Technical Report M16

SEDIMENTATION STUDY OF THE MIDDLE MISSISSIPPI RIVER AT SALT LAKE CHUTE, RIVER MILES 141 TO 133

HYDRAULIC MICRO MODEL INVESTIGATION

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INTRODUCTION

A sedimentation study of the Middle Mississippi River at Salt Lake Chute between Miles 141 and 133 was initiated to examine possible environmental design modifications in the side channel. A hydraulic micro model was used to assist biologists and engineers in the evaluation of numerous design alternatives.

A physical hydraulic micro model was utilized to conduct the study during the period between September 2000 and January 2001, at the St. Louis District's Applied River Engineering Center in St. Louis, Missouri. The model study was conducted by Mr. David Gordon, Hydraulic Engineer, with the assistance of Mr. Peter Russell, civil engineering student intern, and under the direct supervision of Mr. Robert Davinroy, Director of the Applied River Engineering Center and District Potamologist for the St. Louis District. The study and report was sponsored by and prepared for the Corps of Engineers Environmental Management Program (EMP). The EMP project managers during the study included Mr. Michael Thompson, Mr. Thomas Quigley, and Mr. Michael Kruckeberg.

Other personnel from the Corps of Engineers that were involved in the study included: Mr. T. Miller, Ecologist; Mr. Brian Johnson, Fisheries Biologist; Mr. Dave Gates, Natural Resources Planner; Mr. Leonard Hopkins, Hydraulic Engineer; Mr. Steve Redington, River Engineer; Mr. Lance Engle, Dredging Operations Project Manager; and Mr. Dan Erickson, Rivers Project Area Assistant Manager.

Personnel from other agencies also involved in the study included: Mr. Butch Atwood from the Illinois Department of Natural Resources, Ms. Joyce Collins from the U.S. Fish and Wildlife Service, Mr. Tommy Seals, a river industry consultant, Mr. Wayne Williams from the Alton Barge Line, and Mr. Ed Henleben from Orgulf Transport and the River Industry Action Committee (RIAC).

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BACKGROUND

This report details the investigation of a sedimentation and environmental enhancement study of the Middle Mississippi River using a physical hydraulic micro model. Micro model methodology was used to evaluate the current sediment transport conditions in the Mississippi River at the Salt Lake Chute reach, between Miles 141 and 133. The model was also used to evaluate the sediment transport trends that could be expected to occur in both the main channel and side channel of the river from various applied channel improvement design alternatives. These alternatives were conceptualized and submitted by members of a study team representing the St. Louis District, the Missouri Department of Conservation, the Illinois Department of Natural Resources, and the U.S. Fish and Wildlife Service. The primary goal was to evaluate the impacts of these measures on the resultant bed configuration, or sediment transport response, within the study reach.

1. Study Reach

Salt Lake Chute is a side channel on the Middle Mississippi River approximately 35 miles south of St. Louis, Missouri. The chute is positioned along the Illinois bankline approximately halfway between the Missouri cities of Festus and Ste. Genevieve, and about 5 miles north of Illinois' historic Fort De Chartres. Plate 1 displays location and vicinity maps of the study reach.

The 1995 aerial photograph on Plate 2 shows the characteristics and configuration of the study reach. The entrance to Salt Lake Chute is located at Mile 139.5L while the exit to the main channel is near Mile 136.5L. The entire study encompassed an 8-mile reach of the Mississippi River from Mile 141 to 133. The chute is approximately 3 miles long and averages nearly 700 feet wide from the Illinois bank to the main island. The entrance to the chute is constricted by the smaller Durfee Bar island which is located just downstream of Dike 139.3L.

2. Problem Description

The bed configuration within Salt Lake Chute is rather homogenous, consisting mostly of sandy flat areas. The elevations of the bed within the chute are relatively high. Plates 3 and 4 show oblique aerial photos near the entrance and exit of the chute. The pictures show the elevation of the bed of the chute relative to the main channel of the river. Plates 4 and 5 show ground level photos of the chute during low flow conditions on the river when the chute is dry from bank to bank. These high bed elevations indicate that there is little to no flow of water in the side channel during periods of low flow in the river.

Biological studies have shown that side channels provide important backwater habitat for a variety of fish species. Side channel habitat provides fish a place to spawn, rear, rest, and feed. The formation of alternating bars and deep scour holes within the chute is desired to create a more diverse ecosystem within the side channel. Greater depths to maintain a continuous flow of water through the side channel at all river stages is also desired to maintain an overall healthier riverine ecosystem.

A. History of the Middle Mississippi River

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 (Strauser). 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. The fuel was needed in vast quantities for the growing number of steamboats traveling the river at the time. These impacts greatly increased the erosional rates on the river's banklines, which caused the river to unnaturally widen and subsequently deposit excessive quantities of sediment in the main river channel. The land cover of the floodplain near Salt Lake Chute in 1881 and 1908 is shown in the surveys on Plates 6 and 7. These surveys reveal that very small pockets of established forest existed along the floodplain banklines in these years. The main forested region was situated within the rock bluffs along the Missouri bank. However, the floodplain along the Illinois bank had been stripped of the majority of its natural forest that had prevented excess erosion and held the river's banklines together.

By 1881, Congress recognized that a plan of action had to be developed to ensure a dependable channel for navigation and halt the excessive erosional rates. 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 cubic feet per second (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 of approximately 3,200 feet, slightly narrower than in 1821. The following table shows that the Middle Mississippi River has been returned to more natural state (Strauser).

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

B. History of Salt Lake Chute

Plate 6 is an 1881 hydrographic, topographic, and land cover survey of the study reach. The map shows that the river had widened upstream of the present day chute location because of heavy deforestation for cropland use. By 1908 (Plate 7) the small chute shown in the 1881 survey along the right descending bank had become the main channel, and the Salt Lake Towhead had become part of the floodplain.

Plate 8 is a 1928 aerial photograph of the reach, which shows that a series of dikes had begun to constrict the river back to a more natural width as sediment collected within the new dike field. Between 1935 (Plate 9) and 1949 (Plate 10), considerable deposition occurred within the dike field. The 1959 hydrographic survey (Plate 11) shows a well-defined main island and the bathymetry indicates the bed elevations in the main channel and Salt Lake Chute were similar to those shown in recent surveys. The island and bankline configuration in the 1976 aerial photograph (Plate 12) appear very similar to the present day aerial photograph (Plate 2), although more vegetation seems to be established around the banklines in 1995.

This research of historical hydrographic surveys and aerial photography has revealed that Salt Lake Chute is a recently formed side channel. It proves that this side channel, like many others on the Middle Mississippi River, was formed as a result of the river training structures built in the early to mid 1900s. The research also revealed that deforestation led to subsequent channel widening. This created the need to design and construct numerous river-training structures, which eventually returned the river's dimensions back to more natural widths and depths. It also showed that these structures were not only responsible for constricting the river channel back to a more natural width, but for also forming the side channel at weakened structural areas within the dike field.

3. Study Purpose and Goals

The purpose of the study was to test various structural design alternatives within Salt Lake Chute and the Mississippi River main channel. The goal of the study was to create a deeper, more physically and ecologically diverse side channel while maintaining adequate navigation depths in the main channel. Typical conceptual designs that were studied included:

- Additional hard points or dikes within the side channel.
- Removal or notching of existing closing structures within the side channel.
- Removal or notching of existing dikes along the main channel border upstream and downstream of the chute's inlet and outlet.
- Additional structures designed to increase flow, scour, and sediment transport within the side channel.

MICRO MODEL DESCRIPTION

1. Scales and Bed Materials

A photograph of the Salt Lake Chute hydraulic micro model insert is shown on Plate 13. The model encompassed the Mississippi River channel between Miles 142.5 and 131.0. After entrance and exit conditions in the model were adjusted, the actual study reach was located between Miles 141.0 and 133.0. The scales of the model were 1 inch = 800 feet, or 1:9600 horizontal, and 1 inch = 50 feet, or 1:600 vertical, for a 16 to 1 distortion ratio of linear scales. This distortion supplied the necessary forces required for the simulation of sediment transport conditions similar to that of the prototype. The bed material used was granular plastic urea, Type II, with a specific gravity of 1.40.

2. Appurtenances

The micro model insert was constructed according to 1998 high-resolution color aerial photography. The insert was then mounted in a standard micro model hydraulic flume. The riverbanks of the model were constructed from dense polystyrene foam, and modified during calibration with oil-based clay. Rotational jacks located within the hydraulic flume controlled the slope of the model. The measured slope of the insert and flume was approximately 0.009 inch/inch. River training structures in the model were made of galvanized steel mesh.

Flow into the model was regulated by customized computer hardware and software interfaced with an electronic control valve and submersible pump. This interface was used to automatically control the flow of water and sediment into the model. Discharge was monitored by a magnetic flow meter interfaced with the customized computer software. Water stages were manually checked with a mechanical three-dimensional point digitizer. Resultant bed configurations were measured and recorded with a three-dimensional laser digitizer.

MICRO MODEL TESTS

1. Model Calibration

The calibration of the micro model involved the adjustment of water discharge, sediment volume, model 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. (Note: All bed elevations described in this report are referenced to the Low Water Reference Plane (LWRP). The LWRP represents a theoretical water surface elevation based upon a low flow of 54,000 cfs. The reference elevation of 0 feet LWRP is based upon the probability that this stage and flow will be exceeded 97% of the time annually.)

A. Micro Model Operation

In all model tests, a steady state flow was simulated in the Middle Mississippi River channel. This served as the average design energy response of the river. Because of the constant variation experienced in the prototype, this steady state flow was used to theoretically analyze the ultimate expected sediment response. The flow was held steady at a constant flow rate of 1.9 GPM during model calibration and for all design alternative tests. The most important factor during the modeling process is the establishment of an equilibrium condition of sediment transport. The high steady flow in the model simulated an average energy condition representative of the river's channel forming flow and sediment transport potential at bankfull stage.

B. Prototype Data and Observations

To determine the general bathymetric characteristics and sediment response trends that existed in the prototype, several present and historic hydrographic surveys were examined. Hydrographic surveys of the Mississippi River from 1989, 1993, 1995, 1996, and 1998 are shown on Plates 14, 15, 16, 17, and 18, respectively. An extremely detailed hydrographic survey was also collected within Salt Lake Chute in 1999 using sweep technology aboard the St. Louis

District's M/V Simpson. The resultant survey, shown on Plate 19, was the primary survey used to evaluate bathymetric trends within the side channel.

The surveys revealed that the bathymetric trends in the reach have remained relatively stable. The following general trends were observed in the surveys:

- At the upstream end of the study reach, between Miles 141 and 140 the thalweg was located along the right descending bank with depths between –20 and –30 feet LWRP.
- Between Miles 140.0 and 139.5, the channel crossed to the left descending bank with depths between –10 and –30 feet LWRP.
- The thalweg was located briefly along the left descending bank between Miles 139.5 and 139.0 and near the entrance to Salt Lake Chute.
- The thalweg then crossed back to the right descending bank between Miles 139.0 and 138.5 where the river began a gradual 20-degree bend to the east. Depths in the crossing ranged between –10 and –20 feet LWRP.
- Between Miles 138.5 and 137.5, depths in the thalweg were between –20 and –30 feet LWRP. A bar extended from the left descending bank at the apex of the bend with depths above –10 feet LWRP.
- Between Miles 137 and 134, the channel was straight and a well-defined thalweg was not apparent. Although some areas of local scour and deposition were apparent near the dikes along the left descending bank, overall channel depths appeared rather homogenous with depths between –10 and –20 feet LWRP.
- Near Mile 133.5 in a slight bend, the thalweg formed along the right descending bank with depths between –20 and –40 feet LWRP. A large bar was located along the left descending bank on the inside of the bend, with depths above –10 feet LWRP.

The bed elevations within Salt Lake Chute (Plate 19) were rather homogenous, consisting mostly of flat areas with depths above 0 feet LWRP. However, one significant area of scour existed in the chute just downstream of Closure Dike

138.1L. The scour hole was a small, localized deep plunge pool that reached depths of up to –30 feet LWRP. Old Maeystone creek enters Salt Lake Chute downstream of this area near Mile 137.6. Observations during times of low water revealed that when the chute becomes disconnected from the main channel, flow from the creek enters the chute and flows upstream into this area of scour.

2. Base Test

Model calibration was achieved once favorable qualitative comparisons of prototype surveys were made to several surveys of the micro model. The resultant bathymetry of this bed response served as the base test of the micro model. Plates 20 and 21 show the resultant bed configuration of the micro model base test. The base test was developed once bed stability was reached and a similar bed response was achieved as compared with prototype surveys. This survey then served as the comparative bathymetry for all design alternative tests.

Results of the micro model base test bathymetry and a comparison to the prototype surveys indicated the following trends:

- The thalweg was located along the right descending bank, between Miles 141 and 140, with depths between –20 and –40 feet LWRP that were slightly deeper than shown in the prototype.
- At Mile 140, the channel crossed to the left descending bank upstream of the entrance to the Salt Lake Chute. The crossing depths were between –10 and –20 feet LWRP.
- The thalweg was located along the left descending bank between Mile 139.8 and 139, with depths between –20 and –40 feet LWRP that were slightly deeper than shown in the prototype.
- Between Miles 139 and 138.5, the channel crossed to the right descending bank with depths between –10 and –20 feet LWRP.
- Between Miles 138.5 and 137.5, the thalweg was located along the right descending bank with depths between –20 and –40 feet LWRP that were

slightly deeper than shown in the prototype. A bar extended from the left descending bank with depths above –10 feet LWRP

- A well-defined thalweg was not present between Miles 137.5 and 134.0, as observed in the prototype surveys. Channel depths in this area appeared rather homogenous with depths between –10 and –20 feet LWRP. Depositional areas were located in the dike field along the left descending bank with depths above –10 feet LWRP. Localized scour holes were located off the ends of some of the dikes in the prototype.
- Between Miles 137.5 and 134.0 there was a slight tendency for shoaling to occur in the channel with elevations above –10 feet LWRP throughout the calibration of the model.
- At Mile 133.5 a defined thalweg became evident along the right descending bank as the channel entered the bend. Depths in the thalweg were between –20 and –40 feet LWRP.

The elevations of the side channel in the model were slightly different from those shown in the prototype. The side channel in the model had a general range of depths between –10 and +10 feet LWRP, while the side channel in the prototype had depths between 0 and +20 feet LWRP (Plate 19). Although these depths were slightly different, the general trends of the bed were similar.

In the model, Salt Lake Chute was mostly flat with depths above 0 feet LWRP, however, there were some areas with depths between 0 and –10 feet LWRP. One area where the side channel was deeper than the prototype was at the entrance of the chute, downstream of Dike 139.3L and on the Illinois side of Durfee Bar. There was another deeper area, between –10 and 0 feet LWRP, in the side channel between Dike 138.1 and 137.6. The deeper area started on the left descending bank downstream of Dike 138.1 until just upstream of Dike 137.6 when it crossed to the right descending bank. The prototype survey showed a deeper plunge pool immediately downstream of Dike 138.1 with depths that reached to –40 feet LWRP. In the model, there was a deeper area at the exit of the chute in front of the closing Dike 136.5L where the side channel re-entered the main channel.

Overall, the trends of the model as observed in the base test were similar to those observed from the prototype surveys.

3. Design Alternative Tests

A total of 19 design alternative plans were modeled tested with the intent of creating greater depths and physical environmental diversity within Salt Lake Chute without compromising depths in the navigation channel. The effectiveness of each design was evaluated by comparing the resultant bed configuration to that of the base condition. Impacts or changes induced by each alternative were evaluated by observing the sediment response of the model. A qualitative evaluation of the ramifications to the main channel and the side channel was made during team participation meetings at the Applied River Engineering Center in St. Louis, Missouri. Personnel from the Corps of Engineers, Missouri Department of Conservation, Illinois Department of Natural Resources, and the U.S. Fish and Wildlife Service carefully examined and discussed each alternative.

Alternative 1

- *Removal of the longitudinal closure structure at the side channel entrance.*

Plate 22 is a plan view contour map of the resultant bed configuration of Alternative 1. Results indicated that the removal of the closure structure had minimal effect on the bathymetry of both the chute and main channel. A localized increase in depth occurred in the area where the closure structure was removed.

Alternative 2

- *Removal of the longitudinal closure structure at the side channel entrance.*
- *Addition of 10 alternating dikes in the side channel.*

Plate 23 is a plan view contour map of the resultant bed configuration of Alternative 2. Results indicated that the addition of alternating dikes along with the removal of the closure structure had minimal effect on the bathymetry of both the chute and the main channel. A localized increase in depth occurred in the area where the closure structure was removed. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model.

Alternative 3

- *Dike 139.3L notched 400 feet wide and 20 feet deep, beginning 50 feet from the bank.*
- *Removal of the longitudinal closure structure at the side channel entrance.*
- *Addition of 10 alternating dikes in the side channel.*

Plate 24 is a plan view contour map of the resultant bed configuration of Alternative 3. Results indicated that this design had minimal effect on the bathymetry of both chute and the main channel. The notch in Dike 139.3L caused a very slight increase in depth within the chute on the Illinois side of Durfee Bar. A localized increase in depth occurred in the area where the closure structure was removed. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model.

Alternative 4

- *Dike 139.3L notched 400 feet wide and 20 feet deep, beginning 50 feet from the bank.*
- *Removal of the longitudinal closure structure at the side channel entrance.*
- *Addition of 10 alternating dikes in the side channel.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank.*

Plate 25 is a plan view contour map of the resultant bed configuration of Alternative 4. Results indicated that this design had minimal effect on the bathymetry of both chute and the main channel. The notch in Dike 139.3L caused a very slight increase in depth within the chute on the Illinois side of Durfee Bar. A localized increase in depth occurred in the area where the closure structure was removed. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 5

- *Dike 139.3L double-notched: 400 feet wide and 20 feet deep, beginning 50 feet from the bank and 500 feet wide and 20 feet deep, beginning 1200 feet from the bank.*
- *Removal of the longitudinal closure structure at the side channel entrance.*
- *Addition of 10 alternating dikes in the side channel.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank.*

Plate 26 is a plan view contour map of the resultant bed configuration of Alternative 5. Results indicated that this design had minimal effect on the bathymetry of both chute and the main channel. The notches in Dike 139.3L caused a very slight increase in depth within the chute on the Illinois side of Durfee Bar. The notches also resulted in a 20-foot depth increase immediately downstream of the structure. The additional flow introduced by the notches flowed through this area and immediately exited the chute at the location of the closure removal. A localized increase in depth occurred in the area where this structure was removed. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 6

- *Dike 139.3L double-notched: 400 feet wide and 20 feet deep, beginning 50 feet from the bank and 500 feet wide and 20 feet deep, beginning 1200 feet from the bank.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank.*

Plate 27 is a plan view contour map of the resultant bed configuration of Alternative 6. Results indicated that this design had minimal effect on the bathymetry of both chute and the main channel. The notches in Dike 139.3L caused a very slight increase in depth within the chute on the Illinois side of Durfee Bar. The notches also resulted in a depth increase immediately downstream of the dike and near the longitudinal closure structure. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The removal of the closures resulted in insignificant changes in depths throughout the chute. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 7

- *Dike 139.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*
- *Dike 139.3L double-notched: 400 feet wide and 20 feet deep, beginning 50 feet from the bank and 500 feet wide and 20 feet deep, beginning 1200 feet from the bank.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*

- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank.*

Plate 28 is a plan view contour map of the resultant bed configuration of Alternative 7. Results indicated that this design had minimal effect on the bathymetry of both chute and the main channel. The depth of the scour holes off the ends of Dikes 139.8L and 139.5L were reduced by 10 feet. A minor shoaling area appeared along the right descending bank between Miles 139.5 and 139.0. The notches in Dike 139.3L caused a very slight increase in depth within the chute on the Illinois side of Durfee Bar. The notches also resulted in a depth increase immediately downstream of the dike and near the longitudinal closure structure. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The removal of the closures resulted in insignificant changes in depths throughout the chute. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

<u>Alternative 8</u>

- *Dike 139.8L notched 300 feet wide and 20 feet deep, beginning 400 feet from the bank.*
- *Dike 139.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*
- *Dike 139.3L double-notched: 400 feet wide and 20 feet deep, beginning 50 feet from the bank and 500 feet wide and 20 feet deep, beginning 1200 feet from the bank.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank.*

Plate 29 is a plan view contour map of the resultant bed configuration of Alternative 8. Results indicated that this design had minimal effect on the bathymetry of both chute and the main channel. The depth of the scour holes off the ends of Dikes 139.8L and 139.5L were reduced by 10 to 20 feet. The notches in Dike 139.3L caused a very slight increase in depth within the chute on the Illinois side of Durfee Bar. The notches also resulted in a depth increase immediately downstream of the dike and near the longitudinal closure structure. The minor increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The removal of the closures resulted in insignificant changes in depths throughout the chute. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike. Slight increases in depth occurred throughout the chute.

Alternative 9

- *Dike 139.8L notched 300 feet wide and 20 feet deep, beginning 400 feet from the bank.*
- *Dike 139.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*

Plate 30 is a plan view contour map of the resultant bed configuration of Alternative 9. Results indicated that this design had minimal effect on the bathymetry of the main channel. Some increases in depth occurred throughout the chute. The depth of the scour holes off the ends of Dikes 139.8L and 139.5L were reduced by 10 to 20 feet. The removal of a significant portion of Dike 139.3L caused an increase in depth in the chute on the Illinois side of Durfee Bar as well as throughout the side channel. This resulted in a nearly continuous but narrow channel within the chute with depths below 0 feet LWRP. The dike removal also resulted in a depth increase immediately downstream and near the longitudinal closure structure. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 10

- *Dike 139.8 notched 300 feet wide and 20 feet deep, beginning 400 feet from the bank.*
- *Dike 139.5L removed.*
- *Dike 139.3L removed.*
- *Removal of the longitudinal closure structure at the side channel entrance.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*

Plate 31 is a plan view contour map of the resultant bed configuration of Alternative 10. The results of this test showed that the removal of Dikes 139.5L and 139.3L decreased depths in the thalweg between Miles 139.8 and 139.2. Significant scour was induced at the head of Salt Lake Island. Depths in the thalweg and crossing were increased between Miles 139.0 and 138.4. A shallow, wide point bar formed on the right descending bank between Miles 139.4 and 138.6. Some increases in depth occurred throughout the chute. The removal of Dikes 139.5L and 139.3L caused an increase in depth in the chute on the Illinois side of Durfee Bar as well as throughout the side channel. This resulted in a nearly continuous but narrow channel within the chute with depths below 0 feet LWRP. The dike removal also resulted in a depth increase at the entrance to the side channel. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

<u>Alternative 11</u>

- *Dike 139.8L notched 300 feet wide and 20 feet deep, beginning 400 feet from the bank.*
- *Dike 139.5L removed.*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*

Plate 32 is a plan view contour map of the resultant bed configuration of Alternative 11. The results of this test showed that the removal of Dike 139.5L decreased depths in the thalweg between Miles 139.8 and 139.3. Depths in the crossing were increased between Miles 139.0 and 138.4. Some increases in depth occurred throughout the chute. The total and partial removal of Dikes 139.5L and 139.3L caused an increase in depth in the chute on the Illinois side of Durfee Bar as well as throughout the side channel. This resulted in a nearly continuous but narrow channel within the chute with depths below 0 feet LWRP. The dike removal also resulted in a depth increase at the entrance to the side channel and between Durfee Bar and Salt Lake Island. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 12

- *Dike 139.8L removed.*
- *Dike 139.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank.*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*

Plate 33 is a plan view contour map of the resultant bed configuration of Alternative 12. The results of this test showed that the removal of Dike 139.8L decreased depths in the thalweg between Miles 139.8 and 139.3. Depths in the crossing were increased between Miles 139.0 and 138.4. Some increases in depth occurred throughout the chute. The total and partial removal of Dikes 139.8L and 139.3L as well as the notch in Dike 139.5L caused an increase in depth in the chute on the Illinois side of Durfee Bar as well as throughout the side channel. This resulted in a nearly continuous but narrow channel within the chute with depths below 0 feet LWRP. The dike removal also resulted in a depth increase at the entrance to the side channel and between Durfee Bar and Salt Lake Island. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in the Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 13

- *Dike 139.8L removed.*
- *Dike 139.5L removed.*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*

- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*

Plate 34 is a plan view contour map of the resultant bed configuration of Alternative 13. The results of this test showed that the removal of Dikes 139.8L and 139.5 decreased depths in the thalweg between Miles 139.8 and 139.2. A small, shallow point bar formed on the right descending bank between Miles 139.3 and 138.8. Some increases in depth occurred throughout the chute. The total and partial removal of Dikes 139.8L, 139.5L and 139.3L caused an increase in depth in the chute on the Illinois side of Durfee Bar as well as throughout the side channel. This resulted in a nearly continuous but narrow channel within the chute with depths below 0 feet LWRP. The dike removal also resulted in a depth increase at the entrance to the side channel and between Durfee Bar and Salt Lake Island. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

<u>Alternative 14</u>

- *Addition of four bendway weirs on the right descending bank between Miles 140.5 and 140.0.*
- *Dike 139.8L removed.*
- *Dike 139.5L removed.*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*

- *Dike 136.5L removed beginning from the bank to its intersection with its trail for a total of 800 feet removed.*

Plate 35 is a plan view contour map of the resultant bed configuration of Alternative 14. The results of this test showed that the bendway weirs shifted the channel thalweg towards the left descending bank between Miles 140.5 and 139.8. The removal of Dikes 139.8L and 139.5 decreased depths in the thalweg between Miles 139.6 and 139.3. Depths in the crossing were increased between Miles 139.0 and 138.6. Scour occurred near Dike 137.6L. Some increases in depth occurred throughout the chute. The total and partial removal of Dikes 139.8L, 139.5L and 139.3L caused an increase in depth in the chute on the Illinois side of Durfee Bar as well as throughout the side channel. This resulted in a nearly continuous but narrow channel within the chute with depths below 0 feet LWRP. The dike removal also resulted in a depth increase at the entrance to the side channel. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The partial removal of Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

<u>Alternative 15</u>

- *Addition of four bendway weirs on the right descending bank between Miles 140.5 and 140.0.*
- *Dike 139.8L removed.*
- *Dike 139.5L removed.*
- *Addition of two downstream angled weirs at the entrance to the chute between Miles 139.5 and Mile 139.3.*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*

- *Dike 136.5L notched 400 feet wide and 20 feet deep, beginning 200 feet from the bank*

Plate 36 is a plan view contour map of the resultant bed configuration of Alternative 15. The results of this test showed that the bendway weirs shifted the channel thalweg towards the left descending bank between Miles 140.5 and 139.8. The removal of Dikes 139.8L and 139.5 decreased depths in the thalweg between Miles 139.8 and 139.3. Depths in the thalweg and crossing were increased significantly between Miles 139.3 and 138.2. Scour occurred near Dike 137.6L. The downstream angled weirs caused significant scour at the entrance to the side channel. Depths throughout the chute remained relatively stable. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The notch in Dike 136.5L caused minor localized increases in depth along the left descending bank both upstream and downstream of the dike.

<u>Alternative 16</u>

- *Addition of four bendway weirs on the right descending bank between Miles 140.5 and 140.0.*
- *Dike 139.8L removed.*
- *Dike 139.5L removed.*
- *Addition of two downstream angled weirs at the entrance to the chute between Miles 139.5 and Mile 139.3.*
- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Addition of 10 alternating dikes in the side channel.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L removed beginning from the bank to its intersection with its trail for a total of 800 feet removed.*

Plate 37 is a plan view contour map of the resultant bed configuration of Alternative 16. The results of this test showed that the bendway weirs shifted the channel thalweg towards the left descending bank between Miles 140.5 and 139.8. The removal of Dikes 139.8L and 139.5 decreased depths in the thalweg between Miles 139.8 and 139.3. Depths in the thalweg and crossing were increased significantly between Miles 139.3 and 138.2. Scour occurred near Dike 137.6L. The downstream angled weirs caused significant scour at the entrance to the side channel. Depths throughout the chute remained relatively stable. The minor localized increases in depth near the additional dikes were caused by the physical insertion of the structures into the model. The partial removal of Dike 136.5L caused significant increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 17

- *Dike 139.8L removed.*
- *Dike 139.5L removed.*
- *Dike 139.3L removed.*
- *Removal of the longitudinal closure structure at the side channel entrance.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Dike 136.5L removed.*

Plate 38 is a plan view contour map of the resultant bed configuration of Alternative 17. The results of this test showed that the removal of Dikes 139.8L, 139.5L, and 139.3L decreased depths in the thalweg between Miles 139.8 and 139.2. A small, shallow point bar formed on the right descending bank between Miles 139.2 and 138.8. Depths in the thalweg and crossing were increased significantly between Miles 139.2 and 138.2. Scour occurred near Dikes 137.6L and 137.0L. Significant scour was generated at the entrance to the side channel and at the head of Salt Lake Island due to the removal of Dikes 139.8L, 139.5L, and 139.3L. This also resulted in an increase in depth in the chute on the Illinois side of Durfee Bar as well as between Durfee Bar and Salt Lake Island. Depths throughout the remainder of the side channel decreased slightly due to additional deposition. The removal of Dike 136.5L caused significant increases in depth along the left descending bank both upstream and downstream of the dike.

Alternative 18

- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Artificially dredged the side channel to maximum depths greater than –10 feet LWRP.*

Plate 39 is a plan view contour map of the initial dredged bed configuration of Alternative 18. Plate 40 is a plan view contour map of the resultant bed configuration of Alternative 18. The results of this test show deposition within the artificial dredge cut in the side channel. The downstream portion of the chute appeared to shoal more rapidly than the upper portion. The time scale for deposition of sediment back to the original elevations in the chute is unknown.

Alternative 19

- *Dike 139.3L removed beginning from the bank to its intersection with the longitudinal closure structure for a total of 1300 feet removed.*
- *Removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L.*
- *Artificially dredged the side channel to maximum depths greater than –10 feet LWRP.*
- *Removed Dike 136.5L.*

Plate 41 is a plan view contour map of the initial dredged bed configuration of Alternative 18. Plate 42 is a plan view contour map of the resultant bed configuration of Alternative 18. The results of this test show deposition within the artificial dredge cut in the side channel. The time scale for deposition of sediment back to the original elevations in the chute is unknown. The removal of Dike 136.5L caused significant increases in depth along the left descending bank both upstream and downstream of the dike.

CONCLUSIONS

The following is a summary of the findings and recommendations of the Salt Lake Chute Micro Model Study.

1. Evaluation and Summary of the Model Tests

Numerous design combinations were implemented in the micro model to assess structures or structural modifications that may manipulate the sediment transport mechanics within the side channel to generate bed forms conducive to increased habitat. The goal was to define methods of increasing flows and sediment transport in the side channel while also creating greater depths. These methods can be analyzed under 8 categories:

1. Notches in existing dikes
2. Partial removal of existing dikes
3. Removal of existing dikes
4. Addition of hard points in the side channel
5. Removal of existing closure structures in the side channel
6. Addition of bendway weirs upstream of the side channel
7. Addition of downstream angled weirs upstream of the side channel
8. Artificial dredging of the side channel

Although these methods were mostly implemented in combination with one another, observations of the bathymetric response generated by each is summarized below:

1. *Notches in Existing Dikes:* The notches implemented in Dikes 139.8L, 139.5L, 139.3L, and 136.5L in Alternatives 3 through 13 and Alternative 15, generated mainly insignificant effects on the bathymetry of the main channel. Numerous combinations of these notches increased depths in the side channel.

2. *Partial Removal of Existing Dikes:* The partial removal of Dikes 139.3L and 136.5L in Alternatives 9, 11, 12, 13, 14, 15, 16, and 19 did not significantly effect the bathymetry of the main channel. However, the partial removal of Dike 139.3L in each of these Alternatives increased depths in the side channel along with other structural combinations. The partial removal of Dike 136.5L in Alternatives 14 and 16 increased depths near the structure. Significant localized increases in depth were noticed in Alternative 16.
3. *Removal of Existing Dikes:* The removal of Dikes 139.8L, 139.5L, 139.3L, and 136.5L in Alternatives 10 through 17 and Alternative 19 had varying effects on the bathymetry of the main channel. It was evident that Dike 139.3L is crucial for maintaining adequate navigation depths and alignment through the reach. Total removal of this structure along with removal of the longitudinal closure structure in Alternatives 10 and 17 adversely affected the main channel. The removal of the longitudinal closure structure without the total removal of Dike 139.3L in Alternatives 1 through 5 did not change the bathymetry of the main channel or the chute.
4. *Addition of Hard Points:* The addition of 10 alternating hard points or dikes within the side channel in Alternatives 2 through 16 did not have a significant effect on the bathymetry in the main channel or the chute. The minor localized increases in depth shown in each alternative's bathymetry near the hard points were caused by the physical insertion of the structures into the model.
5. *Removal of Existing Closure Structures:* The removal of the existing closure structures in the side channel in Alternatives 6 through 19 did not show a significant effect on the bathymetry in the main channel. Depths in the side channel may have increased slightly due to the removal of the structures in combination with other structural modifications such as dike notching and removal.
6. *Addition of Bendway Weirs:* The addition of bendway weirs upstream of the side channel entrance in Alternatives 14, 15, and 16 shifted the thalweg of the main channel towards the left descending bank between Miles 140.5 and

139.8. Although the weirs forced more flow towards the side channel entrance, depth improvements within the chute were not realized.

7. *<u>Addition of Downstream Angled Weirs:</u>* The addition of downstream angled weirs upstream of the side channel entrance in Alternatives 15 and 16 had a significant effect on the bathymetry of the main channel. Additional scour and turbulence resulted at the entrance to the side channel and the alignment of the main channel changed. An area of significant scour occurred at the head of Durfee Bar but increased depths were not realized throughout the remainder of the chute.
8. *<u>Artificial Dredging:</u>* Artificial dredging of the side channel in Alternatives 18 and 19 did not affect the bathymetry of the main channel. The model showed that the chute would eventually incur deposition up to the original elevations. Structural modifications would not allow the side channel to self maintain the artificial depths indefinitely.

The table below shows the structural modifications implemented in each design alternative.

	Alternative #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Bendway Weirs														X	X	X			
Dike 139.8L	Notched								X	X	X	X								
	Removed												X	X	X	X	X	X		
Dike 139.5L	Notched							X	X	X			X							
	Removed										X	X		X	X	X	X	X		
Dike 139.3L	Single Notched			X	X															
	Double Notched					X	X	X	X											
	Partially Removed									X		X	X	X	X	X	X			X
	Removed										X							X		
	DS Angle Weirs															X	X			
	Long. Closure Removed	X	X	X	X	X					X							X		
	Chute Closures Removed						X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Alternating Dikes		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
	Chute Dredged																		X	X
Dike 136.5L	Notched				X	X	X	X	X	X	X	X	X	X		X				
	Partially Removed														X		X			
	Removed																	X		X

2. Recommendations

The following are recommendations for each of the 8 methods described previously.

1. *Notches in Existing Dikes:* Single notches implemented in Dikes 139.8L and 139.5L in combination with a double notch or partial removal of Dike 139.3L generated increased flow and depth in the side channel. A notch in Dike 136.5L created minor localized increases in depth. Construction of notches in these dikes is recommended.
2. *Partial Removal of Existing Dikes:* The partial removal of Dikes 139.3L and 136.5L increased depths in the side channel slightly greater than notching the same dikes. Since depths or alignment were not compromised in the main channel, partial removal of these structures is recommended. However, the ends of these structures must remain because they are crucial for maintaining the navigation channel
3. *Removal of Existing Dikes:* Although the removal of Dikes 139.8L, 139.5L, 139.3L, and 136.5L resulted in increased depths in the side channel, there was not an improvement as compared to the notching or partial removal of the same dikes. In some instances, the removal of these dikes tended to adversely affect the depths and alignment in the main channel. The removal of the longitudinal closure structure did not affect depths in the main channel or the chute. Removal of these dikes is not recommended.
4. *Addition of Hard Points:* The addition of 10 alternating hard points or dikes did not increase depths within the side channel in combination within other structural modifications. Therefore, construction of these structures is not recommended.
5. *Removal of Existing Closure Structures:* The removal of the closure structures did not adversely affect the main channel while depths in the side channel may have increased slightly. Therefore, removal of these structures is recommended.

6. *<u>Addition of Bendway Weirs:</u>* The bendway weirs upstream of the side channel entrance shifted the main channel thalweg towards the left descending bank. Construction is not recommended since these structures did not increase flow or sediment transport within the chute.
7. *<u>Addition of Downstream Angled Weirs:</u>* The downstream angled weirs upstream of the side channel entrance adversely affected the bathymetry and alignment of the main channel. Although scour occurred at the entrance to the side channel, depths were not increased throughout the remainder of the chute. Construction of these structures is not recommended.
8. *<u>Artificial Dredging:</u>* Artificial dredging of the side channel was tested in the model to examine if and how the sediments redeposit in the chute. It was determined that a deep dredge would not be self-maintaining. Deposition would eventually occur beginning mainly at the downstream end of the chute where backwater from the main channel tends to slow the velocities. A time scale for the re-deposition to occur is not known.

The following is the final recommendation for increasing depths and improving habitat diversity in Salt Lake Chute. These recommendations are similar to the design implemented in Alternative 9.

- A notch placed in Dike 139.8L, 300 feet wide and 20 feet deep, beginning 400 feet from the bank.
- A notch placed in Dike 139.5L, 400 feet wide and 20 feet deep, beginning 200 feet from the bank.
- Partial removal of Dike 139.3L beginning at the bank and ending at its intersection with the longitudinal closure structure for a total of 1300 feet removed. Although the double notches resulted in increased depth in the side channel comparable with partial removal of the dike, partial removal would have a slightly greater affect on increasing depths at the entrance to the chute.
- Total or partial removal of closure structures 139.0L, 138.45L, 138.1L, 137.6L, 137.0L, and 136.8L. Large notches in these structures may have

the same results as total removal. Many of the existing closure dikes may be currently buried and ineffective. Closure Dike 138.1L has formed a large, deep plunge pool directly downstream of the structure. Modifications to this structure should be kept to a minimum to maintain the size and depth of this area.

- Partial removal of Dike 136.5L beginning at the bank and ending 500 feet from the bank. Removal of this dike from the bank to its trail would render this structure completely ineffective. Therefore, only 500 feet should be removed rather than the 800-foot removal tested in the micro model.

3. Interpretation of Model Test Results

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.

This model study was intended to serve as a tool for the river engineer to guide in assessing the general trends that could be expected to occur in the actual river from a variety of imposed design alternatives. Measures for the final design may be modified based upon engineering knowledge and experience, real estate and construction considerations, economic and environmental impacts, or any other special requirements.

FOR MORE INFORMATION

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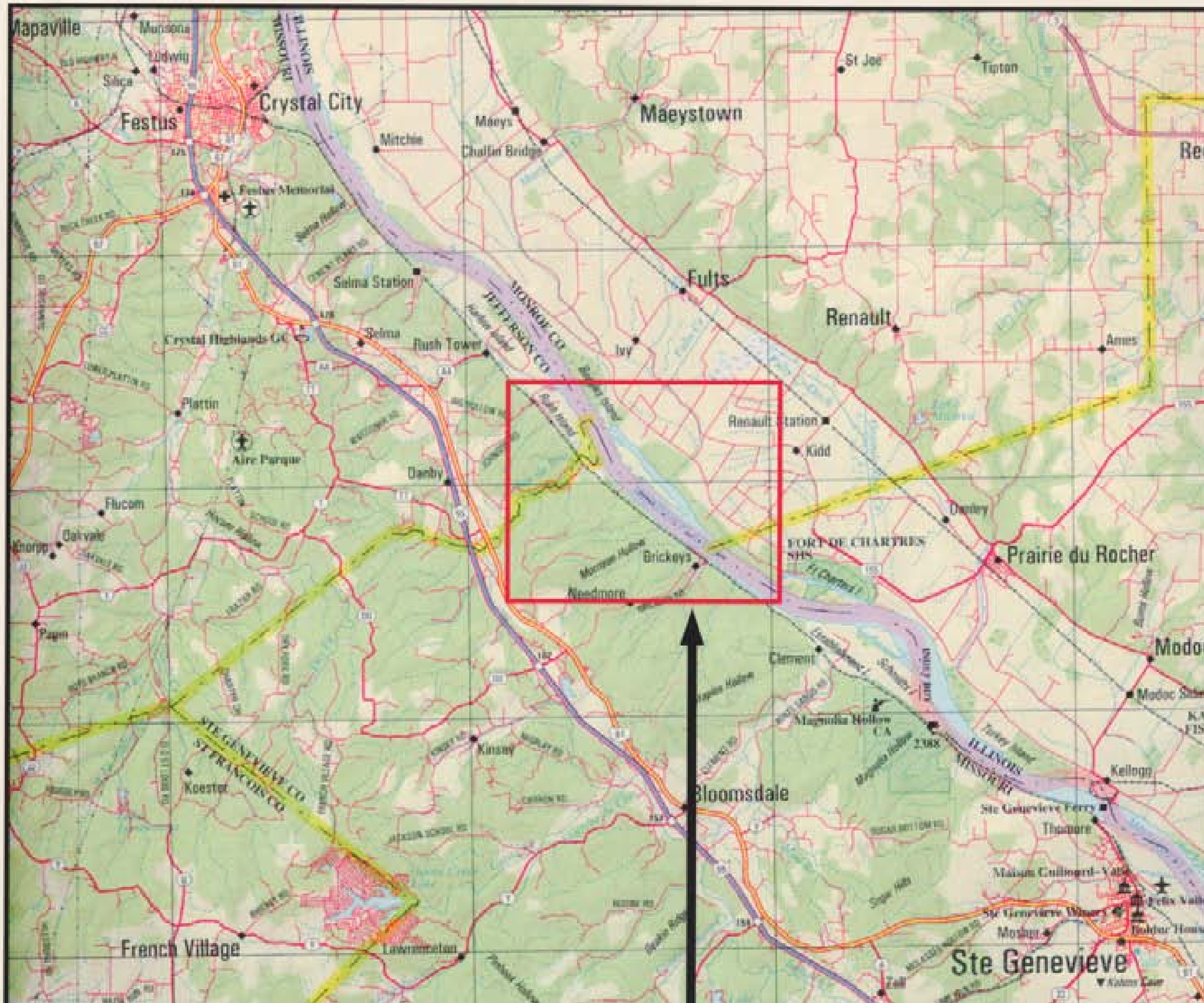
Or you can visit us on the World Wide Web at:

http://www.mvs.usace.army.mil/engr/river/river.htm

APPENDIX OF PLATES

Plate Numbers 1 through 42 follow:

27. Alternative 6
28. Alternative 7
29. Alternative 8
30. Alternative 9
31. Alternative 10
32. Alternative 11
33. Alternative 12
34. Alternative 13
35. Alternative 14
36. Alternative 15
37. Alternative 16
38. Alternative 17
39. Alternative 18 – Phase 1
40. Alternative 18 – Phase 2
41. Alternative 19 – Phase 1
42. Alternative 19 – Phase 2



Study Reach

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

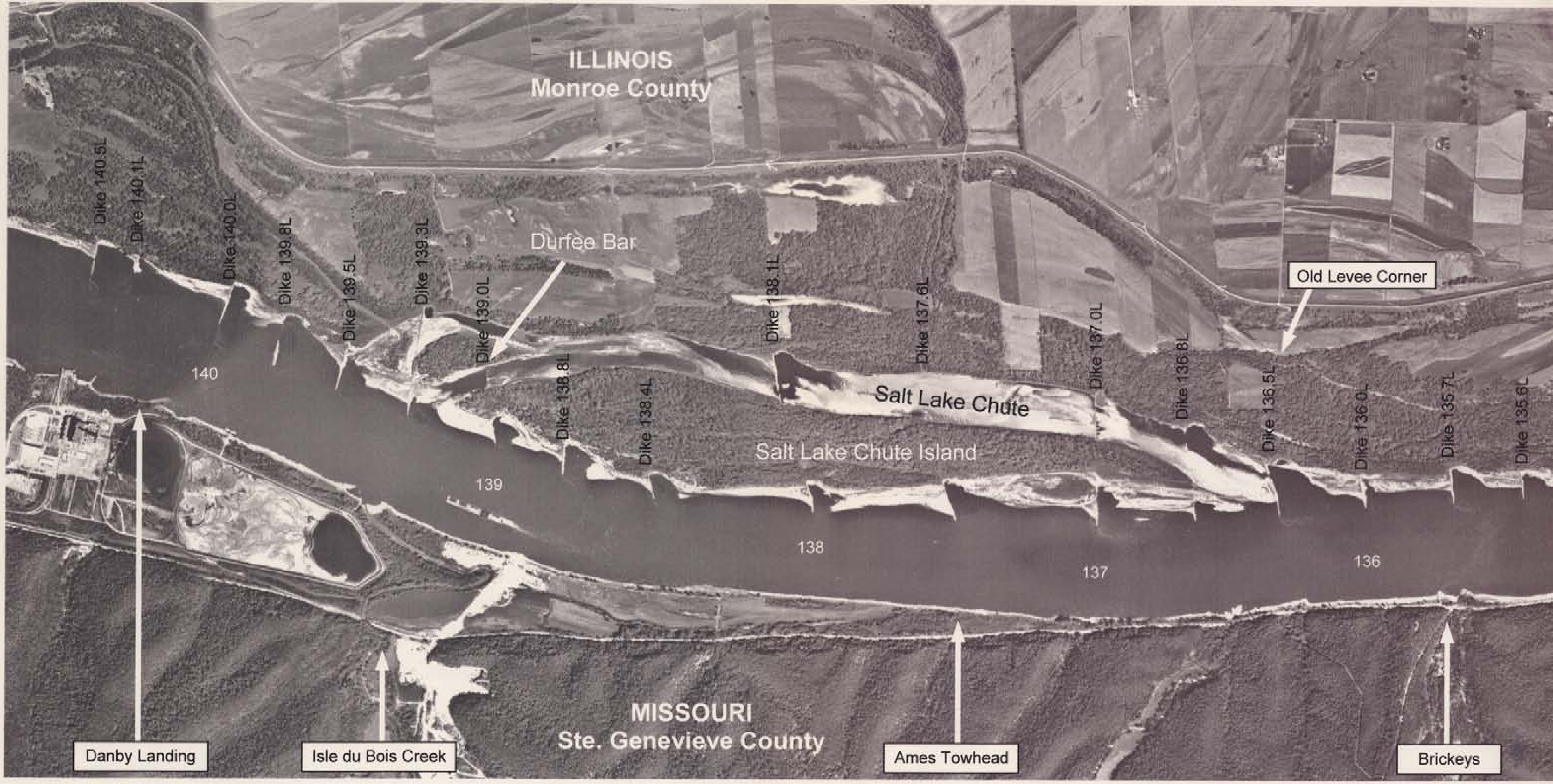
PREPARED BY: P. Russell
CHECKED BY: D. Gordon

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

LOCATION AND VICINITY MAP OF THE STUDY REACH

FILE NAME: LOCATION.PUB

PLATE NO. 1



N

1995 Aerial Photograph

	U.S ARMY ENGINEER DISTRICT, ST. LOUIS CORPS OF ENGINEERS ST. LOUIS, MISSOURI
PREPARED BY: P. Russell CHECKED BY: D. Gordon	SALT LAKE CHUTE MICRO MODEL STUDY MISSISSIPPI RIVER MILES 141 TO 133 1995 AERIAL PHOTOGRAPH OF THE STUDY REACH
	FILE NAME: 1995AERIAL.PUB — PLATE NO. 2

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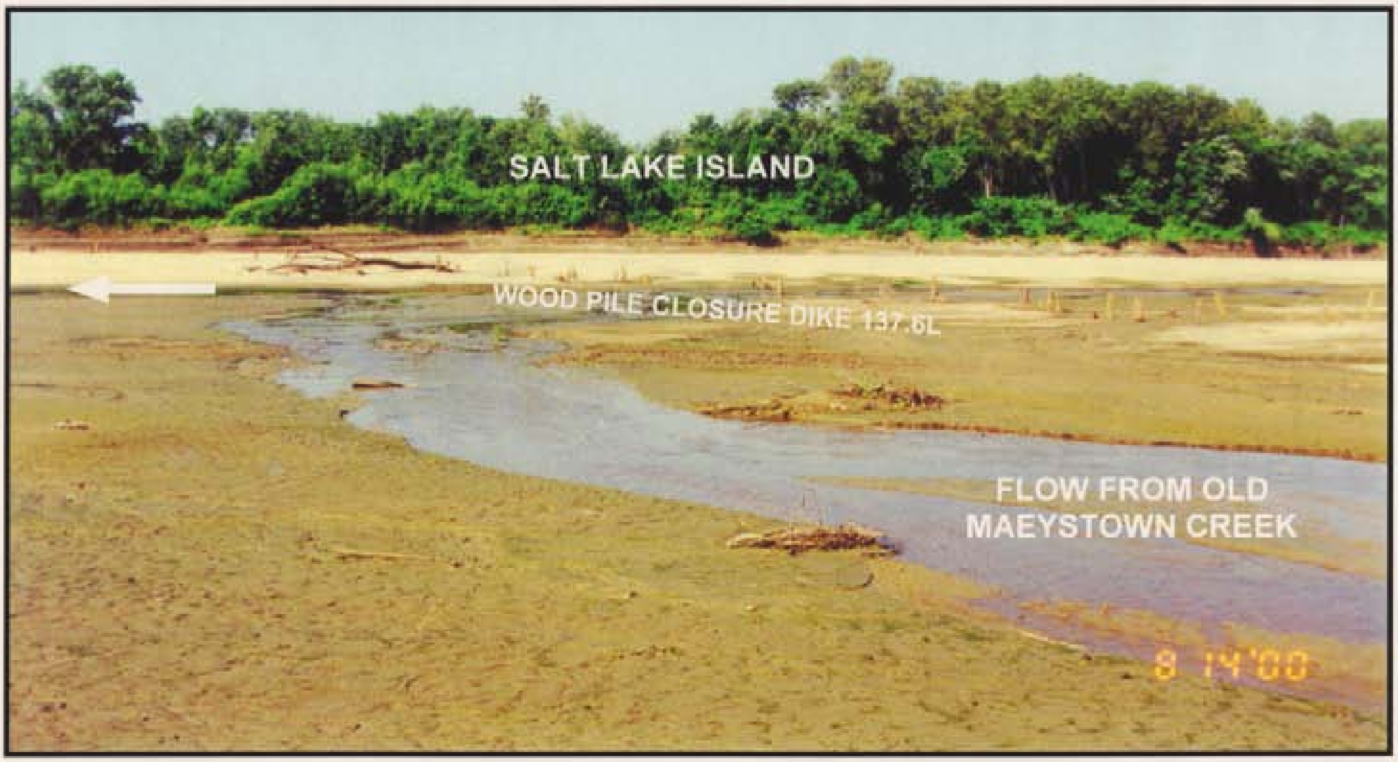
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

UPSTREAM PHOTOS OF SALT LAKE CHUTE

FILE NAME: PHOTOS.PUB

PLATE NO. 3



TOP PHOTO: Downstream View of Salt Lake Chute

BOTTOM PHOTO: Interior Photo of Salt Lake Chute

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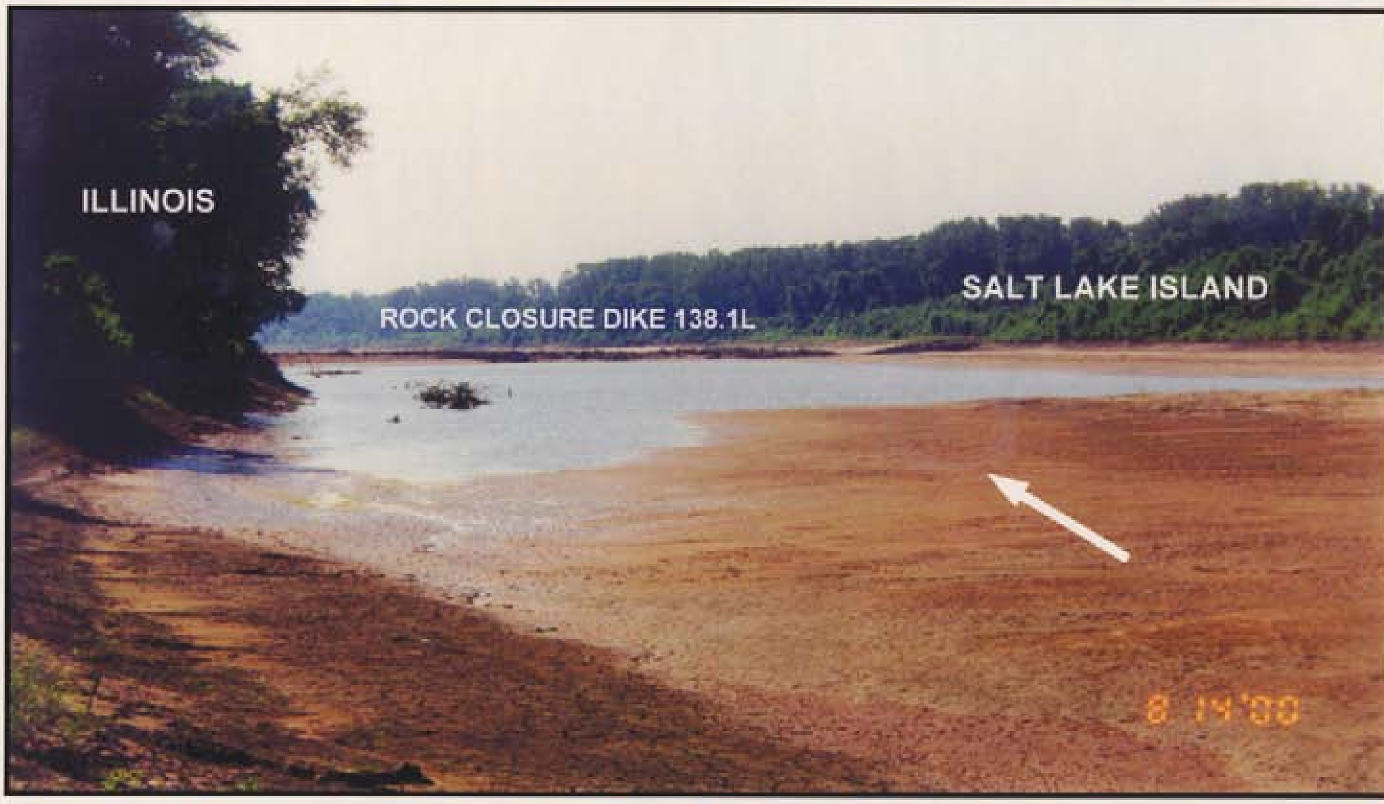
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

PHOTOS OF SALT LAKE CHUTE

FILE NAME: PHOTOS.PUB

PLATE NO. 4



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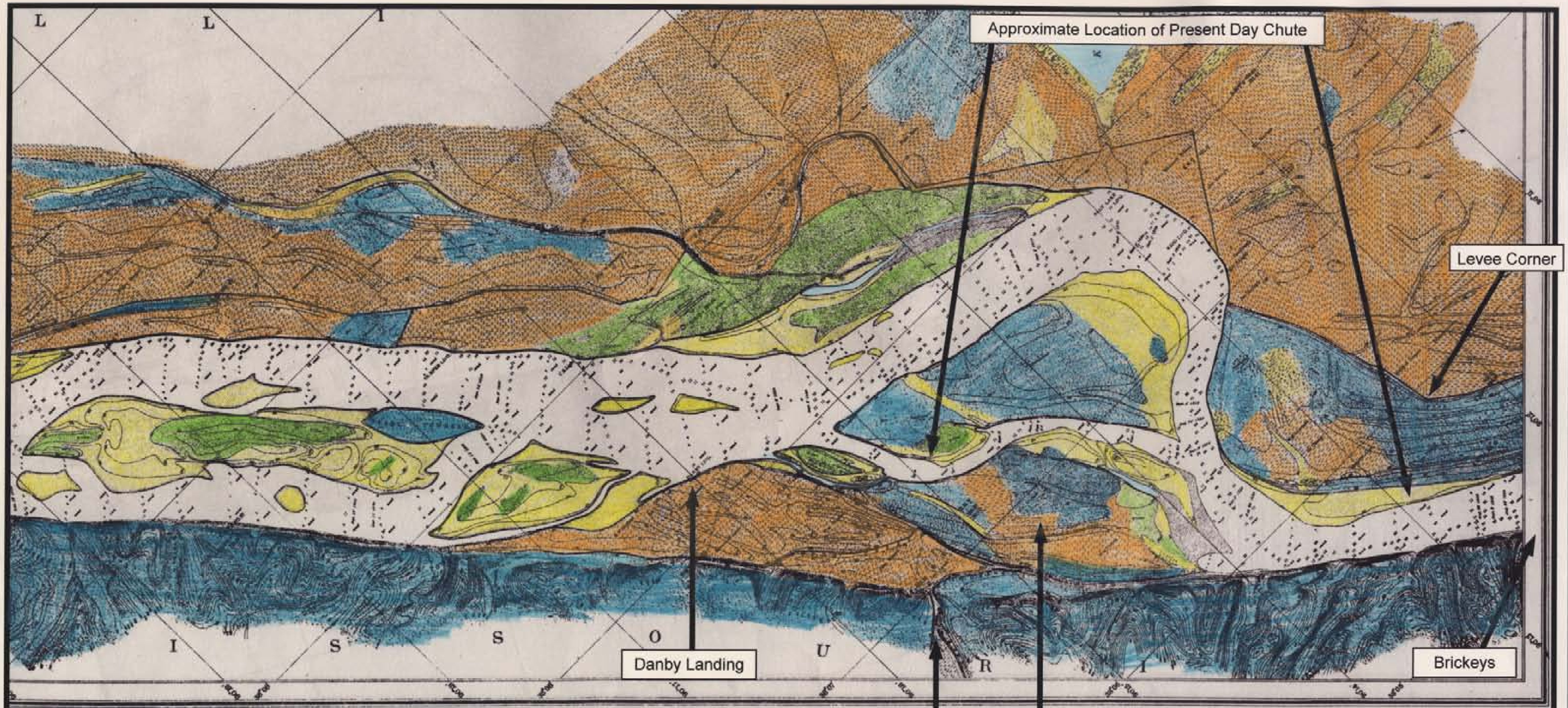
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

INTERIOR PHOTOS OF SALT LAKE CHUTE

FILE NAME: PHOTOS.PUB

PLATE NO. 5



Water Pockets
Sand
Wetland/Mud
Willows
Timber
Cropland

N

1881 Topographic and Hydrographic Survey
With Color-Coded Land Usage

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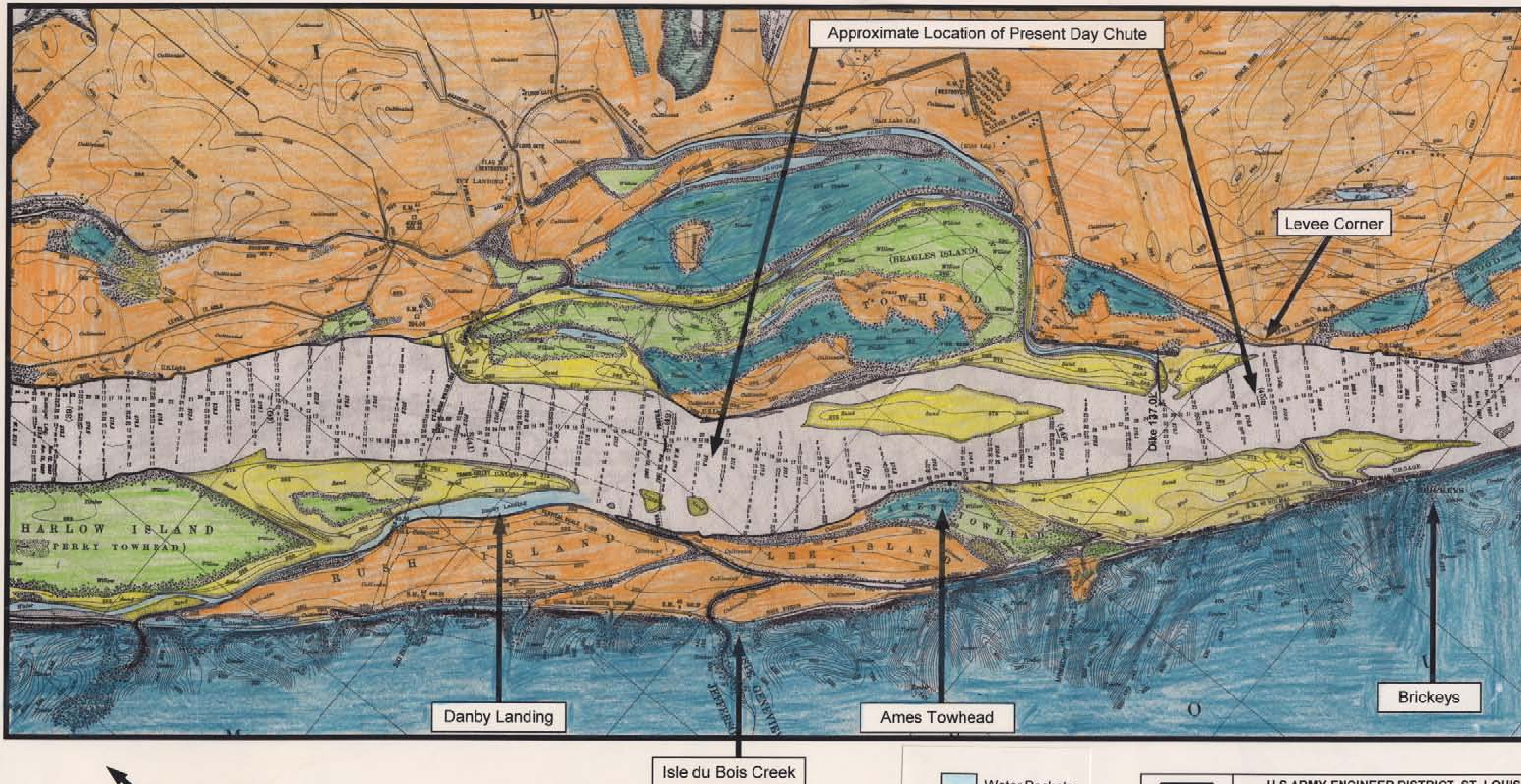
SALT LAKE CHUTE MICRO MODEL STUDY
RIVER MILES 141 TO 133

1881 TOPOGRAPHIC AND HYDROGRAPHIC SURVEY OF THE MISSISSIPPI RIVER VALLEY

FILE NAME: 1881.PUB

PLATE NO. 6



1908 Topographic and Hydrographic Survey
With Color-Coded Land Usage

- Water Pockets
- Sand
- Wetland/Mud
- Willows
- Timber
- Cropland

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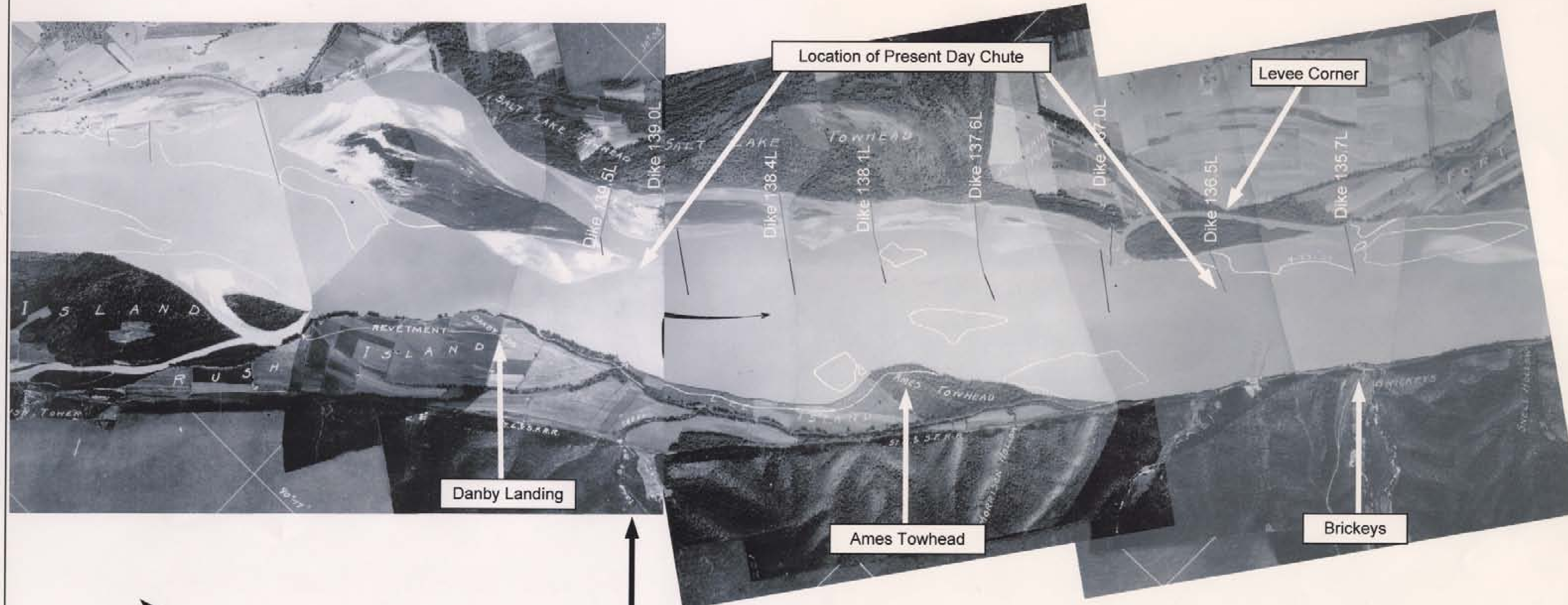
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

1908 TOPOGRAPHIC AND HYDROGRAPHIC SURVEY
OF THE MISSISSIPPI RIVER VALLEY

FILE NAME: 1908.PUB

PLATE NO. 7



1928 Aerial Photograph

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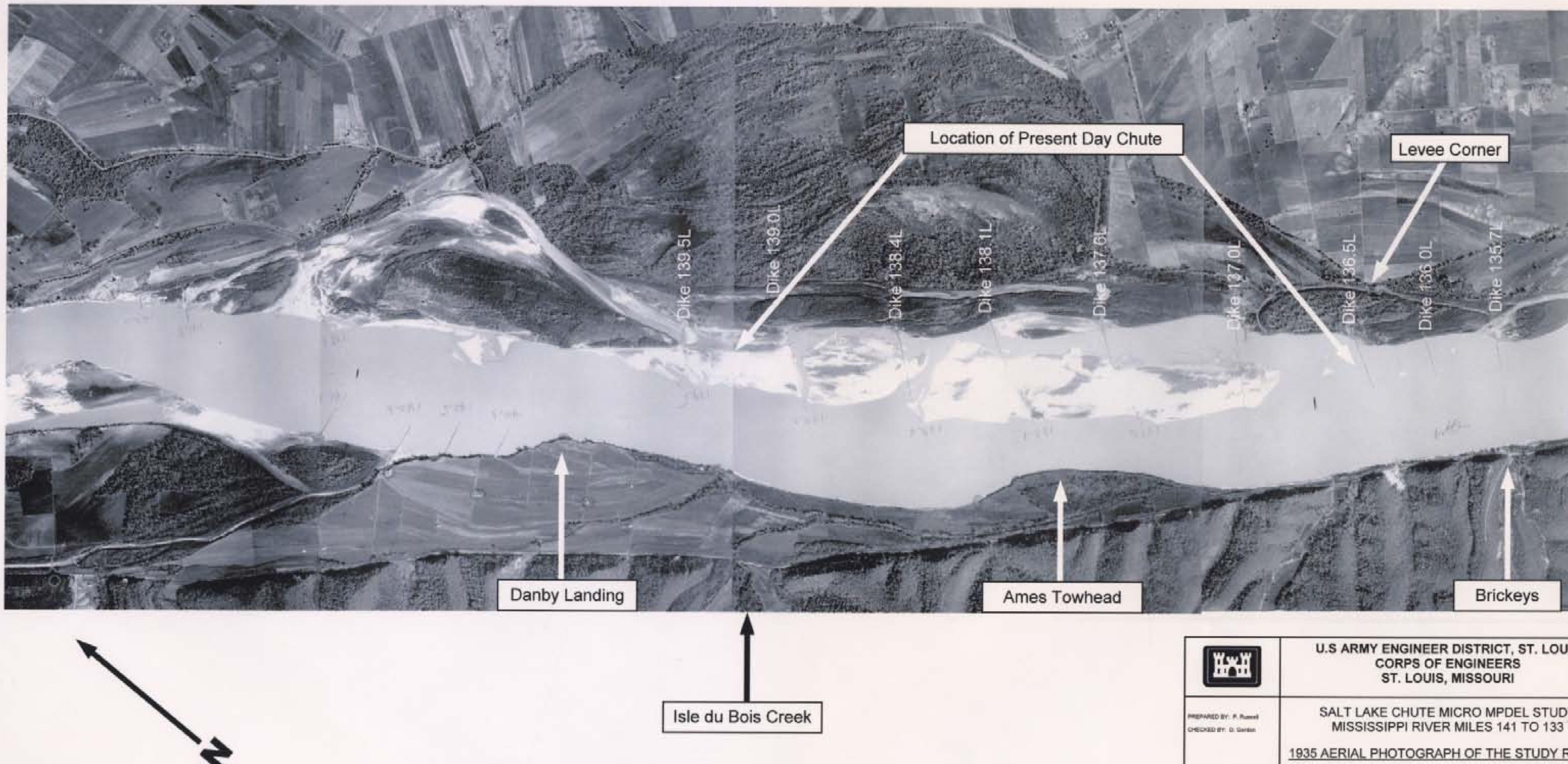
DRAWN BY: P. Russell CHECKED BY: D. Gordon	SALT LAKE CHUTE MICRO MODEL STUDY MISSISSIPPI RIVER MILES 141 TO 133 1928 AERIAL PHOTOGRAPH OF THE STUDY REACH
FILE NAME: 1928AERIAL.PUB	PLATE NO. 8



1935 Aerial Photograph

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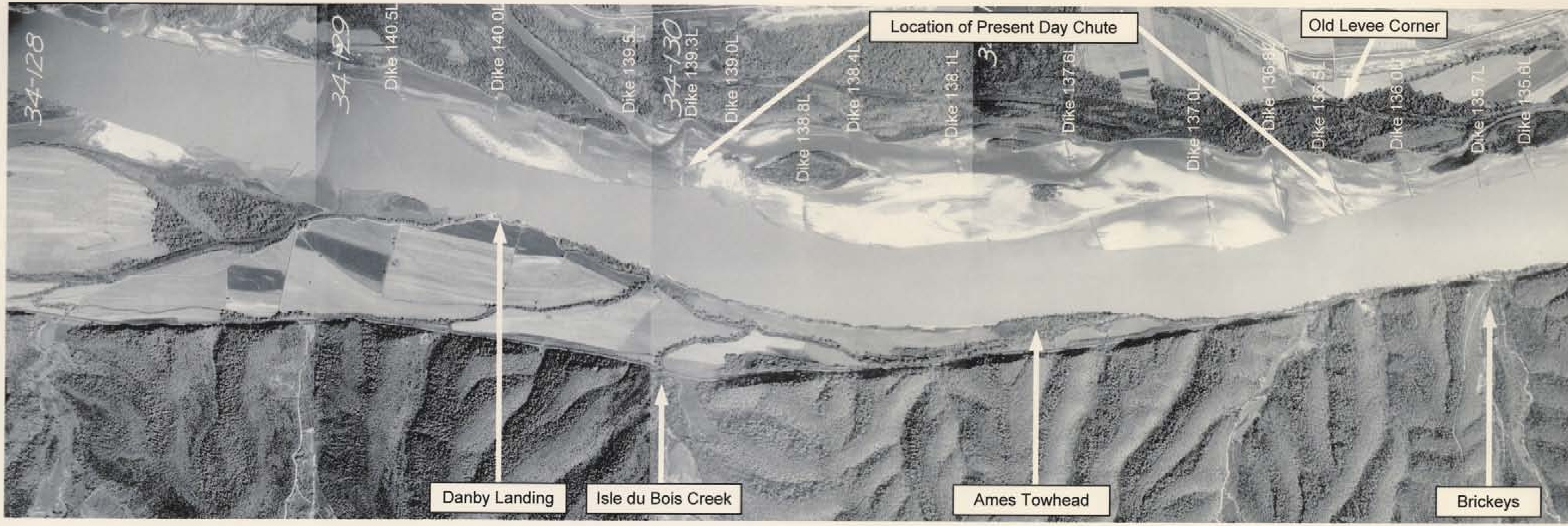
SALT LAKE CHUTE MICRO MPDEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

1935 AERIAL PHOTOGRAPH OF THE STUDY REACH

FILE NAME: 1935AERIAL.PUB

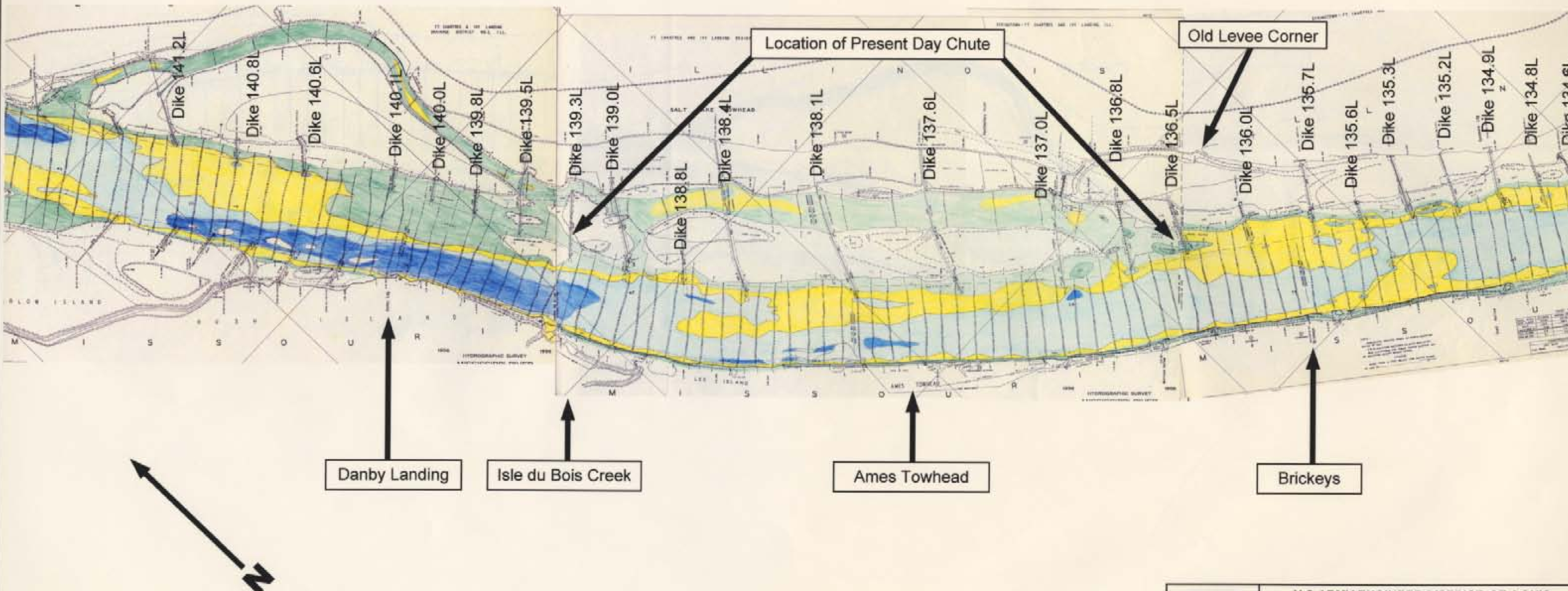
PLATE NO. 9



N

1949 Aerial Photograph

	U.S ARMY ENGINEER DISTRICT, ST. LOUIS CORPS OF ENGINEERS ST. LOUIS, MISSOURI
PREPARED BY: P. Russell CHECKED BY: D. Gordon	SALT LAKE CHUTE MICRO MODEL STUDY MISSISSIPPI RIVER MILES 141 TO 133 1949 AERIAL PHOTOGRAPH OF THE STUDY REACH
	FILE NAME: 1949.PUB — PLATE NO. 10



1959 Hydrographic Survey

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

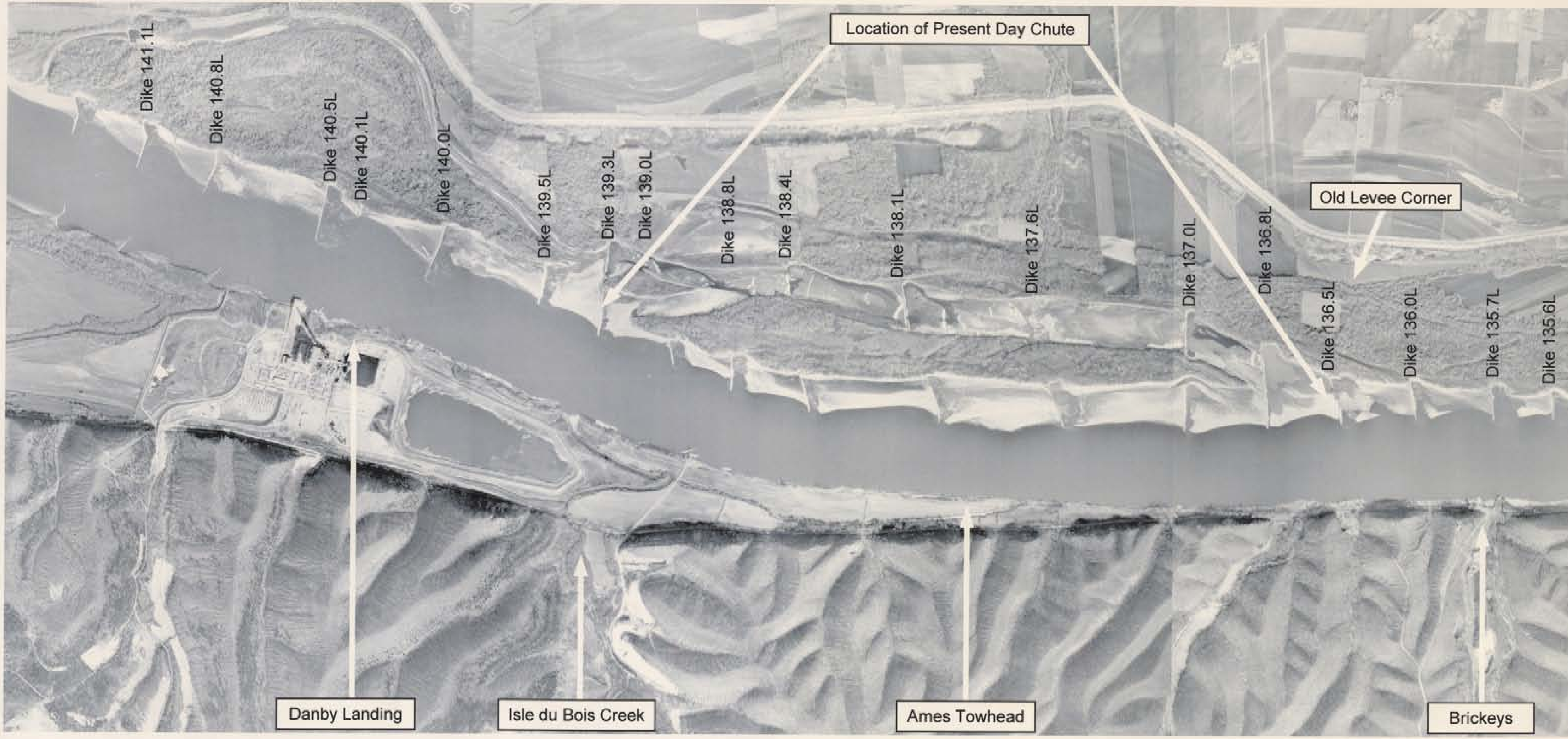
PREPARED BY: P. Russell
CHECKED BY: D. Gordon

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

1959 HYDROGRAPHIC SURVEY
OF THE STUDY REACH

FILE NAME: 1959.PUB

PLATE NO. 11



N

1976 Aerial Photograph

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

PREPARED BY: P. Russell
CHECKED BY: D. Gordon

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

1976 AERIAL PHOTOGRAPH OF THE STUDY REACH

FILE NAME: 1976AERIAL.PUB

PLATE NO. 12

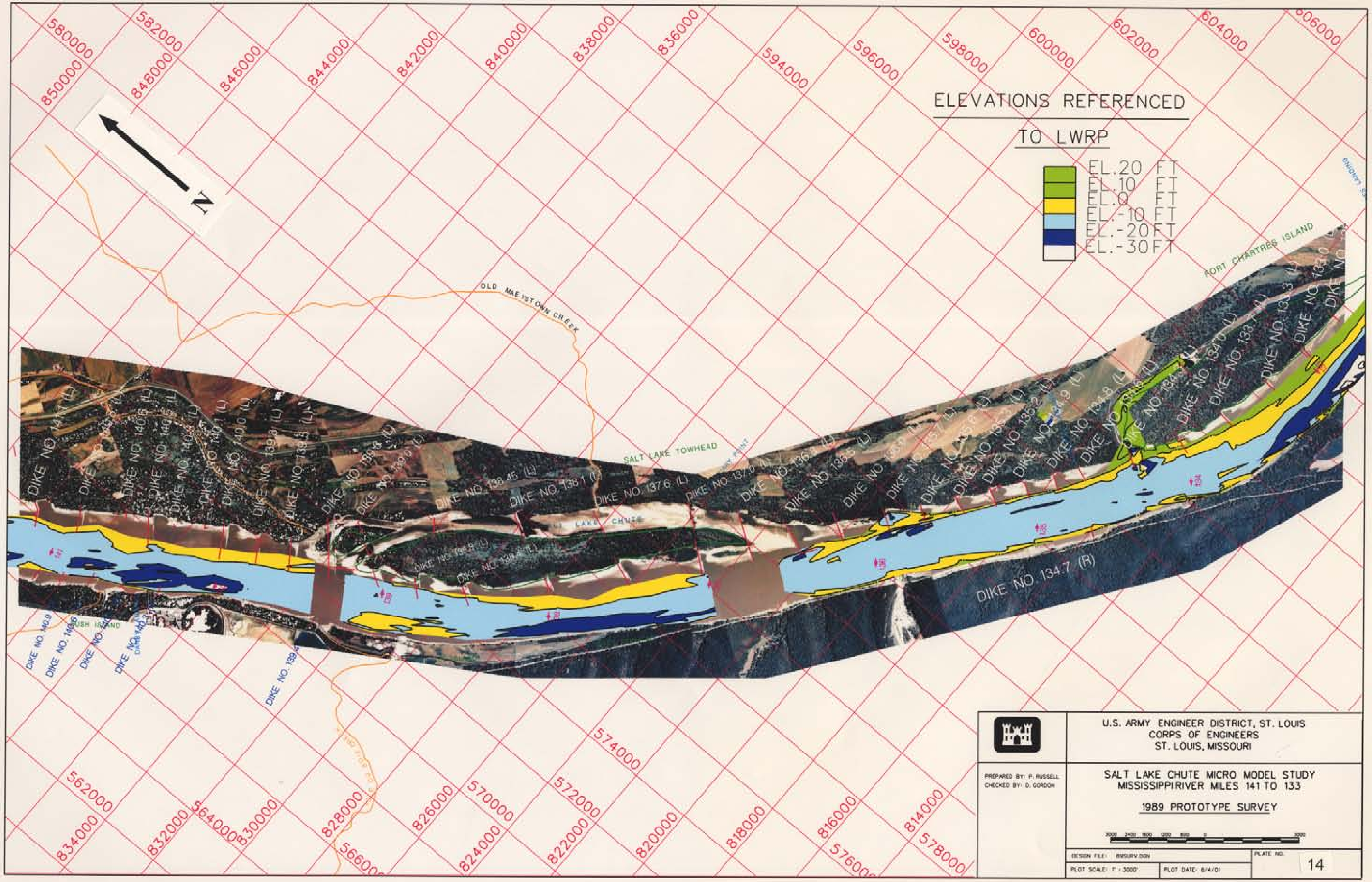
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: P. Russell
CHECKED BY: D.Gordon

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

SALT LAKE CHUTE MICRO MODEL

PLATE NO.
13



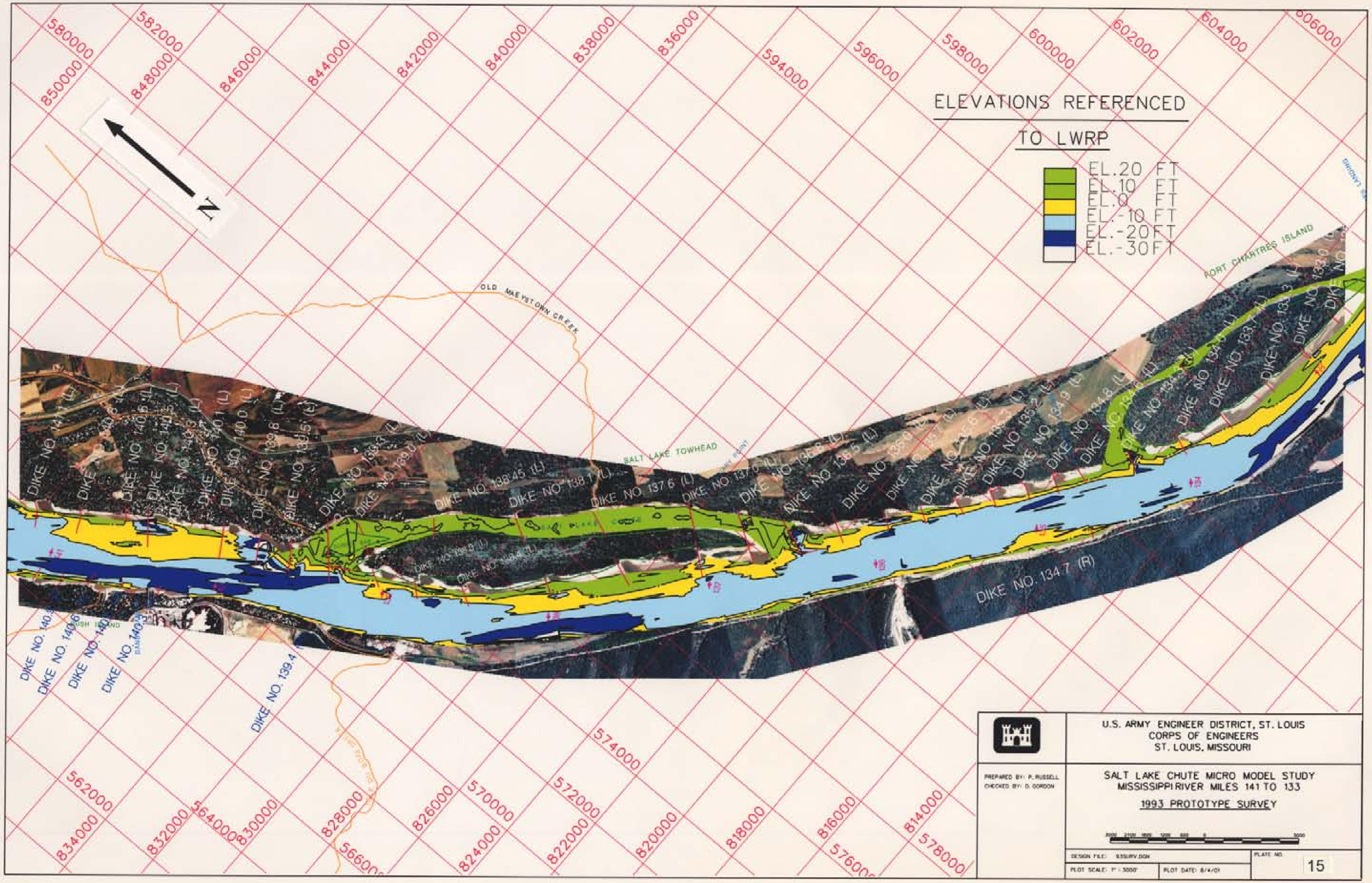
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON

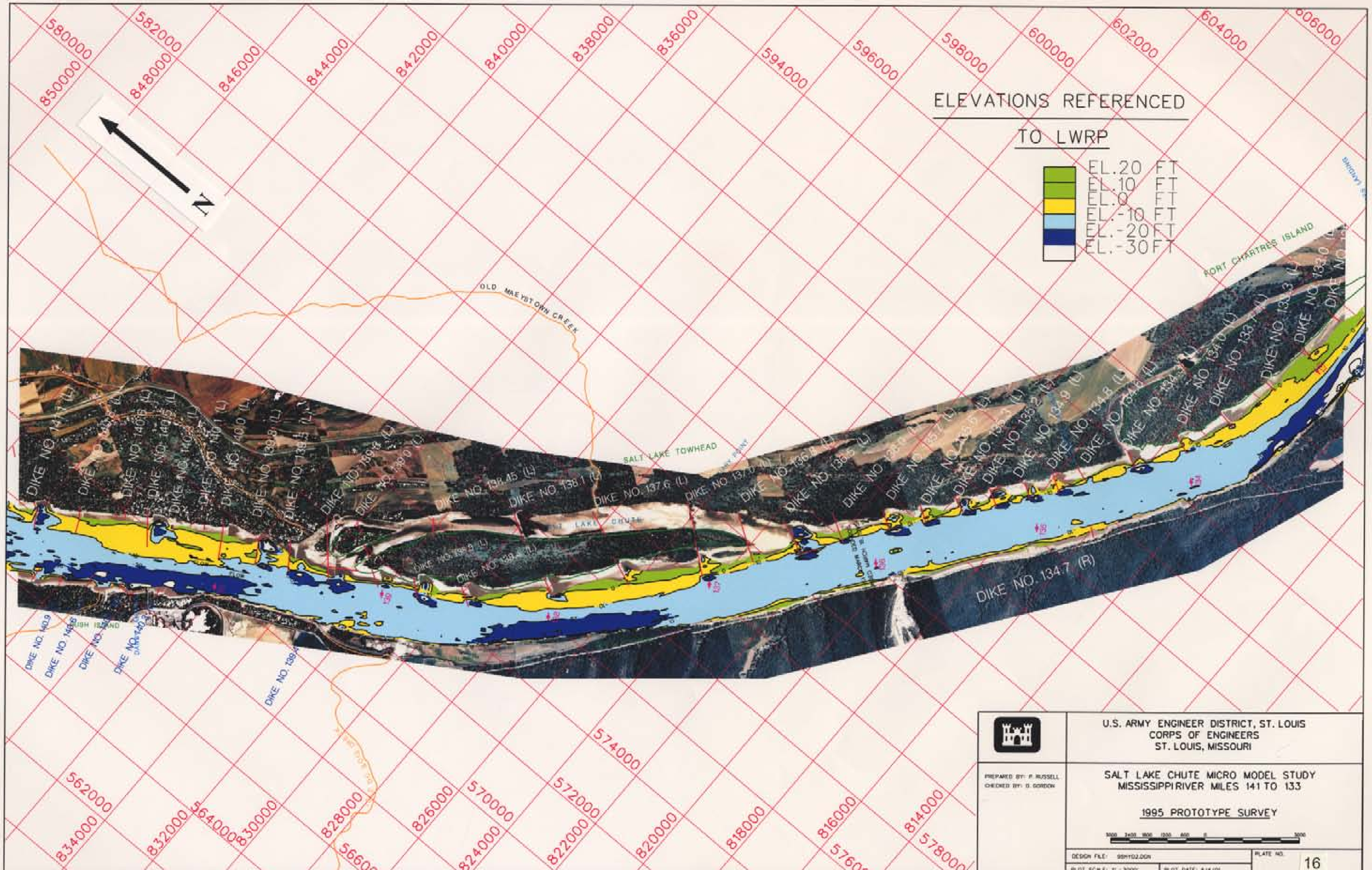
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

1989 PROTOTYPE SURVEY

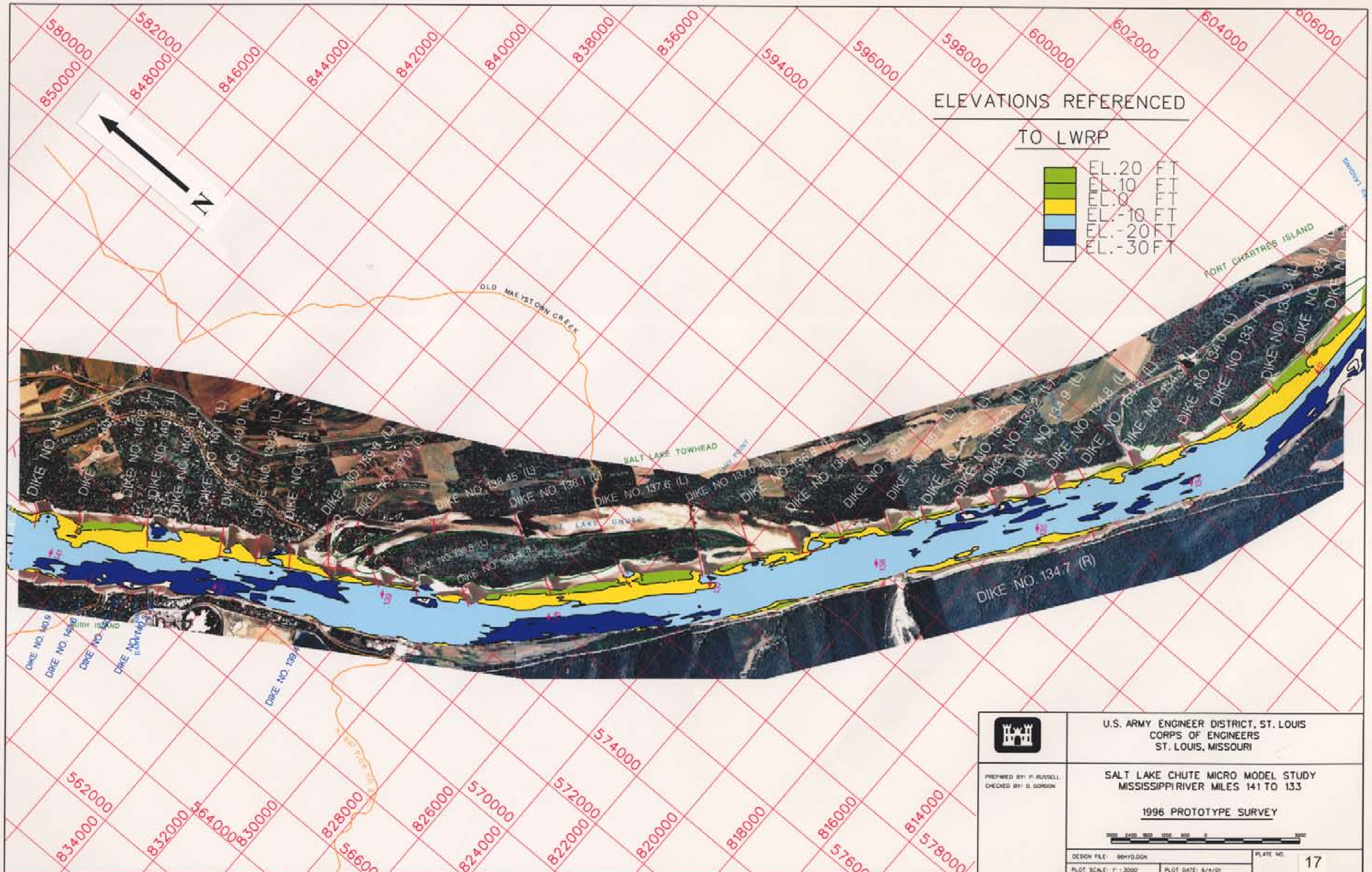
DESIGN FILE: 89SURV.DGN
PLOT SCALE: 1" = 3000'
PLOT DATE: 6/4/01
PLATE NO. 14

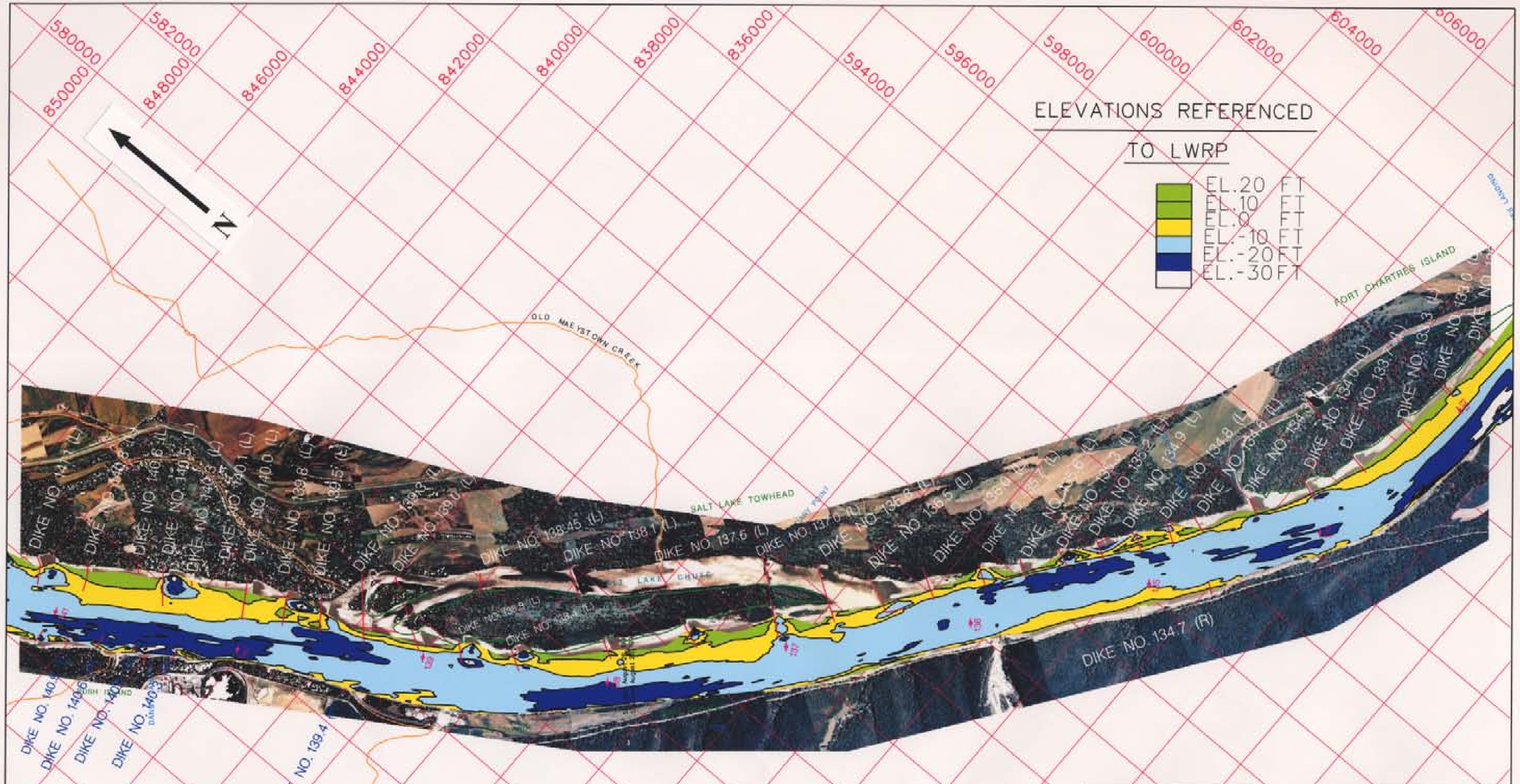


ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20FT
EL.-30FT
N
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
FORT CHARTRES ISLAND
DIKE NO. 134.7 (R)
DIKE NO. 139.4
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
1993 PROTOTYPE SURVEY
PLATE NO.
15



ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
N
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
FORT CHARTRES ISLAND
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 134.7 (R)
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
1995 PROTOTYPE SURVEY
DESIGN FILE: 95HYD2.DGN
PLOT SCALE: 1" : 3000'
PLATE NO.
16


ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
N
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
FORT CHARTRES ISLAND
DIKE NO. 134.7 (R)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
1996 PROTOTYPE SURVEY
PLATE NO.
17



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

PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

1998 PROTOTYPE SURVEY

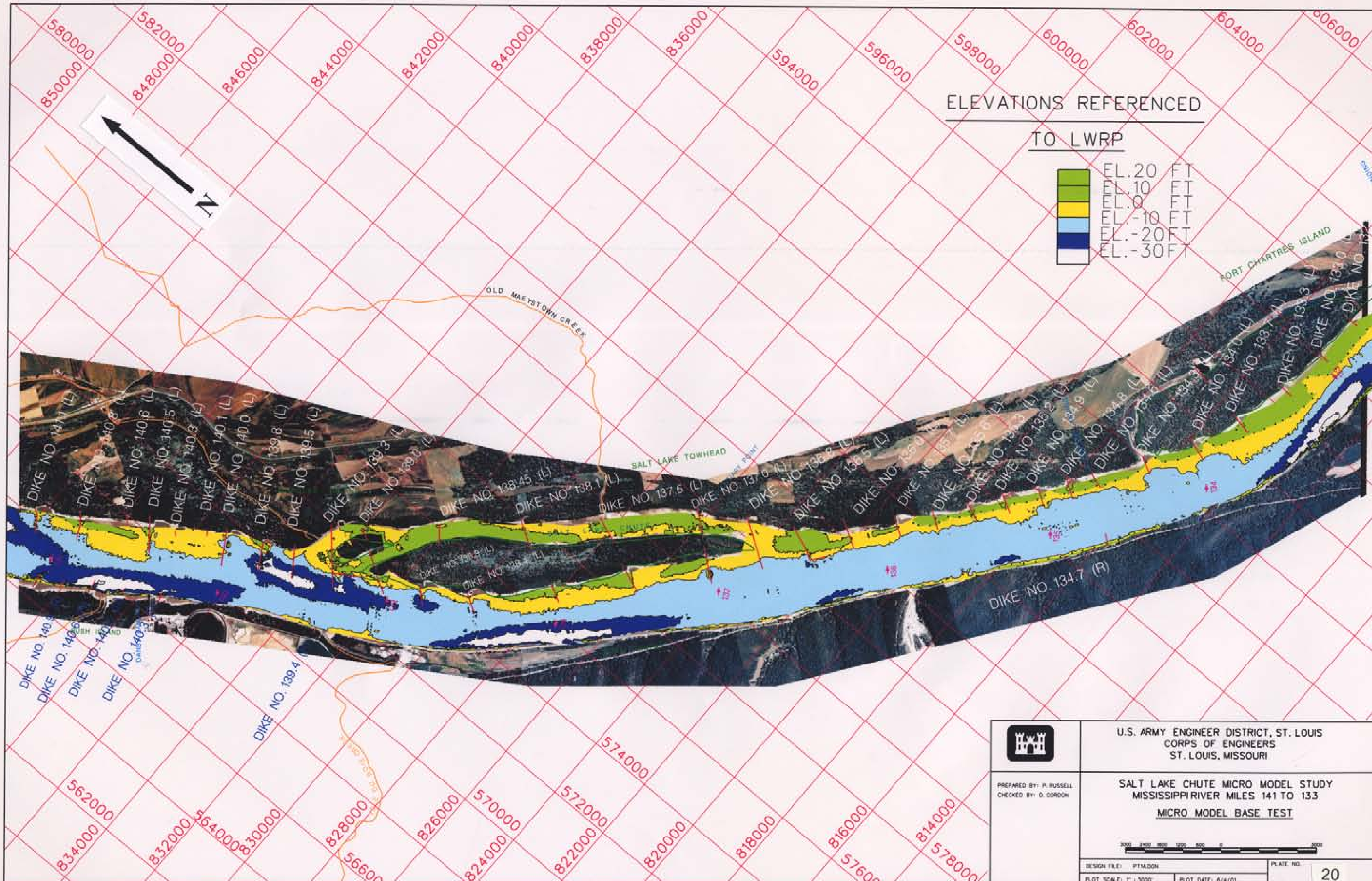
DESIGN FILE: 98SURV.DGN
PLOT SCALE: 1" : 3000'
PLOT DATE: 6/4/01
PLATE NO. 18

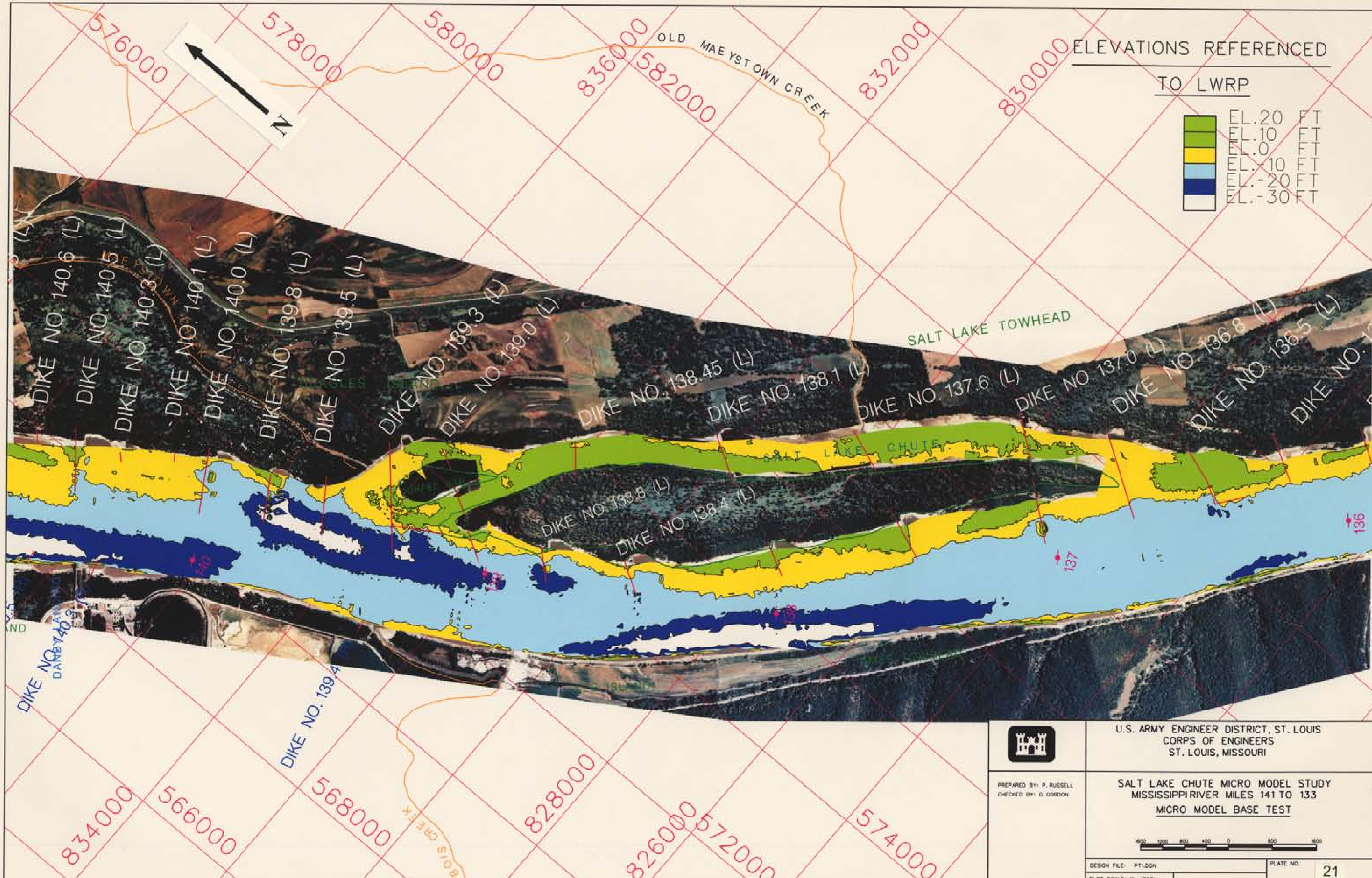
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
1999 SALT LAKE CHUTE
HYDROGRAPHIC SWEEP SURVEY

DESIGN FILE: SALTHYD.DGN
PLOT SCALE: 1" = 1600'
PLATE NO. 19


ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20FT
EL.-30FT
N
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
FORT CHARTRES ISLAND
DIKE NO. 134.7 (R)
DIKE NO. 139.4
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
MICRO MODEL BASE TEST
PLATE NO.
20

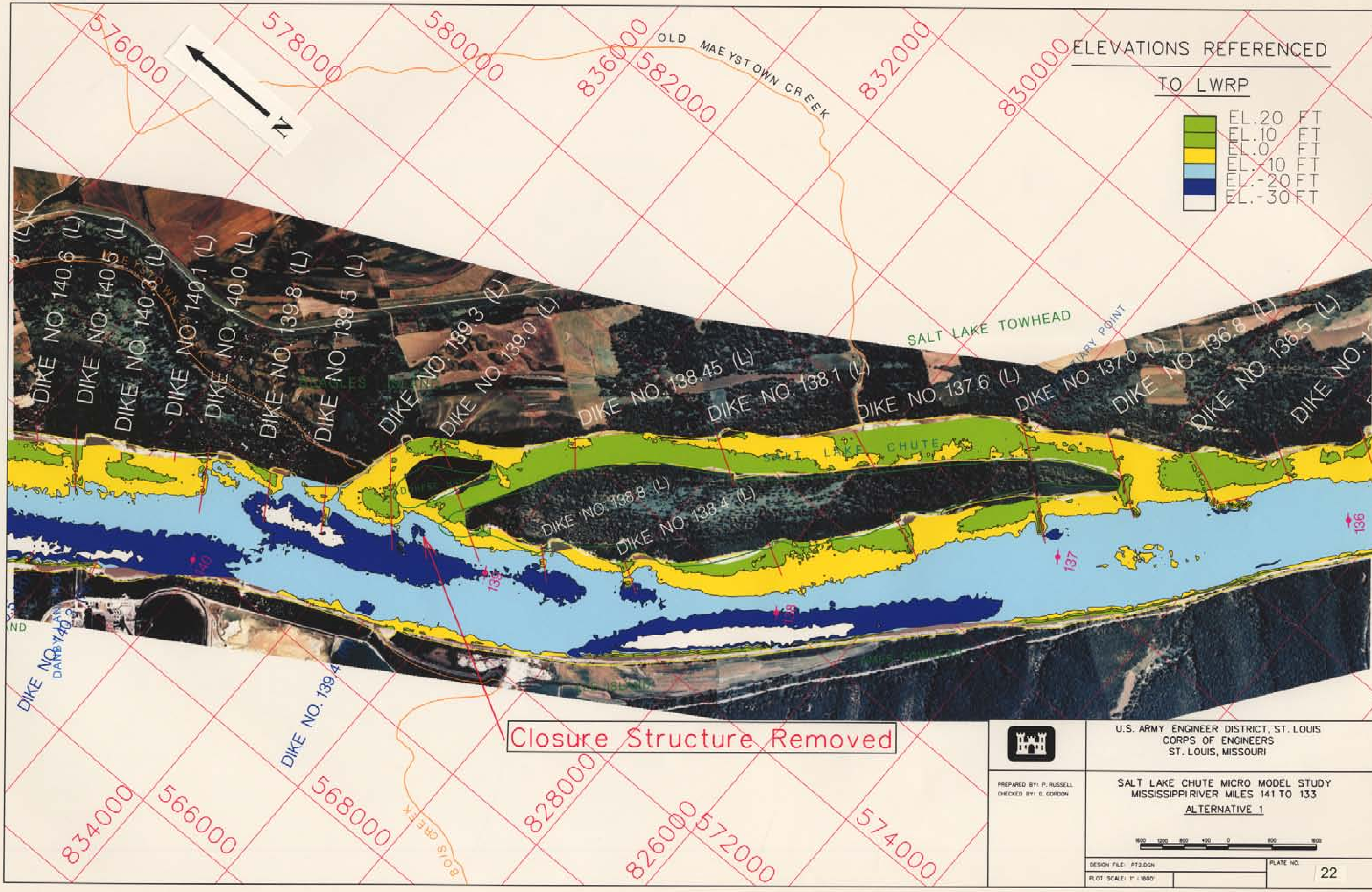


U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

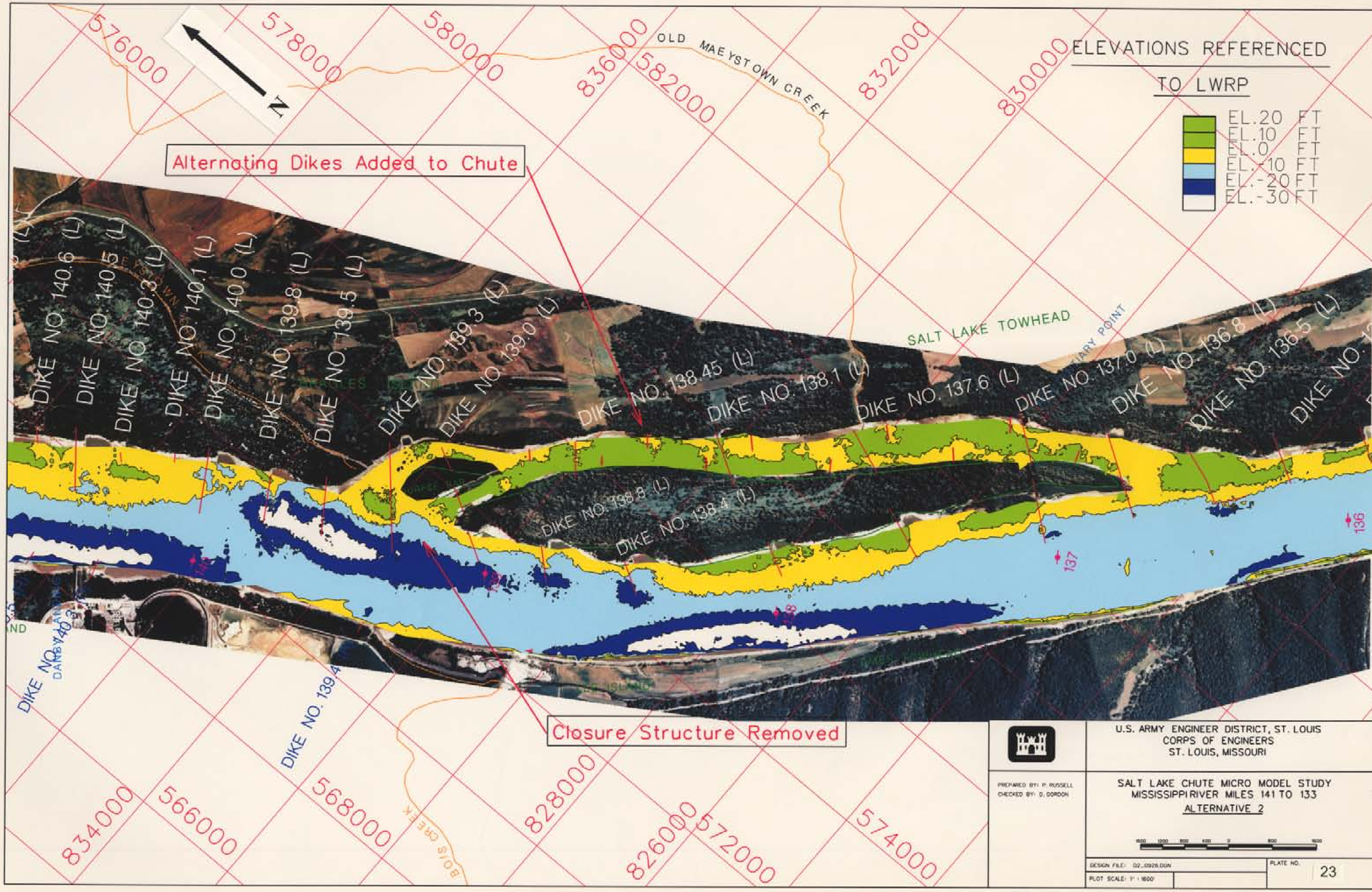
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON

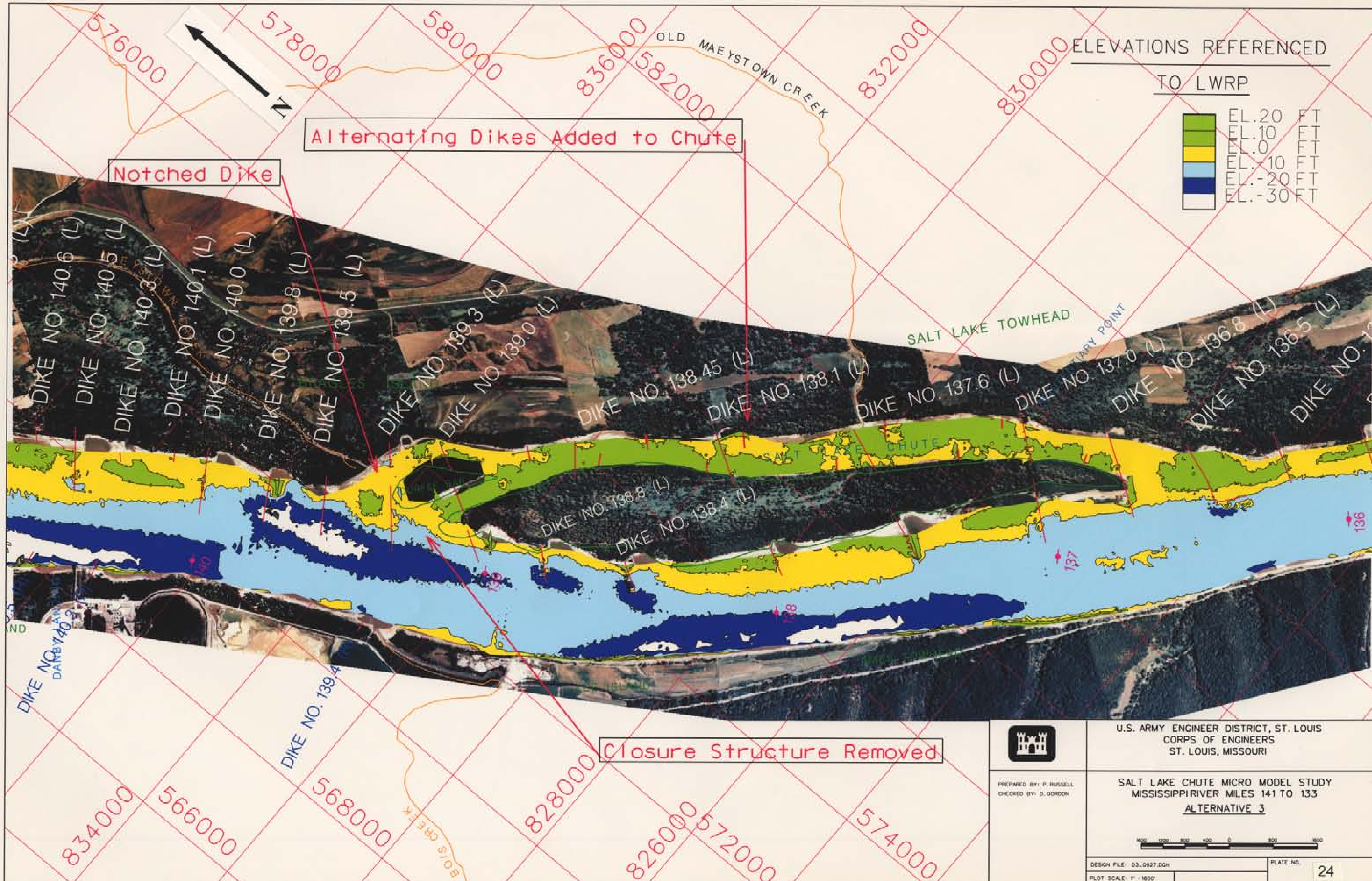
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
MICRO MODEL BASE TEST

DESIGN FILE: PT1.DGN
PLOT SCALE: 1" = 1600'
PLATE NO. 21

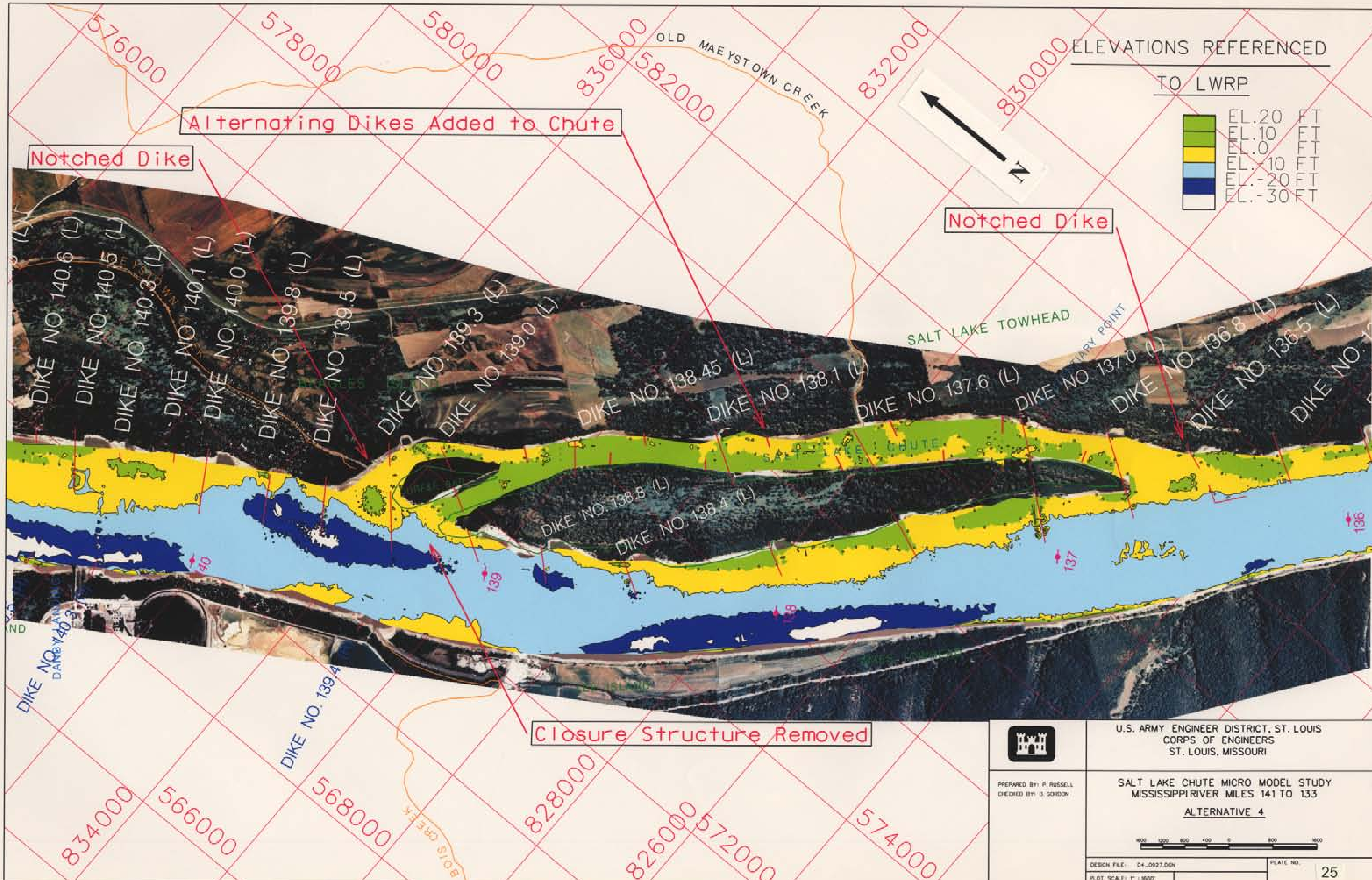


ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
N
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
140
139
138
137
136
BOIS CREEK
Closure Structure Removed
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 1
DESIGN FILE: PT2.DGN
PLOT SCALE: 1" = 1600'
PLATE NO.
22


ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
N
OLD MAEYSTOWN CREEK
Alternating Dikes Added to Chute
Closure Structure Removed
SALT LAKE TOWHEAD
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
BOIS CREEK
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
137
136
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 2
DESIGN FILE: D2_0926.DGN
PLOT SCALE: 1" = 1600'
PLATE NO.
23

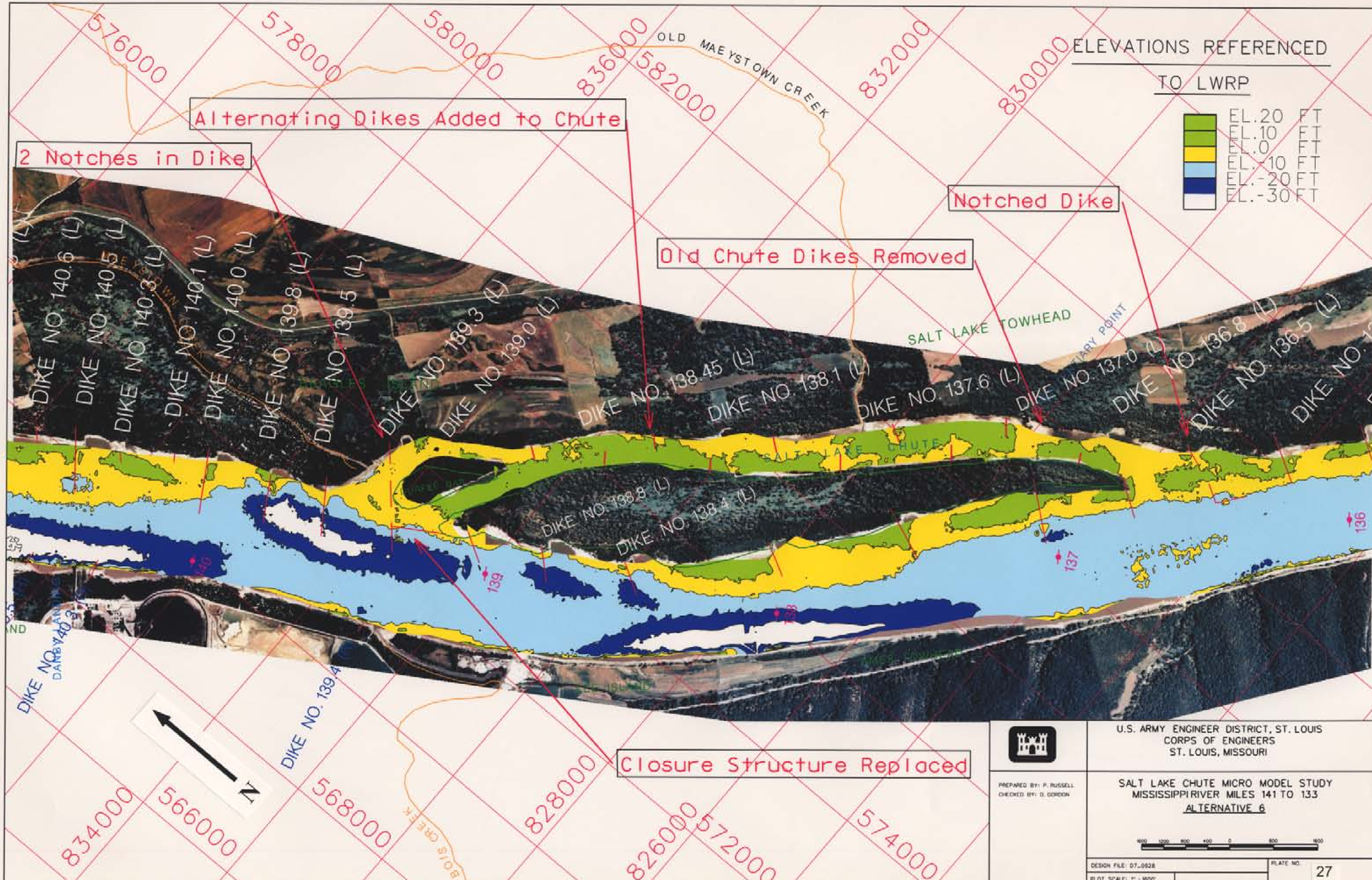


ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
N
OLD MAEYSTOWN CREEK
Alternating Dikes Added to Chute
Notched Dike
Closure Structure Removed
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
BOIS CREEK
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
140
139
138
137
136
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 3
DESIGN FILE: D3_0927.DGN
PLOT SCALE: 1" = 1600'
PLATE NO.
24



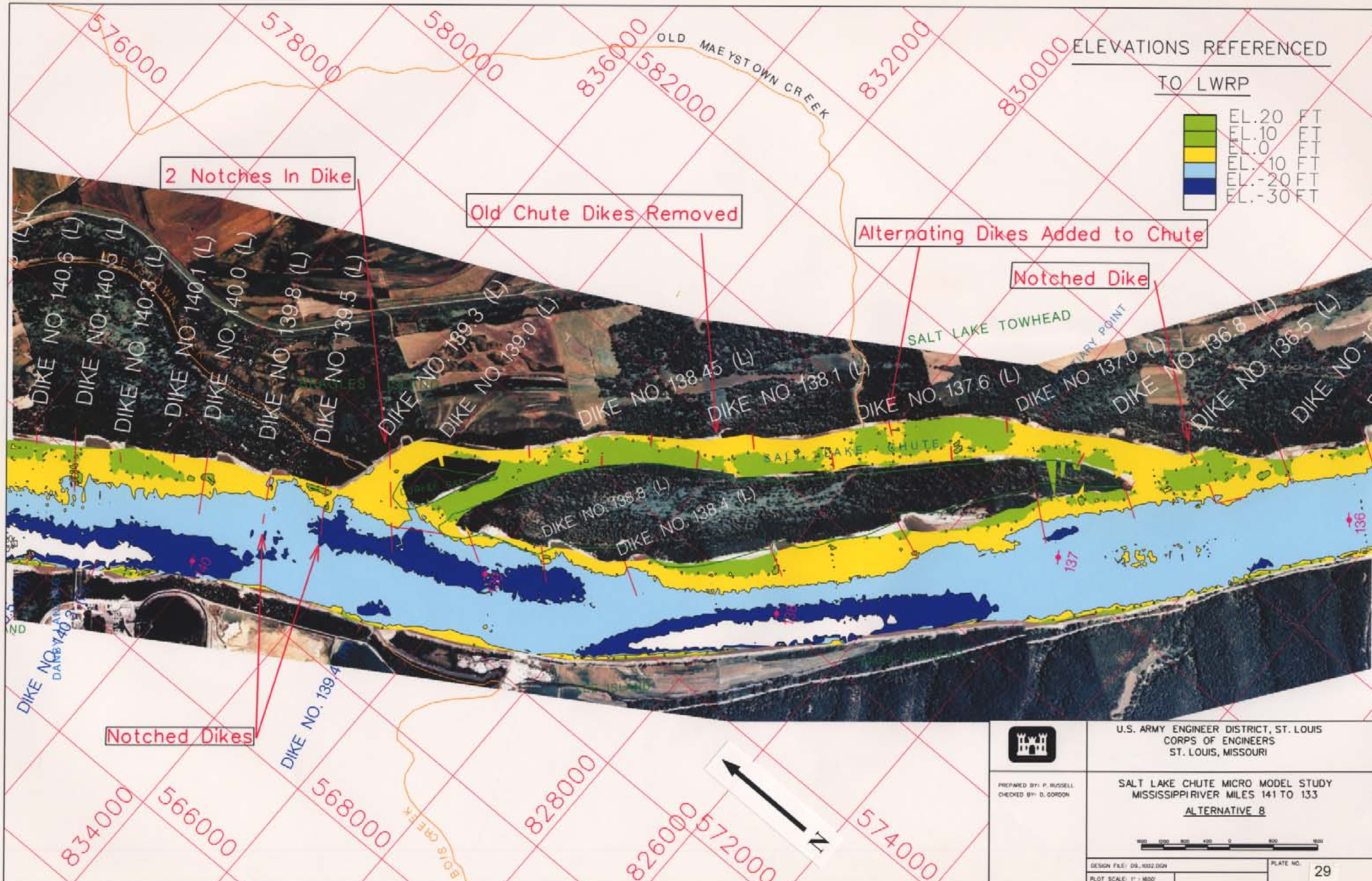
ELEVATIONS REFERENCED
TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
N
Alternating Dikes Added to Chute
Notched Dike
Notched Dike
Closure Structure Removed
OLD MAEYSTOWN CREEK
BOIS CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
140
139
138
137
136
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 4
DESIGN FILE: D4_0927.DGN
PLOT SCALE: 1" : 1600'
PLATE NO.
25

ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Alternating Dikes Added to Chute
2 Notches In Dike
Notched Dike
Closure Structure Removed
OLD MAEYSTOWN CREEK
BOIS CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
N
139
137
136
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 5
PLATE NO.
26



ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Alternating Dikes Added to Chute
2 Notches in Dike
Notched Dike
Old Chute Dikes Removed
Closure Structure Replaced
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
140
139
138
137
136
576000
578000
580000
582000
836000
832000
830000
828000
826000
834000
566000
568000
572000
574000
BOIS CREEK
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 6
DESIGN FILE: 07_0928
PLOT SCALE: 1" = 1600'
PLATE NO.
27


ELEVATIONS REFERENCED
TO LWRP
EL. 20 FT
EL. 10 FT
EL. 0 FT
EL. -10 FT
EL. -20 FT
EL. -30 FT
2 Notches in Dike
Old Chute Dikes Removed
Alternating Dikes Added to Chute
Notched Dike
Notched Dike
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
140
139
138
137
136
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
BOIS CREEK
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 7
DESIGN FILE: DB_1002.DGN
PLOT SCALE: 1" : 1600'
PLATE NO.
28



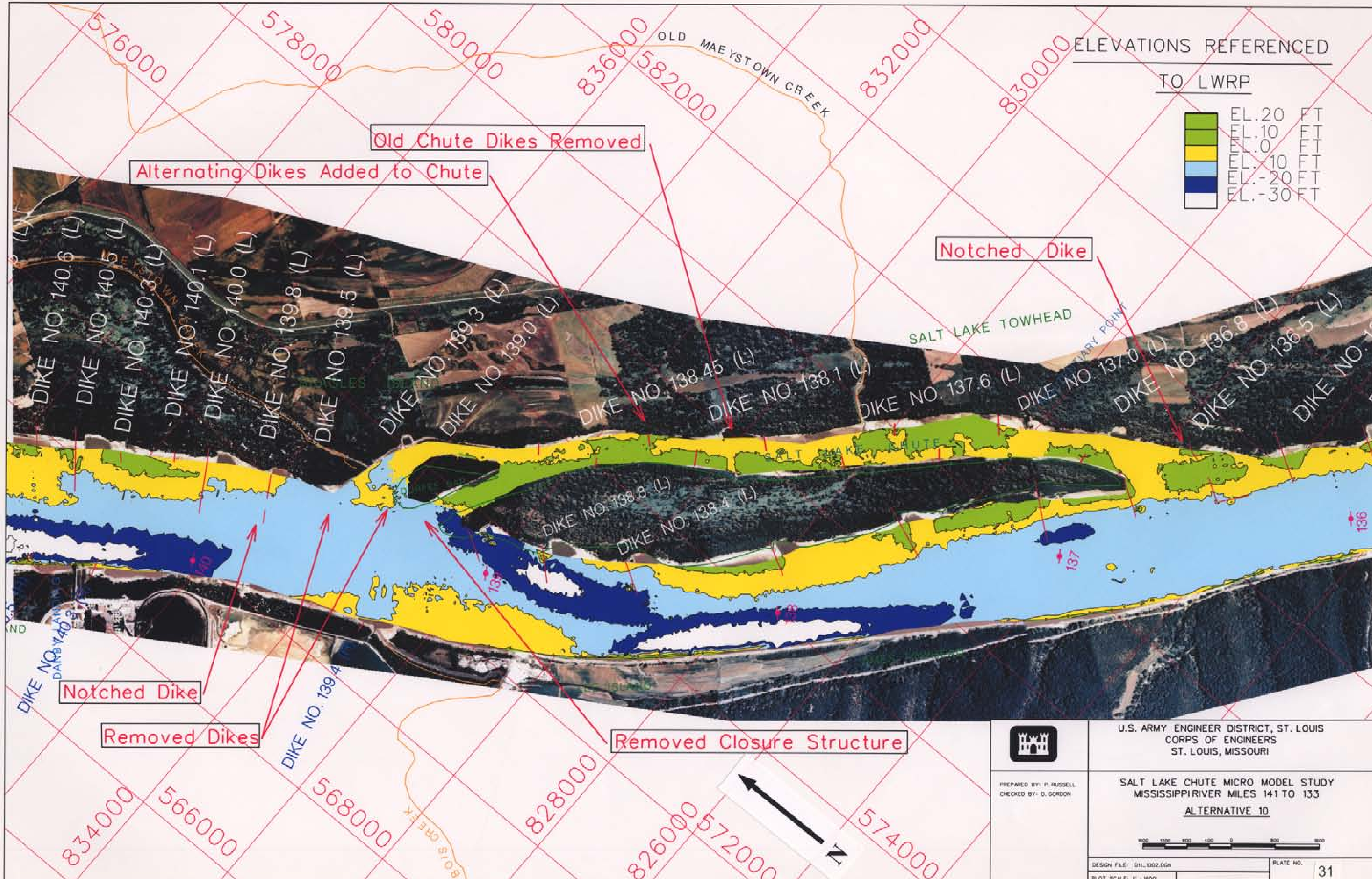
ELEVATIONS REFERENCED
TO LWRP
EL. 20 FT
EL. 10 FT
EL. 0 FT
EL. -10 FT
EL. -20 FT
EL. -30 FT
2 Notches In Dike
Old Chute Dikes Removed
Alternating Dikes Added to Chute
Notched Dike
Notched Dikes
OLD MAEYSTOWN CREEK
BOIS CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
136
137
140
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 8
DESIGN FILE: 09_1002.DGN
PLOT SCALE: 1" = 1600'
PLATE NO.
29

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

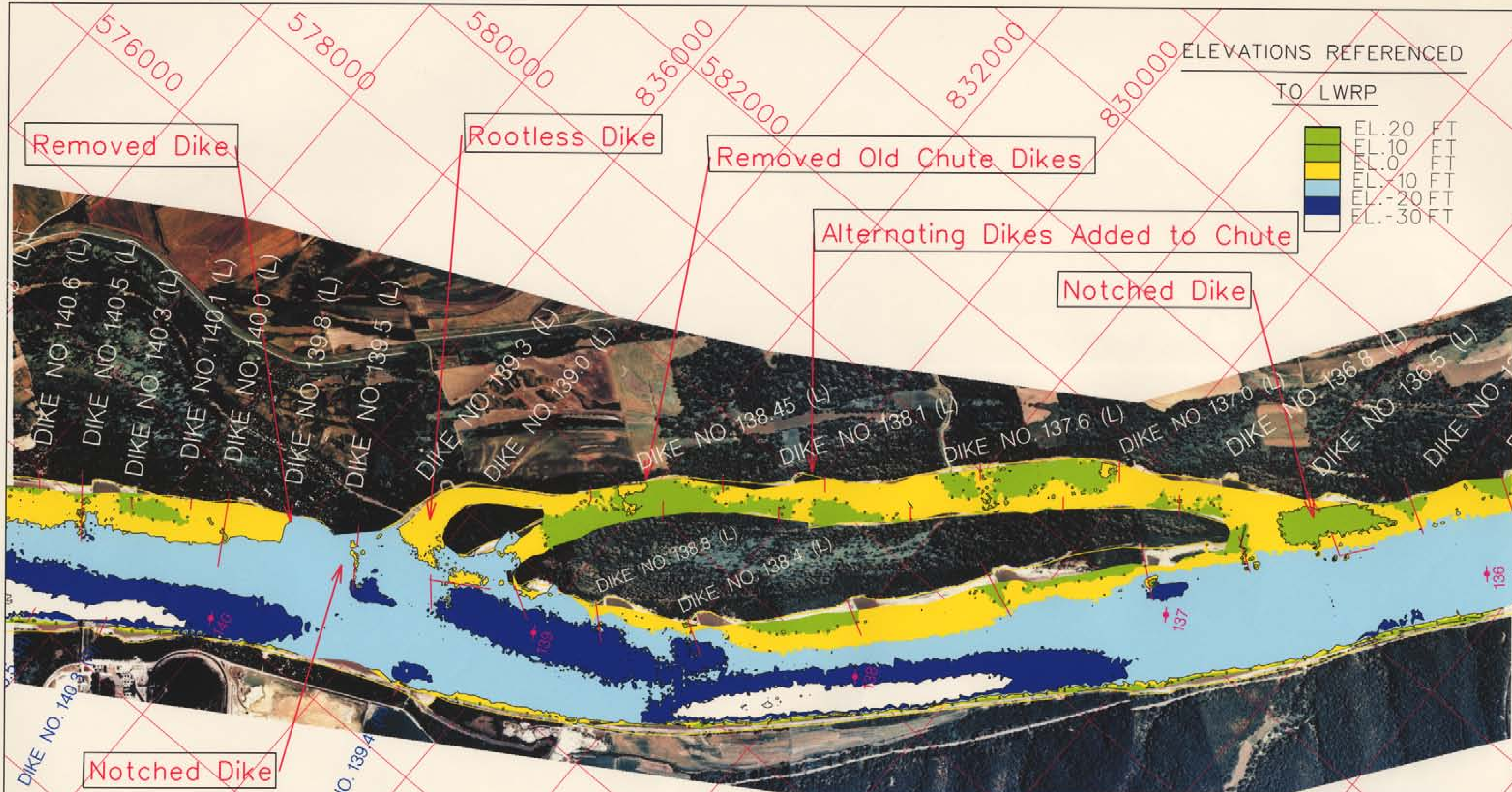
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON

SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 9

DESIGN FILE: D10_1002
PLOT SCALE: 1" : 1600'
PLATE NO. 30


ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Old Chute Dikes Removed
Alternating Dikes Added to Chute
Notched Dike
Notched Dike
Removed Dikes
Removed Closure Structure
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
BOIS CREEK
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
140
137
136
576000
578000
580000
582000
836000
832000
830000
828000
826000
834000
566000
568000
572000
574000
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 10
PLATE NO.
31

ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Rootless Dike
Notched Dike
Removed Old Chute Dikes
Alternating Dikes Added to Chute
Notched Dike
Removed Dike
OLD MAEYSTOWN CREEK
BOIS CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
140
139
137
136
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 11
DESIGN FILE: D12_1003.DGN
PLOT SCALE: 1" = 1600'
PLATE NO.
32



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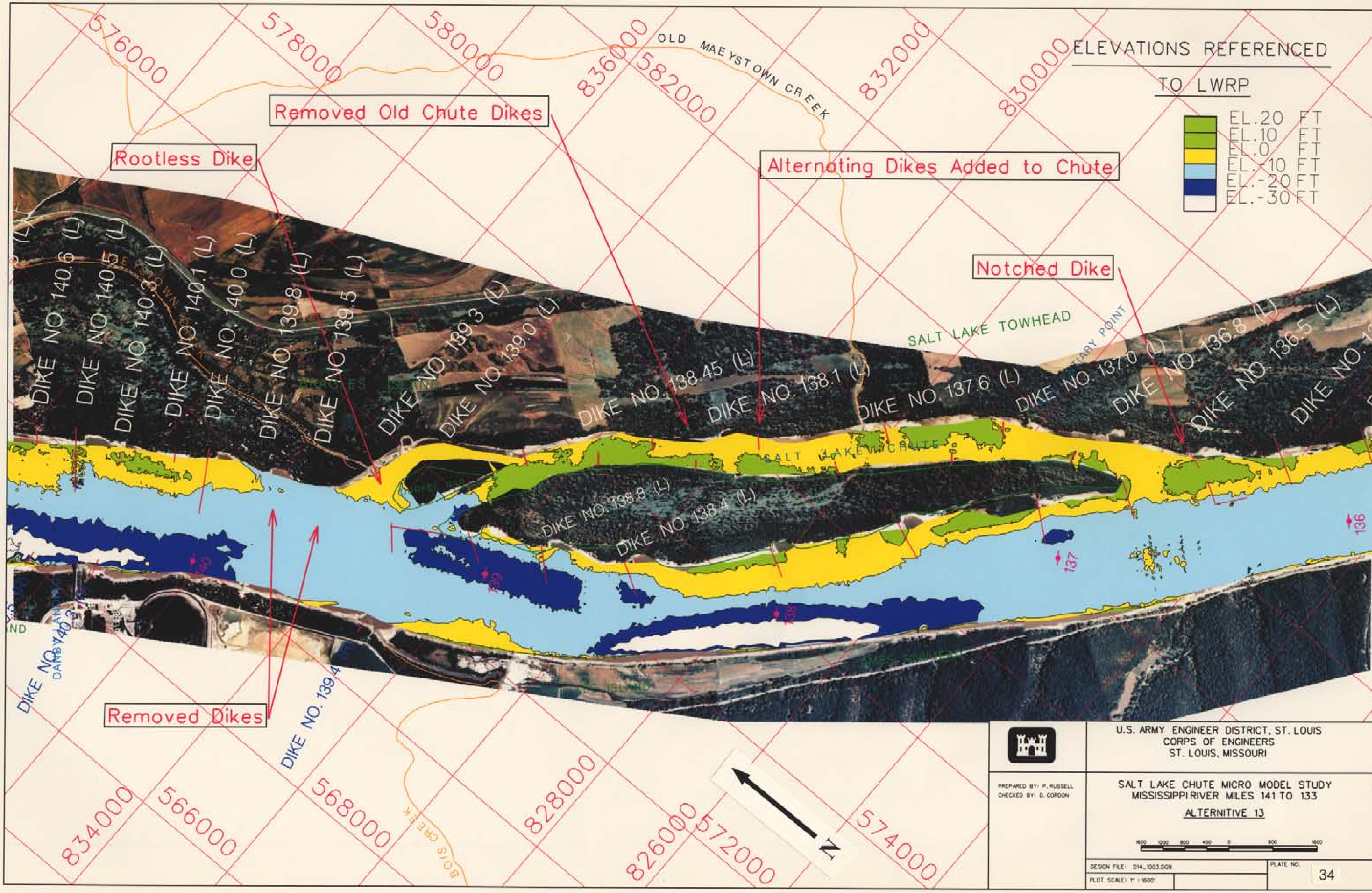
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

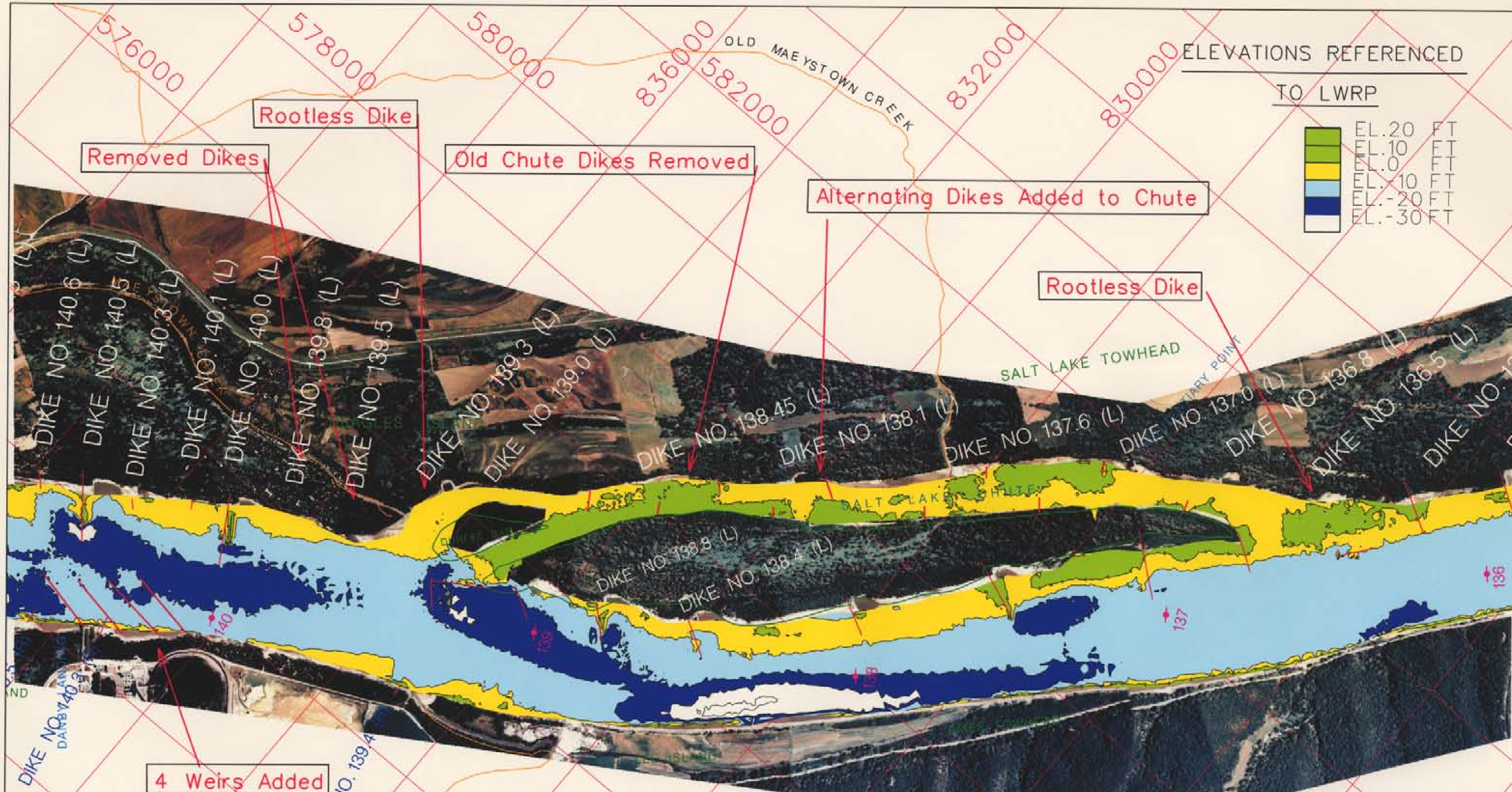
ALTERNATIVE 12

DESIGN FILE: 013_1003.DGN
PLOT SCALE: 1" : 1600'

PLATE NO. 33



ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Removed Old Chute Dikes
Rootless Dike
Alternating Dikes Added to Chute
Notched Dike
Removed Dikes
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
BOIS CREEK
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
DIKE NO. 140.3
136
137
138
139
140
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNITIVE 13
PLATE NO.
34



U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
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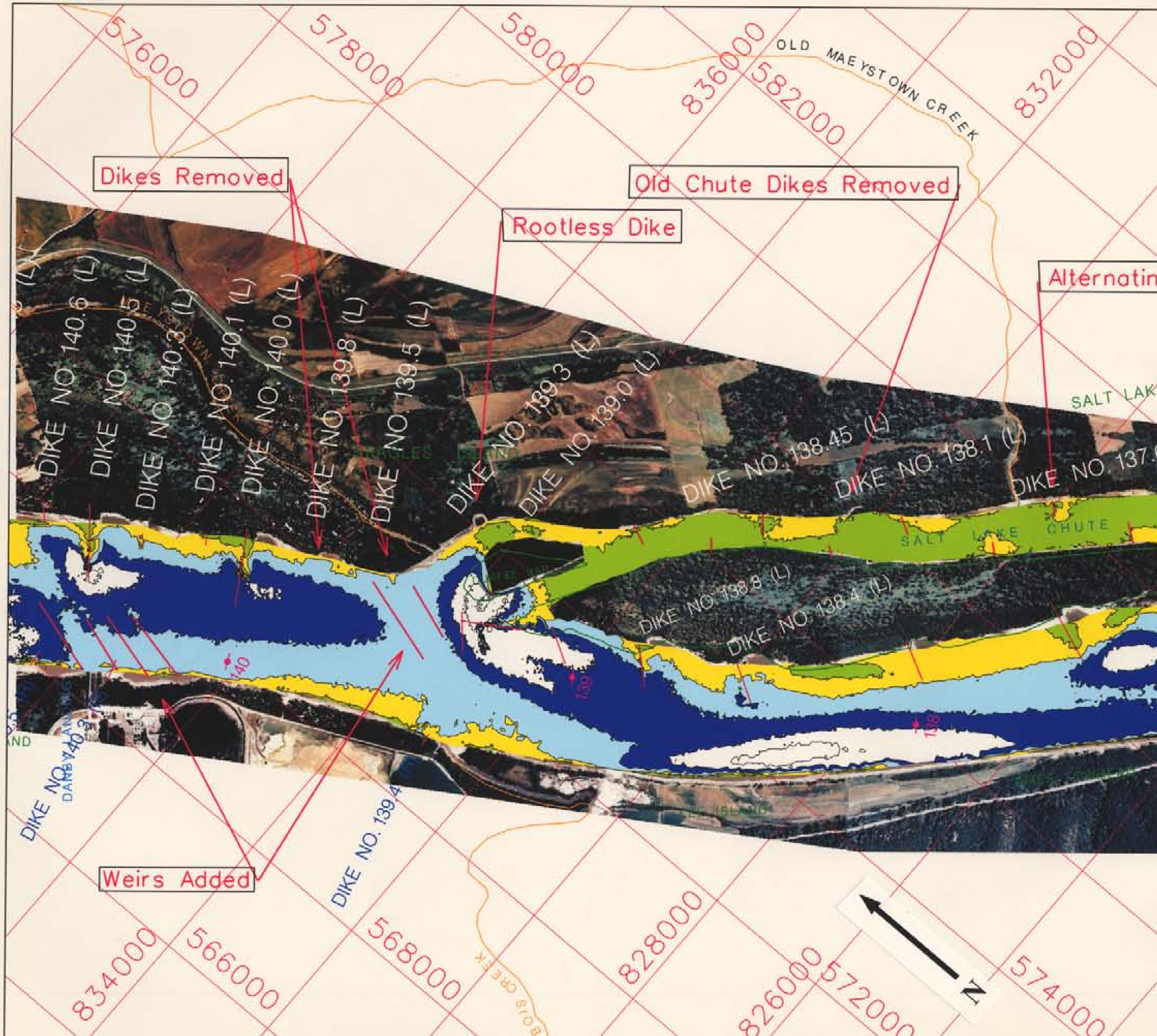
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

ALTERNATIVE 14

DESIGN FILE: D15_1004.DGN
PLOT SCALE: 1" : 1600'

PLATE NO. 35



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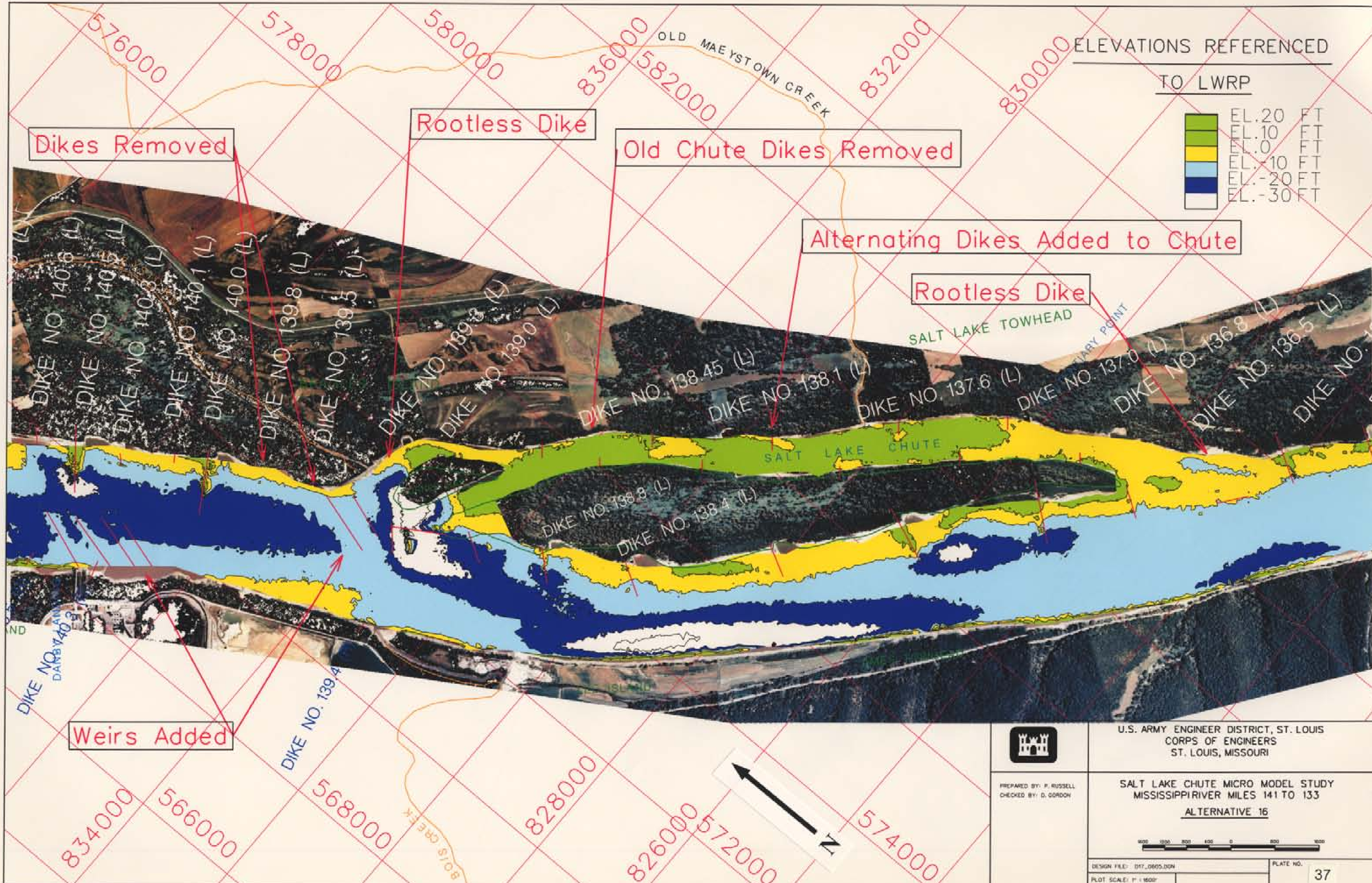
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 15

DESIGN FILE: D1621005.DGN
PLOT SCALE: 1" : 1600'
PLATE NO. 36


ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Dikes Removed
Rootless Dike
Old Chute Dikes Removed
Alternating Dikes Added to Chute
Rootless Dike
Weirs Added
OLD MAEYSTOWN CREEK
BOIS CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
DIKE NO. 140.2
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 16
PLATE NO.
37

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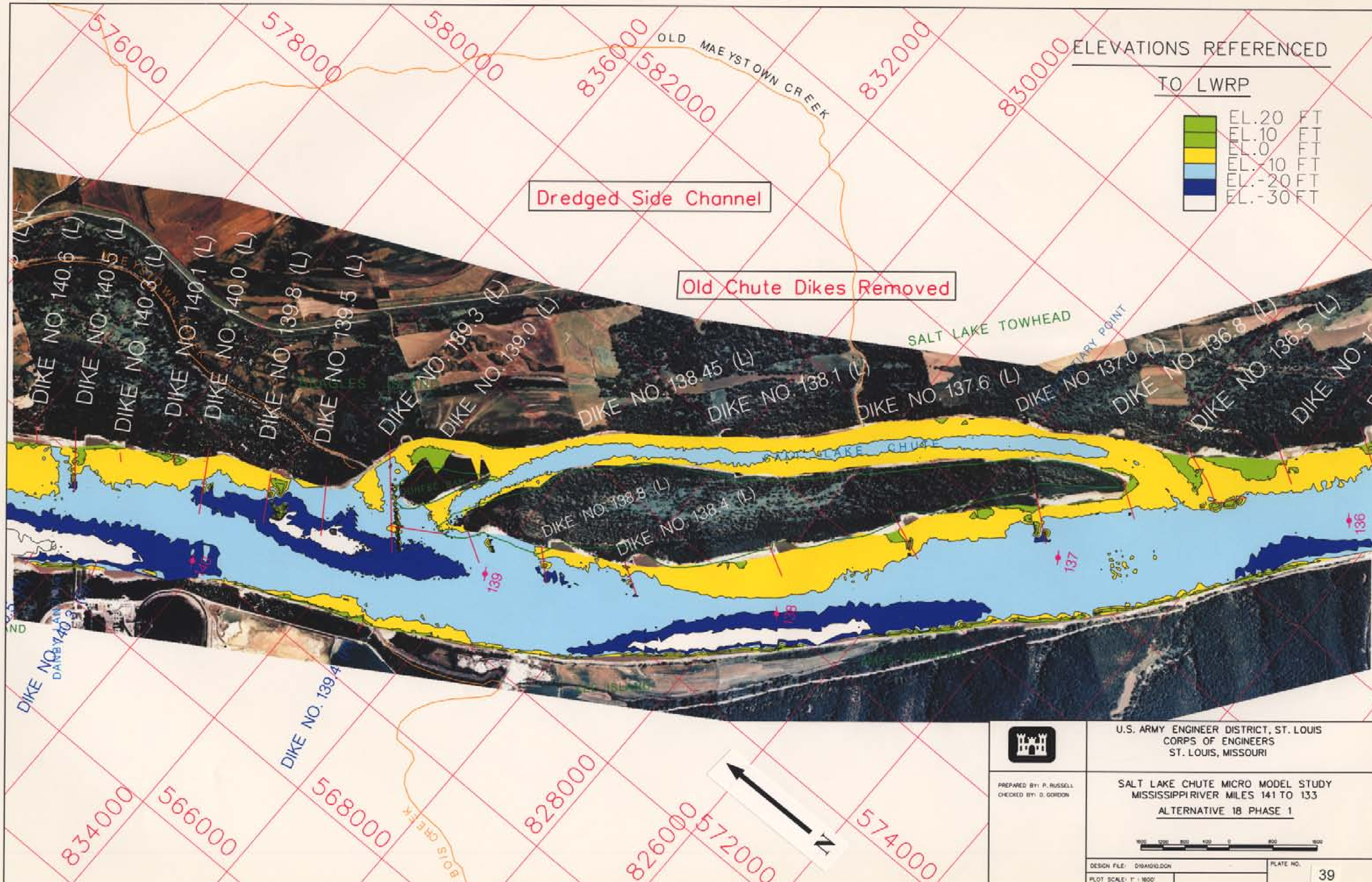
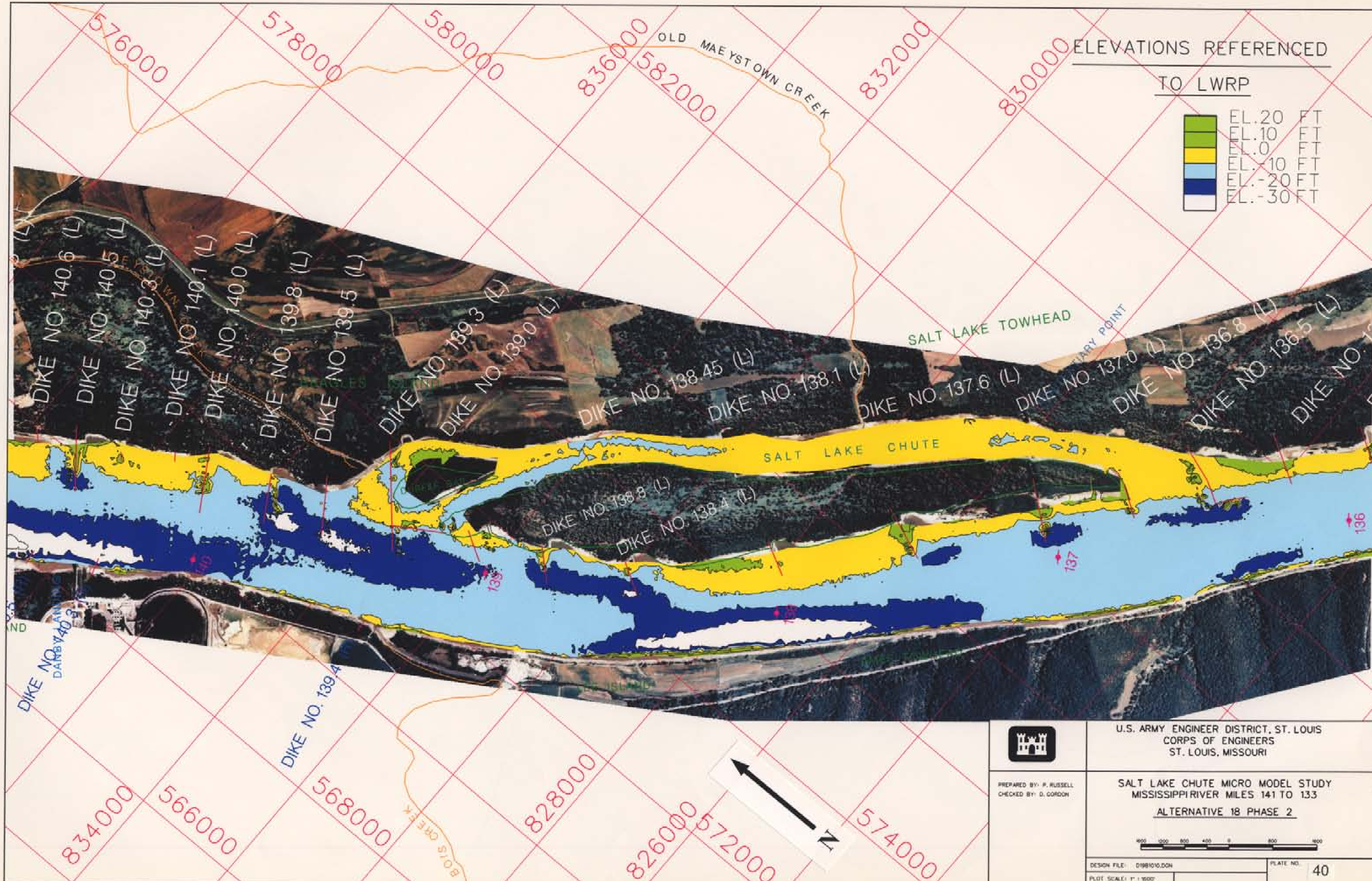
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133

ALTERNATIVE 17

DESIGN FILE: 01BA1005.DGN
PLOT SCALE: 1" : 1600'
PLATE NO. 38



ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Dredged Side Channel
Old Chute Dikes Removed
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
139
138
137
136
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
BOIS CREEK
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 18 PHASE 1
DESIGN FILE: D18A1010.DGN
PLOT SCALE: 1" = 1600'
PLATE NO.
39


ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
BOIS CREEK
136
137
139
140
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
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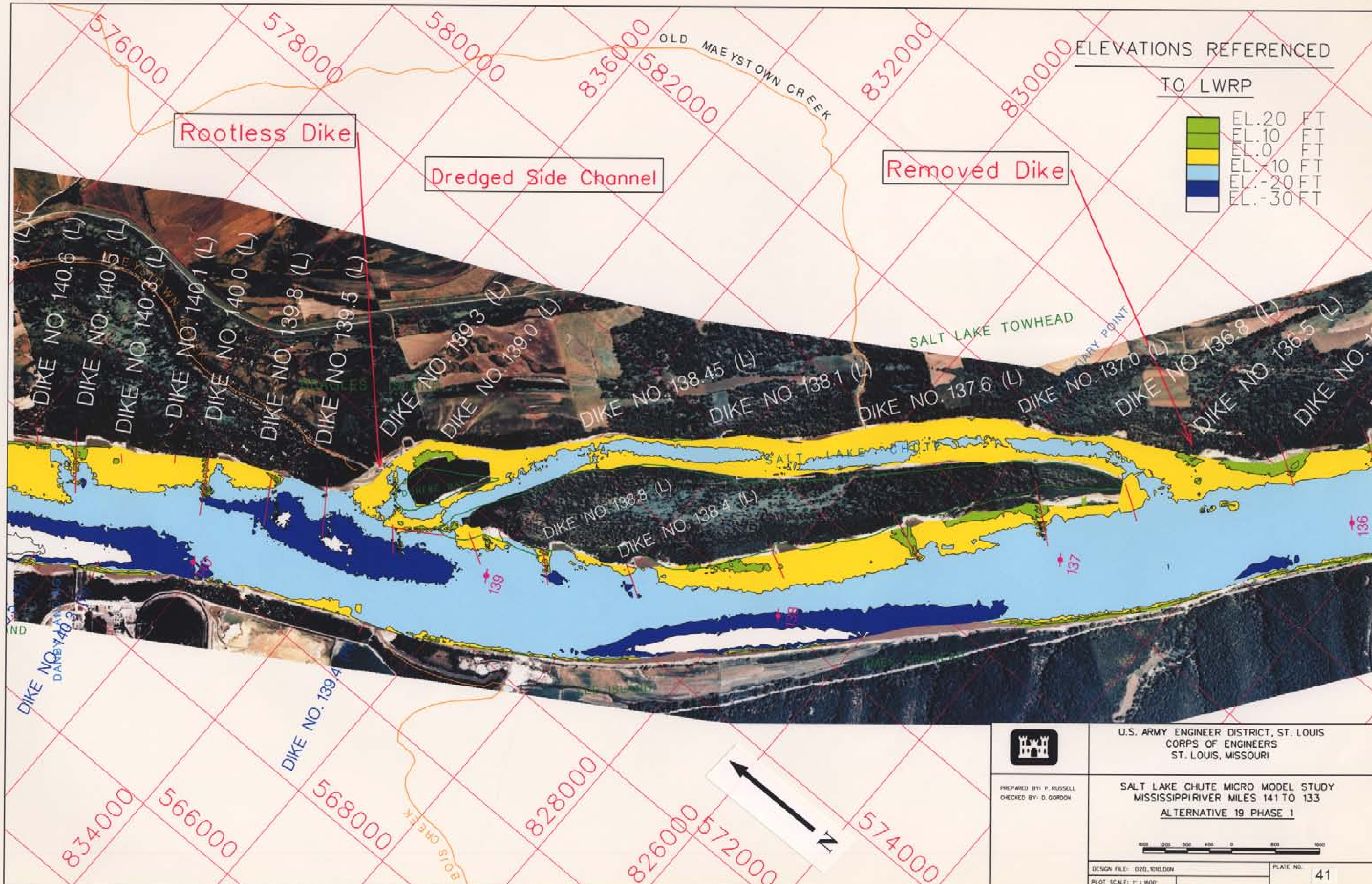
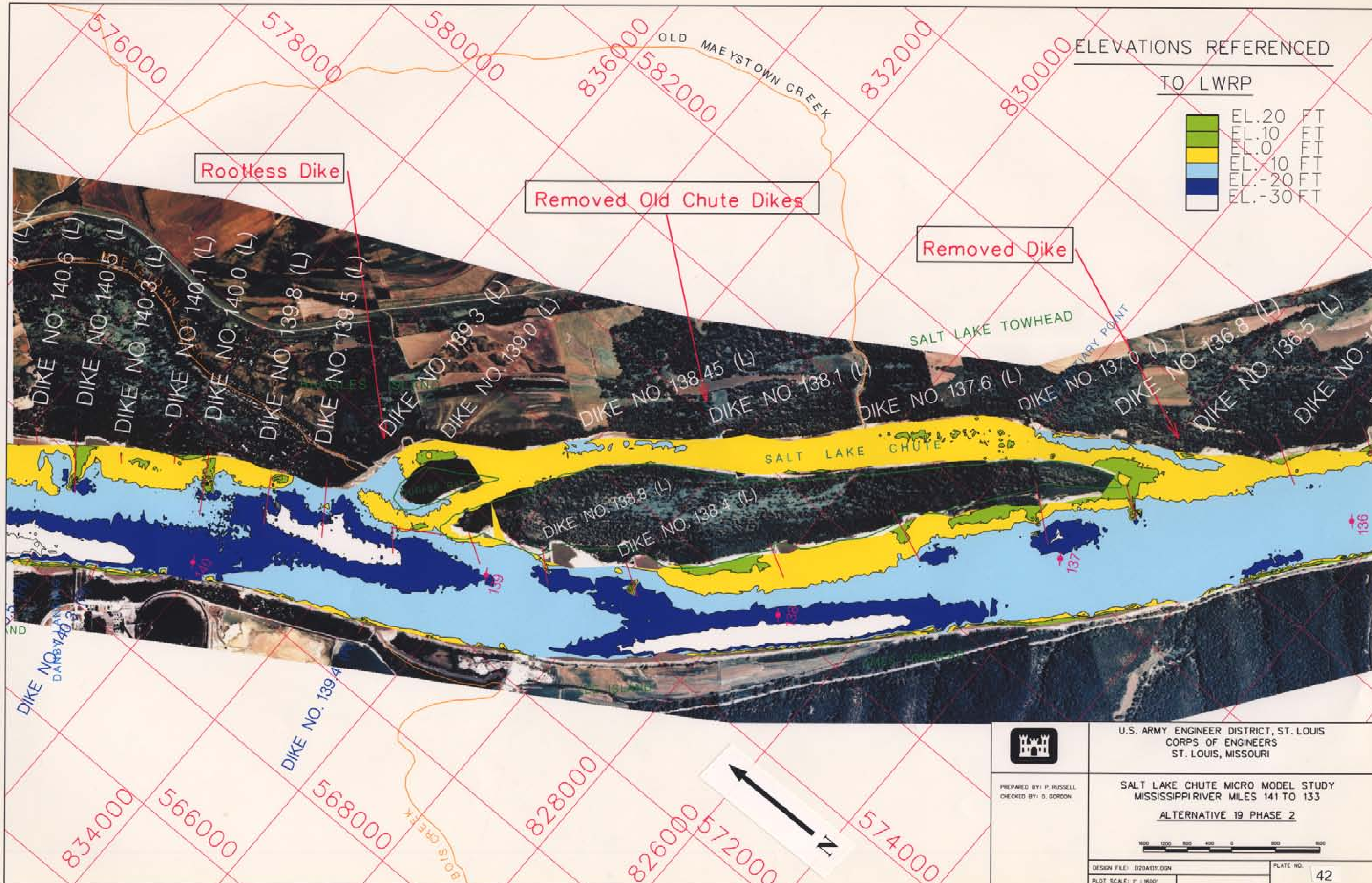
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 18 PHASE 2
PLATE NO. 40


ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Rootless Dike
Dredged Side Channel
Removed Dike
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
BOIS CREEK
139
138
137
136
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 19 PHASE 1
PLATE NO. 41


ELEVATIONS REFERENCED TO LWRP
EL.20 FT
EL.10 FT
EL.0 FT
EL.-10 FT
EL.-20 FT
EL.-30 FT
Rootless Dike
Removed Old Chute Dikes
Removed Dike
OLD MAEYSTOWN CREEK
SALT LAKE TOWHEAD
SALT LAKE CHUTE
DIKE NO. 140.6 (L)
DIKE NO. 140.5 (L)
DIKE NO. 140.3 (L)
DIKE NO. 140.1 (L)
DIKE NO. 140.0 (L)
DIKE NO. 139.8 (L)
DIKE NO. 139.5 (L)
DIKE NO. 139.3 (L)
DIKE NO. 139.0 (L)
DIKE NO. 138.45 (L)
DIKE NO. 138.1 (L)
DIKE NO. 137.6 (L)
DIKE NO. 137.0 (L)
DIKE NO. 136.8 (L)
DIKE NO. 136.5 (L)
DIKE NO. 138.8 (L)
DIKE NO. 138.4 (L)
DIKE NO. 139.4
BOIS CREEK
140
139
138
137
136
576000
578000
580000
582000
836000
832000
830000
834000
566000
568000
828000
826000
572000
574000
N
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
SALT LAKE CHUTE MICRO MODEL STUDY
MISSISSIPPI RIVER MILES 141 TO 133
ALTERNATIVE 19 PHASE 2
PREPARED BY: P. RUSSELL
CHECKED BY: D. GORDON
PLATE NO.
42