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FINAL REPORT— AUGUST 2010

US Army Corps of Engineers
St. Louis District

WILKINSON ISLAND HYDRAULIC SEDIMENT RESPONSE MODEL STUDY

Authors: Edward J. Brauer, P.E., Michael T. Rodgers, P.E., Robert D. Davinroy, P.E., Jason Floyd, Emily Rivera

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ST. LOUIS DISTRICT
HYDROLOGIC AND HYDRAULICS BRANCH
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Sponsored by and Prepared for: U.S. ARMY CORPS OF ENGINEERS– UPPER MISSISSIPPI RIVER ENVIRONMENTAL MANAGEMENT PROGRAM (UMRS-EMP)

In Cooperation With: Illinois Department of Natural Resources, Missouri Department of Conservation, and U. S. Fish and Wildlife Service

APPLIED RIVER ENGINEERING CENTER

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WILKINSON ISLAND
HYDRAULIC SEDIMENT RESPONSE MODEL STUDY
MIDDLE MISSISSIPPI RIVER MILES 98.0-90.0

By
Edward J. Brauer, P.E.
Michael T. Rodgers, P.E.
Robert D. Davinroy, P.E.
Jason Floyd
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INTRODUCTION

A hydraulic sediment response model was initiated to evaluate side channel alternatives on the Wilkinson Island Division of the Middle Mississippi River National Wildlife Refuge. The Division is located along the left descending bank of the Mississippi River between River Miles (RM) 95.5 and 89.0 in Jackson County, Illinois and Perry County, Missouri. The 2700-acre Division is owned and managed by the U.S. Fish and Wildlife Service. The Service purchased the land after the flood of 1993. Prior to the flood of 1993, the site was protected by an agricultural levee and land cover consisted mainly of farmland and lowland forest. Subsequent to the flood of 1993 and the associated breaching of the agricultural levee, land cover has changed to invasive non-native grass, early succession cottonwood/willow forest and some areas of wet meadow and scrub/shrub. The breach in the levee has not been repaired so the site is open to river flood pulses.

Mr. Edward J. Brauer, P.E., hydraulic engineer, and Mr. Jason Floyd, engineering technician, under direct supervision of Mr. Robert D. Davinroy, P.E., Chief of River Engineering, conducted the study between March 2009 and July 2010. Other Corps of Engineers personnel involved with the study included: Brian Markert, Project Manager for the Environmental Management Program, Mr. Ron Dieckmann, Engineering Coordinator for the Environmental Management Program, Mr. Michael Rodgers, P.E., from the Hydraulic Design section, Mr. Brian Kleber, Project Management, Ms. Nancy Tokraks and Ms. Julie Eschmann from Civil Engineering, Mr. Brandon Schneider and Mr. Kip Runyon from the Environmental Branch of the Planning, Programs, and Project Management Division, Ms. Genevieve Walters from Hydraulic Engineering, Mr. Ben McGuire and Ms. Sarah Miller from the Rivers Project Office. 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 and Mr. Matt Mangan from the U.S. Fish and Wildlife Service

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BACKGROUND

Hydraulic Sediment Response (HSR) modeling methodology was used to evaluate side channel alternatives to be excavated on the Wilkinson Island Division of the Middle Mississippi River National Wildlife Refuge. A HSR model was constructed and implemented to evaluate alternatives and develop a sustainable side channel. The model evaluated the sediment transport conditions within the side channel, the effect of the side channel on the flow splits between the side channel and main channel and the effect of the side channel on the velocity and magnitude of the flow in the main channel. This study was funded as part of the Upper Mississippi River Environmental Management Program (UMRS-EMP) of the U. S. Army Corps of Engineers, St. Louis District.

1. Study Reach

The study reach was located approximately 15 miles downstream of Chester, Illinois. The study comprised an 8-mile stretch of the Middle Mississippi River, between Miles 98.0 and 90.0. Plate 1 is a location and vicinity map of the study reach. The study area was located in Perry County in Missouri and Jackson County in Illinois. Due to the historic state boundaries and the meandering of the Mississippi River, the Wilkinson Island Division of the Middle Mississippi River National Wildlife Refuge is located in both Missouri and Illinois.

Plate 2 is a 2006 aerial photograph illustrating the planform and nomenclature of the Middle Mississippi River between Miles 98.0 and 90.0. The right descending bank (RDB) consists of limestone bluffs.   The bluffs are approximately 300 feet tall and act as a natural revetment to the channel. The left descending bank is made of typical alluvial floodplain material consisting of sand, silts and clays with an occasional sedimentary rock outcrop. There are no major tributaries in the study reach. Minor tributaries in the study reach are Cinque Hommes Creek and Reeds Creek. The flow from these tributaries has a negligible effect on the study reach.

A system of dikes and weirs has been used to maintain the navigation channel and create or maintain environmental diversity. Tables 1 and 2 show the elevations and lengths of these structures. Elevations listed on Table 1 were taken from the St. Louis District Enterprise GIS server (EGIS). Not all structures have been surveyed, verified and entered into EGIS. Due to an extended period of high water the elevations of the remaining structures could not be surveyed or verified in the field.

Dike Name	Length (ft) (Trail)	Elevation (ft)	Dike Name	Length (ft)	Elevation (ft)
98.9R	1280	350	94.4L	1340	
98.0L	140		94.3R	100	
98.4R	2140		94.1R	100	
97.9L	230		93.0L	545	347
97.7L	75		92.6L	425	
97.8L	340		92.3L	265	344
97.5R	2400		92.05L	590	346
97.0R	3090	347	91.8L	460	337
96.8R	1040 (500)	340	91.6L	365	346
96.5R	1135	348	91.6R	350 (330)	337
96.2R	950	348	91.4R	575	346
95.2L	800		91.1R	300	337
94.8L	460		90.9R	275	337
94.6R	400		90.7R	325	346
94.6L	645		90.5R	400	337
94.5L	2600				
94.5R	110				

Table 1: Dike Information

Weir Name	Length (ft)	Elevation (ft)	Weir Name	Length (ft)	Elevation (ft)
94.8R	490	316	94.05R	316	530
94.6R	400	316	94.0R	316	660
94.5R	415	316	93.9R	316	680
94.3R	680	316	93.7R	316	798
94.1R	820	316			

Table 2: Weir Information

2. Problem Description

Wilkinson Island has accreted to the mainland and no longer provides historic island and side channel habitat that is an important component of the open river ecosystem. The existing forest habitat was fragmented with low diversity. Invasive non-native grasses, primarily Johnson Grass and reeds canary grass, have invaded some of the former farm fields.

The existing habitat conditions, future habitat needs and proposed actions required for habitat restoration on the MMR are addressed in various publications, including the District's Middle Mississippi River Side Channels Plan (MMRSCP) (COE, undated), the Upper Mississippi River System (UMRS) Habitat Needs Assessment (HNA) Summary Report (COE, 2000), the U.S. Fish and Wildlife Service's Pallid Sturgeon Recovery Plan (USFWS, 1993), and its Final Biological Opinion for the Operation and Maintenance of the 9-Foot Navigation Channel on the Upper Mississippi River System (USFWS, 2000).

Side channels are a critical component of the Mississippi River ecosystem, and those that remain are in various stages of disarray. Most have been degraded by a variety of factors including: reduced flow, uniform bottom depths, lost connectivity to the river and adjacent wetlands, a loss of aquatic habitat structure, increased sedimentation, and a loss of overall habitat diversity. If this degradation process continues into the future a critically important habitat component of the riverine ecosystem could eventually be eliminated. The HNA report estimates there is a need to create or restore MMR backwater and secondary channel habitat by 25,000 acres.

There is also a need to restore or create side channels for the benefit of the pallid sturgeon, a federally endangered species. Pallid sturgeon evolved in the diverse environments of the Missouri and Mississippi Rivers. Floodplains, backwaters, chutes, sloughs, islands, sandbars and main channel waters formed the large-river ecosystem that provided macro habitat requirements for pallid sturgeon and other large river fish. The transition zone between the vegetated floodplain and the main channel included habitats with varied depths described as chutes, sloughs or side channels. The chutes or sloughs between the islands and shore were shallower and had less current than the main channel. These areas provide valuable diversity to the large river fish and probably served as nursery and feeding areas for many aquatic species (Funk and Robinson 1974). The still waters in this transition zone allowed organic matter accumulations, important to macroinvertebrate production. Both shovelnose sturgeon and pallid sturgeon have a high incidence of aquatic invertebrates in their diets (Carlson et al. 1985, Gardner and Stewart 1987). Recent telemetry studies of pallid sturgeon indicate an active selection for downstream island tip habitat that develops at the confluence of the side channel and main channel. In addition, the Missouri Department of Conservation has collected larval pallid sturgeon in this type of habitat.

The Pallid Sturgeon Recovery Plan (USFWS, 1993) and the Biological Opinion for the Operation and Maintenance of the 9-Foot Navigation Channel Project (USFWS, 2000), identified past, present and ongoing loss of habitat diversity in the MMR as a major factor impacting on the endangered pallid sturgeon. As a result, the Reasonable and Prudent Alternative identified in that document specifically included implementation of a long-term habitat restoration program which placed high priority on the restoration of side channels and sandbars to benefit all life stages of pallid sturgeon.

3. History

A. Planform Changes

The Wilkinson Island reach of the Middle Mississippi River has undergone a number of dynamic geomorphologic changes since the first survey in the early 1800's. The first available survey of the river banklines was started by the Government Land Office (GLO) between 1817 in Missouri and 1820 in Illinois (Plate 3). Between Miles 102.0 and 94.0 the river crossed the entire floodplain from bluff to bluff. This crossing from the Missouri bluff to the Illinois bluff occurred approximately 2.5 miles north west of its present location. This crossing slowly migrated to its current location between the 1820's and 1920's.

The Wilkinson Island reach has been very dynamic over the past 190 years. In the early 1800's the reach contained an island and side channel complex with one large vegetated island. This alignment remained constant through the 1860's. In conjunction with the migration of the river crossing between the 1860's and the 1880's, vegetation developed in the side channel surrounding Wilkinson Island causing it to become part of the floodplain. Downstream of Wilkinson Island the planform became wider and more braided with lower depths in the channel and an abundance of sand bars. Transformation to a wider more braided planform was a trend throughout the Middle Mississippi River as the river attempted to respond to the changes. Between the 1880's and 1930's the reach between Miles 93.0 and 89.0 widened and a number of vegetated islands and sand bars developed.

In the late 1920's a number of navigation structures were constructed on the LDB to help define the navigation channel and reduce flow in the side channels (Plate 4). Over time the side channels accreted and vegetation grew creating the floodplain that exists today (Tables 3 and 4). Sometime between 1928 and 1942, revetment was placed along the LDB which led to the present day alignment. The current channel alignment was developed sometime around 1942 as shown in the 1942 "Program of Improvements" survey. Due to the dynamic nature of this river reach many different islands and side channels have existed. It would be impossible to determine one particular location of the historical side channel.

Planform Width (ft)				
1817	**1866**	**1881**	**1928**	**2003**
6903	6963	5172	4843	3076

Table 3: Historic Planform Width

Channel Width (ft)				
	1817	**1881**	**1928**	**2003**
Main	3396	3910	3074	2288
Side	1770	1152	1522	387
Total	**4190**	**4465**	**3809**	**2435**

Table 4: Historic Channel Width

B. Dredging

Dredging occurred twenty four times in the study reach between 1990 and 2009 for a cumulative quantity of approximately 5.1 million cubic yards (Plate 5). Dredging occurred in two distinct areas; Potato Bend (Miles 99.0-96.0) and Wilkinson Landing (Miles 95-91). Fifteen of the dredge cuts were in Potato Bend for a cumulative quantity of approximately 3.4 million cubic yards. Nine of the dredge cuts were in Wilkinson Landing for a cumulative quantity of 1.7 million cubic yards. The details of these dredge cuts can be found in Table 5. Dredging at Potato Bend was addressed as part of the Jone's Chute HSR model study. Plans for the weir and dike construction and modification are on Plate 6. A general plan to alleviate dredging at Wilkinson Landing was developed and tested in the Wilkinson Island model (Plate 7). Plans for the dike modifications are on Plate 8.

Potato Bend			Wilkinson Ldg		
	Upper River Mile	VOLUME (CY)		Upper River Mile	VOLUME (CY)
2008	96.7	178,212	2006	94.7	110,620
2007	97.8	184,210	2006	94.5	110,620
2005	96.7	216,763	2006	93.4	361,422
2003	96.8	306,483	2005	93.0	119,233
2003	97.9	89,360	2005	92.5	119,233
2003	96.6	77,456	1994	94.7	16,194
2002	96.6	307,876	1992	92.5	155,901
2001	96.7	285,074	1990	95.0	330,167
2001	98.6	216,504	1990	92.2	371,135
2001	96.5	66,356			
2000	98.7	775,024			
2000	96.8	119,608			
1999	96.8	63,554			
1998	96.9	160,167			
1996	96.5	342,006			
Total		**3,388,653**			**1,694,525**

Table 5: Reach Dredging History

4. Field Observations

Personnel from the Applied River Engineering Center inspected the study reach by shallow draft boat on July 31, 2009. The stage at the Chester gage was 12.7 feet. The low water reference plain (LWRP) at the Chester gage is -0.7 feet. On this field inspection photographs were taken and the existing navigation structures were examined. Due to a prolonged period of high water, this was the only field visit taken to the study reach.

5. Study Purpose and Goals

This HSR study was part of the Wilkinson Island Habitat Rehabilitation and Enhancement Project feasibility study and the UMRS-EMP. The primary objective of the project was to improve the quality and diversity of the existing habitat on the site. An engineered side channel on the project site will help meet the objectives of the project. The purpose of this study was to test and analyze potential side channel alignments to be excavated on the Wilkinson Island Division of the Middle Mississippi River National Wildlife Refuge. The design included but was not limited to the upstream and downstream connections to the main channel and the elevation and design of potential closure structures and grade control structures within the side channel. A successful side channel alternative must create a diverse bathymetry closely mirroring natural fluvial processes without negatively affecting the existing depths in the navigation channel. Additionally, the side channel alternative should be of a sustainable design, limiting future operational requirements.

MISSOURI RIVER CHUTE DESIGN

1. Background

When designing side channels and chutes for the Wilkinson Island project, engineers used the past experience and lessons learned from the Kansas City District as a guide. The Northwest Division (NWD) has been implementing projects for Missouri River mitigation since the early 1990's. These projects included the creation and enhancement of side channels, modification and creation of navigation structures, river widening and root ball placement.

2. Established Design Criteria

A.) Maintenance of Chutes

Some potential factors causing maintenance of chutes are excessive drift accumulation, silt deposition in the chute, and the failure of rock structures during floods. Excessive drift can close off the chute and cause the chute to fill in and become vegetated over time. Deposition could also potentially reduce flow into the chute and cause the chute to become vegetated and eventually become part of the floodplain. Failure of rock structures is a maintenance issue that is difficult to design for. The structures used to create and maintain the side channel will require monitoring and evaluation to determine if maintenance is needed over the life of the project. The timing and magnitude of this maintenance is dependent on a number of variables including the hydrograph.

B.) General Design Concept

When designing a side channel for the Wilkinson Island project the general design concept of the Northwest Division was used.

General Design Concept

- Construct pilot channel and control structures, allow river to determine final configuration
- Design to be self-maintaining

- Convey 5-10% of the flow at Construction Reference Plane (CRP) levels (CRP is similar to LWRP)
- Design micro-habitat features into chute
- Design bottom elevation 4 to 6 feet below CRP

C.) Lessons Learned

To help establish design criteria, the Kansas City District examined the geometry of roughly 25 existing natural and successful constructed chutes to help establish design criteria. The design criteria were used in this study to screen and analyze alternatives. The lessons were used as a guide to determine which alternatives to test in the model. The lessons learned from the Kansas City District suggest that an ideal chute should have:

- Smooth entrance transitions
- Passive, minimal grade control
- Constructed width 50-ft min, 75+ preferred, invert<-4 ft CRP
- Chute per River Length Ratio 0.5 to 1.1
- Bend Radius of Curvature/ Design Width >>2.5
- Minimum Radius of Curvature: >600’, 2000+ typical
- Constructed Sinuosity of 1.0 to 1.2. Sinuosity is the ratio of stream channel length to down-valley distance.
- Entrance at channel crossing more susceptible to drift
- Rock (>3”) must be stockpiled someplace out of the way

Wilkinson Side Channel Alignment Screening

Ten side channel alignments were analyzed and screened in this study. Six alignments were developed prior to the start of the model study and four were developed during the model study. The alignments developed prior to the implementation of the model study were SC-A, SC-B, SC-C, SC-D, SC-E and SC-F, shown on Plates 9 through 14 respectively. The side channel would be constructed with a bottom width between 50-200 feet. Since the greater width would have the most impact on the amount of water entering the channel and subsequently the amount of flow diverted from the navigation, channel all tests used a width of 200 feet. In order to screen out alignments, the six previously designed side channels were initially compared against the criteria developed by the Kansas City District. The criteria are shown in Table 6. The alternatives that did not meet the criteria developed by the Kansas City District were SC-A, SC-D, SC-E and SC-F.

The sinuosity of side channel alignment SC-A was 1.25 which exceeded the design criteria of 1.20. The 4% deviation from the design standard provided an opportunity to test the potential negative effects of increased sinuosity using the HSR model.

The minimum radius of curvature of SC-D was 448 ft which did not meet the design criteria of 600 feet. The criteria of bend of radius of curvature divided by design width was also not met. The value for SC-D was 2.2, which does not meet the design standard of 2.5. It was determined to test SC-D to quantify the effect of not meeting this design standard. Testing of this alignment was also recommended by the design team. If the tight radius of curvature was the only issue with SC-D, the bend in question could be redesigned and the alignment retested.

	Constructed Width (ft)	Chute Length (mi)	River Length (mi)	Chute per River Length	Shortest Path Length (mi)	Sinuosity	Minimum Bend Radius of Curvature (ft)	Bend Radius of Curvature/Design Width
Design Criteria	w>50'	-	-	0.5-1.1	-	1.0-1.2	>600'	>>2.5
SC-A	100-120	2.15	2.35	0.91	1.72	1.25	605	3.03
SC-B	100-120	2.47	2.85	0.87	2.15	1.15	1768	8.84
SC-C	100-120	5.68	5.74	0.99	4.96	1.15	1669	8.35
SC-D	100-120	1.89	2.25	0.84	1.64	1.15	448	2.24
SC-E	100-120	2.08	2.34	0.89	1.82	1.14	287	1.44
SC-F	100-120	1.77	2.11	0.84	1.6	1.11	287	1.44
SC-G	100-120	1.69	2.02	0.84	1.57	1.08	630	3.15
SC-H	100-120	1.68	2.19	0.77	1.6	1.05	630	3.15
SC-I	100-120	1.22	1.42	0.86	1.15	1.06	979	4.90
SC-J	100-120	1.69	2.02	0.84	1.57	1.08	760	3.80

Table 6: Side Channel Alignment Properties

Both SC-E and SC-F did not meet the criteria due to a bend with a radius of curvature of 287 feet. This minimum radius is substantially less than the recommended 600 feet. The bend radius of curvature divided by design width for SC-E and SC-F was 1.4. This value is much less than the recommended 2.5. Further analysis of these alignments was conducted and it was determined that in addition to the sharp bend, the location of the bend could be problematic. There was a concern that since the bend is adjacent to an area of low elevation, continuous maintenance would be necessary to prevent the side channel from finding a new alignment during high water. As a result of the above mentioned issues alignments SC-E and SC-F were discarded.

Although it met all of the criteria developed by the Kansas City District, SC-C was discarded due to the alignment passing through privately owned lands. Additionally, the quantity of material requiring excavation to construct this side channel made it cost prohibitive.

After discussion with the design team, side channel SC-B was discarded due to the fact that it extended too far onto the Wilkinson Island division. A concern of this side channel alignment was the potential of the flow in the side channel following a low spot and realigning itself into the privately owned property. The downstream connection was also a concern due to its location in relation to privately owned lands.

In summary, of the six alignments designed prior to the model study, it was determined to test SC-A and SC-D in the model. The other side channel alignments were discarded.

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 19 is a photograph of the HSR model used in this study. The zero reference plane of the prototype was assumed to be LWRP (low water reference plane) condition. The model employed a horizontal scale of 1 inch = 400 feet, or 1:4800, and a vertical scale of 1 inch = 50 feet, or 1:600, for a 8 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 2006 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. 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 for proper scaling of roughness.

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 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 Middle Mississippi River channel. This served as the average design energy response of the river. Because of the constant variation experienced in the prototype, this steady state flow was used to theoretically analyze the ultimate expected sediment response. The flow was held steady at a constant flow rate of 2.8 GPM during model calibration and for all design alternative tests. The most important factor during the modeling process is the establishment of an equilibrium condition of sediment transport. The high steady flow in the model simulated an average energy condition representative of the river's channel forming flow and sediment transport potential at bankfull stage.

The purpose of this model was to test a number of excavated channels on the Wilkinson Island Division. In order to test the alternatives independently, inserts were used representing the different alignments of the side channel. After each alternative was tested, the planform insert for that alternative was removed and a new insert was placed into the model.

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. Plates 20 through 30 are plan view hydrographic survey maps of the Mississippi River from 1939 to 2009 respectively.

The bathymetry of the most recent prototype surveys (2009, 2007 and 2005) showed similar trends and were used to calibrate the HSR model. Depths below –15 feet LWRP were maintained in the thalweg throughout most of the study reach, with some areas experiencing depths below –20 feet and –30 feet LWRP. The exceptions were: between RM 97.0 and 96.0, and between RM 93.3 and 92.3. Both of these locations have been dredged repeatedly to maintain an adequate depth for navigation. A general plan for the reach between River Miles 93.3 and 92.3 has been developed to alleviate the dredging problem and was included in the FY10 construction contract.

At the most upstream end of the study reach the channel was aligned along the left descending bank where it remained until the crossing began at river mile 95.5. Due to the sharp bend, a large scour hole existed between RM 96.5 and 95.0 with depths of over - 20 feet LWRP. Following the crossing and entering the bend at RM 94.8, the channel remained along the RDB. After exiting the bend, the channel widened from approximately 900 feet to 1500 feet. This abrupt increase in width caused the repeated dredging observed between River Miles 93.3 and 92.3. The Wilkinson Landing dike modifications were designed to align the navigation channel along the RDB until a crossing at approximately RM 92. Downstream of the crossing, the navigation channel will remain along the LDB through the study reach.

An Acoustic Doppler Current Profiler (ADCP) survey was taken on August 28, 2009 (Plate 31). This survey measured the velocity direction and magnitude throughout the reach. The stage at the Chester gage on the day of the survey was 13.84 ft (14.4 ft above LWRP). The average velocity through the reach was approximately 3-4 feet per second with the highest velocities being 4.5 feet per second. The highest velocities in the upstream end of the reach were along the LDB. In the bend between RM 95.0 and 93.5 the highest velocities were in the middle of the channel along the end of the bendway weirs. Below RM 93.5, the velocities remained constant across the cross section.

2. Base Test

The removal and replacement of the alternative planform inserts required the model to be recalibrated for each alternative test. The model was initially calibrated with a blank insert in place representing the existing channel alignment. The purpose of this calibration was to get the correct water discharge, sediment volume, model slope, and entrance conditions of the model. Initial calibration was achieved once it was determined through qualitative comparisons that the prototype surveys were similar to several surveys of the model (Plate 32). Overall, the trends of the model base test were very similar to the hydrographic surveys and were thus used with confidence for design alternative analysis. One note from the calibration of the model was the dynamic nature of the deposition area on the RDB at approximately RM 95.0. This deposition area would develop and contract as the model was run. This natural phenomenon occurred in the prototype surveys as well as the alternative tests.

After the planform inserts were placed in the model, the side channel alternative was closed off to represent existing conditions. The model was then recalibrated, sediment amount was checked and the model bathymetry was compared to the initial base test. Once it was determined through qualitative comparisons that the model bathymetry showed similar bed response to the initial base test, the model was considered recalibrated and the alternative test was then run.

3. Design Alternative Tests

All design alternatives studied in the HSR model utilized the existing dike configurations in the prototype surveys unless modifications to the existing structures were in contracts to be awarded prior to the expected construction date of the proposed model alternative. Additional structures and existing structure modifications were included in the FY11 construction contract for the dike field on the LDB between RM 93.5-91.6 (Plate 8). This included: construction of dikes 93.25(L) and 93.1(L) and extension and notching of dikes 93.0(L), 92.6(L), and 92.3(L).

The new and modified structures could have an impact on the downstream connection of potential side channel alternatives. Once the model was recalibrated after the placement of the inserts, the configurations of the structures after the FY11 construction was placed into the model and used for each model test (Plate 7). Since all alternatives were tested with the FY11 construction structures in place, alternative tests should be compared with the general plan test survey (Plate 7) rather than the base test survey.

The model looked at the layout of the side channel alternatives as well as the elevation of the grade control structures within the side channels. Two different grade control structure elevations were tested in each alternative: -20 ft LWRP and -5 ft LWRP. The model tests with a grade control structure elevation at -20 ft LWRP were arbitrarily selected to represent a controlled worst case scenario in the model. These results were used to analyze the effect on the main channel by modeling a scenario where substantially more water was diverted from the main channel into the side channel. If tests with grade control structure elevations at -20 ft LWRP showed no adverse effect on the depths in the main channel, it could be stated with confidence that the side channel would not impact the navigation channel. The results of the tests with the grade control structure elevations at -20 LWRP were used to analyze side channel alignment by modeling a scenario where there would exist the maximum amount of energy in the side channel. If large scour holes did not develop in the side channel with the grade control structures at an elevation of -20 ft LRRP, it could be stated with confidence that they would not develop within the side channel.

The tests that used grade control structures with elevations of -20 ft LWRP helped determine potential failures of the side channel alignment. It was necessary to conduct tests with the recommended grade control structures at an elevation of -5 ft LWRP to gain a better understanding of the bed response in the constructed side channel and the effect of the side channel on the navigation channel. Due to the small scale of the side channels, when the grade control structures elevations were set at -5 ft LWRP, it was difficult in some tests to get adequate energy in the side channel for sediment transport. In order to complete the tests, high flow pulses were simulated through the model to initiate sediment transport. These pulses were not necessary in each test and were not consistent in each test. Because of this inconsistency, it is important to focus on qualitative trends rather than quantitative depths.

In each alternative tested in the model existing revetment was removed to allow flow into the channel. The revetment was removed to the elevation of the bottom of the channel and did not act as a closure structure.

SC-A

The only grade control structure elevation tested on side channel alignment SC-A was -20 ft LWRP (Plate 33). After the alternative was completed, it was decided by the team to focus on other side channel alignments. The test of grade control structures at an elevation at -20 ft LWRP showed that there would be no negative impact on the navigation channel as a result of flow diverted to the side channel. Within the side channel alternative, large scour holes existed in the bends. These large scour holes were indicators that bank failure could potentially occur in each of the bends. Because of the low radius bend at the upstream entrance to the side channel, the large scour hole with a depth of -38 ft LWRP in the first bend was a concern. This area would require extensive bank protection to maintain the channel alignment. Similarly, the large scour hole in the fourth bend (from upstream to downstream) was an indicator of an area where extensive bank failure could occur without bank protection. This scour hole had a depth in the model of -55 ft LWRP at its lowest point.

Although the deficiencies of side channel alignment SC-A prevented it from being a potential recommended alternative; the model tests provided lessons to help develop new side channel alignments. Lessons from the model tests of side channel alignment SC-A were that the radius of curvature in the first bend needs to be higher to eliminate the large scour hole and the necessity of a side channel alignment with less sinuosity to eliminate the large scour holes in the bends.

SC-D

There was no negative impact on the navigation channel between RM 95.5 and 93.0 in the model tests of both grade control structure elevations. Between the two different tests the bar along the RDB between RM 96-95 appeared to become more developed as flow was diverted into the side channel. Based on other alternative tests there existed a possibility of channel width reduction.

The model tests of the side channel alignment with grade control structures with elevations at -20 ft LWRP (Plate 34), showed large scour holes in each of the bends. Similar to the tests of SC-A, these scour holes were indicators of the need for extensive bank protection. Since the first bend at the entrance of the side channel was designed exactly like SC-A, the large scour hole with a depth at 39 ft LWRP was expected.

The model tests with grade control structure elevations at -5 ft LWRP (Plate 35) showed shallow depths at the upstream end of the side channel. Within the side channel a pool, riffle, pool relationship developed with the greater depths found in the outside of bends.

The following additional side channel alignments (SC-G through SC-J) were developed as part of the HSR model study. They were developed using research of other successful side channels on the Middle Mississippi River, lessons learned from other side channels tested in the model, and communication with partners involved in the study. A quick analysis of side channels on the Middle Mississippi River showed that most successful side channels had low sinuosity. One of the concerns with side channel SC-A was the potential of bank erosion on the outside of the side channel bends. A side channel with less sinuosity would hopefully alleviate this concern and less maintenance would be necessary.

Criteria for side channel alternatives were developed at early model study meetings by the project partners and team members. The main criteria were cost of construction, limited amount of excavated material, effect on flows and depths in the navigation channel, no negative impact on owners of private land, and limited maintenance. All side channel alternatives developed during the model study had to meet the criteria developed by the Kansas City District as well as the criteria discussed above.

SC-G

SC-G was developed by connecting most of the low points and scour holes within the division with a slightly sinuous channel. The channel configuration was modeled after other successful side channels on the Middle Mississippi River. SC-G was a combination of lessons learned from other model studies, the Kansas City District and input from the project partners.

There was no negative impact to the navigation channel in the model as a result of water being diverted into the side channel. Two small scour holes of depths greater than -30 ft LWRP existed in the channel in the model tests when the grade control structures were at an elevation of -20 ft LWRP (Plate 36). These scour holes were significantly smaller than those found in alternatives SC-A and SC-D. Due to the side channel entrance being modified as a result of the lessons learned from the earlier tests, a large scour hole in the most upstream bend did not exist. A large scour hole formed in the navigation channel along the tips of the proposed structures along the LDB.

The tests with grade control structure elevation -5 LWRP were used to gain a better understanding of the expected bathymetry within the channel (Plate 37). A desirable pool, riffle, pool relationship was found throughout the channel with bars forming on the inside of the bends. There was deposition immediately upstream of the grade control structures throughout the side channel. A scour hole developed as a result of the modified revetment at the entrance of the side channel. This scour was not the result of the channel alignment. Throughout the model study the scour immediately upstream of the side channel was very dynamic. In the -5 ft LWRP model test the scour extended into the modified revetment allowing a large amount of flow to be diverted into the side channel. The result of this increased energy was a large amount of scour around the modified revetment and larger scour holes within the channel. The scour observed in the tests of grade control structure elevations of -20 ft LWRP still existed in the -5 ft LWRP tests but was much smaller. This scour is not expected to have a negative impact on the navigation channel.

SC-H

SC-H had nearly the same alignment as SC-G, but contained additional length and a more downstream connection to the navigation channel. The bathymetry for SC-H with grade control structure elevations at -20 ft LWRP (Plate 38) was very similar to SC-G. The two scour holes discussed in SC-G were not as deep in alternative SC-H. The only large scour hole within the channel was in the most downstream bend. There existed no negative impact on the navigation channel due to the flow being diverted into the side channel. A scour hole in the navigation channel along the LDB did not develop in alternative SC-H. This was likely due to the angle and location of the downstream connection of the side channel within the dike field.

The bathymetry in the side channel with a grade control structure elevation at -5 ft LWRP showed a desirable pool, riffle, pool relationship (Plate 39). Point bars developed in the bends of the side channel with greater depths in the outside of the bends. The scour hole at the entrance of the side channel was the result of the dynamic nature of the crossing rather than the channel alignment.

SC-I

SC-I was developed in an attempt to test a different location for the upstream end of the side channel. Due to the large point bar on the inside of the bend between RM 95.0 and 93.5, it was difficult to divert enough water into the channel to keep sediment from depositing. Tests of SC-I were conducted without grade control structures in the model to allow unimpeded flow into the side channel (Plate 40). The model tests showed that the construction of structures upstream of the side channel were necessary to make SC-I a viable alternative.

SC-J

SC-J had the same alignment as SC-I with the only difference being the main channel connection was further downstream. SC-J was tested with no grade control structures in an attempt to divert as much water as possible from the main channel (Plate 41). Due to the location of SC-J on the inside of a bend, there was not enough flow diverted into the side channel for it to remain open.

MRS-A

In addition to the excavated side channels, main channel alternatives were tested to create environmental diversity within the Wilkinson Island division. One option was a series of multiple round point structures (MRS) on the LDB (Plate 42). The purpose of the MRS's was to potentially create a series of scour holes and bathymetric diversity in the existing sandbar between RM 95.0-93.5. The series of MRS's decreased the elevation of the sandbar but did not create any type of side channel or series of scour holes. The reduction in elevation of the sandbar was most likely the result of removing existing dike 94.5L. The location of the sandbar on the inside of a bend made it difficult to divert enough water to make any type of dike structure alternative successful.

HP-A

Another alternative tested to create environmental diversity on the Wilkinson Island division was a series of hard points along the LDB (Plate 43). The purpose of the hard points was to create a side channel from a series of connected scour holes to isolate the sandbar from the floodplain. Although alternative HP-A did create depth diversity on the sandbar, there was not enough flow along the hard points to create a self sustaining side channel or deep scour holes. The location of the sandbar on the inside of a bend made it difficult to divert enough water to make any type of dike structure alternative successful.

CONCLUSIONS

1. Evaluation and Summary of the Model Tests

Ten side channel alignments were analyzed and screened in this study. Of the ten alignments, six were studied in the HSR model. All of the alignments were analyzed using the Missouri River side channel criteria. Four side channel alignments were not tested due to failures to meet the design criteria or other potential issues determined by the study team. These alignments were:

- SC-B: This alignment extended too far into the Wilkinson Island division increasing the potential of the side channel meandering into a new location and possibly affecting the privately owned property. Since a design criteria was not to effect privately owned property this alignment was discarded.
- SC-C: This channel alignment was discarded because it passed through the privately owned property.
- SC-E: This alignment did not meet the minimum radius of curvature requirement of the Missouri River side channel criteria. In addition to having a sharp bend, the location of the bend was problematic. The sharp bend was located in a low area where the potential of the channel meandering into a new location was high.
- SC-F: This alignment did not meet the minimum radius of curvature requirement of the Missouri River side channel criteria. In addition to having a sharp bend, the location of the bend was problematic. The sharp bend was located in a low area where the potential of the channel meandering into a new location was high.

The remaining side channel alignments were tested in the HSR model. Observations from these tests were as follows:

SC-A: Although the side channel did not have an adverse effect on the navigation channel, large scour holes existed within the side channel in the tests with the highest. These large scour holes were indicators that there could be potential bank failure. This side channel alignment did not meet the criteria of limited maintenance after construction.

SC-D: This side channel alignment showed large scour holes in the bends similar to those observed in alignment SC-A. These large scour holes were indicators that there could be potential bank failure. Channel monitoring and maintenance would be required.

SC-G: This side channel alignment did not have a negative impact on the navigation channel. Model tests did show two small scour holes in the tests with the maximum amount of energy within the channel. These scour holes were much smaller and shallower than the previous tests. Additional bank protection is recommended in these bends during construction of the channel.

SC-H: This side channel alignment was similar to the successful alignment SC-G. The difference between the two was that the downstream connection to the main channel was further downstream. This side channel alignment did not have a negative impact on the navigation channel.

SC-I: Model tests showed that this alignment would not be successful without additional structures built in the navigation channel to divert water into the side channel. There was very little flow and energy within the channel in the model tests which indicated an alignment that would accrete with sediment.

SC-J: Model tests showed that this alignment would not be successful without additional structures built in the navigation channel to divert water into the side channel. There was very little flow and energy within the channel in the model tests which indicated an alignment that would accrete with sediment.

MRS-A: Model tests showed that this alternative would not be successful due to the location of the sandbar on the inside of a bend. It was not possible to divert enough flow towards the structures without having a major effect on the navigation channel.

HP-A: Model tests showed that this alternative would not be successful due to the location of the sandbar on the inside of a bend. It was not possible to divert enough flow towards the structures without having a major effect on the navigation channel.

2. Recommendations

It is recommended that side channel alignment SC-G be constructed on the Wilkinson Island Division. This alignment fulfilled all of the criteria developed on the Missouri River. The HSR model tests did not show any negative impact to the navigation channel. It is recommended at the time of construction that bank protection be placed on the bends where scour holes existed in the -20 ft LWRP tests. Side channel alignment SC-G also successfully addressed all of the concerns of the study partners.

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 Edward Brauer, P.E. or Robert Davinroy, P.E. 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) 865-6332, (314)865-6326 Fax: (314) 865-6352

E-mail:
Edward.J.Brauer@usace.army.mil
Robert.D.Davinroy@usace.army.mil

Or you can visit us on the World Wide Web at:
http://www.mvs.usace.army.mil/arec/index.html

APPENDIX OF PLATES

Plates number 1 through 43 follow:

1. Location and Vicinity Map of the Study Reach
2. Aerial Photography of the Study Reach
3. Geomorphology of the Study Reach
4. Navigation Structure History of the Study Reach
5. Dredging History of the Study Reach
6. Potato Bend Work Location
7. Wilkinson Landing General Plan
8. Wilkinson Landing Work Location
9. Alignment SC-A
10. Alignment SC-B
11. Alignment SC-C
12. Alignment SC-D
13. Alignment SC-E
14. Alignment SC-F
15. Alignment SC-G
16. Alignment SC-H
17. Alignment SC-I
18. Alignment SC-J
19. Photo of Hydraulic Sediment Response Model
20. 1939-56 Hydrographic Survey
21. 1968-71 Hydrographic Survey
22. 1976-1977 Hydrographic Survey
23. 1982-1983 Hydrographic Survey
24. 1986-1987 Hydrographic Survey
25. 1996 Hydrographic Survey
26. 1998 Hydrographic Survey
27. 2001 Hydrographic Survey

28. 2005 Hydrographic Survey
29. 2007 Hydrographic Survey
30. 2009 Multibeam Survey
31. 2009 ADCP Survey
32. Base Test
33. Alternative SC-A, Grade Control Structure Elevation: -20 feet LWRP
34. Alternative SC-D, Grade Control Structure Elevation: -20 feet LWRP
35. Alternative SC-D, Grade Control Structure Elevation: -5 feet LWRP
36. Alternative SC-G, Grade Control Structure Elevation: -20 feet LWRP
37. Alternative SC-G, Grade Control Structure Elevation: -5 feet LWRP
38. Alternative SC-H, Grade Control Structure Elevation: -20 feet LWRP
39. Alternative SC-H, Grade Control Structure Elevation: -5 feet LWRP
40. Alternative SC-I, No Grade Control Structures
41. Alternative SC-J, No Grade Control Structures
42. Alternative MRS-A
43. Alternative HP-A

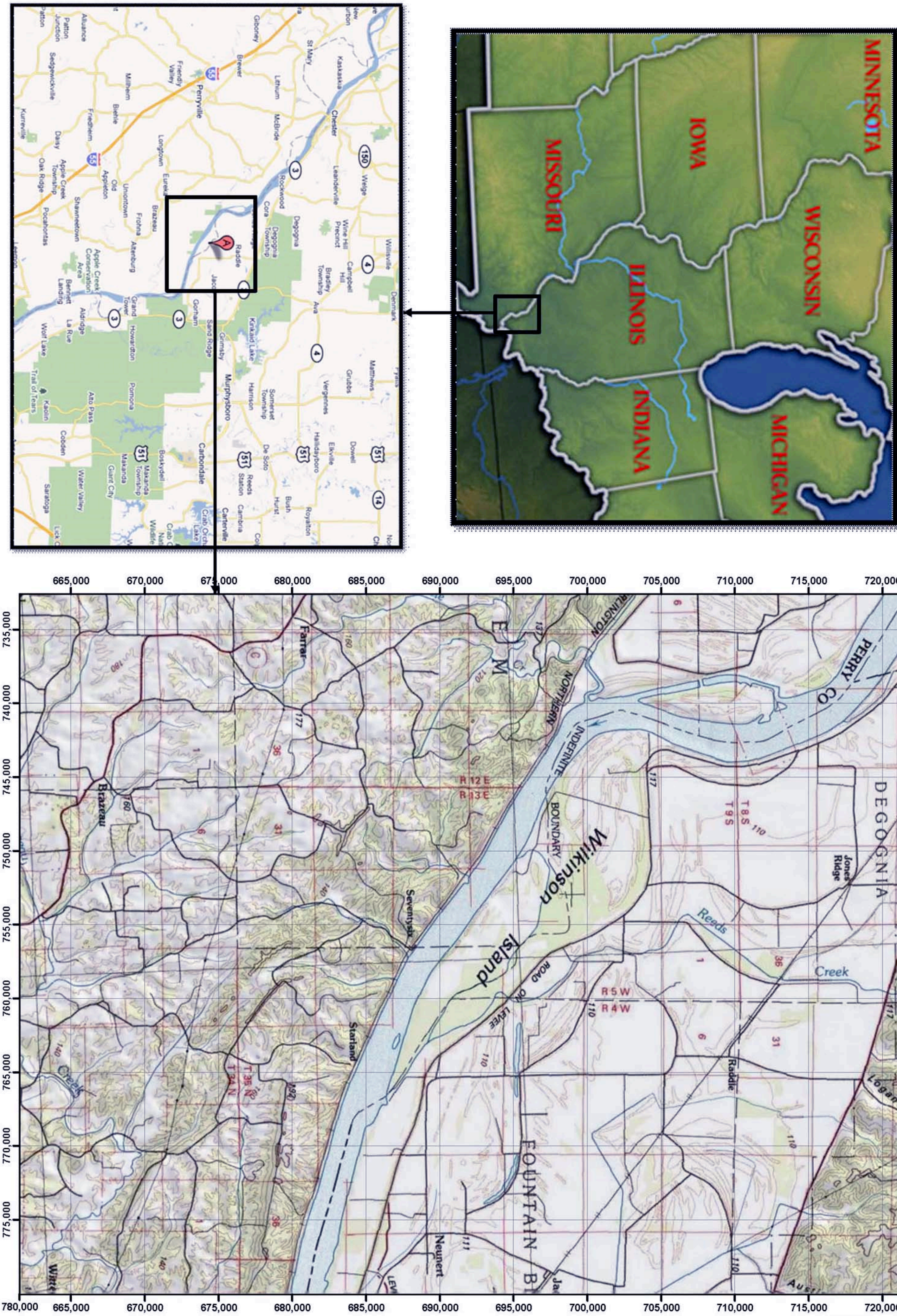

PLATE NUMBER

1

0 1,500 3,000 6,000 9,000 12,000 Feet

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LOCATION AND VICINITY MAP OF THE STUDY REACH

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. BRAUER, P.E.

DRAWN BY: E. RIVERA

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

SUBMITTED: 06/22/2010

FILE NAME: L:\Wilkinson-HSR Model\GIS \Vicinity_Map.mxd

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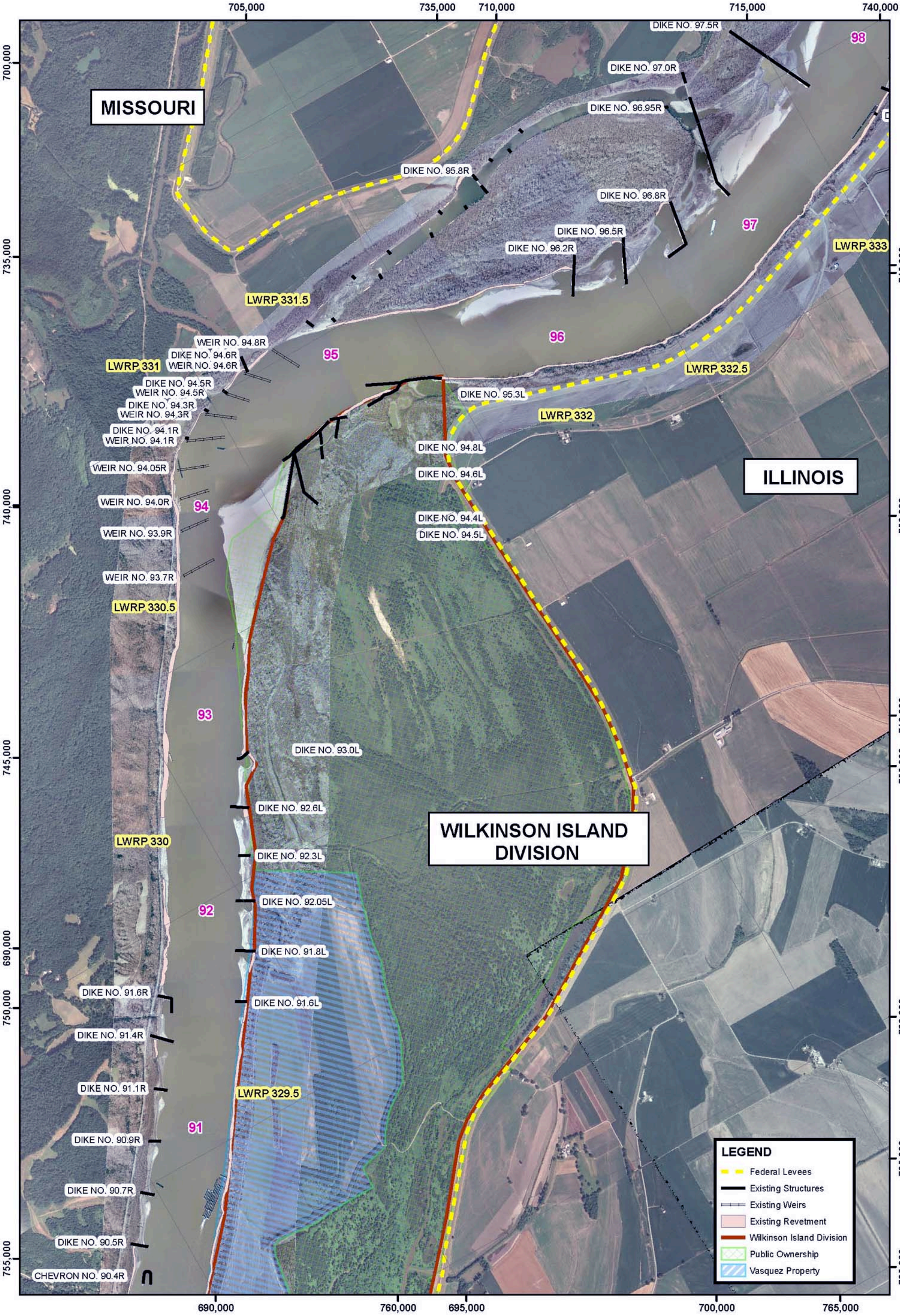

PLATE NUMBER 2

0 500 1,000 2,000 3,000 4,000 Feet

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AERIAL PHOTOGRAPH
OF THE STUDY REACH

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/13/2010

FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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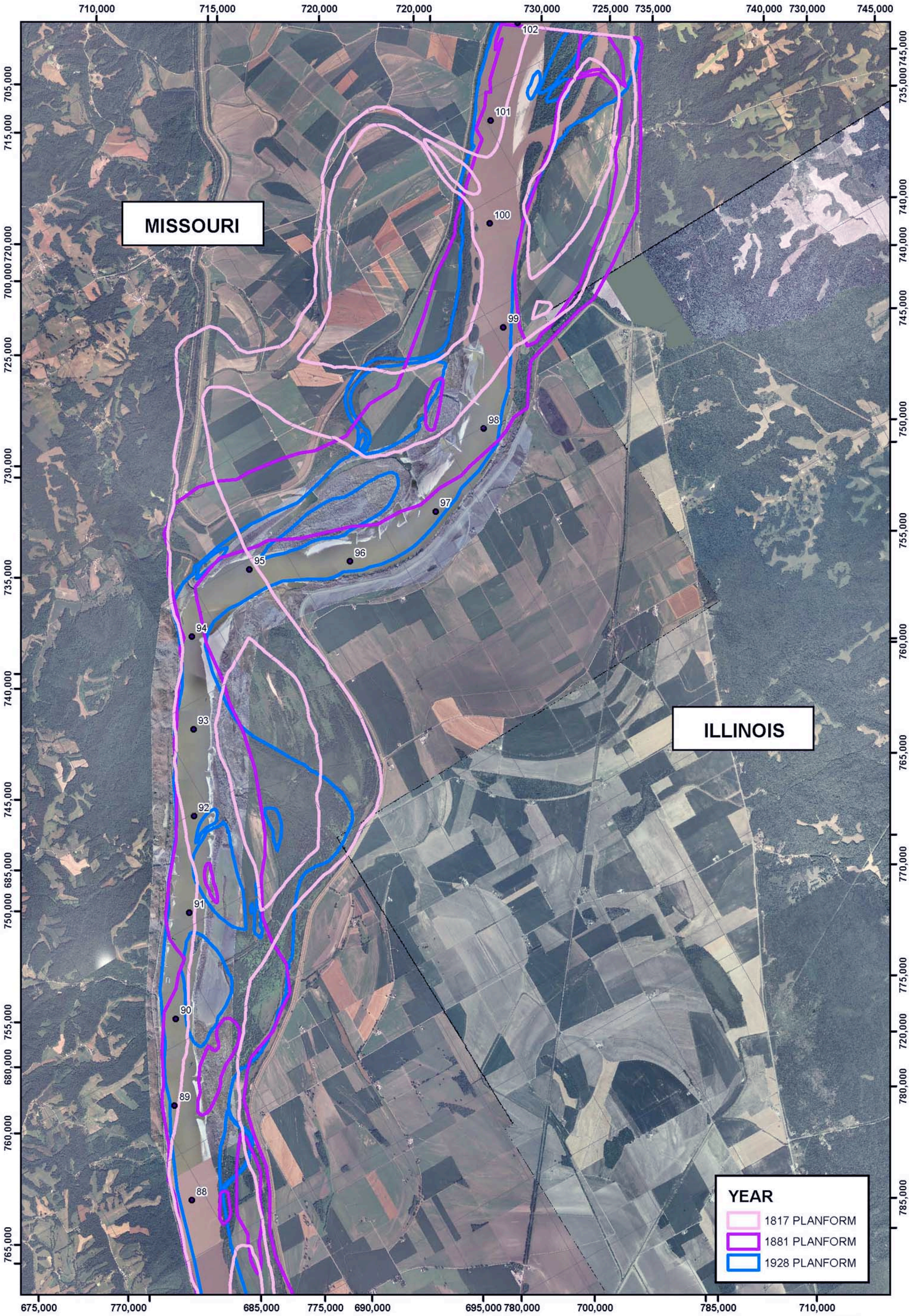

PLATE NUMBER	3	

0 2,250 4,500 9,000 Feet

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GEOMORPHOLOGY

AERIAL PHOTOGRAPH

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILE 98.0 - 90.5

DESIGNED BY: E. BRAUER, P.E.	AERIAL PHOTOGRAPH TAKEN: 08/22/2005 02/24/2006
DRAWN BY: E. RIVERA	SUBMITTED: 07/26/2010
CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\Wilkinson-HSR Model\GIS\Geomorphology.mxd
APPROVED: R. Davinroy, P.E.	

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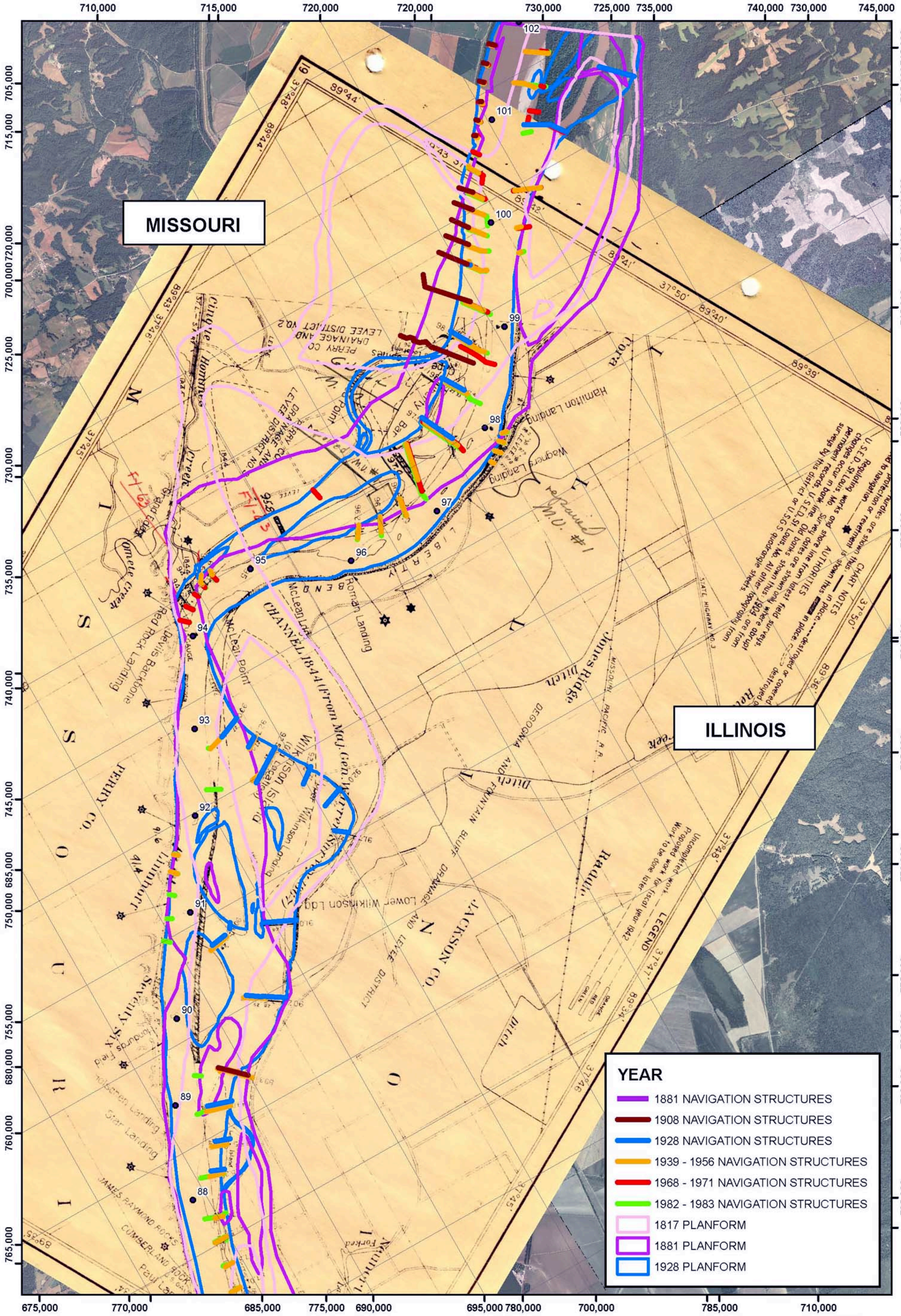

PLATE NUMBER 4	0 2,250 4,500 9,000 Feet THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME	U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. BRAUER, P.E.	AERIAL PHOTOGRAPH TAKEN: 08/22/2005 02/24/2006
	NAVIGATION STRUCTURES HISTORY OF THE STUDY REACH AERIAL PHOTOGRAPH		DRAWN BY: E. RIVERA	SUBMITTED: 07/26/2010
		UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILE 98.0 - 90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\Wilkinson-HSR Model\GIS\Geomorphology.mxd
			APPROVED: R. Davinroy, P.E.	

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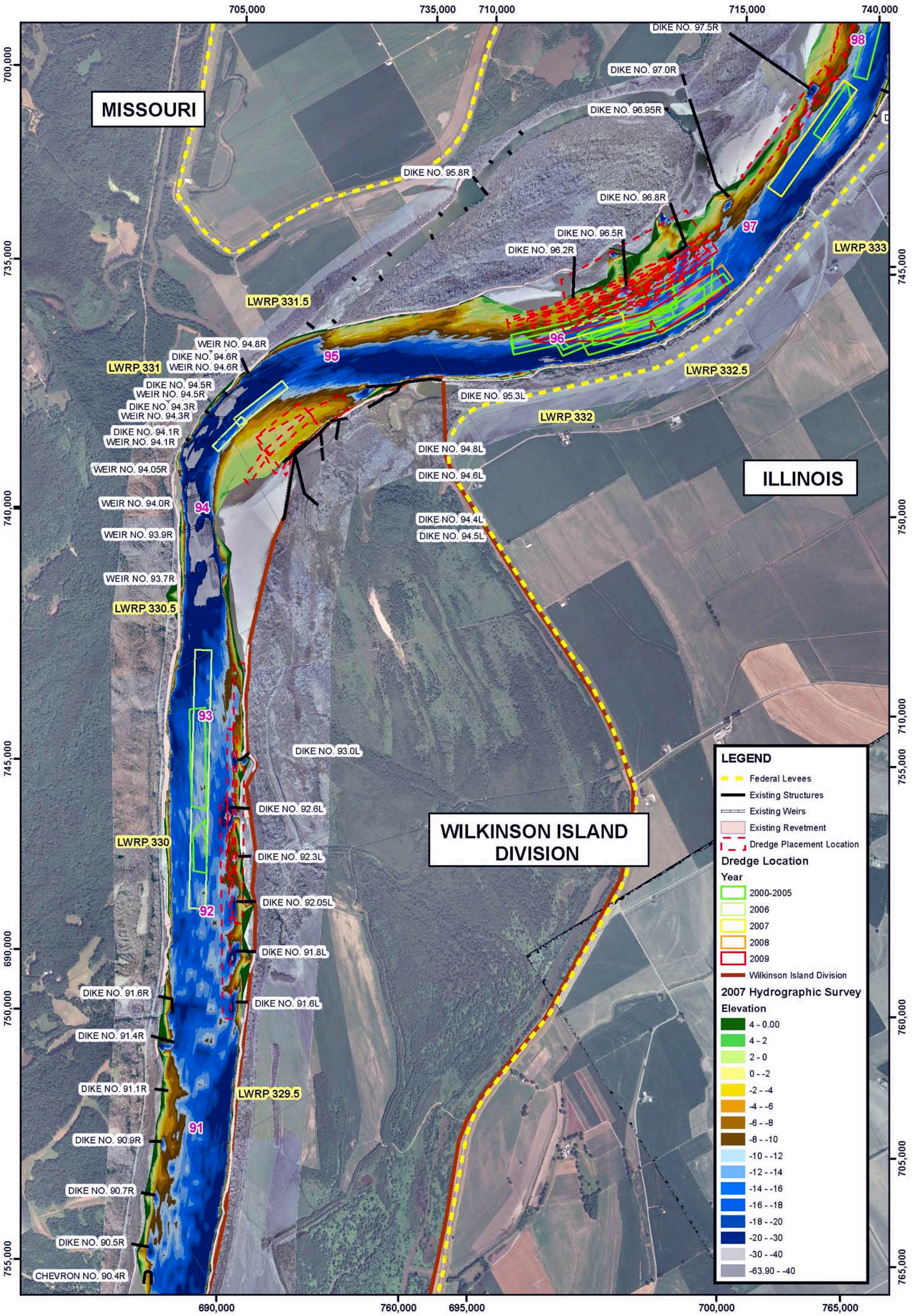

PLATE NUMBER 5

0 500 1,000 2,000 3,000 4,000 Feet

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DREDGING HISTORY OF THE STUDY REACH

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E. DRAWN BY: E. Rivera	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006 SUBMITTED: 07/13/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E. APPROVED: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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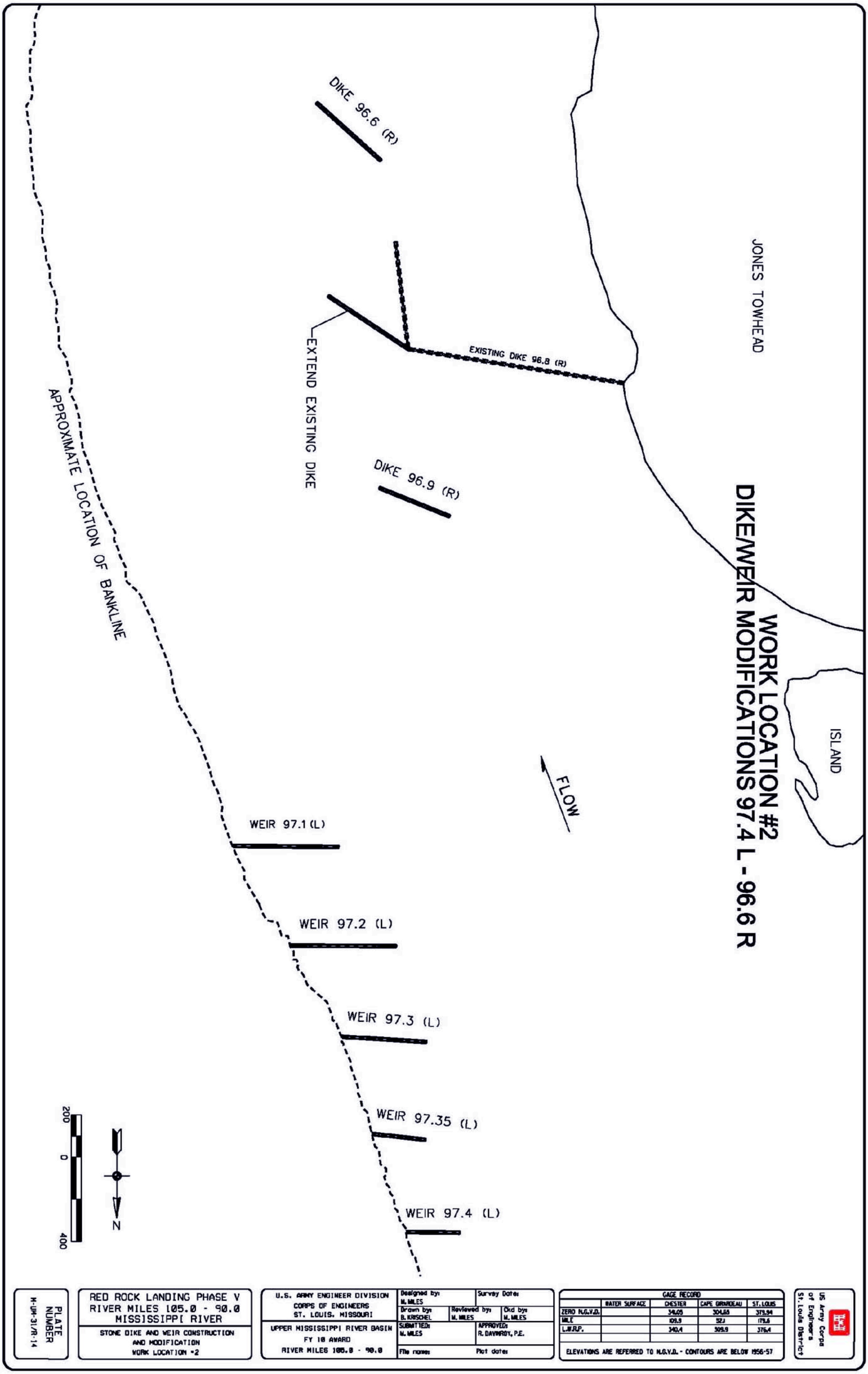

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	POTATO BEND WORK LOCATION FROM RED ROCK LANDING PHASE V PLANS AND SPECS	UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E. APPROVED: R. Davinroy, P.E. FILE NAME: L:\Wilkinson-HSR Model\GIS\Vicinity_Map.mxd

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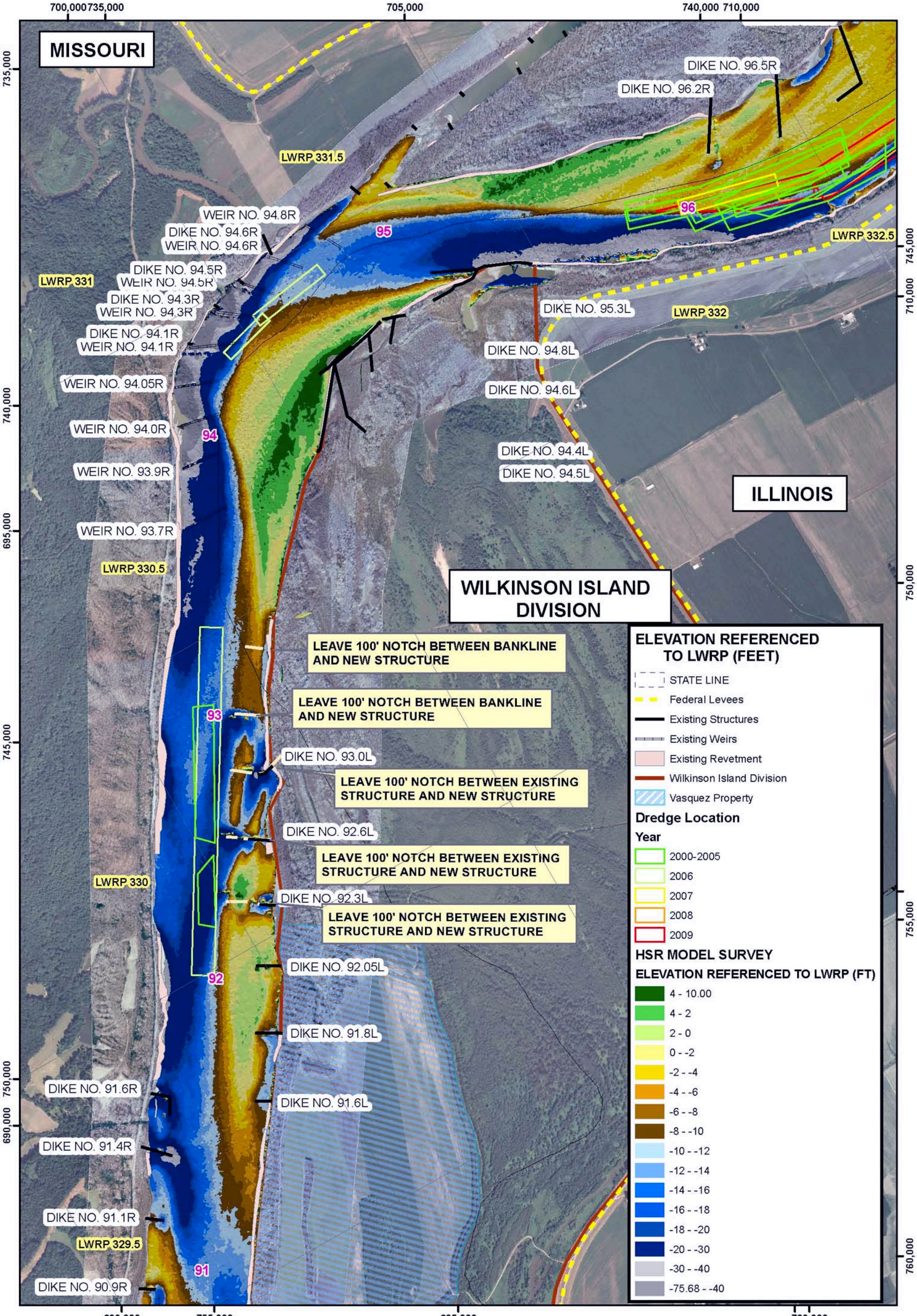

PLATE NUMBER 7

0 375 750 1,500 2,250 3,000 Feet

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WILKINSON ISLAND GENERAL PLAN TEST

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/28/2010

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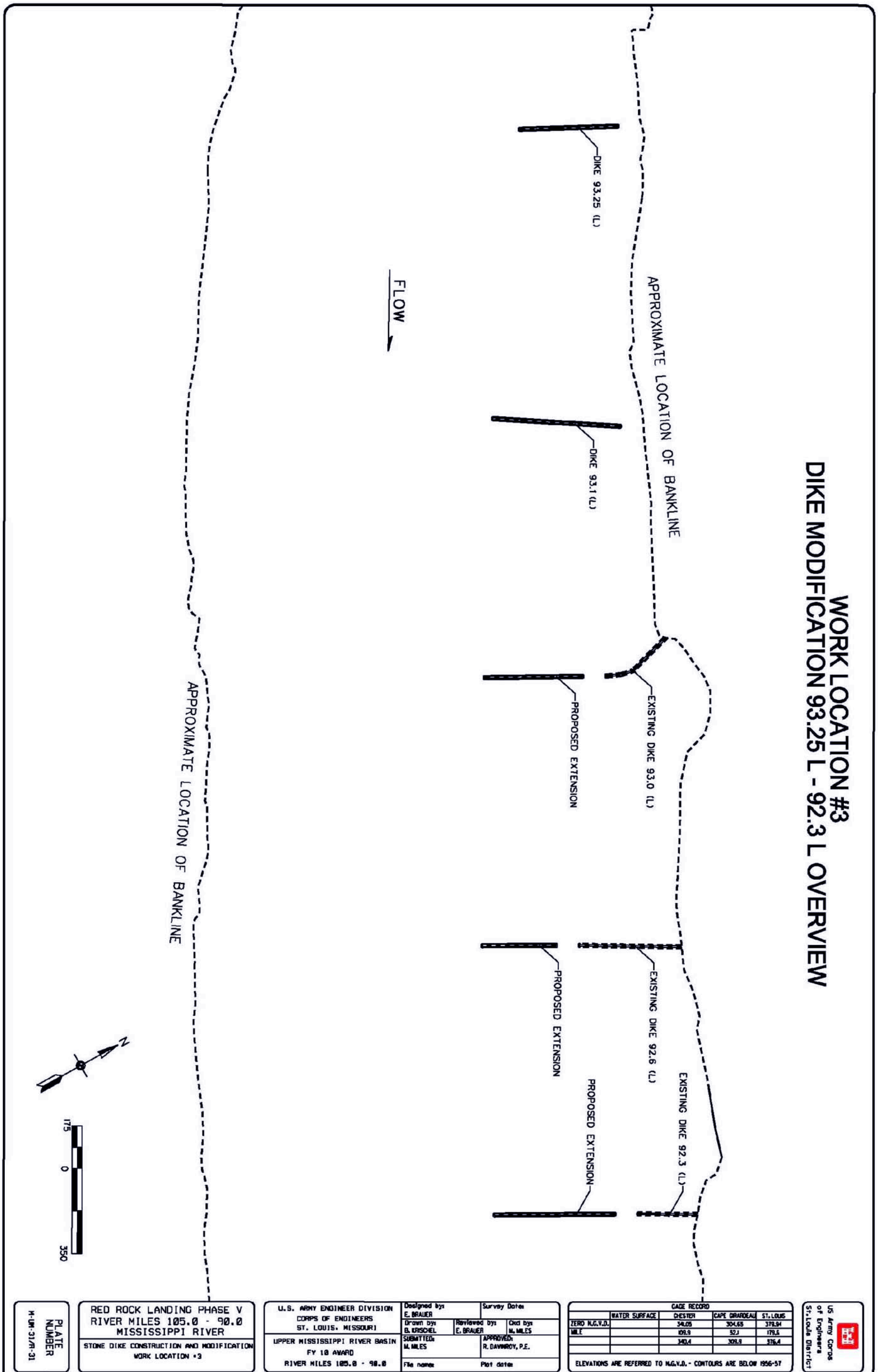

PLATE NUMBER				
8	THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME	U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. BRAUER, P.E.	
			DRAWN BY: E. RIVERA	SUBMITTED: 06/22/2010
	WILKINSON LANDING WORK LOCATION FROM RED ROCK LANDING PHASE V PLANS AND SPECS	UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\Wilkinson-HSR Model\GIS\Vicinity_Map.mxd
			APPROVED: R. Davinroy, P.E.	

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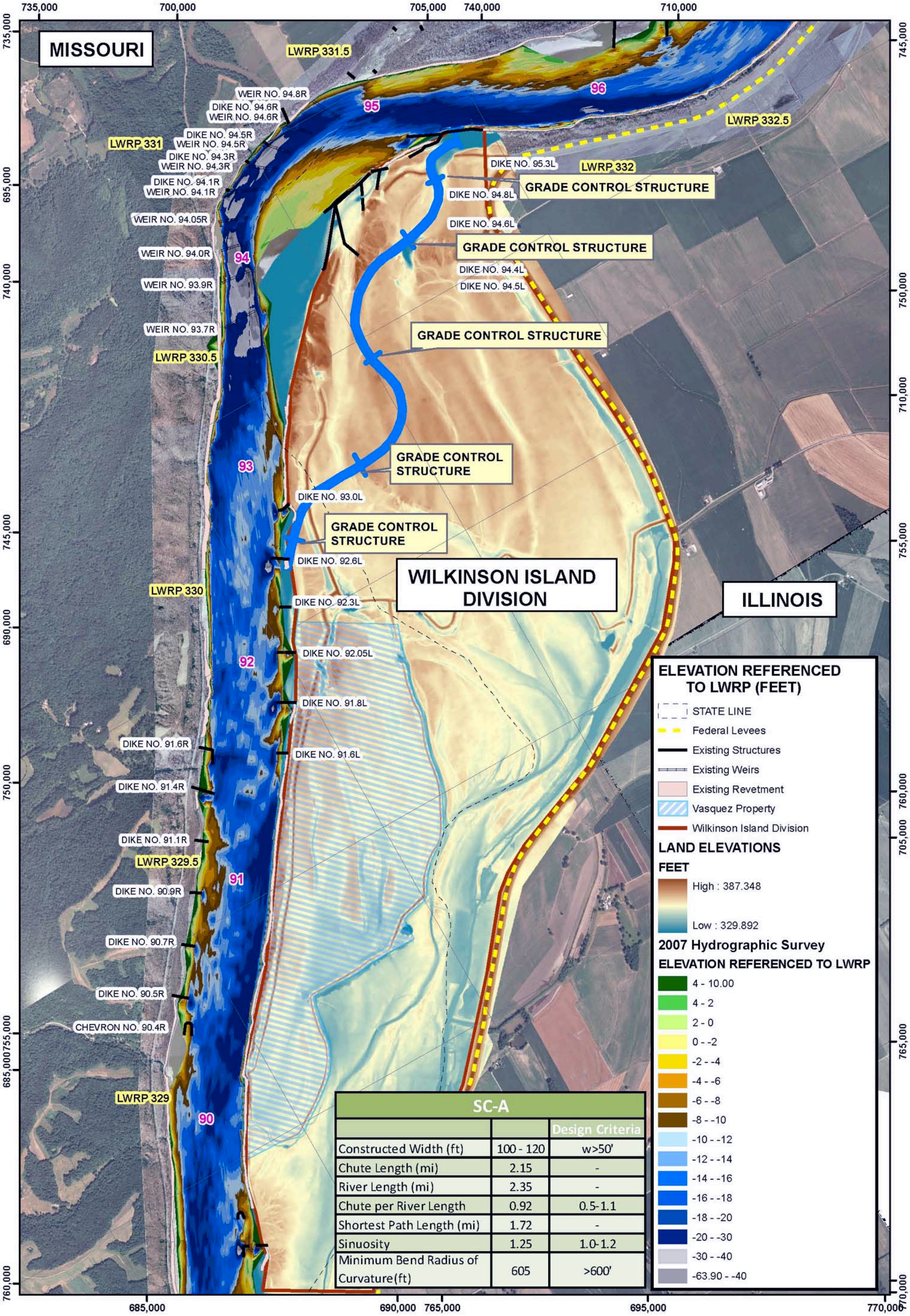

SC-A		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	2.15	-
River Length (mi)	2.35	-
Chute per River Length	0.92	0.5-1.1
Shortest Path Length (mi)	1.72	-
Sinuosity	1.25	1.0-1.2
Minimum Bend Radius of Curvature(ft)	605	>600'

PLATE NUMBER 9

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-A

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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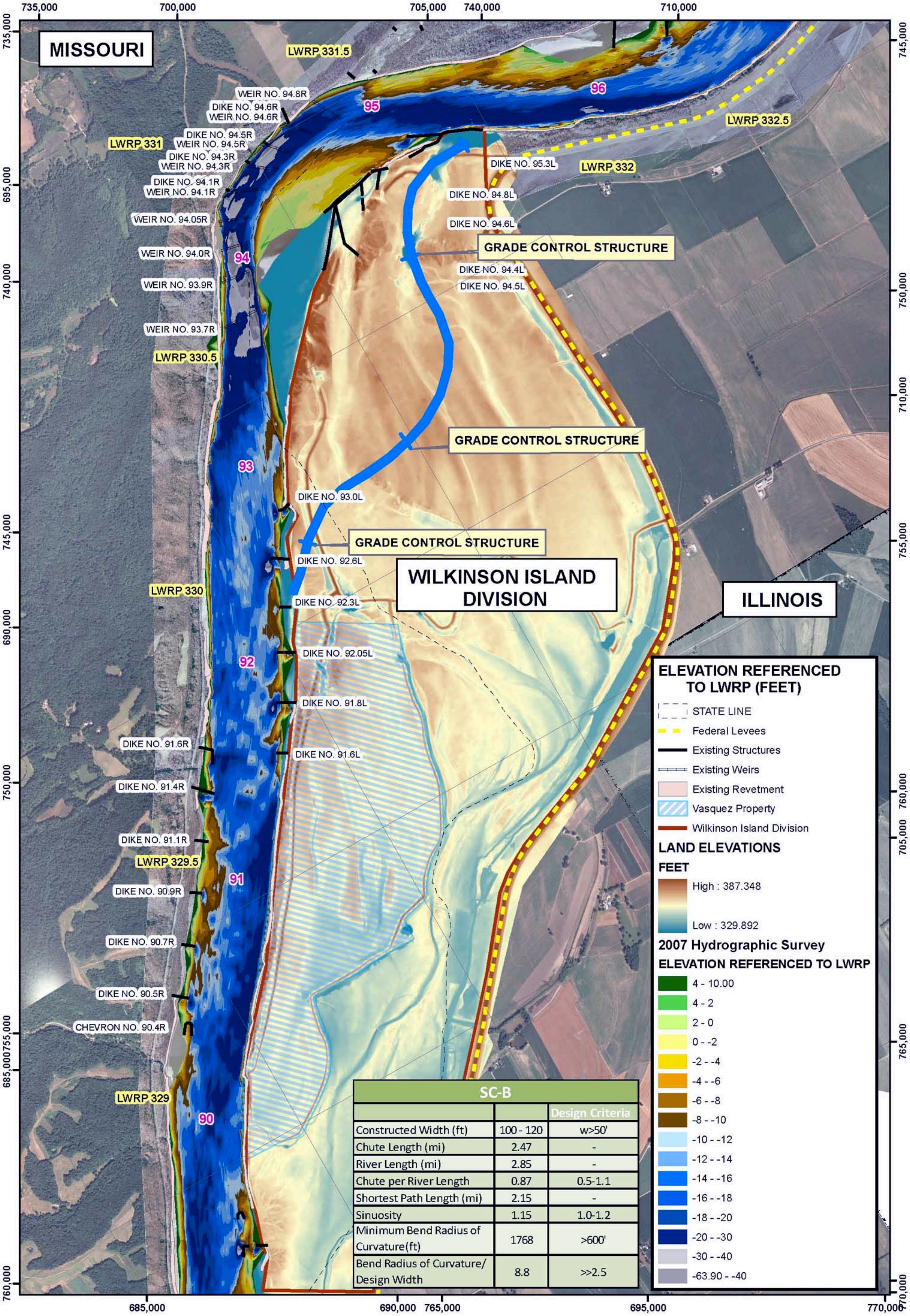

SC-B		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	2.47	-
River Length (mi)	2.85	-
Chute per River Length	0.87	0.5-1.1
Shortest Path Length (mi)	2.15	-
Sinuosity	1.15	1.0-1.2
Minimum Bend Radius of Curvature(ft)	1768	>600'
Bend Radius of Curvature/ Design Width	8.8	>>2.5

PLATE NUMBER 10

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-B

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/28/2010

FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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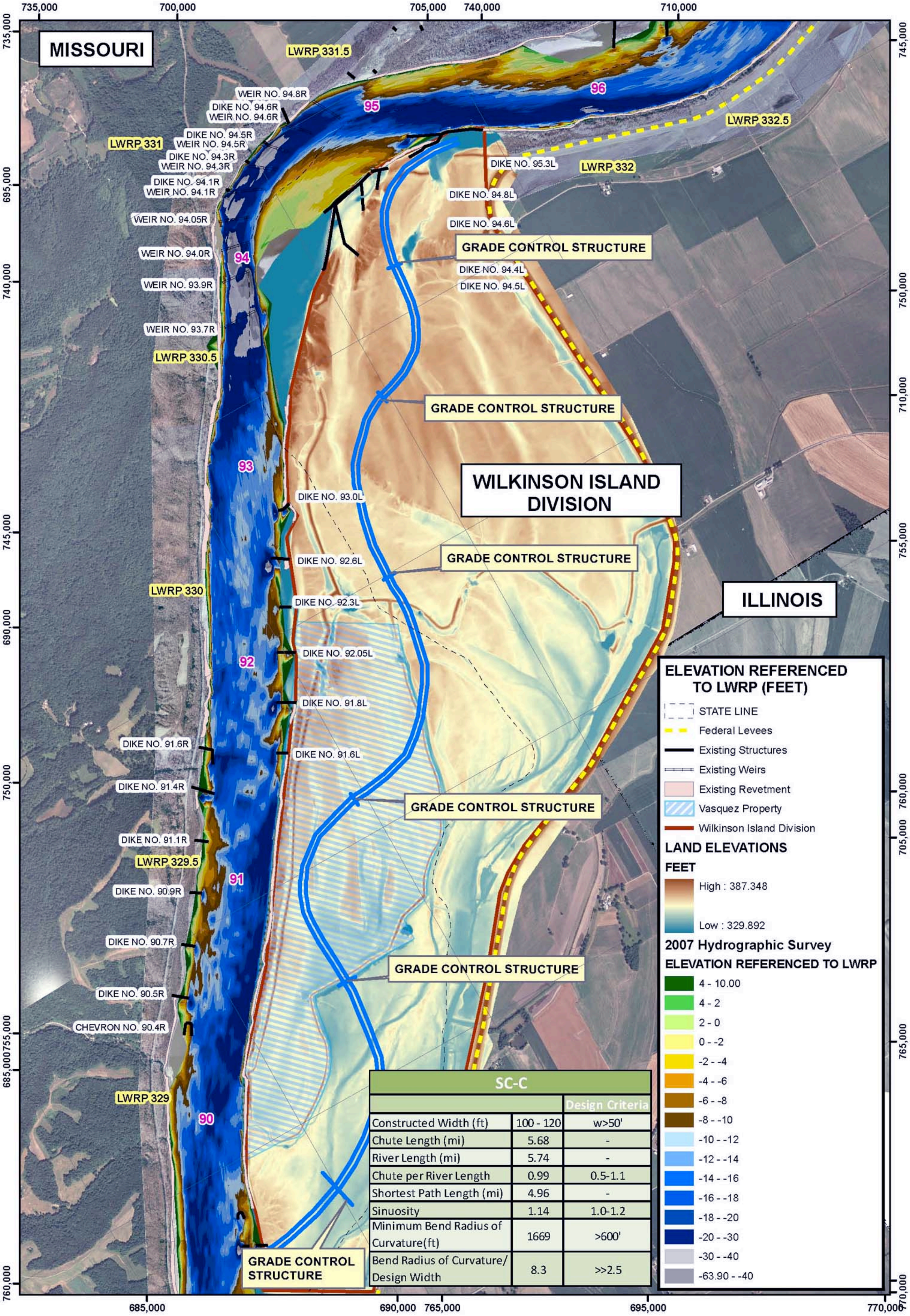

SC-C		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	5.68	-
River Length (mi)	5.74	-
Chute per River Length	0.99	0.5-1.1
Shortest Path Length (mi)	4.96	-
Sinuosity	1.14	1.0-1.2
Minimum Bend Radius of Curvature(ft)	1669	>600'
Bend Radius of Curvature/ Design Width	8.3	>>2.5

PLATE NUMBER 11

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-C

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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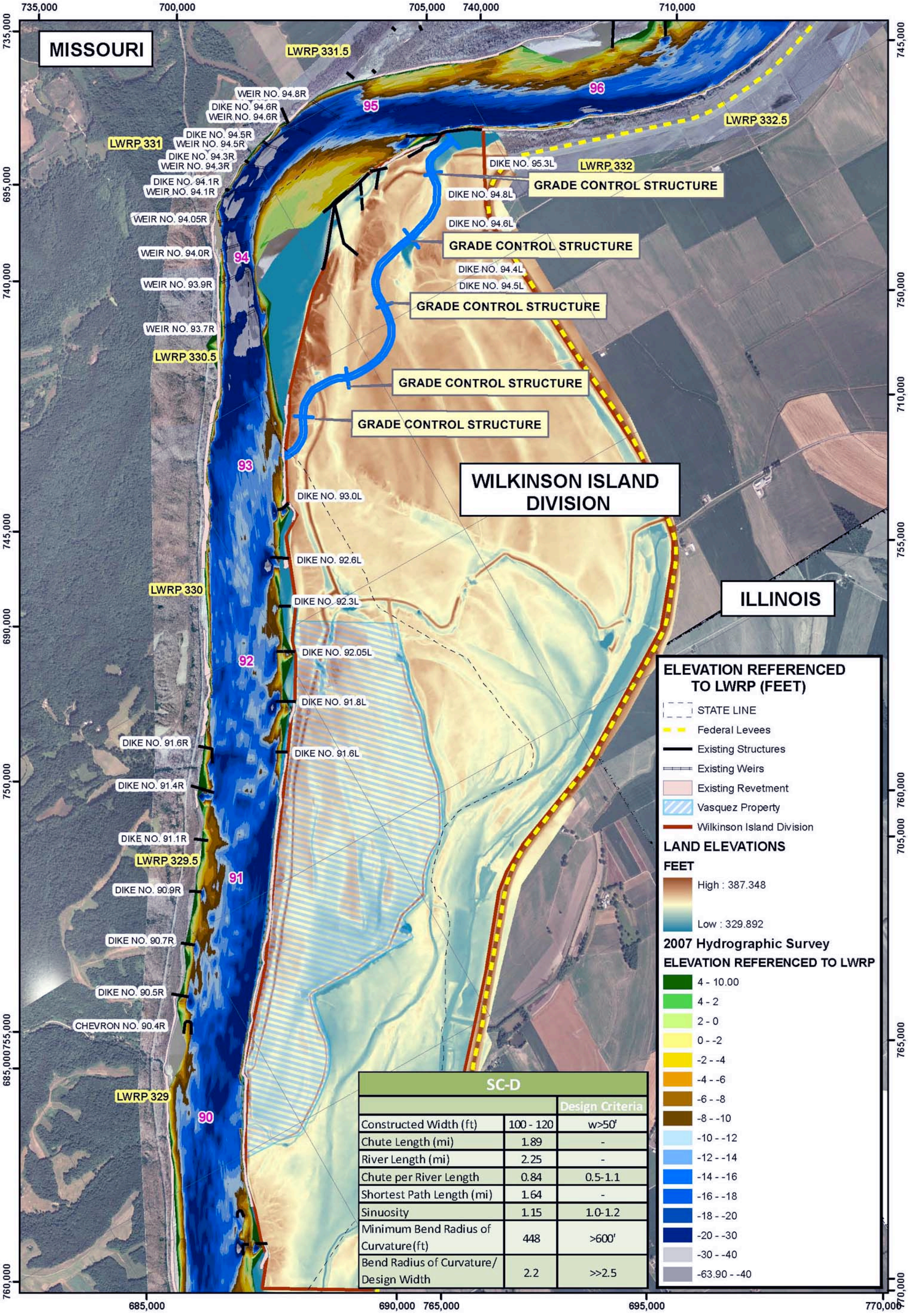

SC-D		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	1.89	-
River Length (mi)	2.25	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.64	-
Sinuosity	1.15	1.0-1.2
Minimum Bend Radius of Curvature(ft)	448	>600'
Bend Radius of Curvature/ Design Width	2.2	>>2.5

PLATE NUMBER 12

0 500 1,000 2,000 3,000 4,000 Feet

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ALIGNMENT SC-D

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.
AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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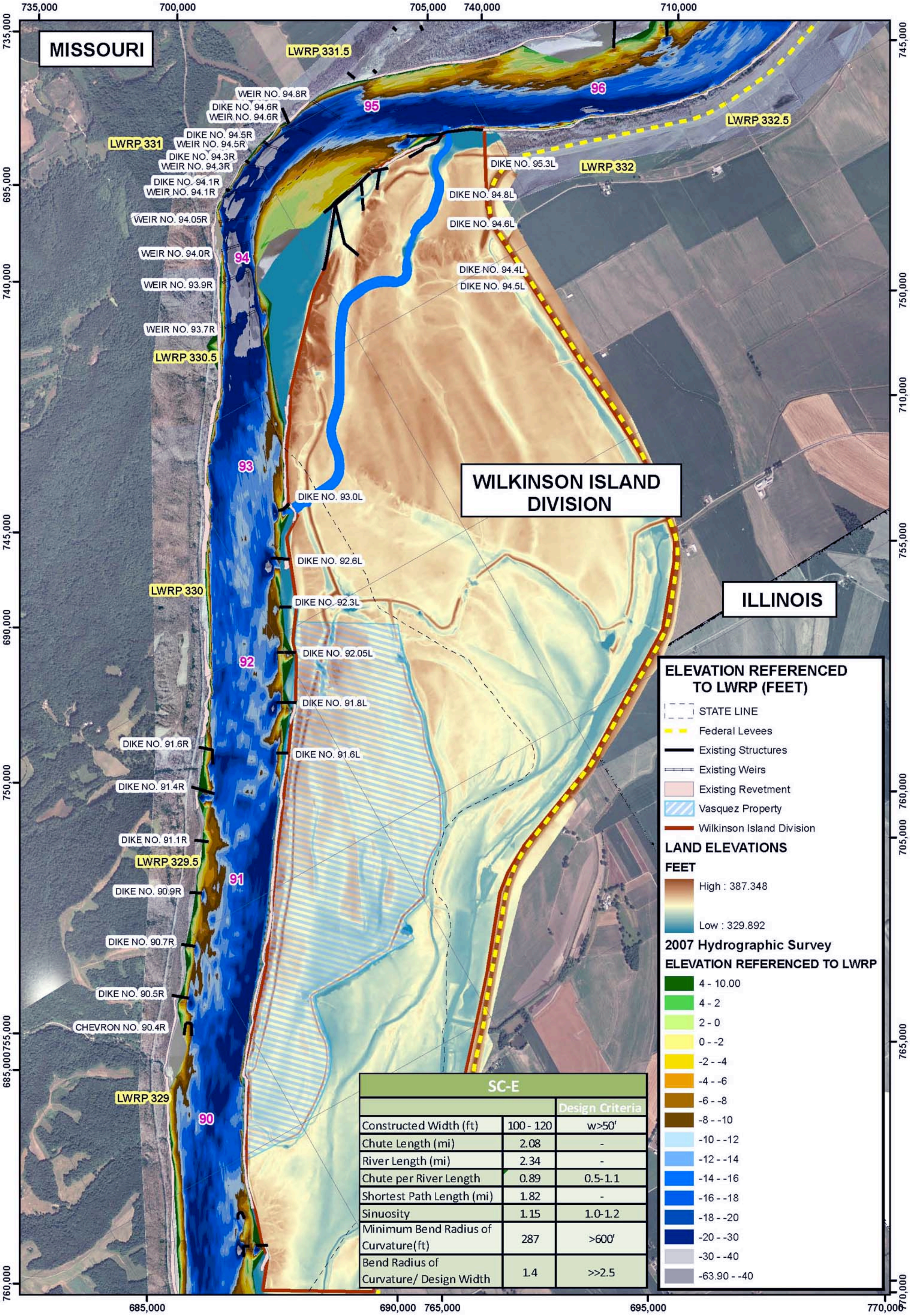

SC-E		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	2.08	-
River Length (mi)	2.34	-
Chute per River Length	0.89	0.5-1.1
Shortest Path Length (mi)	1.82	-
Sinuosity	1.15	1.0-1.2
Minimum Bend Radius of Curvature(ft)	287	>600'
Bend Radius of Curvature/ Design Width	1.4	>>2.5

PLATE NUMBER 13

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-E

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/28/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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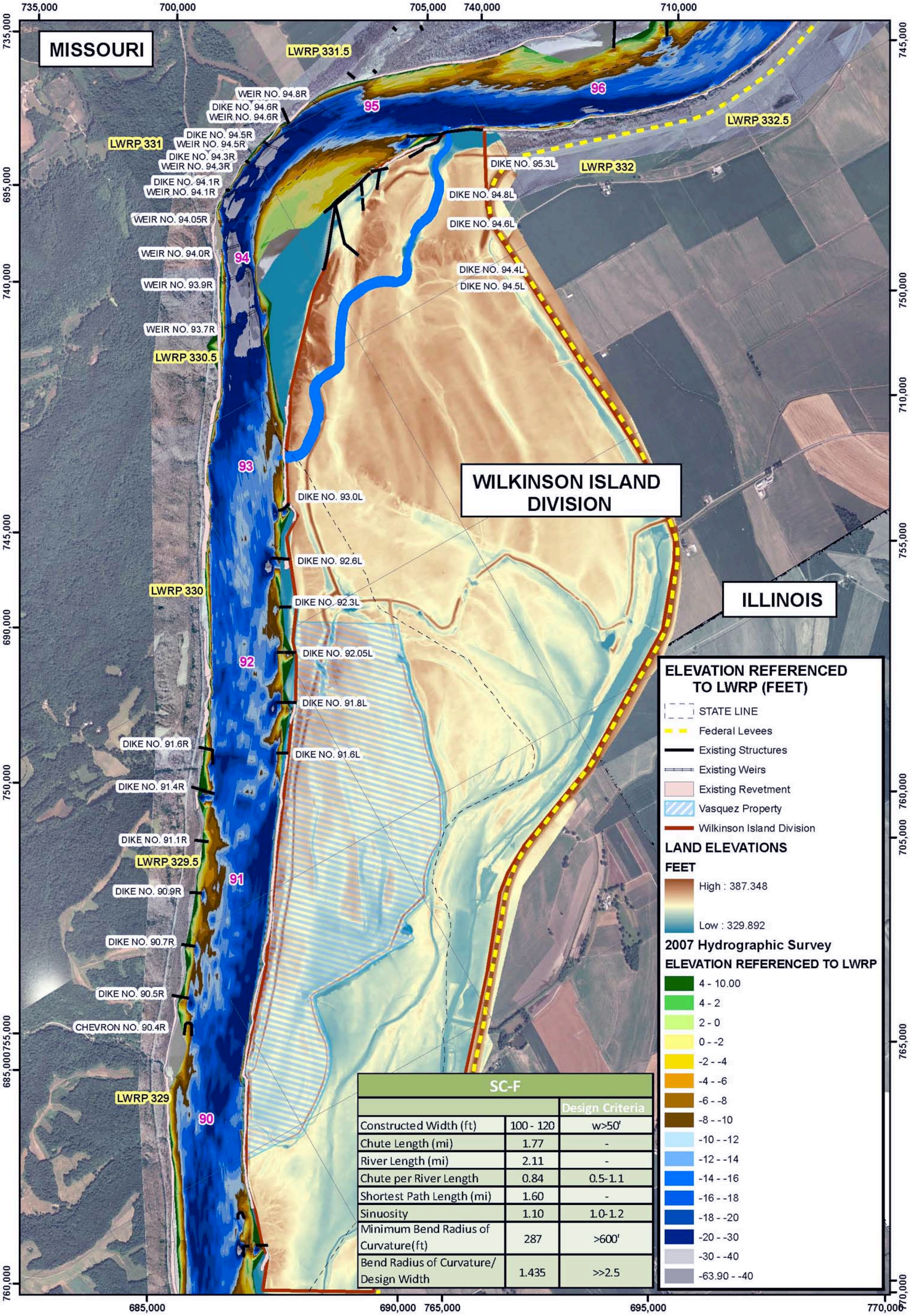

SC-F		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	1.77	-
River Length (mi)	2.11	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.60	-
Sinuosity	1.10	1.0-1.2
Minimum Bend Radius of Curvature(ft)	287	>600'
Bend Radius of Curvature/ Design Width	1.435	>>2.5

PLATE NUMBER 14

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

ALIGNMENT SC-F

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/28/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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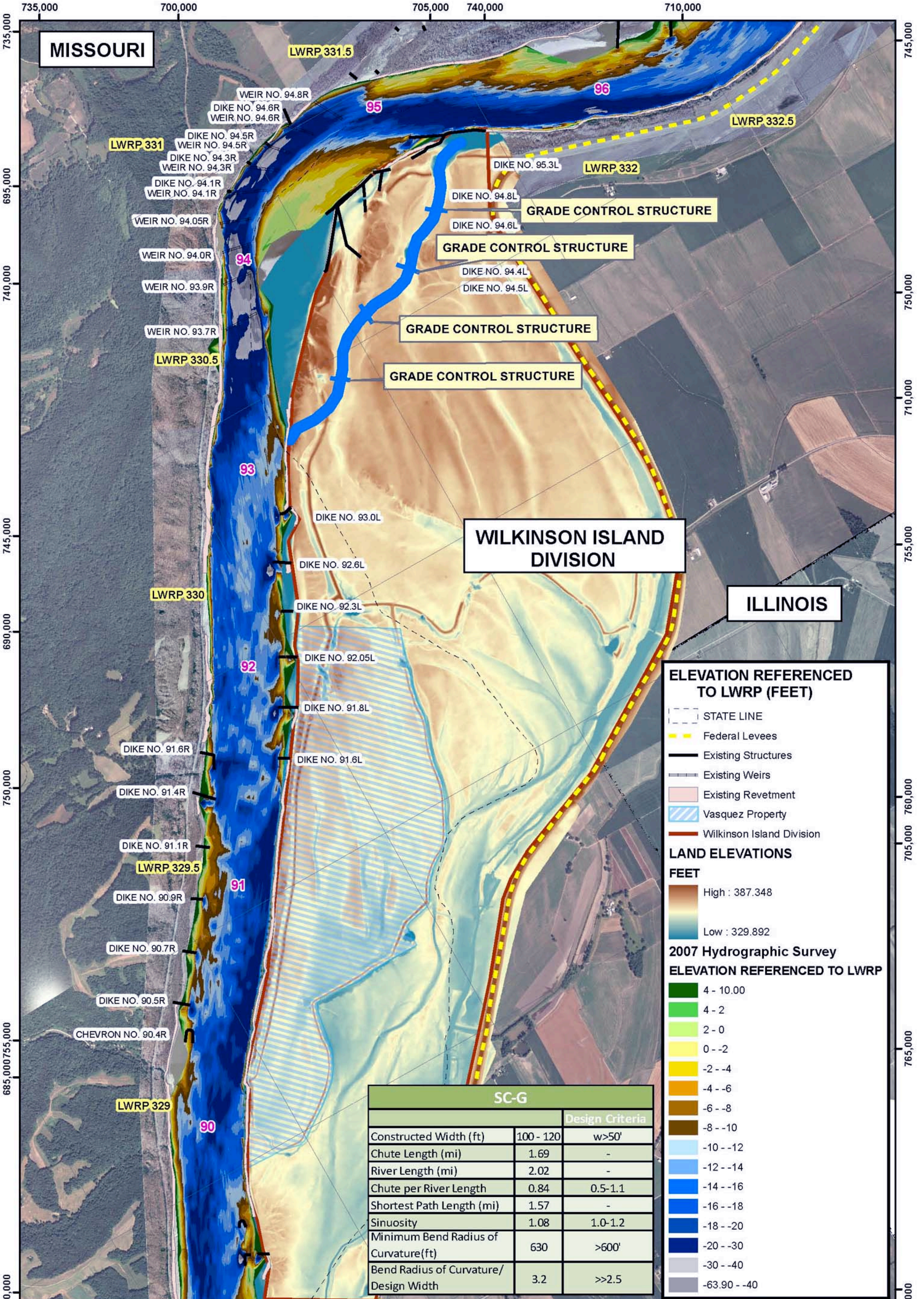

SC-G		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	1.69	-
River Length (mi)	2.02	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.57	-
Sinuosity	1.08	1.0-1.2
Minimum Bend Radius of Curvature(ft)	630	>600'
Bend Radius of Curvature/ Design Width	3.2	>>2.5

PLATE NUMBER 15

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-G

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/28/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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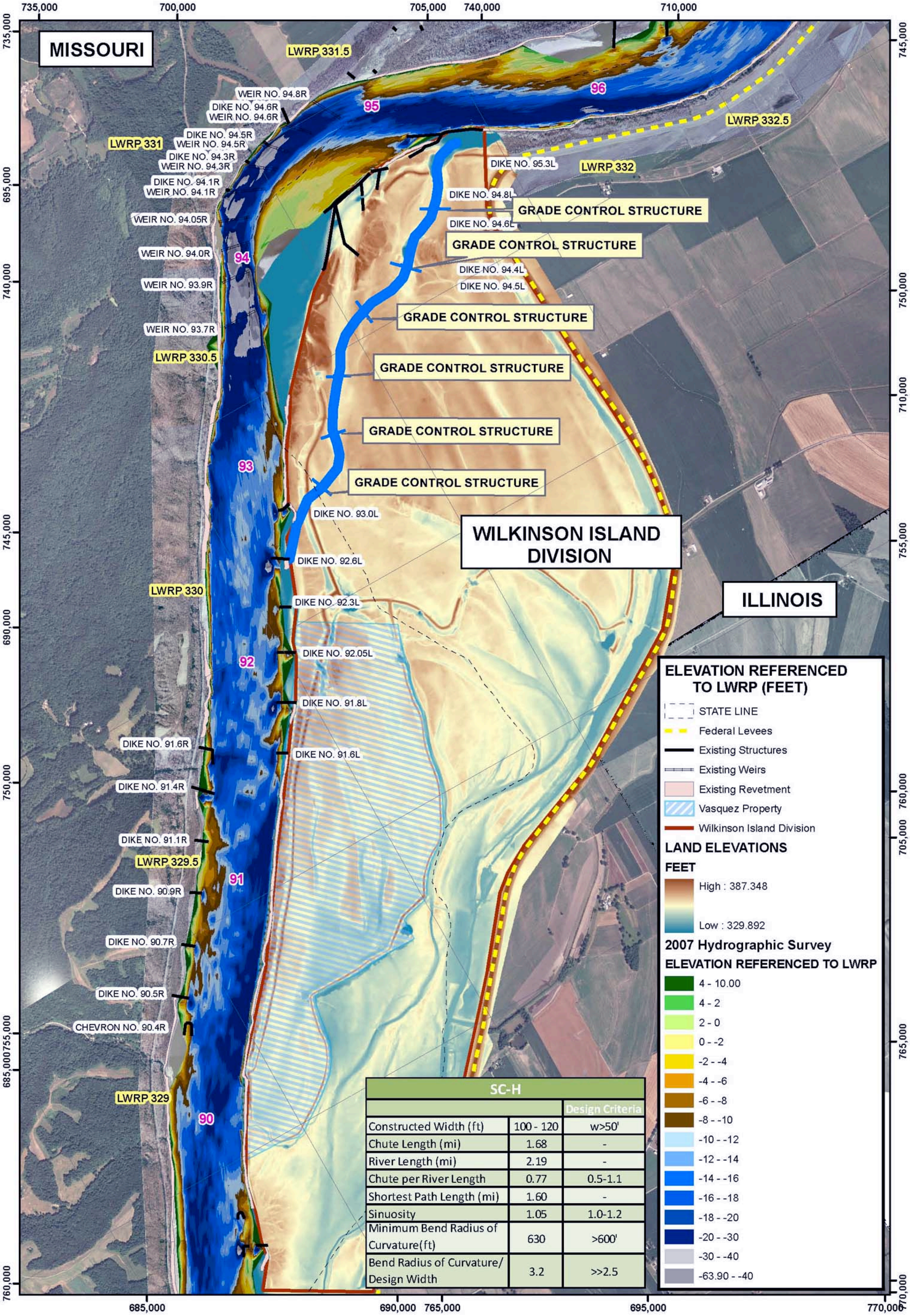

SC-H		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	1.68	-
River Length (mi)	2.19	-
Chute per River Length	0.77	0.5-1.1
Shortest Path Length (mi)	1.60	-
Sinuosity	1.05	1.0-1.2
Minimum Bend Radius of Curvature(ft)	630	>600'
Bend Radius of Curvature/ Design Width	3.2	>>2.5

PLATE NUMBER 16

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-H

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/28/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\ SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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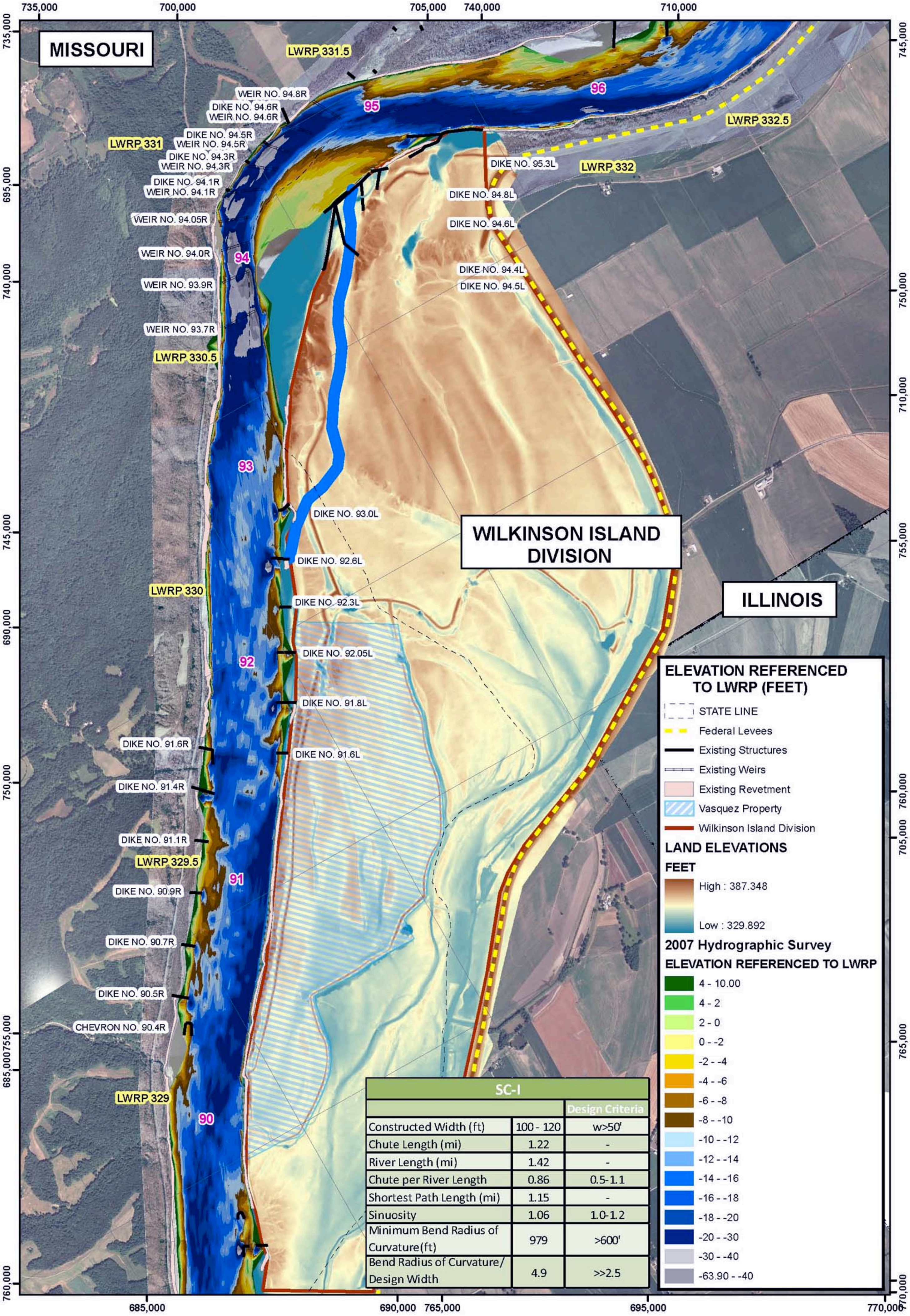

SC-I		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	1.22	-
River Length (mi)	1.42	-
Chute per River Length	0.86	0.5-1.1
Shortest Path Length (mi)	1.15	-
Sinuosity	1.06	1.0-1.2
Minimum Bend Radius of Curvature(ft)	979	>600'
Bend Radius of Curvature/ Design Width	4.9	>>2.5

PLATE NUMBER 17

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-I

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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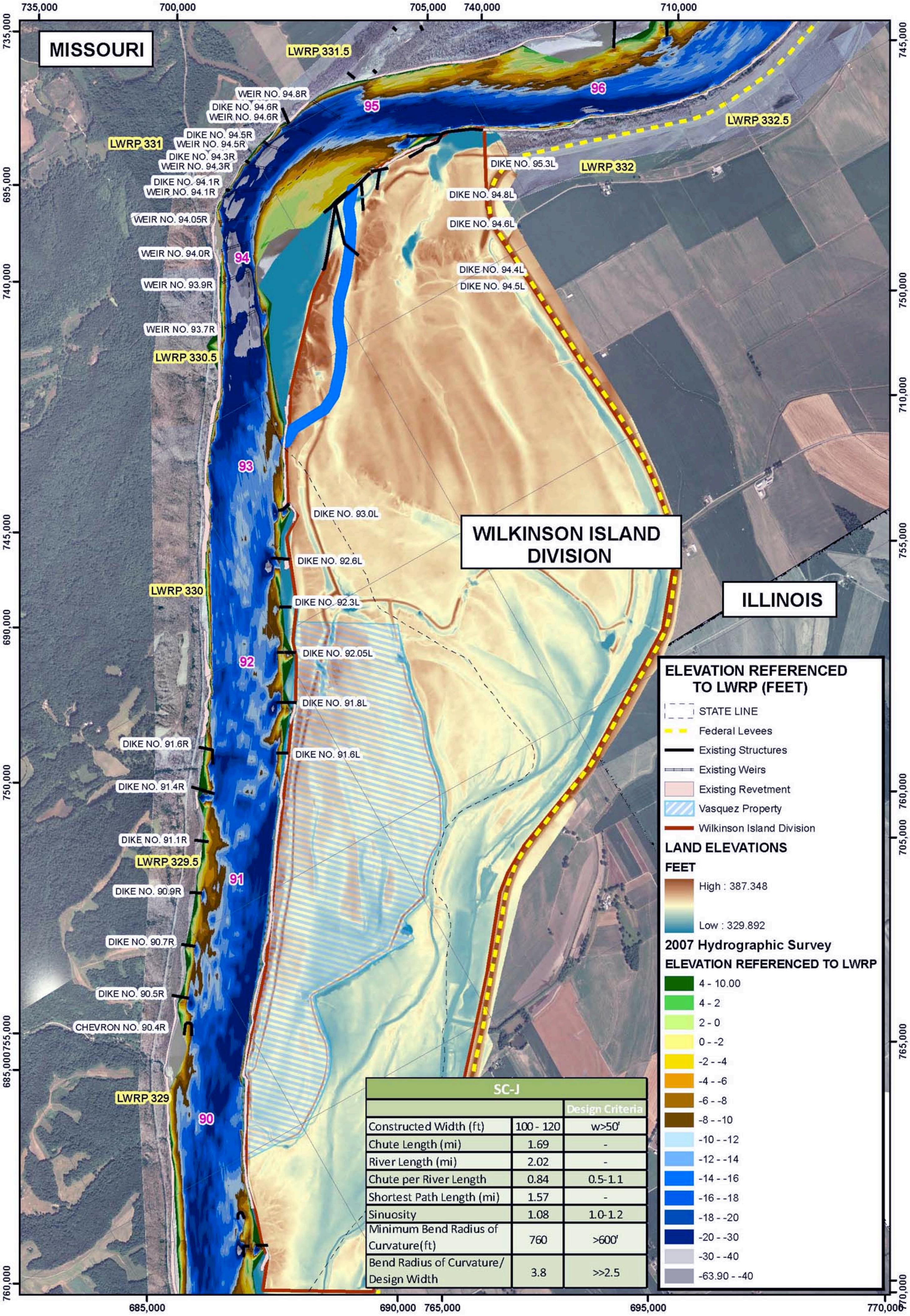

SC-J		
		Design Criteria
Constructed Width (ft)	100 - 120	w>50'
Chute Length (mi)	1.69	-
River Length (mi)	2.02	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.57	-
Sinuosity	1.08	1.0-1.2
Minimum Bend Radius of Curvature(ft)	760	>600'
Bend Radius of Curvature/ Design Width	3.8	>>2.5

PLATE NUMBER 18

0 500 1,000 2,000 3,000 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

ALIGNMENT SC-J

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.
AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
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PLATE NUMBER				
19	PHOTOGRAPH OF HYDRAULIC SEDIMENT RESPONSE MODEL	U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. BRAUER, P.E. DRAWN BY: E. RIVERA	SUBMITTED: 06/23/2010
		UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILE 98.0 - 90.5	CHECKED BY: R. Davinroy, P.E. APPROVED: R. Davinroy, P.E.	FILE NAME: L:\Wilkinson-HSR Model\ARC\Picture.mxd

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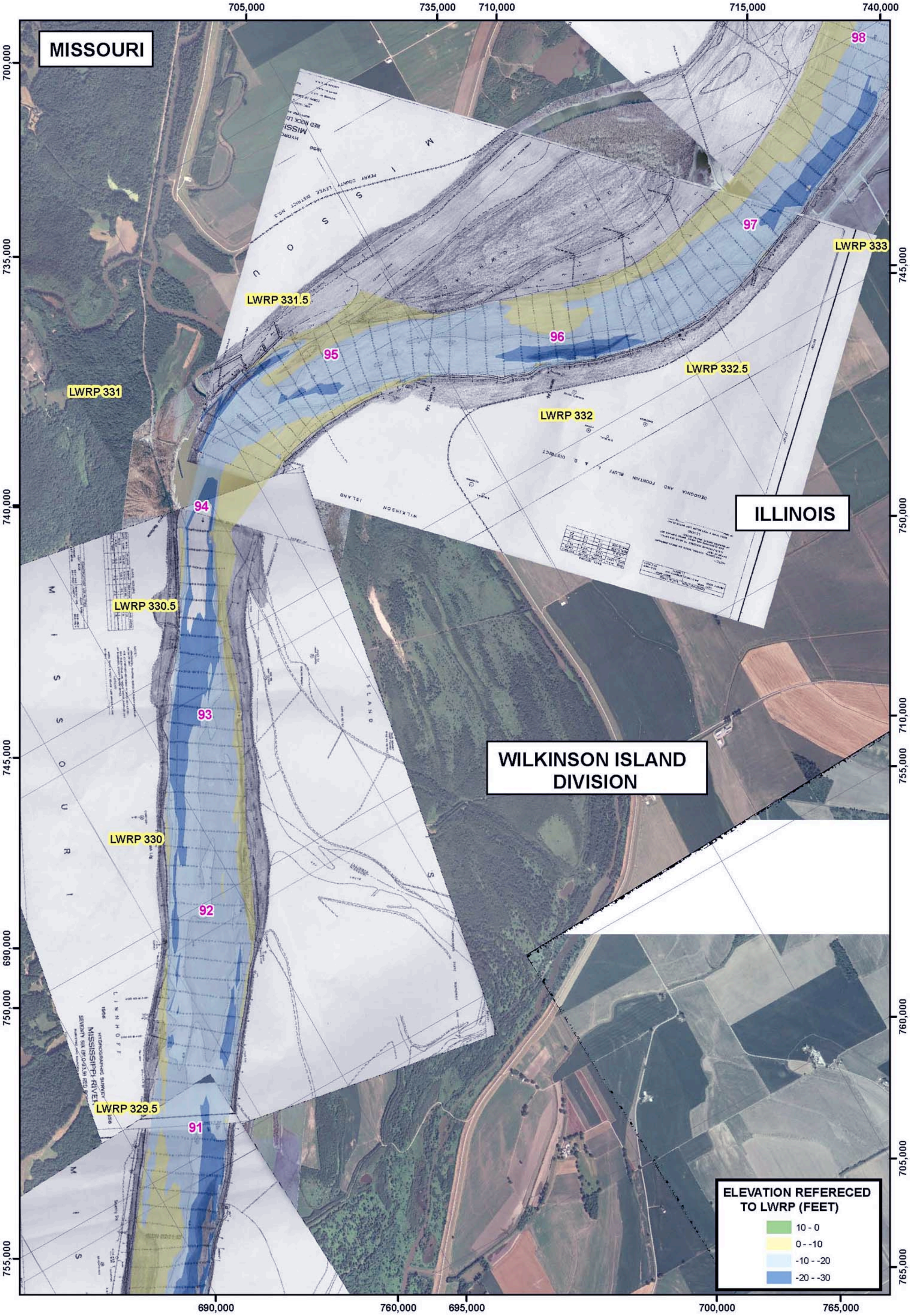

PLATE NUMBER 20

0 500 1,000 2,000 3,000 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

1939 - 1956 HYDROGRAPHIC SURVEY

SOUNDED ON:
MARCH 1, 1956 MARCH 5 - 9, 1956 MARCH 13 & 16, 1956

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/27/2010
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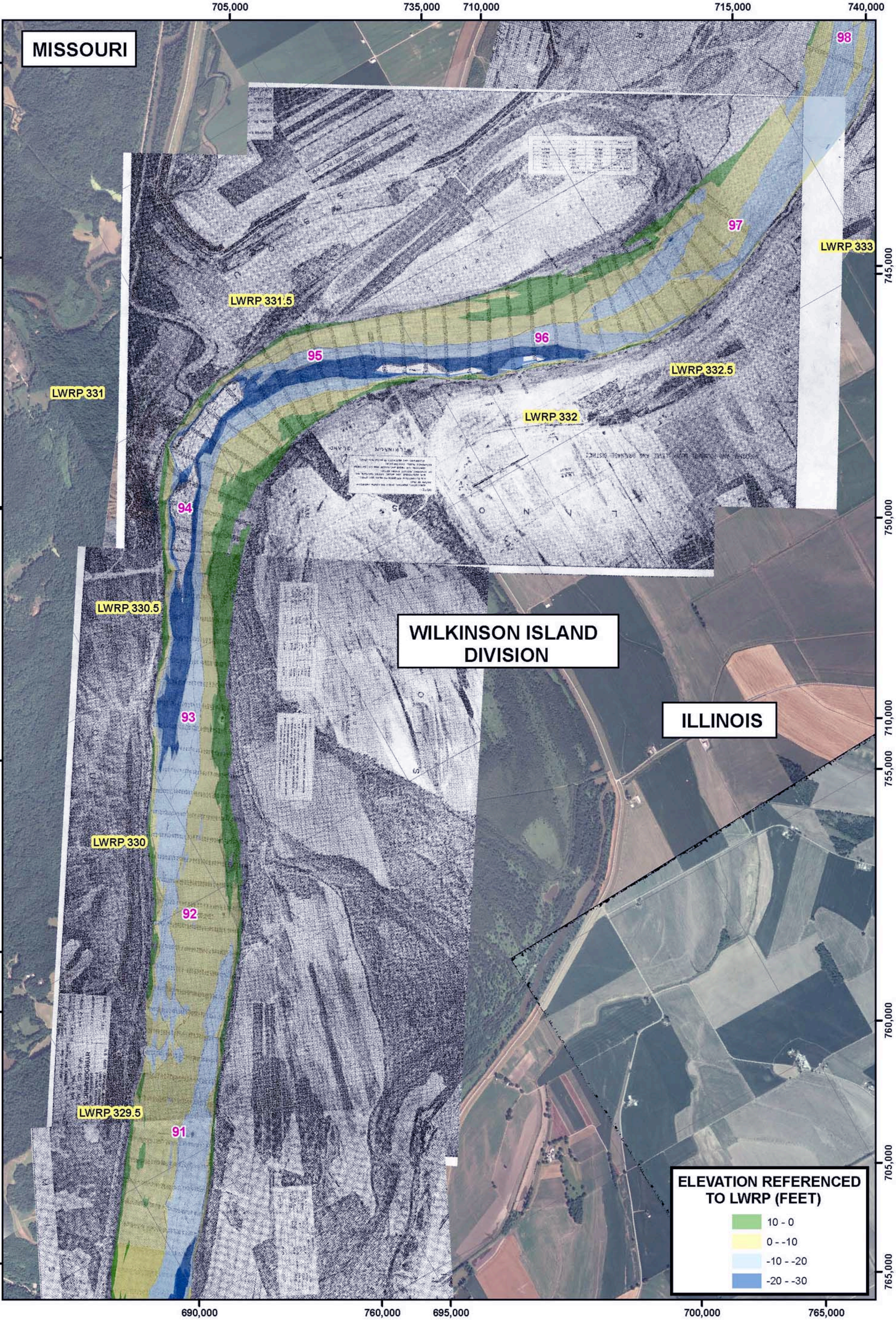

PLATE NUMBER 21

0 500 1,000 2,000 3,000 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

1968 - 1971 HYDROGRAPHIC SURVEY

SOUNDED ON:
JUNE 19 - 20, 1969 JUNE 24 - 26, 1969 OCTOBER 14, 1971

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
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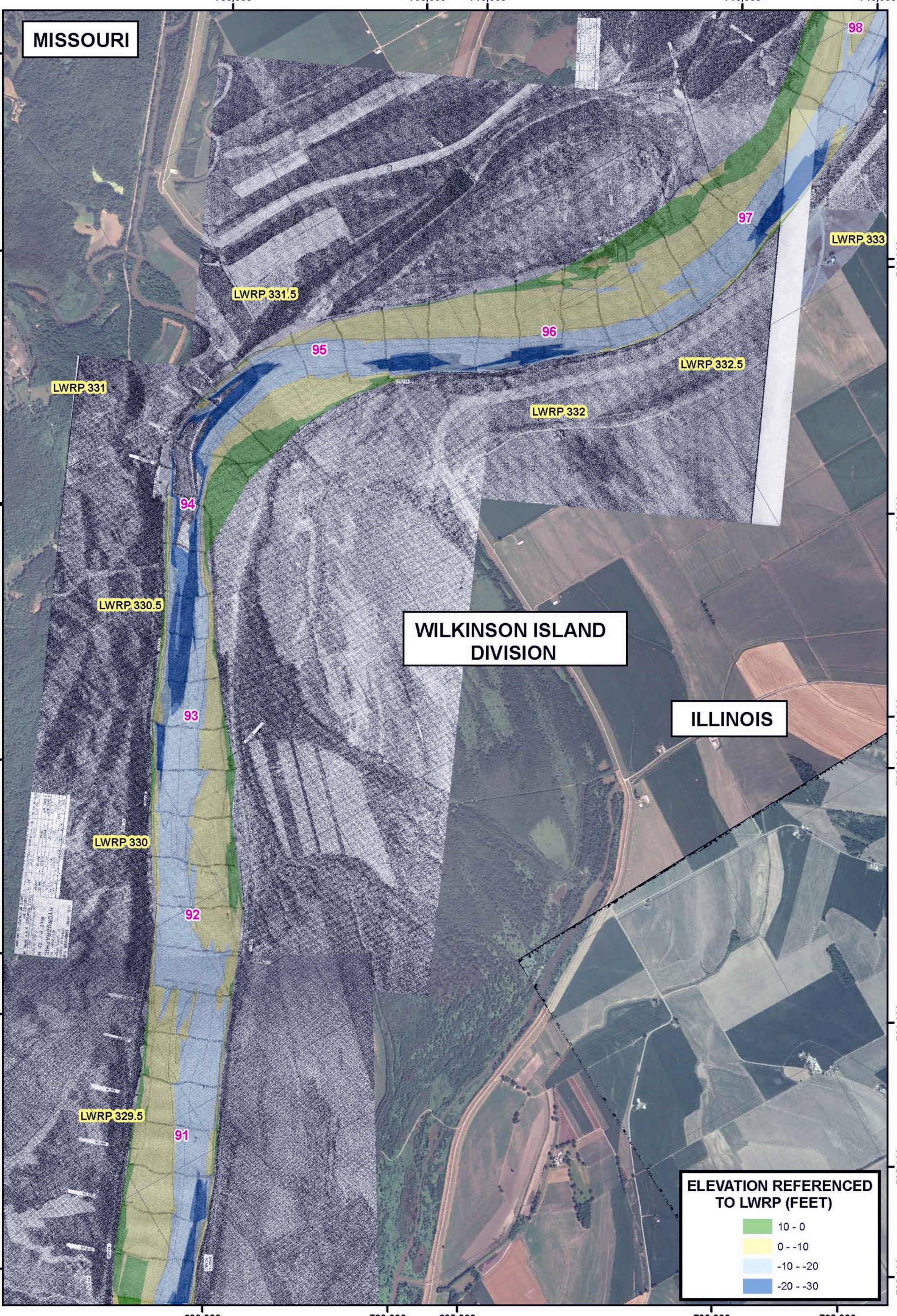

PLATE NUMBER 22

0 500 1,000 2,000 3,000 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

1976 - 1977 HYDROGRAPHIC SURVEY

SOUNDED ON:
APRIL 6 - 8, 1977

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
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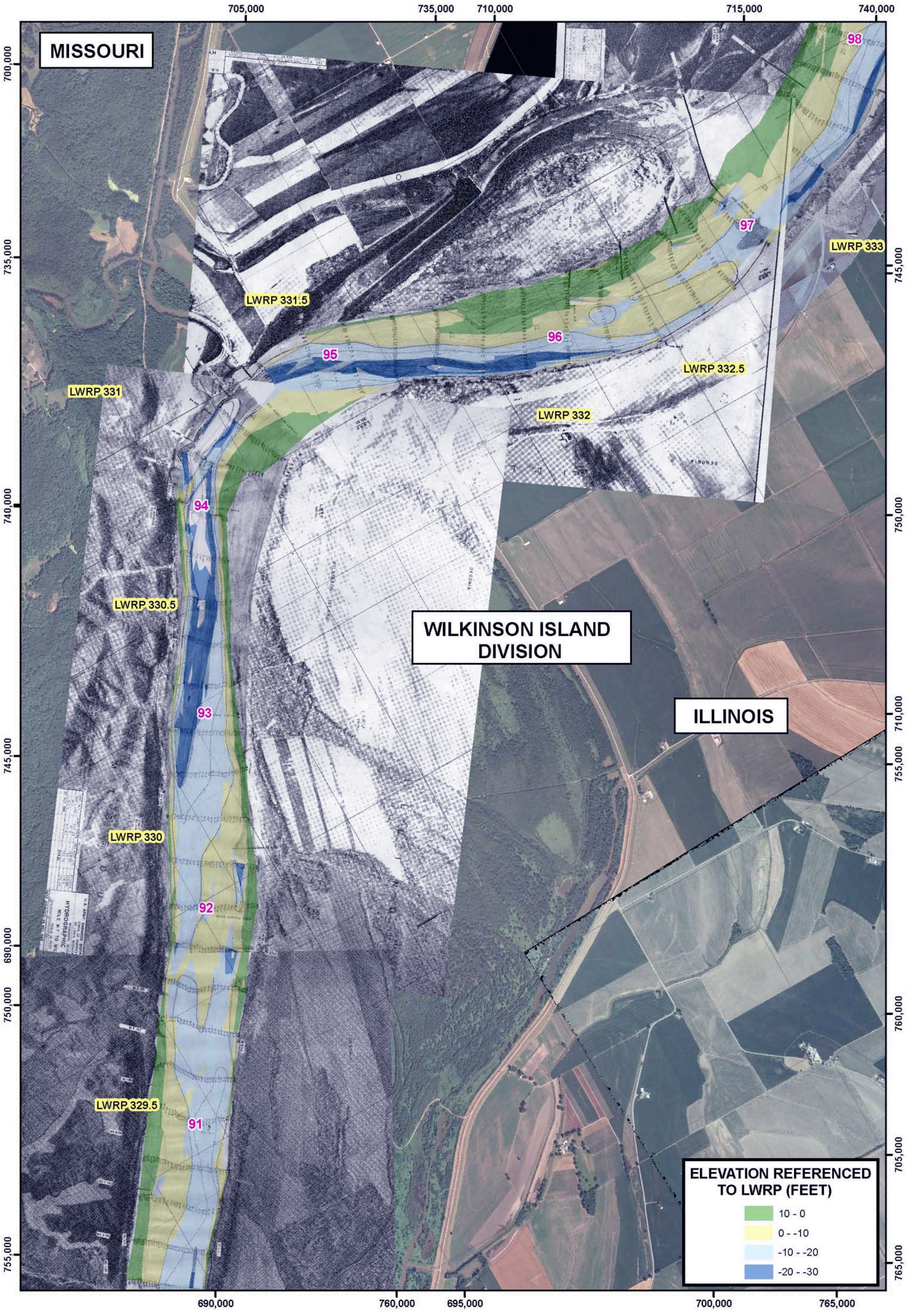

PLATE NUMBER 23

0 500 1,000 2,000 3,000 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

1982 - 1983 HYDROGRAPHIC SURVEY

SOUNDED ON:
OCTOBER 27 & 29, 1982 NOVEMBER 11, 1982
JUNE 13 & 14, 1983

U.S. ARMY ENGINEER DIVISION
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ST. LOUIS, MISSOURI

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
APPROVED: R. Davinroy, P.E.	

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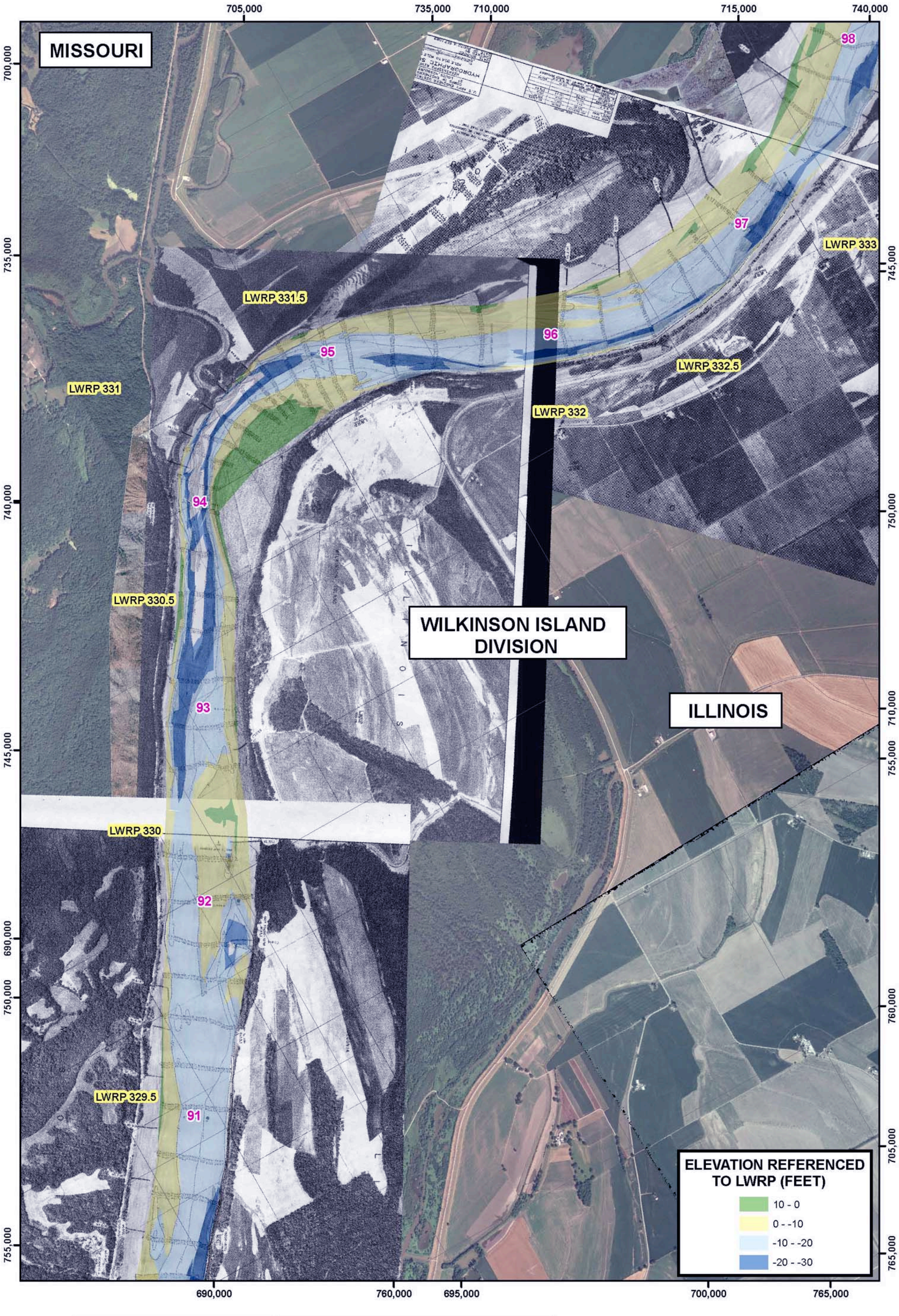

PLATE NUMBER 24

0 500 1,000 2,000 3,000 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

1986 - 1988 HYDROGRAPHIC SURVEY

SOUNDED ON:
MAY 27 & 31, 1988 JUNE 1 & 2, 1988

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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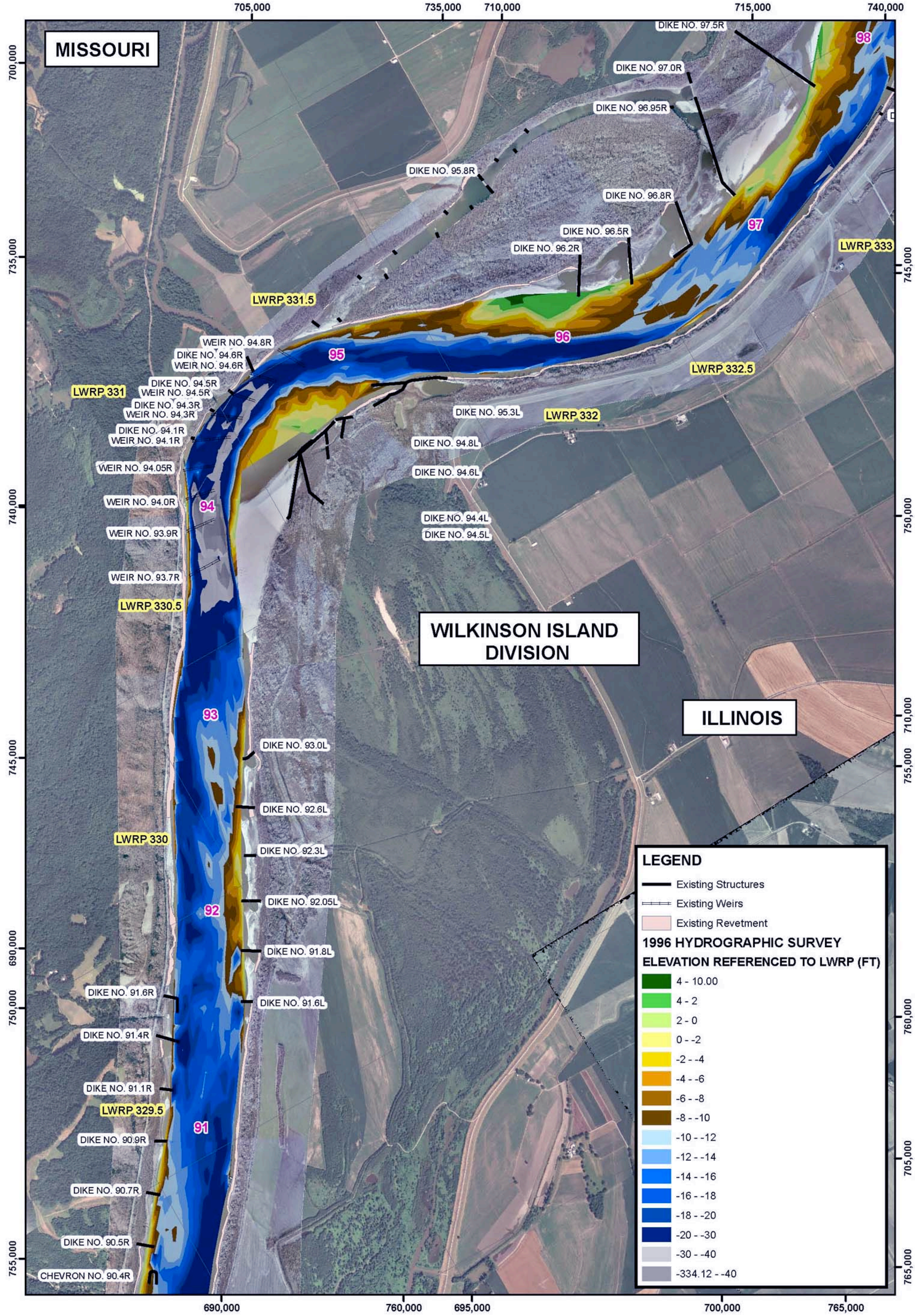

PLATE NUMBER 25

0 500 1,000 2,000 3,000 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

1996 HYDROGRAPHIC SURVEY

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
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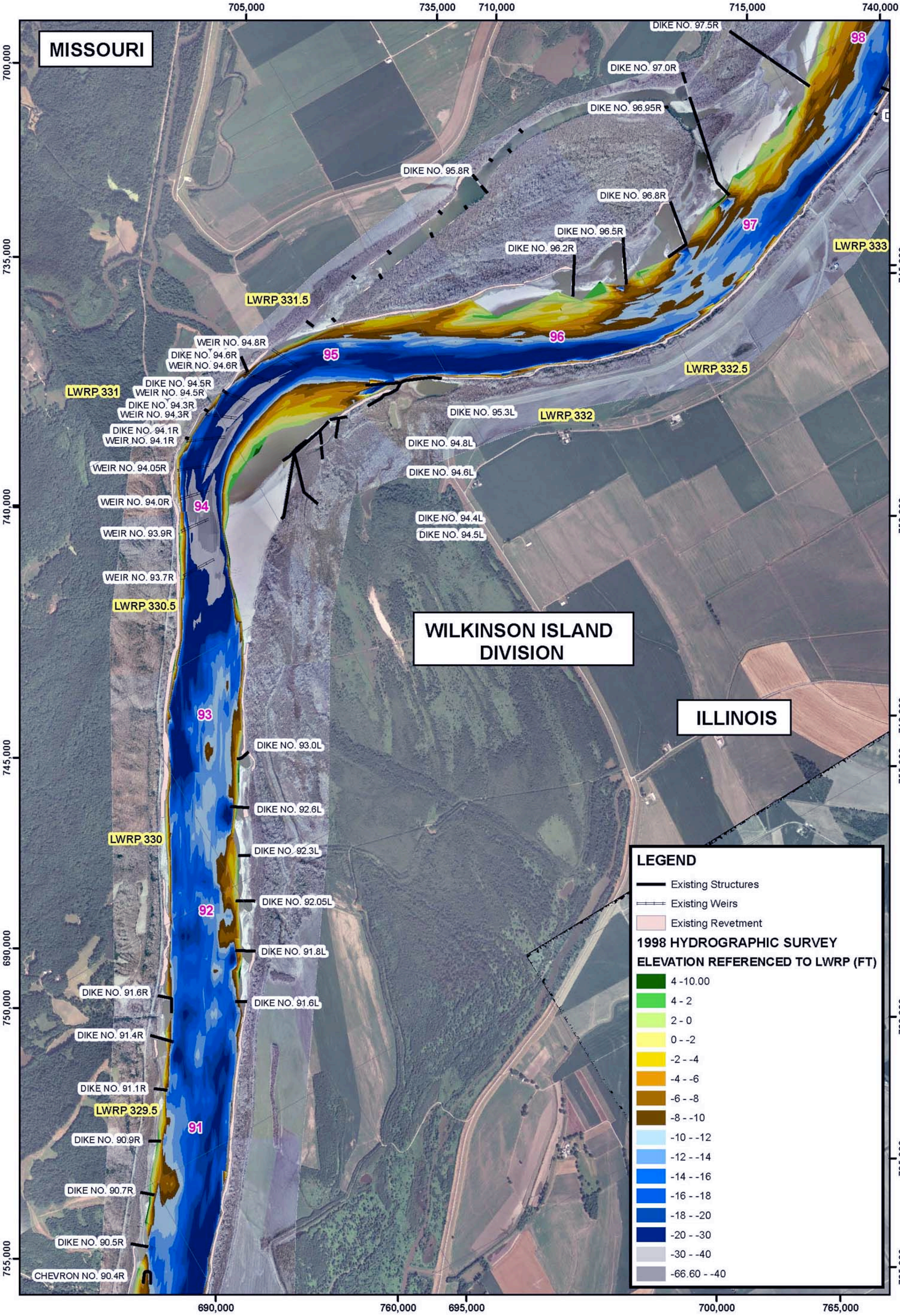

PLATE NUMBER 26

0 500 1,000 2,000 3,000 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

1998 HYDROGRAPHIC SURVEY

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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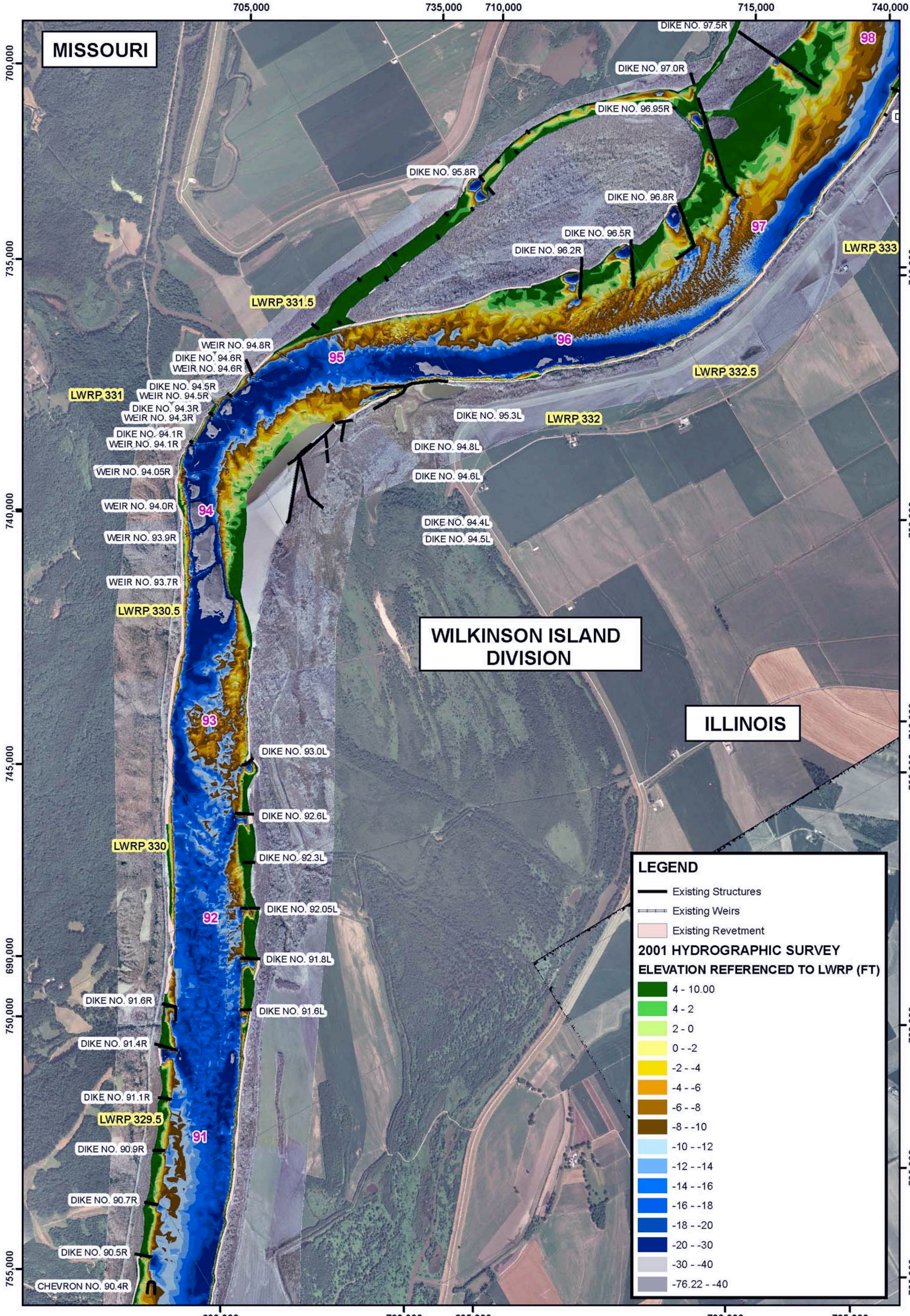

PLATE NUMBER 27

0 500 1,000 2,000 3,000 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

2001 HYDROGRAPHIC SURVEY

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/27/2010

FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

APPLIED RIVER ENGINEERING CENTER

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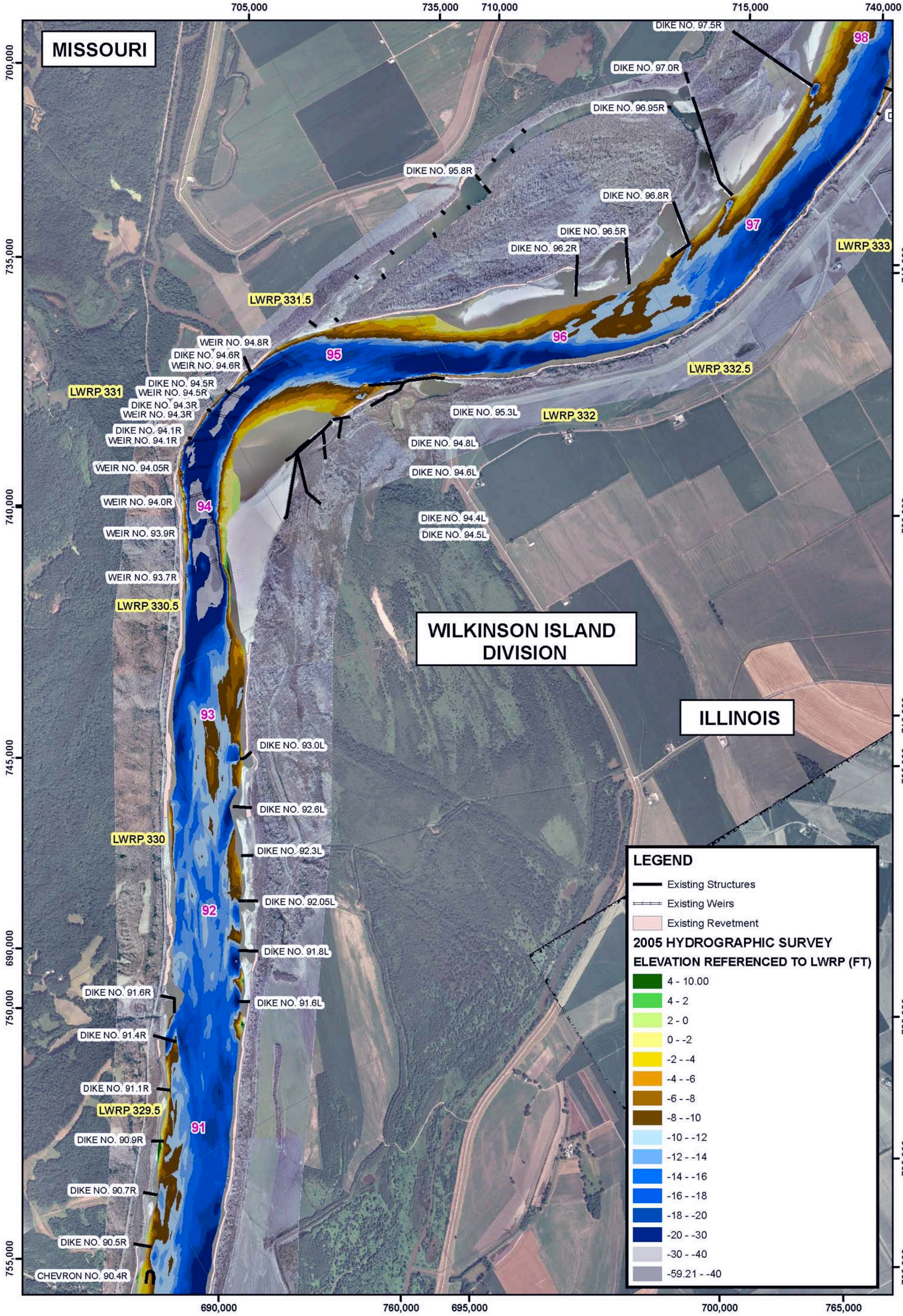

PLATE NUMBER 28

0 500 1,000 2,000 3,000 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

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/27/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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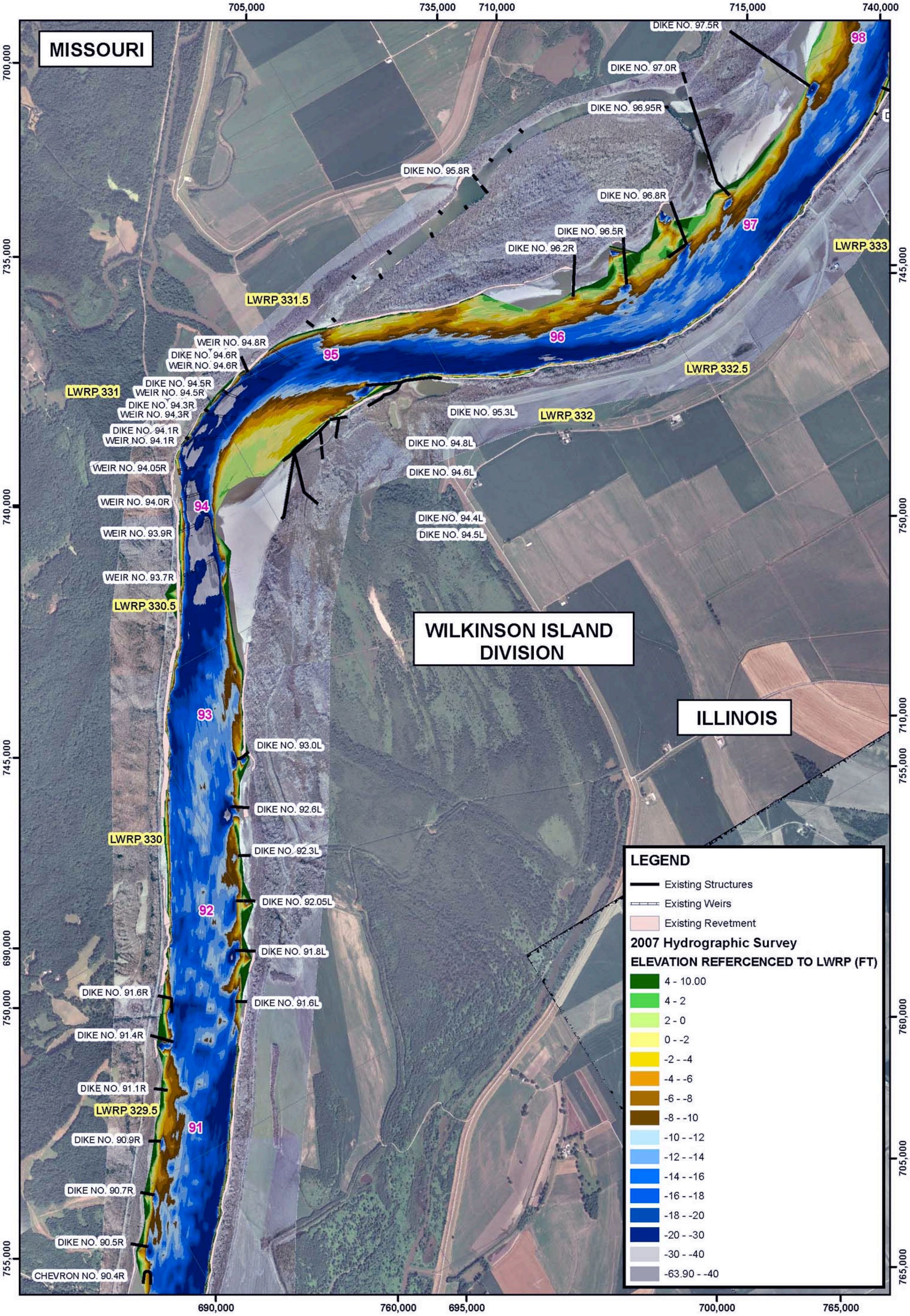

PLATE NUMBER 29

0 500 1,000 2,000 3,000 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

2007 HYDROGRAPHIC SURVEY

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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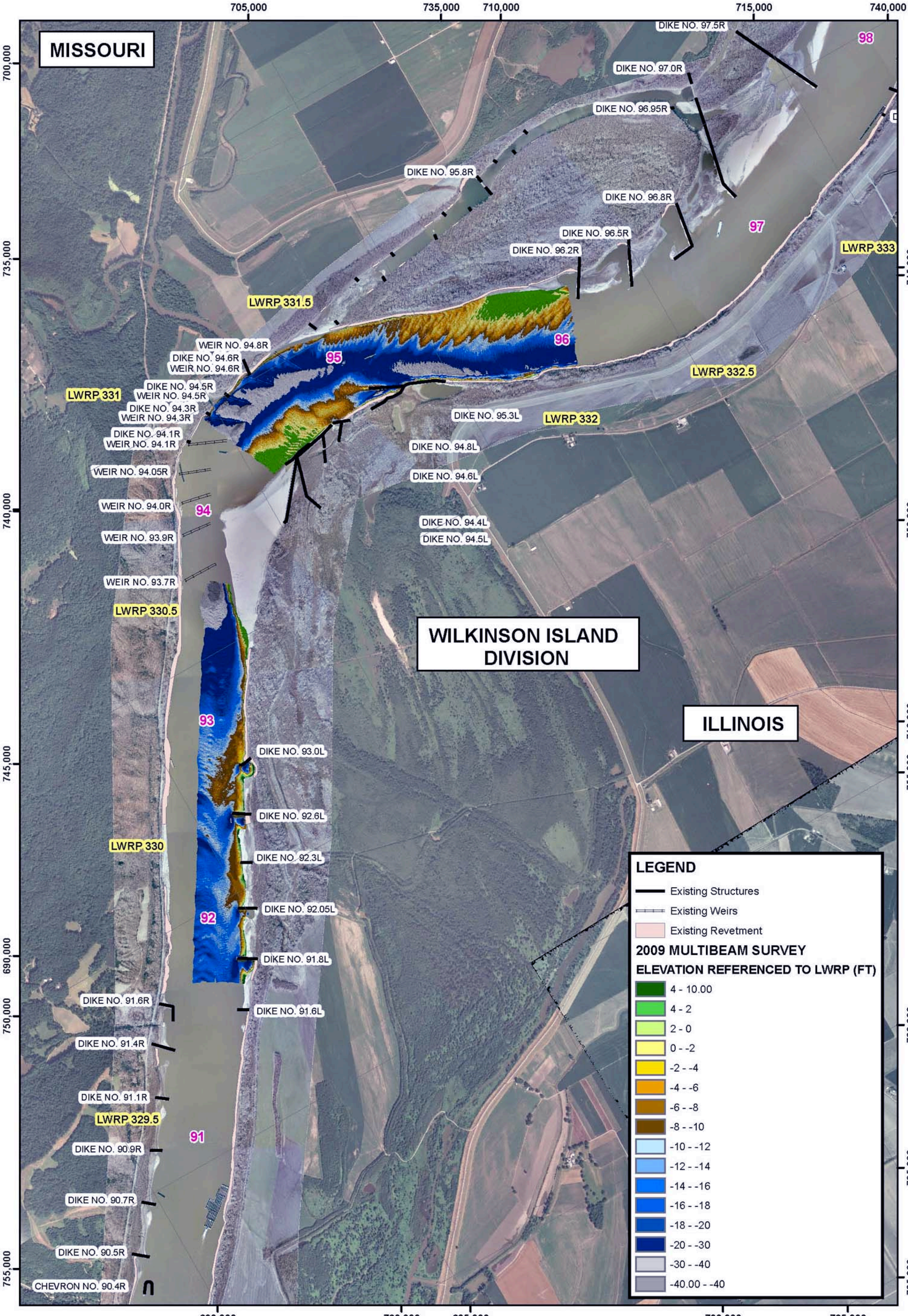

PLATE NUMBER 30

0 500 1,000 2,000 3,000 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

2009 MULTIBEAM SURVEY

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/27/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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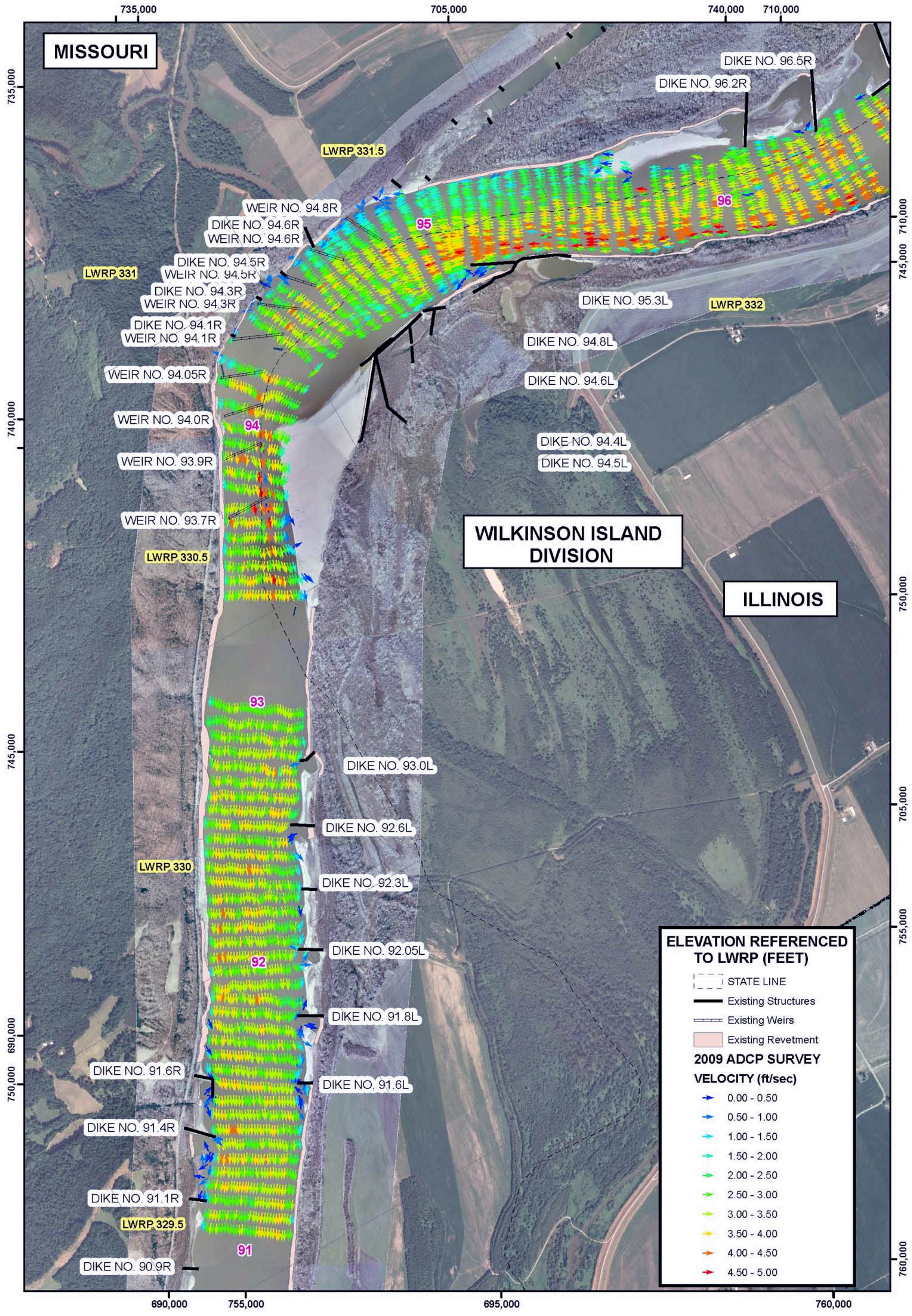

PLATE NUMBER 31	0 375 750 1,500 2,250 3,000 Feet THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME **2009 ADCP SURVEY SURVEYED: AUGUST 28, 2009 STAGE AT CHESTER: 13.84 FT**

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2003 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/28/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
	APPROVED: R. Davinroy, P.E.	

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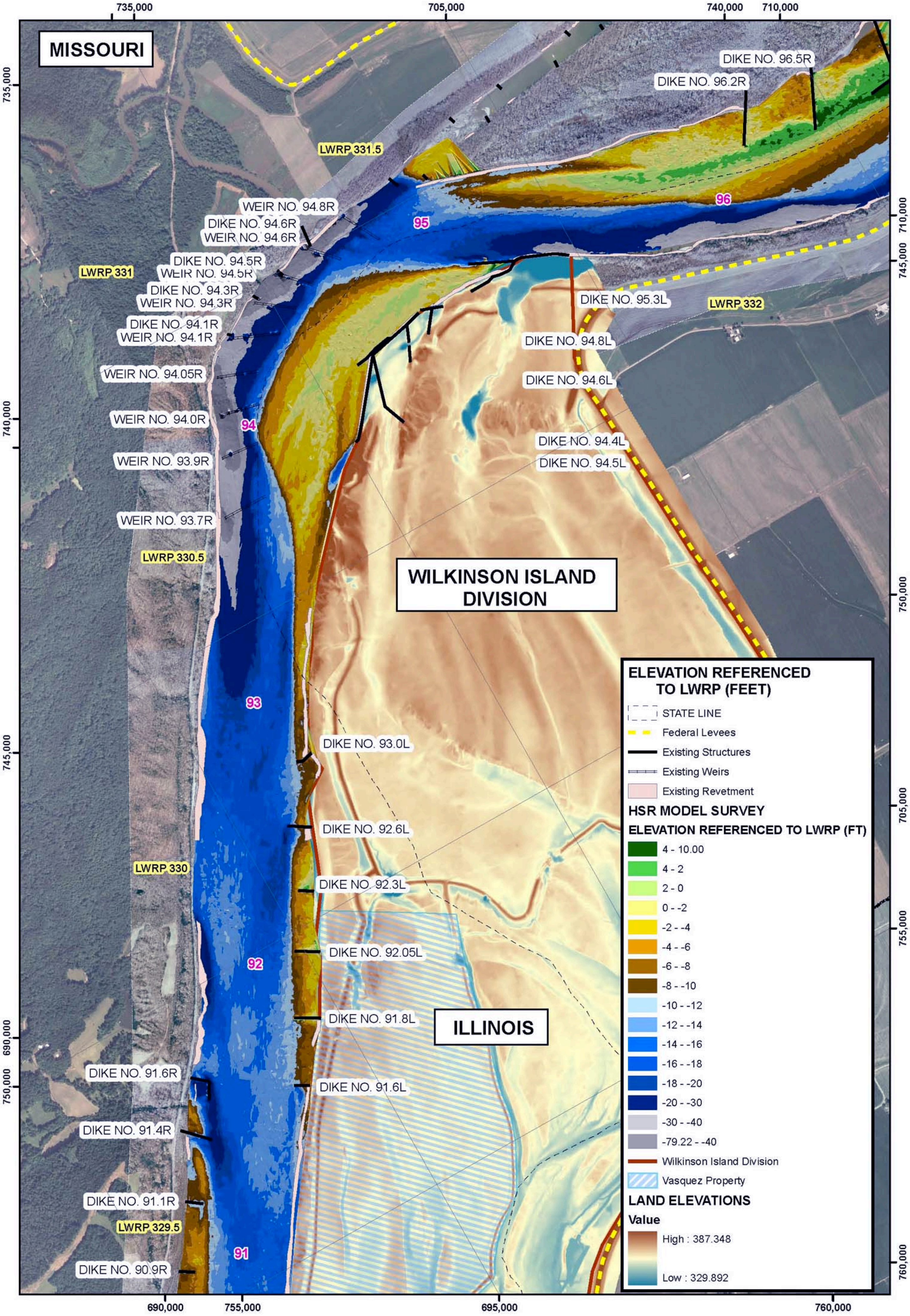

PLATE NUMBER 32

0 375 750 1,500 2,250 3,000 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

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/27/2010

FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

APPLIED RIVER ENGINEERING CENTER

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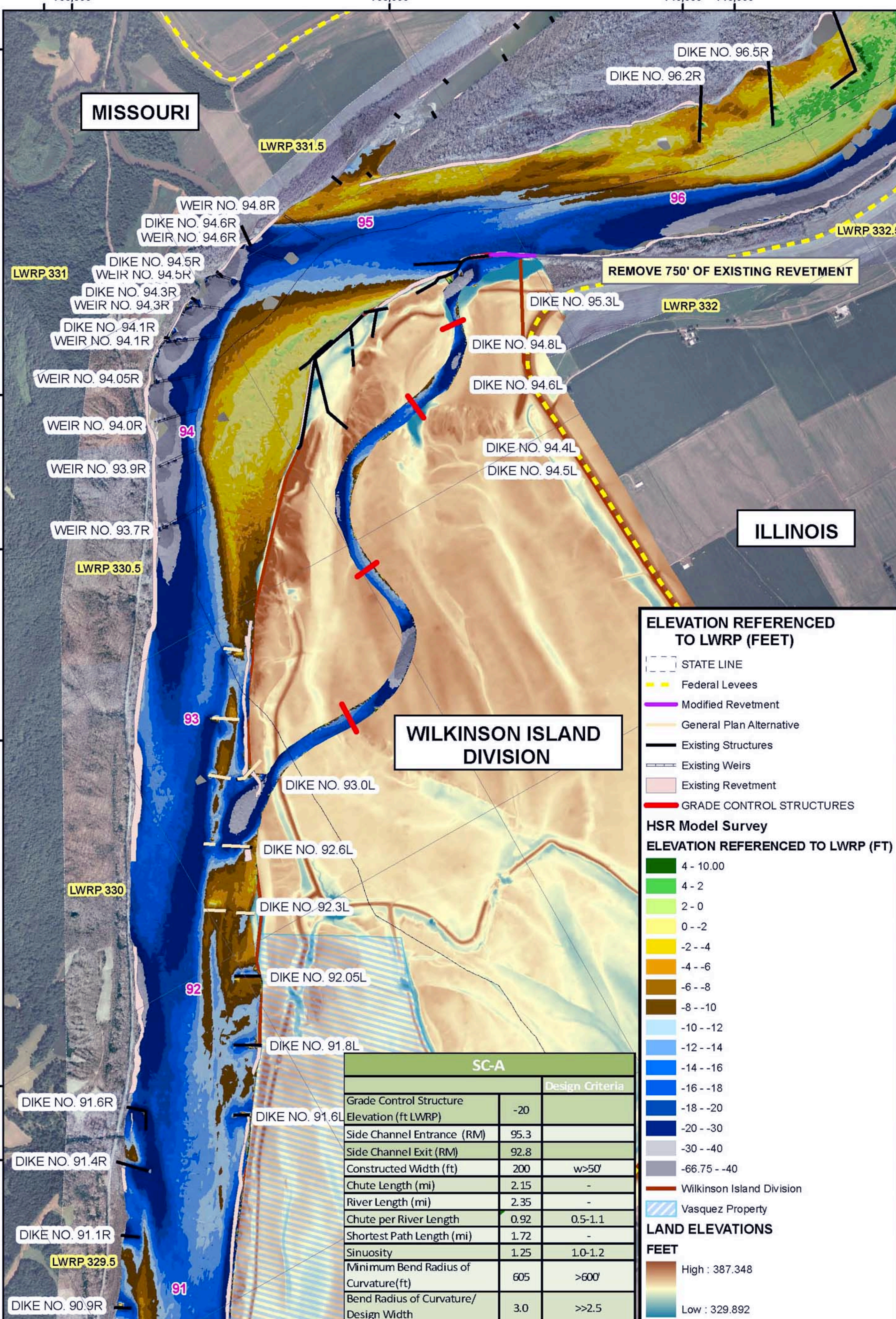

SC-A		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	-20	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	92.8	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	2.15	-
River Length (mi)	2.35	-
Chute per River Length	0.92	0.5-1.1
Shortest Path Length (mi)	1.72	-
Sinuosity	1.25	1.0-1.2
Minimum Bend Radius of Curvature(ft)	605	>600'
Bend Radius of Curvature/ Design Width	3.0	>>2.5

PLATE NUMBER 33

0 375 750 1,500 2,250 3,000 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 SC-A, GRADE CONTROL STRUCTURE ELEVATION: -20 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/28/2010

FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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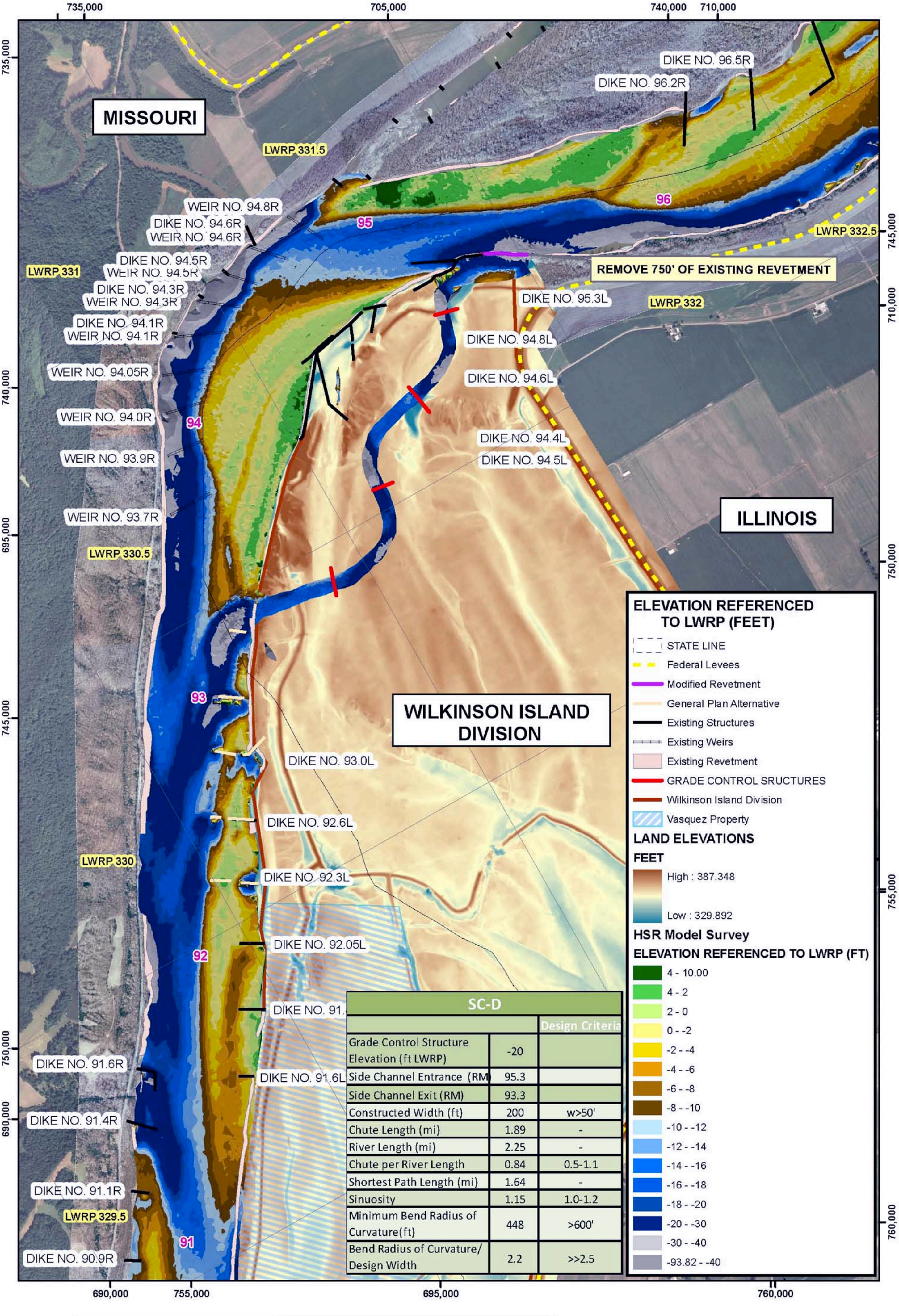

SC-D		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	-20	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	93.3	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.89	-
River Length (mi)	2.25	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.64	-
Sinuosity	1.15	1.0-1.2
Minimum Bend Radius of Curvature(ft)	448	>600'
Bend Radius of Curvature/ Design Width	2.2	>>2.5

PLATE NUMBER 34

0 375 750 1,500 2,250 3,000 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 SC-D, GRADE CONTROL STRUCTURE ELEVATION: -20 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.
AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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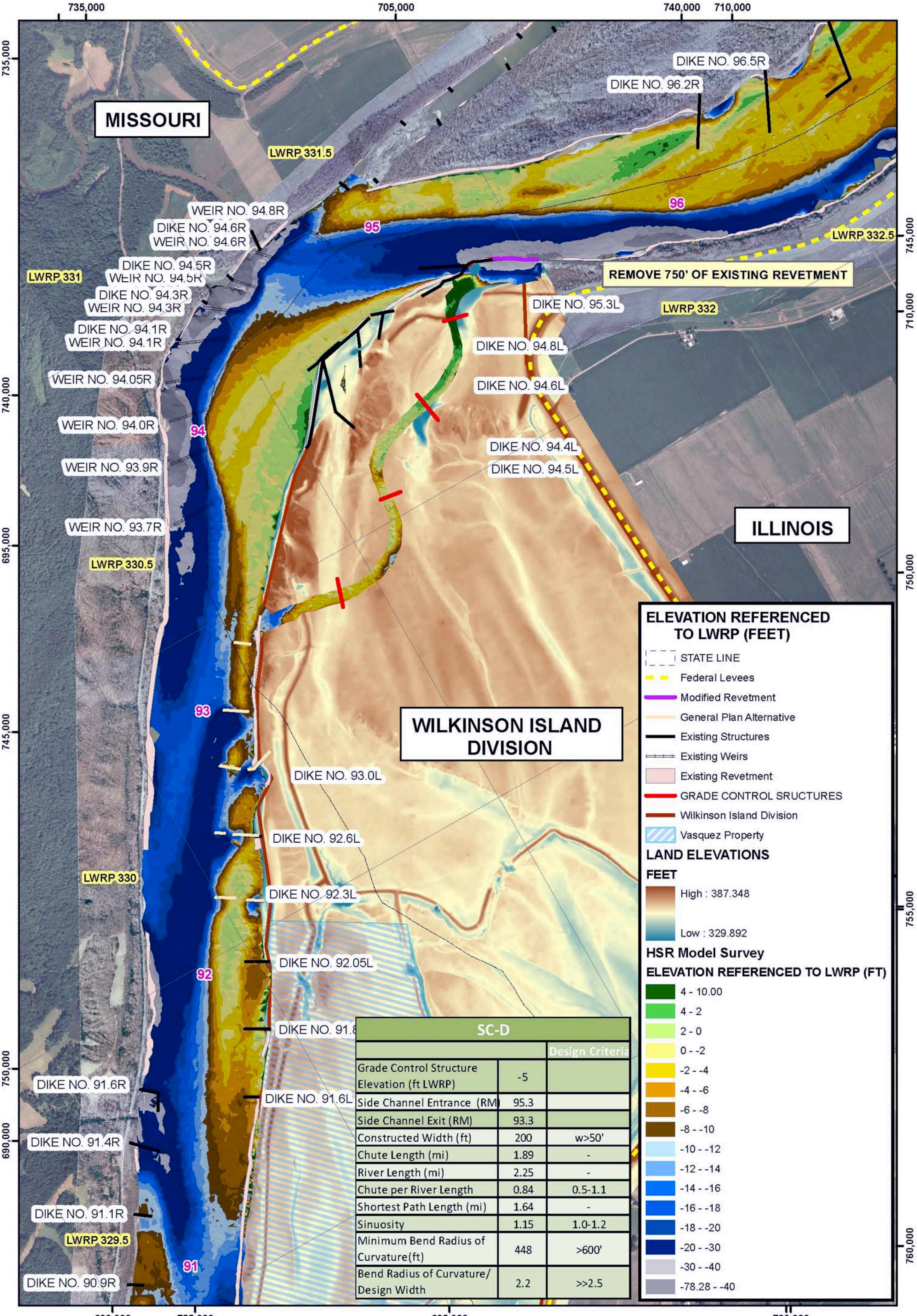

SC-D		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	-5	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	93.3	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.89	-
River Length (mi)	2.25	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.64	-
Sinuosity	1.15	1.0-1.2
Minimum Bend Radius of Curvature(ft)	448	>600'
Bend Radius of Curvature/ Design Width	2.2	>>2.5

PLATE NUMBER 35

0 375 750 1,500 2,250 3,000 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 SC-D, GRADE CONTROL STRUCTURE ELEVATION: -5 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.
AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\ SIDE_CHANNEL_ALTS_PLATES.MXD

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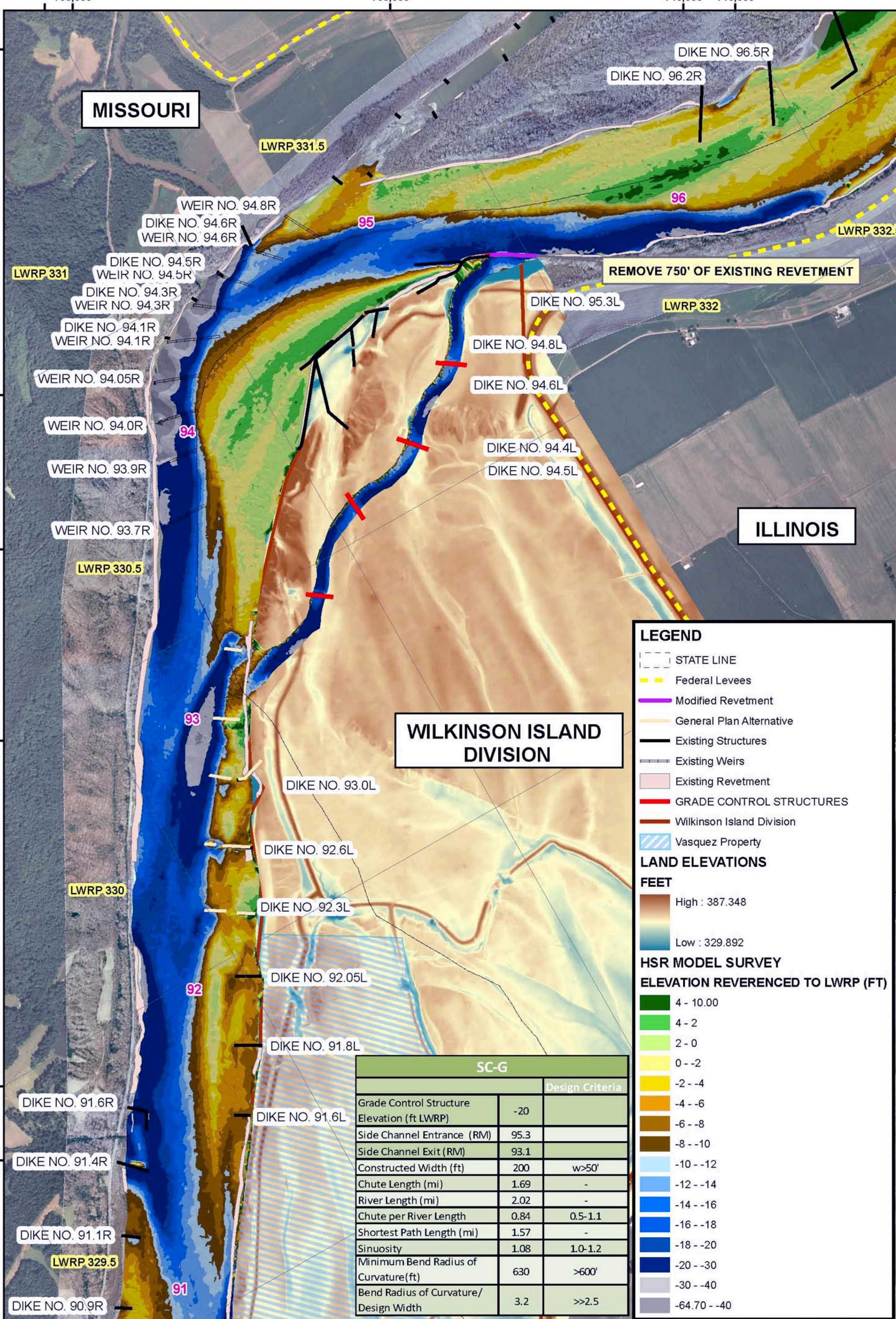

SC-G		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	-20	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	93.1	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.69	-
River Length (mi)	2.02	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.57	-
Sinuosity	1.08	1.0-1.2
Minimum Bend Radius of Curvature(ft)	630	>600'
Bend Radius of Curvature/ Design Width	3.2	>>2.5

PLATE NUMBER 36

0 375 750 1,500 2,250 3,000 Feet

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ALTERNATIVE SC-G, GRADE CONTROL STRUCTURE ELEVATION:-20 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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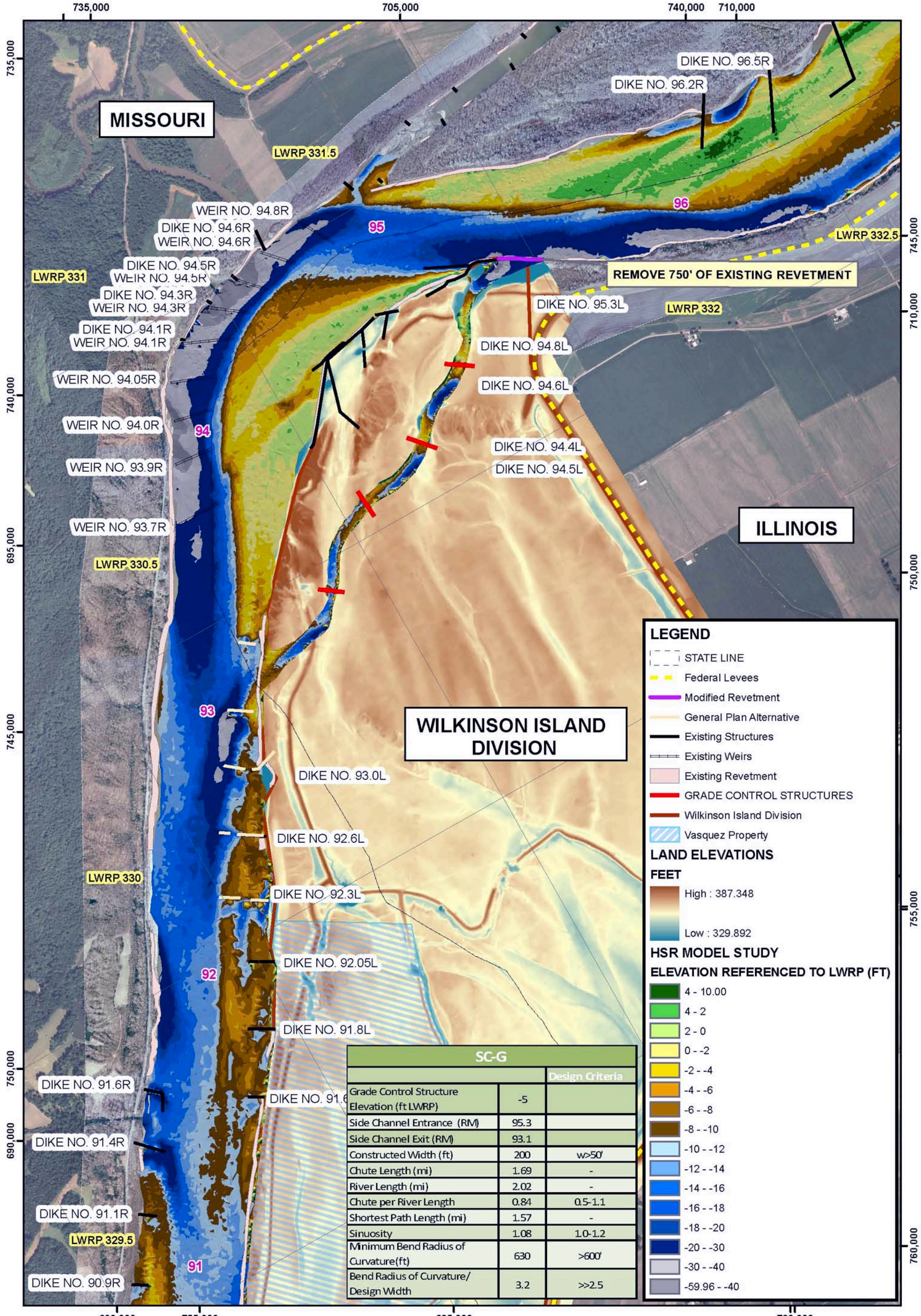

SC-G		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	-5	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	93.1	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.69	-
River Length (mi)	2.02	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.57	-
Sinuosity	1.08	1.0-1.2
Minimum Bend Radius of Curvature(ft)	630	>600'
Bend Radius of Curvature/ Design Width	3.2	>>2.5

PLATE NUMBER 37

0 375 750 1,500 2,250 3,000 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 SC-G, GRADE CONTROL STRUCTURE ELEVATION: -5 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
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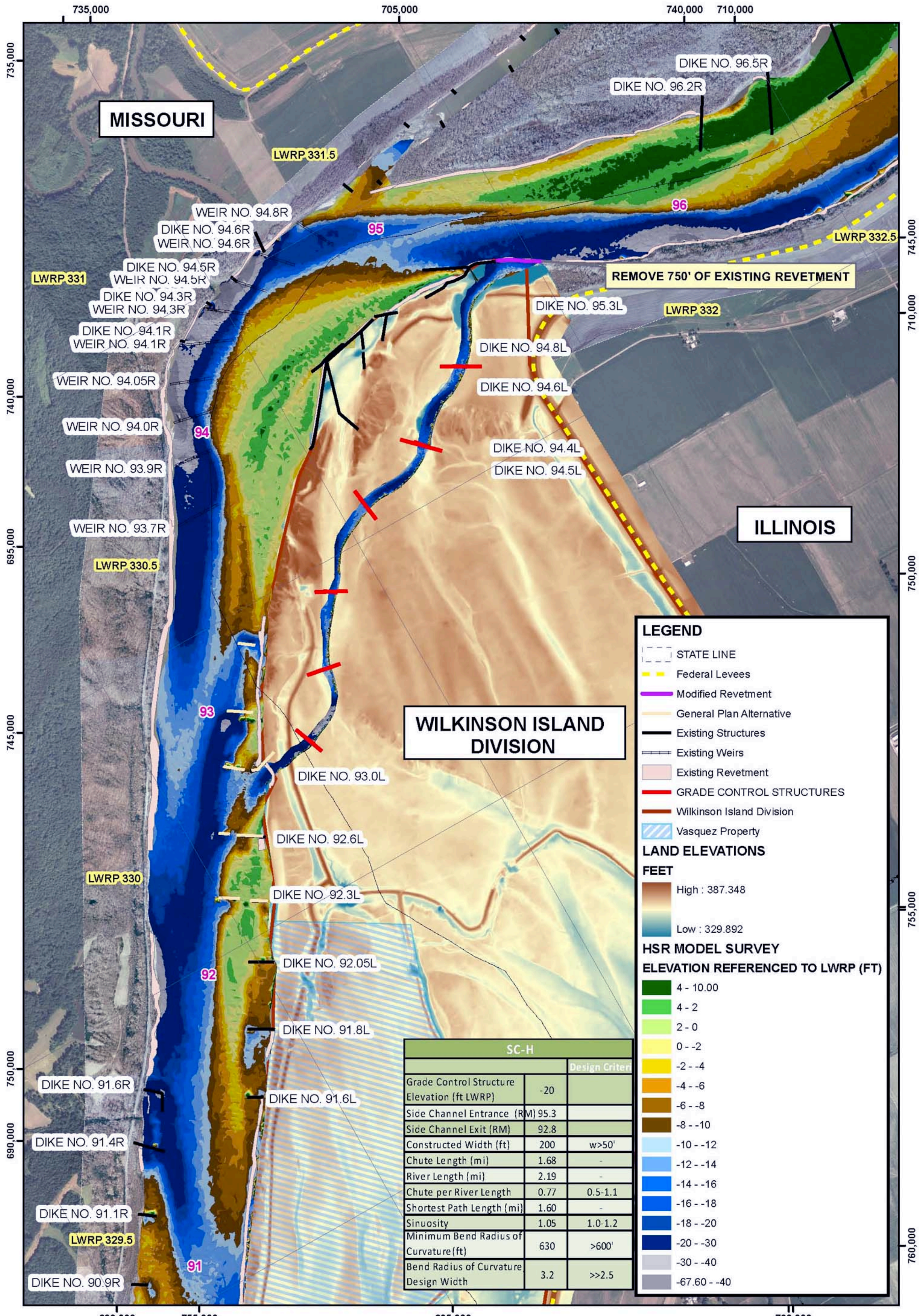

SC-H		
		Design Criteri
Grade Control Structure Elevation (ft LWRP)	-20	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	92.8	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.68	-
River Length (mi)	2.19	-
Chute per River Length	0.77	0.5-1.1
Shortest Path Length (mi)	1.60	-
Sinuosity	1.05	1.0-1.2
Minimum Bend Radius of Curvature (ft)	630	>600'
Bend Radius of Curvature Design Width	3.2	>>2.5

PLATE NUMBER 38

0 375 750 1,500 2,250 3,000 Feet

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ALTERNATIVE SC-H, GRADE CONTROL STRUCTURE ELEVATION:-20 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.

DRAWN BY: E. Rivera

CHECKED BY: R. Davinroy, P.E.

APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006

SUBMITTED: 07/28/2010

FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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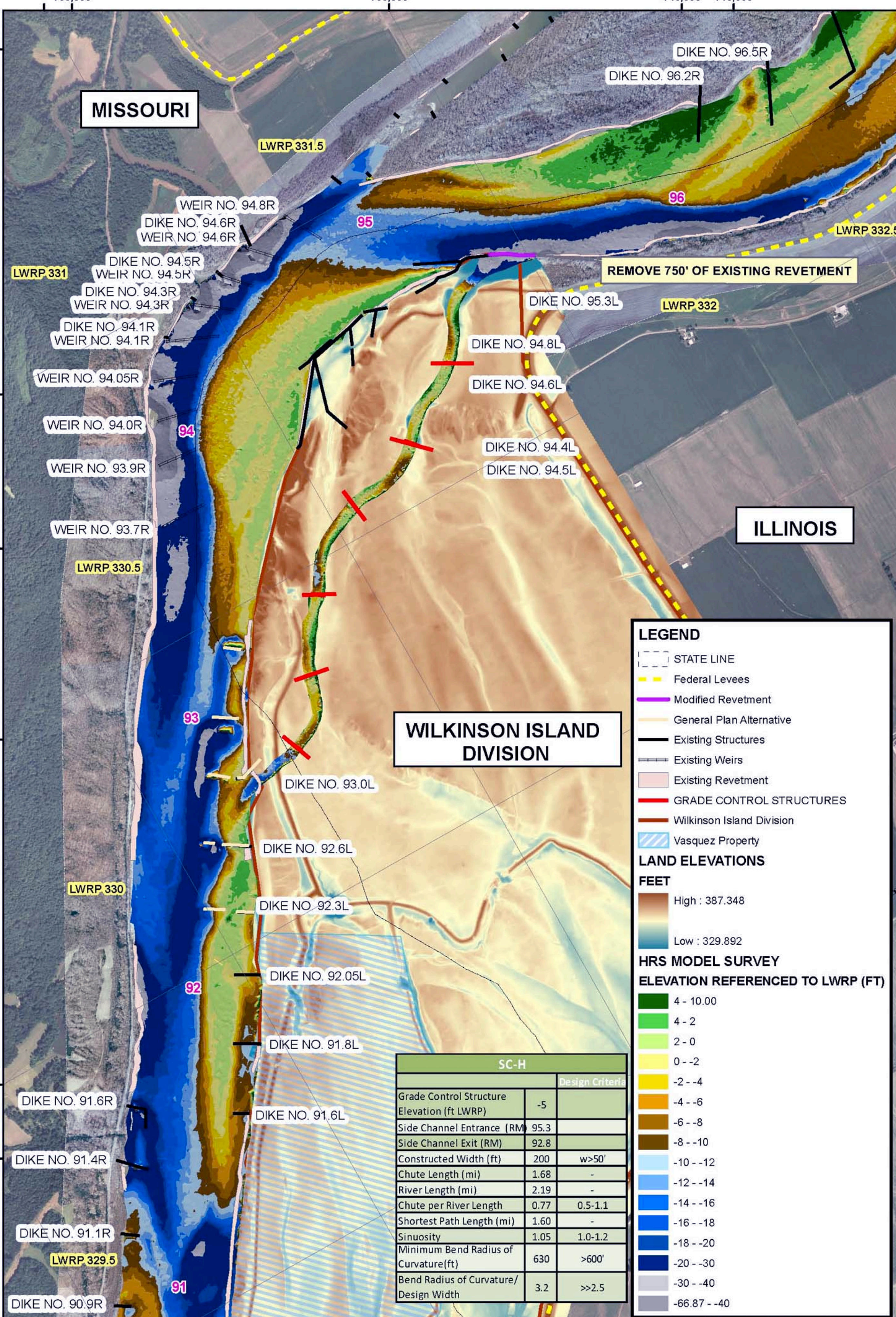

SC-H		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	-5	
Side Channel Entrance (RM)	95.3	
Side Channel Exit (RM)	92.8	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.68	-
River Length (mi)	2.19	-
Chute per River Length	0.77	0.5-1.1
Shortest Path Length (mi)	1.60	-
Sinuosity	1.05	1.0-1.2
Minimum Bend Radius of Curvature(ft)	630	>600'
Bend Radius of Curvature/ Design Width	3.2	>>2.5

PLATE NUMBER 39

0 375 750 1,500 2,250 3,000 Feet

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ALTERNATIVE SC-H, GRADE CONTROL STRUCTURE ELEVATION:-5 LWRP

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.
AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD

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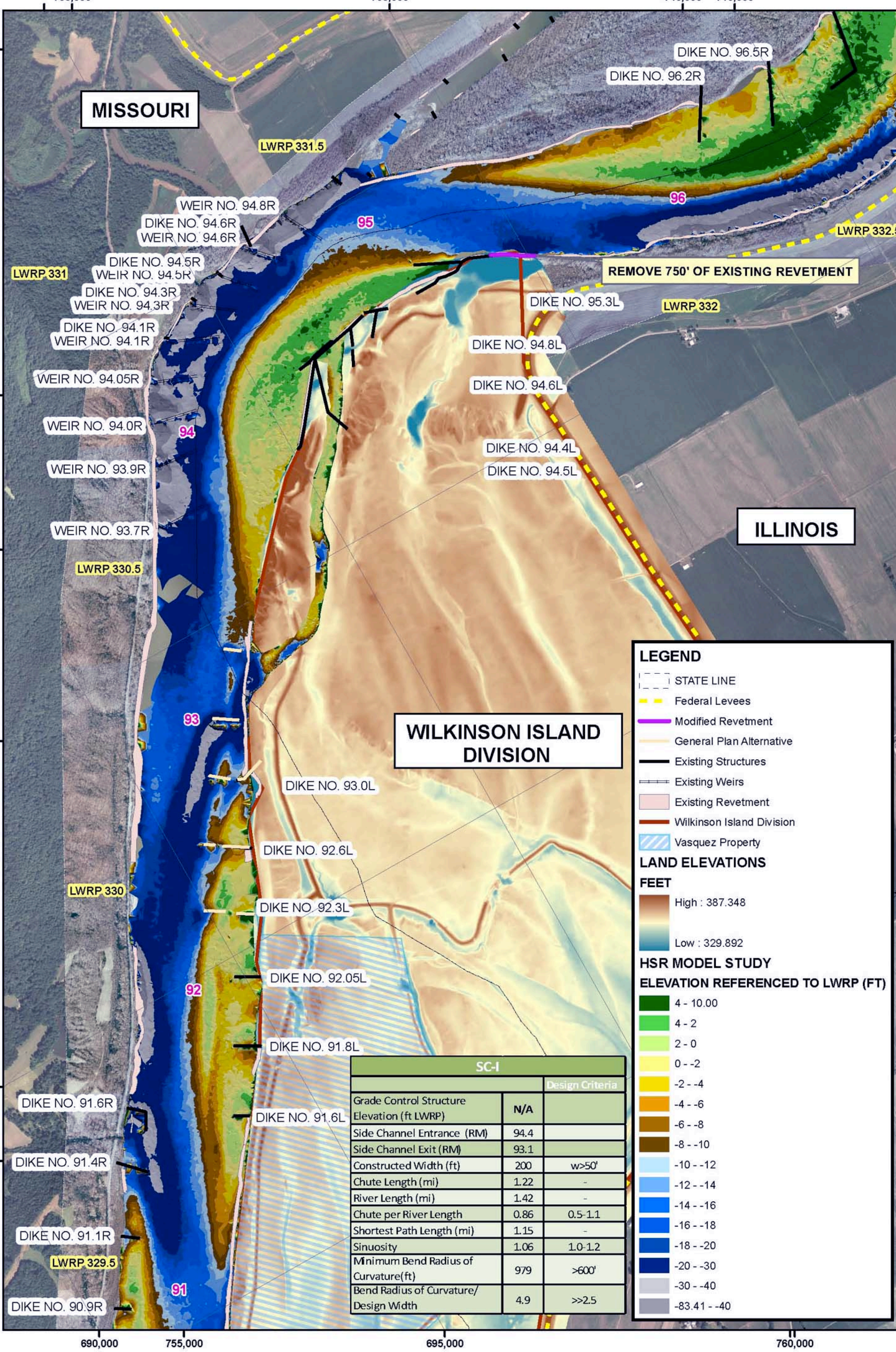

SC-I		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	N/A	
Side Channel Entrance (RM)	94.4	
Side Channel Exit (RM)	93.1	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.22	-
River Length (mi)	1.42	-
Chute per River Length	0.86	0.5-1.1
Shortest Path Length (mi)	1.15	-
Sinuosity	1.06	1.0-1.2
Minimum Bend Radius of Curvature(ft)	979	>600'
Bend Radius of Curvature/ Design Width	4.9	>>2.5

PLATE NUMBER 40

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 SC-I, NO GRADE CONTROL STRUCTURES

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
DRAWN BY: E. Rivera	SUBMITTED: 07/28/2010
CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
APPROVED: R. Davinroy, P.E.	

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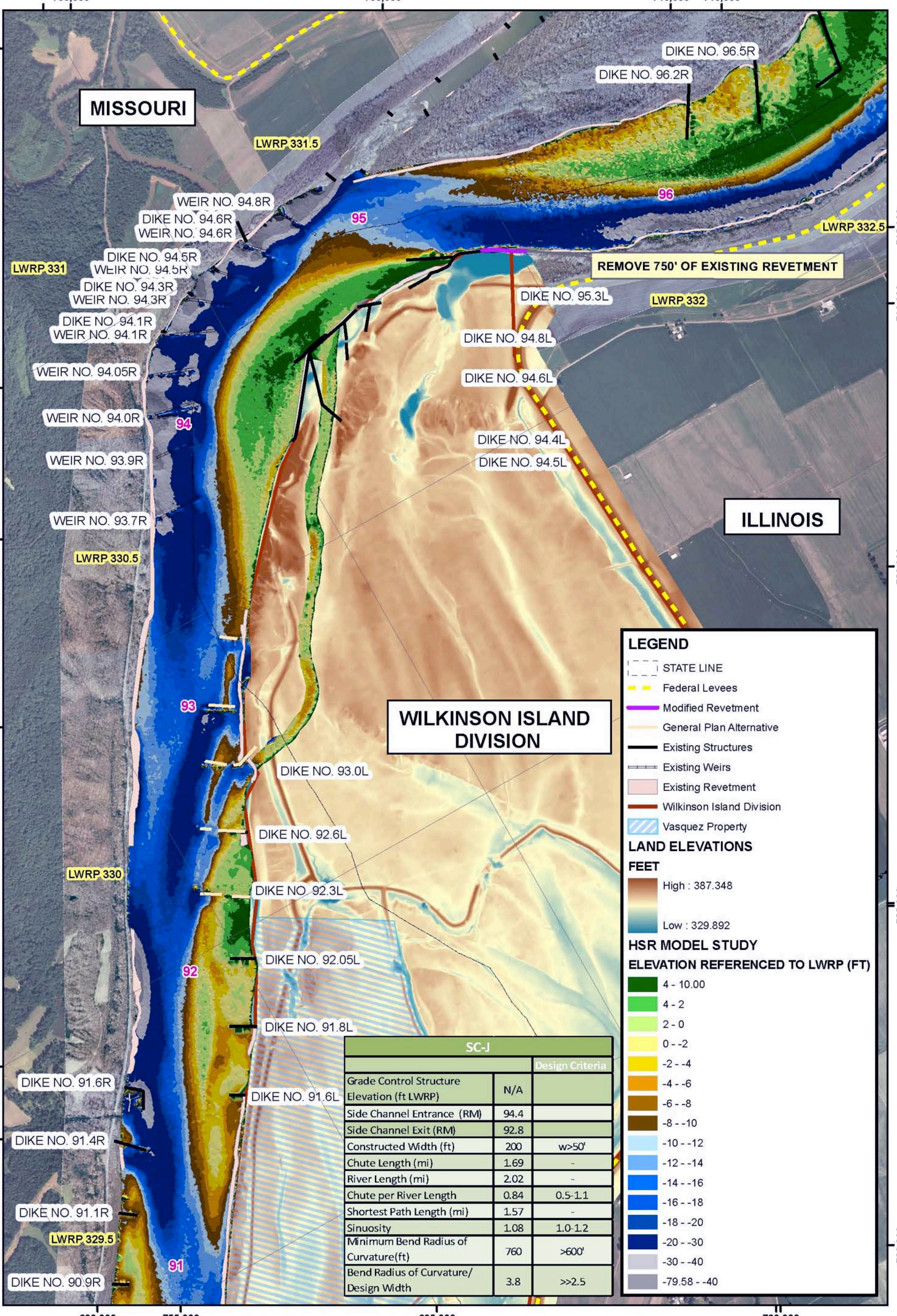

SC-J		
		Design Criteria
Grade Control Structure Elevation (ft LWRP)	N/A	
Side Channel Entrance (RM)	94.4	
Side Channel Exit (RM)	92.8	
Constructed Width (ft)	200	w>50'
Chute Length (mi)	1.69	-
River Length (mi)	2.02	-
Chute per River Length	0.84	0.5-1.1
Shortest Path Length (mi)	1.57	-
Sinuosity	1.08	1.0-1.2
Minimum Bend Radius of Curvature(ft)	760	>600'
Bend Radius of Curvature/ Design Width	3.8	>>2.5

PLATE NUMBER 41

0 375 750 1,500 2,250 3,000 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 SC-J, NO GRADE CONTROL STRUCTURES

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

UPPER MISSISSIPPI RIVER BASIN

WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
DRAWN BY: E. Rivera
CHECKED BY: R. Davinroy, P.E.
APPROVED: R. Davinroy, P.E.

AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
SUBMITTED: 07/28/2010
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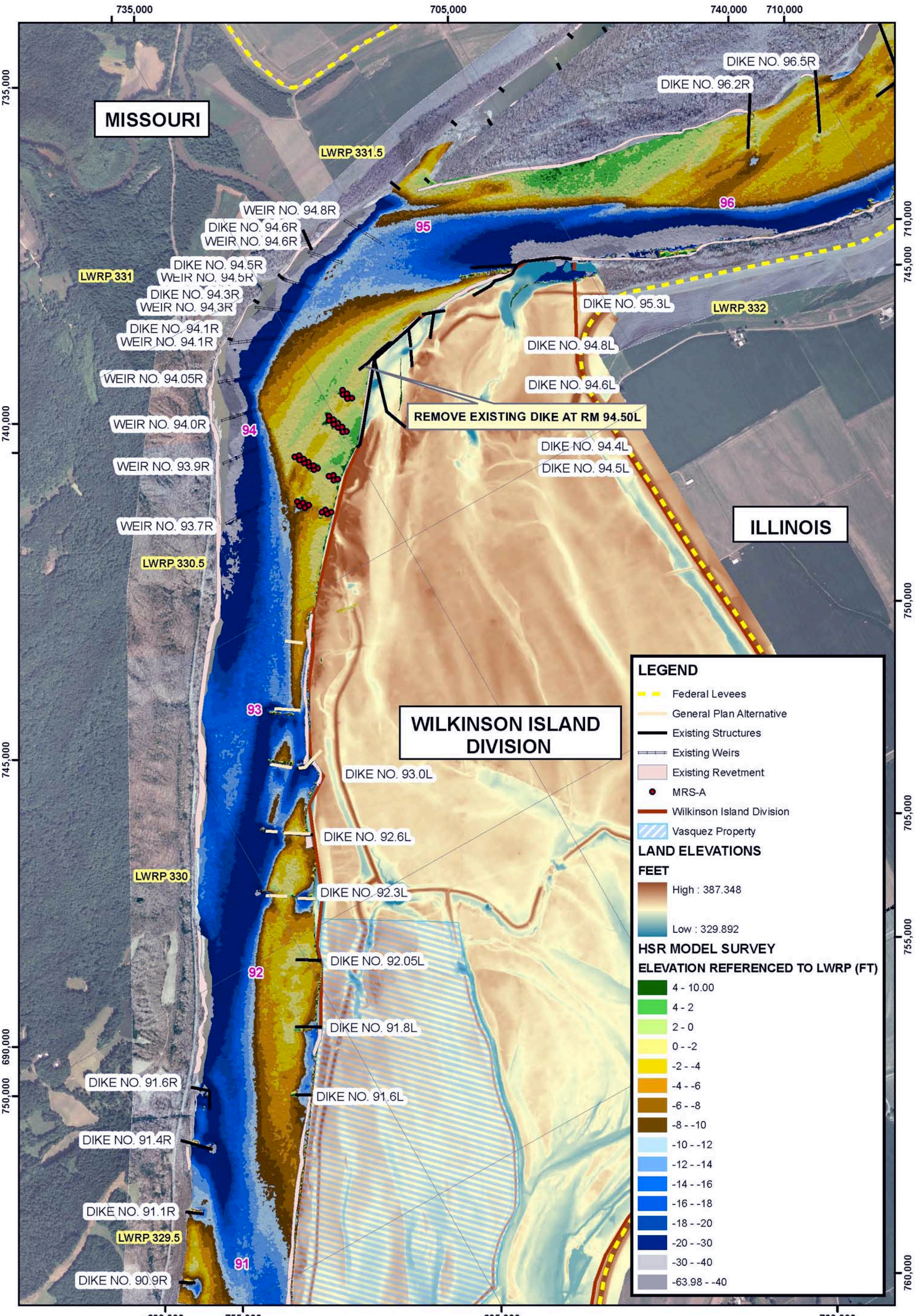

PLATE NUMBER 42

0 375 750 1,500 2,250 3,000 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

MRS-A

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DESIGNED BY: E. Brauer, P.E.	AERIAL PHOTOGRAPHS TAKEN: 8/22/2005 2/24/2006
	DRAWN BY: E. Rivera	SUBMITTED: 07/29/2010
UPPER MISSISSIPPI RIVER BASIN WILKINSON ISLAND HSR MODEL RIVER MILES 98.0-90.5	CHECKED BY: R. Davinroy, P.E.	FILE NAME: L:\WILKINSON-HSR MODEL\PLATES\SIDE_CHANNEL_ALTS_PLATES.MXD
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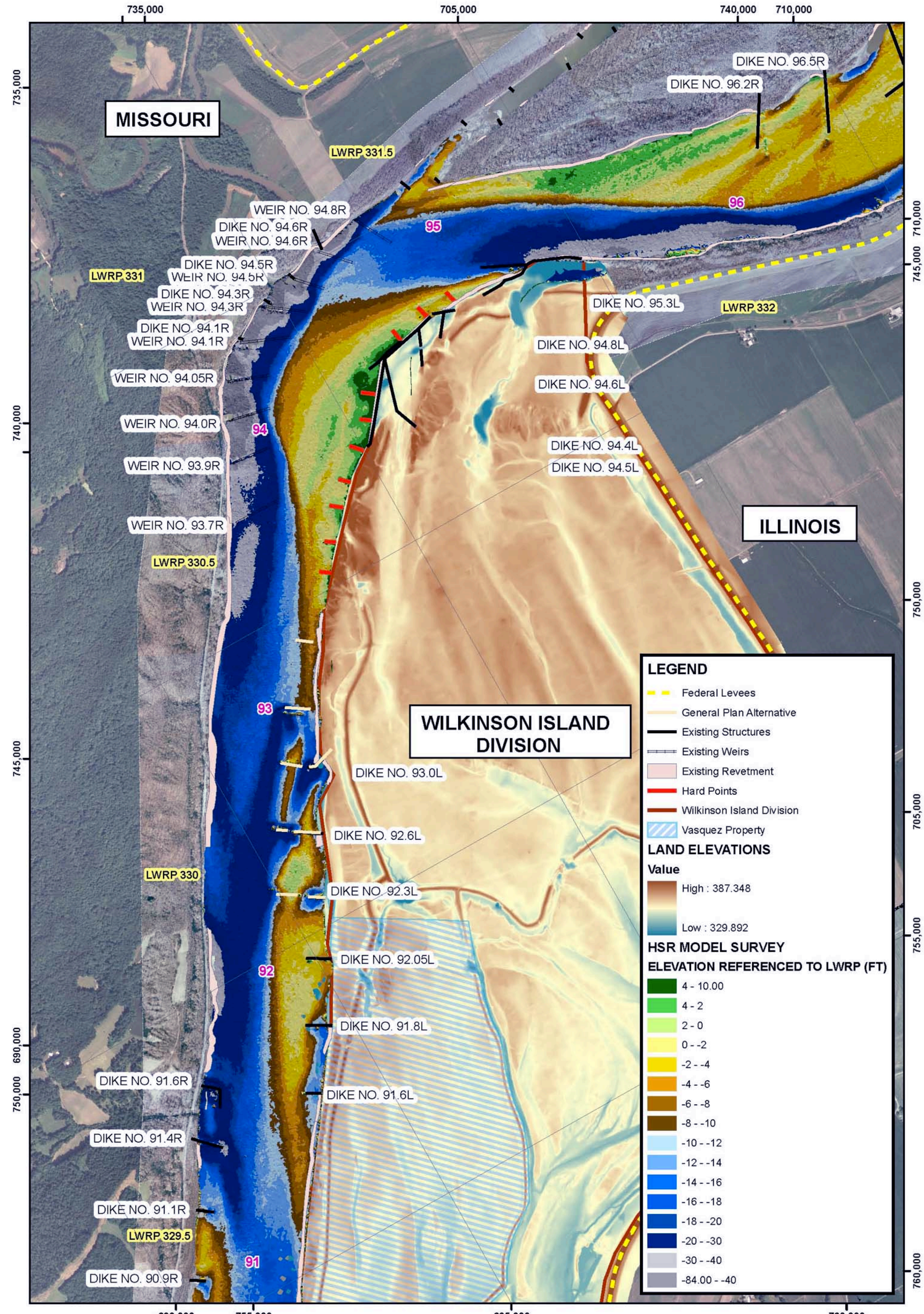

PLATE NUMBER 43

0 375 750 1,500 2,250 3,000 Feet

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HP-A

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

UPPER MISSISSIPPI RIVER BASIN
WILKINSON ISLAND HSR MODEL
RIVER MILES 98.0-90.5

DESIGNED BY: E. Brauer, P.E.
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