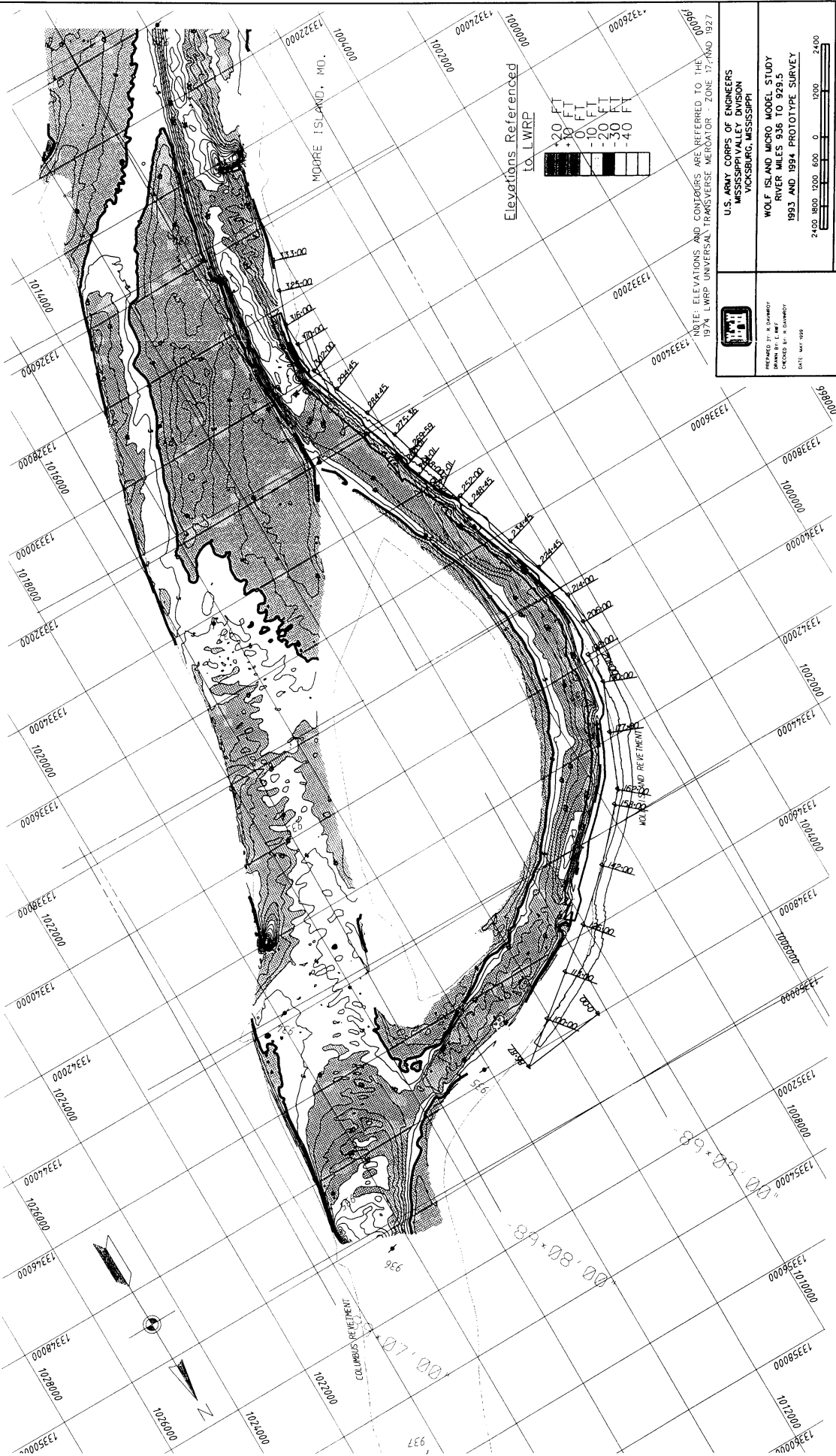
U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

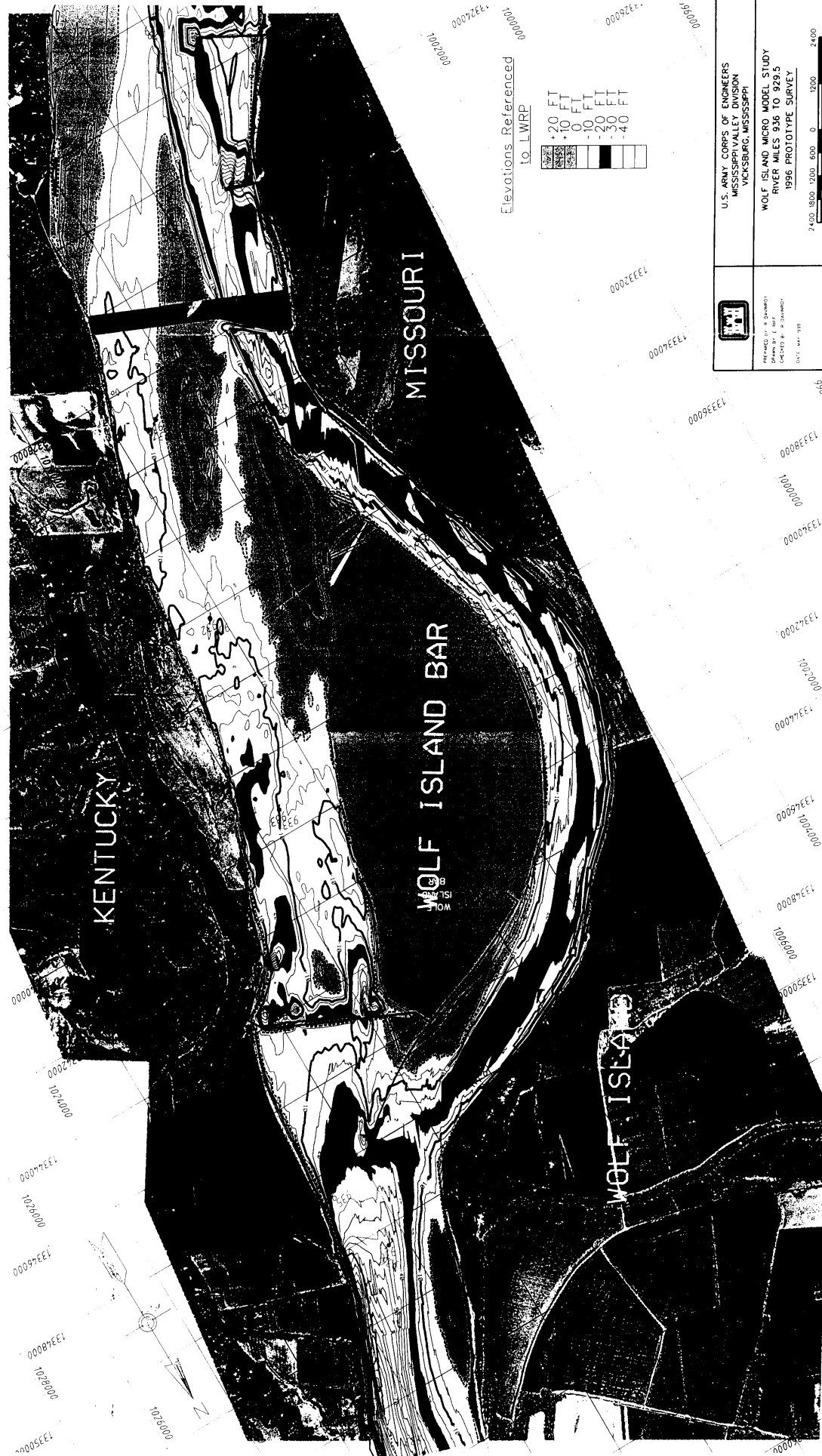
WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5
WOLF ISLAND MICRO MODEL

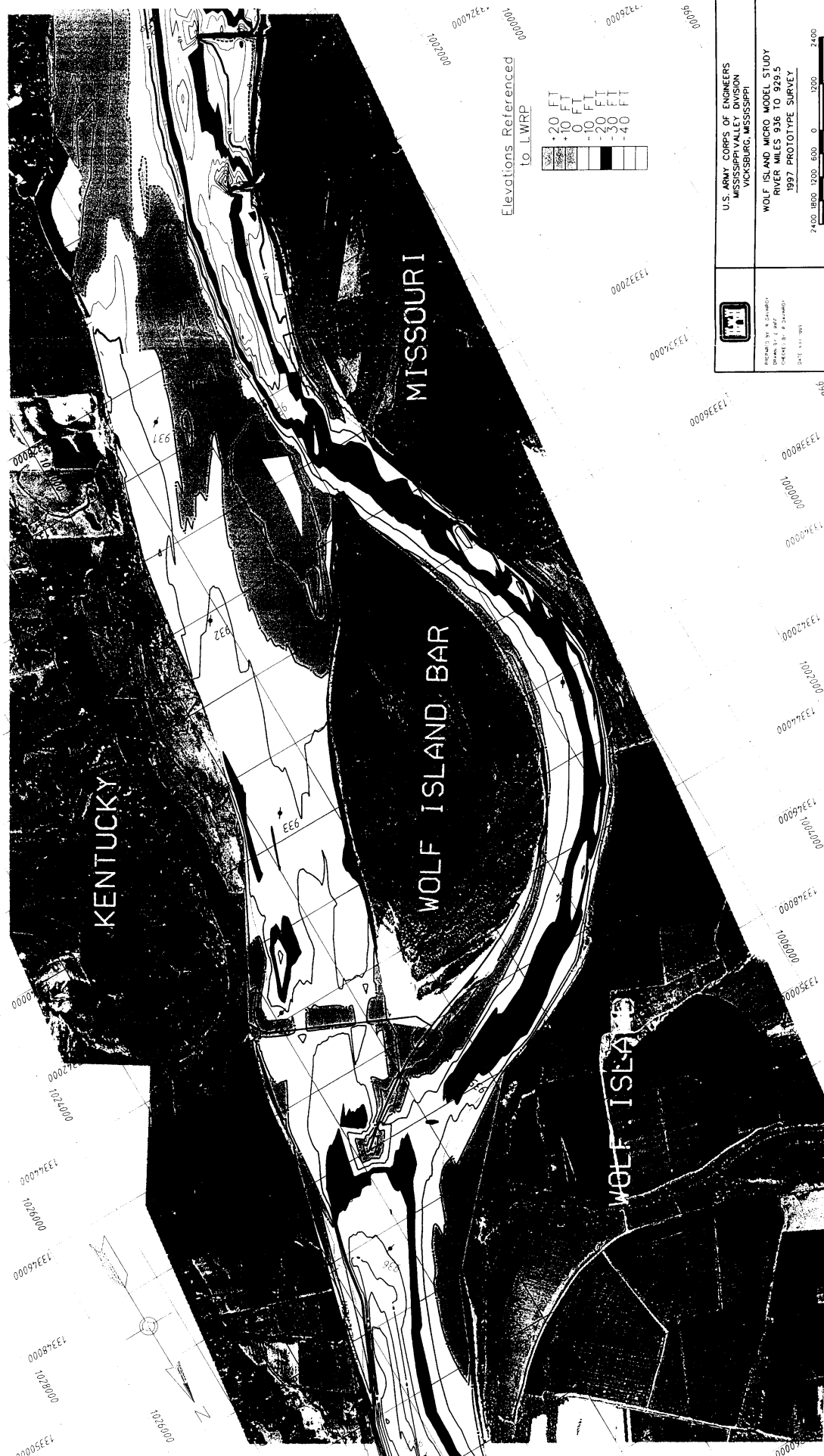
GRAPHIC FILE NO.
PLAT SCALE

PLAT DATE: 11/1/55

PLATE NO.
8





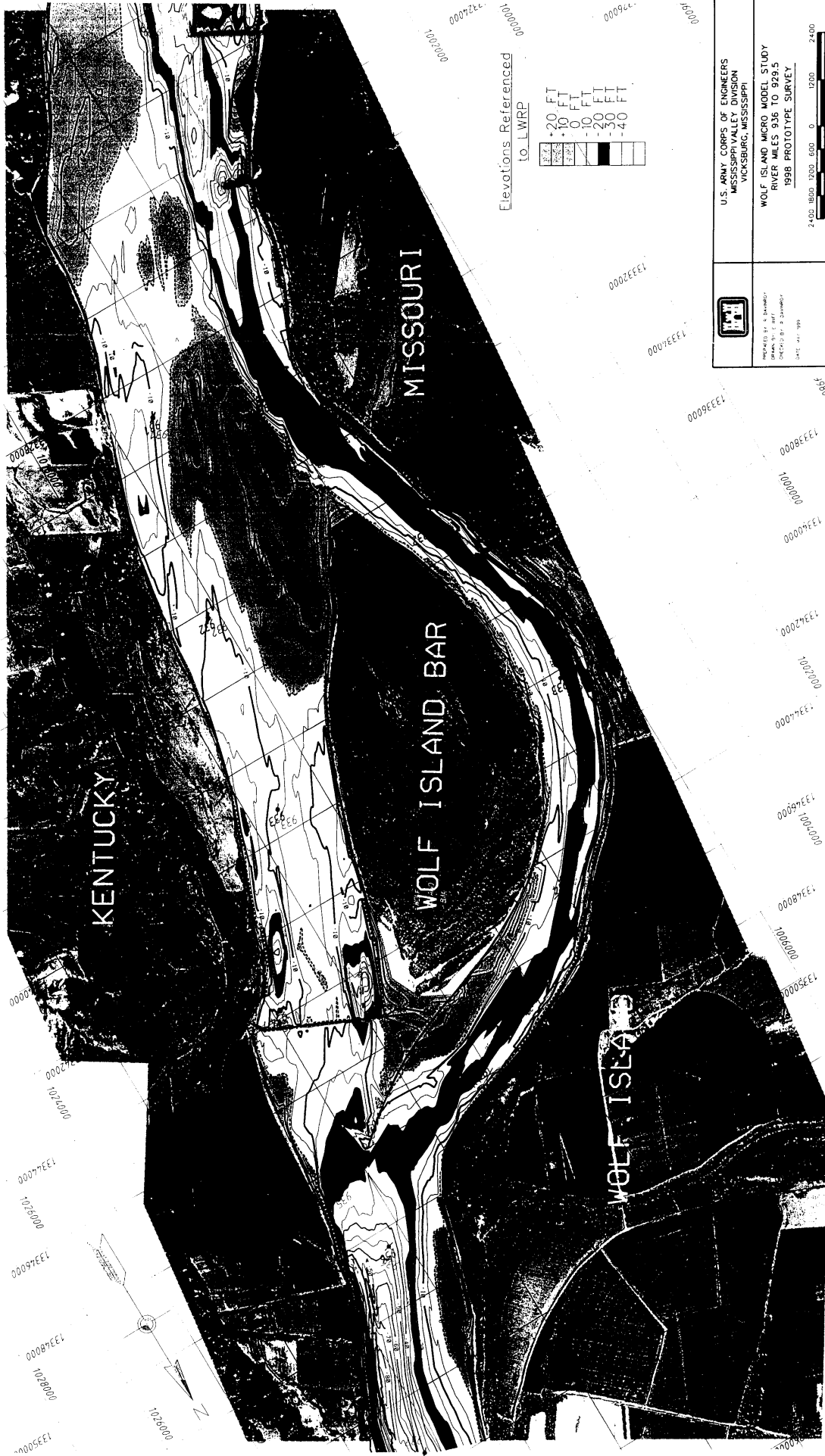




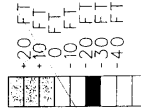
HYDROGRAPHIC SURVEY FOR THE MISSISSIPPI VALLEY DIVISION

Elevations referenced
to LWRP

EL-5
EL-10
EL-15
EL-20
EL-25
EL-30
EL-35
EL-40
EL-45
EL-50
EL-55
EL-60
EL-65



Elevations Referenced
to LWRP



U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI DIVISION
VICKSBURG, MISSISSIPPI

WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5
1998 PROTOTYPE SURVEY



PLATE NO. 13



Elevations referenced
to LWRP

EL. 5
EL. 0
EL. -5
EL. -10
EL. -15
EL. -20
EL. -25
EL. -30
EL. -35
EL. -40
EL. -45
EL. -50
EL. -55
EL. -60
EL. -65



U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

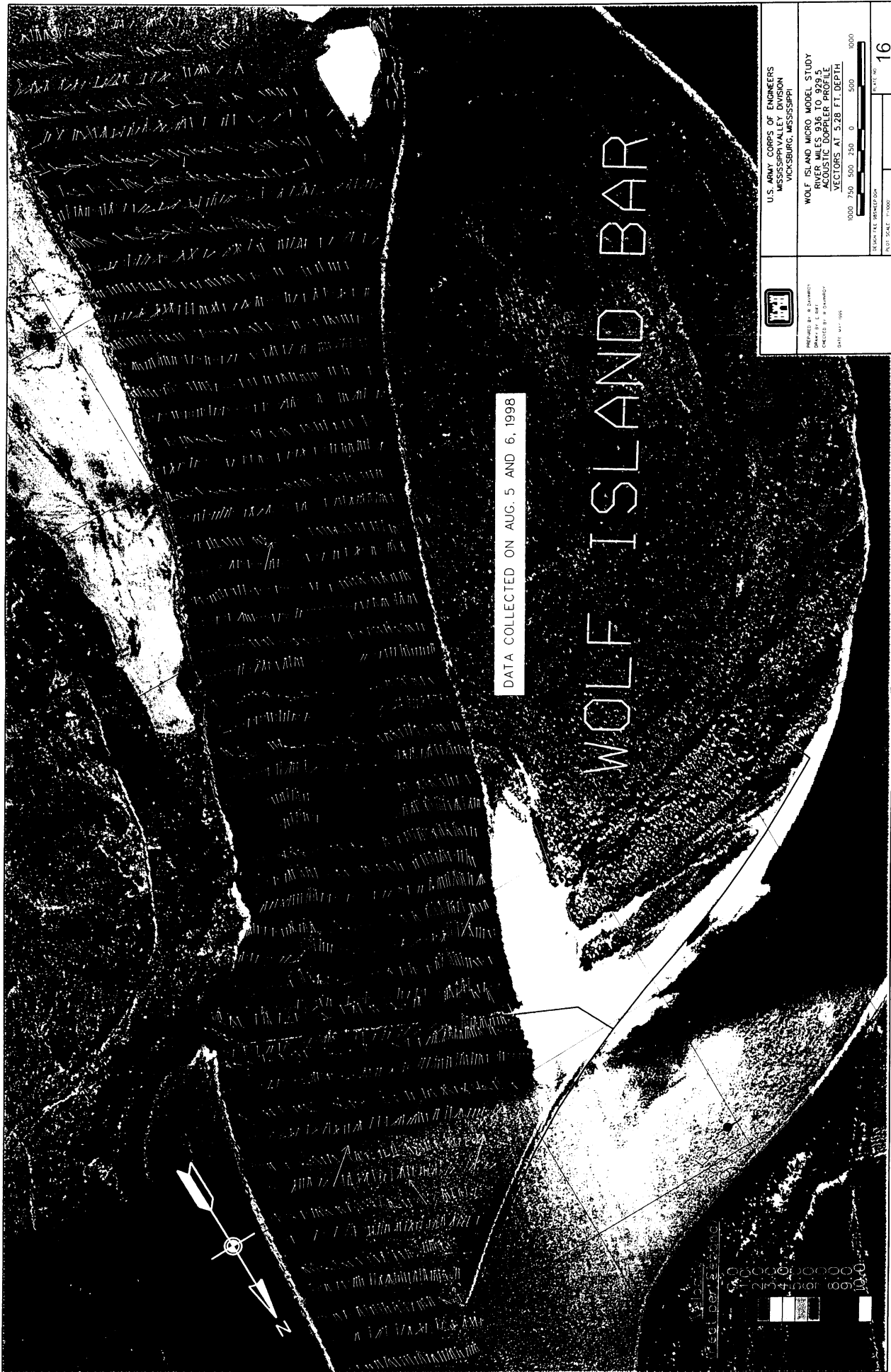
WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5
1998 CHANNEL SWEEP SURVEY

2400 1800 1200 600 0 1200 2400
Feet

DESIGNED BY: J. J. JONES
DRAWN BY: J. J. JONES
CHECKED BY: J. J. JONES
DATE: MAY 1999

PLATE NO.
14

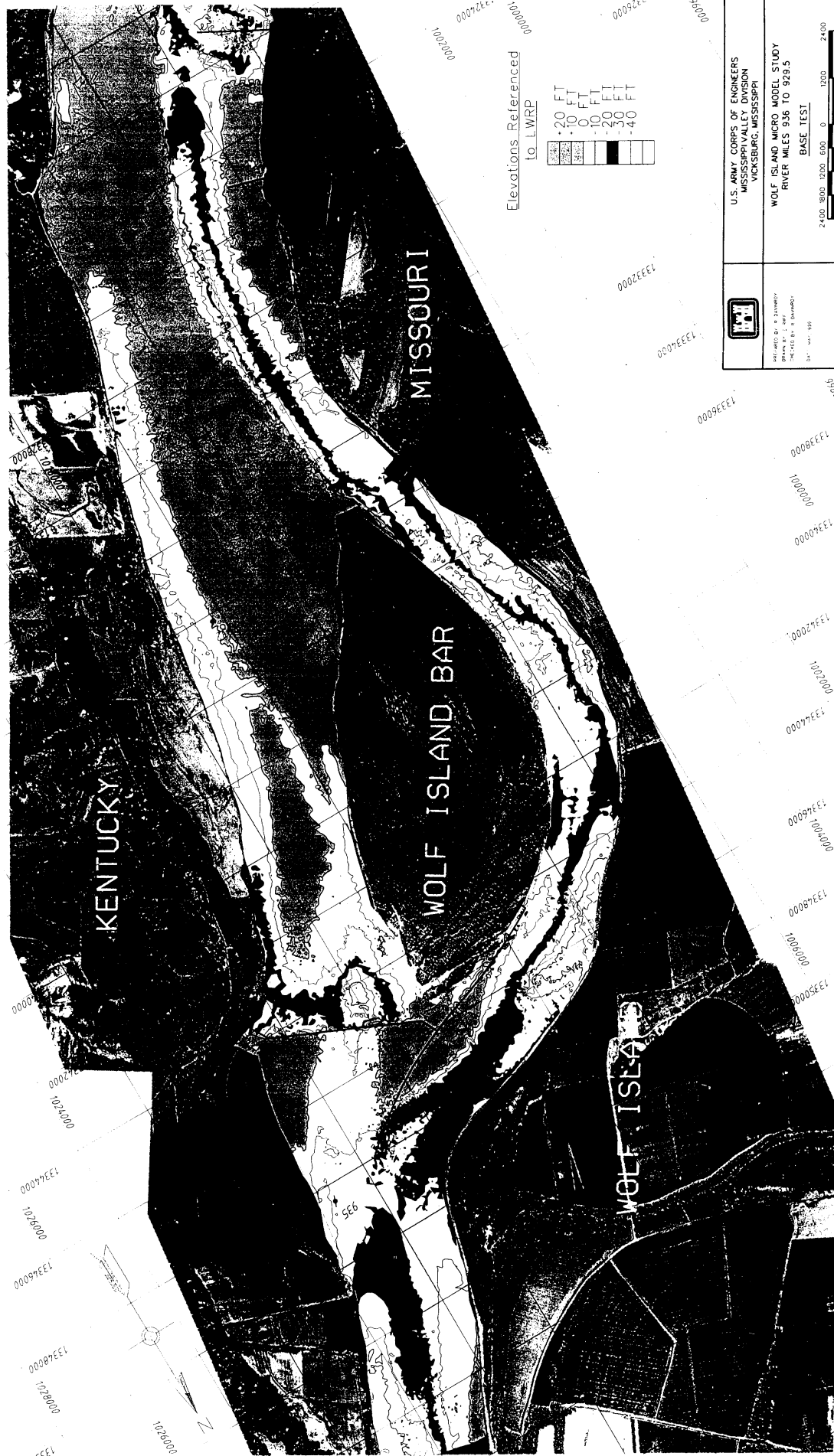
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----



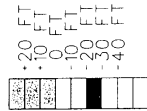
DATA COLLECTED ON AUG. 5 AND 6, 1998

WOLF ISLAND BAR

	U.S. ARMY CORPS OF ENGINEERS MISSISSIPPI VALLEY DIVISION VICKSBURG, MISSISSIPPI
	WOLF ISLAND MICRO MODEL STUDY RIVER MILES 9.36 TO 9.25.5 ACOUSTIC DOPPLER PROFILE VECTORS AT 5.28 FT. DEPTH 1000 750 500 250 0 500 1000 SCALE: 1"=1000'
PREPARED BY: R. J. JAMES DRAWN BY: T. BART CHECKED BY: R. JAMES DATE: MAY 1998	PLATE NO. 16



Elevations Referenced
to LWRP



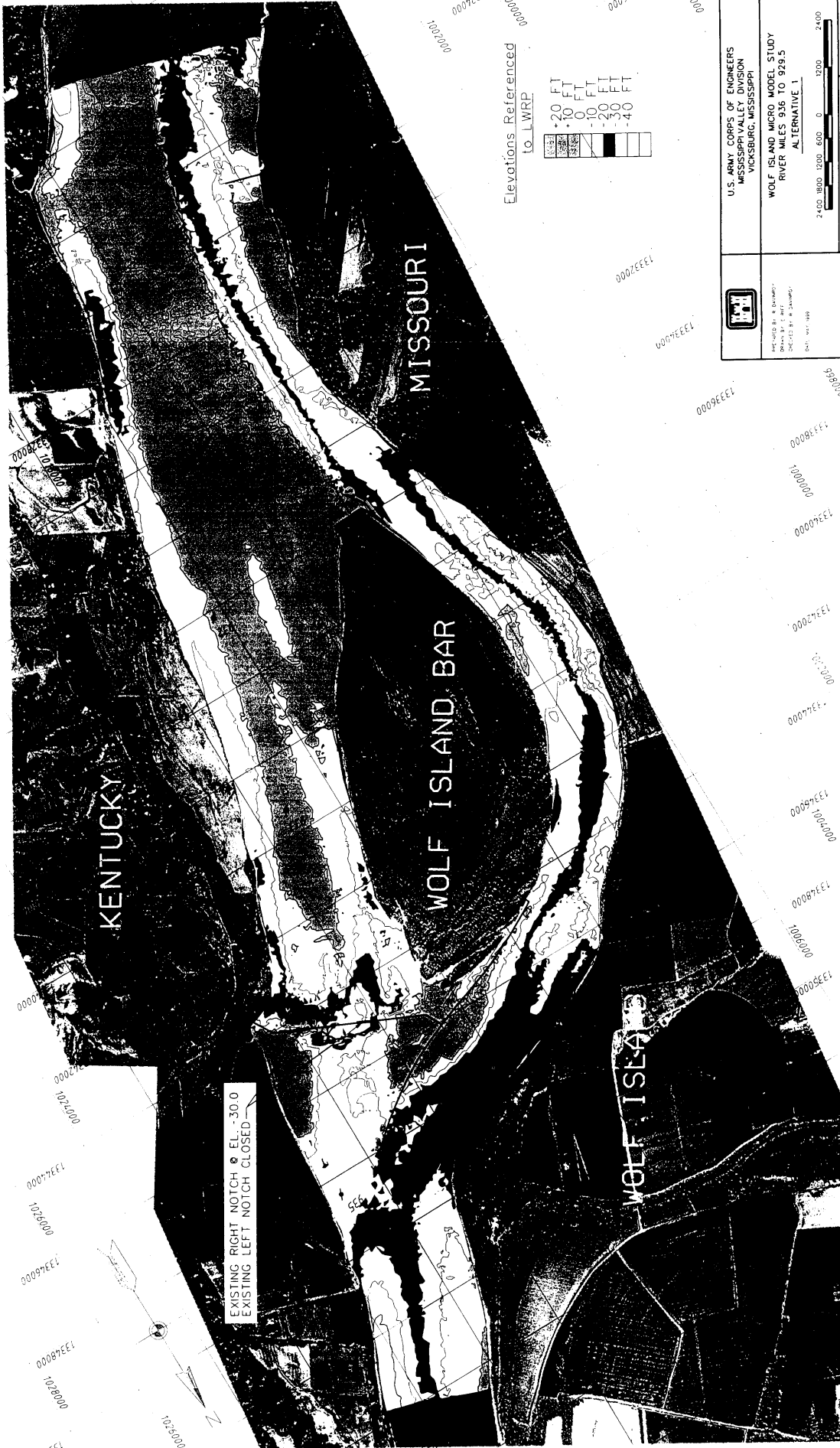
U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5

BASE TEST



17



U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

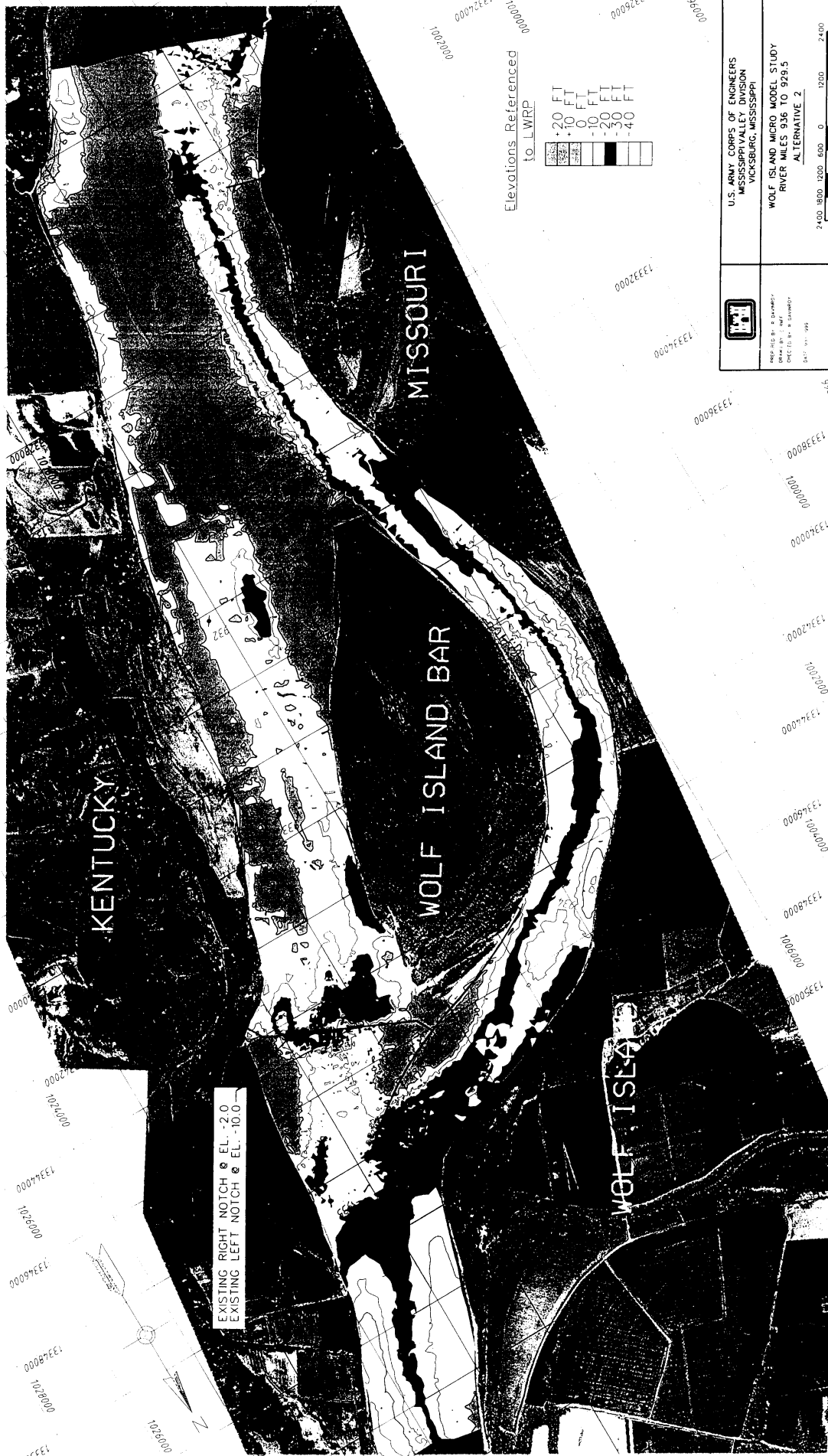
WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5

ALTERNATIVE 1

2400 1800 1200 600 0 1200 2400

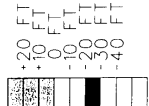
DESIGN FILE NUMBER
SHEET NAME: 18

18



EXISTING RIGHT NOTCH @ EL. -2.0
EXISTING LEFT NOTCH @ EL. -10.0

Elevations Referenced
to LWRP

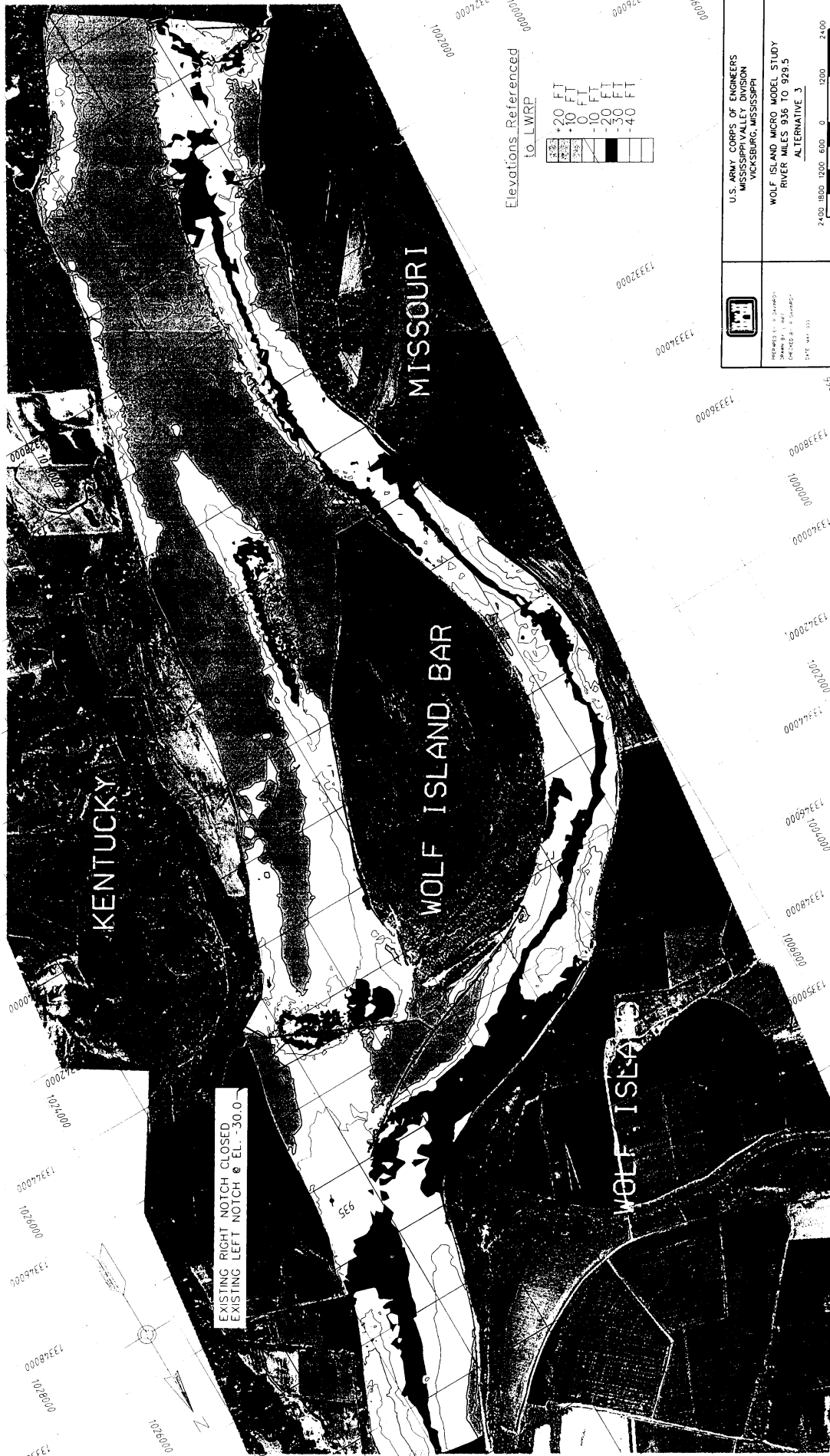


U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

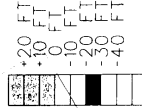
WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 929.5
ALTERNATIVE 2



2400 FEET
2400 METER



Elevations Referenced
to LWRP



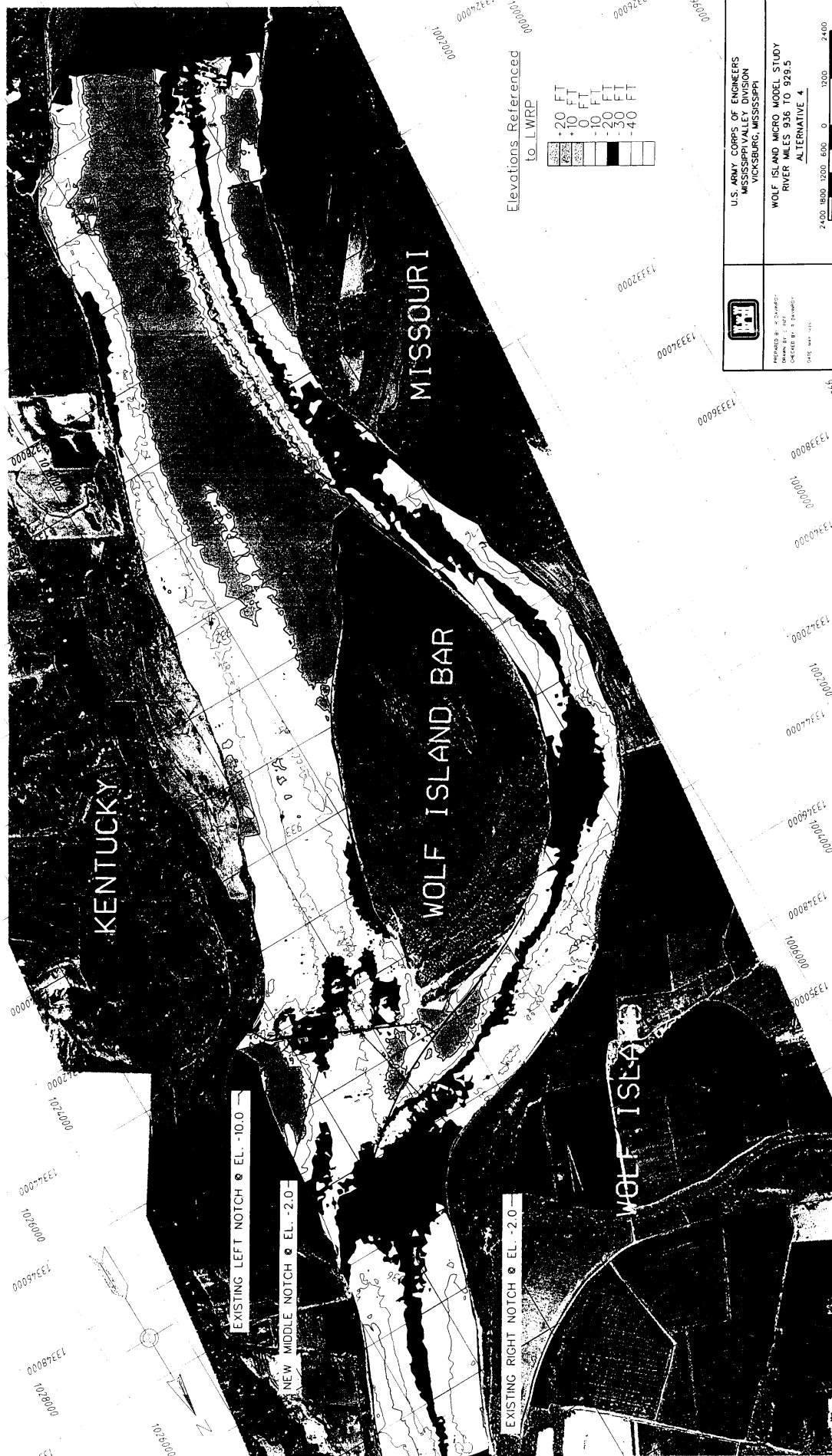
U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

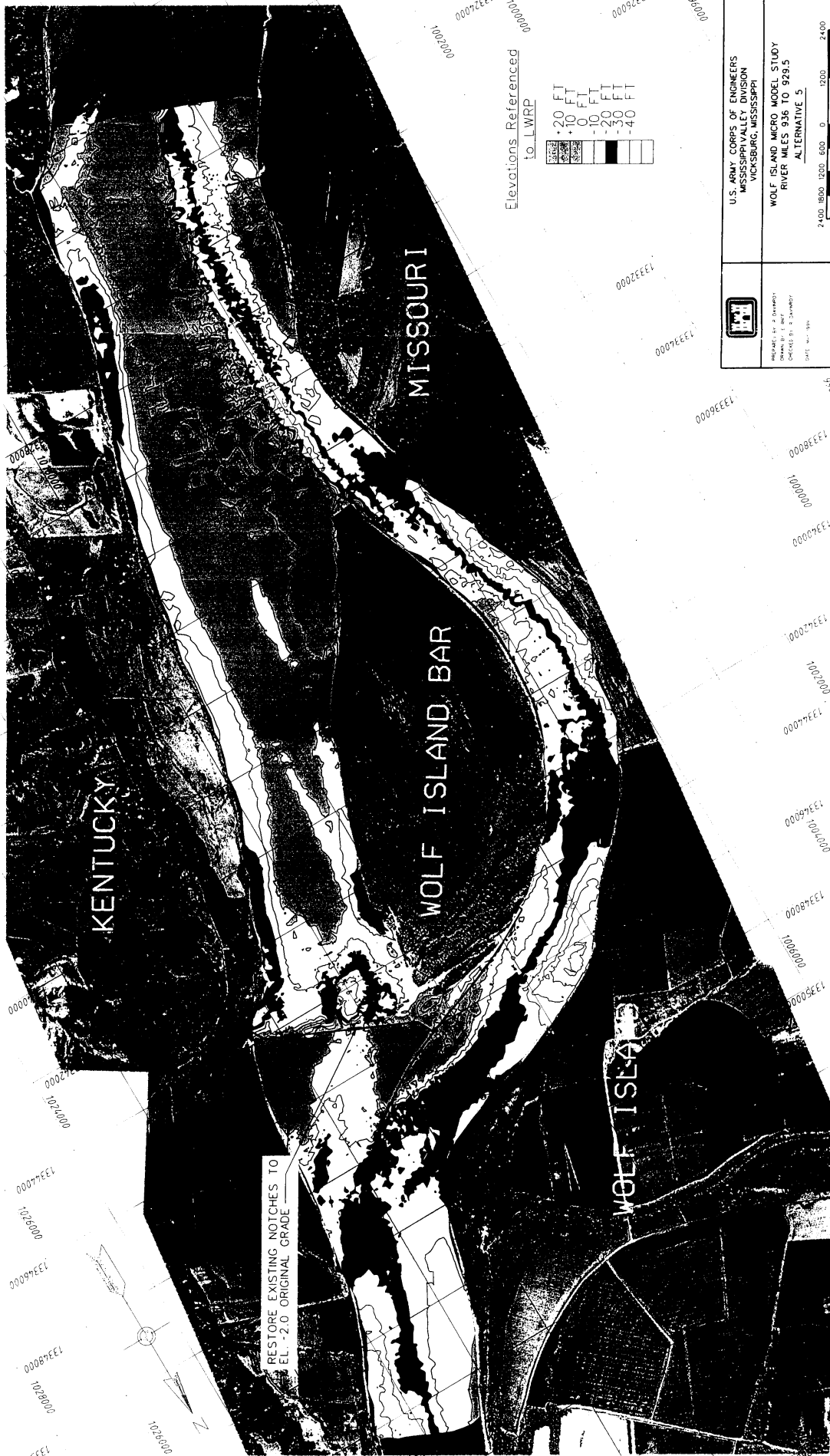
WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 939.5
ALTERNATIVE 3



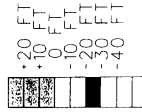
20

DATE: 11/10/00
SHEET: 1 OF 1





Elevations Referenced
to LWRP



U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
VICKSBURG, MISSISSIPPI

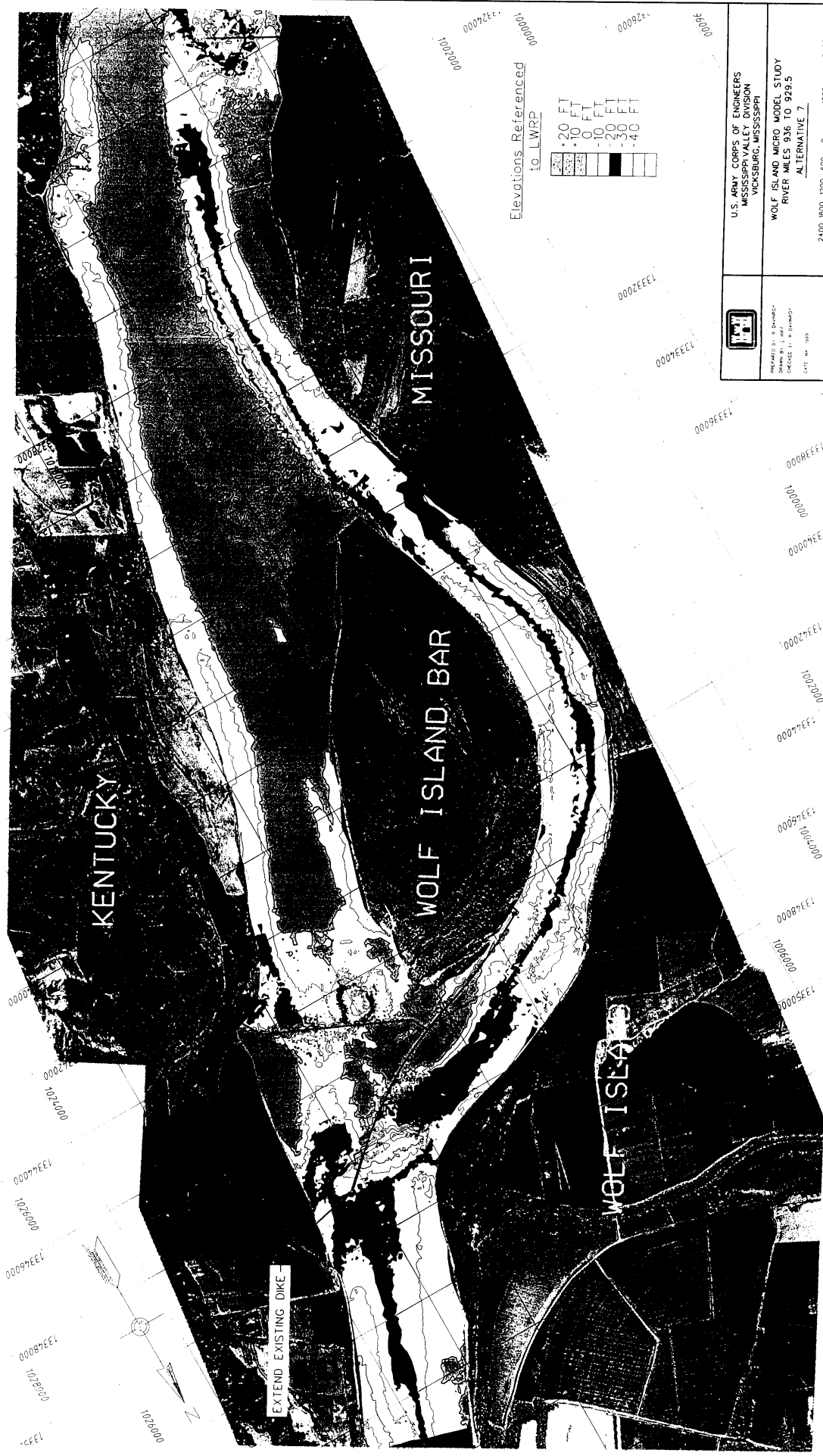
WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 936 TO 939.5
ALTERNATIVE 5



DESIGN SCALE: 1"=100'

DATE: 11-1-94

22



MISSISSIPPI

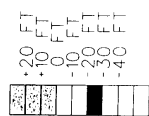
WOLF ISLAND BAR

WOLF ISLAND

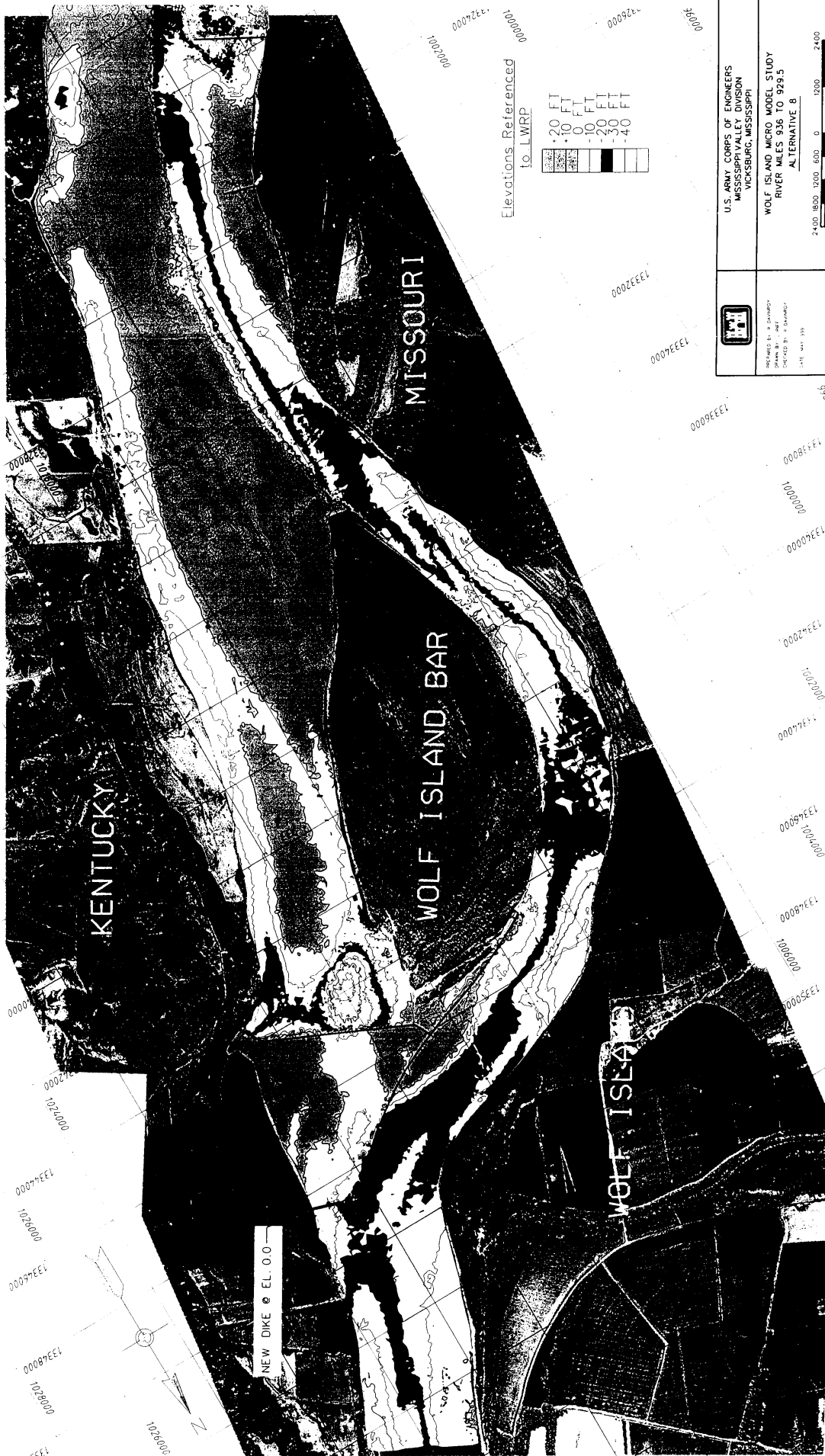
KENTUCKY

EXTEND EXISTING DIKE

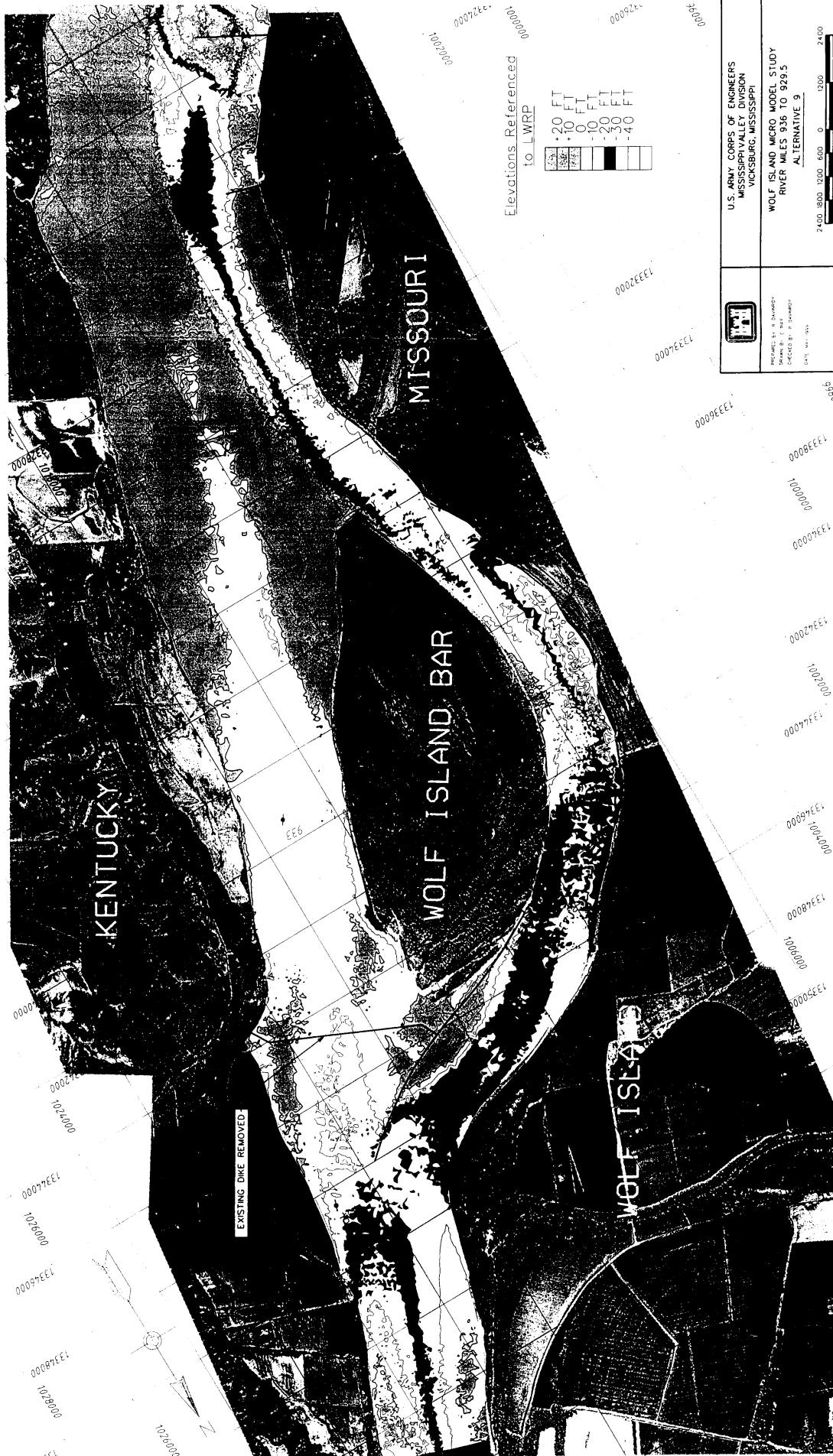
Elevations Referenced
to LWRP



	U.S. ARMY CORPS OF ENGINEERS MISSISSIPPI VALLEY DIVISION VICKSBURG, MISSISSIPPI
	WOLF ISLAND MICRO MODEL STUDY RIVER MILES 9.36 TO 9.29.5 ALTERNATIVE 7
2400 1800 1200 600 0 1200 2400	
SCALE: 1" = 1000' HORIZONTAL SCALE: 1" = 20' VERTICAL	
DATE: MAR 1999	
SHEET NO. 24	



		U.S. ARMY CORPS OF ENGINEERS MISSISSIPPI VALLEY DIVISION VICKSBURG, MISSISSIPPI
PREPARED BY: S. HANCOCK CHECKED BY: T. HANCOCK DATE: MAY 1999		WOLF ISLAND MICRO MODEL STUDY RIVER MILES 9.16 TO 9.29.5 ALTERNATIVE 8
HORIZONTAL SCALE: 1" = 1000' VERTICAL SCALE: 1" = 20'		SHEET NO. 25



Elevations Referenced
to LWRP



U.S. ARMY CORPS OF ENGINEERS
MISSISSIPPI VALLEY DIVISION
KANSAS CITY, MISSOURI

WOLF ISLAND MICRO MODEL STUDY
RIVER MILES 9.36 TO 9.29.5
ALTERNATIVE 9



DESIGN FILE ALTERNATIVE 9
PROJECT NAME: T-1400
PLANT NO. 26