Technical Report M5

SEDIMENTATION STUDY OF THE MISSISSIPPI RIVER SCHENIMANN CHUTE MISSISSIPPI RIVER MILES 63 TO 57 HYDRAULIC MICRO MODEL INVESTIGATION

By
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14. ABSTRACT
A sedimentation study of the Middle Mississippi River, between River Miles 63 and 57, was conducted to study sediment transport mechanics of two side channels, Shenimann Chute and Picayune Chute. A hydraulic micro model was used to assess structural design alternatives to develop physical and biological diversity within the side channels. The study concluded that favorable diversity could be achieved through the use of alternating dikes or hard-points, dredging, and notches in the dikes and closure structures. The study also showed that the desired designs would not have an effect on bed response of the main commercial navigation channel.
Micro modeling is extremely small scale physical hydraulic sediment transport modeling of a river or stream.

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Mississippi River, Schenimann Chute, Micro Model, Sedimentation, Picayune Chute, Closure Structures, Side Channel, Dikes, Chutes

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INTRODUCTION

A sedimentation study was initiated in order to evaluate a number of environmental design alternatives and modifications in the Schenimann Chute side channel complex of the Middle Mississippi River. An expansion of the study included the upper half of Picayune Chute, which is located within the same reach. The study used a physical hydraulic micro model as a means to aid environmentalists, biologists, and engineers in creating more diverse physical and ecological habitats throughout the study reach.

The study was conducted during the period between May 1996 and July 1996 and was performed by Mr. David Gordon and Mr. Robert Hetrick, hydraulic engineers, under direct supervision of Mr. Robert Davinroy, District Potamologist for the St. Louis District. Personnel also involved with and for overseeing the study included Mr. Claude N. Strauser, Chief of the Potamology Section and Mr. Ronald Yarbrough, Avoid and Minimize Program Planner.

Personnel from other agencies involved in the study included:
Mr. Butch Atwood from Illinois Department of Natural Resources, Ms. Jenny Frazier, Mr. Bob Hrabik, Mr. Mike Peterson, and Ms. Leslie Conaway, from the Missouri Department of Conservation Long Term Research Monitoring Station, Mr. Mark Haas, Mr. Gordon Farabee, Mr. Ken Brumett, Mr. Dave Herzog and Mr. Ken Dalrymple, from the Missouri Department of Conservation, and Mr. Bob Clevenstine and Ms. Joyce Collins from the U.S. Fish and Wildlife Service.

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BACKGROUND

This report details the investigation of a sedimentation study using a physical hydraulic micro model. The micro model methodology (1) was used to evaluate the existing sediment transport conditions and the impact of various design measures to improve environmental conditions in the Schenimann Chute side channel complex on the Mississippi River.

1. Study Reach

The location of this study covered a 6-mile reach of the Middle Mississippi River, between River Miles 63 and 57, approximately 5 miles north of Cape Girardeau, Missouri. Plate 1 is a location and vicinity map of the study reach. Plate 2 is a 1994 aerial photograph depicting the study reach. Schenimann Chute is located in Cape Girardeau County, Missouri while Picayune Chute is located in Union and Alexander Counties in Illinois.

2. Problem Description

The photo on Plate 2 depicts the characteristics, configuration, and nomenclature of the Mississippi River between Miles 63 to 57. The entrance to Schenimann Chute is located near Mile 62.5R and ends near Mile 57.0R. The side channel is approximately 4.5 miles long, averages 200 feet in width, and consists of 93 acres of aquatic habitat adjacent to privately owned lands. The entrance to Picayune Chute is located near Mile 61.0L and ends below the study reach at Mile 54.8L. This side channel parallels the main channel for a distance of approximately 6.2 miles. Only the upstream 3 miles of this chute were included in the study.

The Schenimann/Picayune Chute side channel complex serves a vital role in the health of the fisheries of the Middle Mississippi River. It has been well documented that side channels, both continuous and detached, serve as important backwater habitat for a variety of fish species and are vital to the overall health of the ecosystem. These bodies of water function as spawning, rearing, resting, feeding and over-wintering habitat for numerous species of fish. With this premise it is important to note that greater physical diversity, in the form of alternating bars and deep scour holes, were desired in these side channels to create greater biological diversity.

A. History

Before 1821 and man's influence on the river, the width of the Middle Mississippi River averaged approximately 3,600 feet. Between 1821 and 1888, the Mississippi River increased in width with a resulting decrease in depth. By the end of this period, the average width of the river had increased to approximately 5300 feet (2). The width increase and subsequent decrease in depth was due to several factors. Early settlers cleared forests along the river's banklines for farmland and fuel. Fuel was needed in vast quantities for the growing number of steamboats traveling the river at the time. These acts greatly increased the erosional rates on the river's banklines, caused the river to widen excessively, and deposited unnatural quantities of material in the main river channel.

By 1881, Congress recognized that something had to be done to develop a dependable channel for navigation. The plan called for artificially restricting the river back to a more natural width and depth. The 1927 authorization assumed that a 9-foot channel depth at a minimum flow of 40,000 cfs could be maintained through the construction of channel stabilization works such as timber pile dikes and bankline revetments. The low water project flow was later revised to 54,000 cfs in 1933. By 1960, engineers recognized that pile dikes were not capable of maintaining a 9-foot channel during low flows with the designated channel width. Today, many of the deteriorated timber dikes have been replaced with stone. By

1968, Corps of Engineers construction enabled the river to return to a more natural width at an average of approximately 3,200 feet, slightly narrower than in 1821. The following table from Strauser shows that the Middle Mississippi River has been returned to more natural state (2).

YEAR	TOTAL SURFACE AREA (SQ MI)	ISLAND SURFACE AREA (SQ MI)	RIVERBED SURFACE AREA (SQ MI)	AVERAGE RIVER WIDTH (FT)
1821	109	14	95	3600
1888	163	35	128	5300
1968	100	17	83	3200

Research of historical hydrographic surveys and aerial photography has revealed that the Schenimann Chute side channel complex is a relatively newly created chute as a result of the construction of river training structures. The upstream half of the Picayune side channel complex was also a result of river training structures. Plates 3 and 4 are survey maps of the Mississippi River from 1880 and 1908. Schenimann Chute and the upstream end of Picayune chute are in the very early stages of development and are nearly nonexistent in these maps. By this period, man's influence on the river was extremely evident. The Mississippi River channel was unnaturally wide and shallow with numerous sandbars.

Aerial photographs from 1932 and 1935 on Plate 5 show newly constructed river training structures on both the Missouri and Illinois banklines. In 1932, the initial stages of the side channel formation were just beginning in the upper reaches of Schenimann chute. The 1935 photograph shows a rapid development of the upper portion of the chute. Within a short 3-year time period a large portion of the upper side channel had been formed. By 1965 (Plate 6), Picayune Chute was fully developed while the lower reach of Schenimann Chute was still maturing. Plate 2 shows that each complex is now fully developed with one dominant side channel for each.

B. Schenimann Chute

Although Schenimann Chute is long and narrow, there is a fair amount of physical diversity throughout the side channel. A couple of bends located near the upstream end of the chute and several closure structures located along the chute have created both shallow and deep areas. Two narrow entrances to the chute exist at the upstream end near Miles 62.5 and 62.2 (Plate 7). A small tributary, Bainbridge Creek, enters the chute near the upstream end. A 1996 site visit revealed several vertical eroding bank lines, exposed rock closure structures with head differences over each, several submerged remnant wooden closure structures, a few deep holes, and some shallow, flat, homogenous areas.

The three main rock closure structures were originally formed by Dikes 59.8R, 58.7R, and 58.2R, which were constructed before the island and side channel formed. Several wooden pile dikes were constructed from the original right descending bankline of the main channel, which is now the right descending bankline of the side channel. Some of the dikes extended nearly 3500 feet into the main channel. The island now covers the middle portion of the dikes. The ends of the dikes have since been rock covered and extend into the main channel. The beginnings of each dike now act as closure structures in the side channel. Each of the large, rock closure structures in the chute forms both a large scour hole and a vertical round-out in the bankline on the downstream side (Plate 8). The structures also inhibit boat access during periods of low water.

C. Picayune Chute

Picayune Chute borders Devils Island along the length of the side channel. The riverbed of the chute is relatively shallow and homogenous throughout most of the upper end of the chute. A large sand bar occupies the entrance to the chute, which prevents access to the upstream end of the chute during low water conditions (Plate 7). The upstream portion of the chute is narrow and straight with the exception of bends near the entrance and midpoint of the chute.

D. Main Navigation Channel

The main navigation channel is lined with numerous river training structures on both riverbanks throughout most of the reach. Several dikes located on the right descending bankline extend through both the island and Schenimann Chute. These dikes created many of the closure structures located within the chute. The navigation channel has experienced only minor channel maintenance dredging between Miles 59 and 58. A bendway weir field is located on the left descending bankline at the downstream end of the study reach in a bend between Miles 57.5 and 56.0.

2. Study Purpose and Goals

The purpose of the study was to design structural modifications to enhance the physical diversity and flow dynamics within the Schenimann Chute side channel complex. The study was performed to address two separate sediment transport issues. The first objective was to create additional environmental diversity in Schenimann Chute in the form of both shallow and deep-water environments, and to develop areas with fast and slow flow, while maintaining project depths in the main navigation channel. The second objective was to create easier accessibility into the entrance of Picayune Chute during low flows. The major consideration of this objective was to determine the impacts of this measure on depths in the main navigation channel.

The main goal was to evaluate the impacts of the alternatives, if any, on the resultant bed configuration (sediment transport response) within the Mississippi River and the adjacent side channel complexes. Creating desirable biological and physical diversity while at the same time ensuring a reliable navigation channel was the major challenge of this study. It was determined that increased physical diversity in the riverbed would lead to increases in aquatic habitat and greater overall ecological diversity within the area.

MICRO MODEL DESCRIPTION

In order to investigate the sediment transport issues described previously, a physical hydraulic micro model was designed and constructed. Plate 9 is a photograph of the hydraulic micro model used in this study.

1. Scales and Bed Materials

The micro model insert was constructed according to 1994 high-resolution aerial photography of the study reach and placed in a standard micro model hydraulic flume. The model employed a horizontal scale of 1 inch = 400 feet, or 1:4800, and a vertical scale of 1 inch = 50 feet, or 1:600, for an 8 to 1 distortion ratio of linear scales. This distortion supplied the necessary forces required for the simulation of sediment transport conditions similar that of the prototype. The bed material was granular plastic urea, Type II, with a specific gravity of 1.23.

2. Appurtenances

Flow in the model was simulated and regulated electronically by a function generator interfaced to a submersible bilge pump. In all model tests, the effective discharge or hydrograph was simulated automatically with the electronic control system. Each hydrograph was a repeatable triangular response representative of a range of low to high flows within the channel. Peak flow in the model represented an elevation near to bankfull flow in the prototype. The recurrence interval of bankfull flow in the prototype is approximately 1.5 years (3). Resultant bed configurations were measured and recorded with a computer interfaced 3-dimensional mechanical digitizer.

MICRO MODEL TESTS

1. Calibration and Verification

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

A. Design Hydrograph

In all model tests, the effective discharge or design hydrograph was simulated (1) in the Mississippi River channel. This hydrograph served as the average design flow response. Because of the constant variation experienced in the prototype, a design hydrograph was used to theoretically analyze the average expected sediment transport response during any given year. This hydrograph represented a cycle of flows between extreme low flow to a within-bank high flow. The time increment or duration of each cycle (peak to peak) was three minutes.

B. Prototype Data and Observations

Data available from the prototype used for the calibration process included historic and recent hydrographic surveys, historic aerial photography, and on-site field inspections.

Plates 10, 11 and 12 are plan view hydrographic survey maps of the Mississippi River from 1989, 1993, and 1995/96, respectively. Each survey shows that the channel thalweg was located along the right descending bank at the entrance to Schenimann Chute. Near Mile 61.5, a crossing existed with depths near -10 feet LWRP. Here the channel transitioned to the left descending bank just upstream of the entrance to Picayune Chute. The channel created a deep thalweg against

the bank and the dikes with depths near -30 feet LWRP. A long crossing then developed back to right descending bank between Miles 60.0 and 59.0. Depths in this area ranged between -10 and -20 feet LWRP. The channel then crossed back to the left descending bankline between Miles 59.0 and 58.0. Depths in this crossing were near -10 feet LWRP. The channel then remained on the outside of the bend throughout the remainder of the study reach.

Plate 12 contains high-resolution hydrographic sweep surveys of Schenimann and Picayune Chutes from 1995 and 1996. These surveys showed areas of deep water exist near the entrance to Schenimann Chute and on the outside of the bends in the upper reaches of the side channel. Downstream of the bends, the geometry of the chute was relatively straight and shallow. The only depth diversity through this reach was created by the closure structures. Large, deep scour holes existed downstream of closure structures 59.8R, 58.7R, and 58.2R. The banklines downstream of each structure had been rounded out and were actively caving. Except for these few areas of scour, elevations in the chute were generally near 0 feet LWRP.

The bathymetry of Picayune Chute showed the bed to be rather homogenous throughout the upper reaches. Elevations were generally between 0 and –10 feet LWRP. The entrance to the chute was relatively shallow with elevations near 0 feet LWRP. Depth diversity in this side channel was nearly non-existent except for an area of scour near Mile 58.3.

2. Base Test

Once the favorable comparison of model tests and field survey data was made, the model was considered calibrated. The resultant survey of this bed response served as both the verification and base test of the micro model (1). Several different physical combinations of parameters were tested to develop sediment

transport conditions considered to be representative of those experienced in the prototype.

Plate 13 shows the resultant bed configuration of the micro model base test. This survey served as the comparison survey for all future design alternative tests. 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 indicated the following trends:

- At the upper end of the study reach, near Mile 62.5 and the entrance to Schenimann Chute, the thalweg was positioned along the right descending bankline. A short crossing to the left descending bankline was located near Mile 61.7.

- The thalweg, with depths near –50 feet LWRP, remained along the left descending bankline from Mile 61.5, passed the entrance to Picayune Chute, to Mile 60.5. A crossing to the right descending bankline was located between Miles 60.5 to 60.0.

- The thalweg remained along the right descending bankline for a short distance before another crossing back to the left descending bankline between Miles 59.5 and 59.0.

- The thalweg remained along the left descending bankline throughout the remainder of the study reach. Depths were very shallow between Miles 58.3 and 57.5.

- Both Schenimann and Picayune Chutes had depths generally near 0 feet LWRP, as shown in the prototype surveys. Some scour was evident near the bends and main closure structures within Schenimann Chute.

3. Alternative Plans

After discussions with partnering agencies, four alternative design plans were tested in the model. As previously discussed, all tests were initiated to create environmental diversity and enhancements while at the same time ensuring the integrity of the navigation channel. The effectiveness of each plan was gaged by comparing the resultant bed configuration to that of the base test condition.

Representatives of the aforementioned agencies experimented with a variety of environmental design alternatives in the micro model. The following designs were further examined by engineers.

Alternative 1: *75-Foot Wide, 10-Foot Deep Notch Placed in Dike 61.0L*
Plate 14 is a plan view contour map of the resultant bed configuration of Alternative 1. Results of this test indicated that a notch in Dike 61.0L did not deepen the shallow area located at the upstream end of Picayune Chute. The design showed that depths in the main navigation were also unaffected.

Alternative 2: *Dike 62.5R Angled Downstream*
Plate 15 is a plan view contour map of the resultant bed configuration of Alternative 2. Results of this test indicated that angling Dike 62.5 downstream created shallower depths in the main channel upstream and downstream of the structure. The purpose of the design was to divert additional flow into Schenimann Chute when the dike was overtopped. However, the design did not impact the flow or bed response in the side channel.

Alternative 3: *75-Foot Wide, 10-Foot Deep Notch Placed in Dike 62.5R*

Plate 16 is a plan view contour map of the resultant bed configuration of Alternative 3. Results of this test indicated that placing a notch in Dike 62.5R created shallower depths in the main navigation channel just upstream of the structure. The results showed that the notch did not have an effect on the bed response in the entrance or upper portion of Schenimann Chute.

Alternative 4: *15 Dikes or Hard-Points Built to Top of Bank Elevation With Lengths Ranging From 50 Feet to 125 Feet Long Placed in Schenimann Chute Between Miles 60.5 and 59.0. Artificial Dredge Cuts at a Depths near –10 Feet LWRP Simulated in Lower End of Schenimann Chute Between Miles 58.7 to 57.0*

Plate 17 is a plan view contour map of the resultant bed configuration of Alternative 4. Results of this test indicated that each dike created a localized scour hole. The entire dike field created an alternating pattern of small scour holes and depositional bars therefore enhancing the physical diversity within the side channel. The depth of the scour was moderate and did not effect the overall average depth of the side channel through this reach. The structures also created a sinuous flow pattern of fast and slow velocity areas.

The test also revealed that the artificial dredge cut at the lower end of the side channel did not fill with sediments due to the low energy experienced at the end the chute created by the backwater effect of the main channel. These modifications had no effect on the bed response in the main navigation channel.

CONCLUSIONS

1. Summary of Model Tests

The following is a summary of findings and recommendations of the model study:

- A 75-foot wide notch placed in Dike 61.0L, at the entrance to Picayune Chute did not effect the bed response of the navigation channel. However, a notch in this location could be useful for better accessibility for boats entering the side channel from the upper end.

- Changes in the alignment and notches in Dike 62.5R at the entrance to Schenimann Chute had negative effects to the main channel. Modifications to this structure caused deposition in the navigation channel that could halt commercial navigation and require future dredging. The design did not divert additional flow into the side channel and the bed response within the chute remained unchanged by the modifications.

- The addition of several alternating hard-points or dikes in the middle of Schenimann Chute created additional physical diversity in the bed of the channel. Areas of alternating scour holes and depositional areas as well as areas of fast and slow velocity flow were created by a series of these structures.

- Depths in the lower end of Schenimann Chute were maintained after material was artificially removed and several flow events had taken place in the model. The model tests indicated that the Mississippi River main channel formed a backwater area at the lower end of the side channel. This area experienced less sediment transport because of lower energy and velocity of

flow. Therefore, dikes, which need energy to move sediment, did not work as well in this area as artificially dredging deep areas to create habitat. Artificial dredge cuts in this area may remain for several years.

2. Recommended Solutions

Plate 18 shows the recommended design to enhance the Schenimann Chute side channel complex. Model tests indicated that the following recommendations did not effect the bed response in the main navigation channel.

1. Construct a 75-foot wide, 10-foot deep notch in Dike 61.0L to enable better accessibility into Picayune Chute.

2. The upper reaches of Schenimann Chute, between Miles 62.2 and 60.6, should be left unmodified. This reach contained adequate diversity because of the numerous bends located in this area.

3. Construct a series of 15 alternating dikes or hard-points to an elevation near top of bank in Schenimann Chute between Miles 60.5 to 59.0 to create additional physical and biological diversity.

4. Artificially dredge numerous areas in the lower end of Schenimann Chute between Miles 58.7 and 57.0 to create additional deep water habitat

5. Widen and deepen the existing notches in closure structures 59.8R, 58.7R, and 58.2R to allow better accessibility throughout Schenimann Chute. Although this design was not model tested, it will not have an effect on the side channel or main navigation channel. Experience shows that a slight enlargement of these notches for boat and fish passage will not change the hydraulics or sediment transport characteristics of the reach.

In the interpretation and evaluation of the results of the tests conducted, it should be remembered 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 complex physical phenomena, such as the existence of underlying rock formations or other non-erodible variables. Flood flows were not simulated in this study.

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3. Leopold, Luna B., A View of the River, Harvard University Press, Cambridge Massachusetts, London, England, 1995.

FOR MORE INFORMATION

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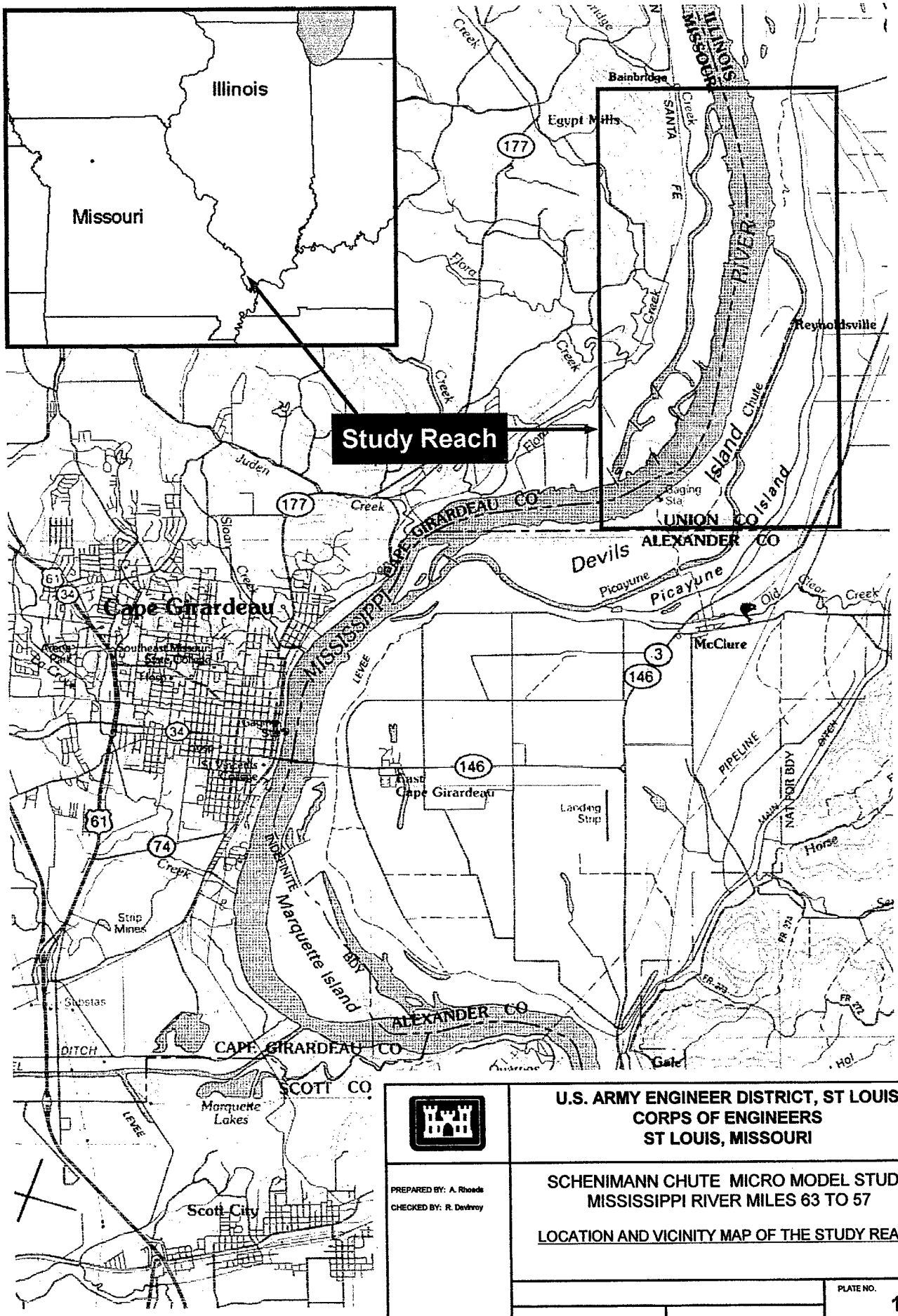
APPENDIX

Plate #'s 1 through 18 follow:

1. Location and Vicinity Map of the Study Reach
2. 1994 Aerial Photograph, Nomenclature & Characteristics of the Study Reach
3. 1880 Historic Survey Map
4. 1908 Historic Survey Map
5. 1932 and 1935 Aerial Photographs
6. 1965 Aerial Photograph
7. Field Photos
8. Field Photos
9. Schenimann Chute Micro Model
10. 1989 Prototype Survey
11. 1993 Prototype Survey
12. 1995 & 1996 Prototype Surveys
13. Micro Model Base Test
14. Alternative 1
15. Alternative 2
16. Alternative 3
17. Alternative 4
18. Design Recommendations



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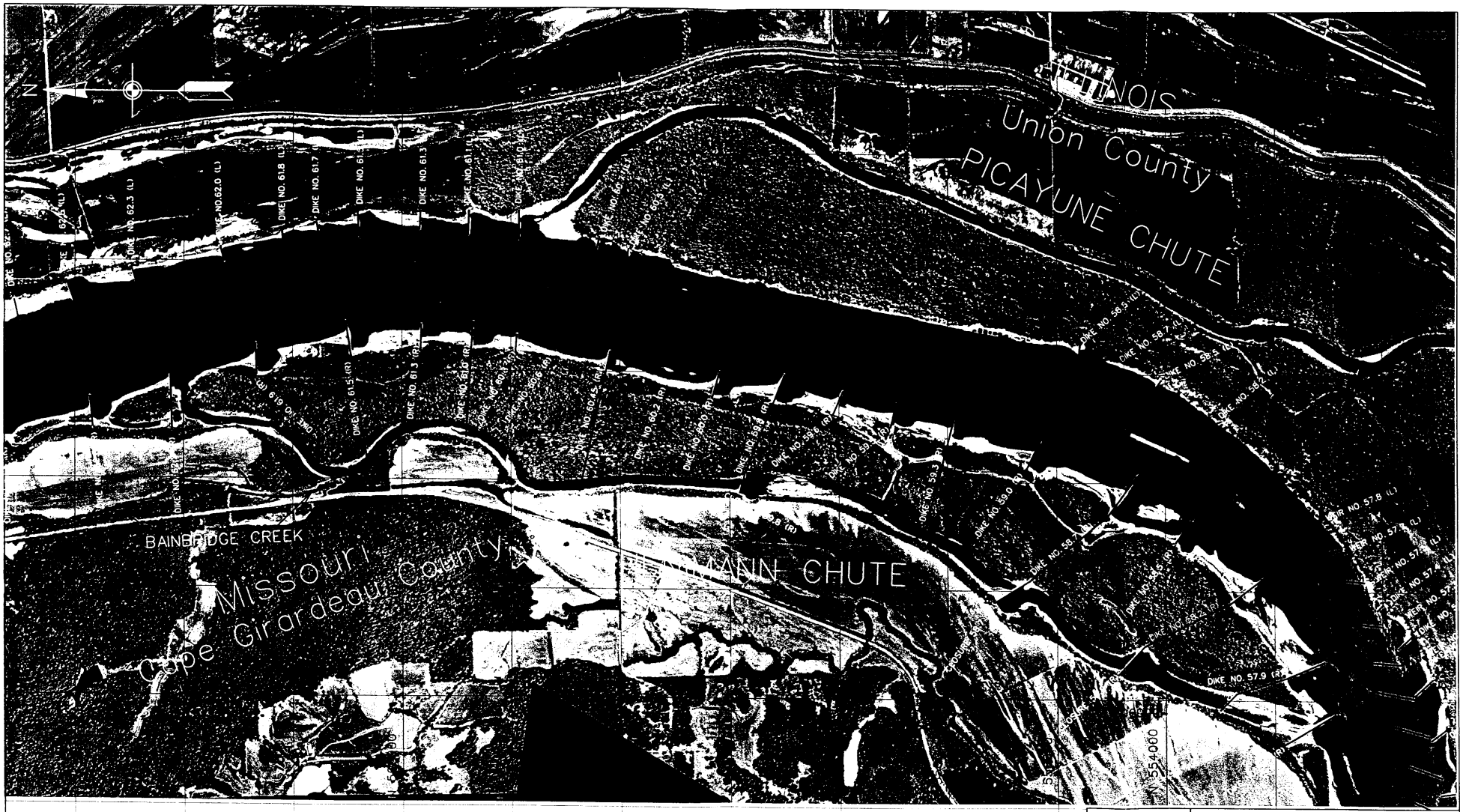
CHECKED BY: R. Devinroy

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

LOCATION AND VICINITY MAP OF THE STUDY REACH

PLATE NO. 1



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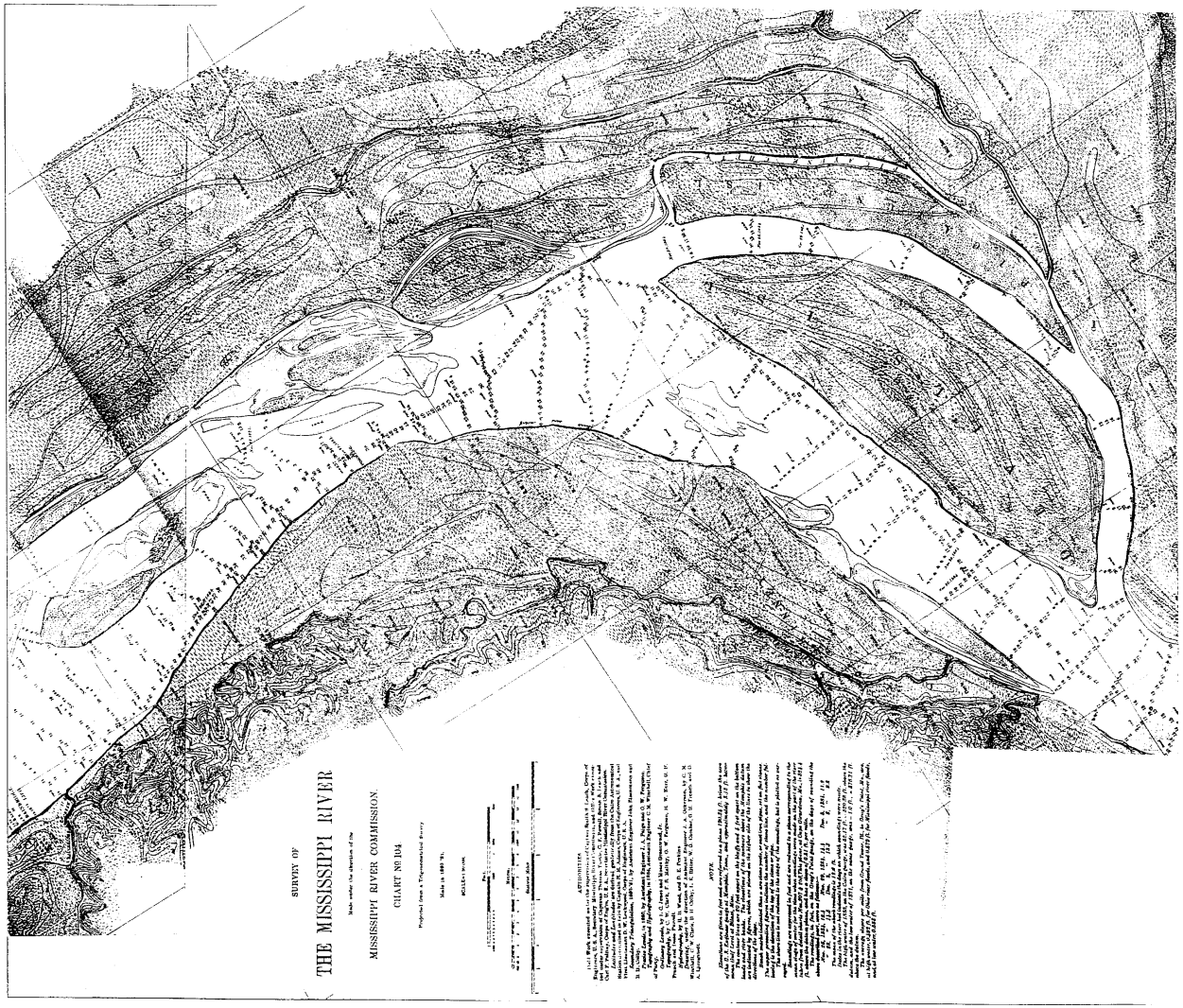
CHECKED BY: R. DAVIRROY

DATE: MAY 2000

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57
1994 AERIAL PHOTOGRAPH

1700 1275 850 425 0 850 1700

DESIGN FILE: 94aerial.dgn
PLATE NO. 2
PLOT SCALE: 1" = 1700'
PLOT DATE: 5/00



1880 Historic Survey Map of the Mississippi River

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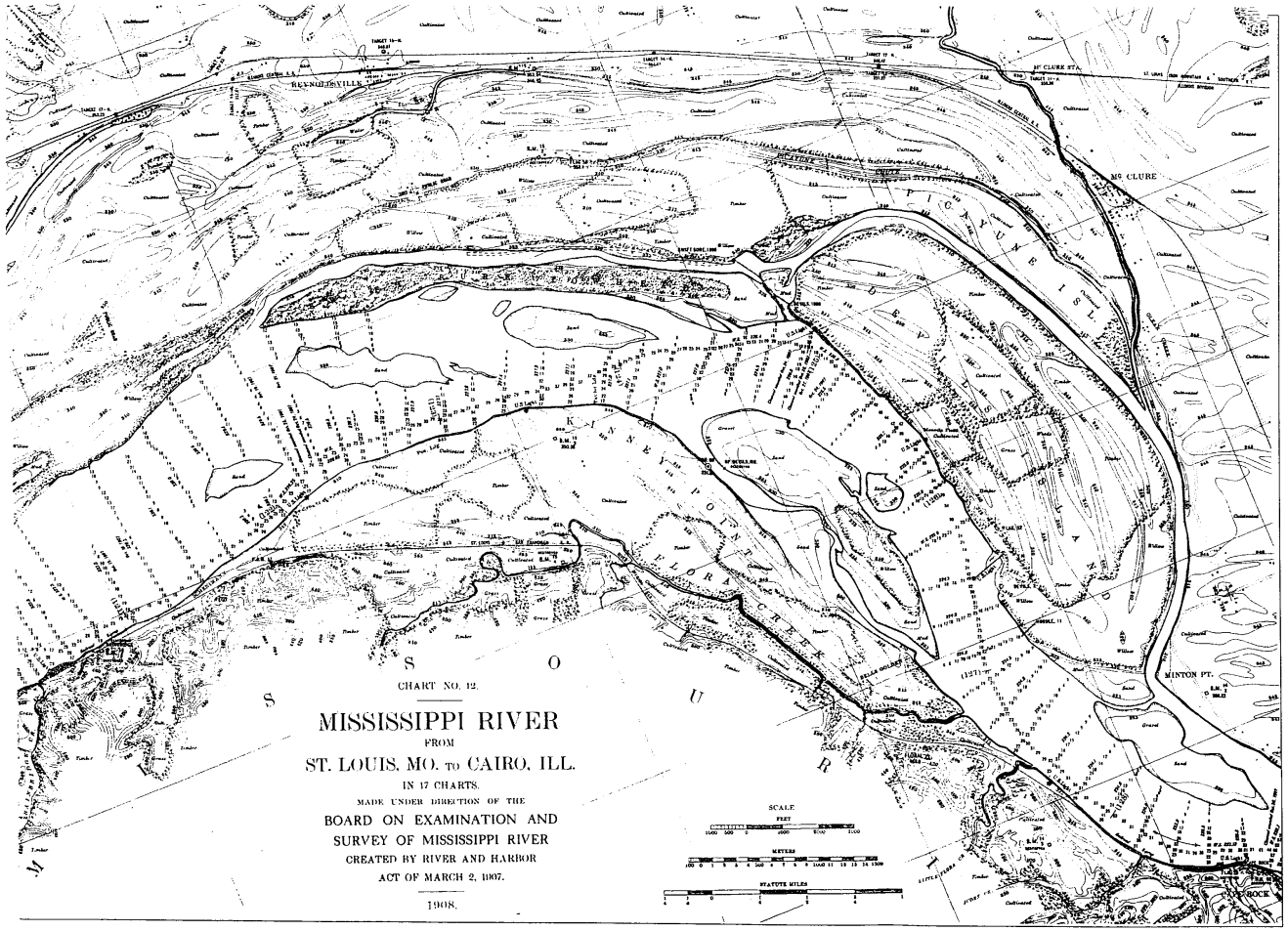
SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

1880 HISTORIC MAP

PLATE NO.
3



1908 Historic Survey Map of the Mississippi River

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PREPARED BY: D. Gordon DRAWN BY: A. Rhoads CHECKED BY: R. Dewinroy	SCHENIMANN CHUTE MICRO MODEL STUDY MISSISSIPPI RIVER MILES 63 TO 57 1908 HISTORIC MAP
	PLATE NO. 4

1932 Aerial Photograph

1935 Aerial Photograph

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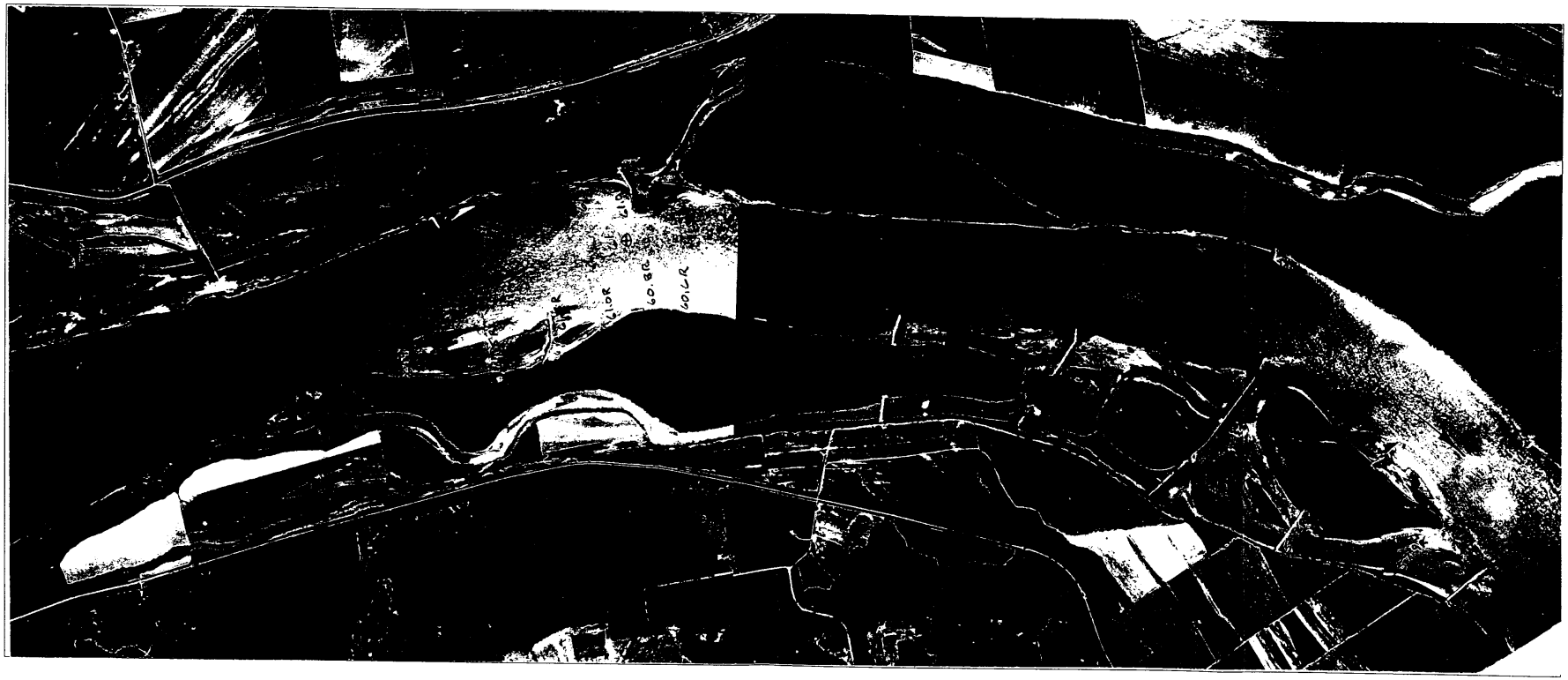
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY D Gordon
DRAWN BY A Rhoads
CHECKED BY R Dawkins

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

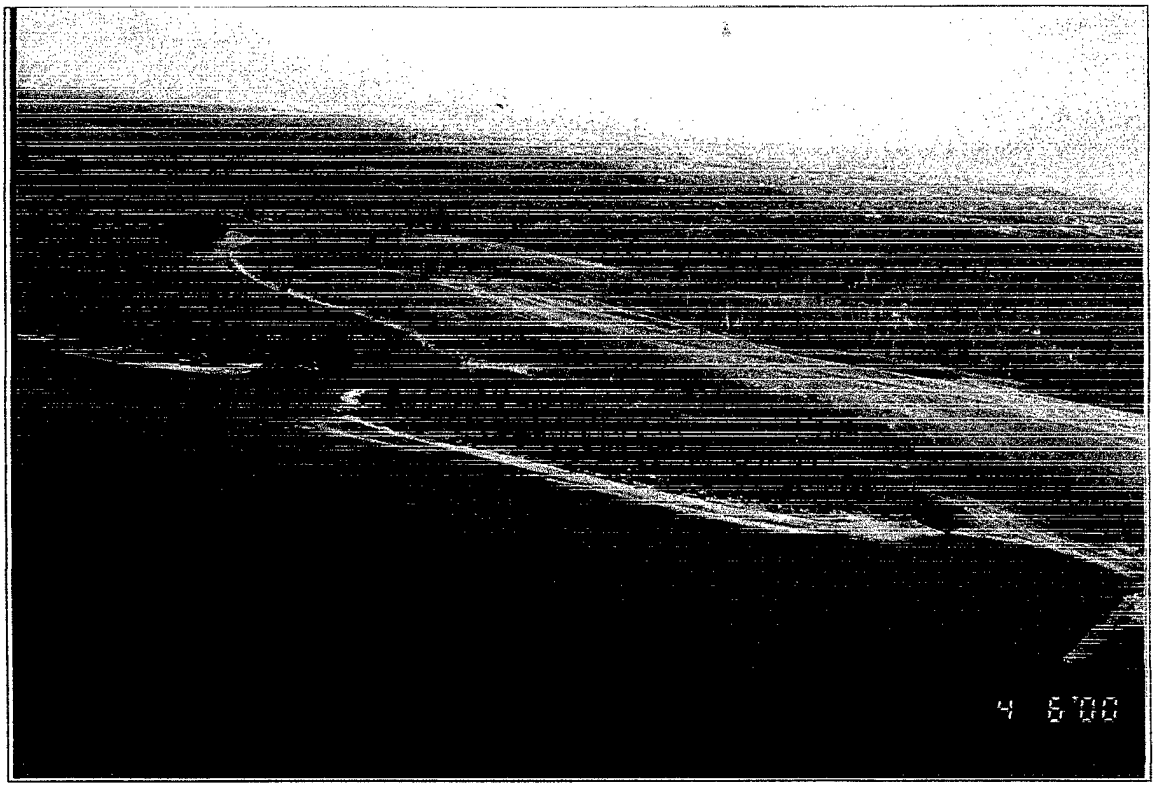
1932 AND 1935 AERIAL PHOTOGRAPHS

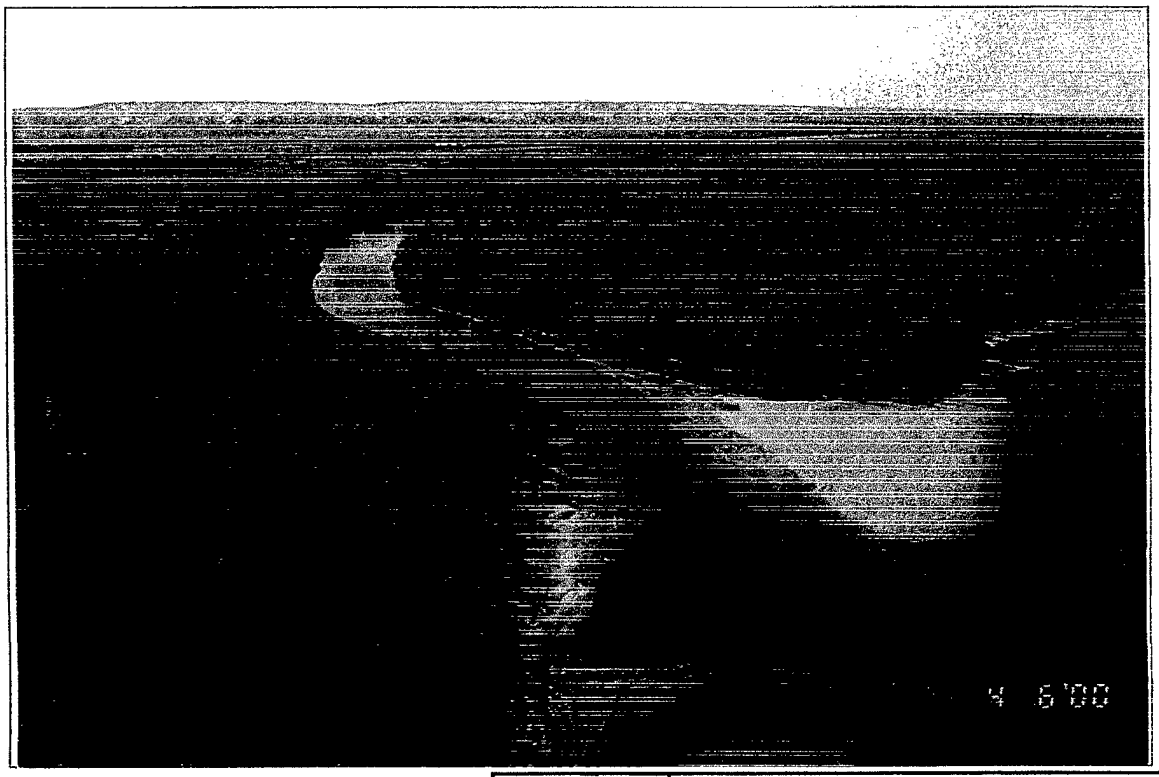
PLATE NO
5



03 August 1965 Aerial Photograph

	U.S ARMY ENGINEER DISTRICT, ST. LOUIS CORPS OF ENGINEERS ST. LOUIS, MISSOURI
PREPARED BY: D. Gordon DRAWN BY: A. Rhoads CHECKED BY: H. Devinroy	SCHENIMANN CHUTE MICRO MODEL STUDY MISSISSIPPI RIVER MILES 63 TO 57 1965 AERIAL PHOTOGRAPH
	PLATE NO. 6





Top Photograph: Upstream Entrance to Schenimann Chute (06 April 2000)

Bottom Photograph: Upstream Entrance to Picayune Chute (06 April 2000)

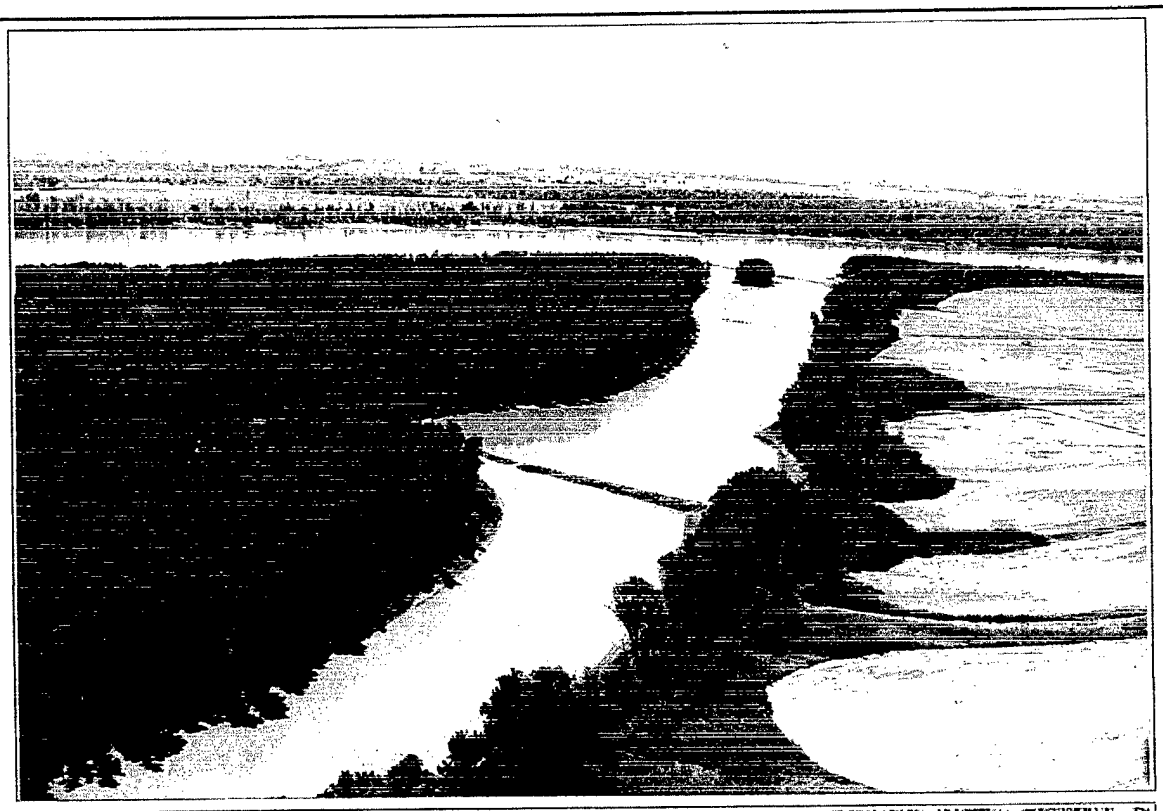
U.S. ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST LOUIS, MISSOURI

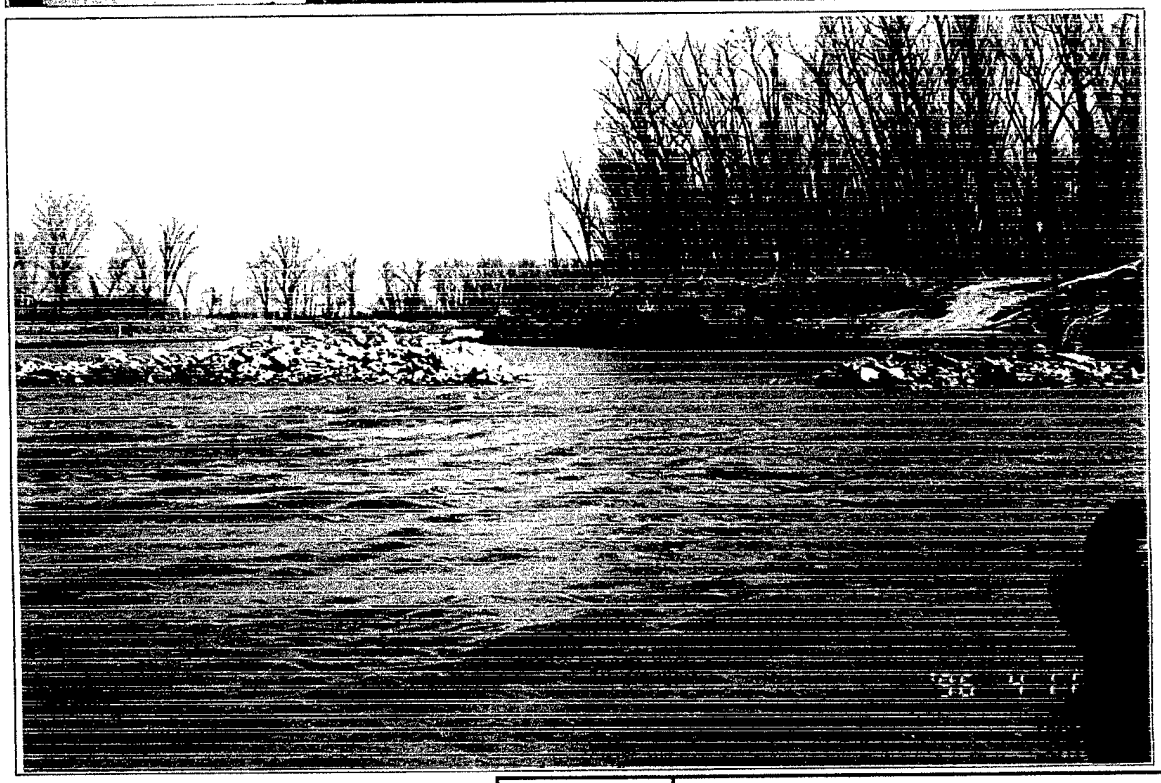
PREPARED BY: A. Rhoads
CHECKED BY: R. Davinroy

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

FIELD PHOTOGRAPHS

PLATE NO. 7





Top Photograph: Rock and Wood-Pile Closure Structures in Downstream End of Schenimann Chute (23 Sept. 1998)

Bottom Photograph: Notched Closure Structure 58.2(R) in Schenimann Chute (11 April 1996)

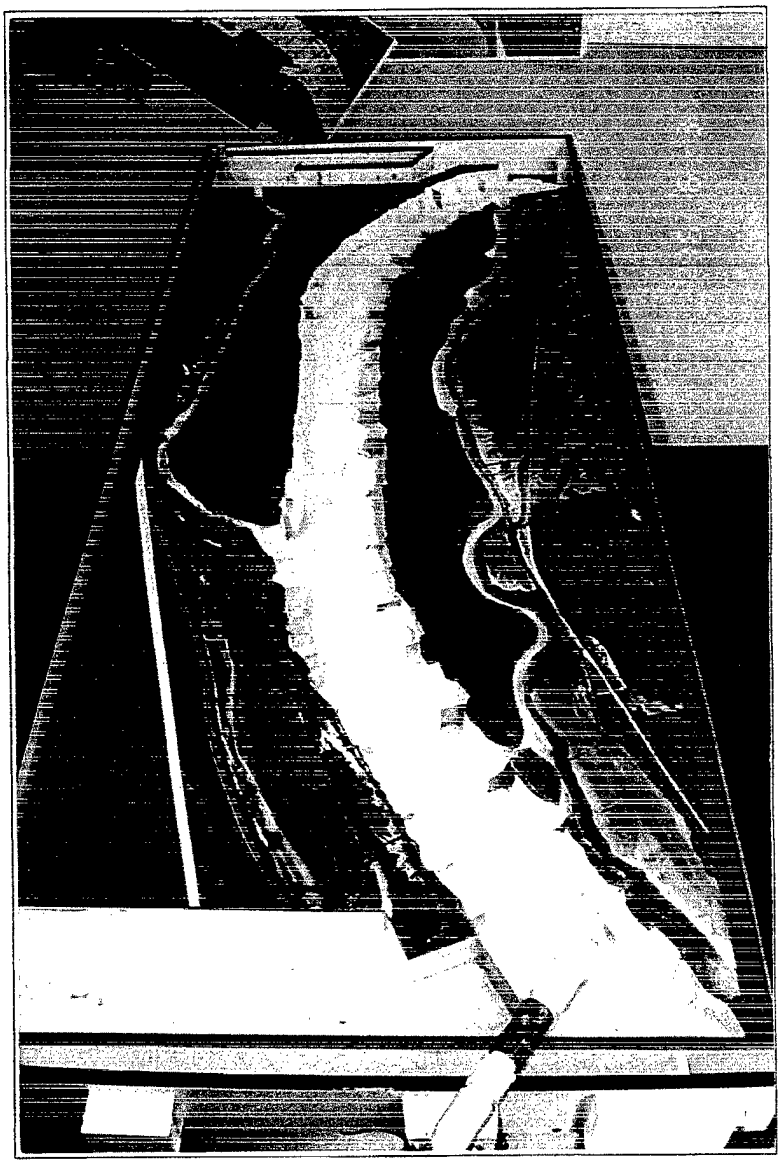
U.S. ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST LOUIS, MISSOURI

PREPARED BY: A. Rhoads
CHECKED BY: R. Davinroy

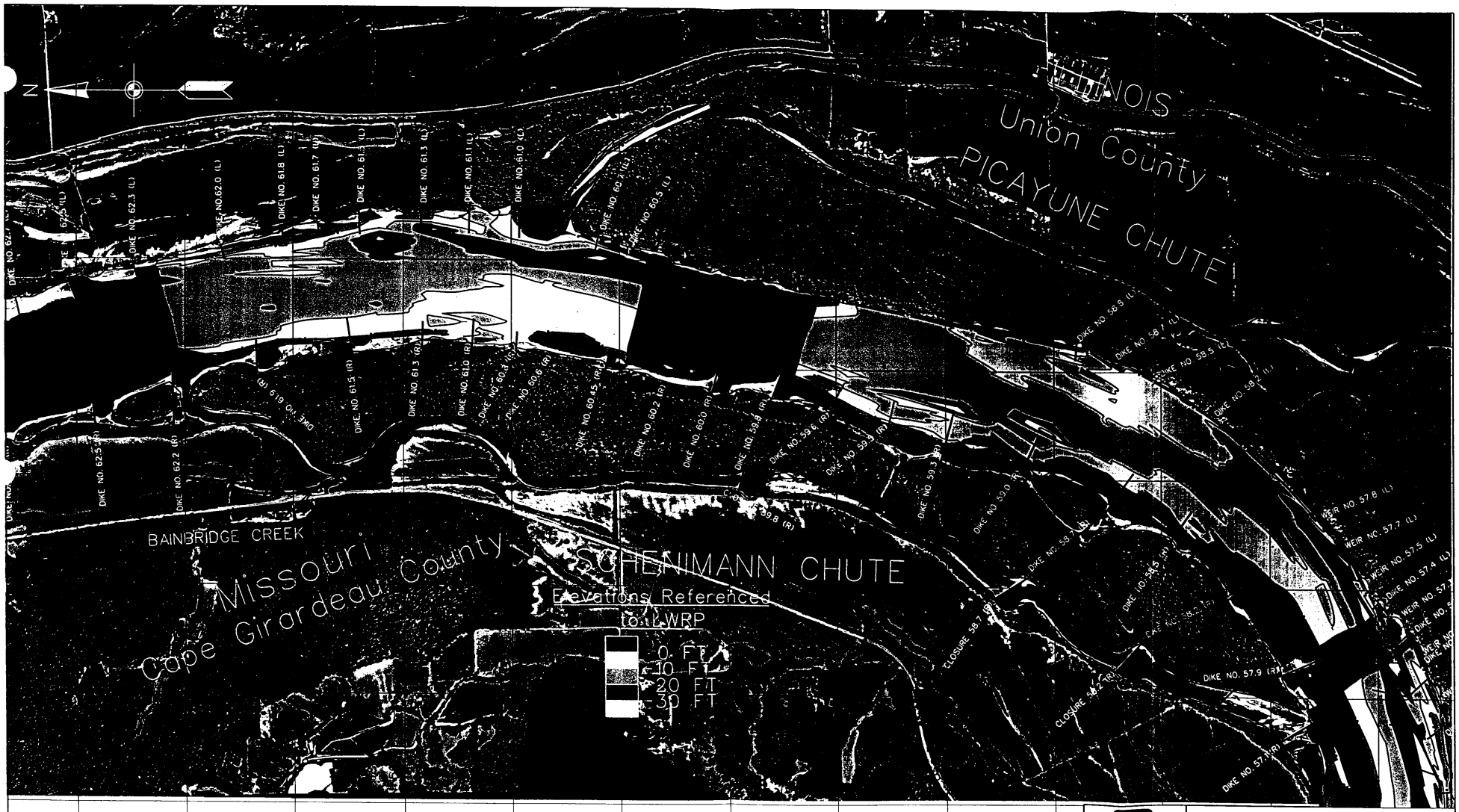
SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

FIELD PHOTOGRAPHS

PLATE NO. 8



	U.S. ARMY ENGINEER DISTRICT, ST LOUIS **CORPS OF ENGINEERS** **ST LOUIS, MISSOURI**
PREPARED BY: A. Rhoads CHECKED BY: R. Davinroy	SCHENIMANN CHUTE MICRO MODEL STUDY MISSISSIPPI RIVER MILES 63 TO 57 SCHENIMANN CHUTE MICRO MODEL
	PLATE NO. 9



PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAVINROY

DATE: MAY, 2000

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

1989 PROTOTYPE SURVEY

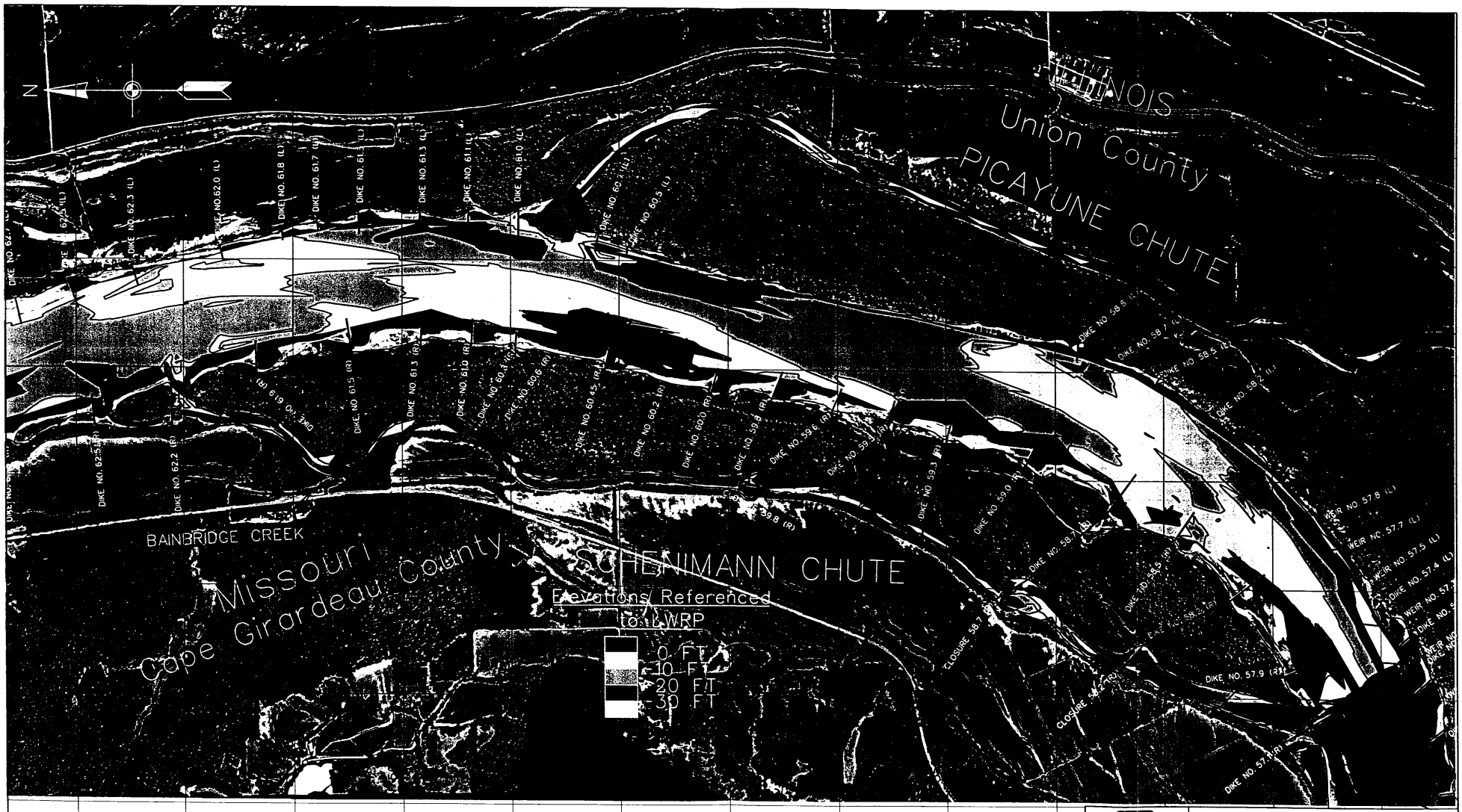
1700 1275 850 425 0 850 1700

DESIGN FILE: sh89sur.dgn

PLOT SCALE: 1" = 1700'

PLOT DATE: 5/00

PLATE NO. 10



PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAVANROY

DATE: MAY, 2000

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57
1993 PROTOTYPE SURVEY

1700 1275 850 425 0 850 1700

DESIGN FILE: dr93sur.dgn
PLOT SCALE: 1" = 1700'
PLOT DATE: 5/00

PLATE NO. 11

PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAVINROY

DATE: MAY, 2000

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

BASE TEST

1700 1275 850 425 0 850 1700

DESIGN FILE: basetest.dgn

PLOT SCALE: 1" = 1700'

PLOT DATE: 5/00

PLATE NO. 13

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAVINROY

DATE: MAY, 2000

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

ALTERNATIVE 1

1700 1275 850 425 0 850 1700

DESIGN FILE: altern1.dgn

PLOT SCALE: 1" = 1700'

PLATE NO. 14

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAVINROY

DATE: MAY, 2000

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57
ALTERNATIVE 2

1700 1275 850 425 0 850 1700

DESIGN FILE: altern2.dgn
PLOT SCALE: 1" = 1700'

PLATE NO. 15

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAVINROY

DATE: MAY, 2000

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57
ALTERNATIVE 3

1700 1275 850 425 0 850 1700

DESIGN FILE: altern3.dgn
PLOT SCALE: 1" = 1700'

PLATE NO. 16

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: D. GORDON
DRAWN BY: A. RHOADS
CHECKED BY: R. DAWNRDY

DATE: MAY, 2000

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

ALTERNATIVE 4

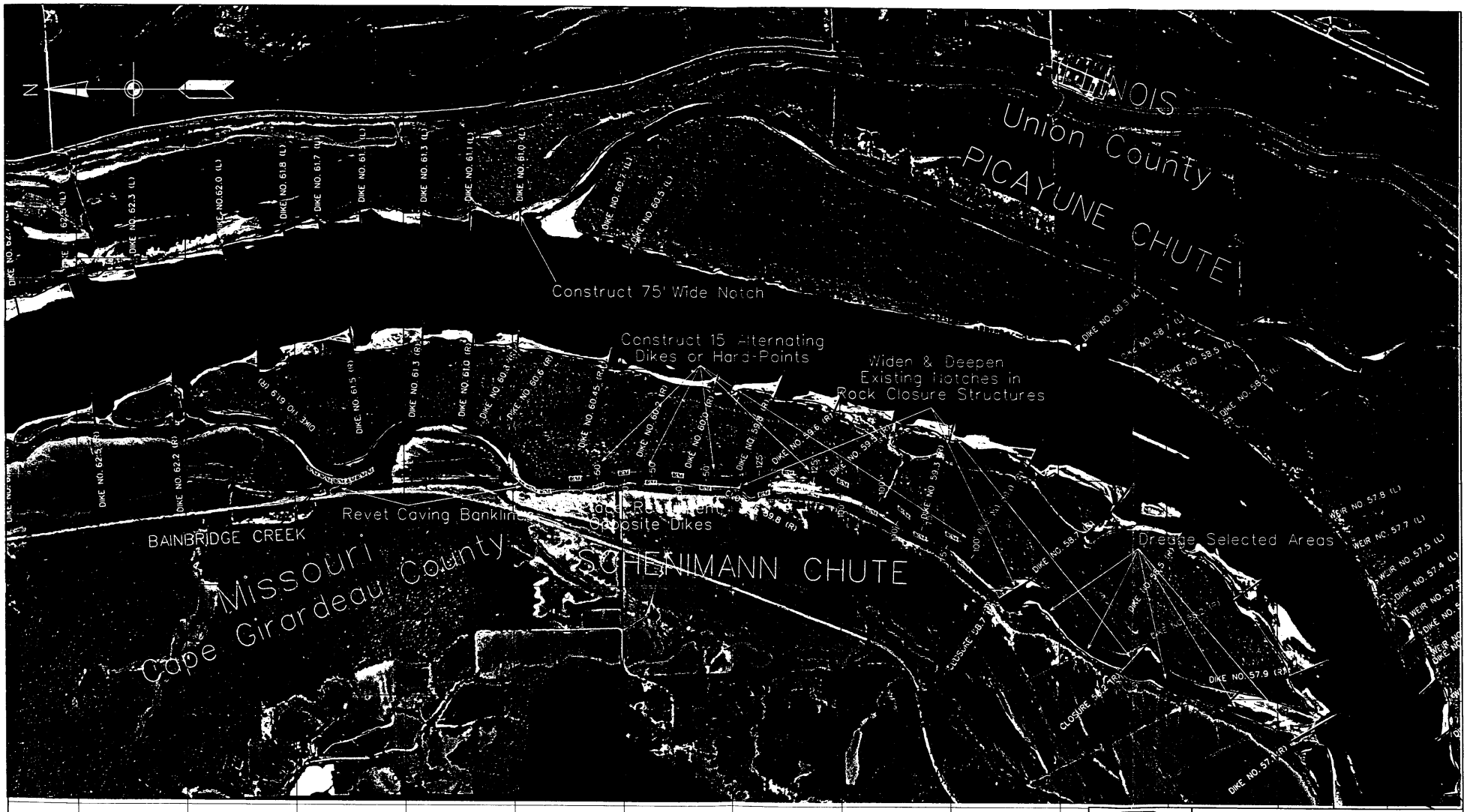
1700 1275 850 425 0 850 1700

DESIGN FILE:

PLOT SCALE: 1" = 1700'

PLOT DATE: 5/00

PLATE NO. 17



U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: D. GORDON
DRAWN BY: A. SHOADS
CHECKED BY: R. DAWNROY

DATE: MAY, 2000

SCHENIMANN CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 63 TO 57

DESIGN RECOMMENDATIONS

1700 1275 850 425 0 850 1700

DESIGN FILE:

PLOT SCALE: 1" = 1700'

PLOT DATE: 5/00

PLATE NO. 18