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US Army Corps of Engineers
St. Louis District

JONES CHUTE
HYDRAULIC SEDIMENT RESPONSE MODEL STUDY
MISSISSIPPI RIVER MILES 100.0—95.0

Authors: Mary M. Miles, Michael T. Rodgers, David C. Gordon, P.E., Edward H. Riiff, Martin Hoffman and Robert D. Davinroy

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
HYDROLOGIC AND HYDRAULICS BRANCH
APPLIED RIVER ENGINEERING CENTER
FOOT OF ARSENAL STREET
ST. LOUIS, MISSOURI 63118

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INTRODUCTION

The U.S. Army Corps of Engineers, St. Louis District initiated a study of the Upper Mississippi River between Miles 100.0 and 95.0, approximately ten miles downstream of Chester, Illinois. The main purpose of the study was to evaluate environmental design alternatives in the Upper and Lower Jones Chutes for the development of side channel habitat, utilizing an existing dike field and island complex on the Mississippi River.

A second phase of this study reach was initiated to model test alternatives to alleviate the reoccurring dredging in the navigation channel between RM 97.0 and 96.0. This second phase was begun upon completion of the first phase of alternative testing for the Upper and Lower Jones Chutes.

Mrs. Mary M. Miles and Mr. Michael T. Rodgers, hydraulic engineers, and Mr. Edward H. Riff, engineering technician, under direct supervision of, Mr. David C. Gordon, hydraulic engineer and Mr. Robert D. Davinroy, Chief of River Engineering, conducted the study between May 2006 and September 2006. The second phase of this study to address the reoccurring dredging problem was completed in April 2007. Other personnel also involved with the study included: Mr. Leonard Hopkins, Project Manager for the Avoid Minimize and Regulating Works Project, Mr. Brian Johnson and Mr. Ken Cook from the Environmental Branch of the Planning, Programs, and Project Management Division, Mr. Lance Engle, Dredging Project Manager. Personnel from other agencies involved in the study included: Mr. Butch Atwood from the Illinois Department of Natural Resources, and Ms. Joyce Collins, Mr. Robert Cail, Mr. Dick Steinbach from the U.S. Fish and Wildlife Service, Ms. Elisa Royce from the American Land Conservancy and Mr. Danny Brown from the Missouri Department of Conservation.

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BACKGROUND

Hydraulic Sediment Response (HSR) modeling methodology was used to evaluate sediment transport conditions and the impact associated with the incorporation of future design alternatives along a reach of the Middle Mississippi River including Upper and Lower Jones Chute. This first phase of the study was funded as part of the Avoid and Minimize Program of the U. S. Army Corps of Engineers, St. Louis District. The second phase of this study to alleviate dredging between RM 97.0 and 96.0 was funded by the Regulating Works Project of the U. S. Army Corps of Engineers, St. Louis District.

The primary goal of the first phase of this study was to diversify aquatic habitat in the Upper and Lower Jones Chute by modifying present dike structures, developing new side channels and bar formations while maintaining the integrity of the navigation channel. The secondary goal of the first phase was to alleviate reoccurring dredging between RM 97.0 and 96.0. A solution to the dredging problem was not found during the first phase so a second phase making the secondary goal the primary goal was begun upon completion of the first phase.

1. Study Reach

The study reach was located approximately 10 miles downstream of Chester, Illinois. The reach modeled was approximately 8 miles of the Middle Mississippi River, between River Miles (RM) 102.0 and 94.0. The study area was concentrated to a 5 mile stretch of the Middle Mississippi River, between RM 100.0 and 95.0. Plate 1 is a location and vicinity map of the study reach. The study area was located in Perry County, Missouri, and Randolph and Jackson Counties in Illinois. The side channels that are the focus of this study are located on the Missouri side of the river.

Plate 2 is a 2006 aerial photograph illustrating the planform and nomenclature of the Middle Mississippi River between RM 98.4 and 95.0. The right and left descending banks (RDB, LDB) in the Jones Chute reach are both made of typical alluvial flood plain material. Jones Chute is composed of new growth (cottonwoods) on both the

RDB and LDB. The banks are in good condition with little erosion and are comprised of clay and silt. The closure structure near RM 95.8 creates a deep scour hole. There are two additional locations where Dike 97.0R acts as a closure structure at the upper end of Jones Chute.

At the time of this study, the entire study reach had a total of 30 dikes (3 of them being remnant pilings) and six existing bendway weirs. One dike and parts of two other dikes are closure structures for the Upper and Lower Jones Chutes. Dikes existing in side channel on the LDB upstream of RM 100 had no affect on the model and were therefore not included in this study. At the time of the first phase of this study construction plans for the fiscal year 2007 were scheduled to place three chevrons in the main channel of this study area, raise six existing dikes in the main channel and construct three hardpoints along Liberty Bar. Table 1 lists all the dikes and weirs in the study reach. The dike fields are shown on Plate 3.

Table 1: Existing River Training Structures

Structure Name	Length (feet)	Top Elevation (feet)	Height Above LWRP (Nearest half foot)	Date of Readings
Dikes				
101.2R	150	Underwater		April 5, 2000
101.0R	150	Underwater		April 5, 2000
100.8R	150	Sloped		April 5, 2000
100.7R	300	346.5	11.0	April 5, 2000
100.6R	850	344.4	9.0	April 5, 2000
100.4R	1000	344.3	9.5	April 5, 2000
100.1R	850	346.1	11.0	April 5, 2000
100.4L	400	Underwater		April 5, 2000
100.1L	150	Underwater		April 5, 2000
99.9R	450	344.0	10.0	April 5, 2000
99.8R	850	344.9	10.5	April 5, 2000
99.6R	900	344.8	10.5	April 5, 2000
99.2R	1350	343.6	9.0	April 5, 2000
98.9R	1150	343.4	9.5	April 5, 2000
98.4R	1250	344.1	10.0	April 5, 2000
98.0L	150	344.9	11.5	April 5, 2000
97.9L	150	344.8	11.5	April 5, 2000
97.8L	250	Sloped		April 5, 2000
97.7L	100	Underwater		April 5, 2000
97.5R	1150	341.5	8.0	April 6, 2000
97.0R	2700	341.2	9.0	April 6, 2000
96.8R	1500	342.1	9.5	April 6, 2000
96.5R	1000	342.9	10.5	April 6, 2000
96.2R	550	342.7	11.0	April 6, 2000
95.8R	500	345.5	13.5	April 6, 2000
94.8L	Remnant Pilings			-
94.6L	Remnant Pilings			-
Side Channel Closure Structures				
101.1L	880	Underwater		April 5, 2000
100.4L	360	Underwater		April 5, 2000
100.1L	300	Underwater		April 5, 2000
97.5R	120	No Reading		-
97.0R	340	342.2	9.0	April 6, 2000
95.8R	500	345.5	13.5	April 6, 2000
Weirs				
94.8R	1050	Underwater		-
94.6R	750	Underwater		-
94.5R	700	Underwater		-
94.3R	1100	Underwater		-
94.1R	1200	Underwater		-
94.05R	1100	Underwater		-

2. Study Goal

The Upper and Lower Jones Chutes can lose their connectivity with the main channel and become dry during low water periods. The main goal of the first phase this study was to investigate alternatives to direct more flow through the two chutes in this section of the Mississippi River without causing negative effects to the navigation channel. Increased flow to the chutes will allow for more aquatic habitat diversity. Fish species thrive in slow, shallow channels, deep pools and around bar formations. The goal of the second phase of this study was to investigate alternatives that would alleviate the reoccurring dredging problems between RM 97.0 and 96.0 by deepening and/ or widening this stretch of the river.

3. History

The river channel in the Jones Chute area has changed due to the construction of dike fields. A project and progress map (Plate 4) from 1928 shows little change in the main channel along the LDB. A series of dikes on the RDB from RM 100.4 to 97.5 in combination with two dikes in the old chute behind the 1928 location of Liberty Bar helped to form the current shape of the RDB. The old chute was closed off by dikes and the 1928 location of Liberty Bar is now the RDB of Upper Jones Chute. Jones Towhead is shown in the 1928 map as a growing island. The current location of Liberty Bar, Jones Towhead and therefore the Upper and Lower Jones Chutes were formed by the construction of the dike fields shown in the 1928 map and further extensions and additions to the dike fields. The side channel area that would be Lower Jones Chute today was approximately 1000 ft wide and the current Upper Jones Chute was not formed yet. A 1928 and 2006 comparison between main channel widths at different river miles is shown on Table 2.

Table 2: Main Channel Width by Year and River Mile (RM) as Designated in 2006

Year	RM 100	RM 98	RM 97	RM 96	RM 95
1928	3000 ft	3800 ft	4600 ft (with sandbar forming in middle of channel)	1800 ft	2500 ft
2006	3000 ft (with island on RDB)	2500 ft	2600 ft	2100 ft	2300 ft

Additions and notching to the dikes around RM 100 helped to create a series of islands known as the Mile 100 islands complex. Aerial photography from 1970 (Plate 5) shows the beginning stages of the complex. By 1987 (Plate 5) aerial photography showed that five islands had formed. Aerial photography from 2006 shows further formation of the Mile 100 islands complex.

Dredging occurred in the Jones Chute reach of the Middle Mississippi River (RM 100 to 94) 36 times between 1979 and 2006 for a volume of approximately 6,748,700 cubic yards of material. Dredging has consistently occurred between RM 100.4 and 99.5, and RM 97.0 and 95.5.

4. Field Observations

Personnel from the Applied River Engineering Center inspected the study reach. These reconnaissance missions allowed the site to be photographed and studied. The site visits are described below.

May 18 and 19, 2006 (Plate 6):

The Chester, Illinois gage (RM 109.9) was at a stage of 15.9 ft / +16.6 ft LWRP. The Red Rock gage (RM 94.1) was at a stage of 20.5 ft / +18.7 ft LWRP.

Field observations were recorded and data was collected in this study reach by shallow draft boat. At the time of data collection, the water depth in side channel was approximately 15 ft through the reach with velocities averaging 2.4 ft/s and bed material consisting of clay with fines and sand. The closure structure near RM 95.8 creates a deep scour hole with depths reaching 70 ft. There are two additional locations where Dike 97.0R acts as a closure structure at the upper end of Jones Chute. The data collected during this site visit included sediment samples, velocity profiles and general field observations

Jones Chute is composed of new growth (cottonwoods) on both the RDB and LDB. The banks are in good condition with little erosion and are comprised of clay and silt.

Field observations were also recorded for the Mile 100 Islands complex. The complex consists of a series of 5 islands which formed as a result of the notching river training structures. The islands increase in size (square footage) in downstream direction and they are a function of dike spacing. The more distance between the structures results in a large island formation.

Both the RDB and LDB in this reach are made of typical alluvial flood plain material. Dike height, notch locations and notch depths are imperative in the island development. The islands are well vegetated, and show few signs of bank erosion. Depths in the side channels between the islands and the main river bank varied between 9 and 15 ft, velocities averaged 1.5 ft/s and the bed material was clay with fines.

September 6, 2006 (Plate 7):
The Chester, Illinois gage (RM 109.9) was at a stage of 3.9 ft / +4.6 ft LWRP. The Red Rock gage (RM 94.1) was at a stage of 7.8 ft / +6.0 ft LWRP.

The Upper and Lower Jones Chute entrances were closed due to sedimentation. Vegetation in the side channel entrances was approximately three feet height except for the lower entrance to Lower Jones Chute which had growth of less than one foot. Isolated pools that existed in the chutes were mostly stagnant with the exception of small, approximately two foot wide, sources of water from the main channel. Approximately half of the area within the two chutes was silted in and dry.

September 14, 2006 (Plate 8):
The Chester, Illinois gage (RM 109.9) was at a stage of 3.3 ft / +4.0 ft LWRP. The Red Rock gage (RM 94.1) was at a stage of 6.9 ft / +5.1 ft.

Aerial Photography shows the Upper Jones Chute almost entirely silted in and the Lower Jones Chute silted in at the upstream and downstream entrances.

HYDRAULIC SEDIMENT RESPONSE (HSR) MODEL DESCRIPTION

1. Scales and Bed Materials

In order to investigate the sediment transport conditions described previously, a physical HSR model was designed and constructed. Plate 9 is a photograph of the HSR model used in this study. The zero reference plane of the prototype was assumed to be at the LWRP (Low Water Reference Plane) condition. The model employed a horizontal scale of 1 inch = 500 ft, or 1:6000, and a vertical scale of 1 inch = 55 ft, or 1:660, for a 9.1 to 1 distortion ratio of linear scales. This distortion supplied the necessary forces required for the simulation of sediment transport conditions similar to those of the prototype. The bed material was granular plastic urea, Type II, with a specific gravity of 1.40.

2. Appurtenances

The HSR model insert was constructed according to the 1996 high-resolution aerial photograph of the study reach. The insert was then mounted in a standard HSR flume. The riverbanks of the model were constructed from dense polystyrene foam, and modified during calibration with galvanized steel mesh. Rotational jacks located within the hydraulic flume controlled the slope of the model. The measured slope of the insert and flume was approximately 0.01 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.

HSR MODEL TESTS

1. Model Calibration

The calibration of the HSR 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.

A. HSR Model Operation

In all model tests, a steady state flow was simulated in the Upper Mississippi River channel. This served as the average design energy response for the river. This steady state was used to theoretically analyze the ultimate expected sediment response. The flow was held steady at a constant flow rate of approximately 2.2 gallons per minute (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. 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 stages.

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. Comprehensive hydrographic surveys were taken in 1956, 1971, 1977, 1982, 1988, 1996, 1998, 2001, and 2005. A 2001 detailed channel and side channel sweep survey of the study reach, between RM 102 and 94 is shown on Plate 10. The 2005 survey showed the thalweg of the main channel was located in the same general alignment as the 2001 and 1998 survey. The bathymetry of the most recent prototype surveys (1998, 1999 side channel, 2001 and 2005) were very similar to each other and were used to calibrate the micro model. The 1998, 1999 side channel and 2005 hydrographic surveys are shown on Plates 11, 12 and 13.

The general trends of the prototype as observed in the hydrographic surveys are described as follows:

- The thalweg entered the study reach along the RDB near RM 102 with depths up to -30 ft LWRP.
- Scour holes of various sizes existed downstream of the dikes on the RDB between RM 100.6 and 98.4. Plunge pools below Dikes 100.6R, 100.4R and 99.2R reached depths up to -40 ft LWRP; below Dikes 100.1R, 99.9R and 98.4R reached depths up to -30 ft LWRP; and below Dikes 99.6R and 98.6R reached depths up to -20 ft LWRP. Dike 99.8 had a shallow scour hole below it reaching a depth up to -6 ft LWRP.
- The thalweg crossed to the LDB between River Mile 100.7 and 99.8. A dredging problem exists within this crossing with some depths surveyed as shallow as -6 ft LWRP. Future construction plans for a series of three chevrons around River Mile 100L will most likely increase the depths in the crossing.
- The thalweg remained along the LDB from River Mile 99.8 to 95 with depths ranging between -20 ft to -30 ft LWRP.
- The main channel shoaled to depths of -6 ft. to -8 ft. LWRP between RM 96.8 and 96.4 on the outside of the bend on the LDB.
- Depths in the Upper Jones Chute (River Mile 98.4 to 99.6) range from -2 ft to above 10 ft LWRP.
- Depths downstream of Dike 97.0R between Liberty Bar and the triangularly shaped island reached depths up to -30 ft LWRP. A small scour hole towards the LDB of the island reached depths up to -14 ft LWRP.
- Depths in scour holes downstream of Dikes 96.8R, 96.5R and 96.2R ranged from -20 to -40 ft LWRP.
- Depths in the Lower Jones Chute (River Mile 96.9 to 95) range from -10 ft to greater than 10 ft LWRP except for a scour hole downstream of Dike No. 95.8 where depths reach -20 ft to -30 ft LWRP.
- The thalweg of the main channel crosses back over to the RDB between River Mile 95.4 to 94.6 with depths approaching -30 ft LWRP.

C. Scheduled Construction

At the time of the first phase of this study several river training structures were scheduled to be constructed in this reach of river. These scheduled construction projects were placed in the model after the model was calibrated with current river structures. Structure dimensions were taken off constructions plans. Future, scheduled river structures are shown on Plate 14. A list of structures scheduled for construction is shown on Table 3.

Table 3: Planned Construction of River Training Structures

River Mile	Structure Type	Status	Elevation (LWRP)
100.1(L)	Chevron	New	+ 20 ft
100.0(L)	Chevron	New	+ 20 ft
99.9(L)	Chevron	New	+ 20 ft
98.4(R)	Dike	Existing-Raise	+ 17.0 ft.
97.5(R)	Dike	Existing-Raise	+ 16.5 ft.
97.0(R)	Dike	Existing-Raise	+ 19.5 ft.
96.8(R)	Dike	Existing-Raise	+ 17.5 ft.
96.5(R)	Dike	Existing-Raise	+ 19.5 ft.
96.2(R)	Dike	Existing-Raise	+ 19.0 ft.
97.4 (R)	Hardpoint	New	+ 26.5 ft.
97.3 (R)	Hardpoint	New	+ 26.5 ft.
97.2 (R)	Hardpoint	New	+ 26.5 ft.

2. Base Test

Model calibration was achieved when it was determined through qualitative comparisons that the base test surveys were similar to several prototype surveys of the model. The resultant bathymetry of the base test is shown on Plate 15. The base test was developed from the simulation of successive repeatable design hydrographs until bed stability was reached and a similar bed response was achieved as compared with prototype surveys. After the base test was achieved, the river training structures scheduled to be constructed and altered with the exclusion of the hardpoints were added to the HSR model. This base test survey (including the river training structures to be constructed and altered) served as the comparative bathymetry for all design alternative tests (Plate 16).

Results of the HSR base test bathymetry (without river training structures to be constructed) and a comparison to the prototype surveys indicated the following trends:

- The thalweg entered the study reach along the RDB near River Mile 102 with depths up to -30 ft LWRP.
- Scour holes were formed downstream of Dikes 100.6R, 99.9R, 99.2R, and 98.9R. The scour holes reached depths ranging from -16 ft to -30 ft LWRP. The scour holes were smaller in size from the prototype.
- The thalweg crossed to the LDB between River Mile 100.7 to 99.8. Sediment formed in this crossing with depths as shallow as -6 ft LWRP.
- The scour hole downstream of Dikes 98.4R reached depths of -30 ft. LWRP. The scour hole downstream of Dike 97.5R reached depths up to -10 ft LWRP.
- The thalweg remained along the LDB from River Mile 99.8 to 95 with depths ranging from -30 ft to -40 ft LWRP.
- The main channel shoaled to depths of -10 ft. to -18 ft. LWRP between RM 96.8 and 96.4 on the outside of the bend on the LDB.
- Depths in the Upper Jones Chute (RM 98.4 to 97.0) ranged from -2 ft to above 10 ft LWRP.
- Depths downstream of dike 97.0R between Liberty Bar and the triangularly shaped island reached depths up to -30 ft LWRP.
- Depths in the Lower Jones Chute (RM 96.9 to 95) ranged from -8 ft to greater than 10 ft LWRP. A scour hole was not formed downstream of Dike 95.8R.
- Scour holes were not formed behind Dikes 96.8R, 96.5R and 96.2R, but depths along the RDB between RM 96.8 to 95.4 ranged from 0 ft to -12 ft LWRP.
- The thalweg of the main channel crossed back over to the RDB between River Mile 95.4 to 94.6 with depths reaching -50 ft LWRP and sedimentation occurring to -4 ft LWRP.

The main differences between the model (without river training structures to be constructed) and prototype surveys are:

- Scour holes downstream of dikes were not as deep or as large in the model with the exception of Dike 98.9R.
- Bar formations along the RDB between RM 100 and 98 were not as high in the model.
- Bar formations along the RDB between RM 97 and 95 are higher and wider in the model.
- Depths in the Lower Jones Chute are shallower in the model. A scour hole is not formed downstream of Dike 95.8R.
- The main channel crossing between RM 95.4 and 94.6 was shallower in the model.

Results of the HSR base test bathymetry (including the river training structures to be constructed and altered with the exclusion of the hardpoints) differed slightly from the base test. The differences are as follows:

- The sedimentation problem that existed in the channel crossing between RM 101.4 to 99.8 was slightly alleviated with a wider section of depths below -10 ft LWRP.
- Depths downstream of Dikes 98.4R through 96.8R were slightly shallower.

In general, the overall bathymetric trends established in the HSR model base test were similar to those trends observed in the prototype. The main differences were the shallow depth or lack of scour holes behind most of the dikes in this stretch of the Upper Mississippi River. The depth shown in the prototype of the scour holes were most likely formed during a high flow events. Since this model study simulated average design energy the scour holes were shallower in the base test.

3. Design Alternative Tests

All design alternatives studied in the HSR model utilized the existing dike configurations in the prototype surveys. All proposed construction as listed in Table 3 was utilized except the proposed hardpoints at River Miles 97.4, 97.3, and 97.2. These hardpoints are only included in Alternative 1. Thirteen design alternative plans were model tested to examine methods of modifying the sediment transport response trends that would foremost create greater depth in the side channels and secondly alleviate dredging problems within this reach of the Middle Mississippi River. The effectiveness of each design was evaluated by comparing the resultant bed configuration to that of the base test. Impacts or changes induced by each alternative were evaluated by observing the sediment response of the model.

Alternatives were considered successful if at least half the length of either the Upper or Lower Jones Chutes experienced greater depths of water while not negatively affecting the navigation channel. Because of these loose criteria many alternatives were considered successful. The alternatives with the most depth created in the greatest length of the chutes while not negatively affecting the navigation channel were considered the most successful. Table 4 outlines the different alternatives that were run, defines if an alternative was successful or not, and shows brief comments about that alternative.

Table 4: HSR Model Alternatives and Evaluations

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
1 (Plate 17)	97.40R	Install Dike	150 / +18 LWRP	No	This alternative showed little change from the base test. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	97.30R	Install Dike	100 / +18 LWRP		
	97.20R	Install Dike	100 / +18 LWRP		
2 (Plate 18)	98.40R	Existing Dike - Notched	200 / 0 LWRP	No	This alternative created scour holes behind the notches but did not deepen the side channels past the bend on Upper Jones Chute. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	97.50R	Existing Dike - Notched	200 / 0 LWRP		
2a (Plate 19)	98.40R	Existing Dike - Notched	200 / 0 LWRP	No	This alternative created scour holes behind the notches but did not deepen the side channels. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	97.50R	Existing Dike - Notched	200 / 0 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
3 (Plate 20)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created scour holes behind the notches and deepened the side channels from Upper Jones Chute through the first quarter of Lower Jones Chute. More depth is desired in the lower ¾ of Lower Jones Chute. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.20R	Install Chevron	400 x 400 / +18 LWRP		
	97.80R	Install Chevron	400 x 400 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.50R	Existing Dike - Notched	200 / 0 LWRP		
	97.00R	Existing Closure Structure - Removed	-		
	97.00R	Existing Dike - Notched	200 / 0 LWRP		
4 (Plate 21)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created scour holes behind the notches and deepened the Upper Jones Chute side channel. More depth is desired in both Upper and Lower Jones Chutes. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.20R	Install Chevron	400 x 400 / +18 LWRP		
	97.80R	Install Chevron	400 x 400 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.50R	Existing Dike - Notched	200 / 0 LWRP		
	97.00R	Existing Closure Structure - Removed	-		
	97.00R	Existing Dike - Notched	200 / 0 LWRP		
	96.90R	Install Closure Structure	300 / +18 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
5 (Plate 22)	98.50R	Install Chevron	400 x 400 / +18 LWRP	No	This alternative created a scour hole at the upstream entrance of Upper Jones Chute, but did not create depth in the side channel. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.40R	Existing Dike - Removed	-		
	98.30R	Install Chevron	400 x 400 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		
6 (Plate 23)	98.90R	Existing Dike - Notched	200 / 0 LWRP	No	This alternative created a scour hole at the upstream entrance of Upper Jones Chute, but did not create depth in the side channel. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.50R	Install Chevron	400 x 400 / +18 LWRP		
	98.40R	Existing Dike - Removed	-		
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
7 (Plate 24)	98.90R	Existing Dike - Notched	200 / 0 LWRP	No	This alternative created a scour hole at the upstream entrance of Upper Jones Chute, but did not create depth in the side channel. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.90L	Install Rock Blanket	1200 x 300 / -15 LWRP		
	98.40R	Existing Dike - Notched	200 / 0 LWRP		
	97.50R	Existing Dike - Notched	500 / 0 LWRP		
	97.00R	Existing Closure Structure - Removed	-		
8 (Plate 25)	98.90L	Install Rock Blanket	1200 x 300 / -15 LWRP	No	This alternative created a scour hole at the upstream entrance of Upper Jones Chute, but did not create depth in the side channel. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.40R	Existing Dike - Notched	200 / 0 LWRP		
	97.50R	Existing Dike - Notched	400 / 0 LWRP		
	96.95R	Install Dike	550 / +18 LWRP		
9 (Plate 26)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created a scour hole downstream of notch in dike 98.40R. Desirable depth was achieved in Upper and the upper 3/4 of Lower Jones Chute. Greater depth the whole length of Lower Jones Chute is desired. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
10 (Plate 27)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created a scour hole downstream of notch in dike 98.40R. Desirable depth was achieved in Upper and Lower Jones Chute. Greater depth is desired downstream at the edge of Lower Jones Chute. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		
	95.70R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.60R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.50R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.40R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.30R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.20R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
11 (Plate 28)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created a scour hole downstream of notch in dike 98.40R. Desirable depth was achieved in Upper and Lower Jones Chute. Greater depth was achieved downstream at the edge of Lower Jones Chute. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.35R	Install Dike	750 / +18 LWRP		
	97.60L	Install Dike	100 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.50L	Install Dike	100 / +18 LWRP		
	97.40L	Install Dike	100 / +18 LWRP		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	96.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	96.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		
	95.70R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.60R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.50R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.40R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.30R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.20R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.80R	Install Dike/ Hardpoint	200 / +18 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
12 (Plate 29)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created a scour hole downstream of notch in dike 98.40R. Desirable depth was achieved in Upper and Lower Jones Chute. Greater depth was achieved downstream at the edge of Lower Jones Chute. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.00R	Install Chevron	400 x 400 / +18 LWRP		
	97.75R	Install Chevron	400 x 400 / +18 LWRP		
	97.50R	Install Chevron	400 x 400 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	96.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	96.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		
	95.70R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.60R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.50R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.40R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.30R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.20R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.80R	Install Dike/ Hardpoint	200 / +18 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
13 (Plate 30)	98.40R	Existing Dike - Notched	200 / 0 LWRP	Yes	This alternative created a scour hole downstream of notch in dike 98.40R. Desirable depth was achieved in Upper and Lower Jones Chute. Greater depth was achieved downstream at the edge of Lower Jones Chute. Greater depth is desired in the main channel in the bend along the LDB between RM 97.0 and 96.2.
	98.35R	Install Dike	550 / +18 LWRP		
	97.50R	Existing Dike - Extended	200 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	96.80R	Existing Dike - Extended	250 / +18 LWRP		
	96.50R	Existing Dike - Extended	200 / +18 LWRP		
	96.20R	Existing Dike - Extended	300 / +18 LWRP		
	96.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	96.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		
	95.70R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.60R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.50R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.40R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.30R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.20R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.80R	Install Dike/ Hardpoint	200 / +18 LWRP		

CONCLUSIONS

1. Summary

Several alternative design tests were conducted for this HSR model. Each alternative tested was with the primary intention of increasing depth in the two side channels, Upper and Lower Jones Chutes, without causing negative effects to the navigation channel. A secondary objective was to evaluate alternatives that would alleviate the dredging problems between RM 97.0 and 96.0.

Table 5: Evaluation of Model Tests for Primary and Secondary Purposes

Alternative 1	X			
Alternative 2	X			
Alternative 2a	X			
Alternative 3	X	X		
Alternative 4	X	X		
Alternative 5	X			
Alternative 6	X			
Alternative 7	X			
Alternative 8	X			
Alternative 9	X	X		
Alternative 10	X	X		
Alternative 11	X	X		
Alternative 12	X	X		
Alternative 13	X	X		

Other alternatives that were screened but not tested to alleviate the dredging problems between RM 97.0 and 96.0 that are not shown in the plates include the following: a weir field on the LDB at the upstream of the dredging problem area; a rock blanket on the LDB upstream of the dredging problem area; and shortening of Dikes 96.8R, 96.5R and 96.2R. None of these alternatives showed a significant increase in depth of water on the LDB between RM 97.0 and 96.0. A second phase of alternative testing to relieve the dredging problem was begun after the initial testing showed improvements to the conditions in the side channels. Dredging

Alternative testing results and recommendations are shown in the dredging section of this report.

2. Recommendations

Alternative 11, without the added dikes on the LDB, is recommended due to its ability to increase the depth of water in both the Upper and Lower Jones Chutes. No alternative was found that would alleviate the dredging problem between RM 97.0 and 96.0.

The recommended design includes the following:

- Notch Dike 98.4R 200 ft from the RDB to a depth of 0 ft LWRP. Raise remaining portions of Dike 98.4R to +18 ft LWRP.
- Construct a longitudinal closure structure from end of notch in Dike 98.4R to Liberty bar to +18 ft LWRP.
- Remove the portions of Dikes 97.5R and 97.0R that are contained within the Upper Jones Chute side channel.
- Construct a longitudinal closure structure between Liberty Bar and Jones Towhead to +18 ft LWRP with a 100 ft.- top width, v-notch on center to +5 ft LWRP invert.
    - This closure structure will keep the flow entering Upper Jones Chute from exiting the side channel complex between Upper and Lower
- Notch closure structure 95.8R in the Lower Jones Chute channel. Notch will be 150 ft wide on center and to a depth of 0 ft LWRP.

Additional considerations to the above model design are the revetment of all bank lines inside both the Upper and Lower Jones Chutes. Revetment will also be needed along the upstream end of Liberty Bar extending to the closure structure between Liberty Bar and the notch in Dike 98.4R. It was also determined that the scheduled dike raises to DIKES 98.4R, 97.5R, 97.0R, 96.8R, 96.5R and 96.2 R did not have the desired affect of widening the main channel at depths greater than -10 ft LWRP between RM 97.0 and 96.0. These dike raises were taken of the scheduled construction list from channel improvement.

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.

DREDGING HSR MODEL TESTS

Dredging Alleviation (RM 97.0 – 96.0)

1. Model Calibration – Dredging (RM 97.0-96.0)

A. Scheduled Construction

Three chevrons are scheduled to be constructed in this reach of river. Future structure dimensions were taken off construction plans. Key structures that were recommended from Alternative 11 of the first phase of this study to improve the side channel conditions were included in the second phase of this study to alleviate dredging. A list of structures included in the model is shown on Table 6.

Table 6: Planned Construction of River Training Structures

River Mile	Structure Type	Elevation (LWRP)
100.1(L)	Chevron	+ 20 ft
100.0(L)	Chevron	+ 20 ft
99.9(L)	Chevron	+ 20 ft
98.40R	Existing Dike - Notched	200 / 0 LWRP
98.35R	Longitudinal Dike	750 / +18 LWRP
97.50R	Existing Closure Structure - Removed	-
97.00R	Existing Closure Structure - Removed	-
96.95R	Longitudinal Dike	550 / +18 LWRP
95.80R	Existing Dike - Notched	150 / 0 LWRP

2. Base Test – Dredging (RM 97.0-96.0)

Structures and alterations shown in Table 6 were added to the HSR model to create a base test for the second phase of this study. This base test survey served as the comparative bathymetry for all dredging design alternative tests (Plate DRG 1).

Results of the HSR dredging base test bathymetry (including structures and alterations listed in Table 6) differed slightly from the base test from the first phase of this study. The differences are as follows:

- The sedimentation problem that existed in the channel crossing between RM 101.4 to 99.8 was slightly alleviated with a wider section of depths below -10 ft LWRP.
- The depth and size of the scour hole downstream of Dike 98.9R was increased.
- Depths in the Upper and Lower Jones Chutes were increased to depths between 0 ft LWRP and greater than -50 ft LWRP.

3. Design Alternative Tests – Dredging (RM 97.0-96.0)

All design alternatives studied in the HSR model utilized the existing dike configurations in the prototype surveys with the exception of those listed in Table 6. Seventeen design alternative plans were model tested to examine methods of modifying the sediment transport response trends that would foremost create greater depth and width in the main channel bend between RM 97.0 and 96.0. The effectiveness of each design was evaluated by comparing the resultant bed configuration to that of the dredging base test. Impacts or changes induced by each alternative were evaluated by observing the sediment response of the model.

Alternatives were considered successful if a minimum width of 300 ft around the bend between RM 97.0 and 96.0 at a depth of -10 ft LWRP or greater was achieved. Success was also determined if the river between RM 96.0 and 95.5 was not constricted to a width less than 400 ft at depths less than -10 ft LWRP. The alternatives with the most width created while meeting the constriction criteria were considered the most successful. Some alternatives that would be considered successful from the above criteria were not chosen because they would involve structures encroaching too far upon the navigation channel or sufficient depth for construction of underwater structures was not available. Table 7 outlines the different alternatives tested, defines if an alternative was successful or not, and shows brief comments about that alternative.

Table 7: HSR Dredging Model Alternatives and Evaluations

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
DRG ALT 1-17 Include:	98.40R	Existing Dike - Notched	200 / 0 LWRP	-	-
	98.35R	Install Dike	550 / +18 LWRP		
	97.50R	Existing Closure Structure - Removed	-		
	97.00R	Existing Closure Structure - Removed	-		
	96.95R	Install Dike	550 / +18 LWRP		
	95.80R	Existing Dike - Notched	150 / 0 LWRP		
DRG ALT 1 (Plate DRG 2)	96.80 R	Extend Existing Dike	400 / +18 LWRP	No	Provided a max. width at the bend of 140 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 180 ft.
	96.50 R	Extend Existing Dike	350 / +18 LWRP		
	96.20 R	Extend Existing Dike	350 / +18 LWRP		
DRG ALT 2 (Plate DRG 3)	96.80 R	Extend Existing Dike	550 / +18 LWRP	No	Provided a max. width at the bend of 120 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 220 ft.
	96.50 R	Extend Existing Dike	550 / +18 LWRP		
	96.20 R	Extend Existing Dike	500 / +18 LWRP		
DRG ALT 3 (Plate DRG 4)	96.80 R	Extend Existing Dike	1100 / +18 LWRP	No	Provided a max. width at the bend of 150 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 250 ft.
	96.50 R	Extend Existing Dike	1050 / +18 LWRP		
	96.20 R	Extend Existing Dike	1000 / +18 LWRP		
DRG ALT 4 (Plate DRG 5)	96.80 R	Extend Existing Dike-Upstream Angle	350 / +18 LWRP	No	Provided a max. width at the bend of 0 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 160 ft.
	96.50 R	Extend Existing Dike-Upstream Angle	400 / +18 LWRP		
	96.20 R	Extend Existing Dike-Upstream Angle	350 / +18 LWRP		
DRG ALT 5 (Plate DRG 6)	96.80 R	Extend Existing Dike-Upstream Angle	600 / +18 LWRP	No	Provided a max. width at the bend of 100 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 200 ft.
	96.50 R	Extend Existing Dike-Upstream Angle	600 / +18 LWRP		
	96.20 R	Extend Existing Dike-Upstream Angle	650 / +18 LWRP		
DRG ALT 6 (Plate DRG 7)	96.80 R	Extend Existing Dike-Upstream Angle	900 / +18 LWRP	No	Provided a max. width at the bend of 270 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 370 ft.
	96.50 R	Extend Existing Dike-Upstream Angle	1000 / +18 LWRP		
	96.20 R	Extend Existing Dike-Upstream Angle	1050 / +18 LWRP		
DRG ALT 7 (Plate DRG 8)	96.80 R	Extend Existing Dike-Upstream Angle	1100 / +18 LWRP	Yes	Provided a max. width at the bend of 430 ft. at depths greater than -10 ft. LWRP. No channel constriction downstream.
	96.50 R	Extend Existing Dike-Upstream Angle	1200 / +18 LWRP		
	96.20 R	Extend Existing Dike-Upstream Angle	1250 / +18 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
DRG ALT 8 (Plate DRG 9)	97.50R	Extend Existing Dike	450 / +18 LWRP	Yes	Provided a max. width at the bend of 340 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 530 ft.
	97.30L	Install Weir	600 / -15 LWRP		
	96.80R	Change Layout of Existing Dike	1250 / +18 LWRP		
	96.50R	Change Layout of Existing Dike	1350 / +18 LWRP		
	96.20R	Change Layout of Existing Dike	1100 / +18 LWRP		
	96.20L	Install Weir	500 / -15 LWRP		
	96.00L	Install Weir	500 / -15 LWRP		
DRG ALT 9 (Plate DRG 10)	98.00R	Existing Dike - Removed	-	No	Provided a max. width at the bend of 0 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 0 ft.-
	97.90R	Existing Dike - Removed	-		
	97.80R	Existing Dike - Removed	-		
	97.50R	Extend Existing Dike	450 / +18 LWRP		
	97.30L	Install Weir	700 / -15 LWRP		
	97.20L	Install Peak Nosed Chevron	300 / -15 LWRP		
	97.10L	Install Peak Nosed Chevron	300 / -15 LWRP		
	97.00L	Install Peak Nosed Chevron	300 / -15 LWRP		
	96.80R	Change Layout of Existing Dike	1250 / +18 LWRP		
	96.50R	Change Layout of Existing Dike	1350 / +18 LWRP		
	96.20R	Change Layout of Existing Dike	1100 / +18 LWRP		
	96.20L	Install Weir	500 / -15 LWRP		
	96.00L	Install Weir	500 / -15 LWRP		
DRG ALT 10 (Plate DRG 11)	98.00R	Existing Dike - Removed	-	No	Provided a max. width at the bend of 100 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 260 ft.
	97.90R	Existing Dike - Removed	-		
	97.80R	Existing Dike - Removed	-		
	97.50R	Extend Existing Dike	400 / +18 LWRP		
	97.30L	Install Weir	600 / -15 LWRP		
	97.20L	Install Weir	500 / -15 LWRP		
	96.80R	Install J-Hook	600 x / -15 LWRP		
	96.50 R	Extend Existing Dike	350 / +18 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
DRG ALT 11 (Plate DRG 12)	97.30L	Install Weir	700 / -15 LWRP	No	Provided a max. width at the bend of 150 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 420 ft.
	97.20L	Install Blunt Nosed Chevron	300 / -15 LWRP		
	97.10L	Install Blunt Nosed Chevron	300 / -15 LWRP		
	96.80R	Extend Existing Dike	350 / +18 LWRP		
	96.50R	Extend Existing Dike	350 / +18 LWRP		
	96.20R	Extend Existing Dike	300 / +18 LWRP		
	95.70R	Install Dike	600 / +18 LWRP		
DRG ALT 12 (Plate DRG 13)	97.30L	Install Weir	700 / -15 LWRP	Yes	Provided a max. width at the bend of 320 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 450 ft.
	97.20L	Install Blunt Nosed Chevron	300 / -15 LWRP		
	97.10L	Install Blunt Nosed Chevron	300 / -15 LWRP		
	97.00L	Install Blunt Nosed Chevron	300 / -15 LWRP		
	97.00R	Extend Existing Dike	1250 / +18 LWRP		
	96.80R	Extend Existing Dike	600 / +18 LWRP		
	96.50R	Extend Existing Dike	500 / +18 LWRP		
	96.20R	Extend Existing Dike	500 / +18 LWRP		
DRG ALT 13 (Plate DRG 14)	96.90R	Install Blunt Nosed Chevron	300 / -15 LWRP	No	Provided a max. width at the bend of 0 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 180 ft.
	96.80R	Remove Existing Dike	-		
	96.80R	Install Blunt Nosed Chevron	300 / -15 LWRP		
	96.70R	Install Blunt Nosed Chevron	300 / -15 LWRP		
	96.60R	Install Blunt Nosed Chevron	300 / -15 LWRP		
	96.50R	Install Blunt Nosed Chevron	300 / -15 LWRP		
DRG ALT 14 (Plate DRG 15)	98.40R	Extend Existing Dike	550 / +18 LWRP	No	Provided a max. width at the bend of 0 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 190 ft.
	97.50R	Extend Existing Dike	650 / +18 LWRP		
	97.00R	Extend Existing Dike	800 / +18 LWRP		
	96.80R	Extend Existing Dike	500 / +18 LWRP		
	96.20L	Install Weir	500 / -15 LWRP		
	96.10L	Install Weir	550 / -15 LWRP		
	96.00L	Install Weir	550 / -15 LWRP		
	95.90L	Install Weir	550 / -15 LWRP		
	95.80L	Install Weir	550 / -15 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
DRG ALT 15 (Plate DRG 16)	97.40L	Install Weir	250 / -15 LWRP	Yes	Provided a min. width at the bend of 370 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 450 ft.
	97.35L	Install Weir	250 / -15 LWRP		
	97.30L	Install Weir	400 / -15 LWRP		
	97.20L	Install Weir	500 / -15 LWRP		
	97.10L	Install Weir	500 / -15 LWRP		
	96.90R	Install Rootless Dike	500 / +18 LWRP		
	96.80R	Extend Existing Dike	700 / +18 LWRP		
	96.60R	Install Rootless Dike	600 / +18 LWRP		
	96.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	96.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.70R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.60R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.50R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.40R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.30R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.20R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.80R	Install Dike/ Hardpoint	200 / +18 LWRP		
DRG ALT 16 (Plate DRG 17)	97.40L	Install Weir	250 / -15 LWRP	No	Provided a max. width at the bend of 370 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 270 ft.
	97.35L	Install Weir	250 / -15 LWRP		
	97.30L	Install Weir	400 / -15 LWRP		
	97.20L	Install Weir	500 / -15 LWRP		
	97.10L	Install Weir	500 / -15 LWRP		
	96.90R	Install Rootless Dike	300 / +18 LWRP		
	96.80R	Install Rootless Dike	450 / +18 LWRP		
	96.20R	Install Rootless Dike	350 / +18 LWRP		

Alternative Number	Structure	Type of Structure	Dimension/Height (ft)	Alternative Successful	Comments
DRG ALT 17 (Plate DRG 18)	97.40L	Install Weir	250 / -15 LWRP	No	Provided a min. width at the bend of 0 ft. at depths greater than -10 ft. LWRP. Constricted channel downstream to 300 ft.
	97.35L	Install Weir	250 / -15 LWRP		
	97.30L	Install Weir	400 / -15 LWRP		
	97.20L	Install Weir	500 / -15 LWRP		
	97.10L	Install Weir	500 / -15 LWRP		
	96.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	96.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.70R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.60R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.50R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.40R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.30R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.20R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.10R	Install Dike/ Hardpoint	100 / +18 LWRP		
	95.00R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.90R	Install Dike/ Hardpoint	100 / +18 LWRP		
	94.80R	Install Dike/ Hardpoint	200 / +18 LWRP		

DREDGING CONCLUSIONS

Dredging Alleviation (RM 97.0 – 96.0)

1. Summary - Dredging (RM 97.0 – 96.0)

Several alternative design tests were conducted for this HSR model. Each alternative was conducted with the primary intention of increasing depth and width in the dredging problem area between RM 97.0 and 96.0.

Table 8: Evaluation of Model Tests for Primary and Secondary Purposes

Drg Alt 1			**6**
Drg Alt 2			**9**
Drg Alt 3			**8**
Drg Alt 4			**17**
Drg Alt 5			**11**
Drg Alt 6			**10**
Drg Alt 7	X		**2**
Drg Alt 8	X	X	**5**
Drg Alt 9			**16**
Drg Alt 10			**14**
Drg Alt 11		X	**7**
Drg Alt 12	X	X	**4**
Drg Alt 13			**12**
Drg Alt 14			**15**
Drg Alt 15	X	X	**1**
Drg Alt 16	X		**3**
Drg Alt 17			**13**

.

2. Recommendations – Dredging (RM 97.0 – 96.0)

Dredge Alternative 15 is recommended because of the increased width and depth in the bend between RM 97.0 and 96.0 while not constricting the main channel at RM 96.0 to 95.5 to less than 400 ft.

The recommended dredging design includes the following:

- Construct 5 Weirs (97.40L, 97.35L, 97.30L, 97.20L, and 97.10L) to -15 ft LWRP.
- Construct two rootless dikes (96.90R and 96.60R) to +18 ft LWRP.
- Extend existing Dike 96.80R to +18 ft LWRP and raise existing portion of Dike to +18 ft LWRP.

3. Interpretation of Model Test Results – Dredging (97.0-96.0)

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.

FINAL CONCLUSIONS

Phase 1 and 2

1. Summary

Thirteen design alternatives were tested to increase depth in the Upper and Lower Jones Chutes. Seventeen design alternatives were tested to alleviate reoccurring dredging in the navigation channel between RM 97.0 and 96.0.

2. Recommendations

Table 9: Jones Chute, HSR Model Study, Recommended River Training Structures

Structure	Type of Structure	Dimension/ Height (ft)	Post Construction Considerations
97.40L	Install Weir	250 / -15 LWRP	
97.35L	Install Weir	250 / -15 LWRP	
97.30L	Install Weir	400 / -15 LWRP	
97.20L	Install Weir	500 / -15 LWRP	
97.10L	Install Weir	500 / -15 LWRP	
98.40R	Notch Existing Dike	200 / 0 LWRP	
98.40R	Raise Existing Dike	+18 LWRP	
98.35R	Install Longitudinal Dike	550 / +18 LWRP	
97.50R	Remove Existing Closure Structure	-	
97.00R	Remove Existing Closure Structure	-	
96.95R	Install Longitudinal Dike	550 / +18 LWRP	
96.95R	V-Notch New Dike, 100 ft Top Width on Center, Invert + 5 LWRP		
95.80R	Notch Existing Dike	150 / 0 LWRP	
96.90R	Install Rootless Dike	350 / +18 LWRP	Increase Length to 550 ft if Necessary
96.80R	Extend Existing Dike	450 / +18 LWRP	Increase Length to 700 ft if Necessary
96.80R	Raise Existing Dike	+18 LWRP	
96.60R	Install Rootless Dike	400 / +18 LWRP	Increase Length to 600 ft if Necessary
96.10R	Install Dike/ Hardpoint	100 / +18 LWRP	
96.00R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.90R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.70R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.60R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.50R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.40R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.30R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.20R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.10R	Install Dike/ Hardpoint	100 / +18 LWRP	
95.00R	Install Dike/ Hardpoint	100 / +18 LWRP	
94.90R	Install Dike/ Hardpoint	100 / +18 LWRP	
94.80R	Install Dike/ Hardpoint	200 / +18 LWRP	

Additional considerations to the above model design are the revetment of all bank lines inside both the Upper and Lower Jones Chutes. Revetment will also be needed along the upstream end of Liberty Bar extending to the closure structure between Liberty Bar and the notch in Dike 98.4R and 100 ft upstream of Weir 97.40L extending to 100 ft downstream of Weir 97.10L. Plate Final 1 shows a lay out the recommended structures.

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

For more information about HSR modeling or the Applied River Engineering Center, please contact Mr. Robert Davinroy, Mrs. Mary Miles or Mr. Michael Rodgers at:

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

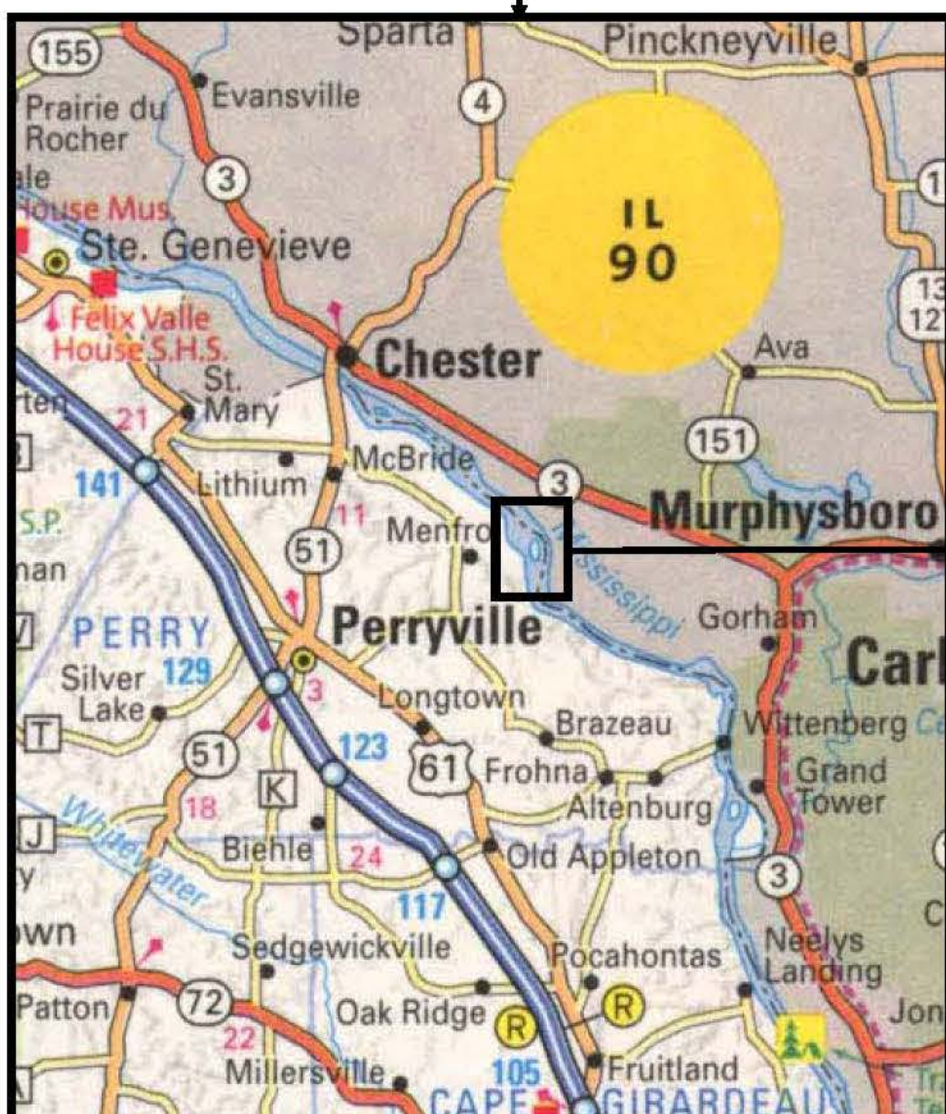
Phone: (314) 263-4714, (314) 263-8090 or (314) 263-8091
Fax: (314) 263-4166

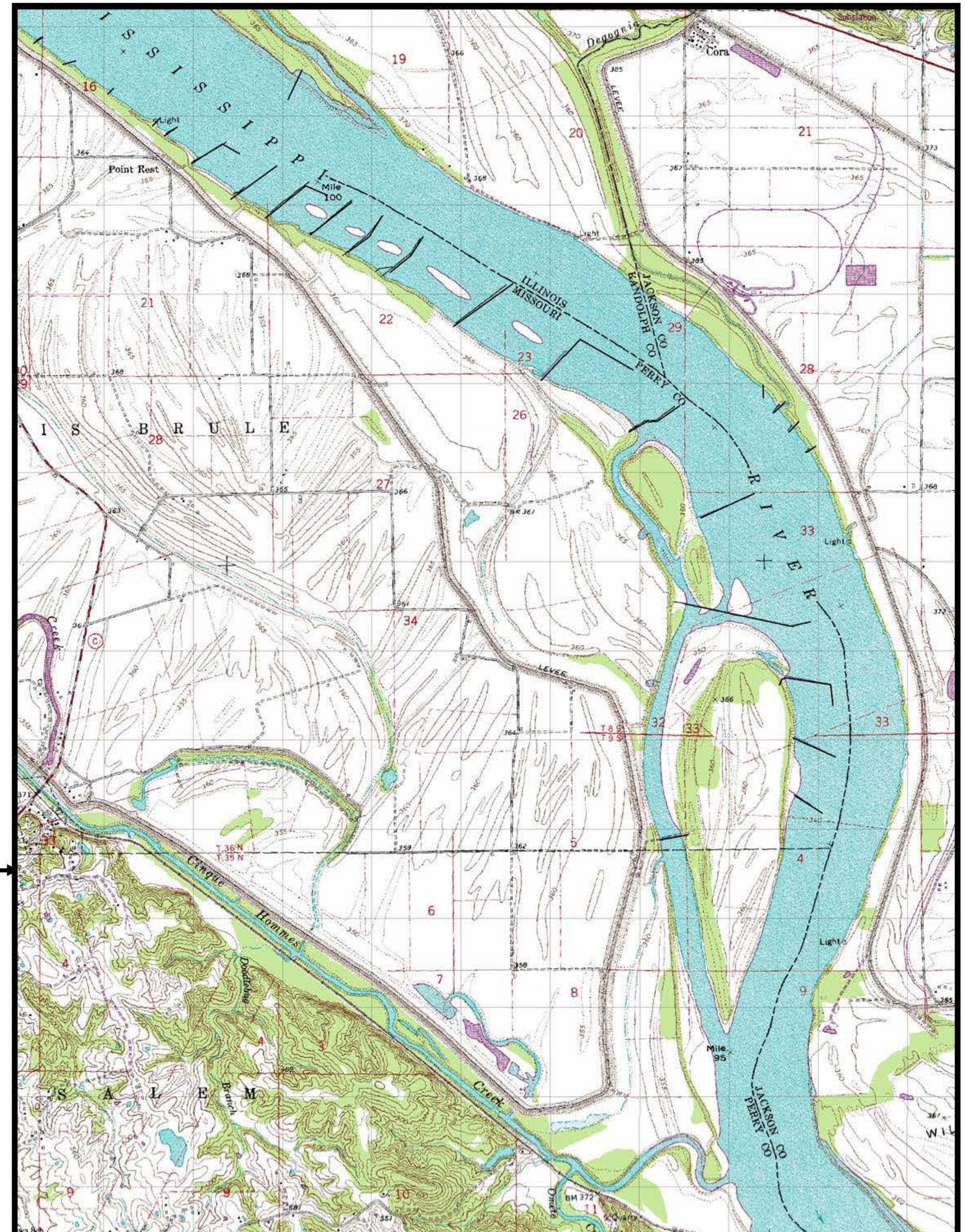
E-mail:
Robert.D.Davinroy@usace.army.mil
Mary.M.Miles@usace.army.mil
Michael.T.Rodgers@usace.army.mil

Or you can visit us on the World Wide Web at:
http://www.mvs.usace.army.mil/eng-con/expertise/arec/reports_AREC.html

APPENDIX OF PLATES

DRG 1. Dredging Base Test with Scheduled Construction and Recommend Improvements to Side Channels
DRG 2. Dredging Alternative 1
DRG 3. Dredging Alternative 2
DRG 4. Dredging Alternative 3
DRG 5. Dredging Alternative 4
DRG 6. Dredging Alternative 5
DRG 7. Dredging Alternative 6
DRG 8. Dredging Alternative 7
DRG 9. Dredging Alternative 8
DRG 10. Dredging Alternative 9
DRG 11. Dredging Alternative 10
DRG 12. Dredging Alternative 11
DRG 13. Dredging Alternative 12
DRG 14. Dredging Alternative 13
DRG 15. Dredging Alternative 14
DRG 16. Dredging Alternative 15
DRG 17. Dredging Alternative 16
DRG 18. Dredging Alternative 17
Final 1. Recommended Structures, Study Phase 1 and 2





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U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER
Jones Chute HSR Model
River Miles 102 - 94

PLOT DATE: September 21, 2006
REVIEWED BY: D. Gordon
DRAWN BY: M. Miles
FILE NAME: ...REPORT\PLATES

LOCATION AND VICINITY MAP – USGS QUAD SHEET

PLATE NUMBER
1

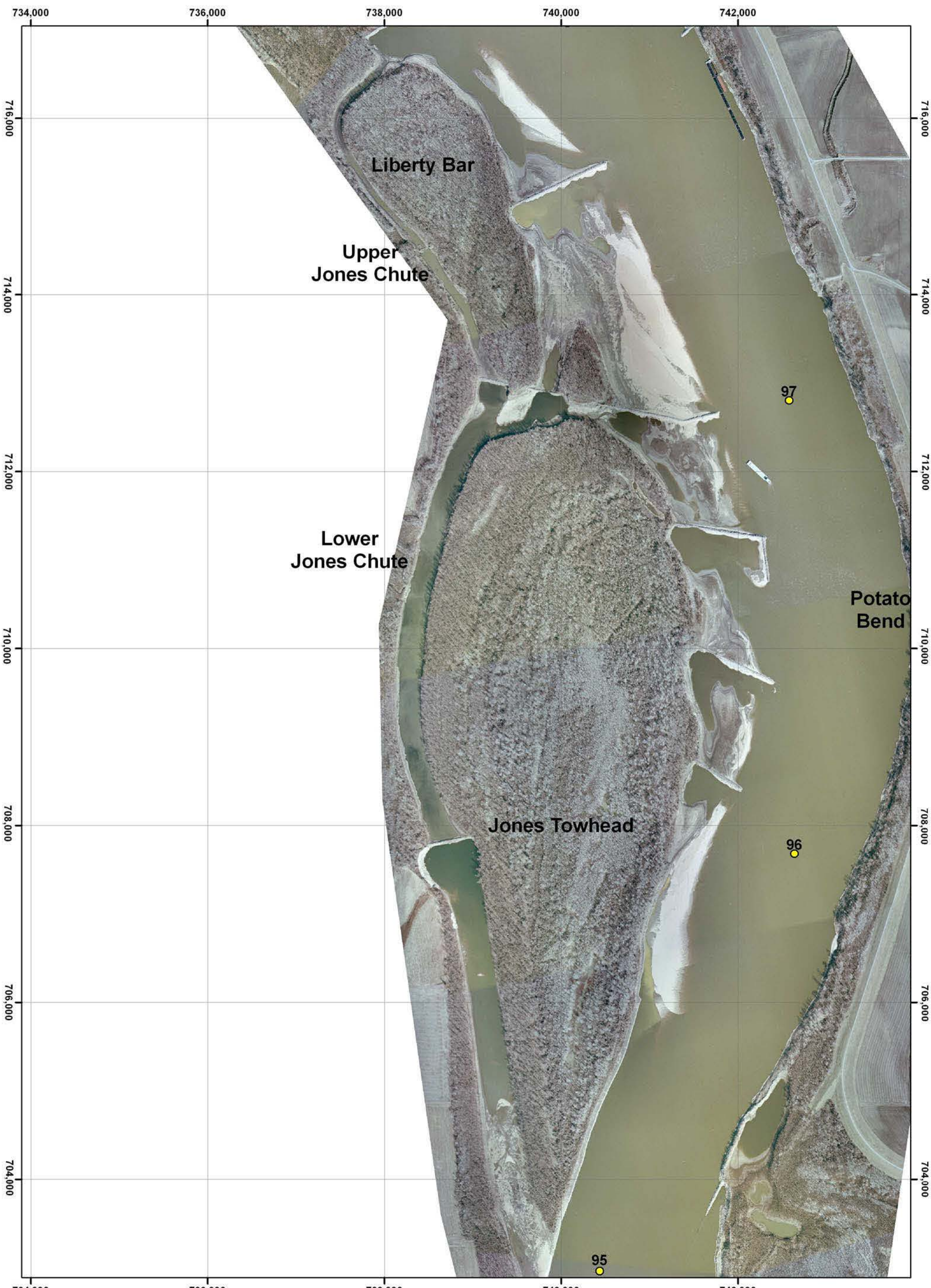

PLATE NUMBER 2

0 500 1,000 2,000 Feet

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2006 AERIAL PHOTO

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 98.4 - 95.0

PLOT DATE: SEPTEMBER 19, 2006	
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FILE NAME: ...ARC/JONESCHUTE	

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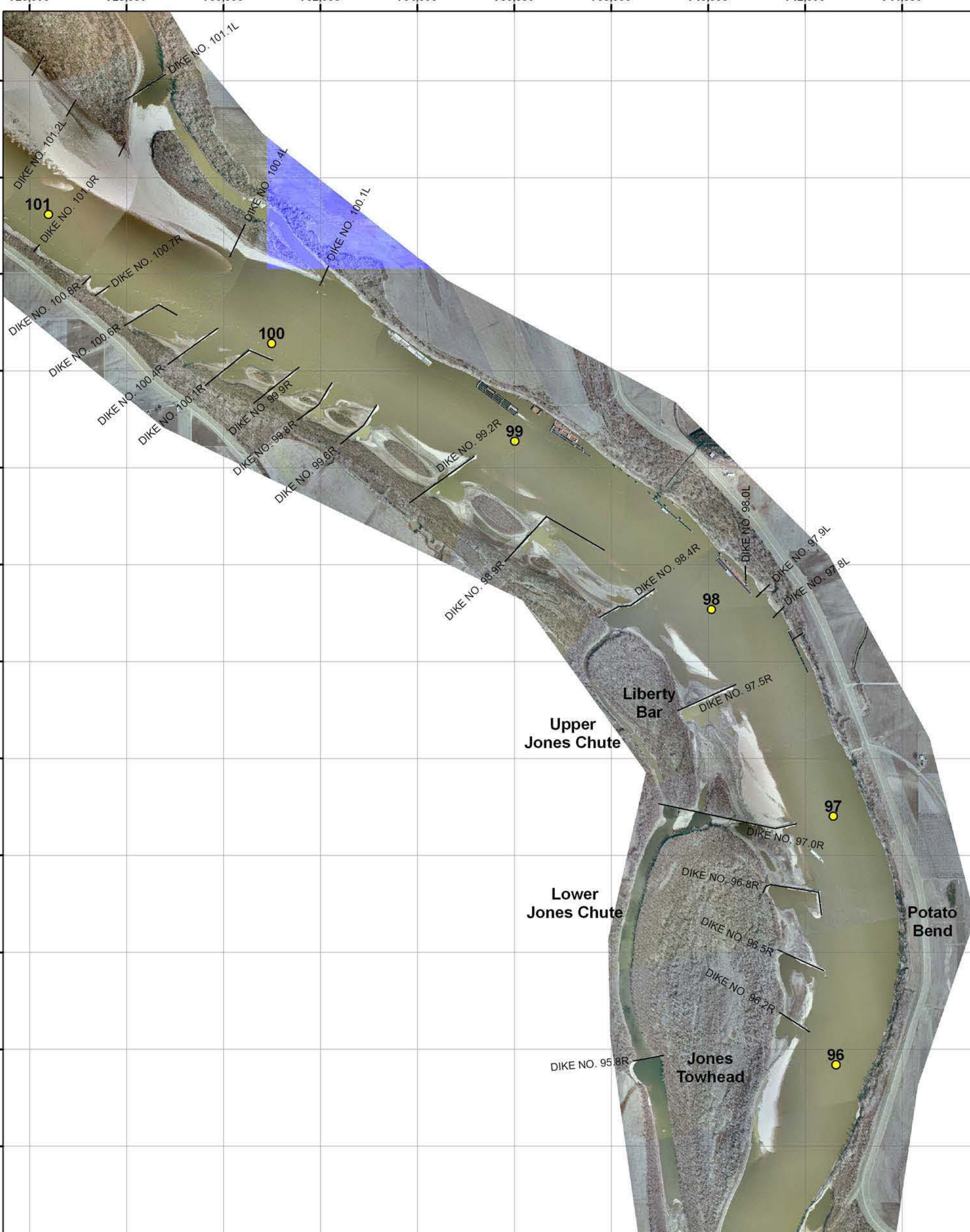

PLATE NUMBER 3

0 1,000 2,000 4,000 Feet

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DIKE FIELD

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
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FILE NAME: ...ARC/JONESCHUTE	

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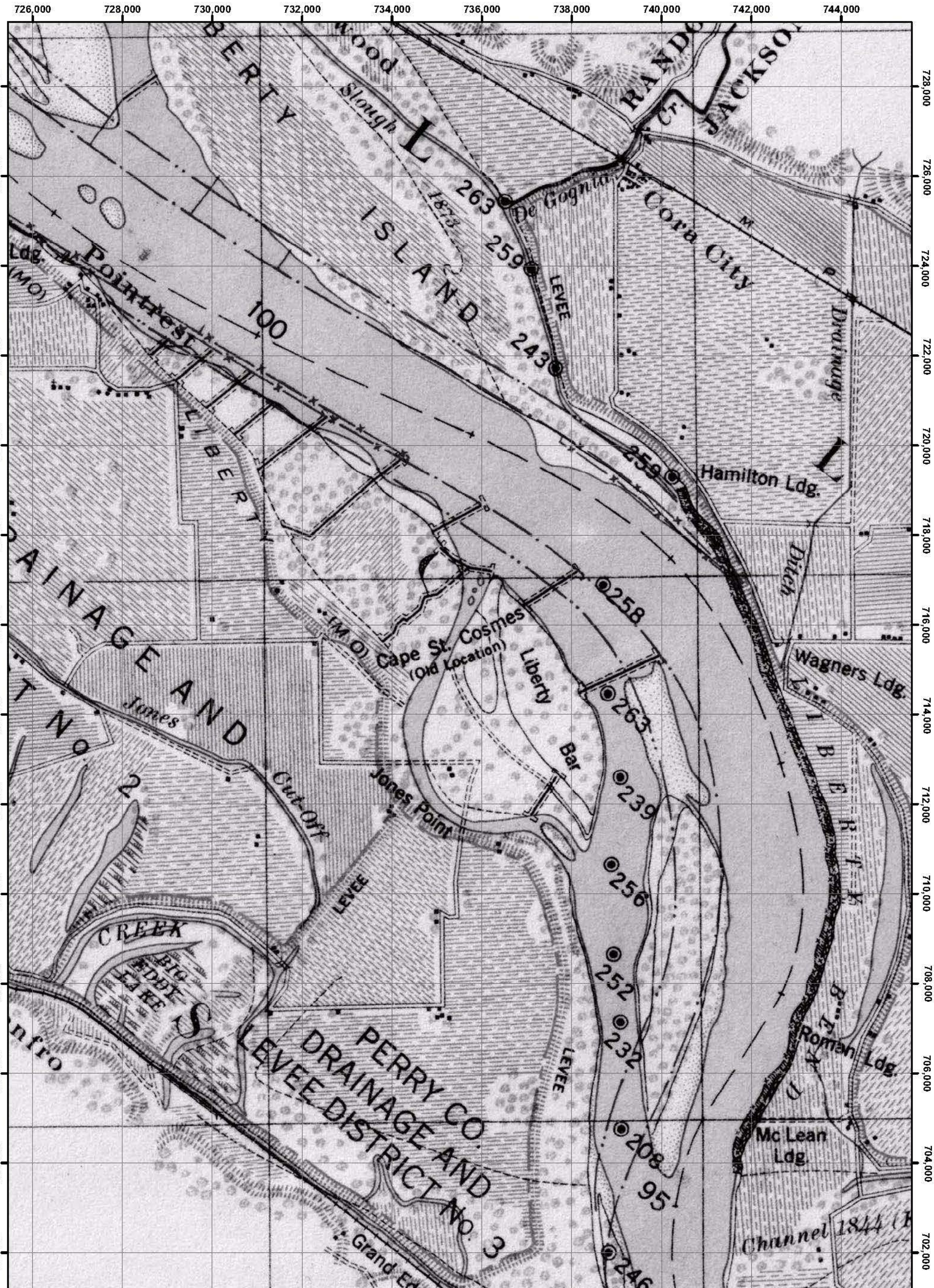

PLATE NUMBER

4

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME.

1928 PROJECT AND PROGRESS MAP

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
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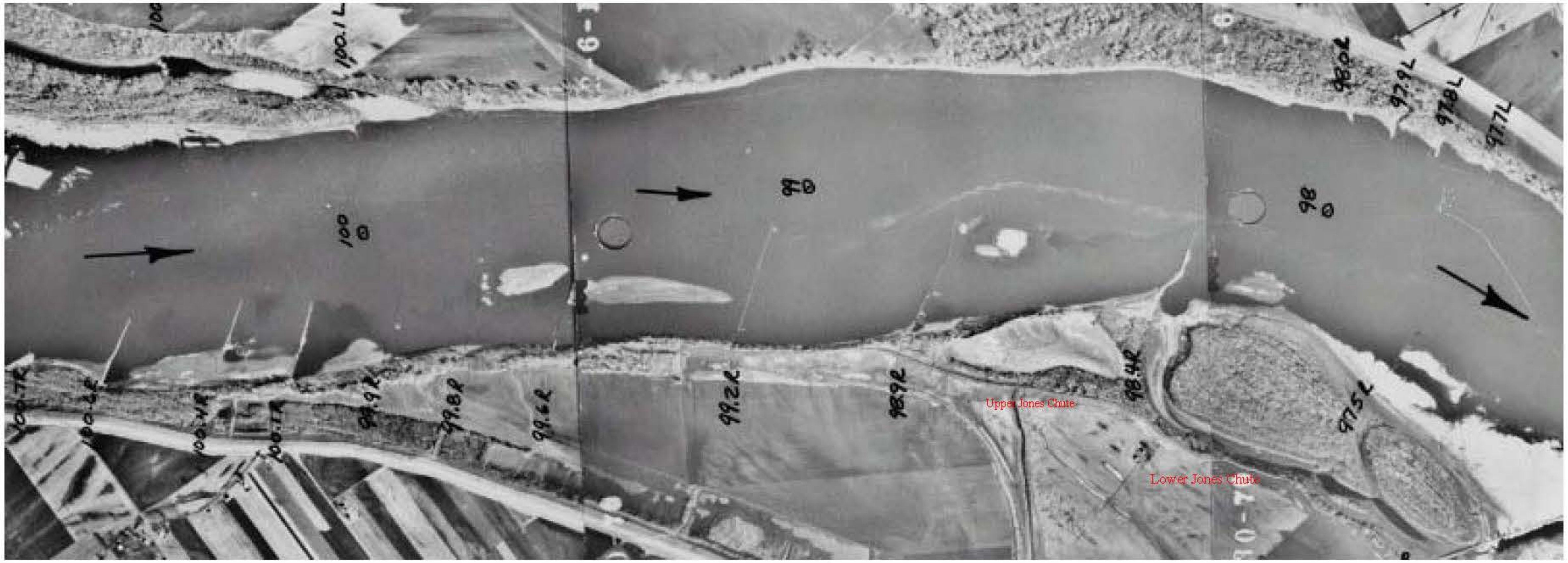

1970 Aerial Photograph

1987 Aerial Photograph

U.S. ARMY CORPS OF ENGINEERS ST. LOUIS DISTRICT	PHOTOGRAPH DATE: 1970/ 1987 REVIEWED BY: D. GORDON
UPPER MISSISSIPPI RIVER Jones Chute HSR Model River Miles 100.7-97.0	PHOTOGRAPH TAKEN BY: U.S. Army Corps, St. Louis District FILE NAME: ...REPORT/PLATES

**AERIAL PHOTOPGRAPHS
1970 & 1987
UPPER AND LOWER JONES CHUTES**

PLATE NUMBER
5

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Jones Chute Bank, Predominantly Cottonwoods

Closure Structure 95.8R (identified by riffle)

Downstream Entrance of Lower Jones Chute

Closure Structure near River Mile 97.0

NOTE:
Chester, Illinois gage (RM 109.9): Stage = 15.9 ft / +16.6 ft LWRP
Red Rock gage (RM 94.1): Stage = 20.5 ft / +18.7 ft LWRP

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PHOTOGRAPH DATE: May 18 & 19, 2006
REVIEWED BY: D. Gordon
PHOTOGRAPH TAKEN BY: M. Rodgers
FILE NAME: ...REPORT/PLATES

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER
Jones Chute HSR Model

UPPER AND LOWER JONES CHUTES
Date Photographed: May 18 & 19, 2006

PLATE NUMBER
6

Lower Jones Chute – Looking Upstream to Closure Structure 95.8R

Inlet at North Entrance of Upper Jones Chute

Lower Jones Chute: Looking Downstream

Growth at North Entrance of Upper Jones Chute

NOTE:
Chester, Illinois gage (RM 109.9): Stage = 3.9 ft / +4.6 ft LWRP.
Red Rock gage (RM 94.1): Stage of 7.8 ft / +6.0 ft LWRP

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PHOTOGRAPH DATE: September 6, 2006

REVIEWED BY: D. Gordon

PHOTOGRAPH TAKEN BY: M. Miles

FILE NAME: ...REPORT/PLATES

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ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER
Jones Chute HSR Model

UPPER AND LOWER JONES CHUTES
Date Photographed: September 6, 2006

PLATE NUMBER

7

Upper and Lower Jones Chute (RM 98.4 – 95.0)

Lower Jones Chute - Closure Structure 95.8R

NOTE:
Chester, Illinois gage (RM 109.9): Stage = 3.3 ft / +4.0 ft LWRP.
Red Rock gage (RM 94.1): Stage = 6.9 ft / +5.1 ft.

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PHOTOGRAPH DATE: September 14, 2006
REVIEWED BY: D. Gordon
PHOTOGRAPH TAKEN BY: E. Brauer
FILE NAME: ...REPORT/PLATES

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER
Jones Chute HSR Model

UPPER AND LOWER JONES CHUTES
Date Photographed: September 14, 2006

PLATE NUMBER
8

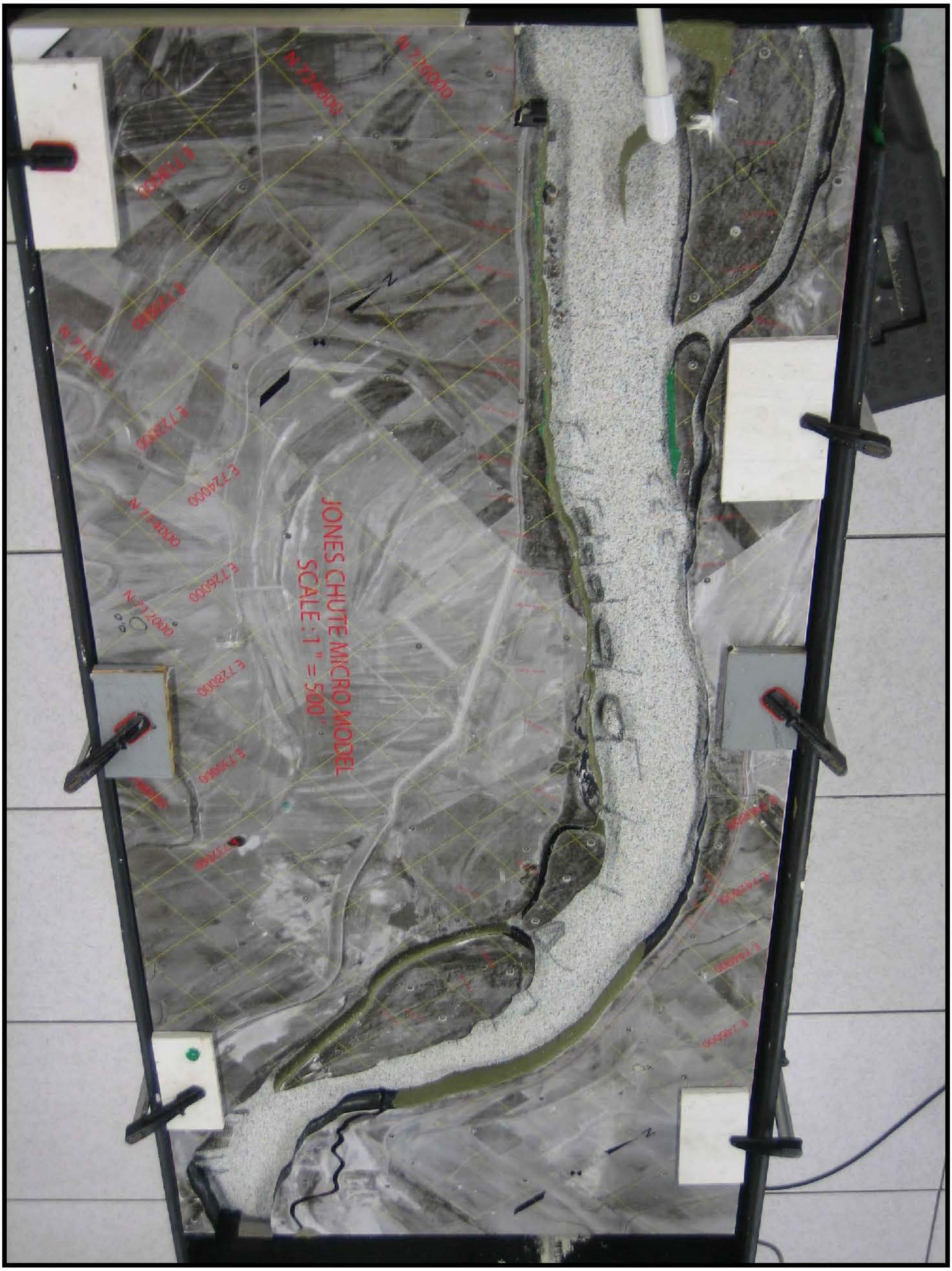

PLATE NUMBER 9

HYDRAULIC SEDIMENT RESPONSE MODEL JONES CHUTES (River Miles 101.2-94.6)

U.S. ARMY CORPS OF ENGINEERS ST. LOUIS DISTRICT	PHOTOGRAPH DATE: September 23, 2006
	REVIEWED BY: David Gordon
UPPER MISSISSIPPI RIVER Jones Chute HSR Model River Miles 101.2 - 94.6	PREPARED BY: M. Miles
	FILE NAME: ....REPORT/PLATES

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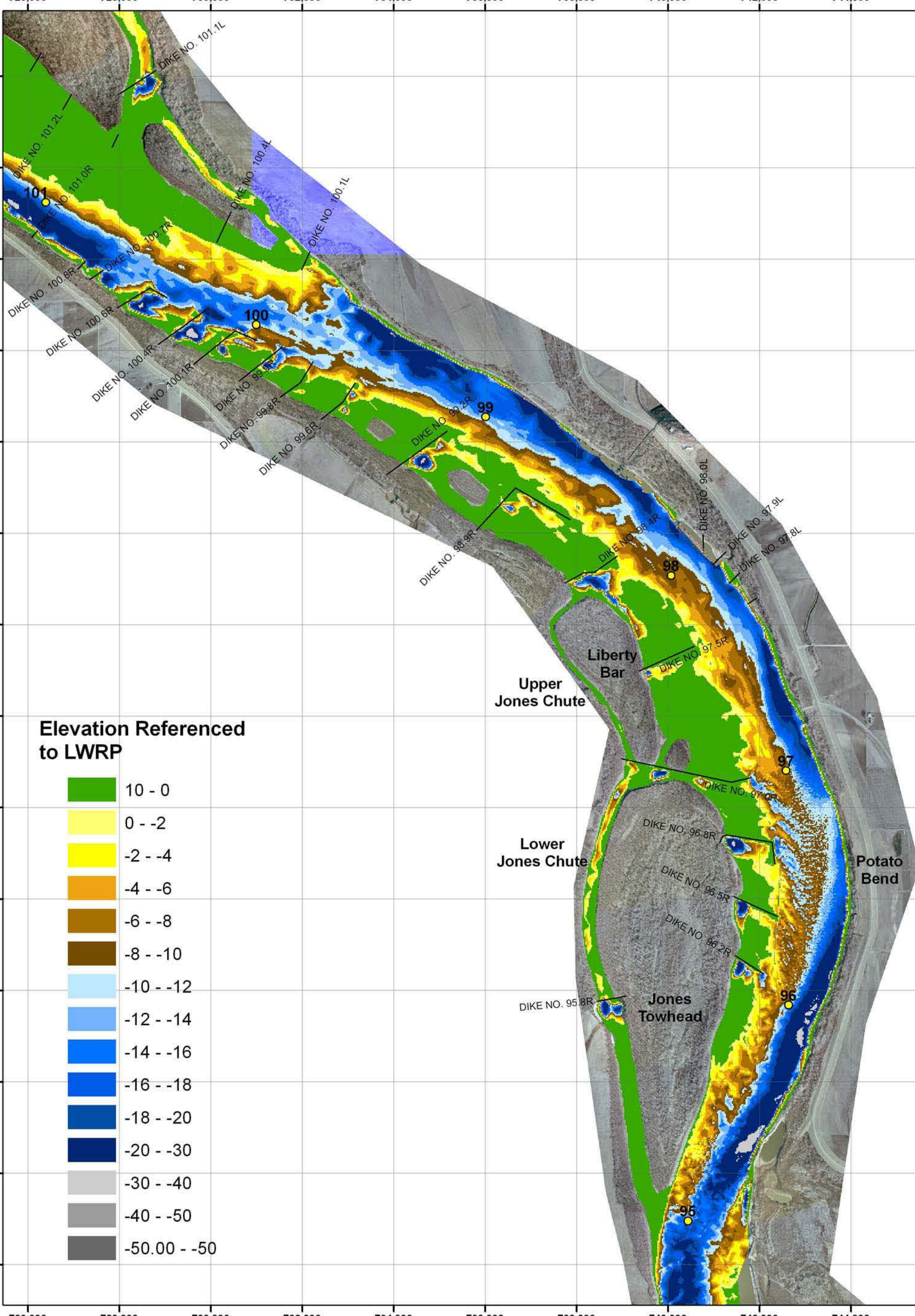

PLATE NUMBER 10

0 1,000 2,000 4,000 Feet

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2001 HYDROGRAPHIC SURVEY

2006 AERIAL PHOTOGRAPH
EXACT DATES OF SURVEY:
MAY 5, 7, 24, 29, AND JUNE 4, 2001

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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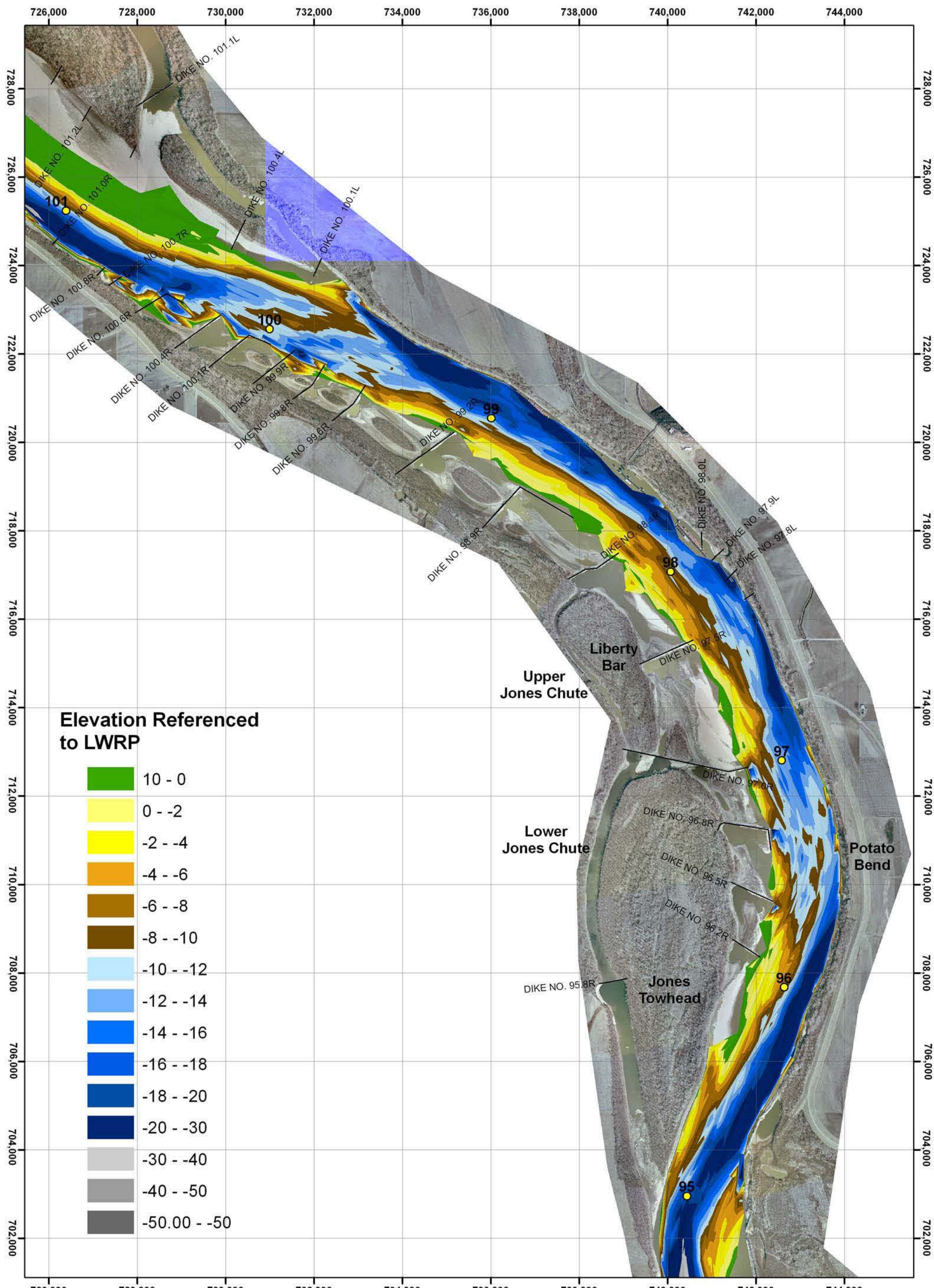

PLATE NUMBER 11

0 1,000 2,000 4,000 Feet

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1998 HYDROGRAPHIC SURVEY
2006 AERIAL PHOTOGRAPH
EXACT DATES OF SURVEY:
AUGUST 11, SEPTEMBER 29 & 30, 1998

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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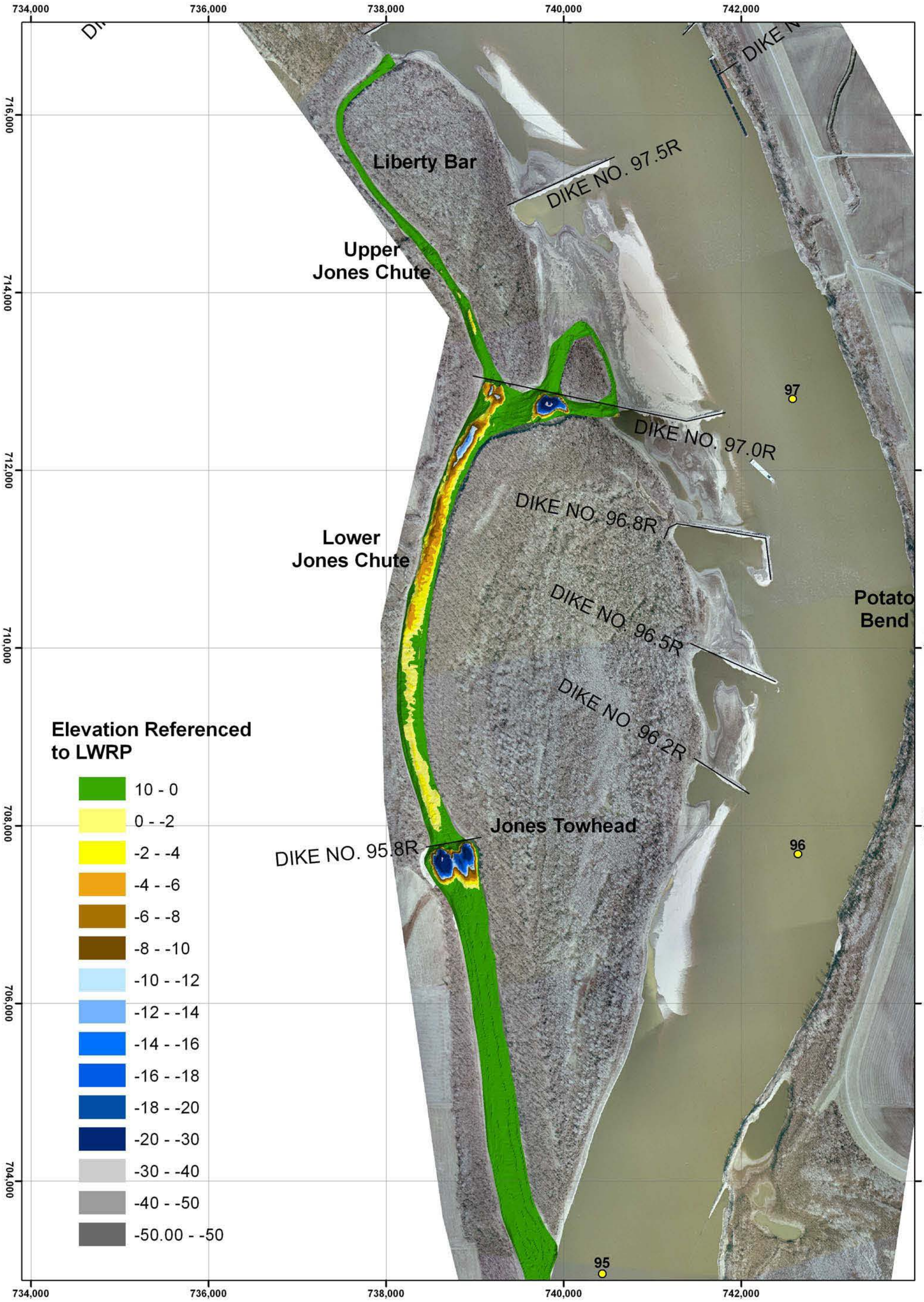

PLATE NUMBER 12

0 500 1,000 2,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

1999 SIDE CHANNEL HYDROGRAPHIC SURVEY

2006 AERIAL PHOTOGRAPH
EXACT DATES OF SURVEY: MAY 27, 1999

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 98.4 - 95.0

PLOT DATE: SEPTEMBER 19, 2006	
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FILE NAME: ...ARC/JONESCHUTE	

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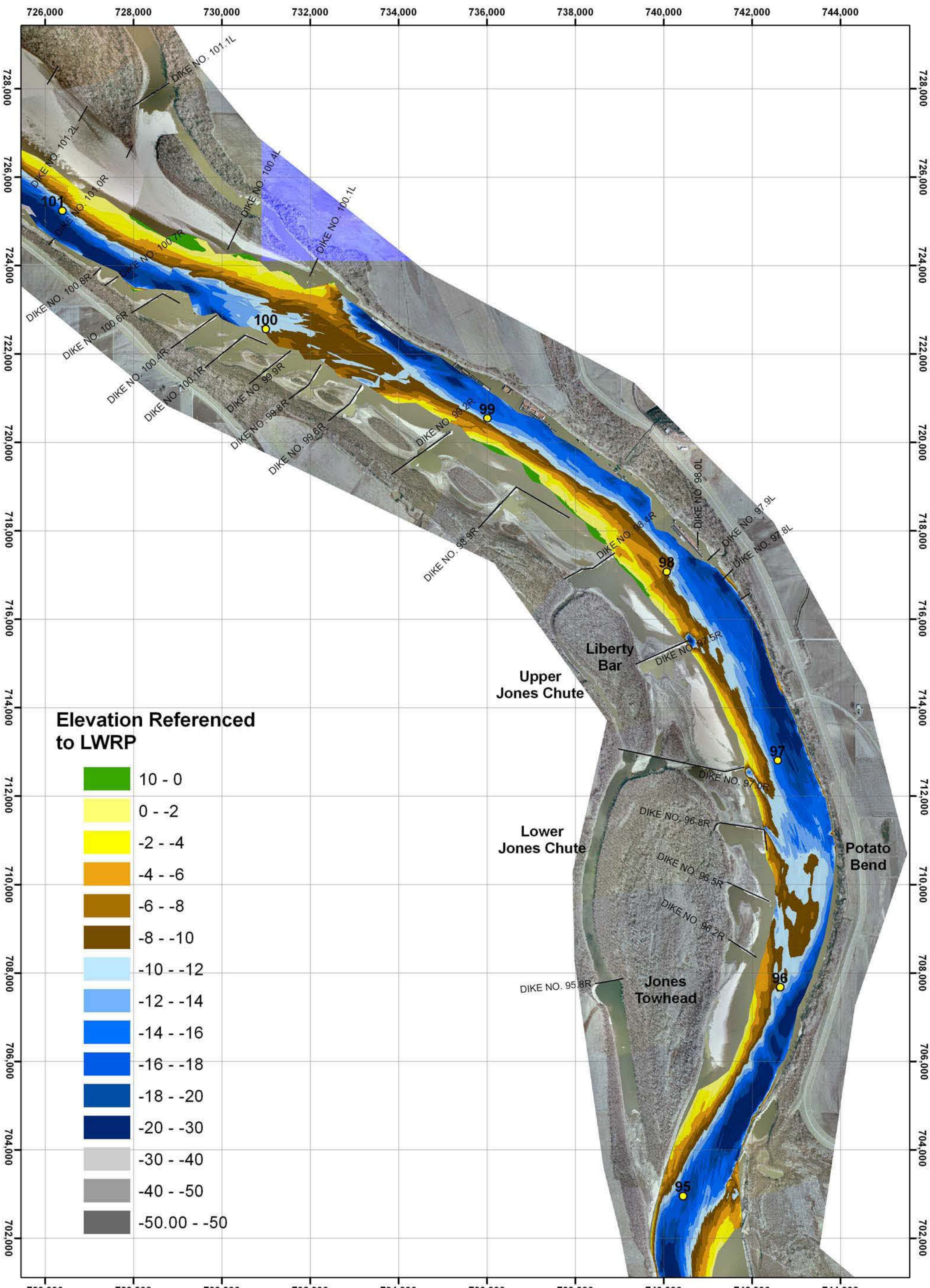

PLATE NUMBER 13

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

2005 HYDROGRAPHIC SURVEY
2006 AERIAL PHOTOGRAPH
EXACT DATES OF SURVEY:
MARCH 30, 31, AUGUST 27, & DECEMBER 16, 2005

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
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FILE NAME: ...ARC/JONESCHUTE	

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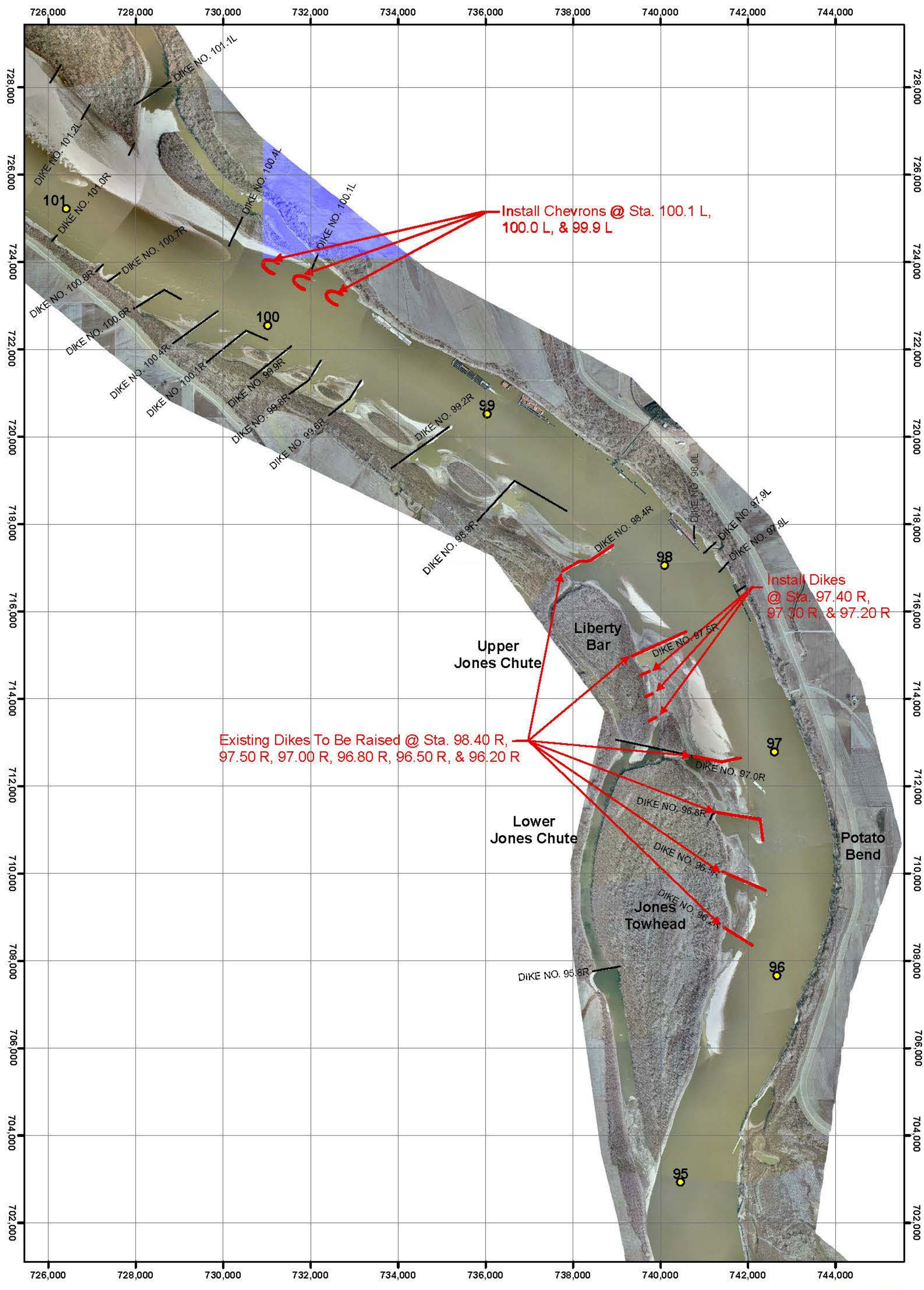

PLATE NUMBER

14

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

SCHEDULED CONSTRUCTION IN STUDY REACH

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
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UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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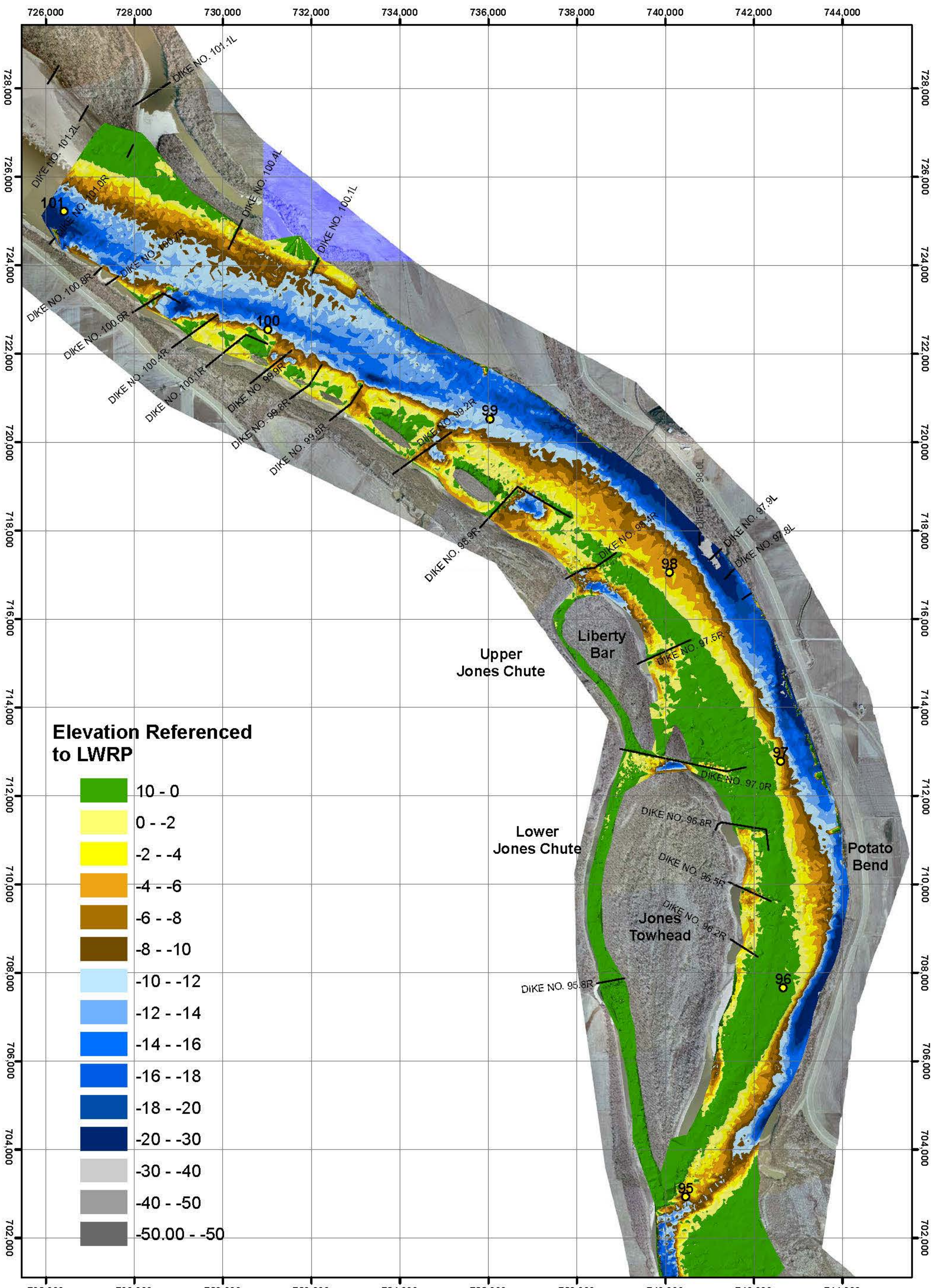

PLATE NUMBER 15

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

BASE TEST

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: OCTOBER 27, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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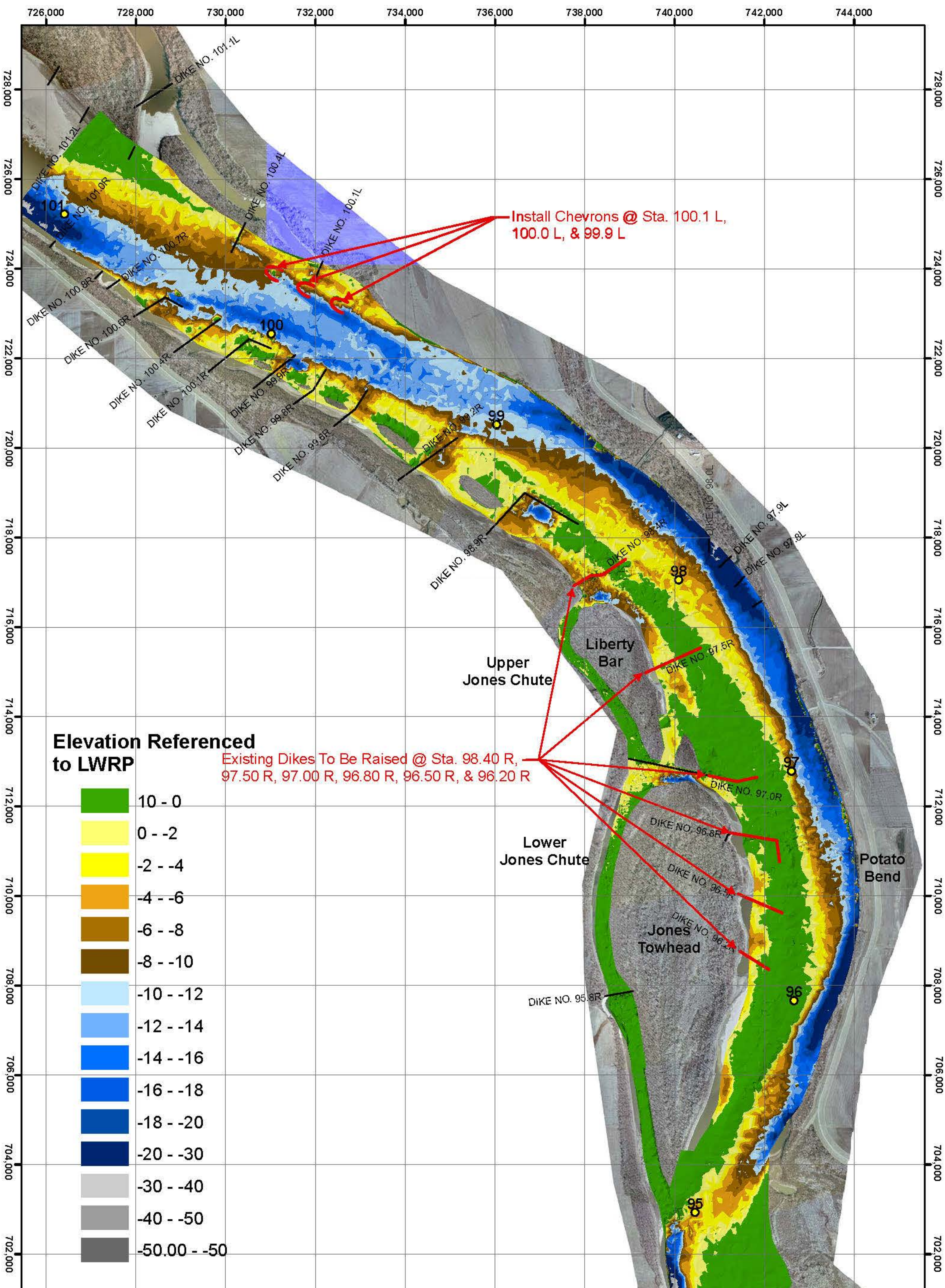

PLATE NUMBER

16

0 1,000 2,000 4,000
Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

BASE TEST WITH SCHEDULED CONSTRUCTION

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: OCTOBER 27, 2006

PREPARED BY: M. MILES

DRAWN BY: M. HOFFMAN

CHECKED BY: D. GORDON

FILE NAME: ...ARC/JONESCHUTE

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W E
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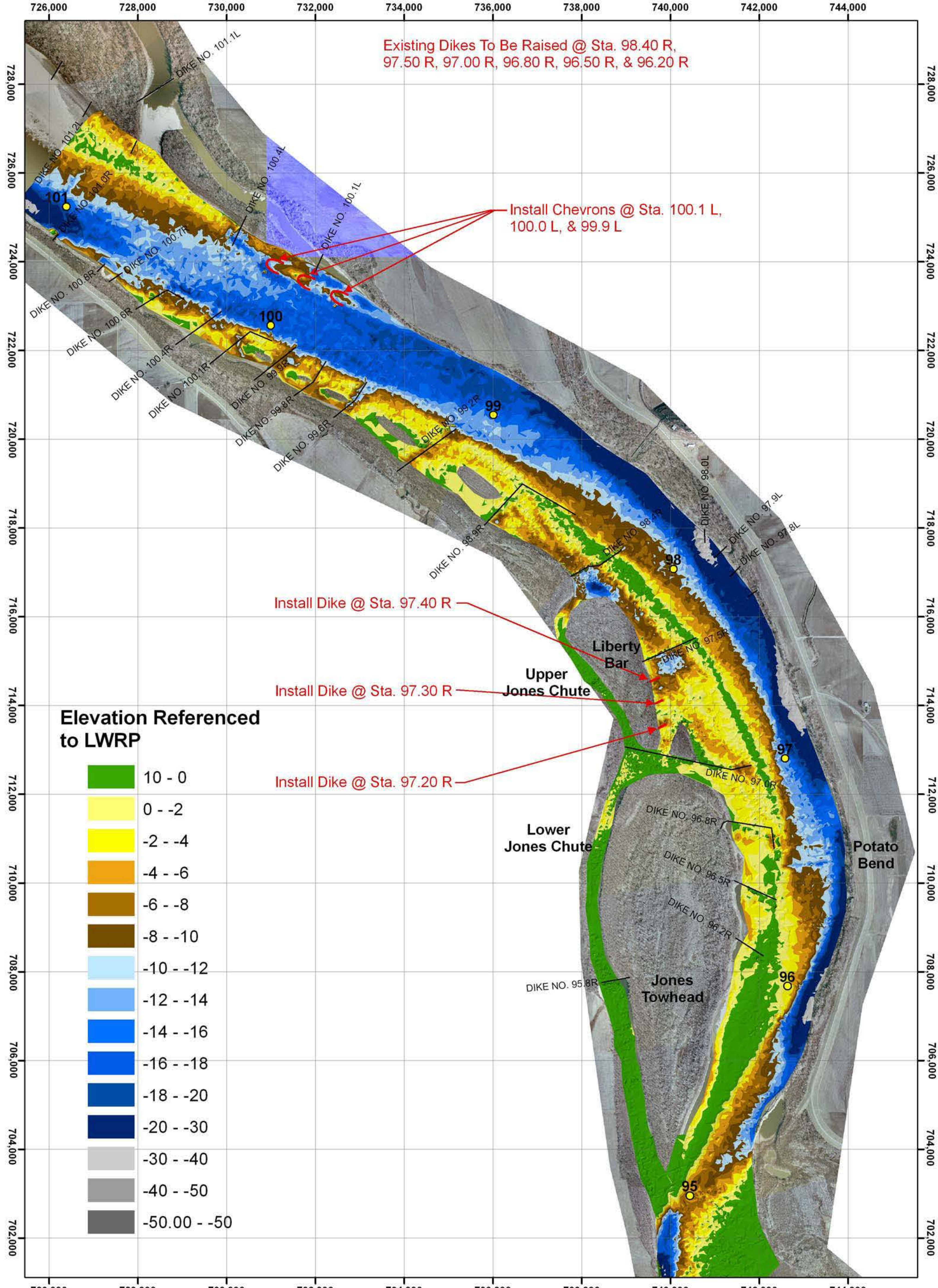

PLATE NUMBER 17

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 1

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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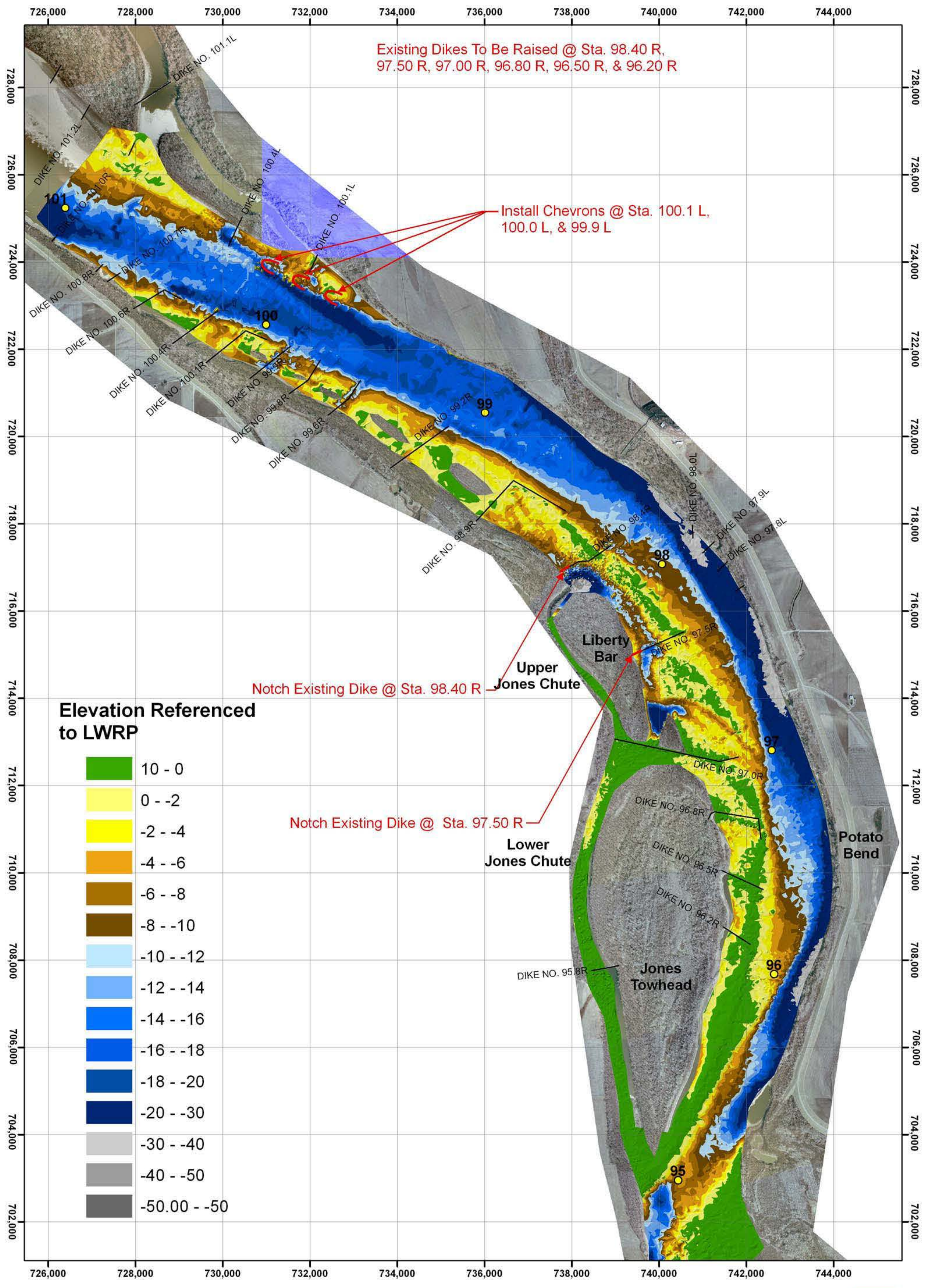

PLATE NUMBER 18

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 2

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006
PREPARED BY: M. MILES
DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE

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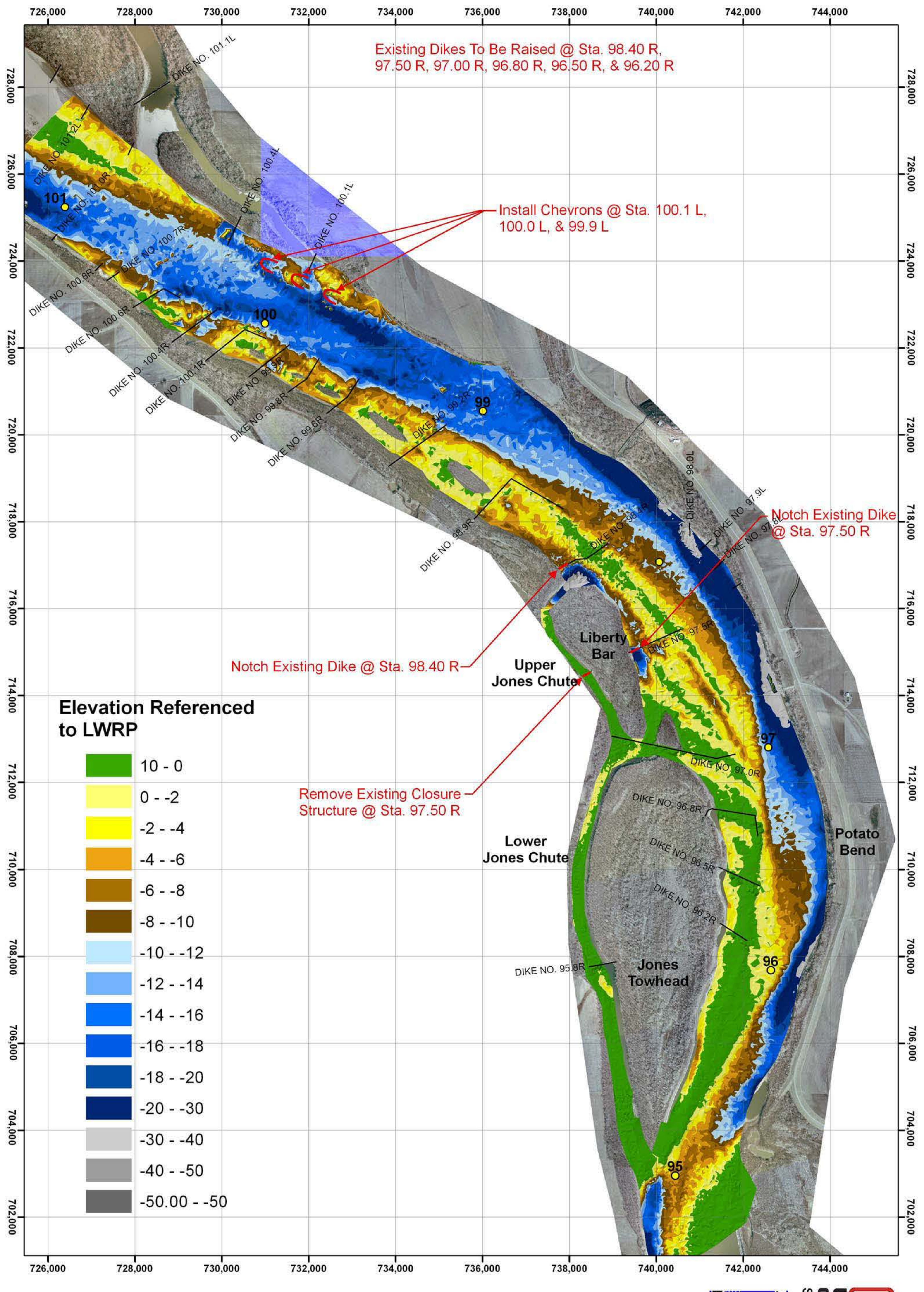

PLATE NUMBER 19

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 2A

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE:	SEPTEMBER 19, 2006
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY:	D. GORDON
FILE NAME:	...ARC/JONESCHUTE

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District®

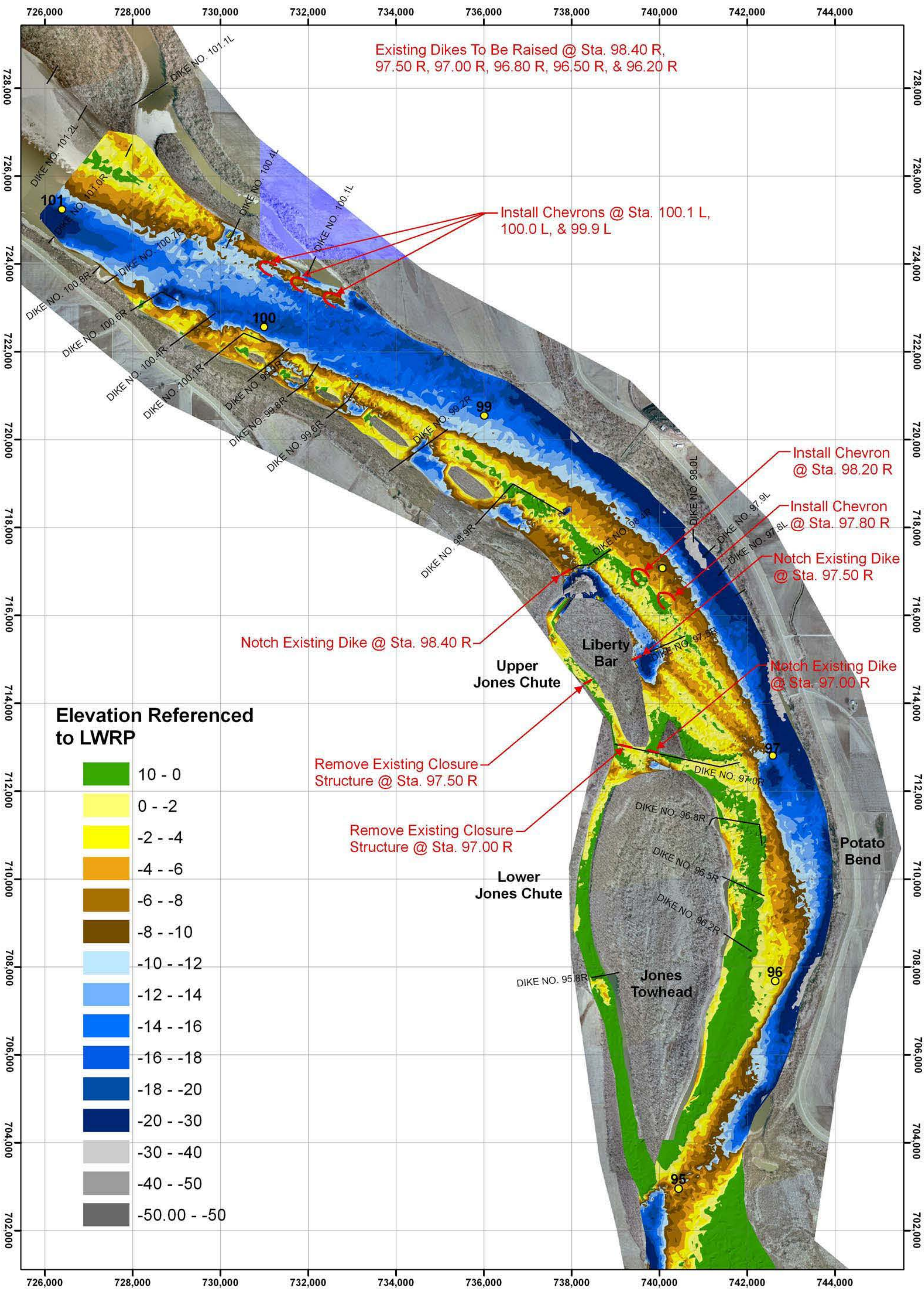

PLATE NUMBER 20

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 3

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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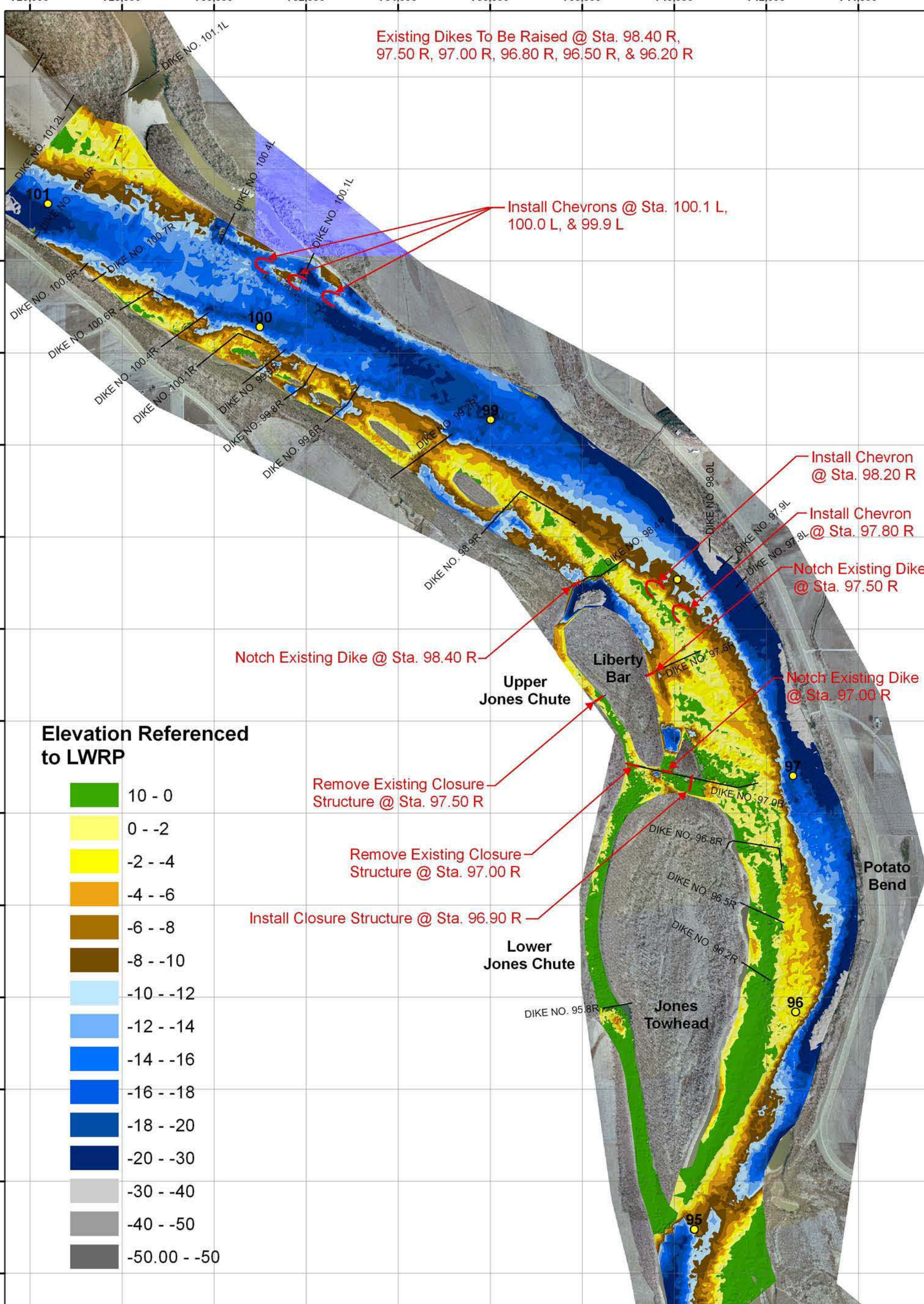

PLATE NUMBER 21

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 4

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

APPLIED RIVER ENGINEERING CENTER

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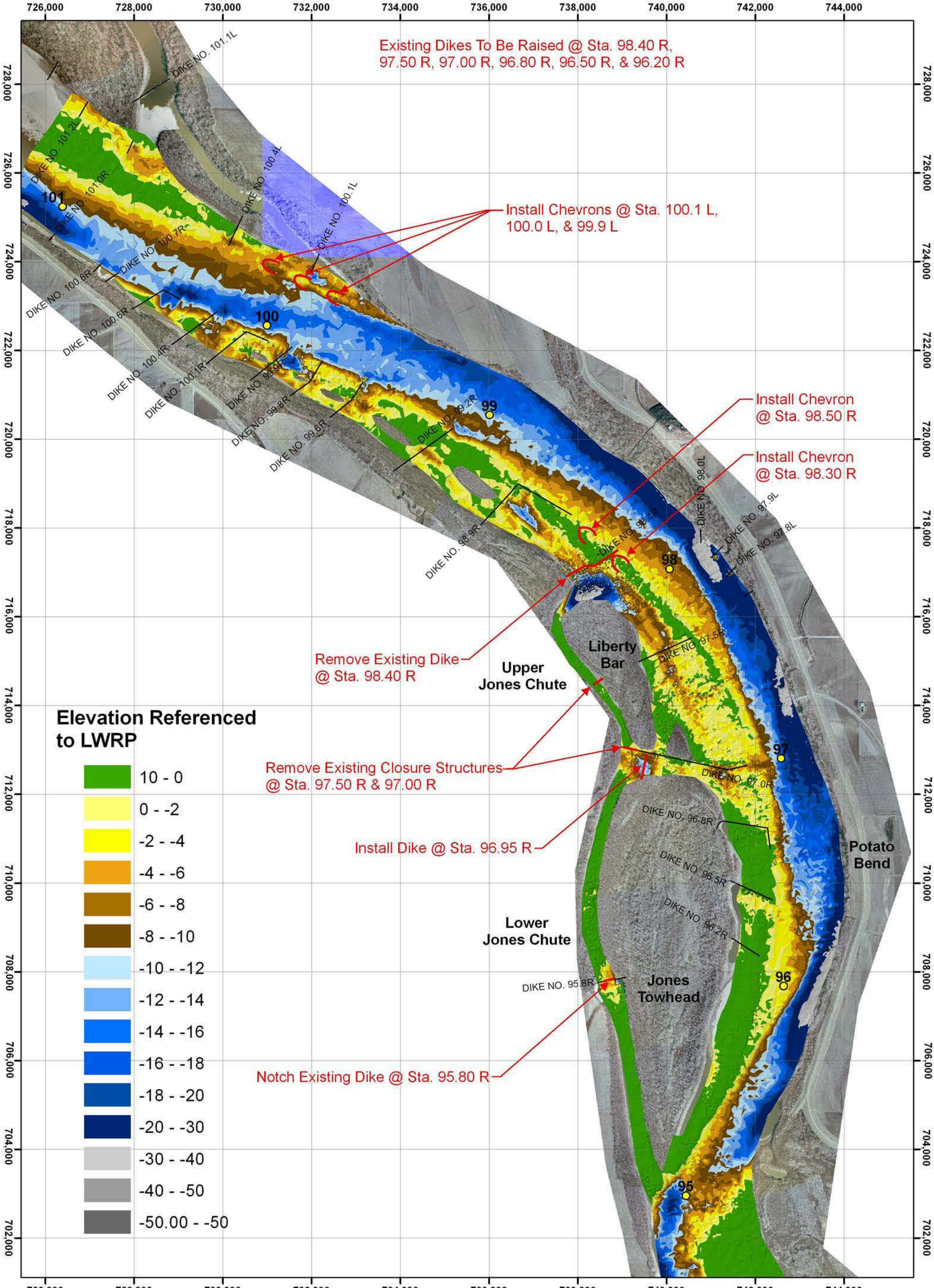

PLATE NUMBER 22

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 5

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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APPLIED RIVER ENGINEERING CENTER

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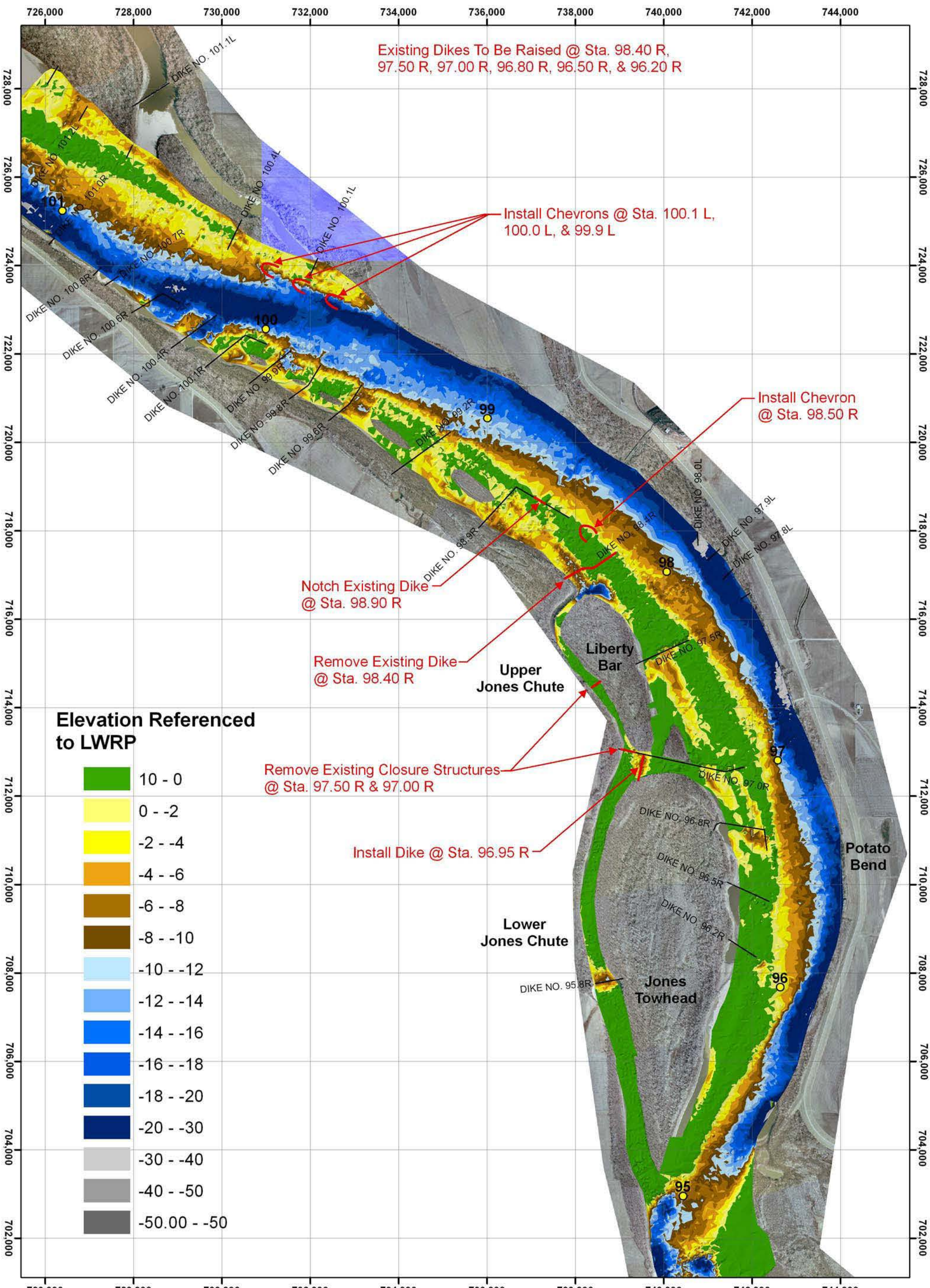

PLATE NUMBER 23

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 6

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
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FILE NAME: ...ARC/JONESCHUTE	

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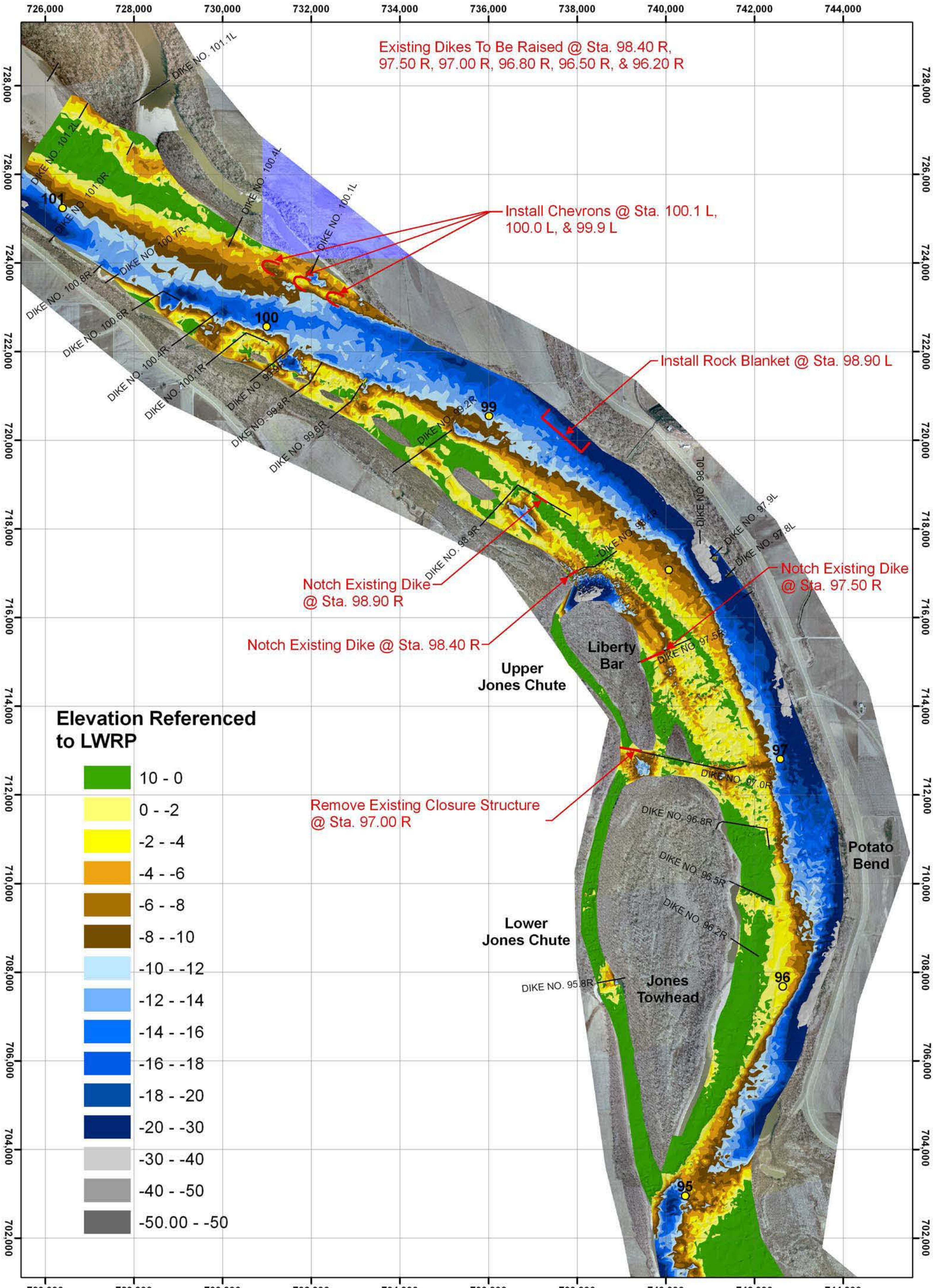

PLATE NUMBER 24

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 7

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

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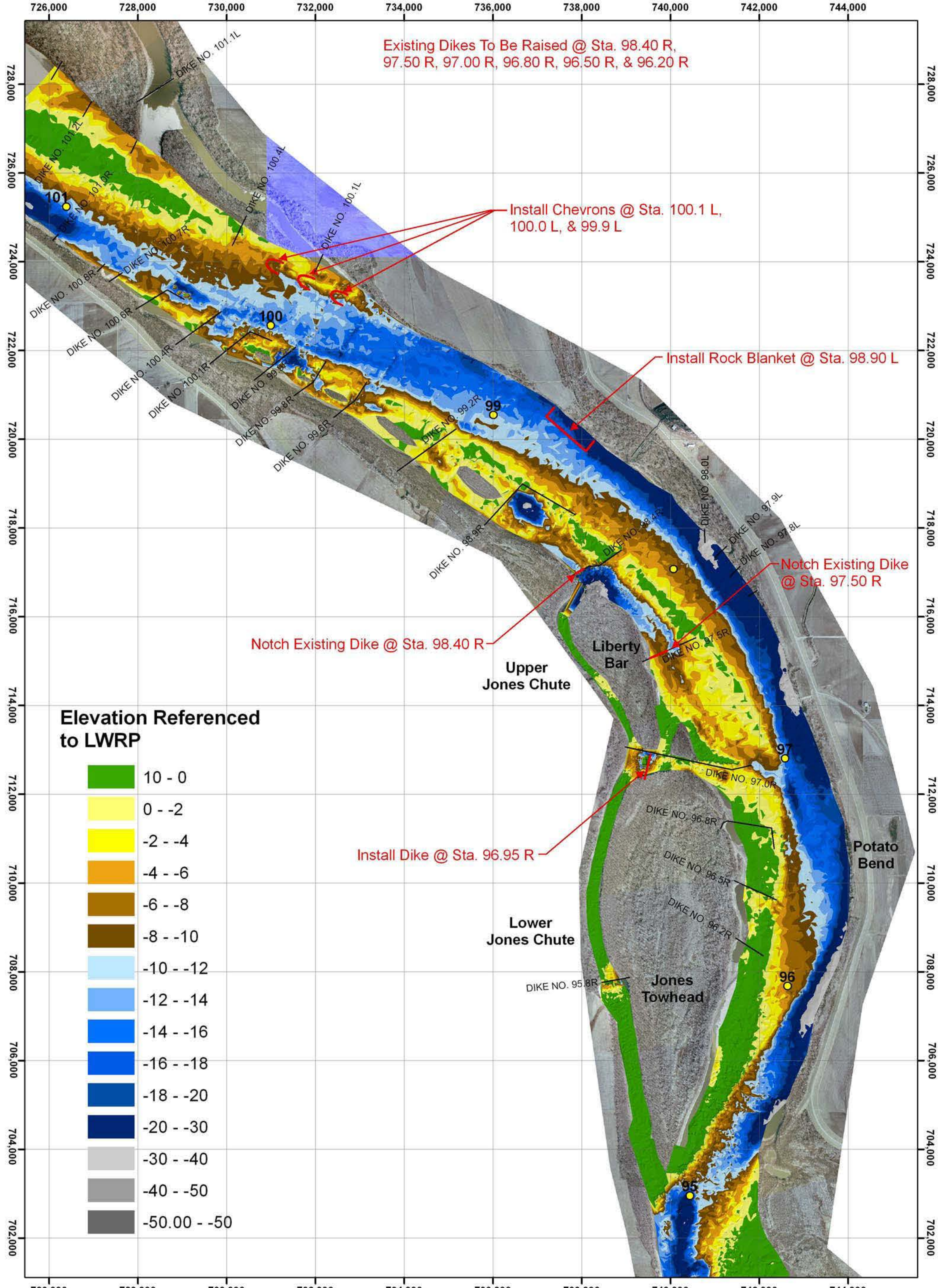

PLATE NUMBER 25

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 8

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
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FILE NAME: ...ARC/JONESCHUTE	

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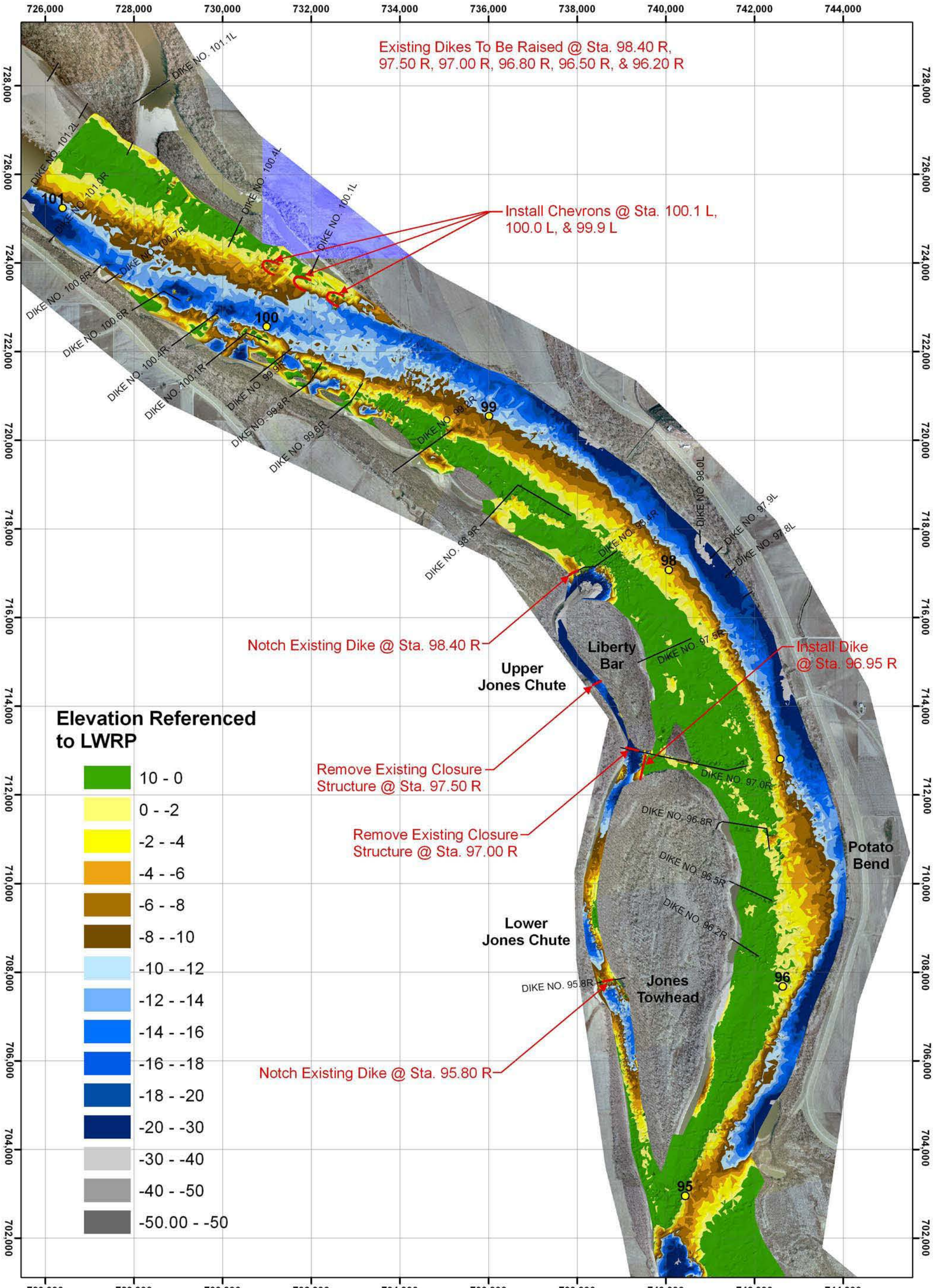

PLATE NUMBER 26

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 9

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE	

APPLIED RIVER ENGINEERING CENTER

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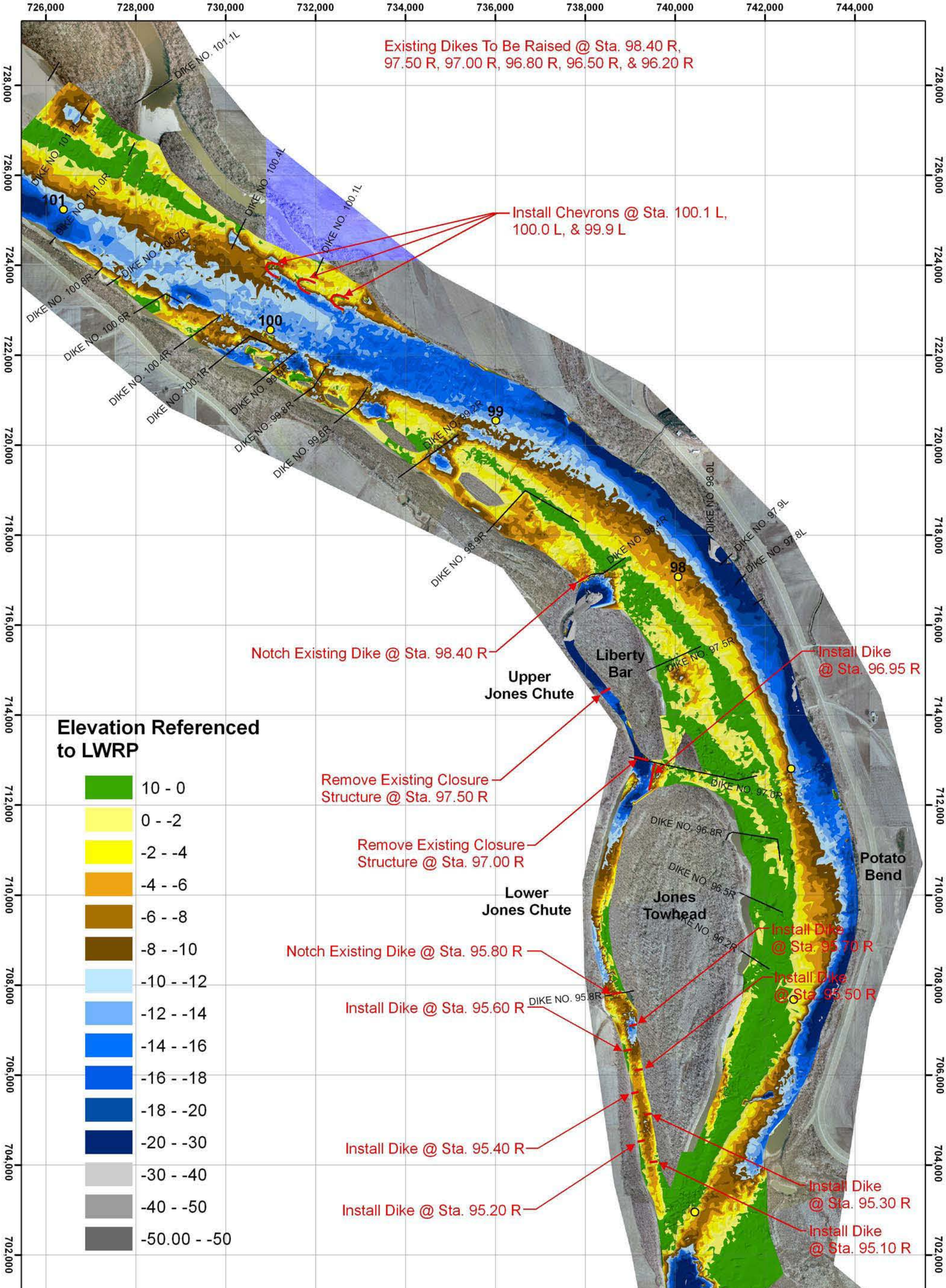

PLATE NUMBER 27

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 10

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006
PREPARED BY: M. MILES
DRAWN BY: M. HOFFMAN
CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE

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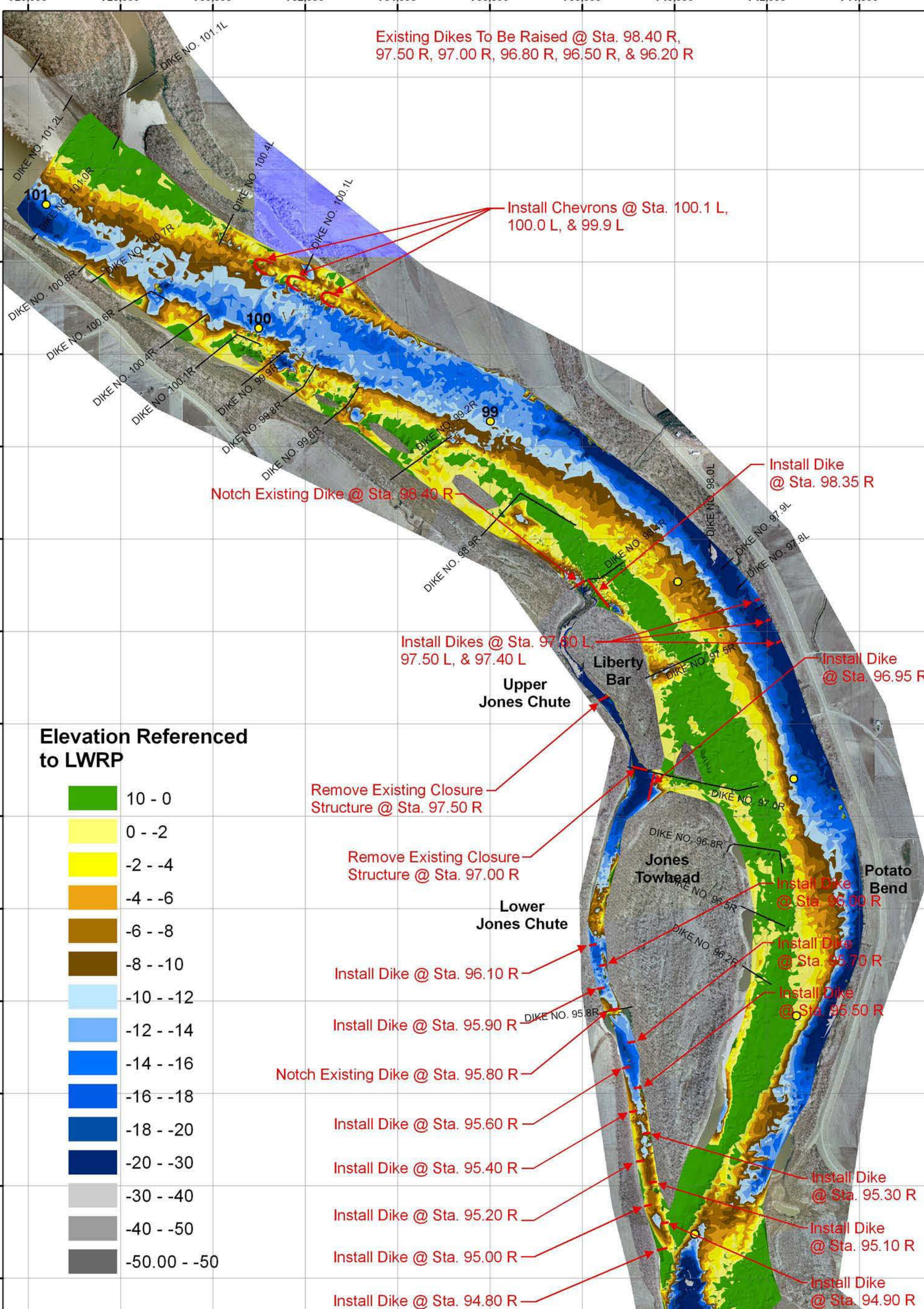

PLATE NUMBER 28

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 11

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
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FILE NAME: ...ARC/JONESCHUTE	

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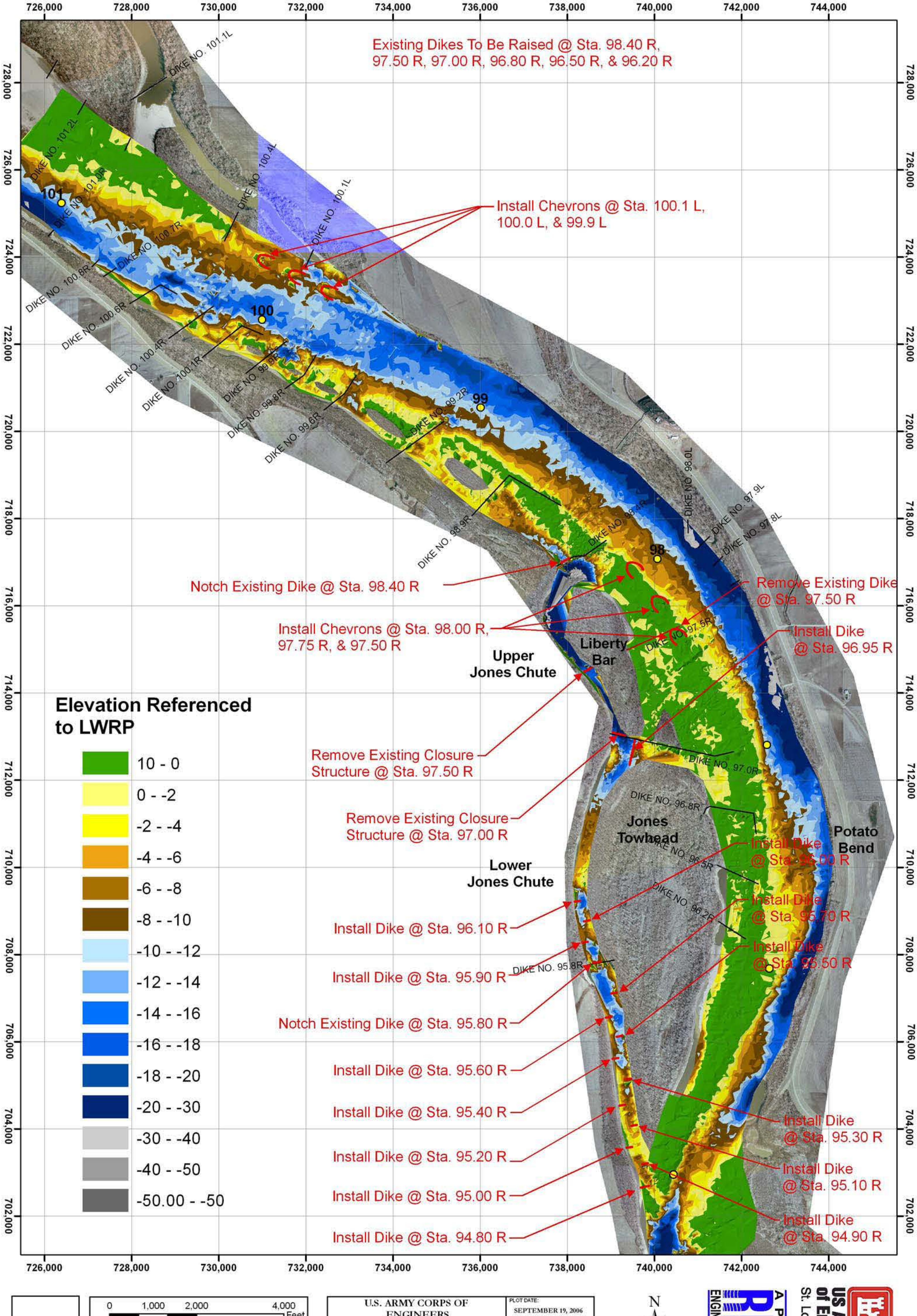

PLATE NUMBER 29

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 12

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006
PREPARED BY: M. MILES
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FILE NAME: ...ARC/JONESCHUTE

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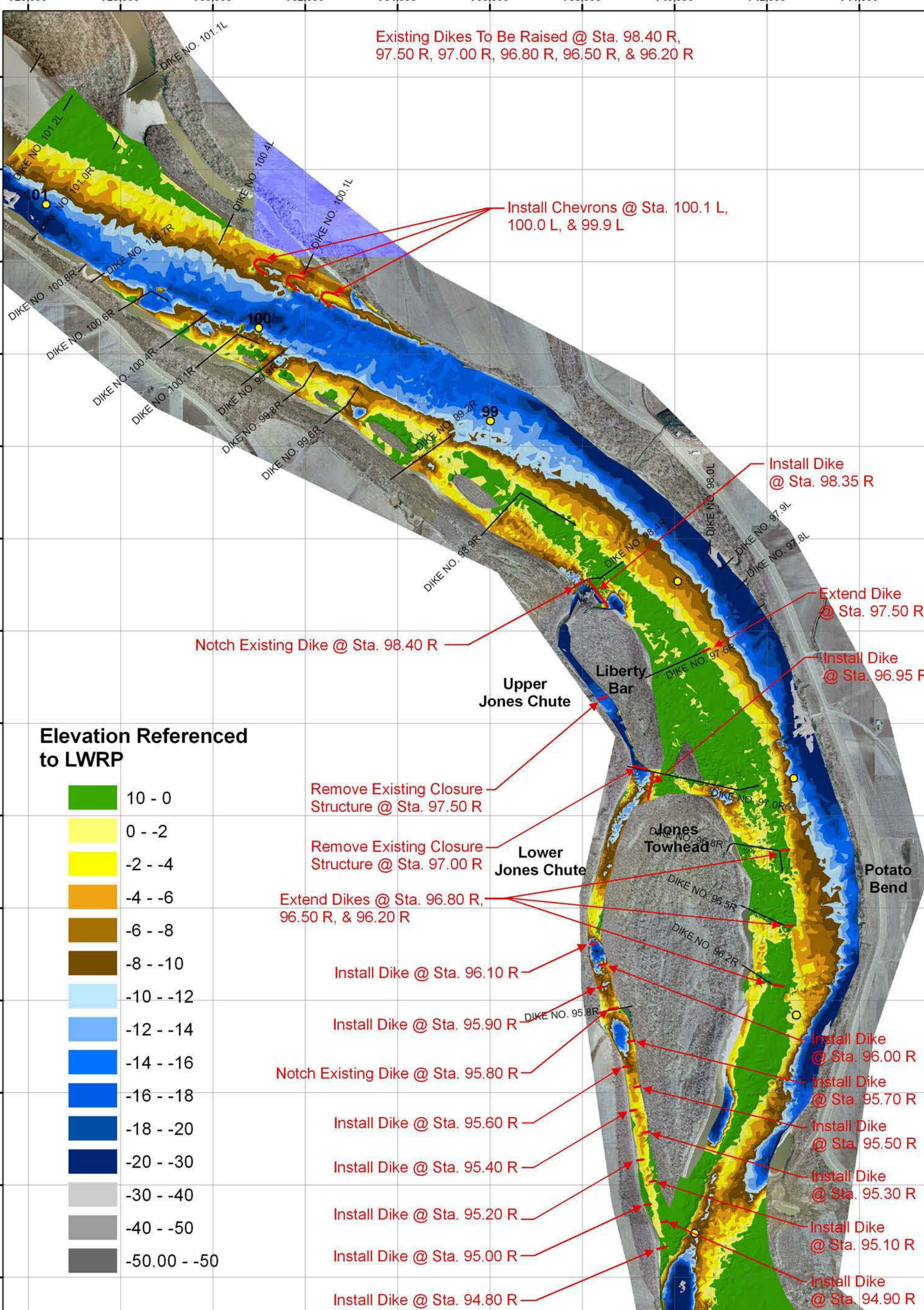

PLATE NUMBER 30

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

ALTERNATIVE 13

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: SEPTEMBER 19, 2006	
PREPARED BY: M. MILES	DRAWN BY: M. HOFFMAN
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FILE NAME: ...ARC/JONESCHUTE	

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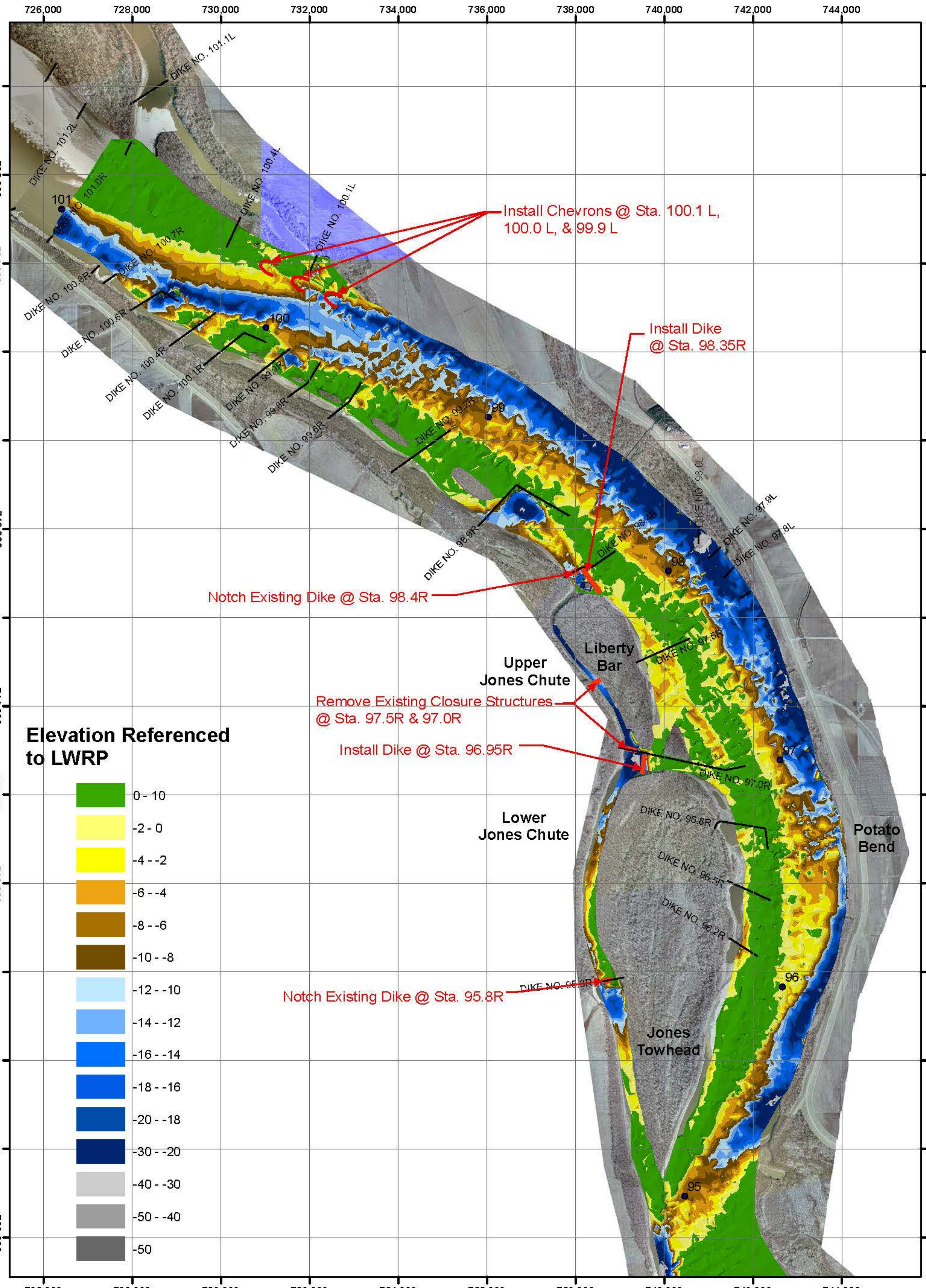

PLATE NUMBER DRG 1

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING BASE TEST WITH SCHEDULED CONSTRUCTION AND RECOMMENDED IMPROVEMENTS TO SIDE CHANNELS
2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE(dredg/bg)	

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St. Louis District

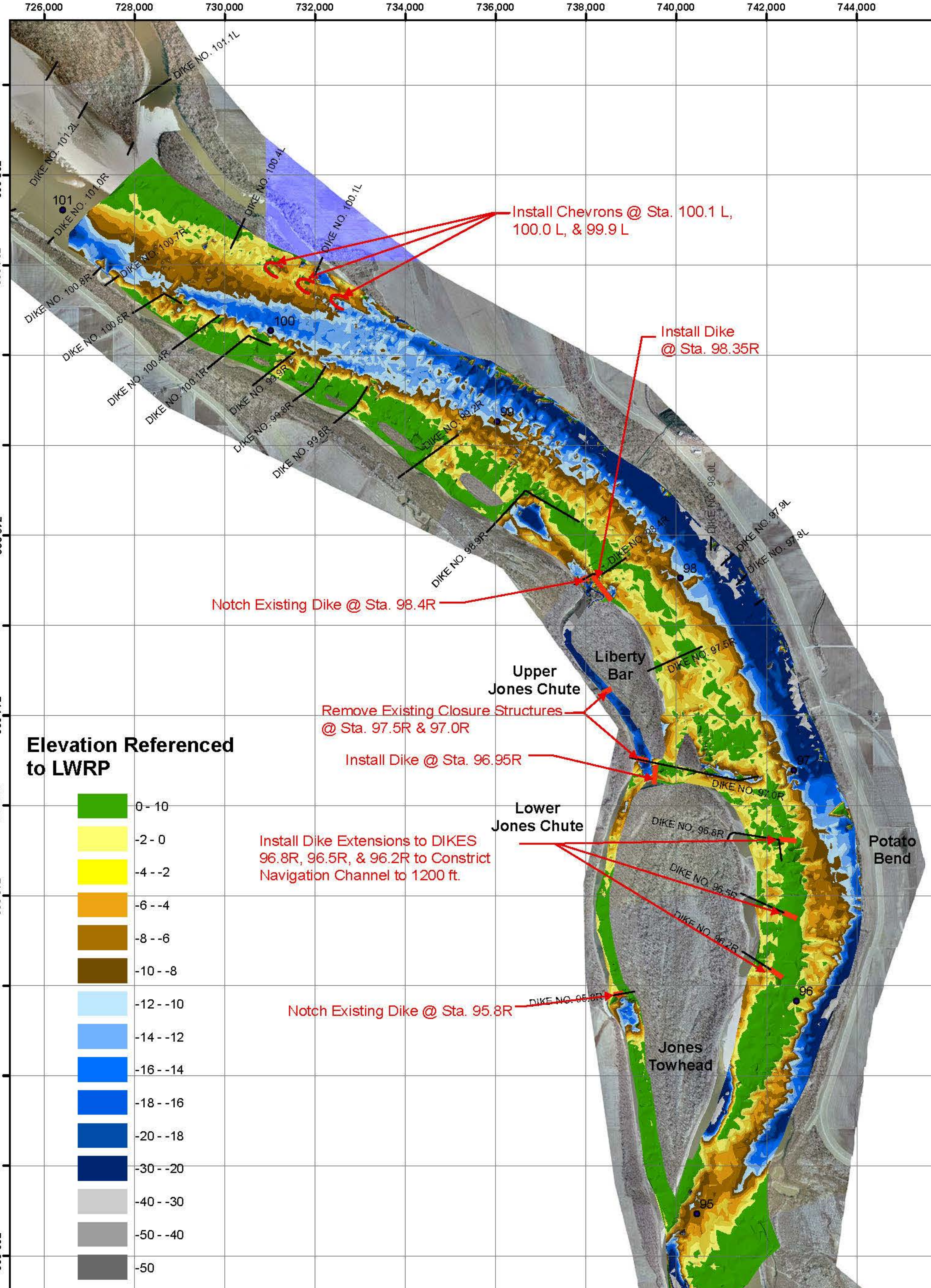

PLATE NUMBER
DRG 2

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 1

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE(dredging)	

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St. Louis District

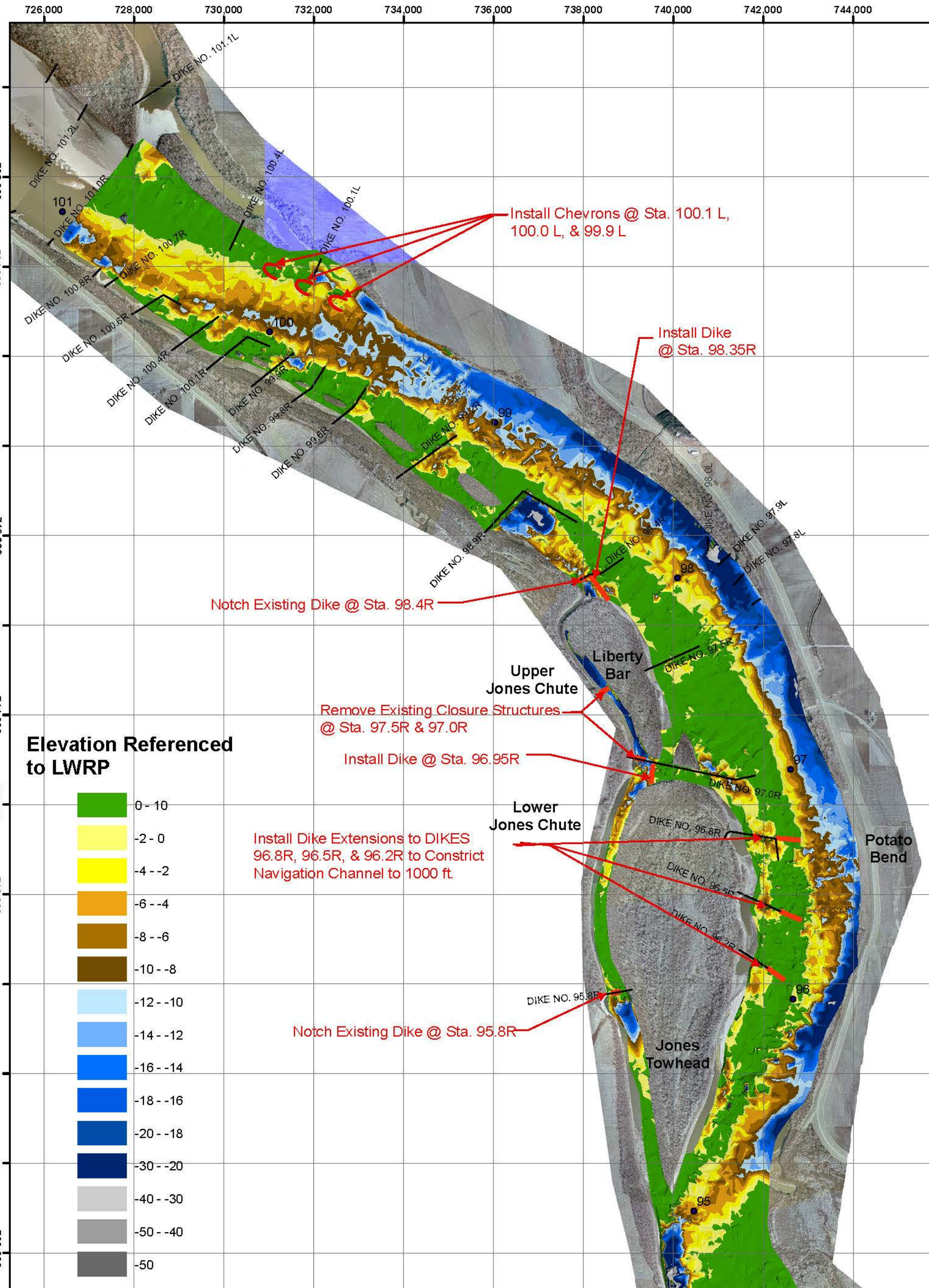

PLATE NUMBER
DRG 3

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 2

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE(dredging)	

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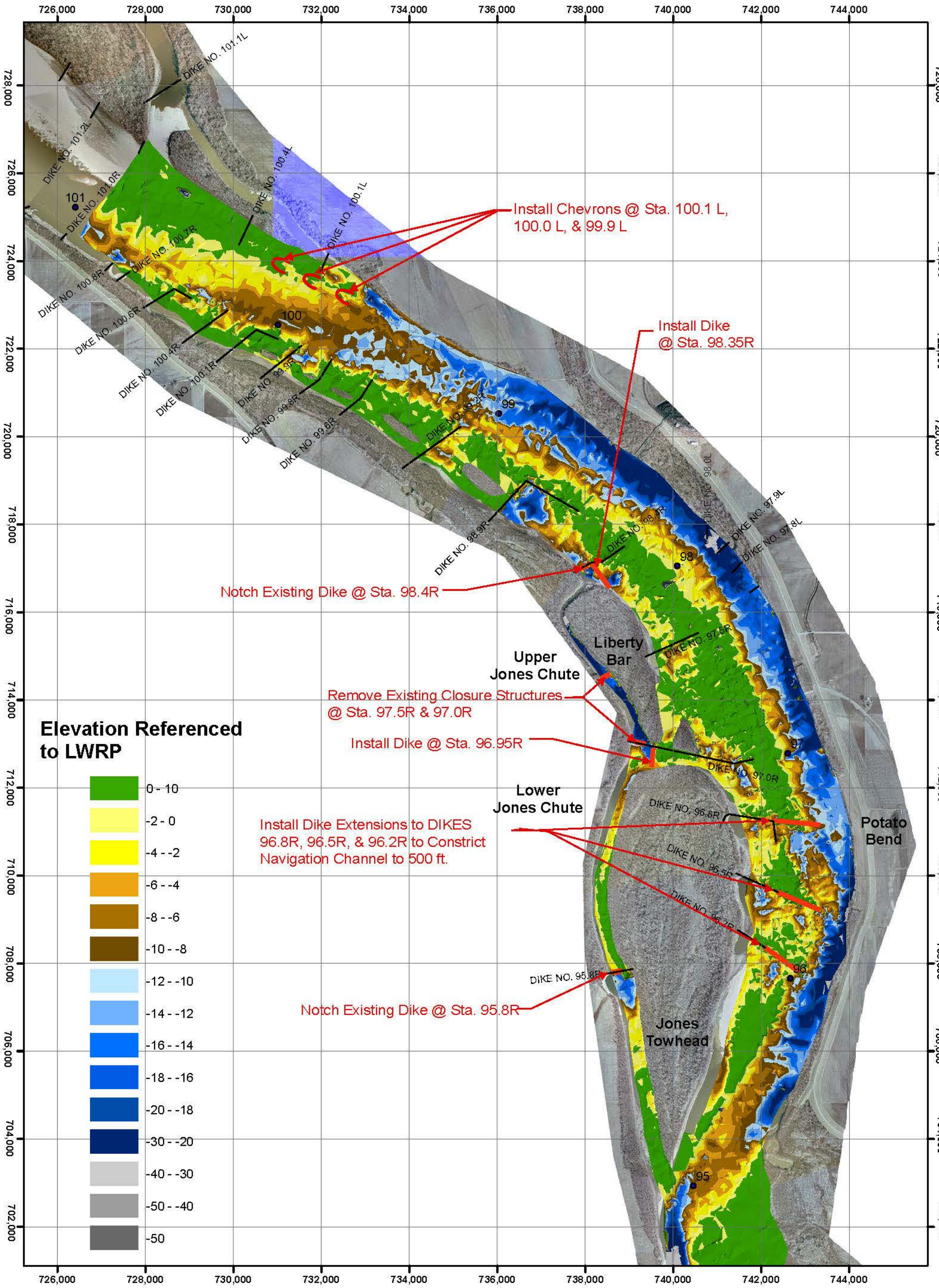

PLATE NUMBER
DRG 4

0 1,000 2,000 4,000 Feet

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DREDGING ALTERNATIVE 3

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007
PREPARED BY: M. MILES
DRAWN BY: M. MILES
CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE(dredging)

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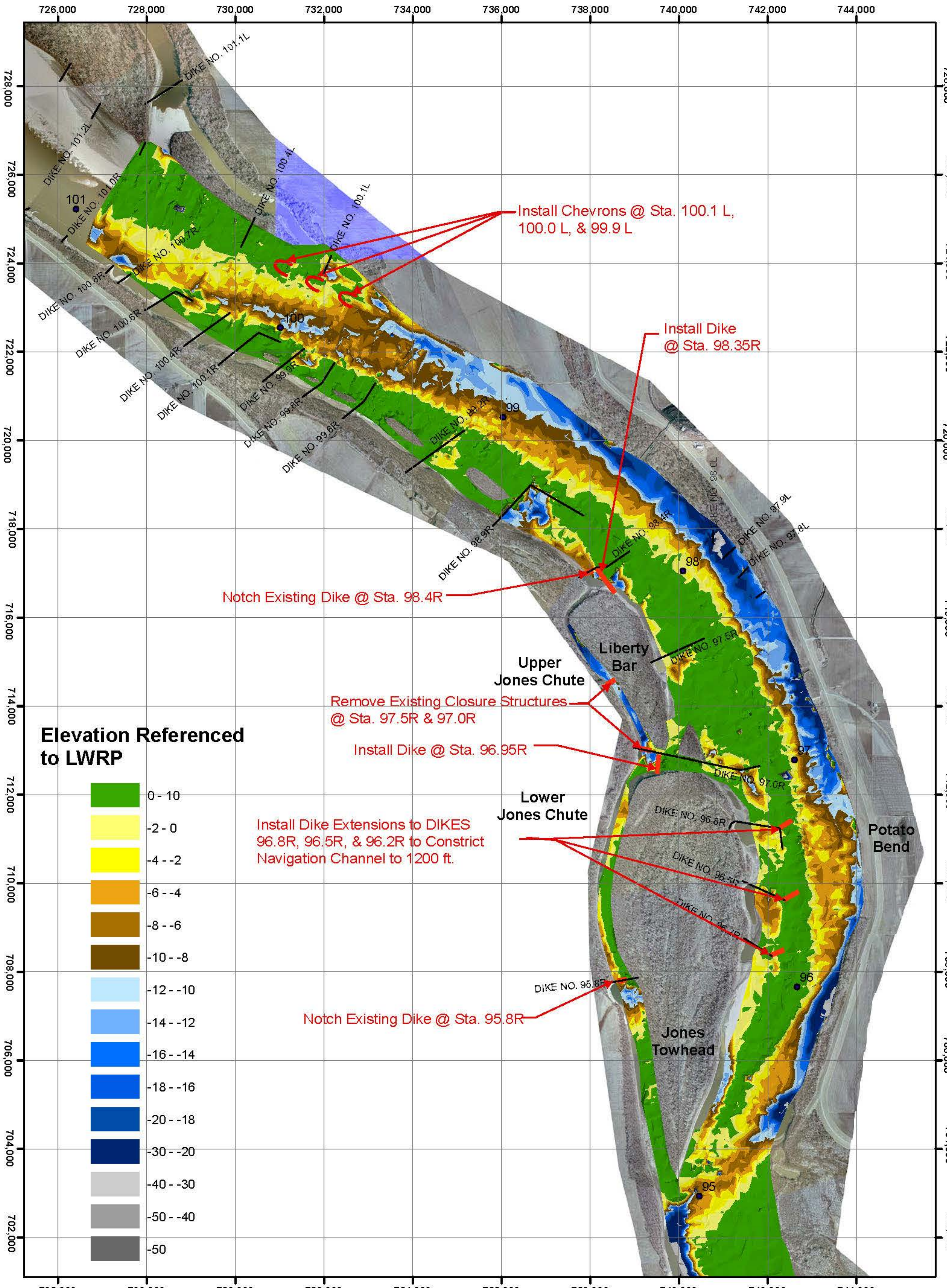

PLATE NUMBER DRG 5

0 1,000 2,000 4,000 Feet

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DREDGING ALTERNATIVE 4

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007
PREPARED BY: M. MILES
DRAWN BY: M. MILES
CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE(dredging)

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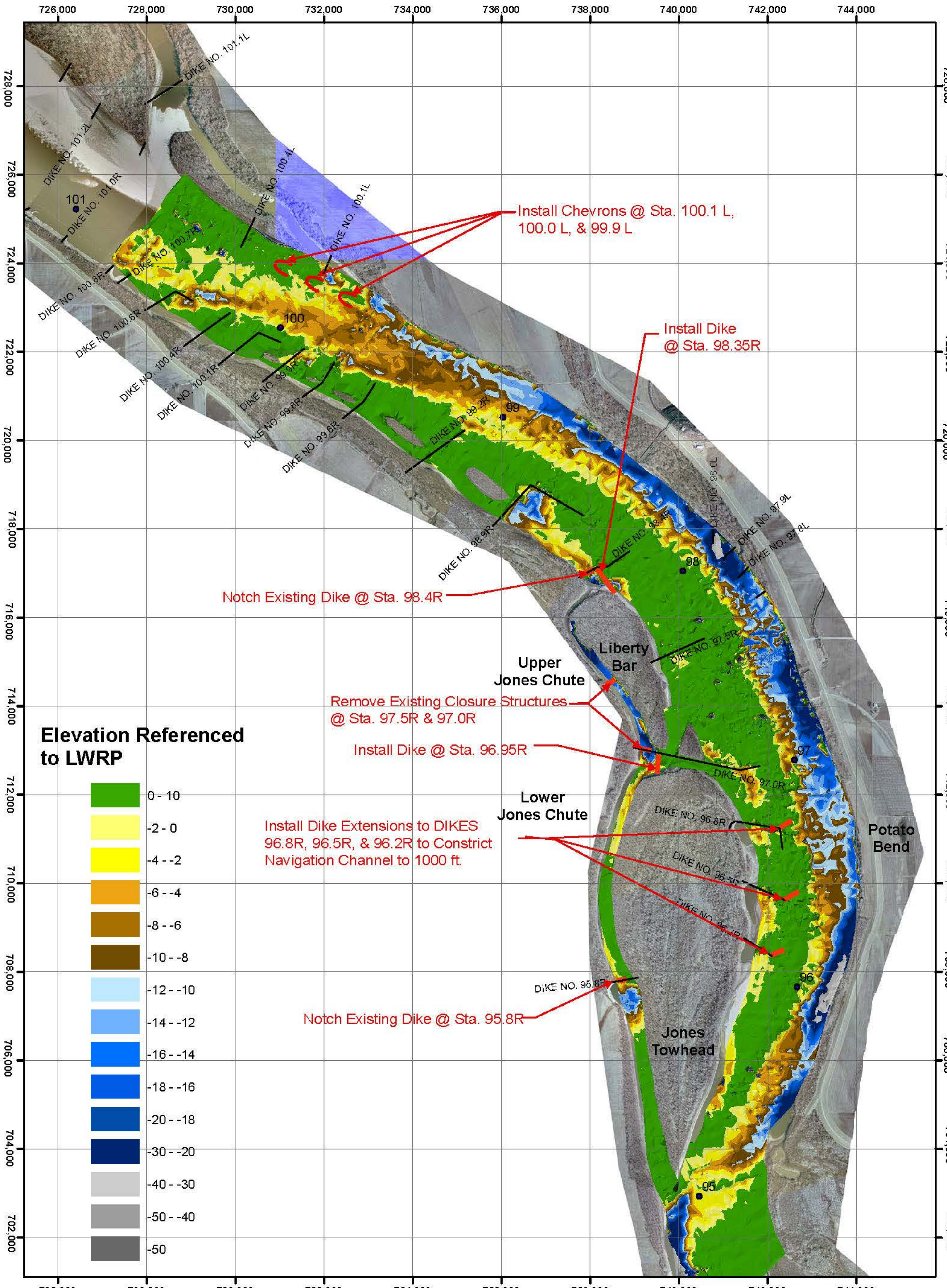

PLATE NUMBER
DRG 6

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 5

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007
PREPARED BY: M. MILES
DRAWN BY: M. MILES
CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE(dredging)

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St. Louis District

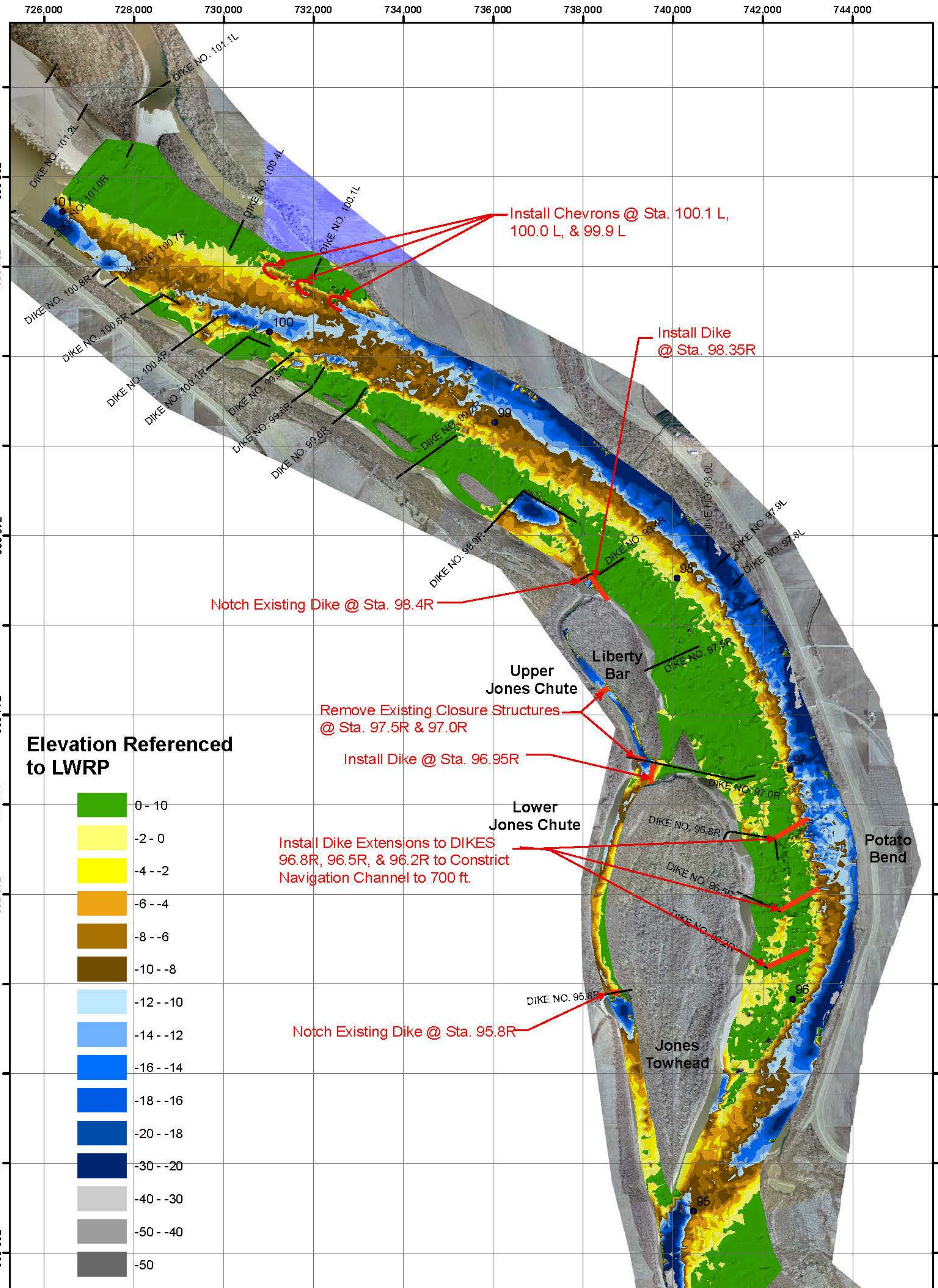

PLATE NUMBER **DRG 7**

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 6

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME: _ARC/JONESCHUTE(dredg6bg)	

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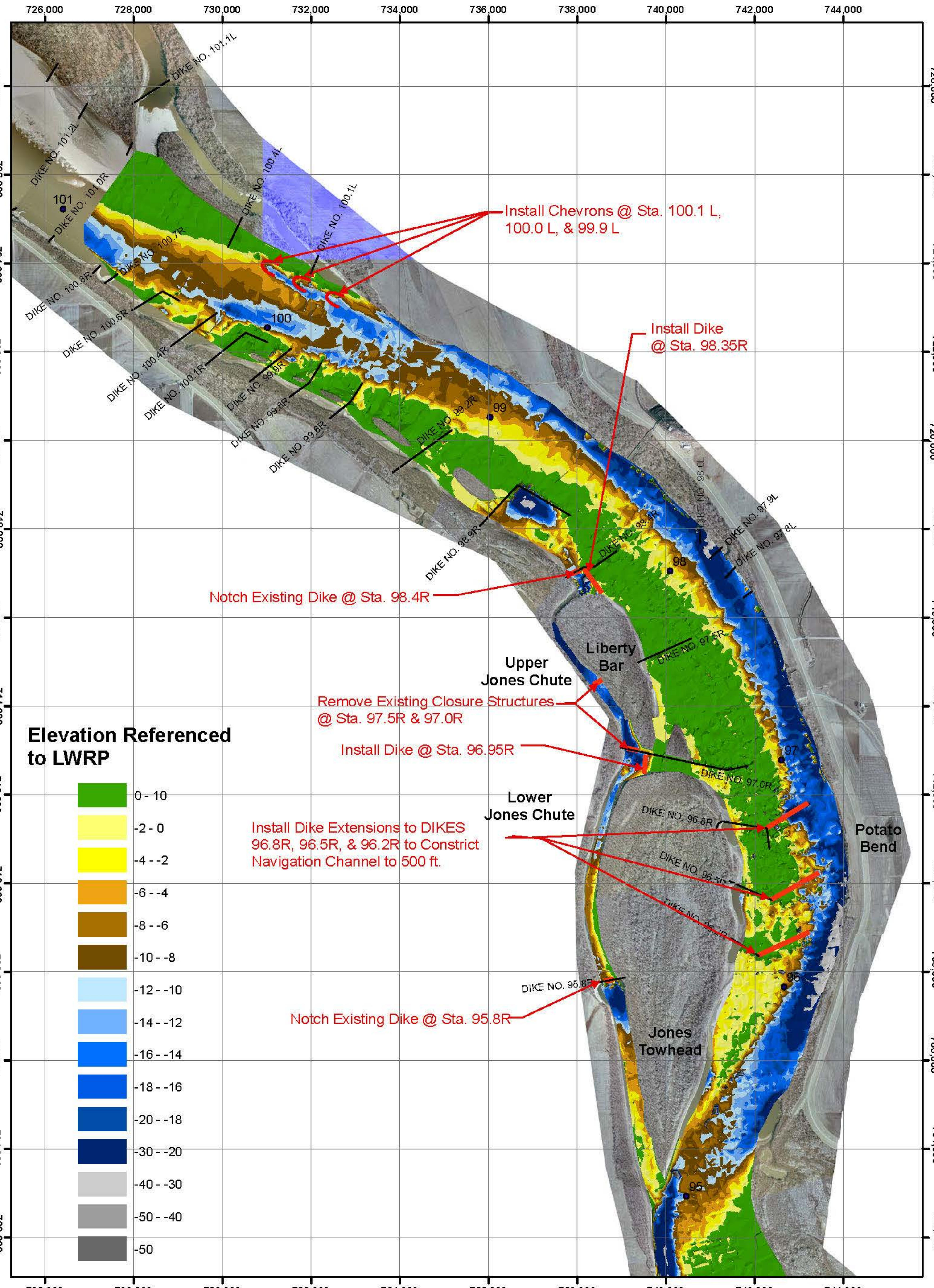

PLATE NUMBER

DRG 8

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 7

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007

PREPARED BY: M. MILES

DRAWN BY: M. MILES

CHECKED BY: D. GORDON

FILE NAME: ...ARC/JONESCHUTE(dredging)

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St. Louis District

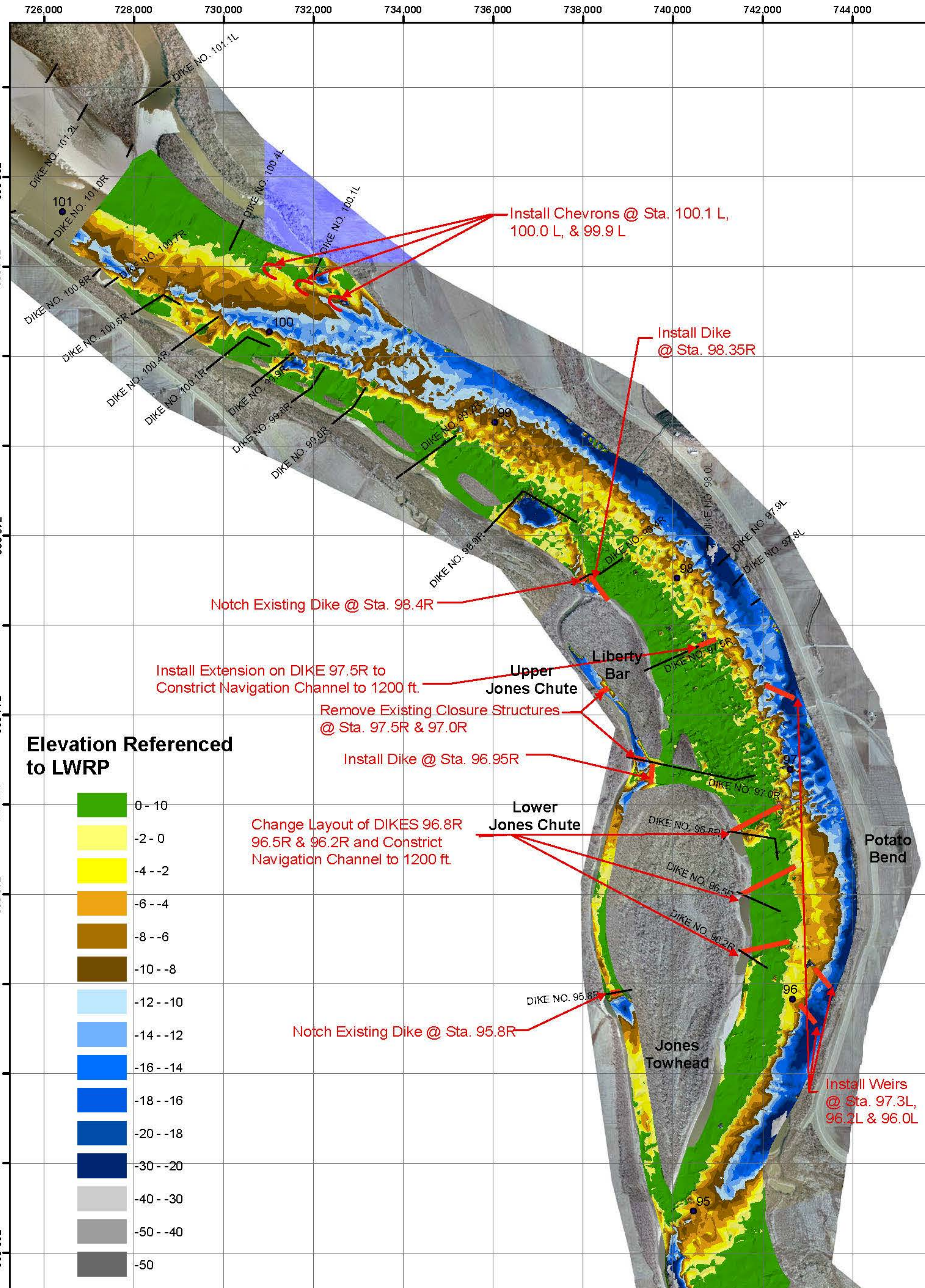

PLATE NUMBER DRG 9

0 1,000 2,000 4,000 Feet

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DREDGING ALTERNATIVE 8

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007
PREPARED BY: M. MILES
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CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE(dredging)

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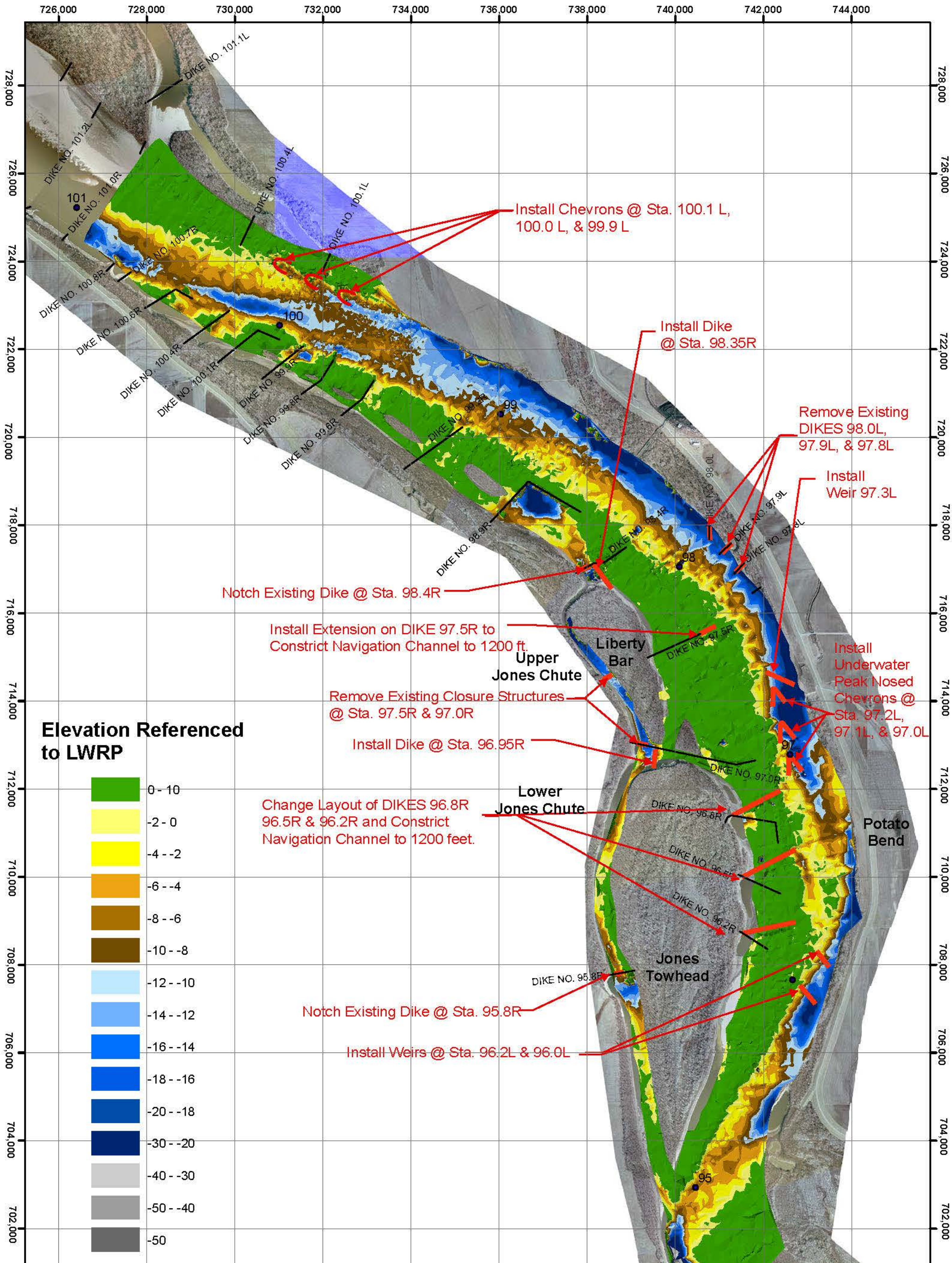

PLATE NUMBER
DRG 10

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 9

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
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PLOT DATE: MARCH 19, 2007
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CHECKED BY: D. GORDON
FILE NAME: ARC/JONESCHUTE(dredging)

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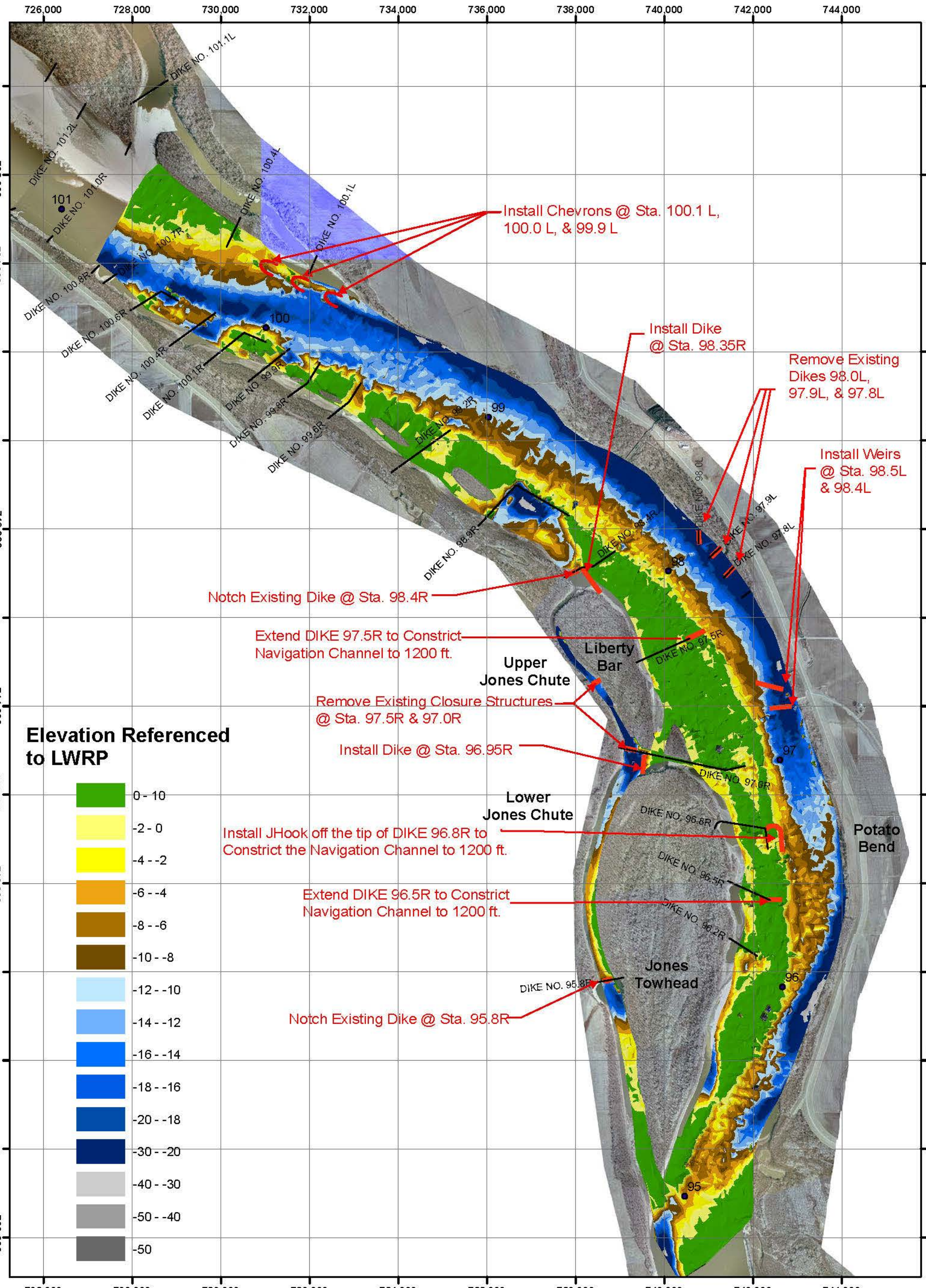

PLATE NUMBER
DRG 11

0 1,000 2,000 4,000 Feet

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DREDGING ALTERNATIVE 10
2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

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PREPARED BY: M. MILES
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CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE(dredging)

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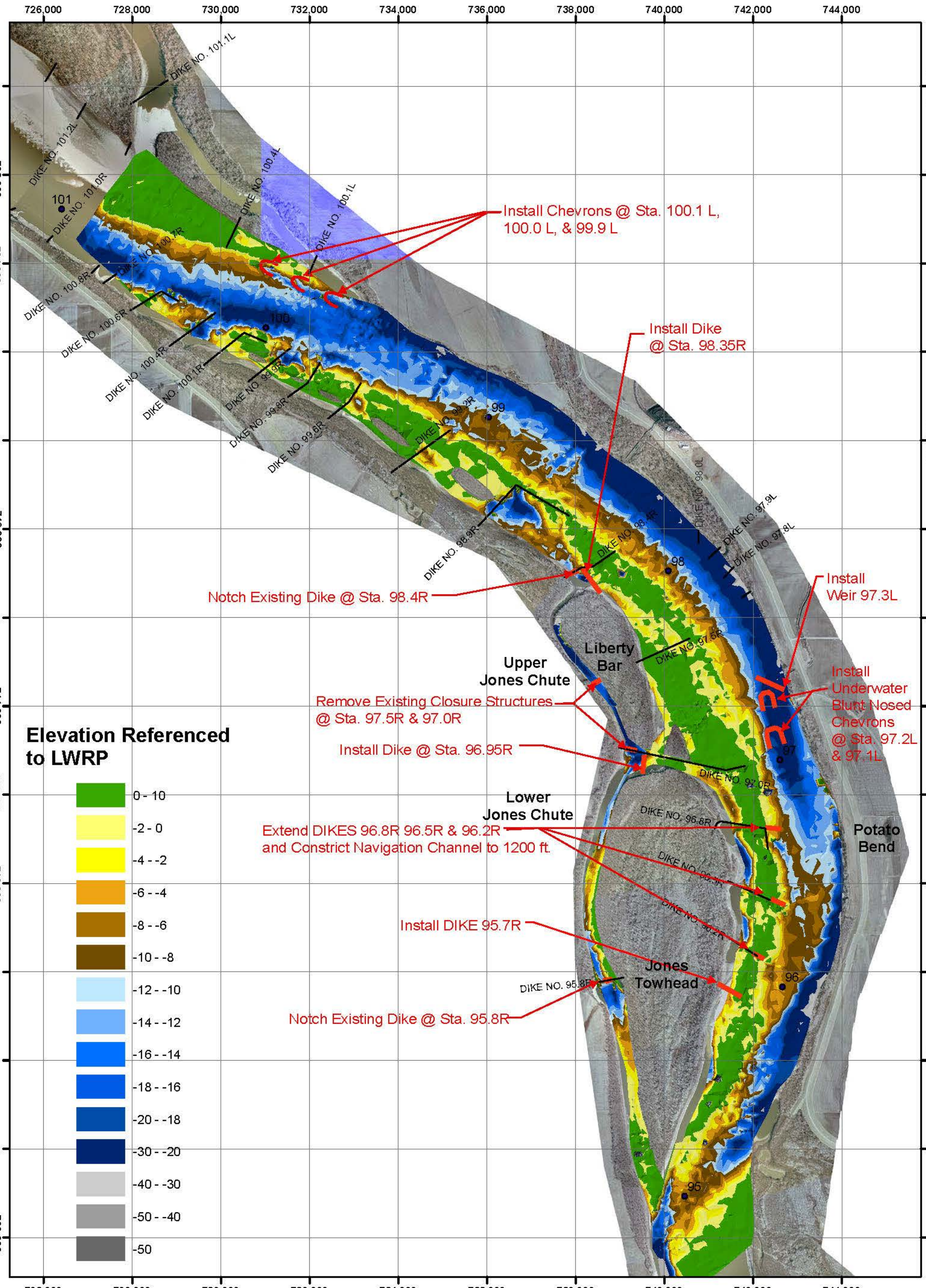

PLATE NUMBER DRG 12

0 1,000 2,000 4,000 Feet

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DREDGING ALTERNATIVE 11

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
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US Army Corps of Engineers
St. Louis District

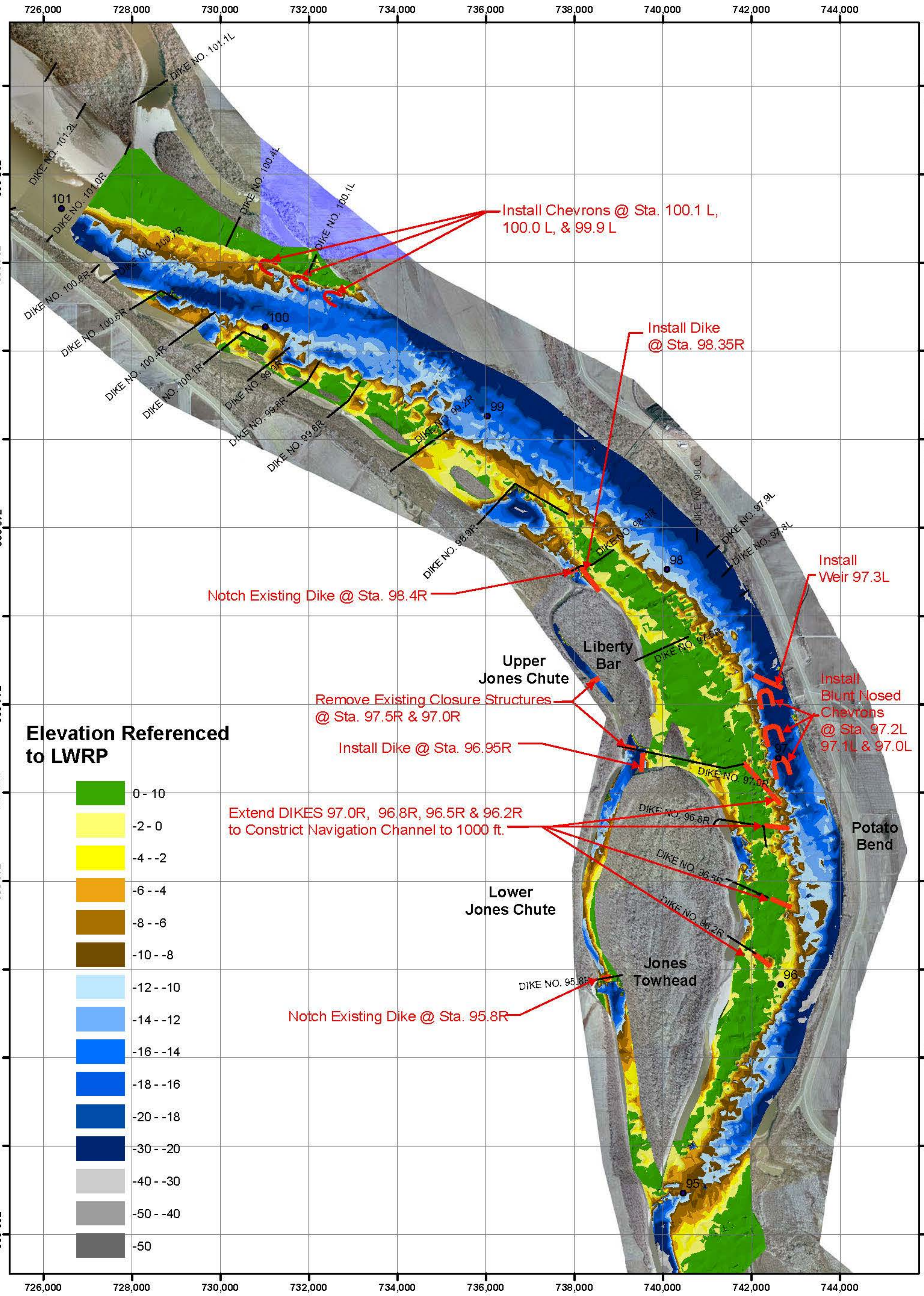

PLATE NUMBER
DRG 13

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 12

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007
PREPARED BY: M. MILES
DRAWN BY: M. MILES
CHECKED BY: D. GORDON
FILE NAME: ...ARC/JONESCHUTE(dredging)

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

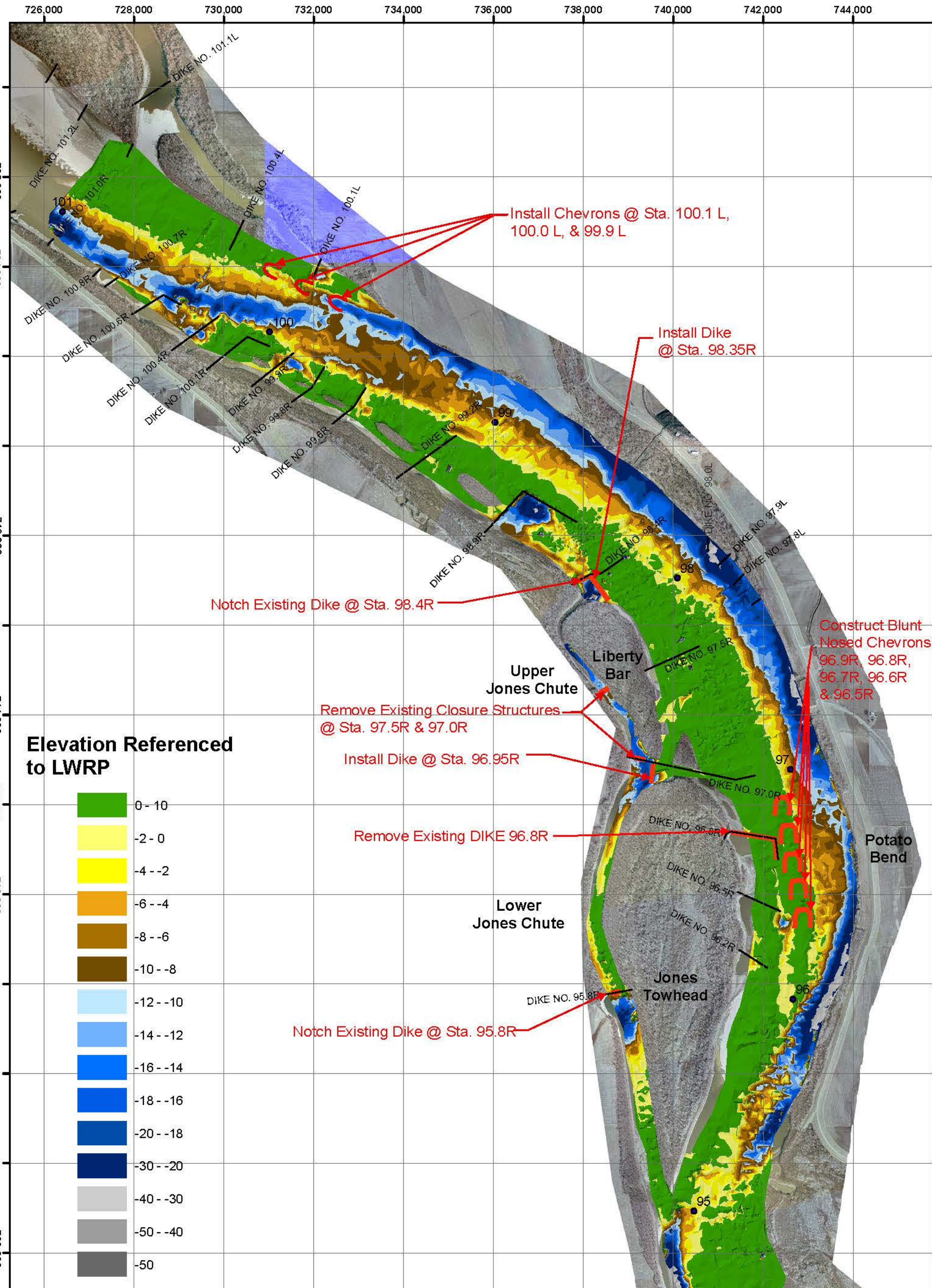

PLATE NUMBER DRG 14

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 13

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS ST. LOUIS DISTRICT	PLOT DATE: MARCH 19, 2007
	PREPARED BY: M. MILES / DRAWN BY: M. MILES
UPPER MISSISSIPPI RIVER BASIN Jones Chute HSR Model River Miles 101.2 - 94.6	CHECKED BY: D. GORDON
	FILE NAME: ...ARC/JONESCHUTE(dredging)

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers St. Louis District

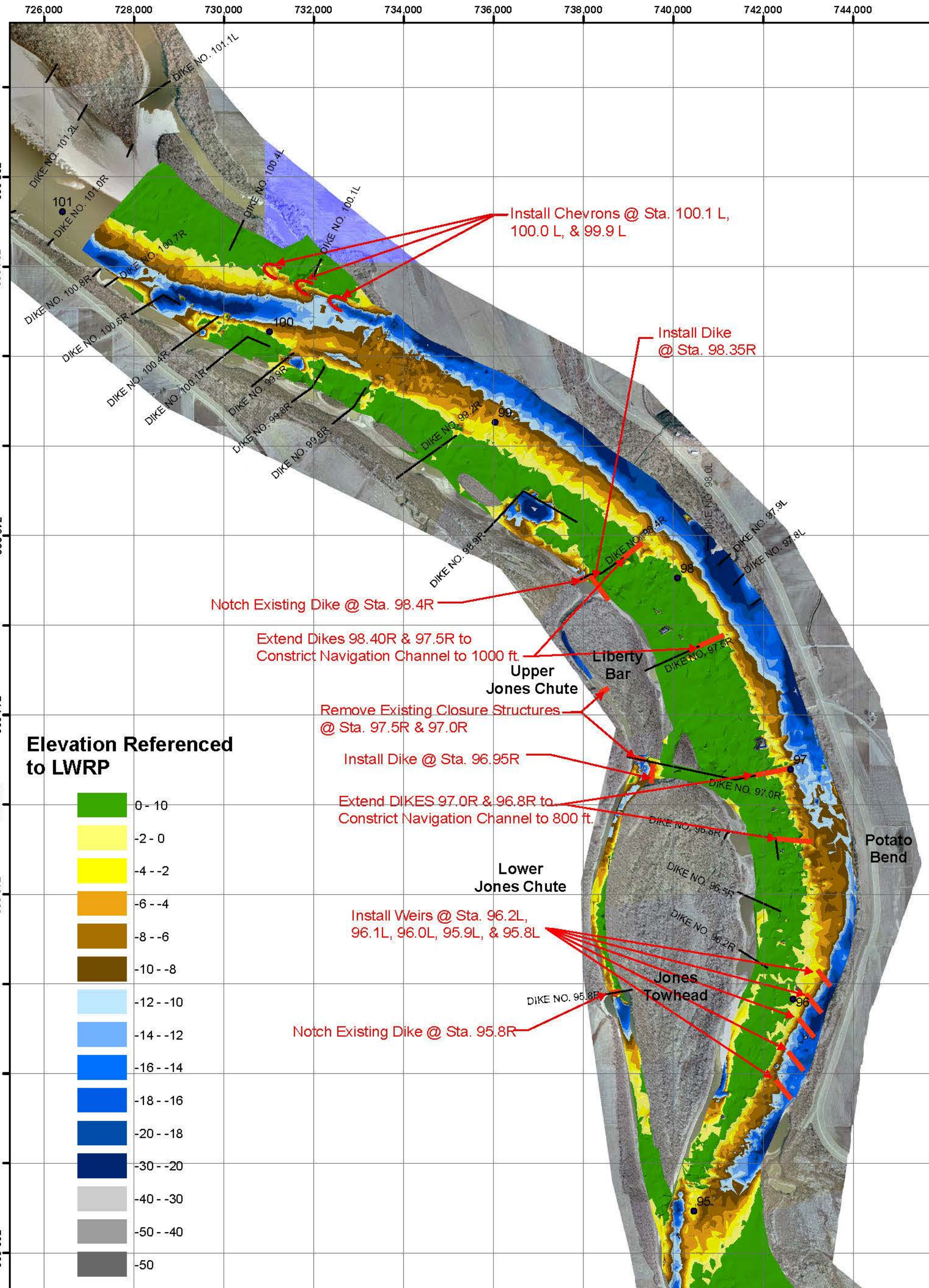

PLATE NUMBER
DRG 15

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 14

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME: ...ARC/JONESCHUTE(dredging)	

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

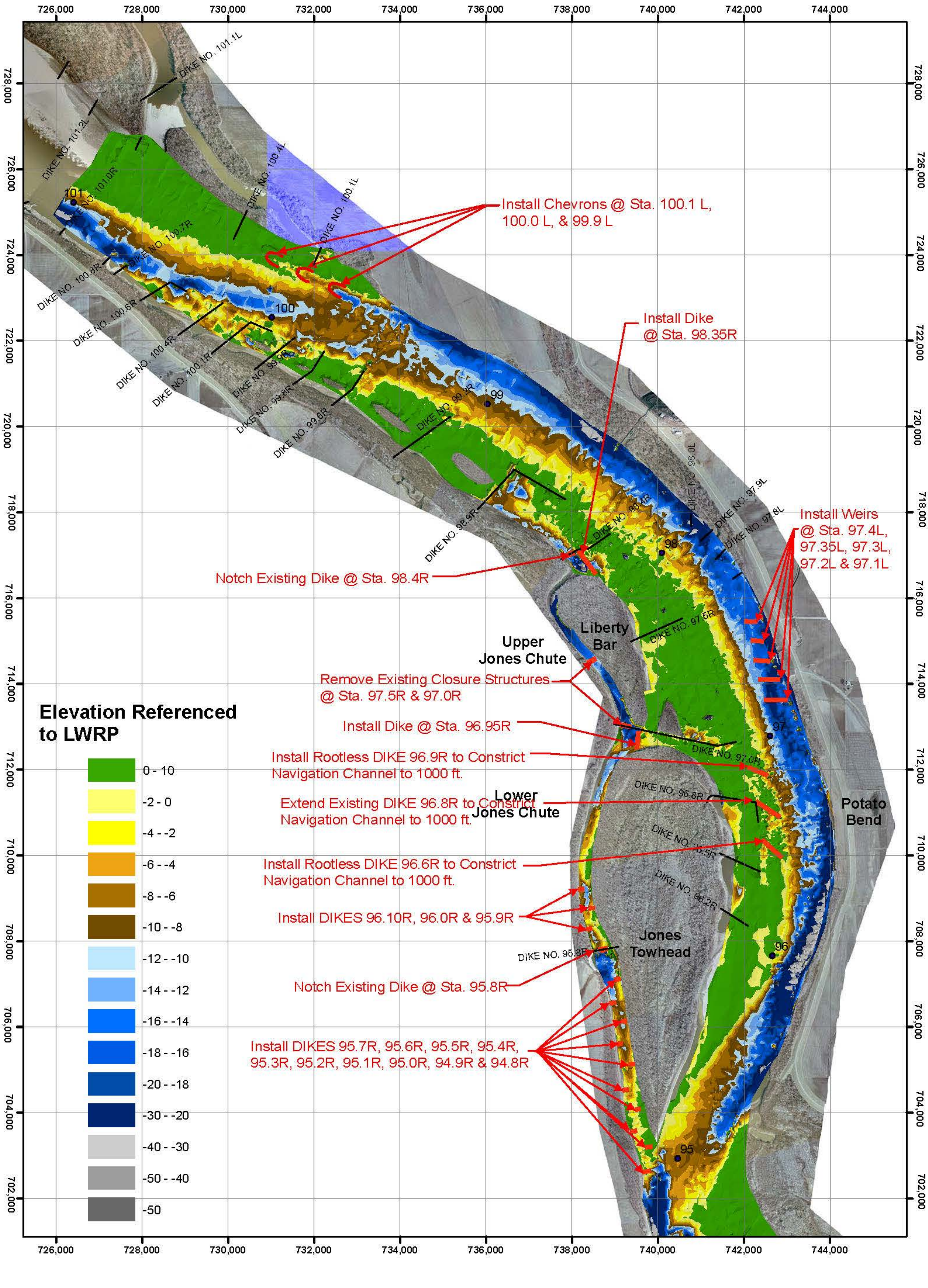

PLATE NUMBER

DRG 16

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 15

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007

PREPARED BY: M. MILES

DRAWN BY: M. MILES

CHECKED BY: D. GORDON

FILE NAME: ...ARC/JONESCHUTE(dredging)

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

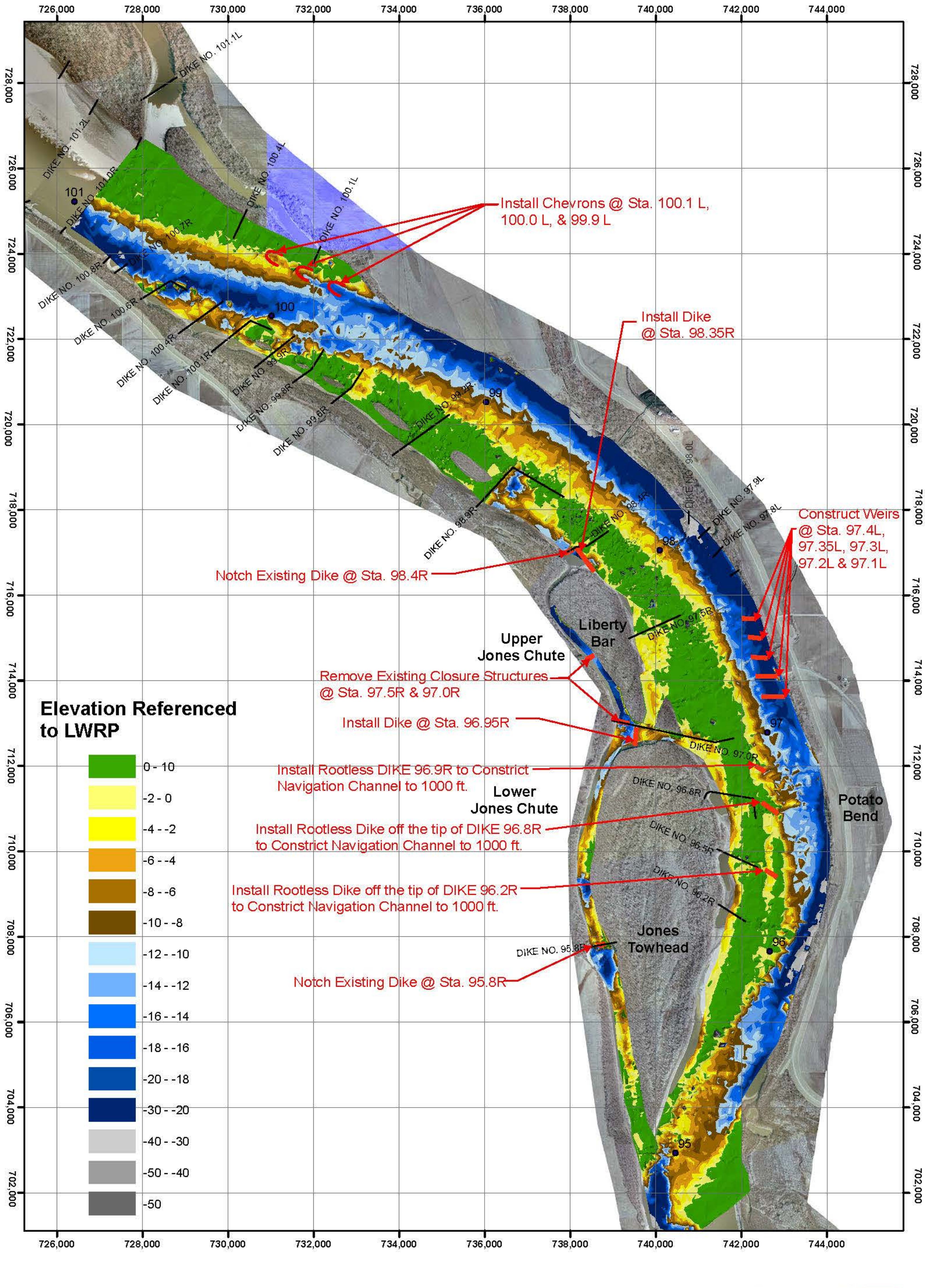

PLATE NUMBER **DRG 17**

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

DREDGING ALTERNATIVE 16

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: MARCH 19, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME: _ARC/JONESCHUTE(dredging)	

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US Army Corps of Engineers
St. Louis District

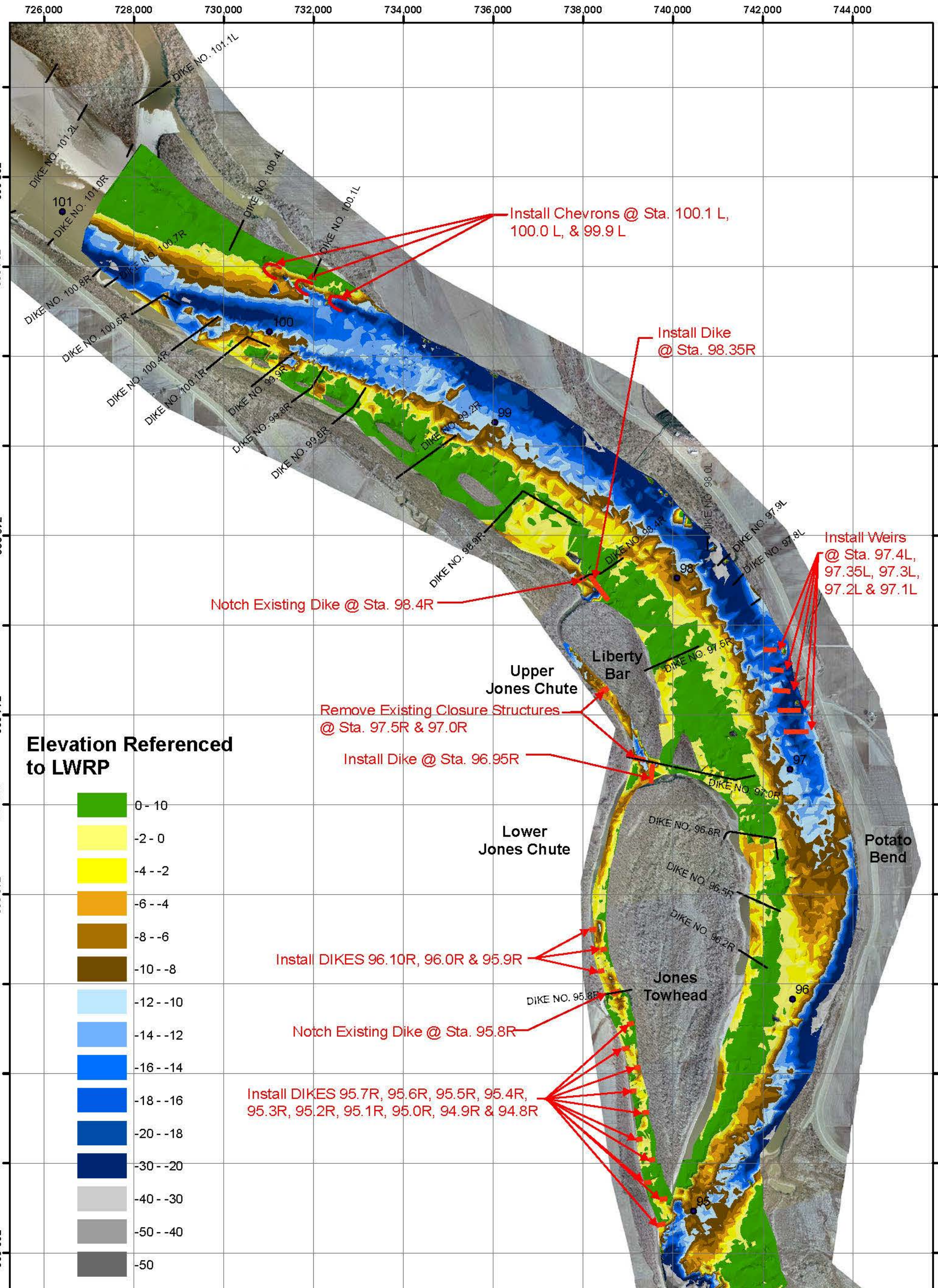

PLATE NUMBER	0 1,000 2,000 4,000 Feet	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS DISTRICT	PLOT DATE: APRIL 4, 2007
DRG 18	THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME	UPPER MISSISSIPPI RIVER BASIN Jones Chute HSR Model River Miles 101.2 - 94.6	PREPARED BY: M. MILES DRAWN BY: M. MILES
	DREDGING ALTERNATIVE 17 2006 AERIAL PHOTOGRAPH		CHECKED BY: D. GORDON
			FILE NAME: ...ARC/JONESCHUTE(dredg.lbg)

N W E S

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers® St. Louis District

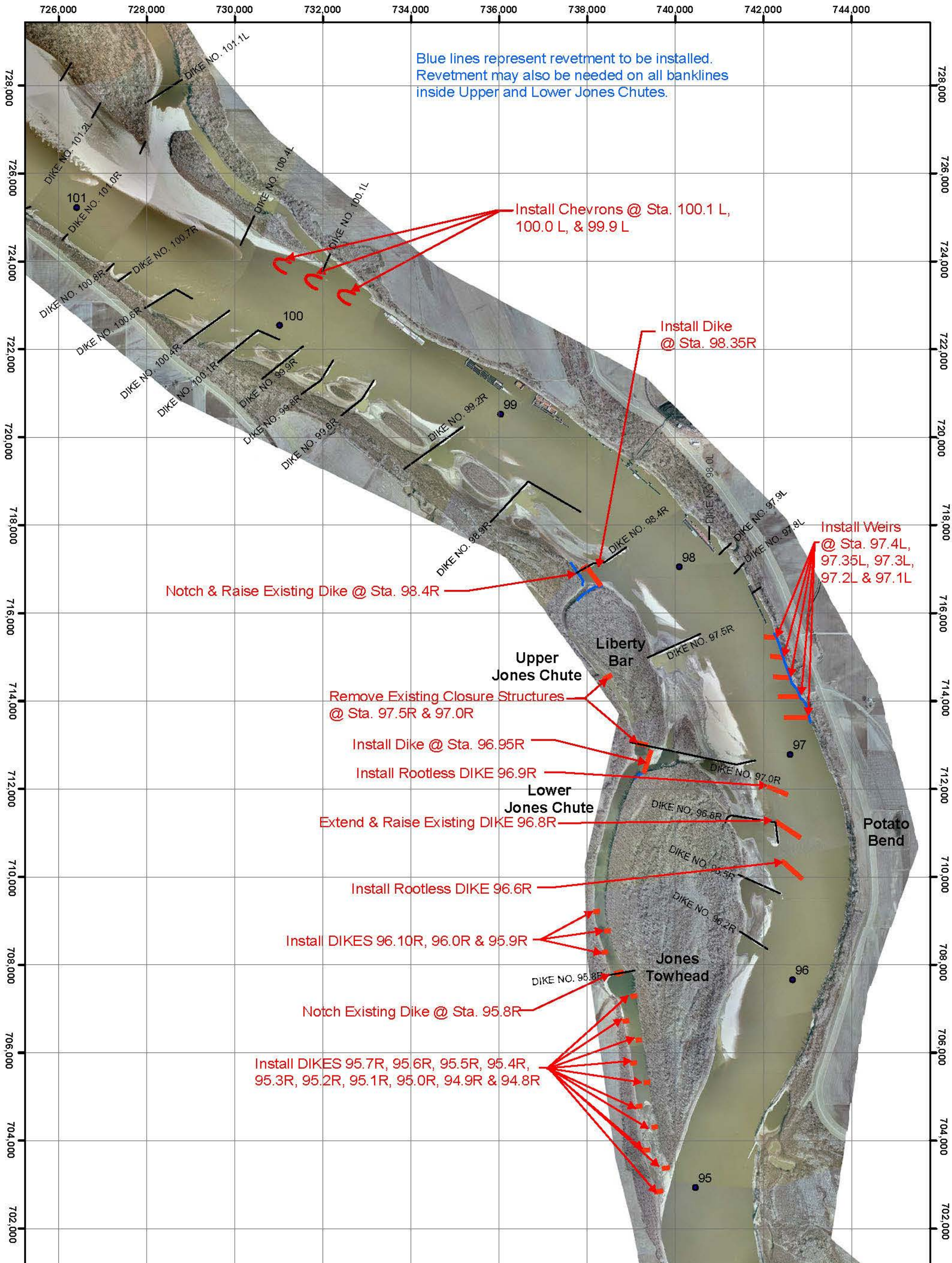

PLATE NUMBER

FINAL 1

0 1,000 2,000 4,000 Feet

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME

RECOMENDED DESIGN
STUDY PHASE 1 & PHASE 2

2006 AERIAL PHOTOGRAPH

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT

UPPER MISSISSIPPI RIVER BASIN
Jones Chute HSR Model
River Miles 101.2 - 94.6

PLOT DATE: APRIL 4, 2007	
PREPARED BY: M. MILES	DRAWN BY: M. MILES
CHECKED BY: D. GORDON	
FILE NAME:	

N W E S

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District