Technical Report M44

STE GENEVIEVE
RIVER MILES 123 - 129

HYDRAULIC SEDIMENT RESPONSE
MODEL INVESTIGATION

By
Peter M. Russell, P.E.
Jasen L. Brown, P.E.
Edward J. Brauer
Robert D. Davinroy, P.E.

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

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INTRODUCTION

The U.S. Army Corps of Engineers, St. Louis District, conducted a sedimentation improvement study of the Upper Mississippi River between Miles 129 and 123 near Ste Genevieve, Missouri. The purpose of the study was to evaluate design alternatives with a goal of alleviating repetitive channel maintenance dredging.

The study was conducted between November 2008 and March 2009 using a physical hydraulic sediment response (HSR) model. Mr. Peter Russell, P.E., Hydraulic Engineer, performed the model study under direct supervision of Mr. Robert Davinroy, Chief, River Engineering for the St. Louis District.

Corps of Engineers personnel involved with the study include:

Jasen Brown P.E.,	Hydraulic engineer.
Eddie Brauer,	Hydraulic Engineer.
Lance Engle,	Dredging Project Manager.
Leonard Hopkins P.E.,	Chief of the Hydrologic and Hydraulics Branch.
Dave Gordon P.E.,	Chief of the Hydraulic Design Branch.
Brian Johnson,	Fishery Biologist.
Charlie Hanneken,	Ecologist.

Also involved in the study include:

Butch Atwood,	Illinois Department of Natural Resources.
Nate Caswell,	U.S. Fish and Wildlife Service.
Matt Mangan,	U.S. Fish and Wildlife Service.
Mark Boone,	Missouri Department of Conservation.

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BACKGROUND

1. Problem Description

Sediment deposition in the navigation channel between Middle Mississippi River Miles 127 and 124 caused repetitive channel maintenance dredging.

Repetitive dredging occured where the river thalweg crosses from the right descending bank at river mile 127 to the left descending bank at river mile 125. Between river mile 128-125 there were six ports, several fleeting areas and a ferry crossing. The ports, fleeting, and ferry located in the thalweg crossing must be considered when placing river training structures. This is especially true where the most dredging occured, at river mile 125.5. At mile 125.5 there was a port on both sides of the river and a ferry landing on both sides of the river (see plate 3).

2. Study Purpose and Goals

The purpose of the HSR model study was to evaluate different design alternatives with a goal of alleviating repetitive channel maintenance dredging.

3. Study Reach

The study comprised a 6-mile stretch of the Middle Mississippi River, between Miles 129 and 123 near Ste Genevieve, MO. Plate 1 shows a location and vicinity map of the study reach. There are six ports, several fleeting areas, and a ferry crossing located in the study reach that must be considered when evaluating design alternatives.

4. Study Reach Bathymetric Characteristics and General Trends

Present and historic bathymetric surveys of the Mississippi River, in the HSR Model study area, are shown on Plates S1 – S7. (The plates show both the river survey and the model survey for comparison.)

Comparison of the river's hydrographic surveys revealed the following trends have remained relatively constant:

River Miles	Description
129 - 128.5	The thalweg was located on the right descending bank with depths between -20 and -40 LWRP.
128.5 – 127.5	The thalweg was located on the right descending bank with depths between -10 and -20 LWRP.
127.5 – 125.5	There was not an apparent thalweg. Depths range between -10 and -20 LWRP. Near mile 127 a relatively small bar developed on the right descending bank. Repetitive channel dredging has occurred between mile 127 and 126.
125.5 - 125	The thalweg crossed to the left descending bank. A bar developed in the crossing that requires repetitive channel dredging.
125 – 123.5	The thalweg was located on the left descending bank with depths between -10 and -20 LWRP with localized scour off the dike tips reaching depths up to -40 LWRP.

HSR MODEL DESCRIPTION

A photo of the Ste Genevieve Hydraulic Sediment Response (HSR) model is shown on plate 2. The model encompassed Mississippi River miles 129 – 123. After entrance and exit conditions in the model were accounted for, the actual study reach was located between Mississippi River miles 127 – 124.

1. Scales and Bed Materials

The model employed a horizontal scale of 1 inch = 500 feet, or 1:6000, and a vertical scale of 1 inch = 60 feet, or 1:720, for a 8.3 to 1 distortion ratio of linear scales. This distortion supplied the necessary forces required for the simulation of sediment transport conditions similar to those observed in 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 using 2006 high-resolution aerial photography of the study reach. The insert was mounted on a standard HSR model flume. The riverbanks of the model were constructed from dense polystyrene foam, and modified during calibration with clay and galvanized steel mesh. Rotational jacks located within the hydraulic flume controlled the slope of the model. The measured slope of the insert and flume was approximately 0.009 inch/inch. River training structures in the model were made of galvanized steel mesh.

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

HSR MODEL TESTS

1. Model Calibration

The calibration of the 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 river.

HSR Model Operation

In all model tests, steady state flow was simulated in the channel. This served as the average design energy response of the river. Because of the constant variation experienced in the prototype, this steady state flow was used to theoretically analyze the ultimate expected sediment response. The flow was held steady at a constant flow rate of 1.51 gallons per minute for all design alternatives tested. An important factor during the modeling process was 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 bank full stage.

2. Base Test

Model calibration was achieved after several favorable qualitative comparisons between the river's and the model's bathymetric surveys. Plates S1 – S7 show the resultant bed configuration of the HSR model base test compared to the river.

Bathymetric surveys are a snapshot of the river bed elevation, which constantly changes due to the many variables involved with sediment transport. The trends in the river and the model, described on page 5, remained constant.

After every alternative test, the model was ran at base conditions and resurveyed. Therefore, every alternative has its own unique base test, which are shown on the A-series plates.

3. Design Alternative Tests

The model testing process consists of installing alternative structure configurations in an attempt to alter the bathymetry and velocity distribution. Alternatives were evaluated through a qualitative comparison to the model base test bathymetry.

Alternative 1:

See Plates A1 and C1

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	125.8	L	300 x 350	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellog Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 2:

See Plates A2 and C2

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	126.1	L	300 x 250	368
Construct Chevron	125.8	L	300 x 250	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellog Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 3:

See Plates A3 and C3

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.2	R	430	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 4:

See Plates A4 and C4

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.2	R	430	368
Construct Chevron	125.9	L	300x400	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 5:

See Plates A5 and C5

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	126.5	L	175x175	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 6:

See Plates A6 and C6

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	126.5	L	175x175	368
Construct Chevron	126.4	L	175x175	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 7:

See Plates A7 and C7

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	126.5	L	175x175	368
Construct Chevron	126.4	L	175x175	368
Construct Chevron	126.2	L	175x175	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 8:

See Plates A8 and C8

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	125.9	L	750	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 9:

See Plates A9 and C9

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Notched Dike	125.9	L	800 Total 200 Notch	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 10:

See Plates A10 and C10

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Notch Existing Dike	126.6	L	230	358
Construct Notched Dike	125.9	L	800 Total 200 Notch	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4		x	
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 11:

See Plates A11 and C11

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Notch Existing Dike	126.6	L	180	358
Construct Chevron	126.35	L	220x240	368
Construct Notched Dike	125.9	L	800 Total 200 Notch	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4		x	
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 12:

See Plates A12 and C12

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Notch Existing Dike	126.6	L	180	358
Construct Chevron	126.4	L	220x240	368
Construct Chevron	126.3	L	220x240	368
Construct Notched Dike	125.9	L	800 Total 200 Notch	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 13:

See Plates A13 and C13

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.4	L	720	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 14:

See Plates A14 and C14

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.4	L	720	368
Construct Chevron	126	L	200x240	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 15:

See Plates A15 and C15

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.3	L	650	368
Construct Dike	126	L	600	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 16:

See Plates A16 and C16

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.3	L	650	368
Construct Dike	126	L	600	368
Construct Dike	125.8	L	600	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 17:

See Plates A17 and C17

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.1	R	150	368
Construct Dike	126	R	150	368
Construct Dike	125.8	R	230	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 18:

See Plates A18 and C18

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.6	R	150	368
Construct Dike	126.5	R	150	368
Construct Dike	126.4	R	250	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 19:

See Plates A19 and C19

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	125.4	R	200x240	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 20:

See Plates A20 and C20

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Chevron	125.8	R	200x240	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x	x	
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 21:

See Plates A21 and C21

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	125.3	R	520	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R	x		
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 22:

See Plates A22 and C22

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.3	R	200	368
Construct Dike	126	R	220	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 23:

See Plates A23 and C23

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.5	R	250	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3			x
Mississippi Lime Port	125.3 R		x	
Ferry Landing	125.3R		x	
Kellogg Port	125.3L	x		
Ferry Landing	125.3L	x		

Alternative 24:

See Plates A24 and C24

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Extend Existing Dike	126.6	L	320	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3			x
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 25:

See Plates A25 and C25

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Extend Existing Dike	125.3	R	480	368
Extend Existing Dike	126.6	L	320	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 26:

See Plates A26 and C26

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Extend Existing Dike	126.6	L	320	368
Construct Dike	126.2	L	680	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 27:

See Plates A27 and C27

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126	L	750	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 28:

See Plates A28 and C28

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	125.7	L	400	368
Extend Existing Dike	125.2	L	300	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 29:

See Plates A29 and C29

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Extend Existing Dike	126.6	L	280	368
Construct Dike	126.3	L	800	368
Extend Existing Dike	125.9	L	730	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 30:

See Plates A30 and C30

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Extend Existing Dike	126.6	L	280	368
Construct Dike	126.3	L	800	368
Construct Dike	125.9	L	730	368
Extend Existing Dike	125.3	R	600	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4	x		
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R	x		
Ferry Landing	125.3R	x		
Kellogg Port	125.3L		x	
Ferry Landing	125.3L	x		

Alternative 31:

See Plates A31 and C31

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.3	L	575 with 325 wing	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 32:

See Plates A32 and C32

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.25	L	600	368
Construct Dike	125.9	L	400	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 33:

See Plates A33 and C33

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.5	L	430 with 375 wing	368
Construct Dike	126.3	L	375	368
Construct Dike	125.9	L	250	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3	x		
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 34:

See Plates A34 and C34

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Construct Dike	126.3	L	350	368
Construct Dike	126	L	200	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3			x
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L		x	
Ferry Landing	125.3L		x	

Alternative 35:

See Plates A35 and C35

Structure Modifications	Location (River Mile)	(L) Left Descending Bank (R) Right Descending Bank	Dimensions (Feet)	Elevation (Feet)
Shorten Existing Dike	124.9	L	-250	368

Bathymetry Change

Site	River Mile	Degradation	Aggradation	No Change
Mississippi River Channel	126.4			x
Mississippi River Channel	125.3			x
Mississippi Lime Port	125.3 R			x
Ferry Landing	125.3R			x
Kellogg Port	125.3L			x
Ferry Landing	125.3L			x

CONCLUSIONS

1. Evaluation and Summary of the Model Tests

Alternative	Degradation		Aggradation			
	River Channel RM 126.4	River Channel RM 125.3	Mississippi Lime Port RM 125.3R	Ferry Landing RM 125.3 R	Kellogg Port RM 125.3L	Ferry Landing RM 125.3L
1		x			x	x
2		x			x	x
3		x	x	x		
4		x	x	x	x	
5		x			x	
6		x			x	
7	x	x			x	x
8		x			x	x
9		x			x	x
10		x			x	x
11		x			x	x
12		x			x	x
13	x	x			x	
14	x	x			x	x
15	x	x			x	x
16		x	x	x	x	x
17		x	x	x		
18	x	x	x	x		
19		x				
20		x	x			
21		x	x			
22		x	x	x		
23	x		x	x		
24	x				x	
25	x	x			x	
26	x	x			x	x
27		x			x	x
28		x			x	x
29	x	x			x	
30	x	x			x	
31		x				x
32		x			x	x
33					x	x
34					x	x
35						

The table above summarizes the change in bathymetry after every alternative was tested. Degradation is a lowering in elevation of the river bed and is the desired result in the river channel at RM 126.4 and RM125.3. Aggradation is the raising in elevation of the river bed and, in this case, is an unwelcome consequence of degradation (see figure 1). Although alternatives 19 and 35 do not show any aggradation of the ports or ferry crossing, they are not practical solutions. Alternative 19 is not a feasible alternative because of the restriction it would place on river navigation. Alternative 35 was downstream of the dredging area and will not alleviate the repetitive maintenance dredging that occurred in the study area.

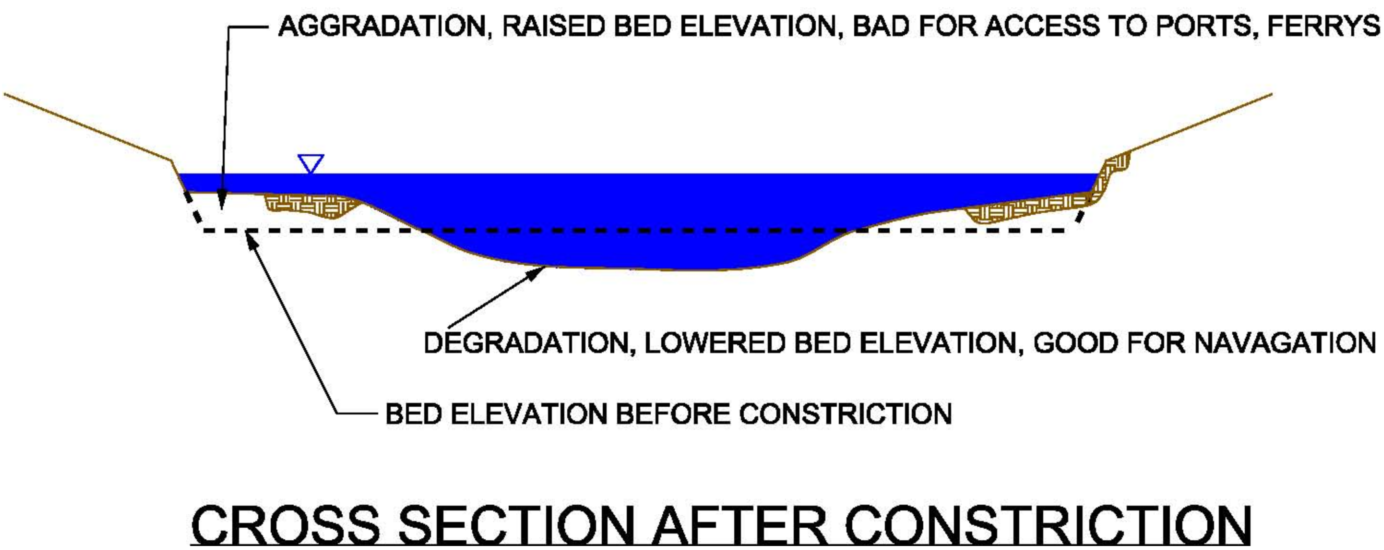

Figure 1.
A simplified cross section of the river bed before and after constriction.

2. Recommendations

Several alternatives will help alleviate the repetitive maintenance dredging at River Mile 126.4 and 125.3. But most alternatives that degraded the river bed in the dredging areas caused aggradation in the ports located in the area. Alternatives that caused aggradation in the ports were considered unsuccessful.

Alternative 34 is the recommended alternative (see plates A34 and C34). Alternative 34 included the construction of two dikes on the left descending bank at river mile 126.3 and 126.0 with lengths of 350 and 200 feet respectively. The dikes probably will not eliminate the need for channel maintenance dredging but should help. After construction, monitoring of the bathymetry is recommended. If aggradation does not occur in Kellogg port or the ferry landing, extending the dikes even further is recommended, see alternative 15 (plates A15 and C15). Alternative 15 will significantly reduce and may even eliminate the need for channel maintenance dredging.

3. Interpretation of Model Test Results

Interpretation of A - Series Plates:

"A – series" plates show the model's bathymetry before and after each alternative test. The model was run at base conditions and the bathymetry (alternative base test) was scanned (surveyed) before testing each alternative. Every base test is unique.

Interpretation of C – Series Plates:

"C – series" plates visually show the change in bathymetry between the alternative base test and the alternative. The blue colors show were degradation (scour) occurred after the alternative was tested. The red colors show aggradation (deposition) occurred after the alternative was tested.

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 (river). 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 Hydraulic Sediment Response modeling or the Applied River Engineering Center, please contact Robert Davinroy or Peter Russell 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) 865-6326
Fax: (314) 865-6352

E-mail:
Robert.D.Davinroy@usace.army.mil
Peter.M.Russell@usace.army.mil

Or you can visit us on the World Wide Web at:
http://www.mvs.usace.army.mil/eng-con/expertise/arec/welcome_page_2.html

APPENDIX OF PLATES

1	Location and Vicinity Map
2	Model Flume and Insert Picture
3	Considerations
S1	2007 Bathymetric Survey
S2	2005 Bathymetric Survey
S3	2001 Bathymetric Survey
S4	1987 Bathymetric Survey
S5	1982-83 Bathymetric Survey
S6	1976-77 Bathymetric Survey
S7	1968-71 Bathymetric Survey
A1	Alternative 1 Bathymetry
C1	Alternative 1 Bathymetry Comparison
A2	Alternative 2 Bathymetry
C2	Alternative 2 Bathymetry Comparison
A3	Alternative 3 Bathymetry
C3	Alternative 3 Bathymetry Comparison
A4	Alternative 4 Bathymetry
C4	Alternative 4 Bathymetry Comparison
A5	Alternative 5 Bathymetry
C5	Alternative 5 Bathymetry Comparison
A6	Alternative 6 Bathymetry
C6	Alternative 6 Bathymetry Comparison
A7	Alternative 7 Bathymetry
C7	Alternative 7 Bathymetry Comparison
A8	Alternative 8 Bathymetry
C8	Alternative 8 Bathymetry Comparison
A9	Alternative 9 Bathymetry
C9	Alternative 9 Bathymetry Comparison
A10	Alternative 10 Bathymetry

C10 Alternative 10 Bathymetry Comparison

A10 Alternative 10 Bathymetry

C10 Alternative 10 Bathymetry Comparison

A11 Alternative 11 Bathymetry

C11 Alternative 11 Bathymetry Comparison

A12 Alternative 12 Bathymetry

C12 Alternative 12 Bathymetry Comparison

A13 Alternative 13 Bathymetry

C13 Alternative 13 Bathymetry Comparison

A14 Alternative 14 Bathymetry

C14 Alternative 14 Bathymetry Comparison

A15 Alternative 15 Bathymetry

C15 Alternative 15 Bathymetry Comparison

A16 Alternative 16 Bathymetry

C16 Alternative 16 Bathymetry Comparison

A17 Alternative 17 Bathymetry

C17 Alternative 17 Bathymetry Comparison

A18 Alternative 18 Bathymetry

C18 Alternative 18 Bathymetry Comparison

A19 Alternative 19 Bathymetry

C19 Alternative 19 Bathymetry Comparison

A20 Alternative 20 Bathymetry

C20 Alternative 20 Bathymetry Comparison

A21 Alternative 21 Bathymetry

C21 Alternative 21 Bathymetry Comparison

A22 Alternative 22 Bathymetry

C22 Alternative 22 Bathymetry Comparison

A23 Alternative 23 Bathymetry

C23 Alternative 23 Bathymetry Comparison

A24 Alternative 24 Bathymetry

C24 Alternative 24 Bathymetry Comparison

A25 Alternative 25 Bathymetry
C25 Alternative 25 Bathymetry Comparison
A26 Alternative 26 Bathymetry
C26 Alternative 26 Bathymetry Comparison
A27 Alternative 27 Bathymetry
C27 Alternative 27 Bathymetry Comparison
A28 Alternative 28 Bathymetry
C28 Alternative 28 Bathymetry Comparison
A29 Alternative 29 Bathymetry
C29 Alternative 29 Bathymetry Comparison
A30 Alternative 30 Bathymetry
C30 Alternative 30 Bathymetry Comparison
A31 Alternative 31 Bathymetry
C31 Alternative 31 Bathymetry Comparison
A32 Alternative 32 Bathymetry
C32 Alternative 32 Bathymetry Comparison
A33 Alternative 33 Bathymetry
C33 Alternative 33 Bathymetry Comparison
A34 Alternative 34 Bathymetry
C34 Alternative 34 Bathymetry Comparison
A35 Alternative 35 Bathymetry
C35 Alternative 35 Bathymetry Comparison

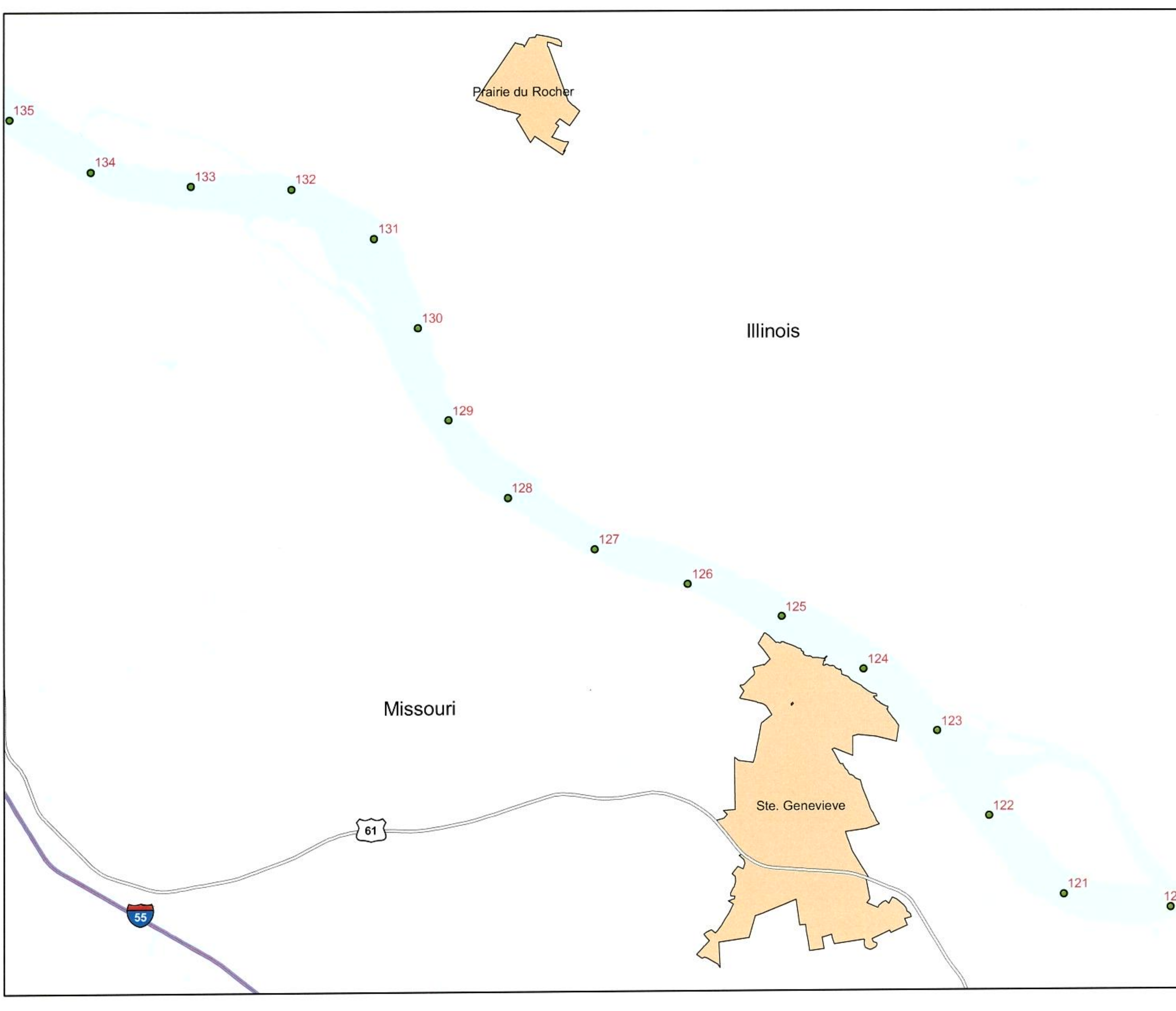

PLATE NUMBER 1

Location and Vicinity Map

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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P. Russell, P.E.
CHECKED BY:
J. Brown, P.E.

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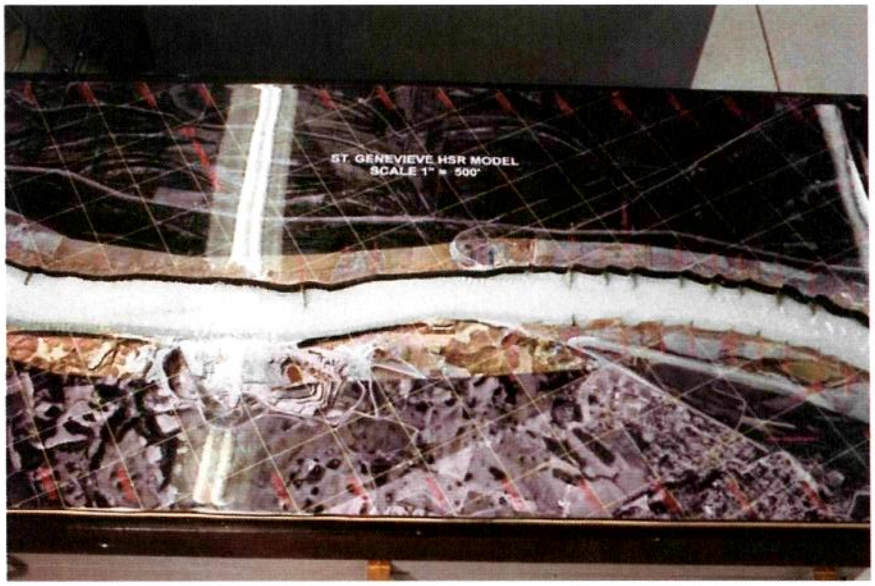

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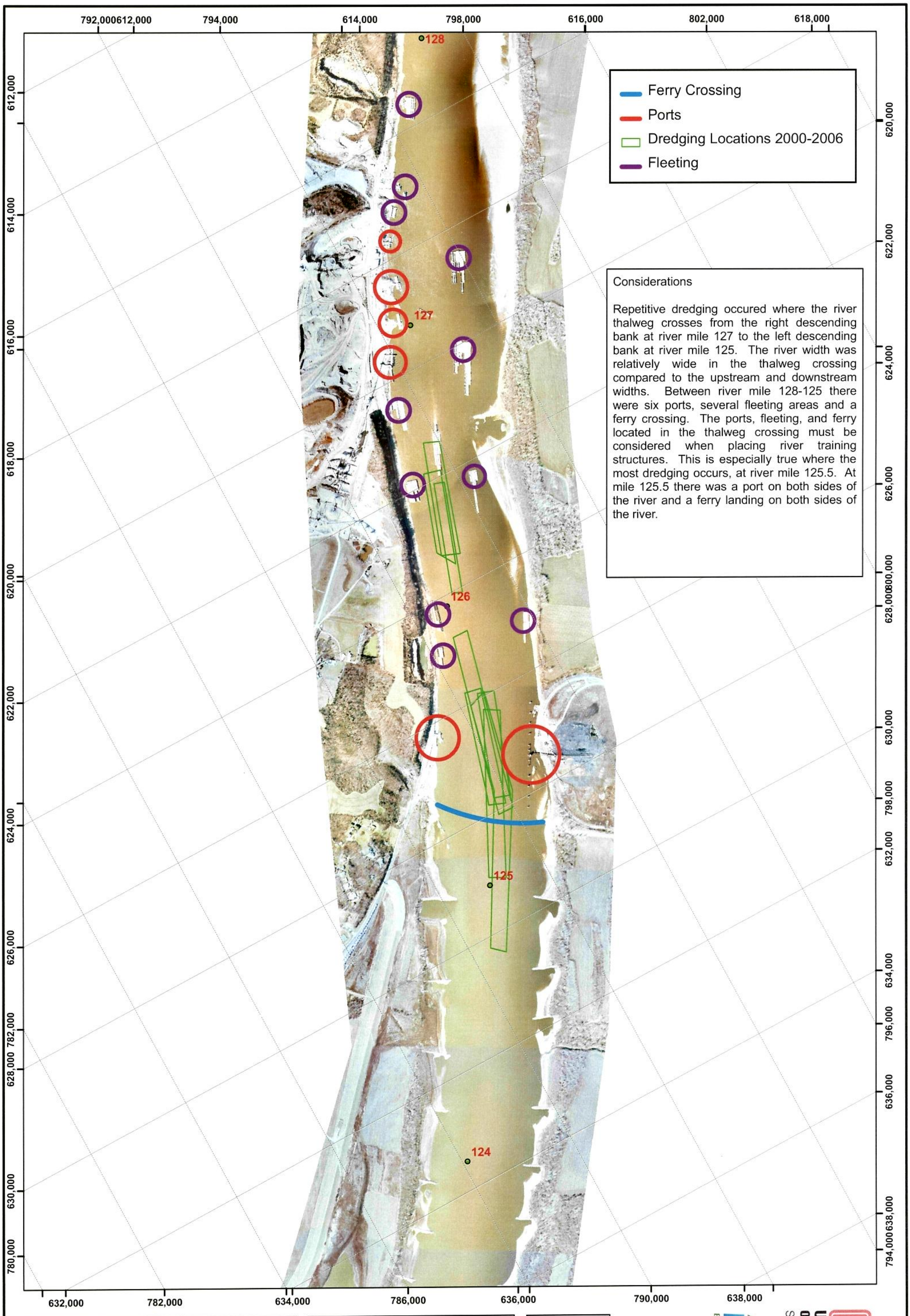
Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

Model Flume and Insert

PLATE
NUMBER
2



Considerations

Repetitive dredging occured where the river thalweg crosses from the right descending bank at river mile 127 to the left descending bank at river mile 125. The river width was relatively wide in the thalweg crossing compared to the upstream and downstream widths. Between river mile 128-125 there were six ports, several fleeting areas and a ferry crossing. The ports, fleeting, and ferry located in the thalweg crossing must be considered when placing river training structures. This is especially true where the most dredging occurs, at river mile 125.5. At mile 125.5 there was a port on both sides of the river and a ferry landing on both sides of the river.

PLATE NUMBER 3

0 500 1,000 2,000 Feet

Considerations

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Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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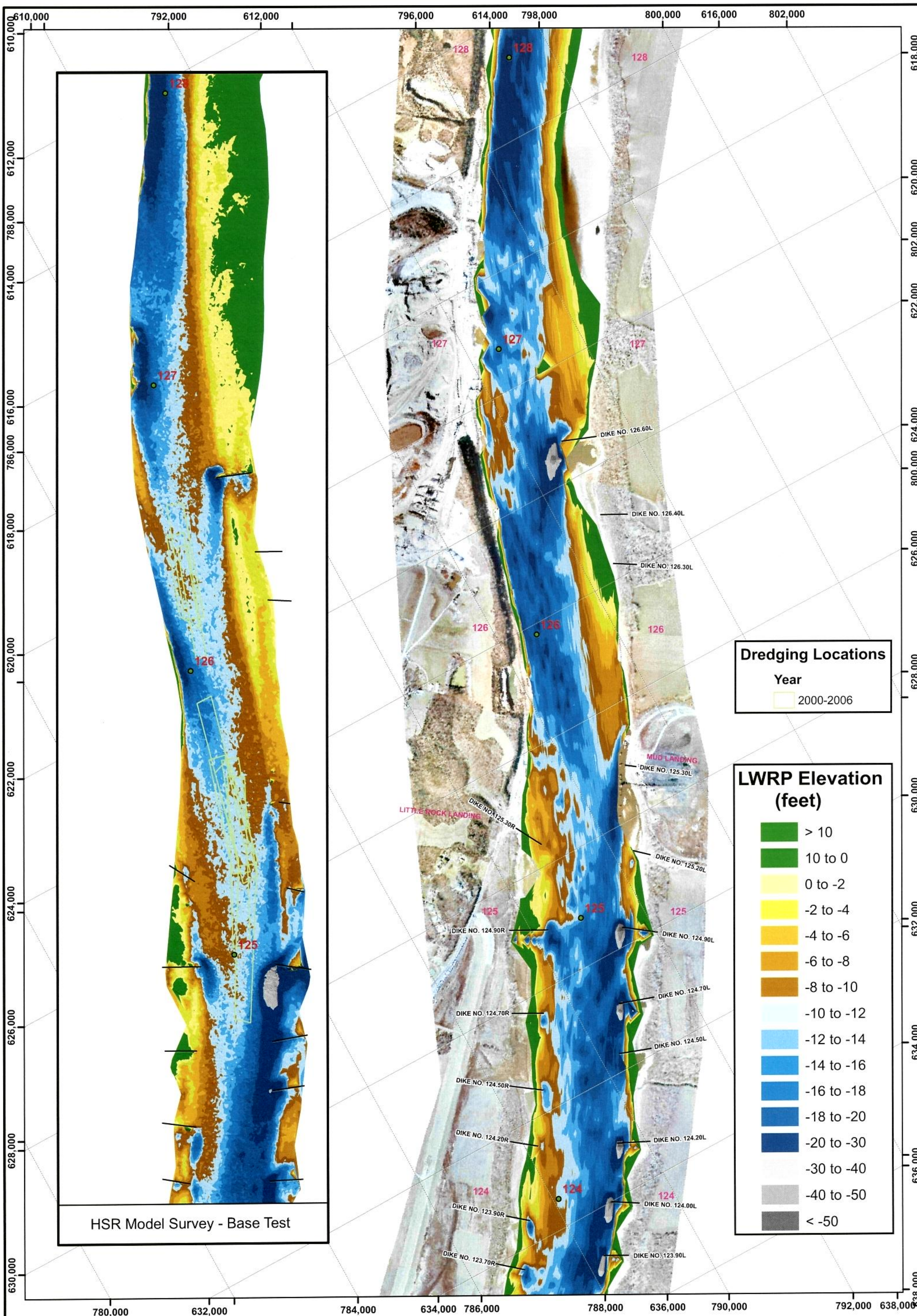

PLATE NUMBER S1

0 500 1,000 2,000 Feet

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

2007 Bathymetric Survey

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ST. LOUIS, DISTRICT

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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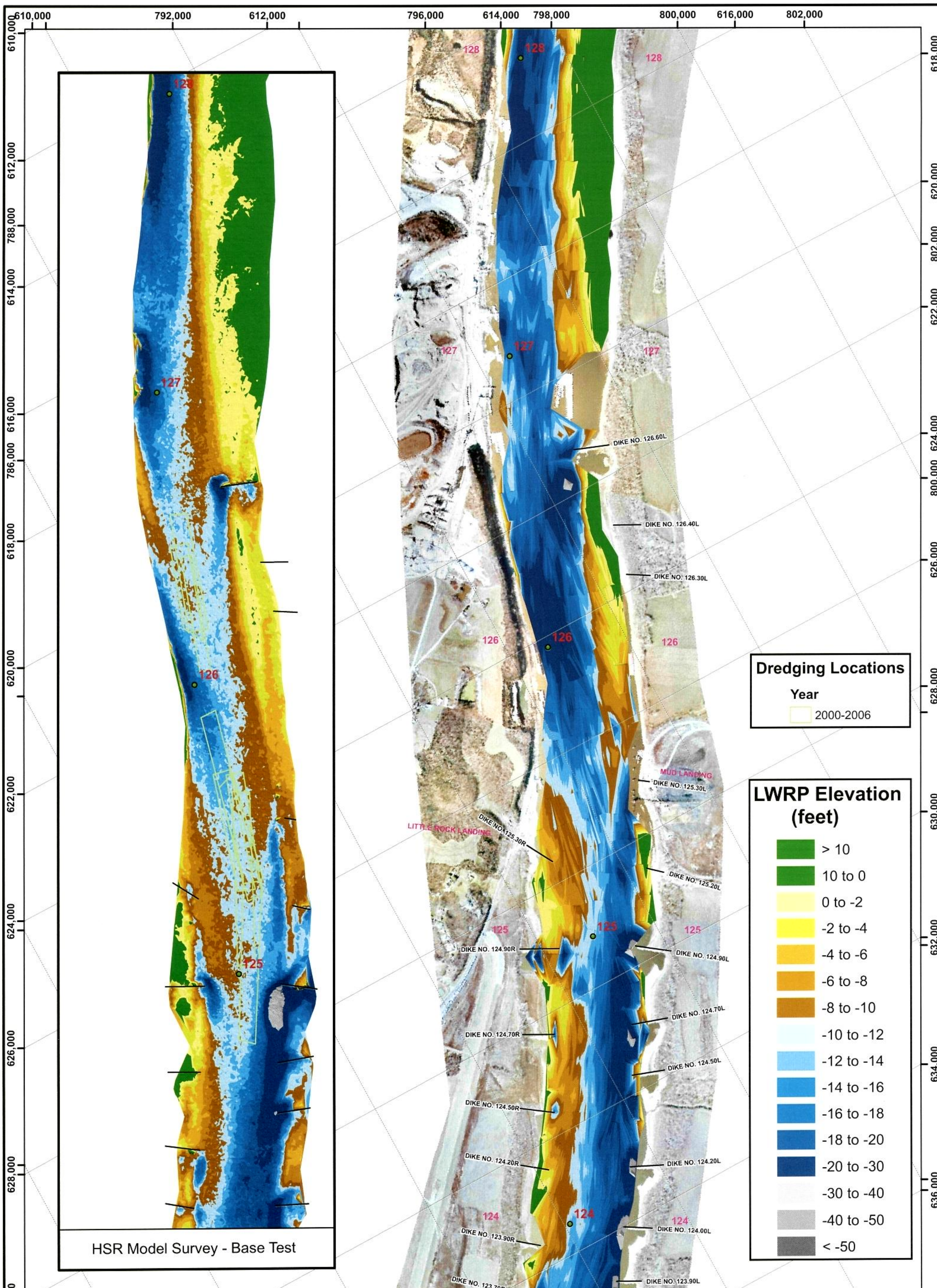

PLATE NUMBER S2

0 500 1,000 2,000 Feet

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2005 Bathymetric Survey

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ST. LOUIS, DISTRICT

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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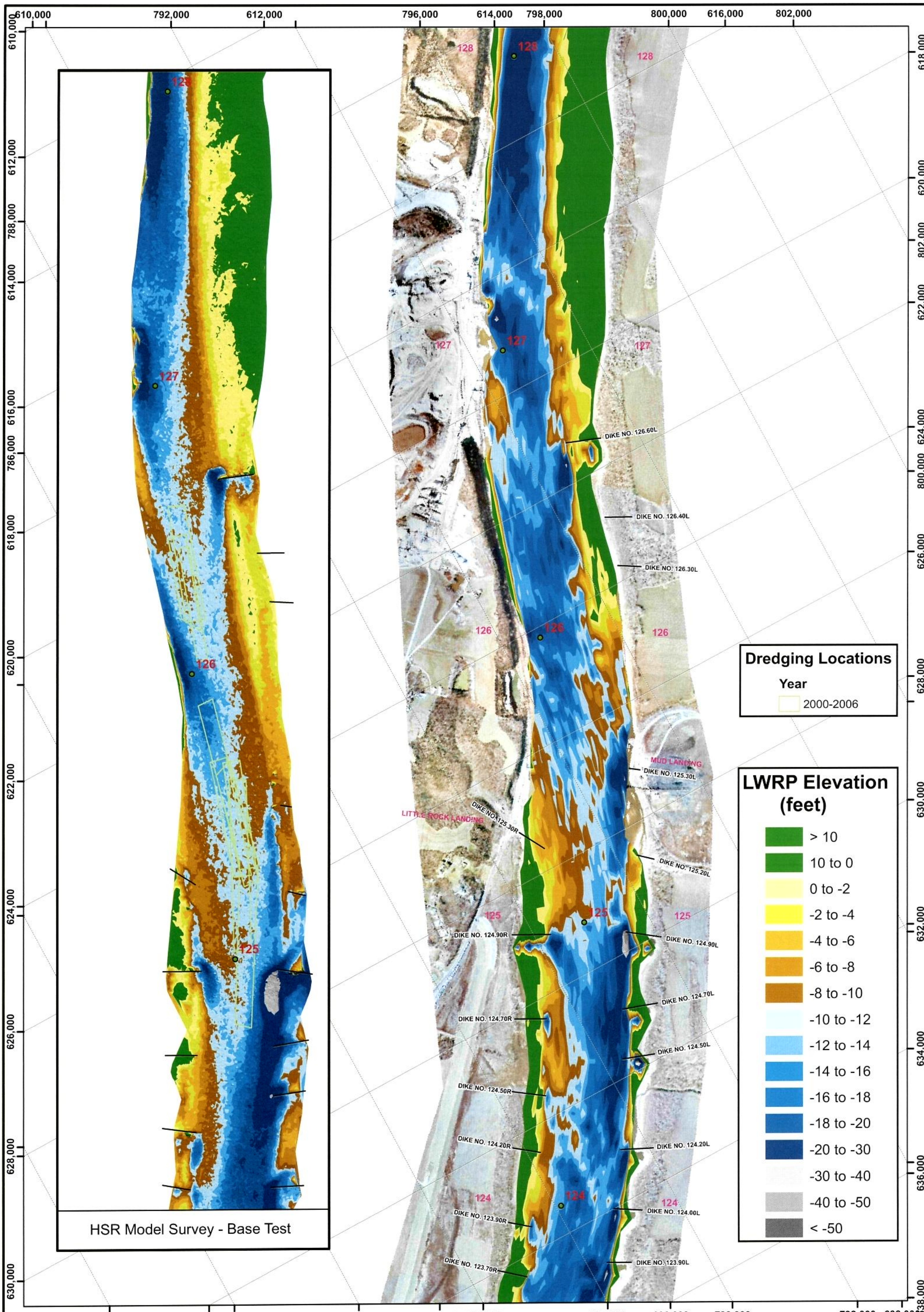

PLATE NUMBER S3

0 500 1,000 2,000 Feet

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

2001 Bathymetric Survey

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ST. LOUIS, DISTRICT

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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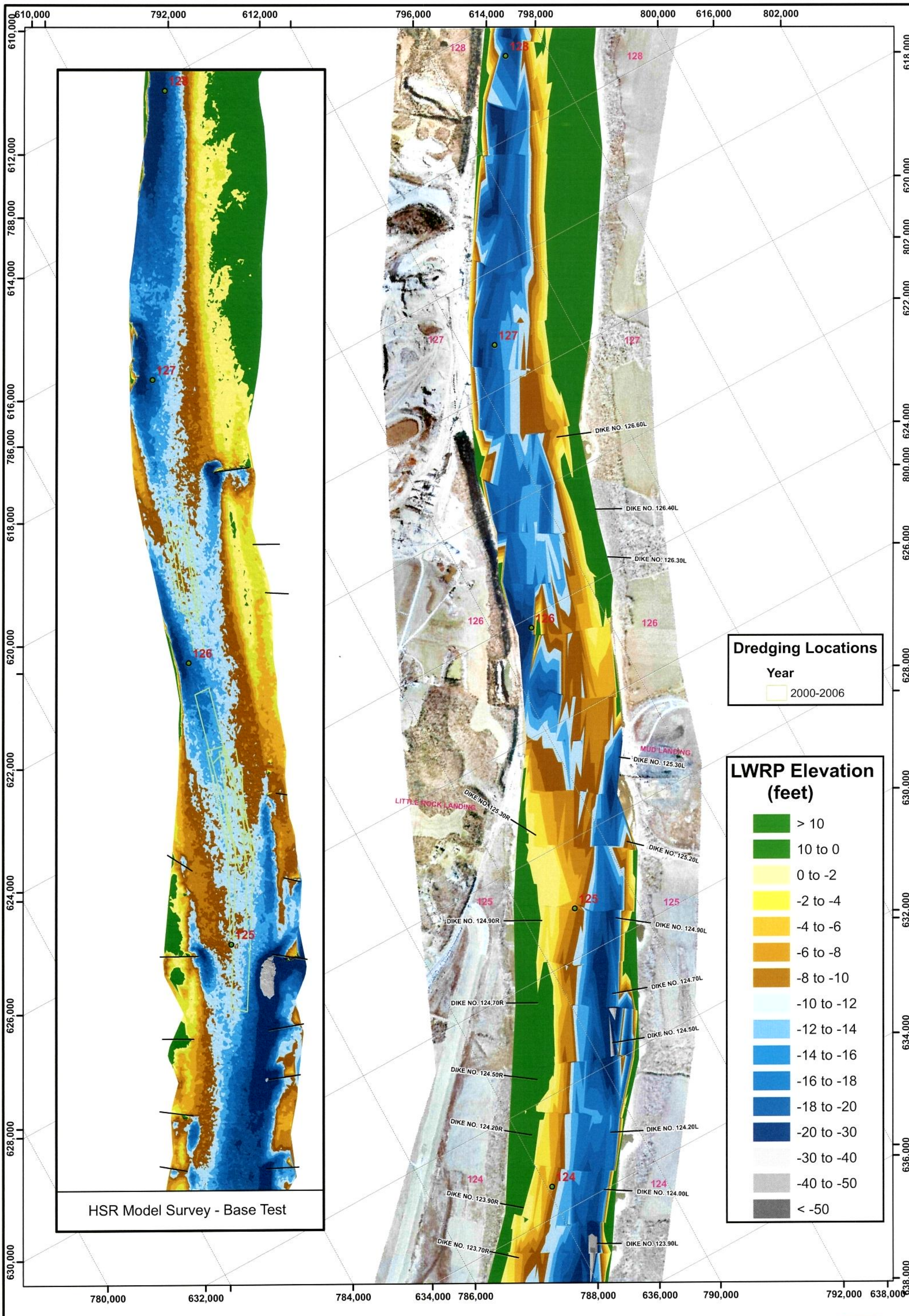

PLATE NUMBER
S4

0 500 1,000 2,000 Feet

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

1987 Bathymetric Survey

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

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Middle Mississippi River Miles 123 - 129

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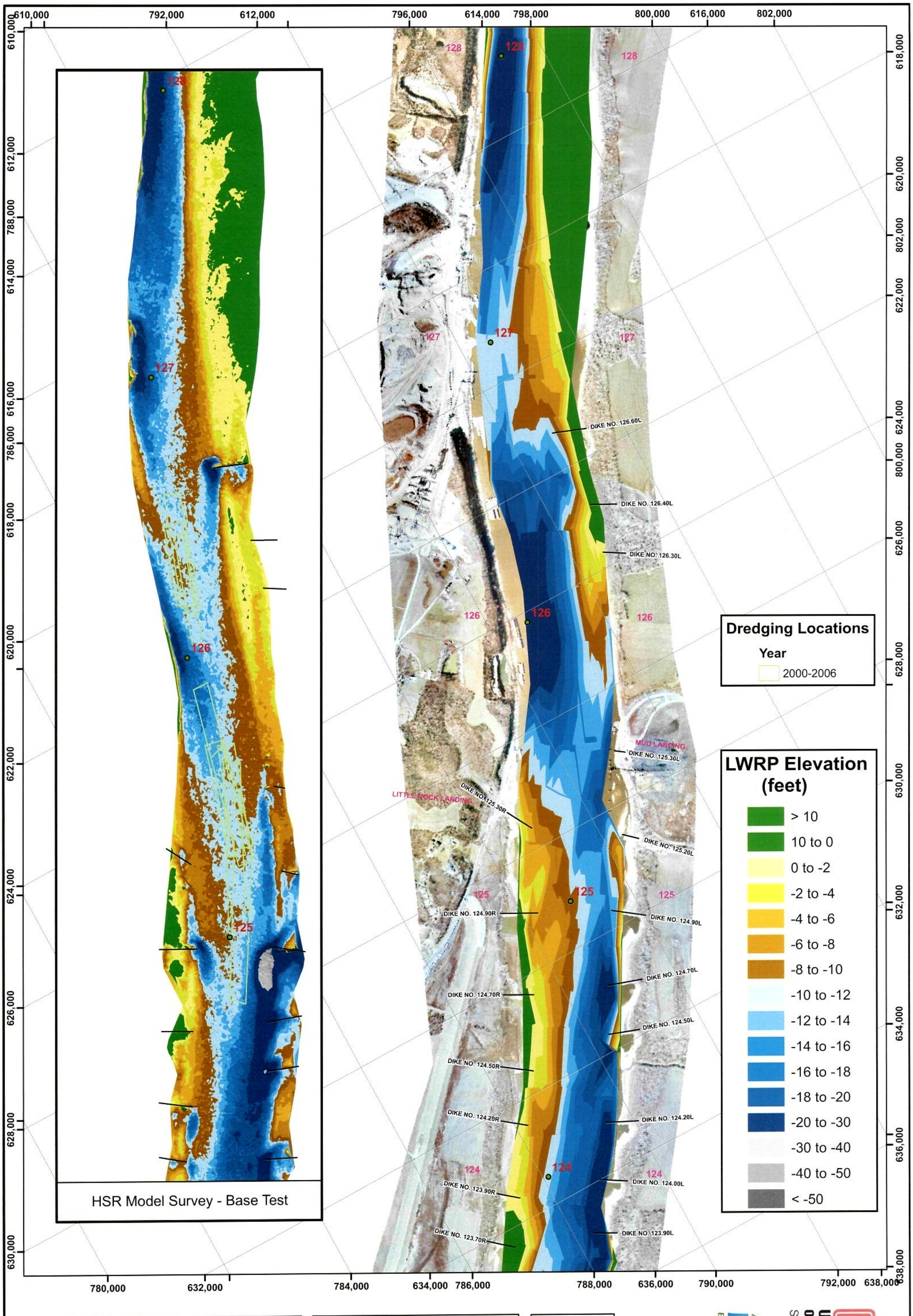

PLATE NUMBER S5

0 500 1,000 2,000 Feet

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

1982-83 Bathymetric Survey

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

Ste. Genevieve HSR Model
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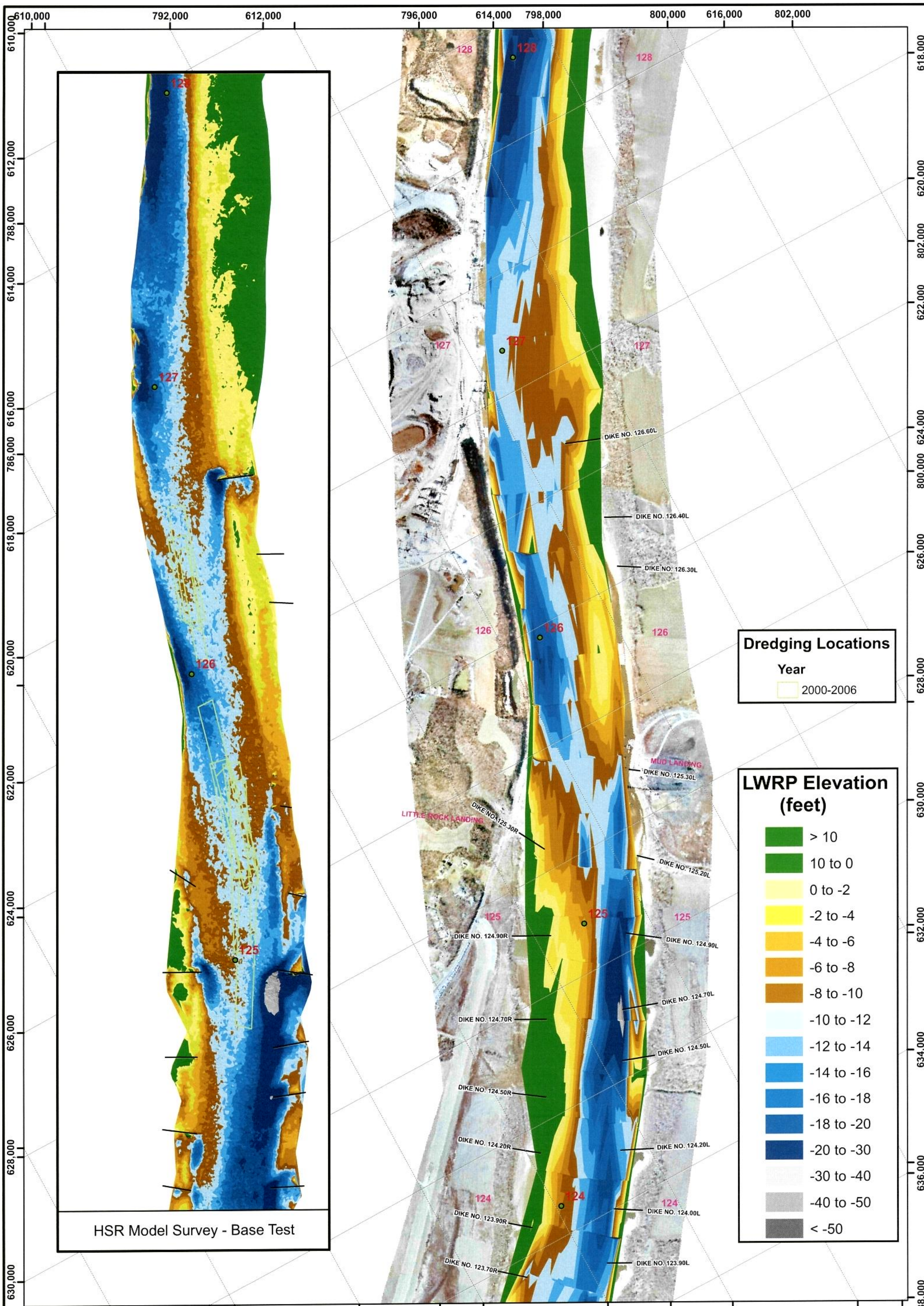

PLATE NUMBER S6	0 500 1,000 2,000 Feet THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS EXISTING AT THAT TIME 1976-77 Bathymetric Survey	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH	APPLIED RIVER ENGINEERING CENTER US Army Corps of Engineers St. Louis District

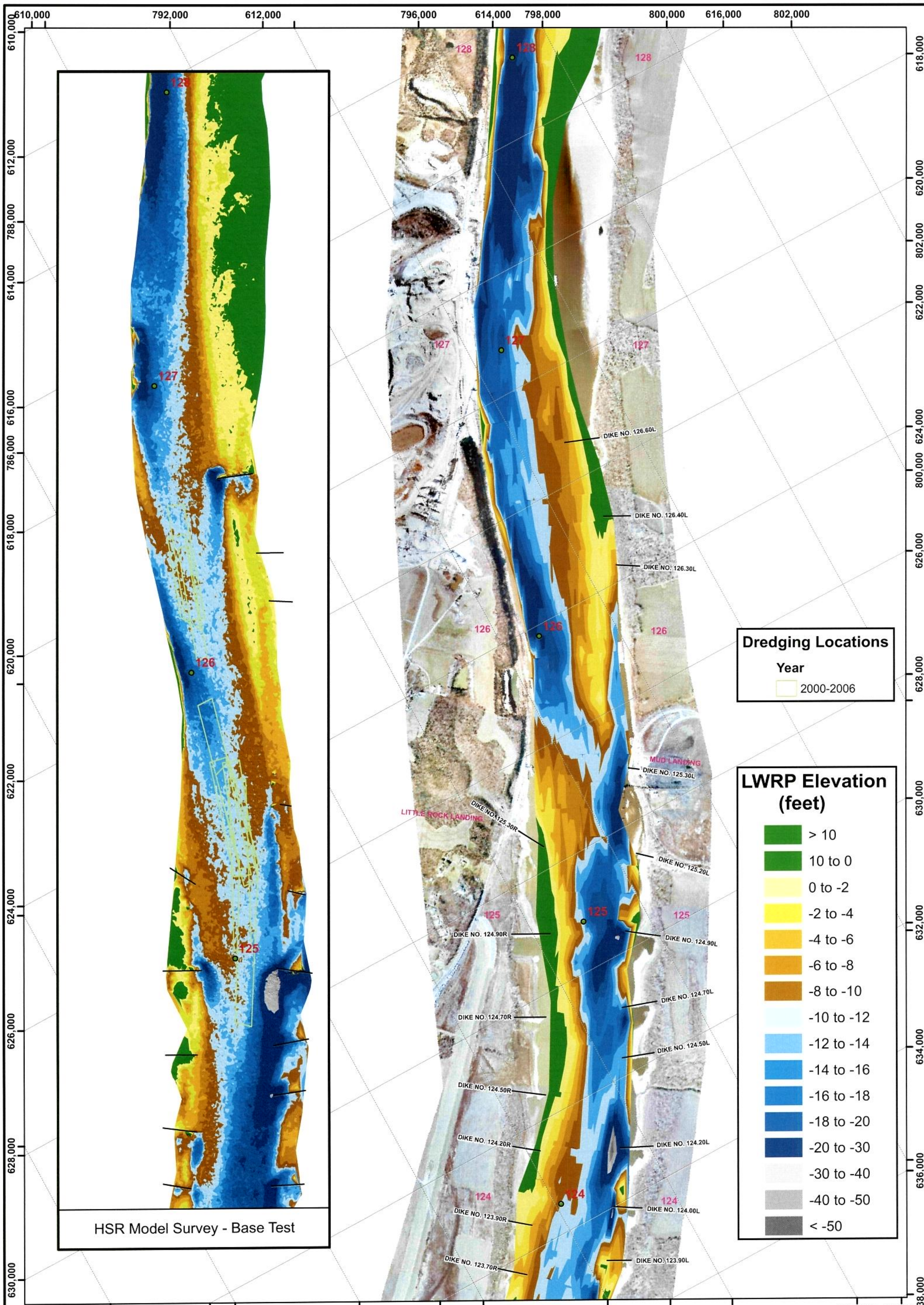

PLATE NUMBER S7

0 500 1,000 2,000 Feet

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

1968-71 Bathymetric Survey

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Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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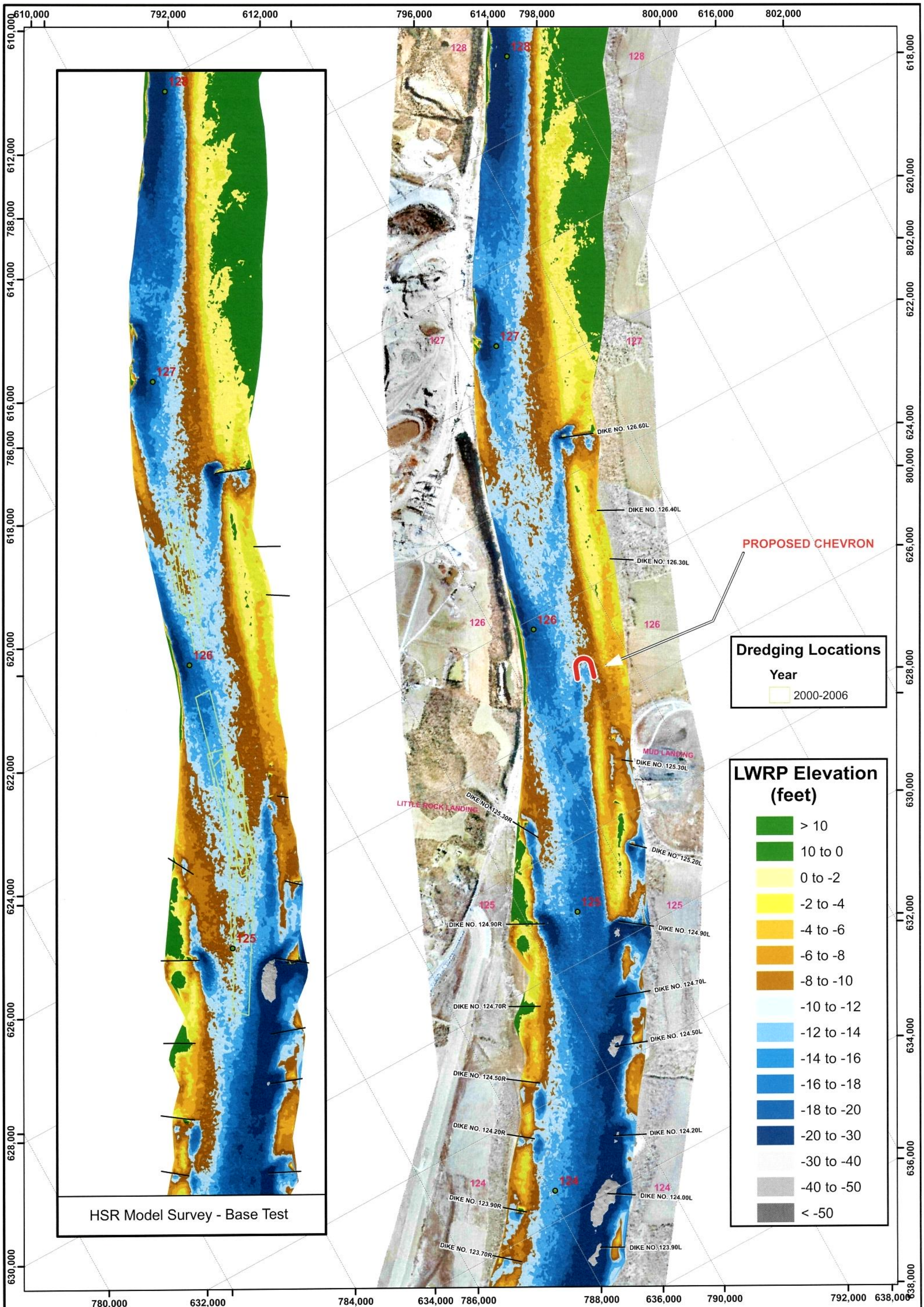

PLATE NUMBER A1

0 500 1,000 2,000 Feet

Alternative 1

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ST. LOUIS, DISTRICT

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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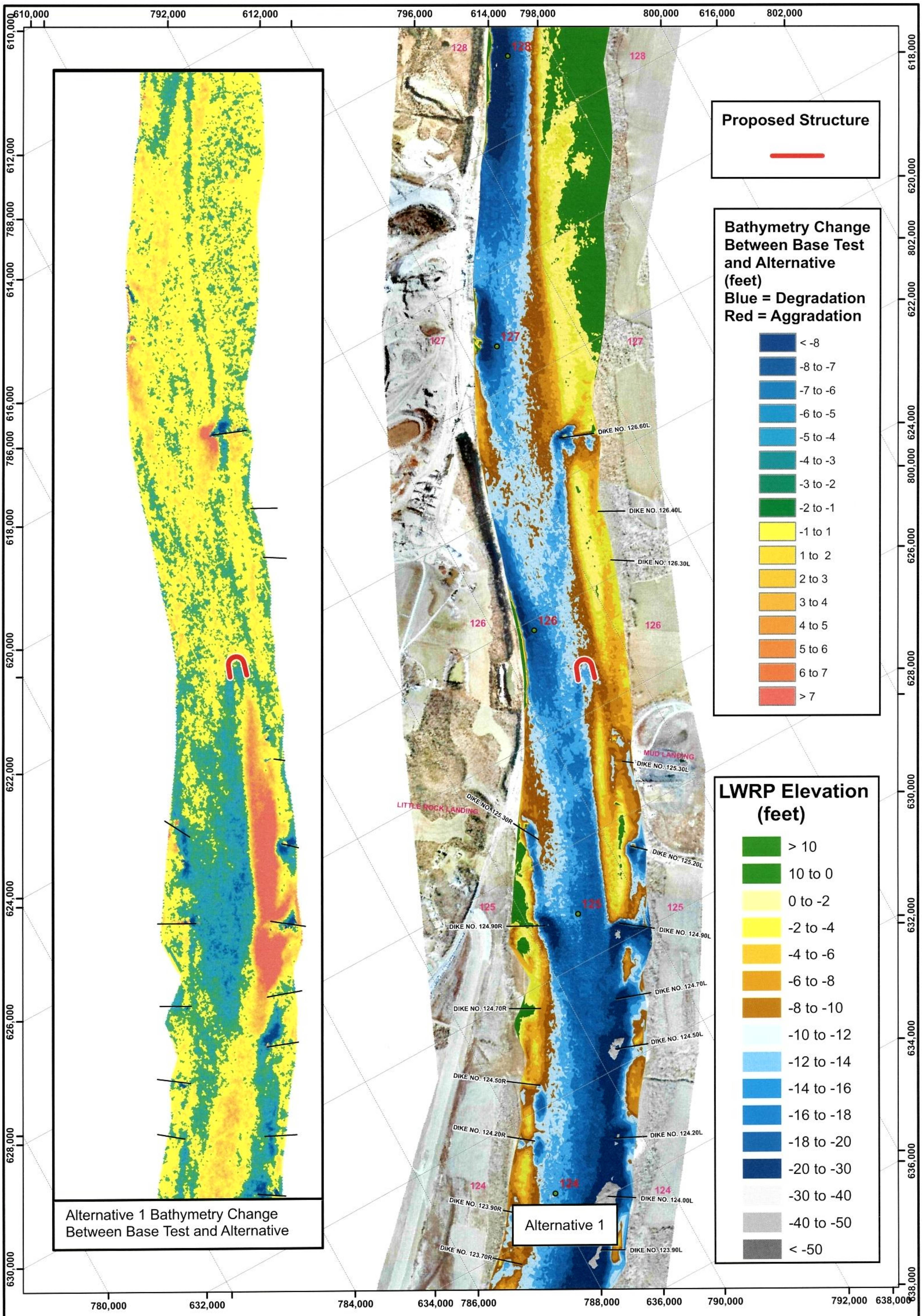

PLATE NUMBER C 1

0 500 1,000 2,000 Feet

Alternative 1 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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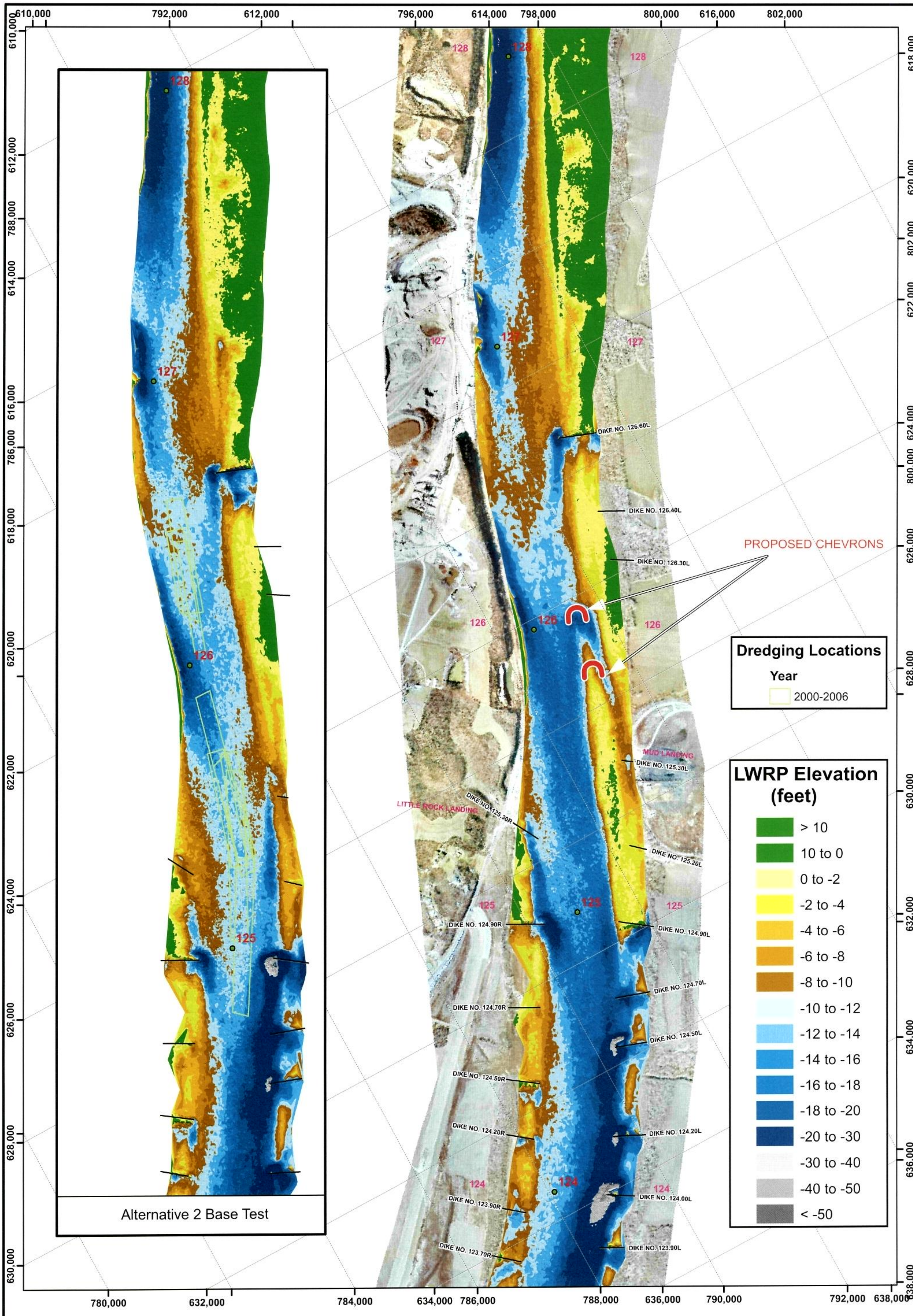

PLATE NUMBER A2	0 500 1,000 2,000 Feet	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT	PREPARED BY: P. Russell, P.E.	
	Alternative 2	Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH	

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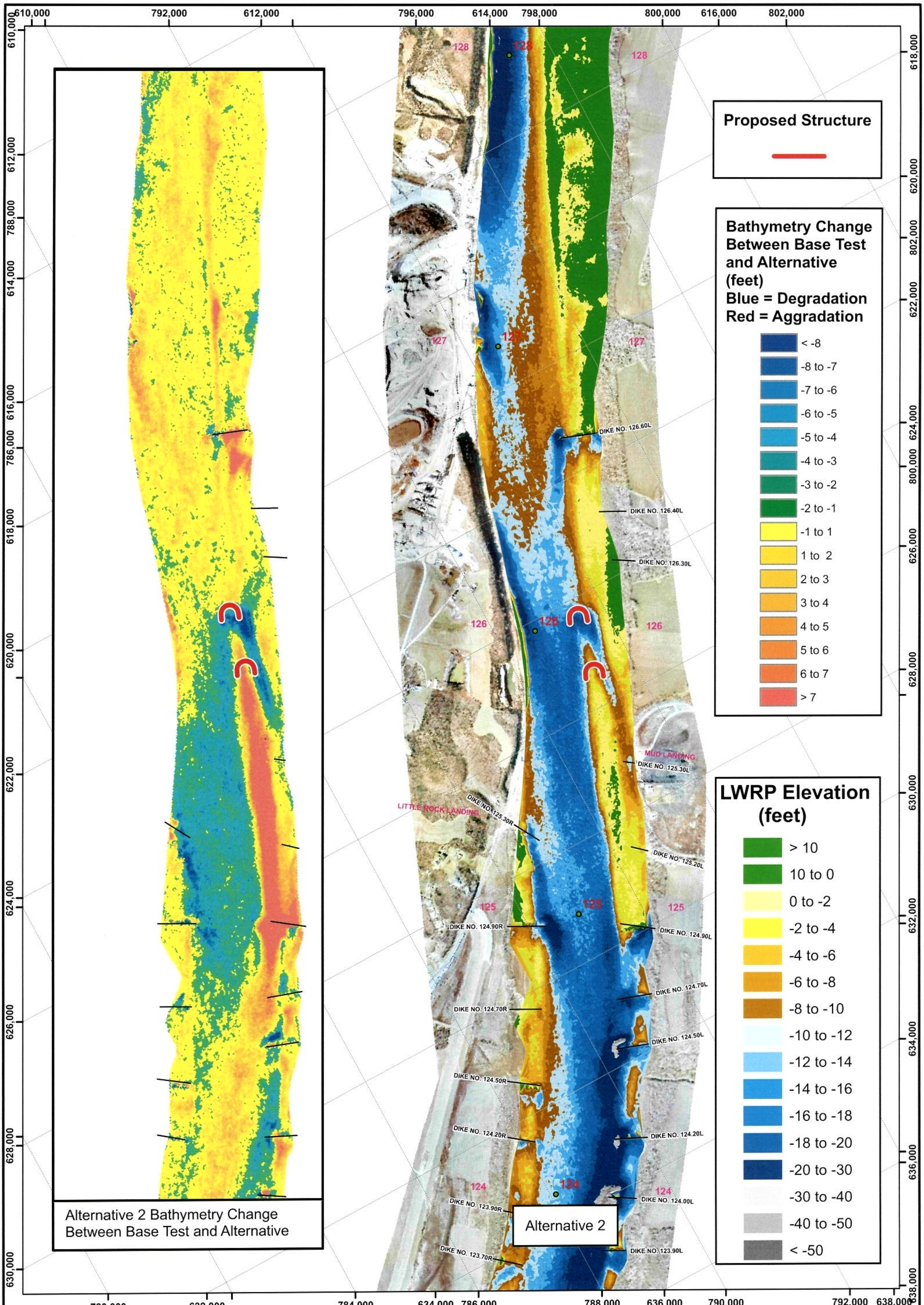

PLATE NUMBER C 2

0 500 1,000 2,000 Feet

Alternative 2 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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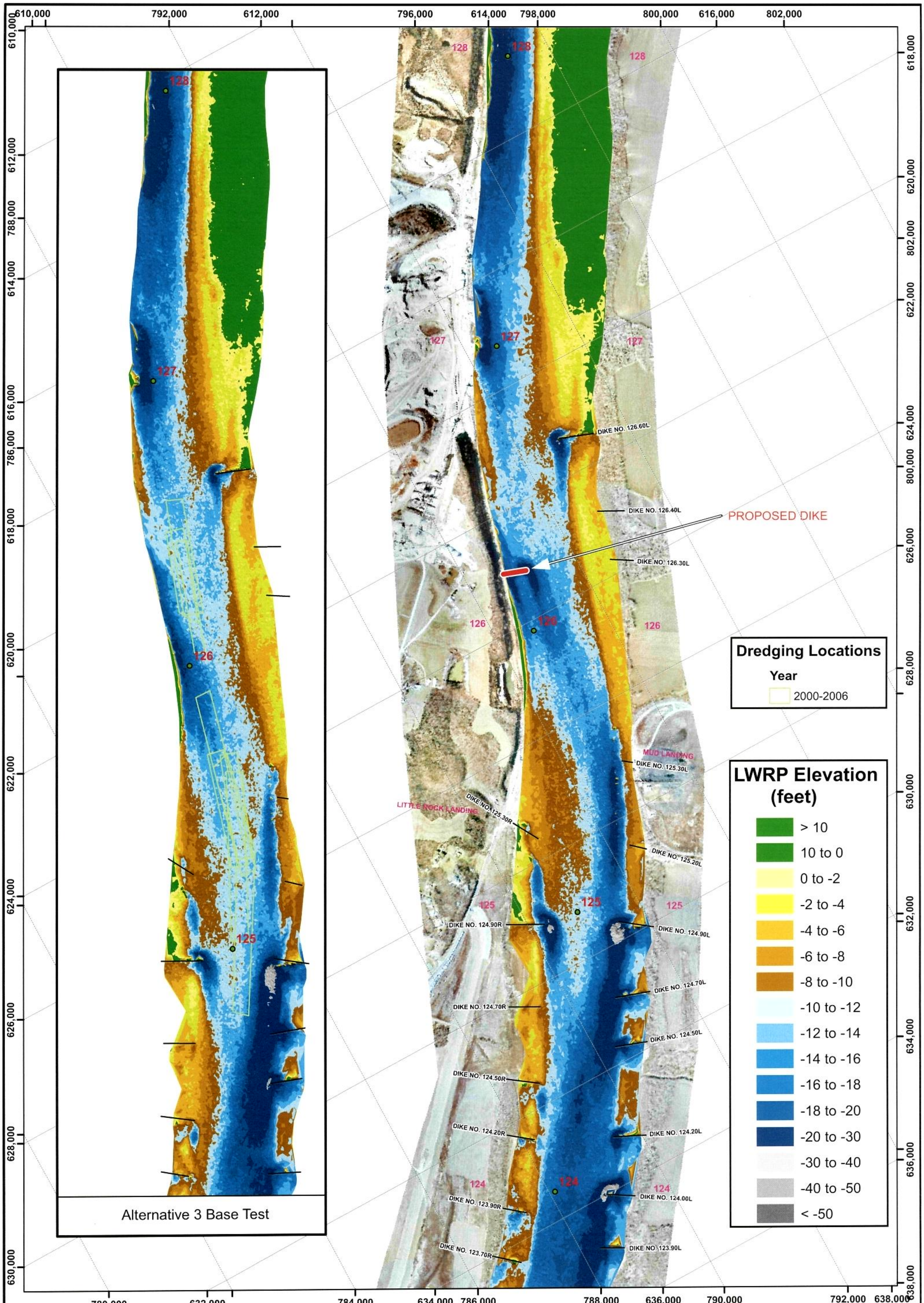

PLATE NUMBER A3

0 500 1,000 2,000 Feet

Alternative 3

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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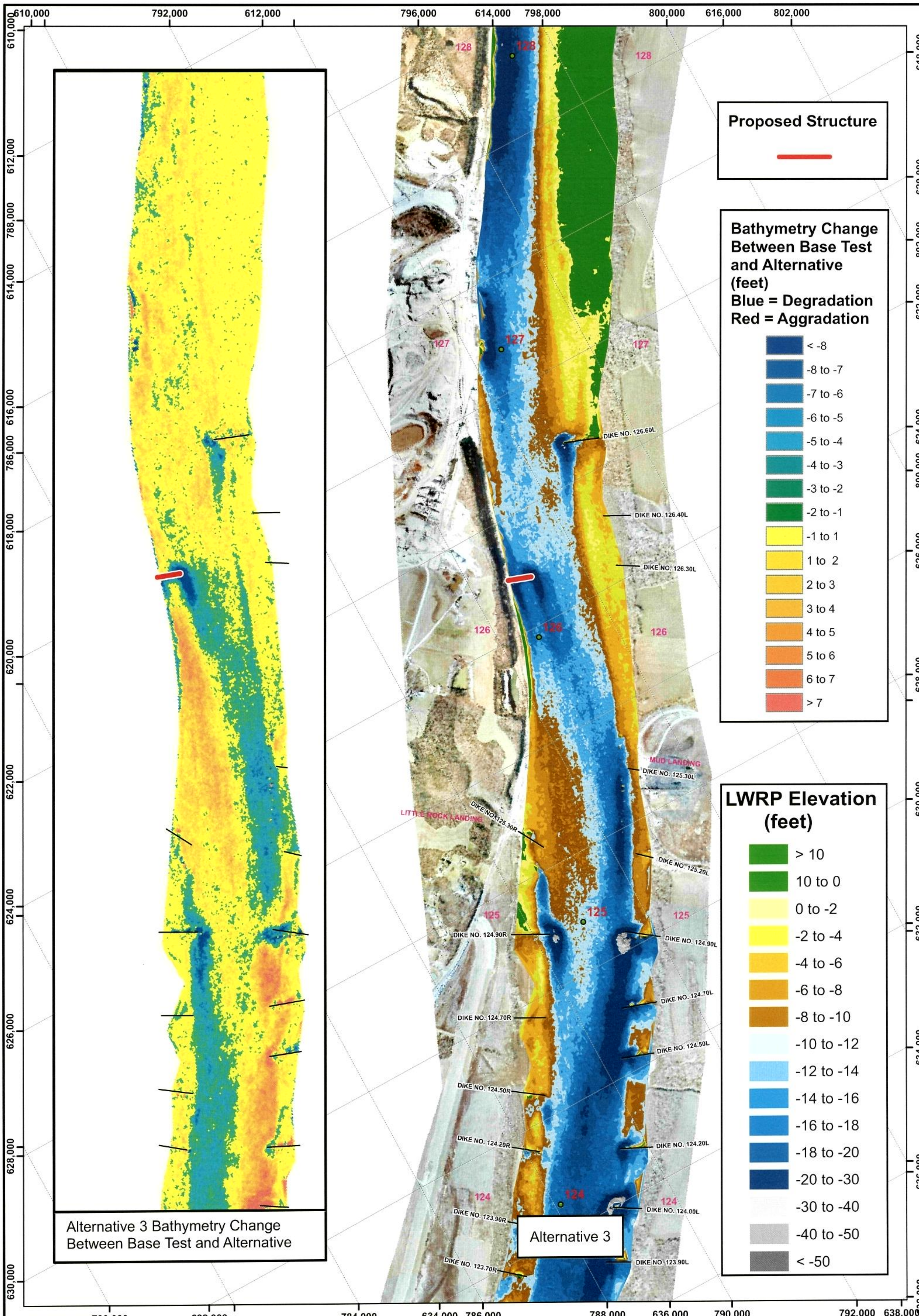

PLATE NUMBER
C 3

0 500 1,000 2,000 Feet

Alternative 3 Bathymetry Change Between Base Test and Alternative

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ST. LOUIS, DISTRICT

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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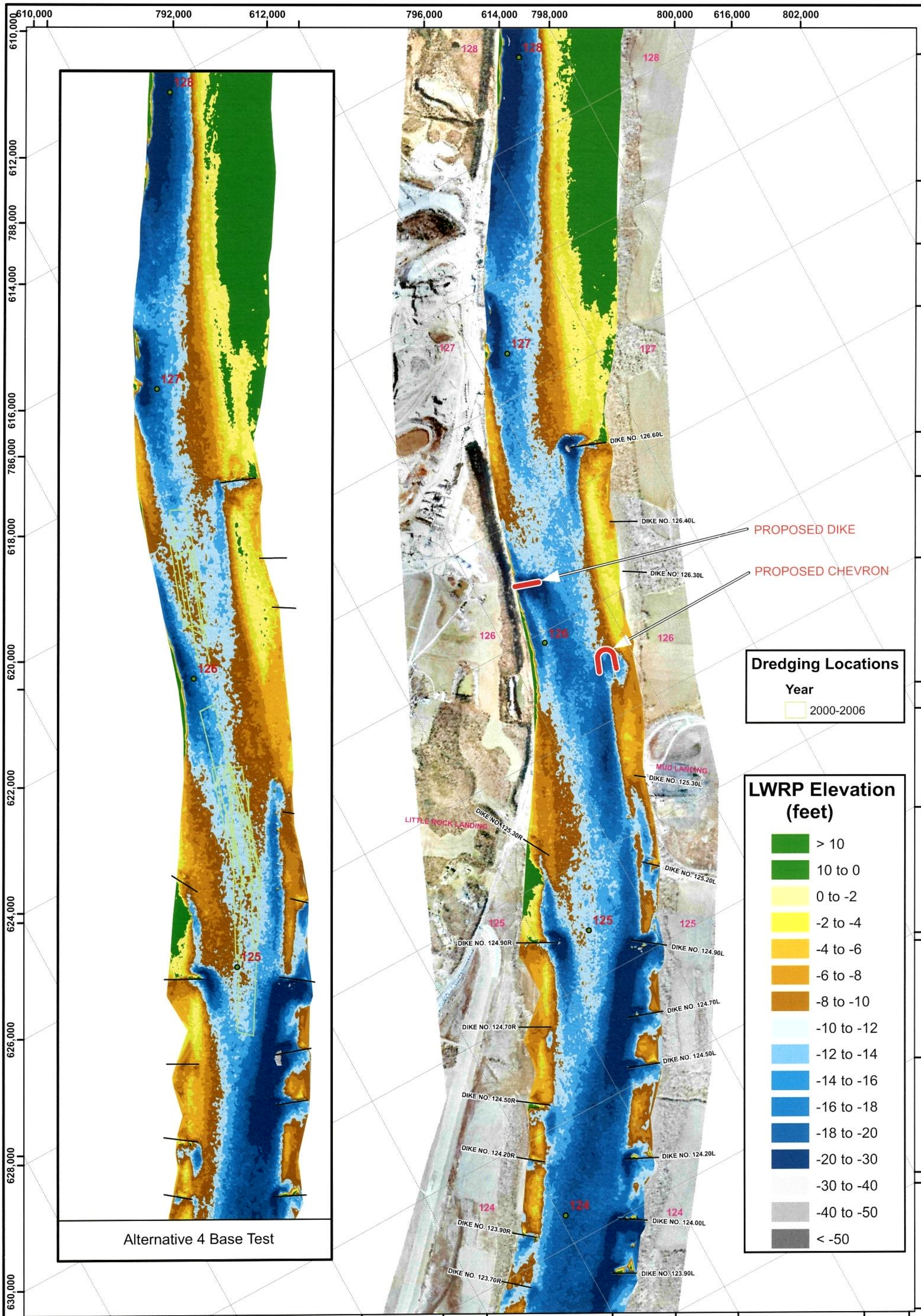

PLATE NUMBER
A4

0 500 1,000 2,000 Feet

Alternative 4

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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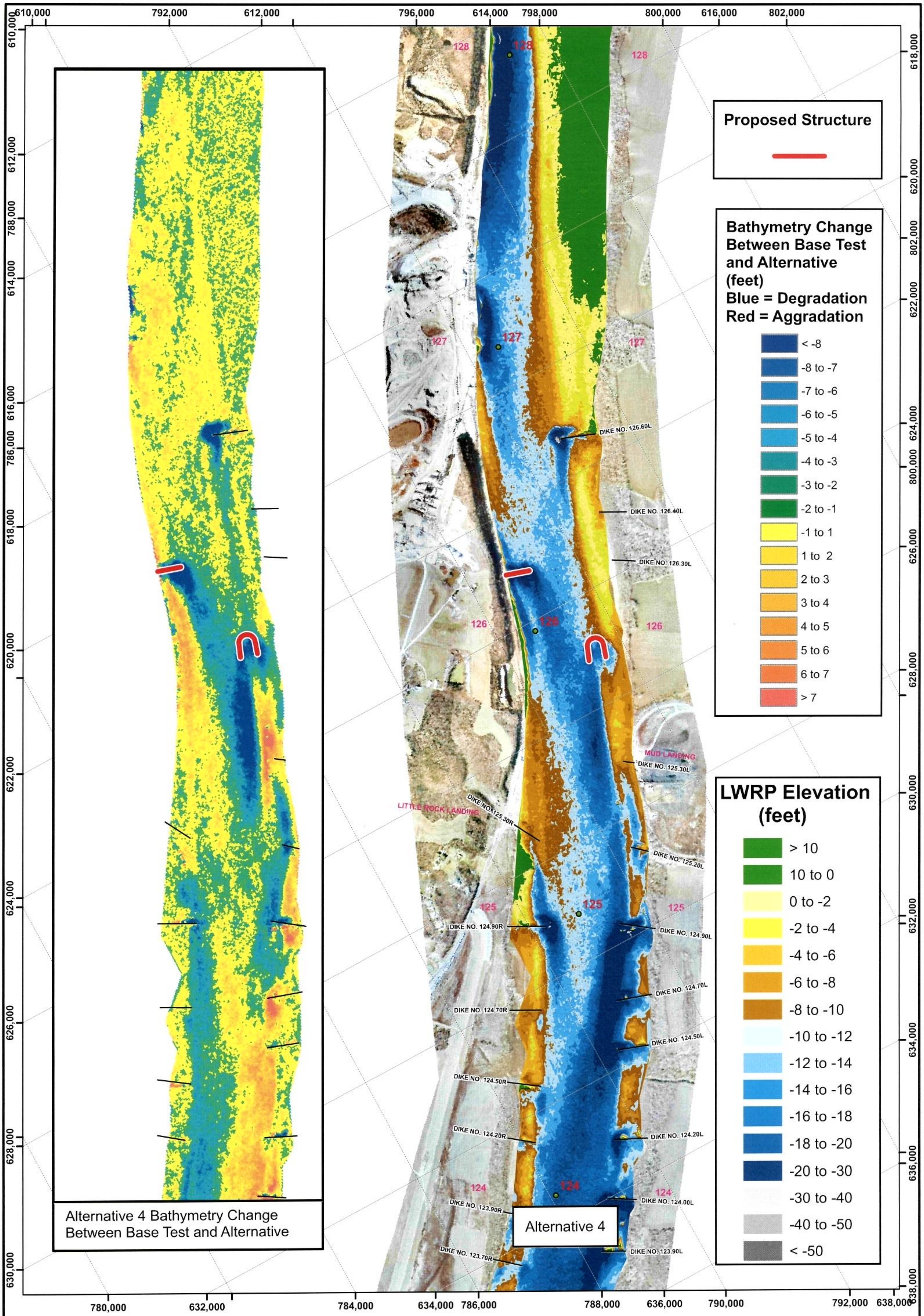

PLATE NUMBER C 4

0 500 1,000 2,000 Feet

Alternative 4 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

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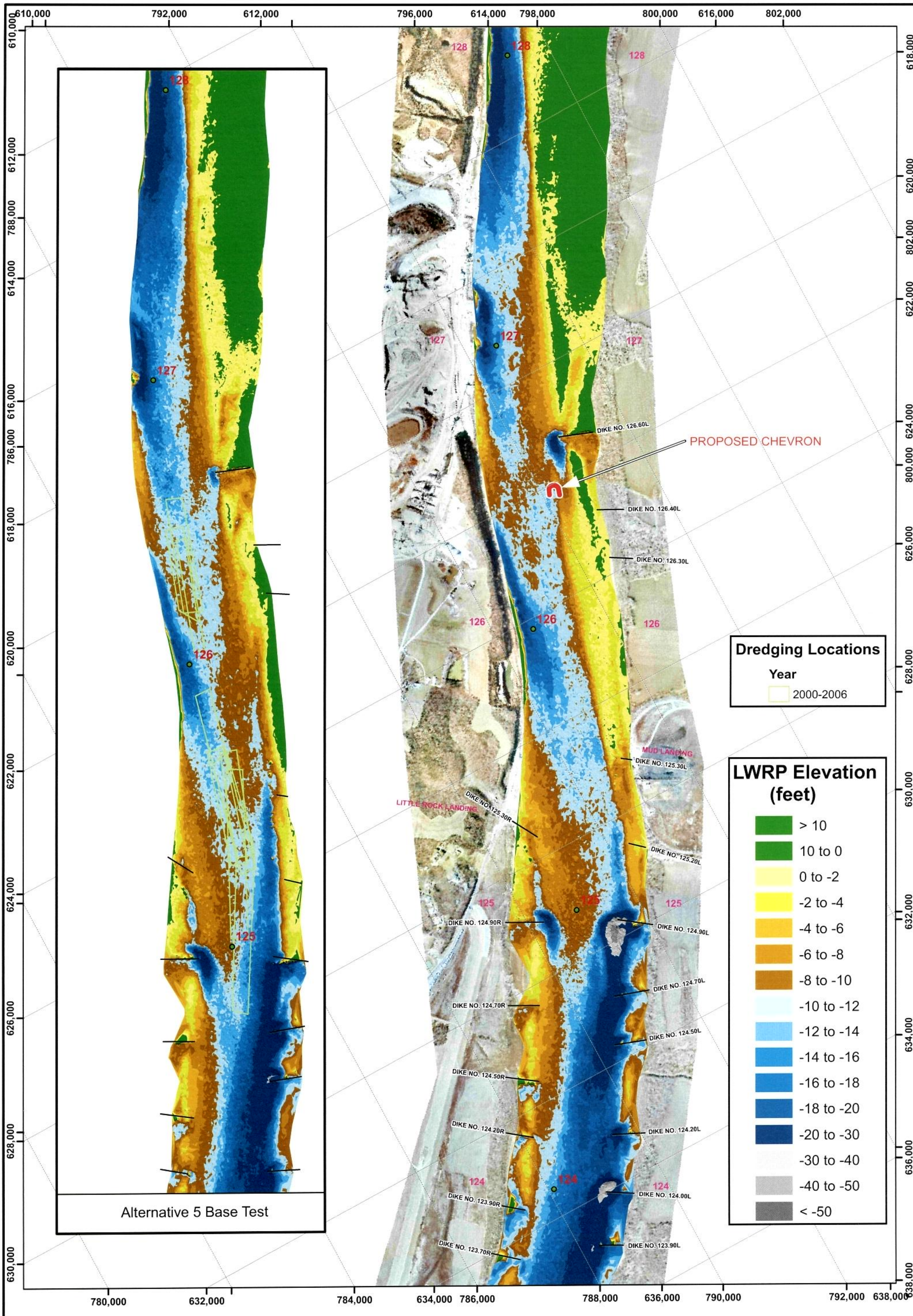

PLATE NUMBER A5

Alternative 5

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

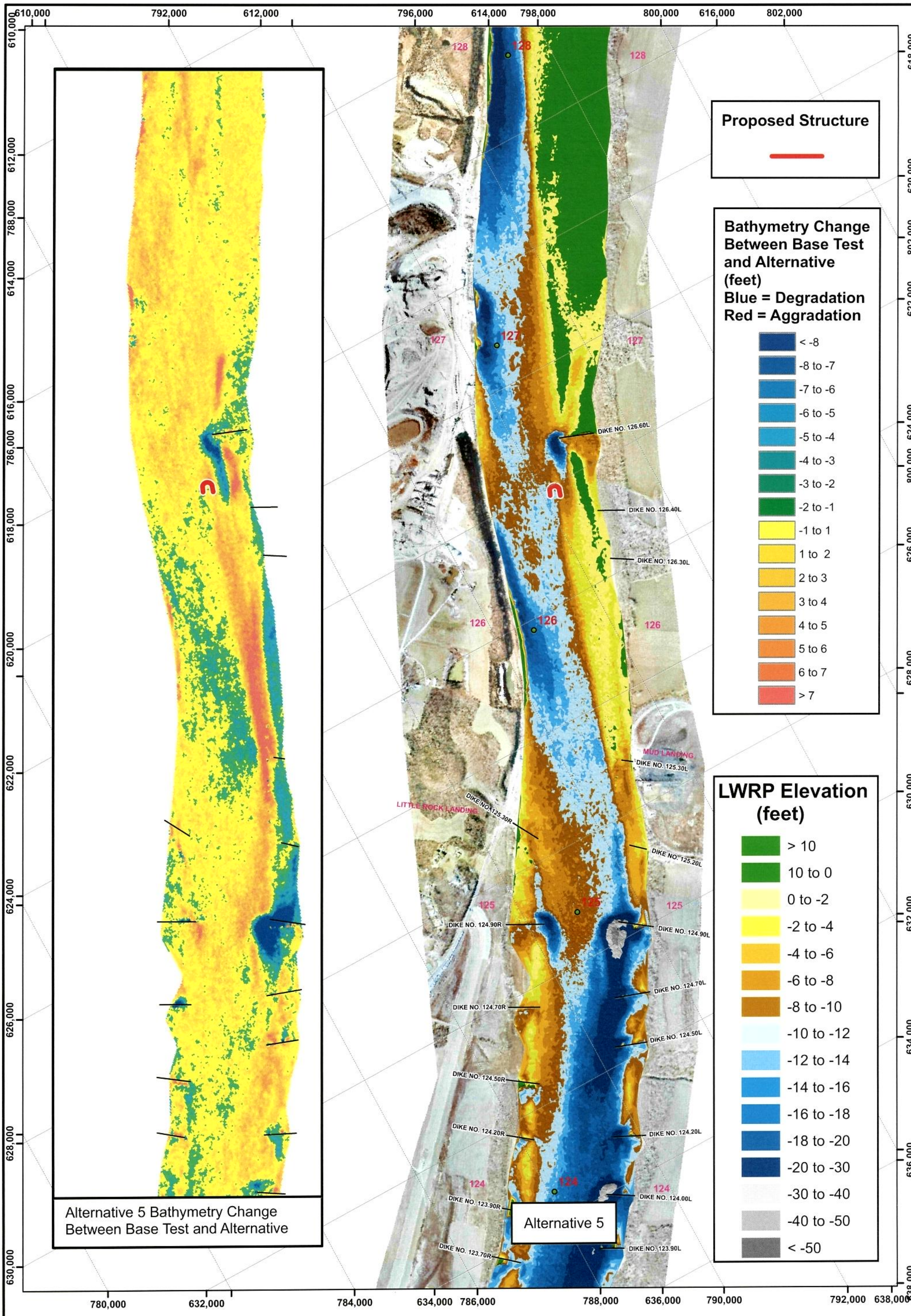

PLATE NUMBER C 5

0 500 1,000 2,000 Feet

Alternative 5 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

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St. Louis District

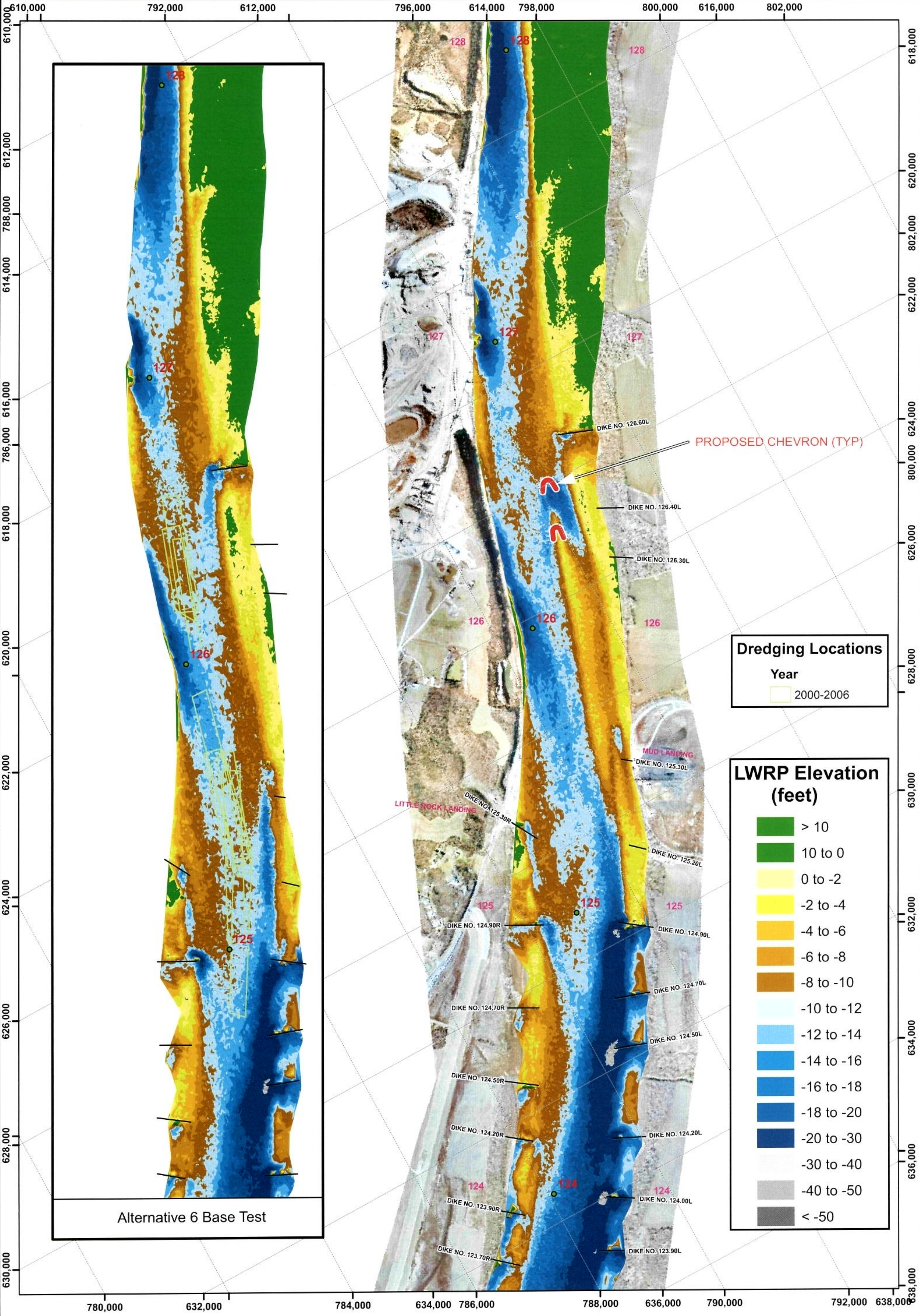

PLATE NUMBER A6

Alternative 6

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

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US Army Corps of Engineers
St. Louis District

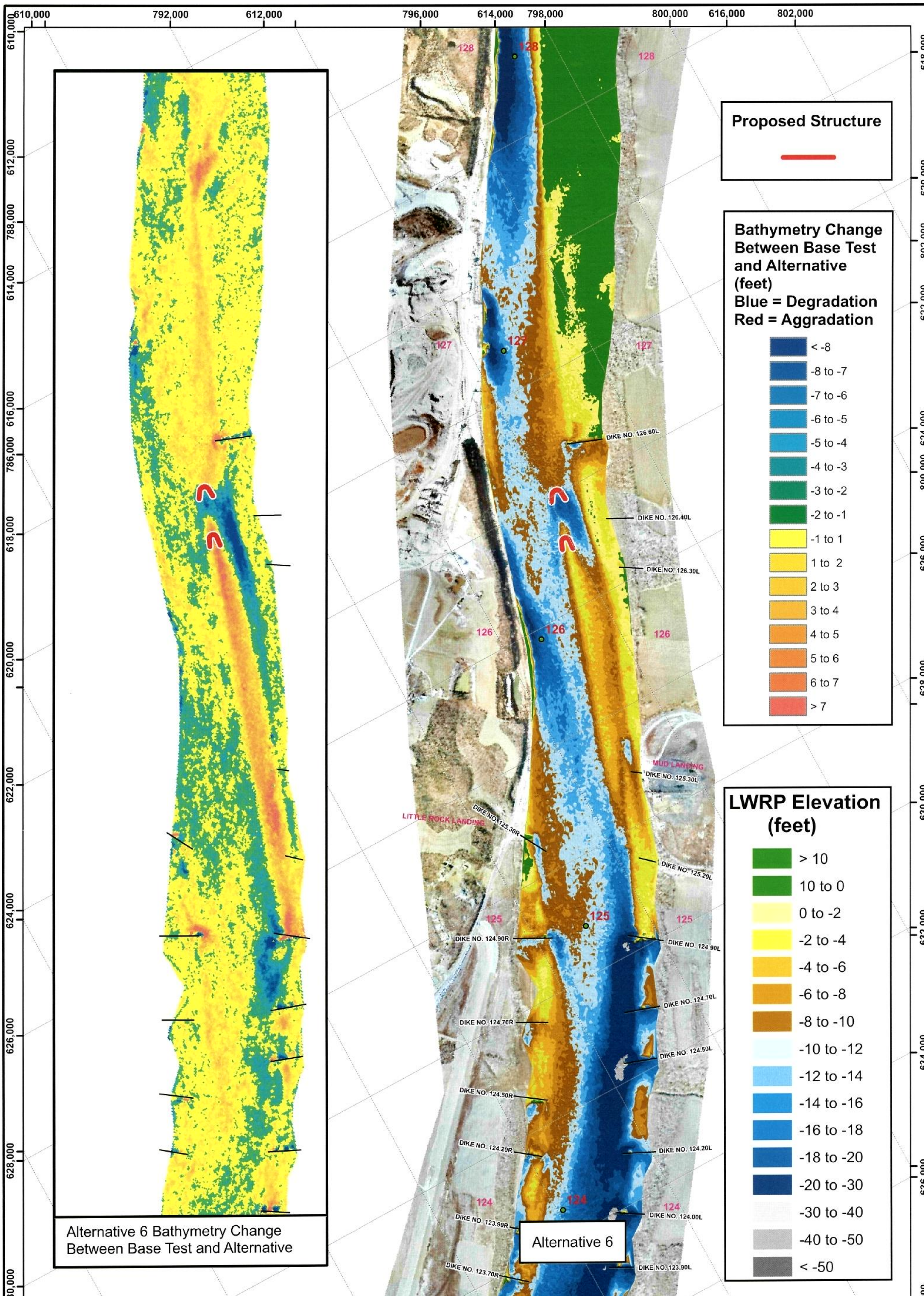

PLATE NUMBER C 6

0 500 1,000 2,000 Feet

Alternative 6 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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St. Louis District

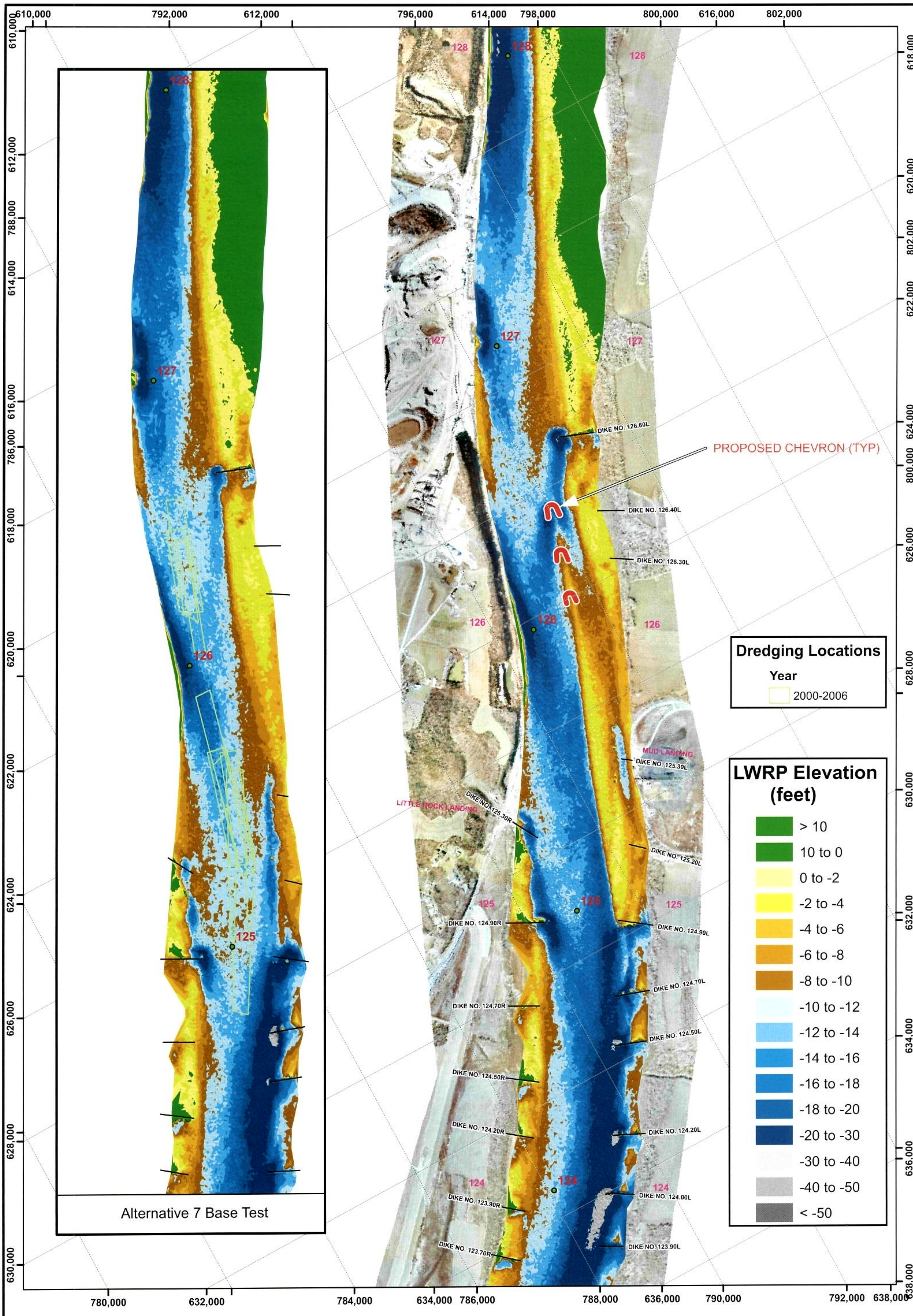

PLATE NUMBER A7

0 500 1,000 2,000 Feet

Alternative 7

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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St. Louis District

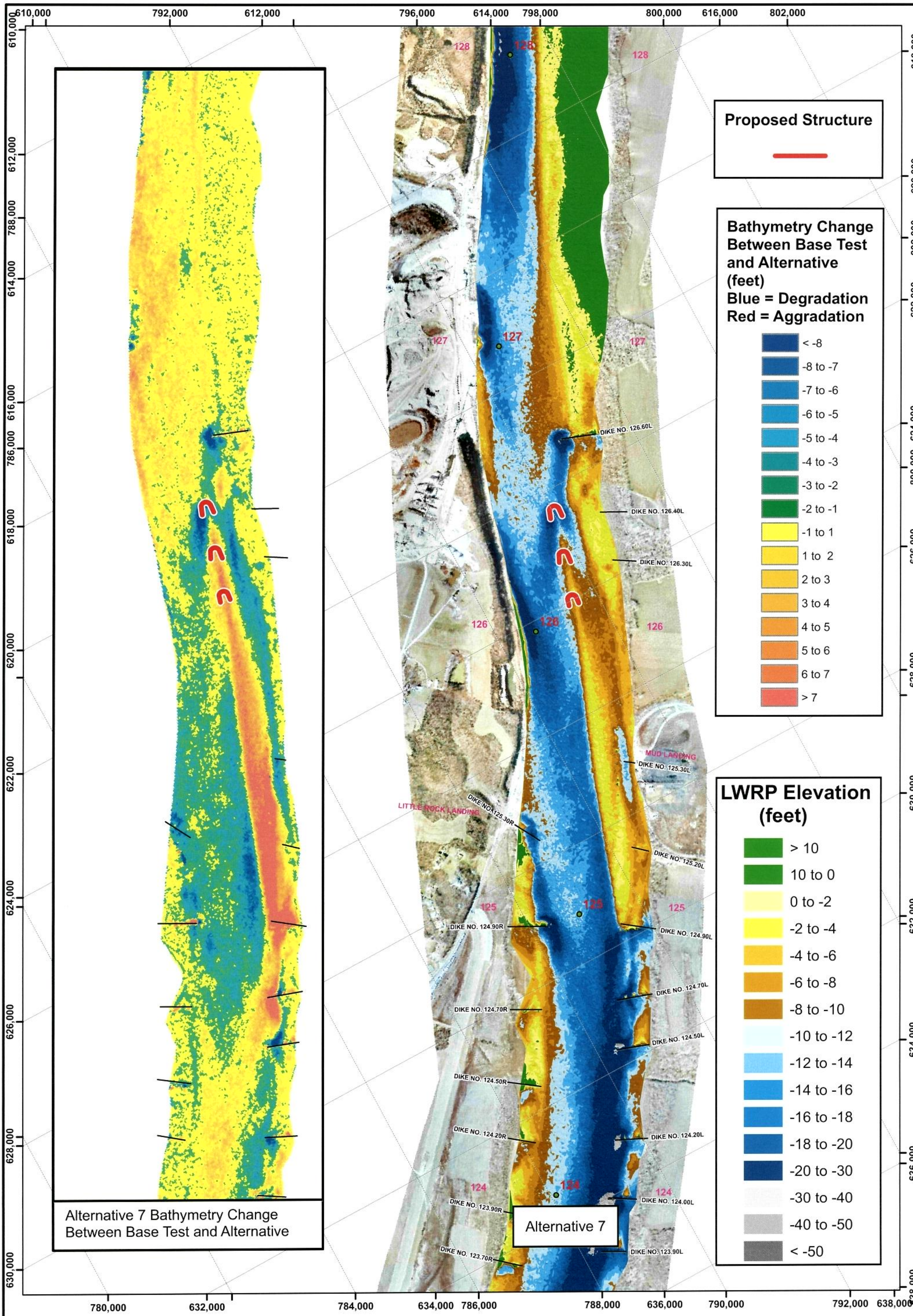

PLATE NUMBER C 7

0 500 1,000 2,000 Feet

Alternative 7 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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St. Louis District

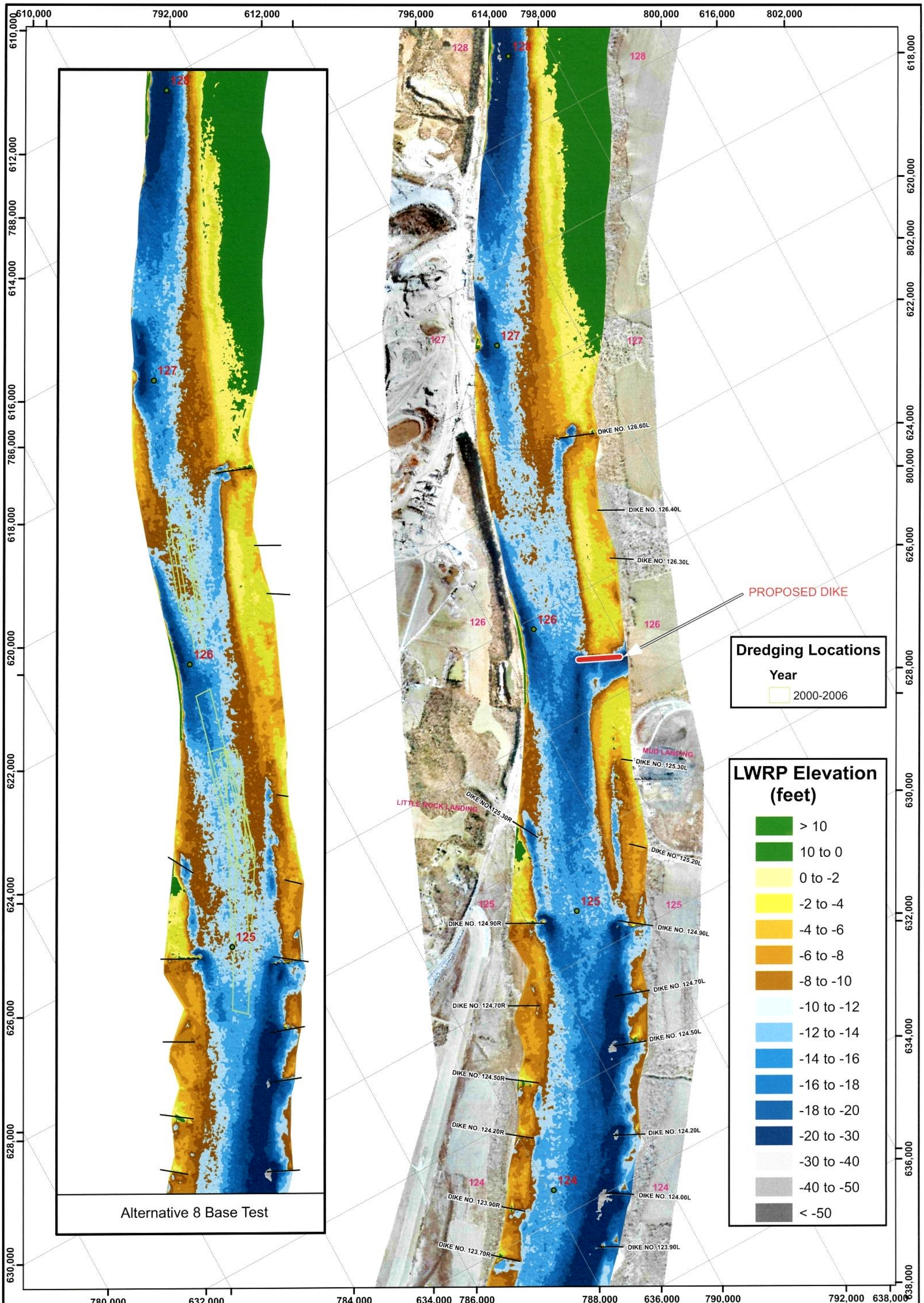

PLATE NUMBER A8

0 500 1,000 2,000 Feet

Alternative 8

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

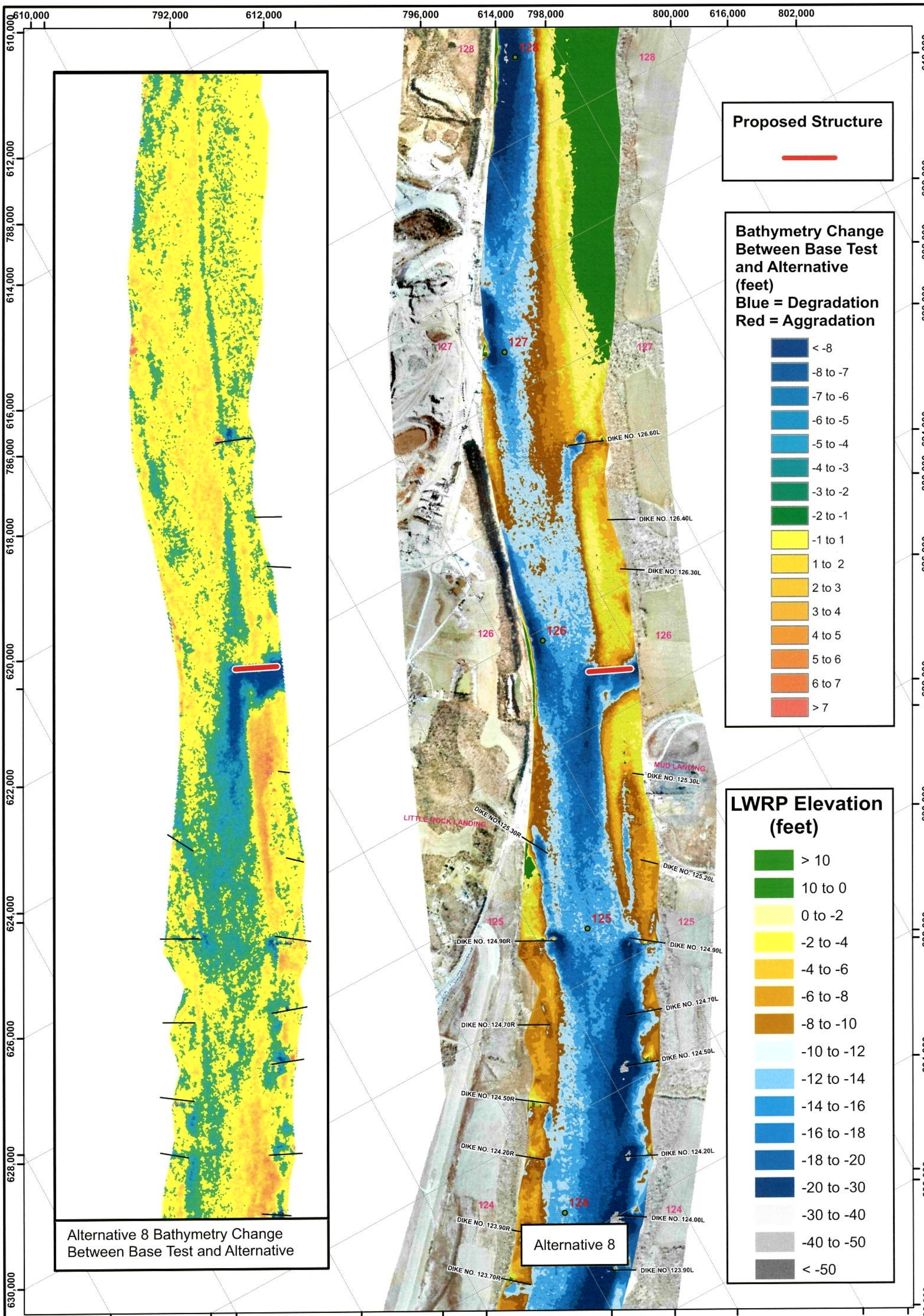

PLATE NUMBER C 8

0 500 1,000 2,000 Feet

Alternative 8 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

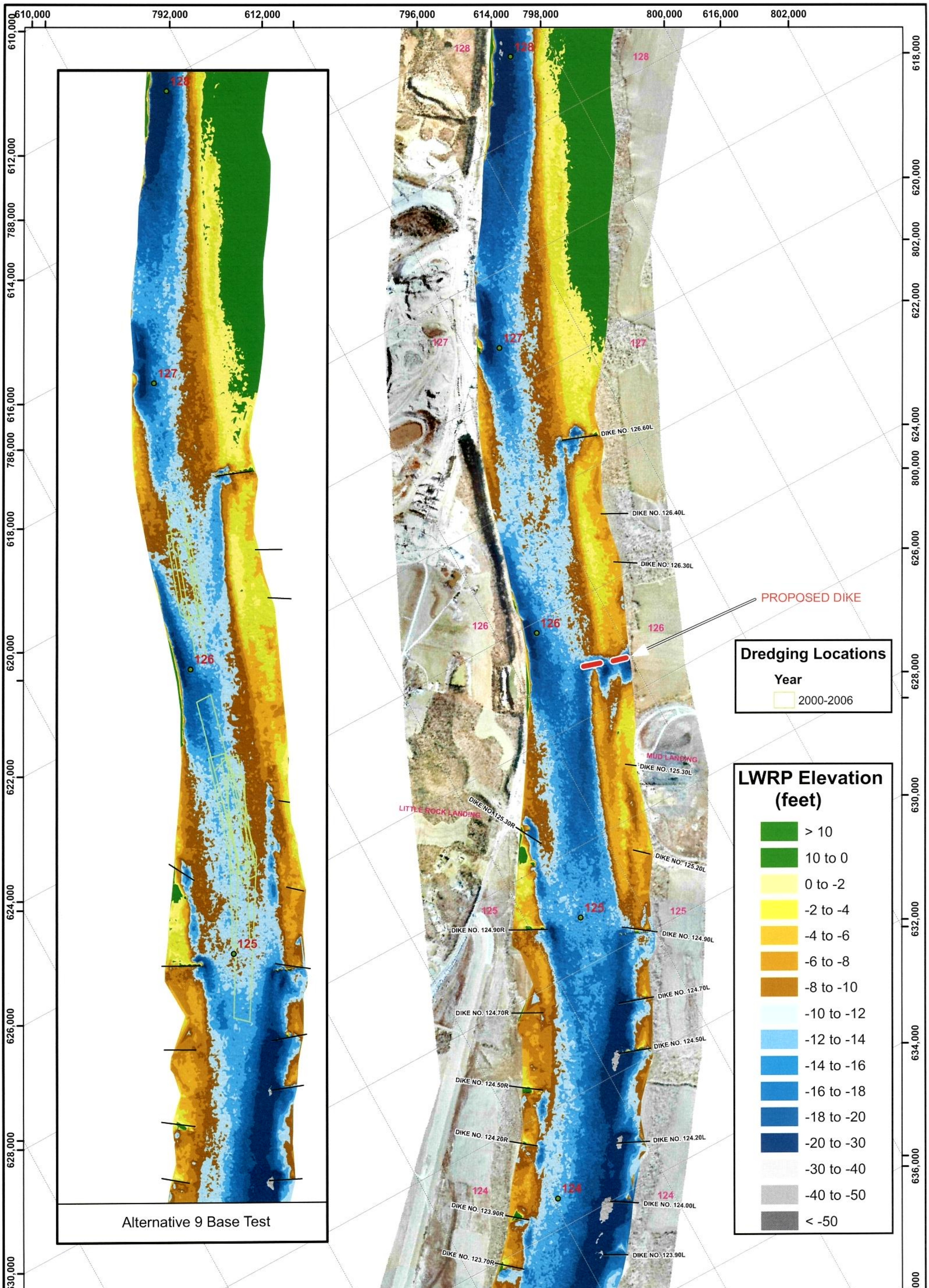

PLATE NUMBER A9

0 500 1,000 2,000 Feet

Alternative 9

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

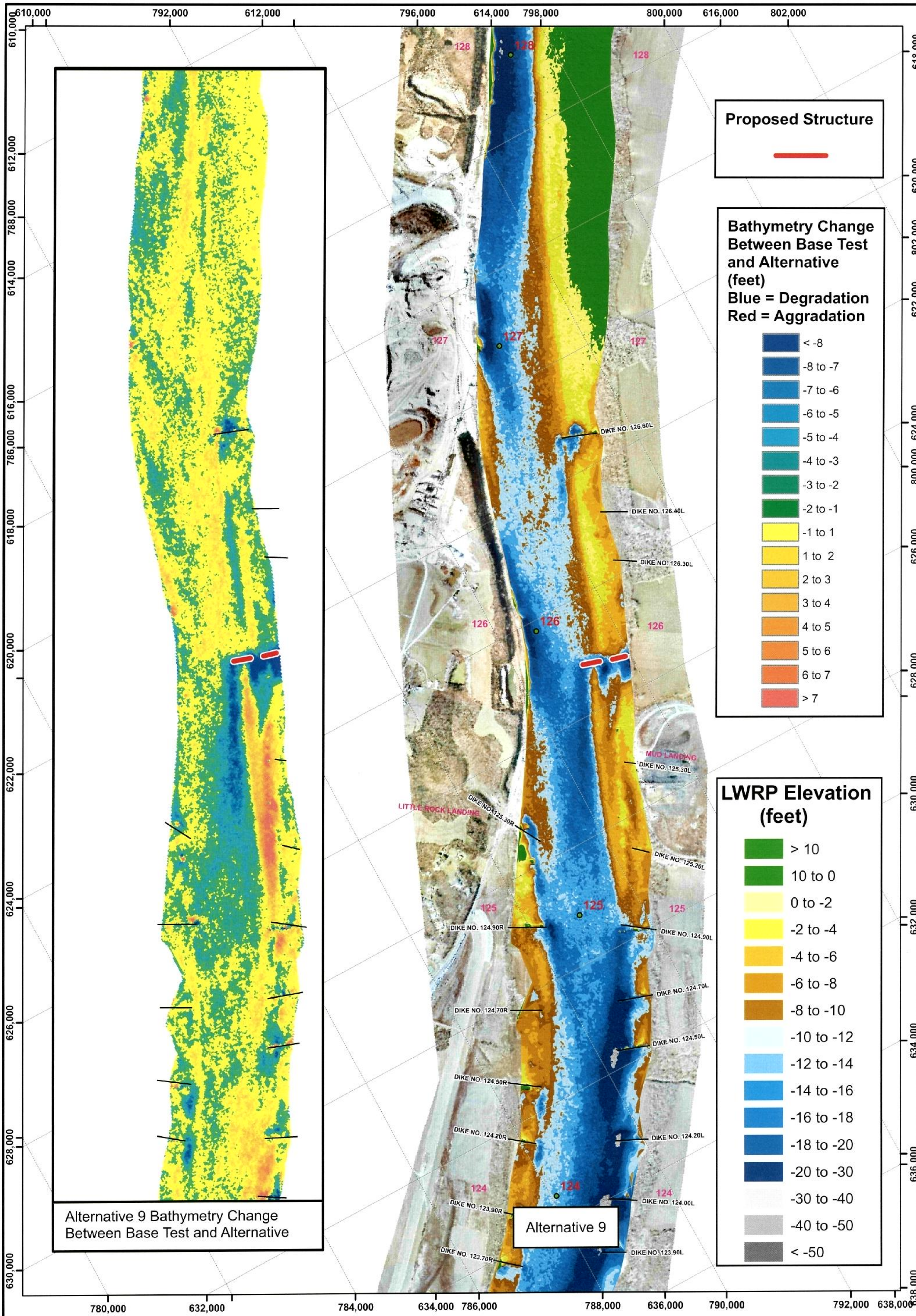

PLATE NUMBER C 9	0 500 1,000 2,000 Feet Alternative 9 Bathymetry Change Between Base Test and Alternative	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH	APPLIED RIVER ENGINEERING CENTER US Army Corps of Engineers St. Louis District

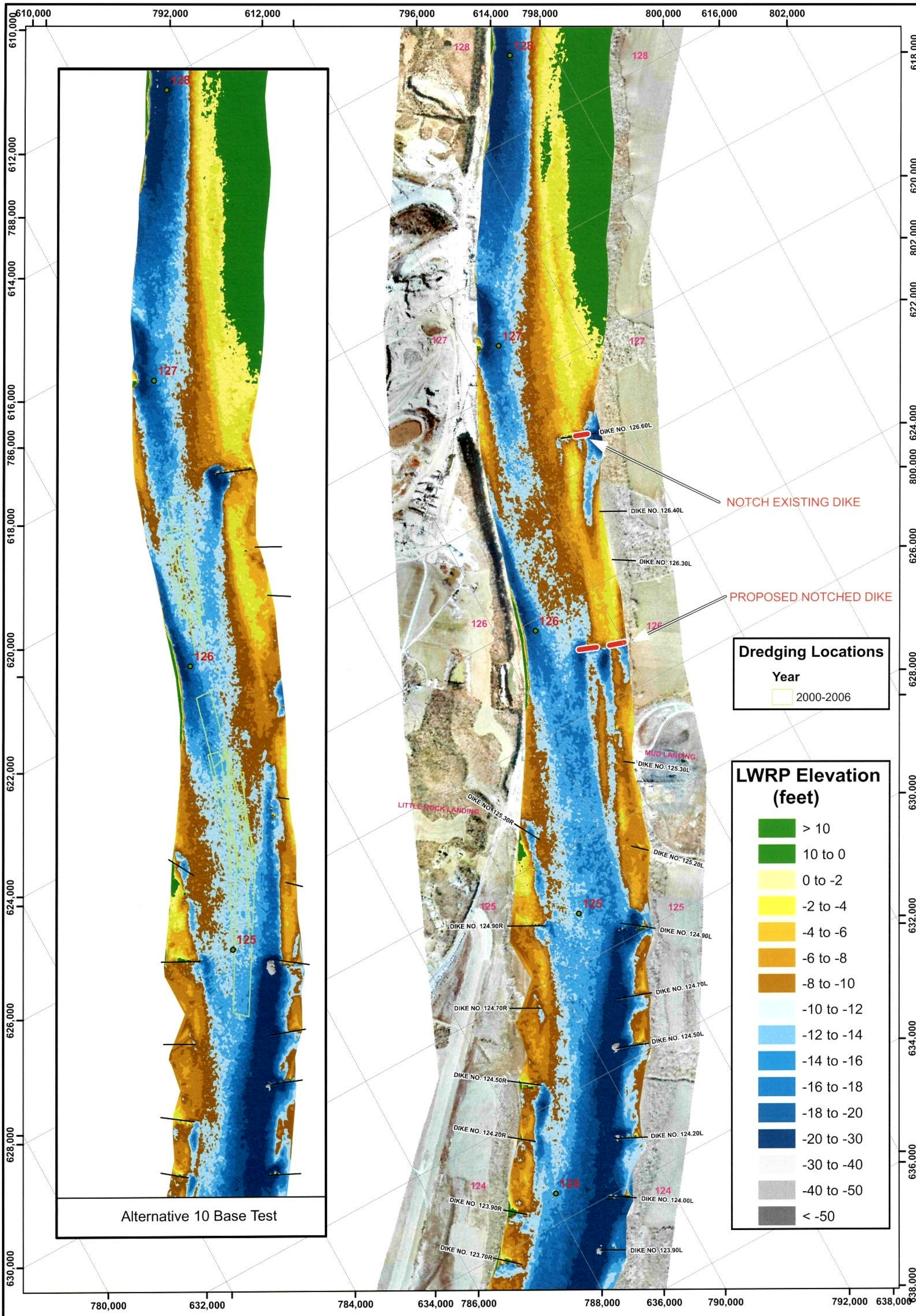

PLATE NUMBER A10	0 500 1,000 2,000 Feet Alternative 10	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH

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US Army Corps of Engineers
St. Louis District

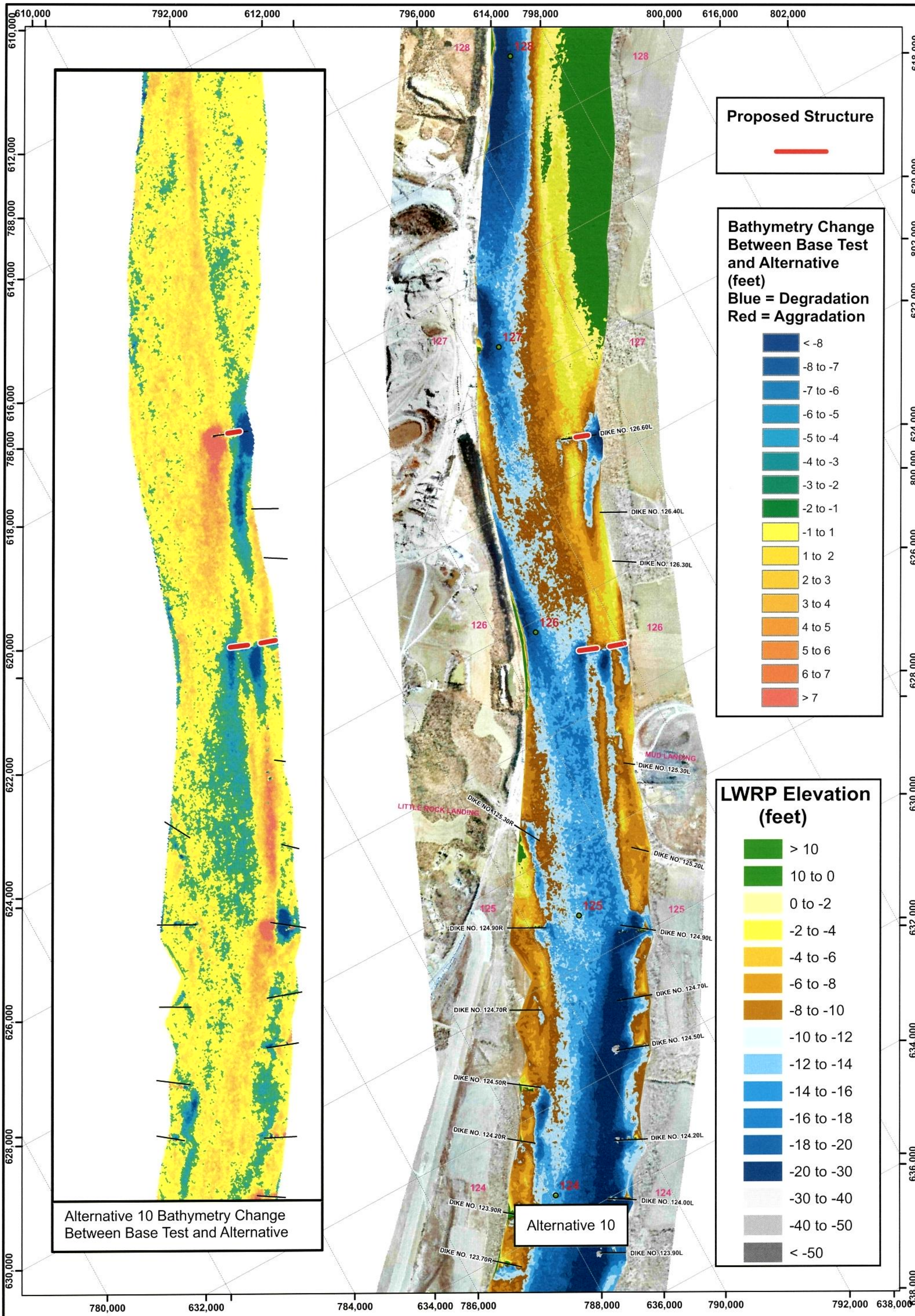

PLATE NUMBER C 10

0 500 1,000 2,000 Feet

Alternative 10 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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St. Louis District

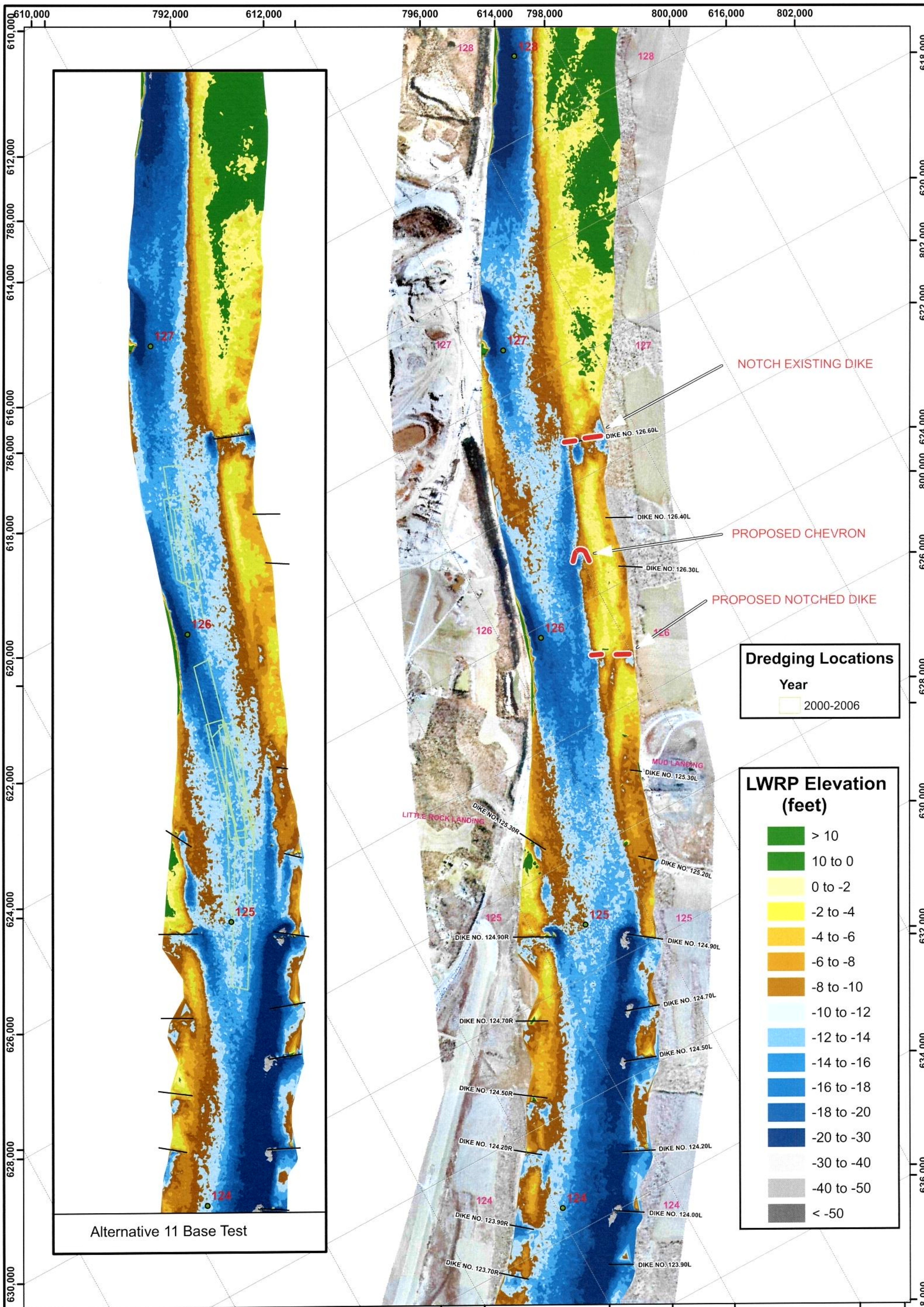

PLATE NUMBER
A 11

0 500 1,000 2,000
Feet

Alternative 11

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

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St. Louis District

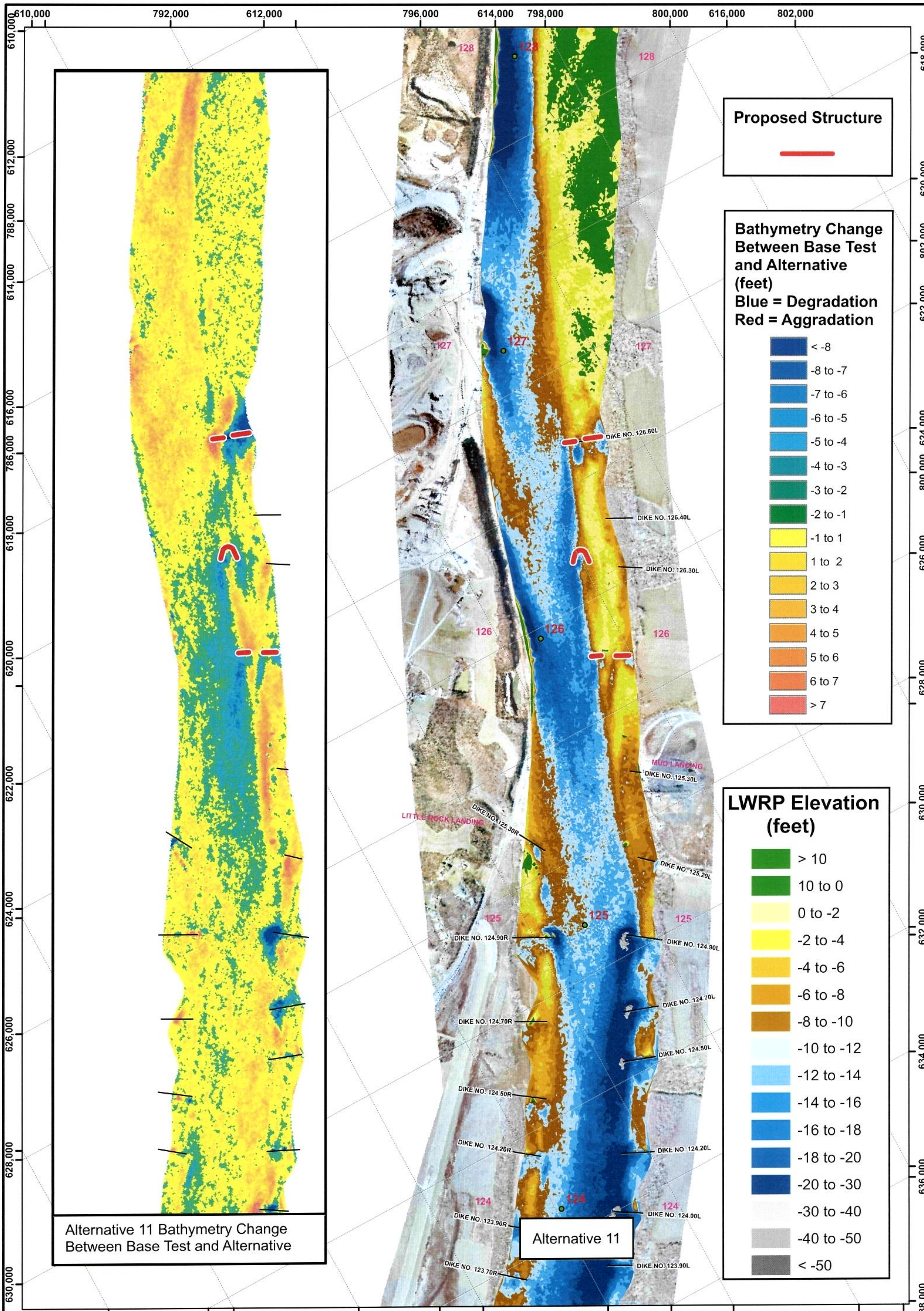

PLATE NUMBER
C 11

0 500 1,000 2,000 Feet

Alternative 11 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

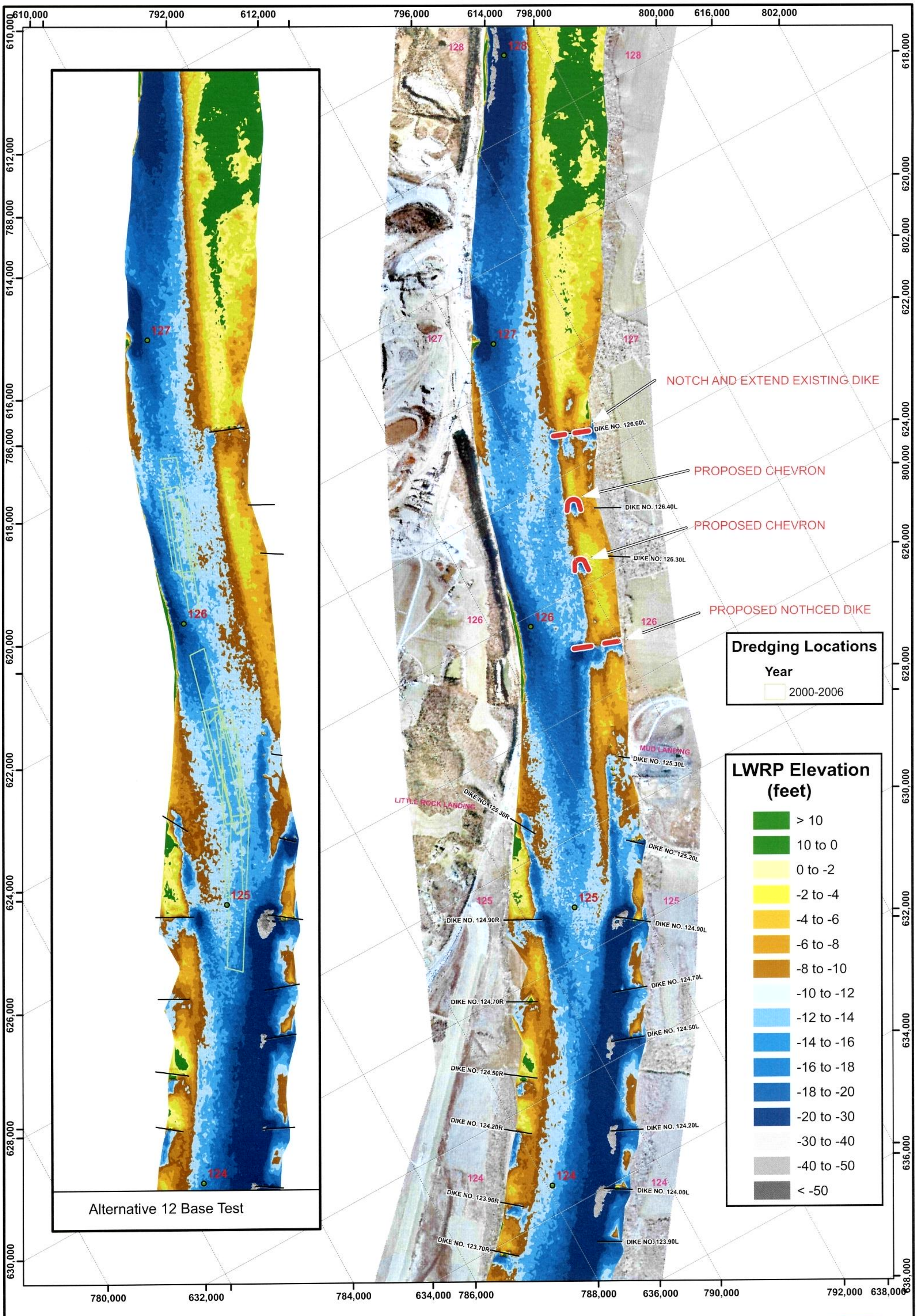

PLATE NUMBER A 12

0 500 1,000 2,000 Feet

Alternative 12

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

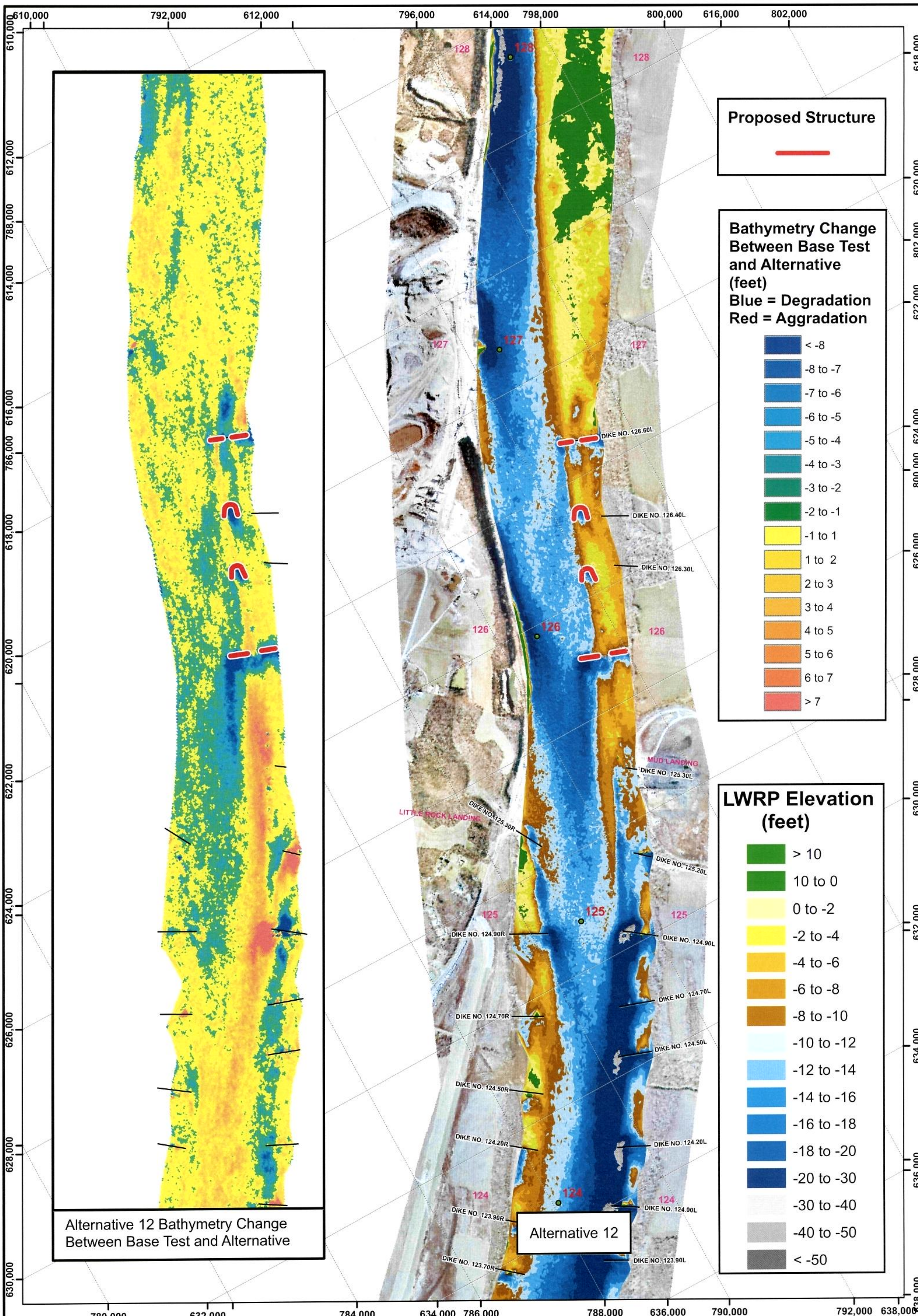

PLATE NUMBER
C 12

0 500 1,000 2,000 Feet

Alternative 12 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

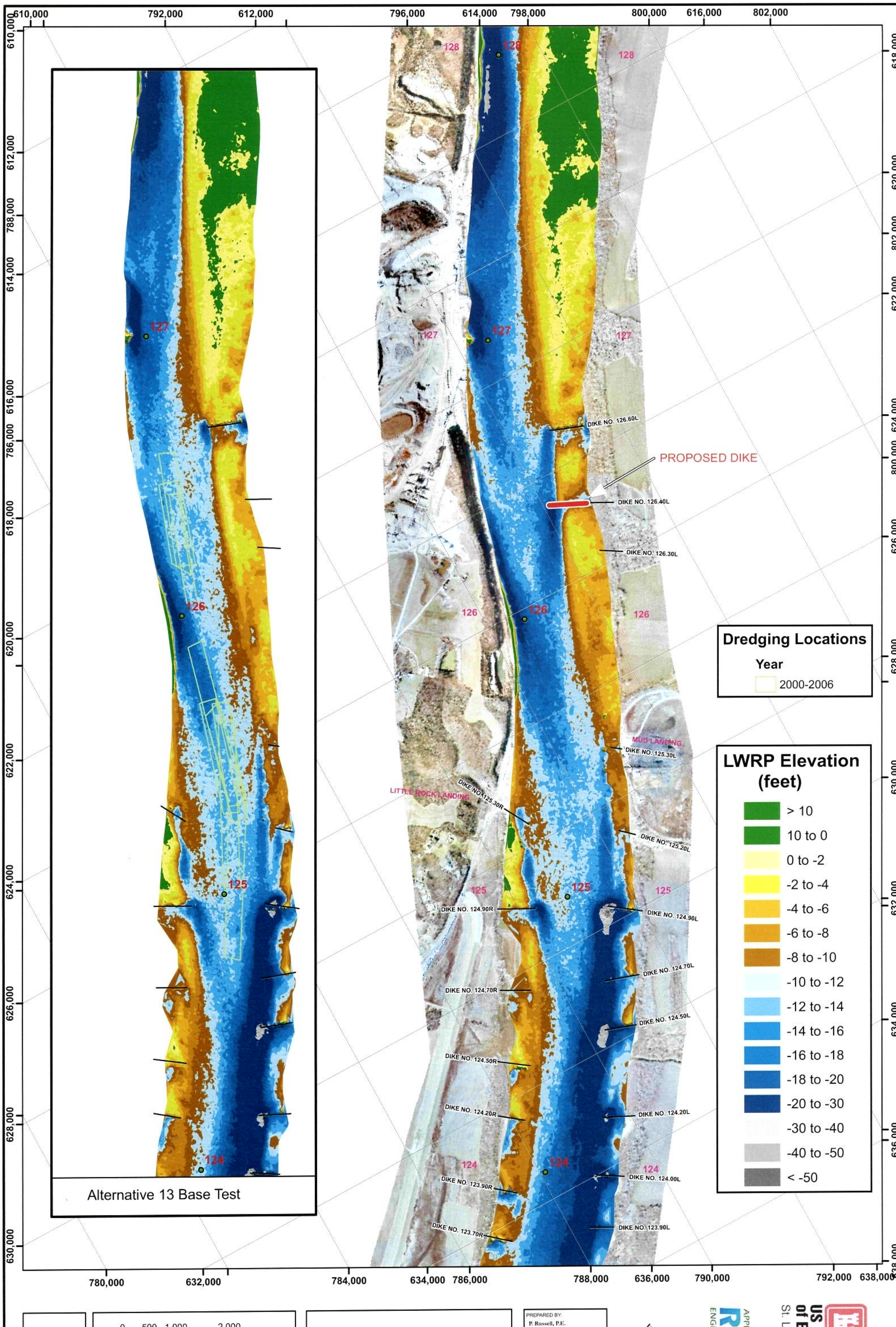

PLATE NUMBER A 13

0 500 1,000 2,000 Feet

Alternative 13

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

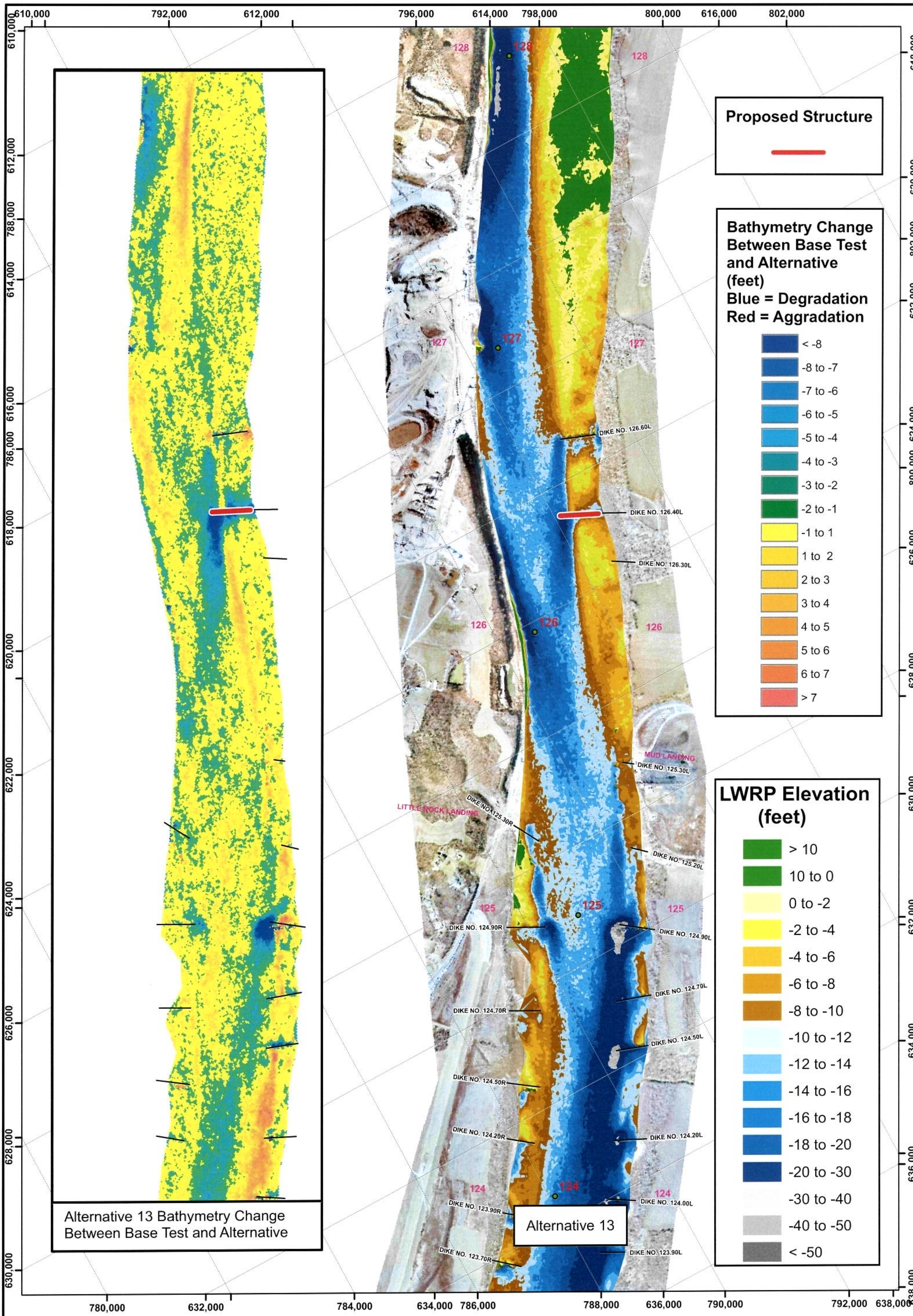

PLATE NUMBER C 13

0 500 1,000 2,000 Feet

Alternative 13 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

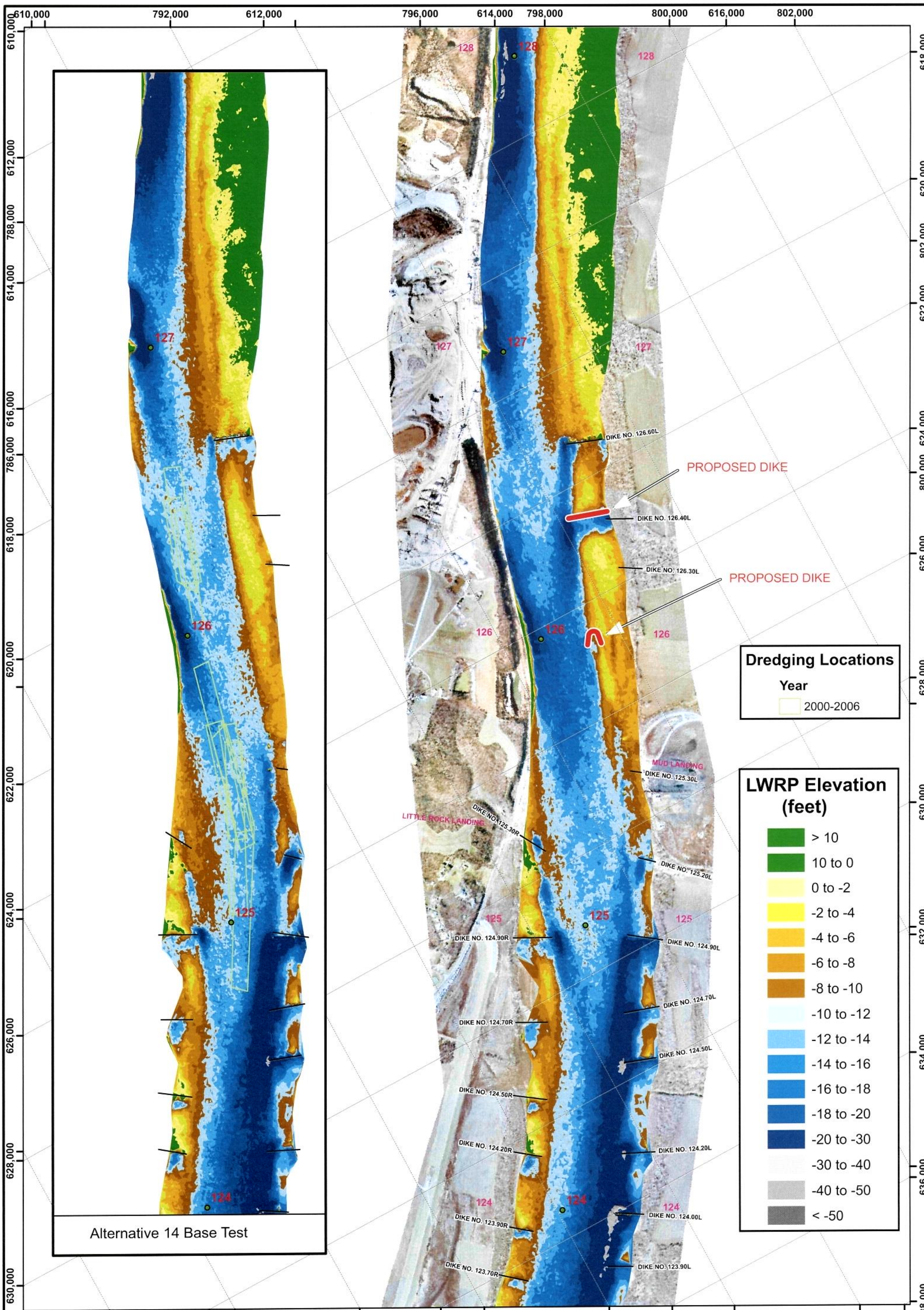

PLATE NUMBER
A 14

0 500 1,000 2,000 Feet

Alternative 14

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

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St. Louis District

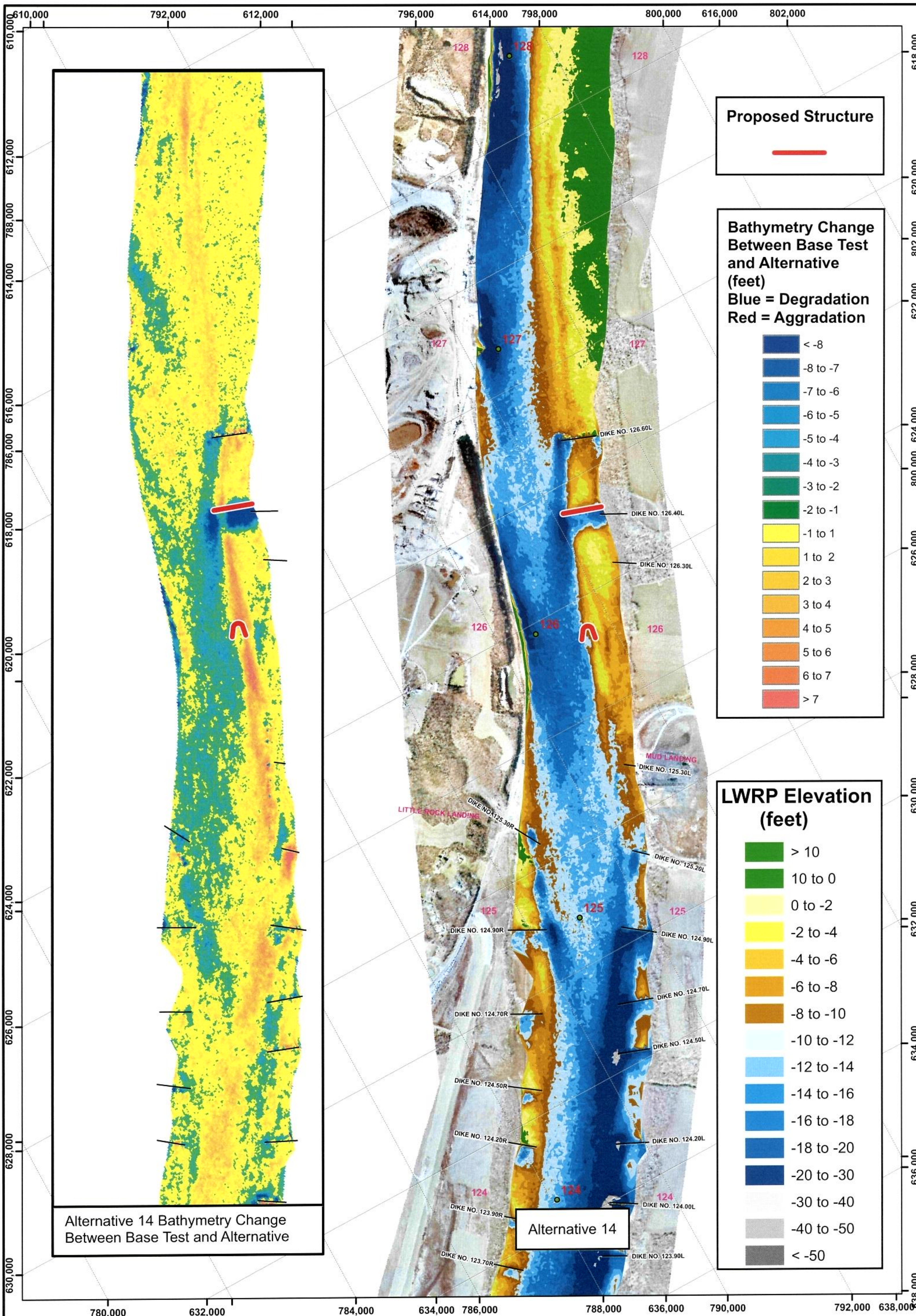

PLATE NUMBER C 14

0 500 1,000 2,000 Feet

Alternative 14 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

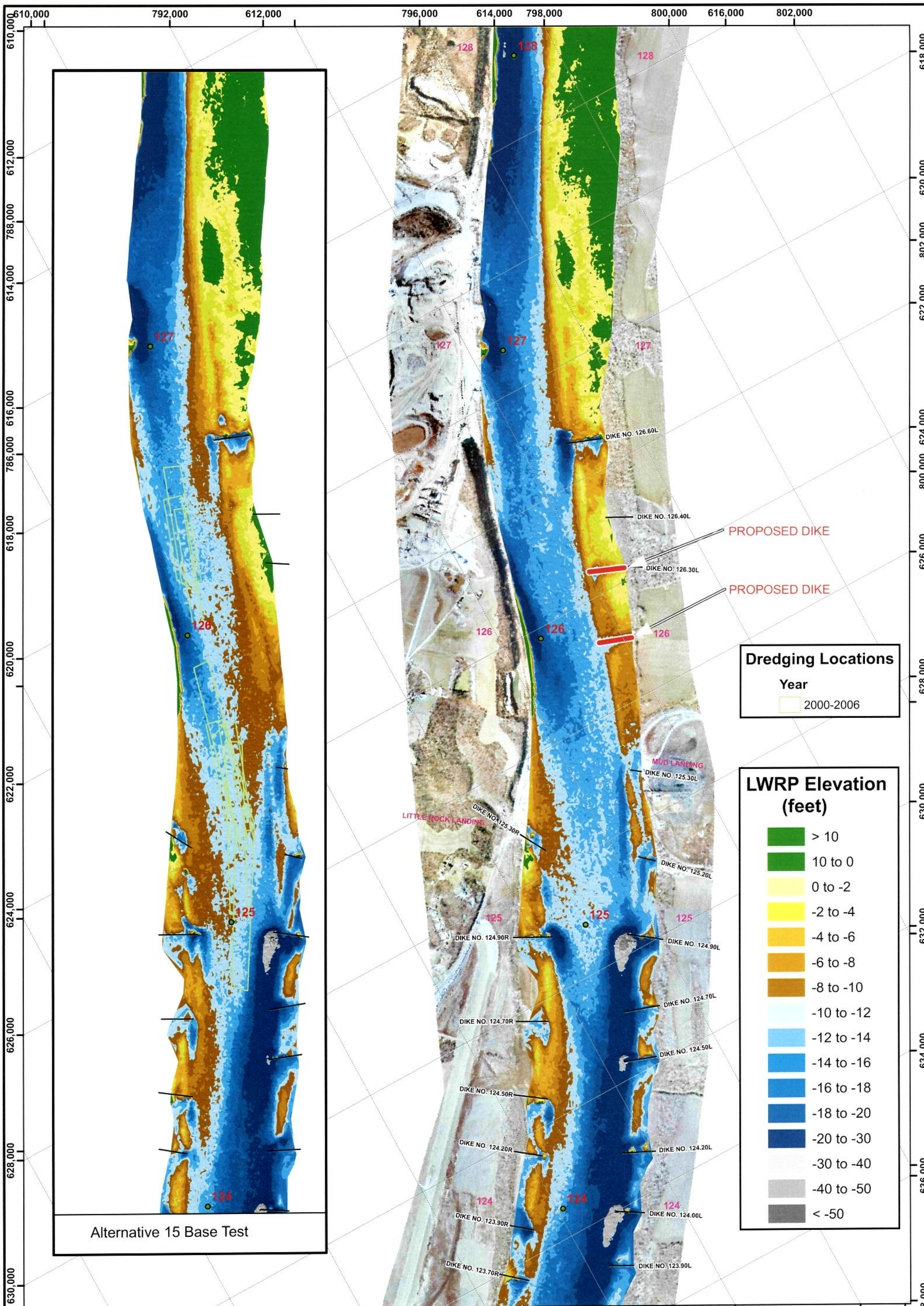

PLATE NUMBER
A 15

0 500 1,000 2,000
Feet

Alternative 15

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

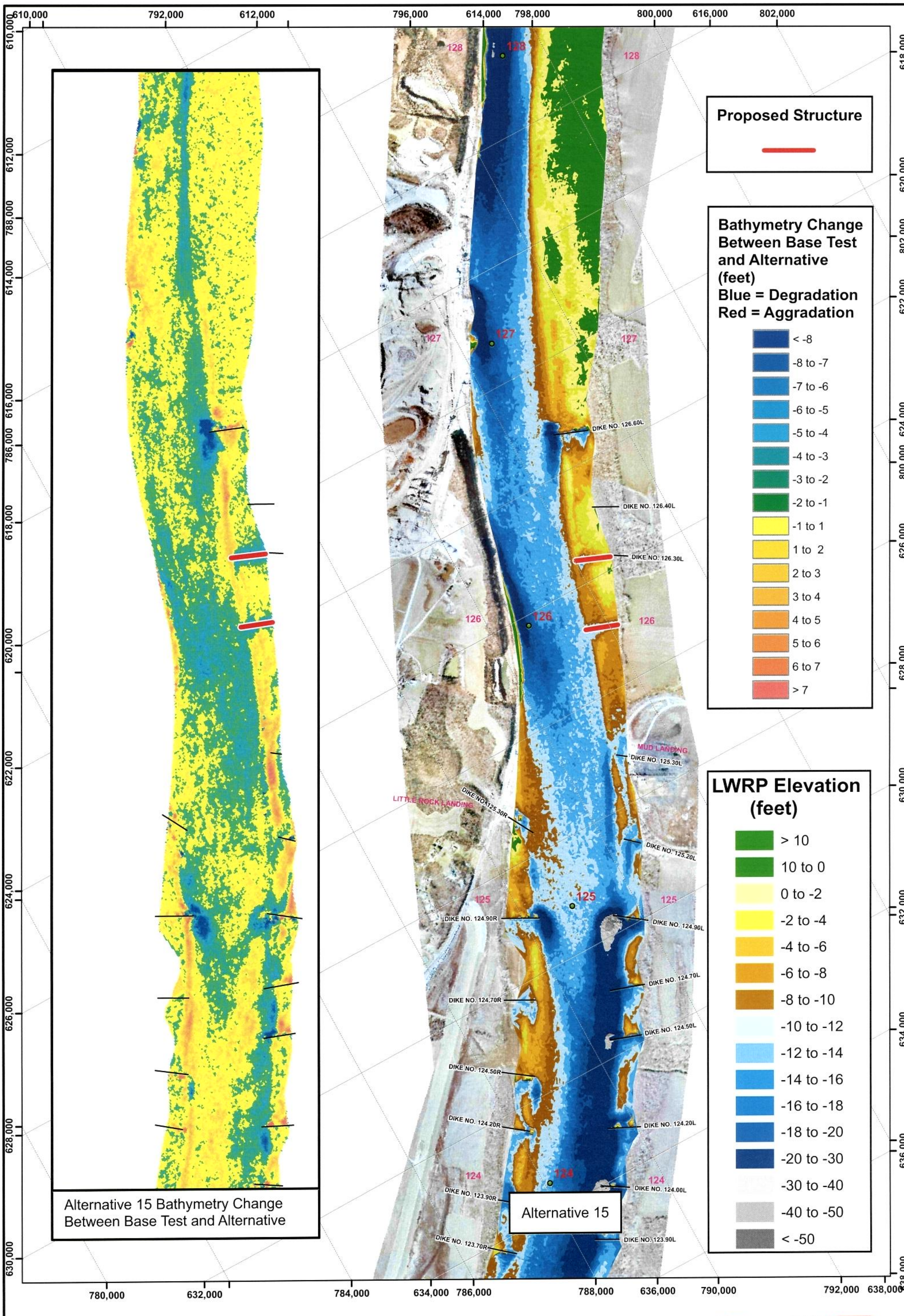

PLATE NUMBER C 15

0 500 1,000 2,000 Feet

Alternative 15 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

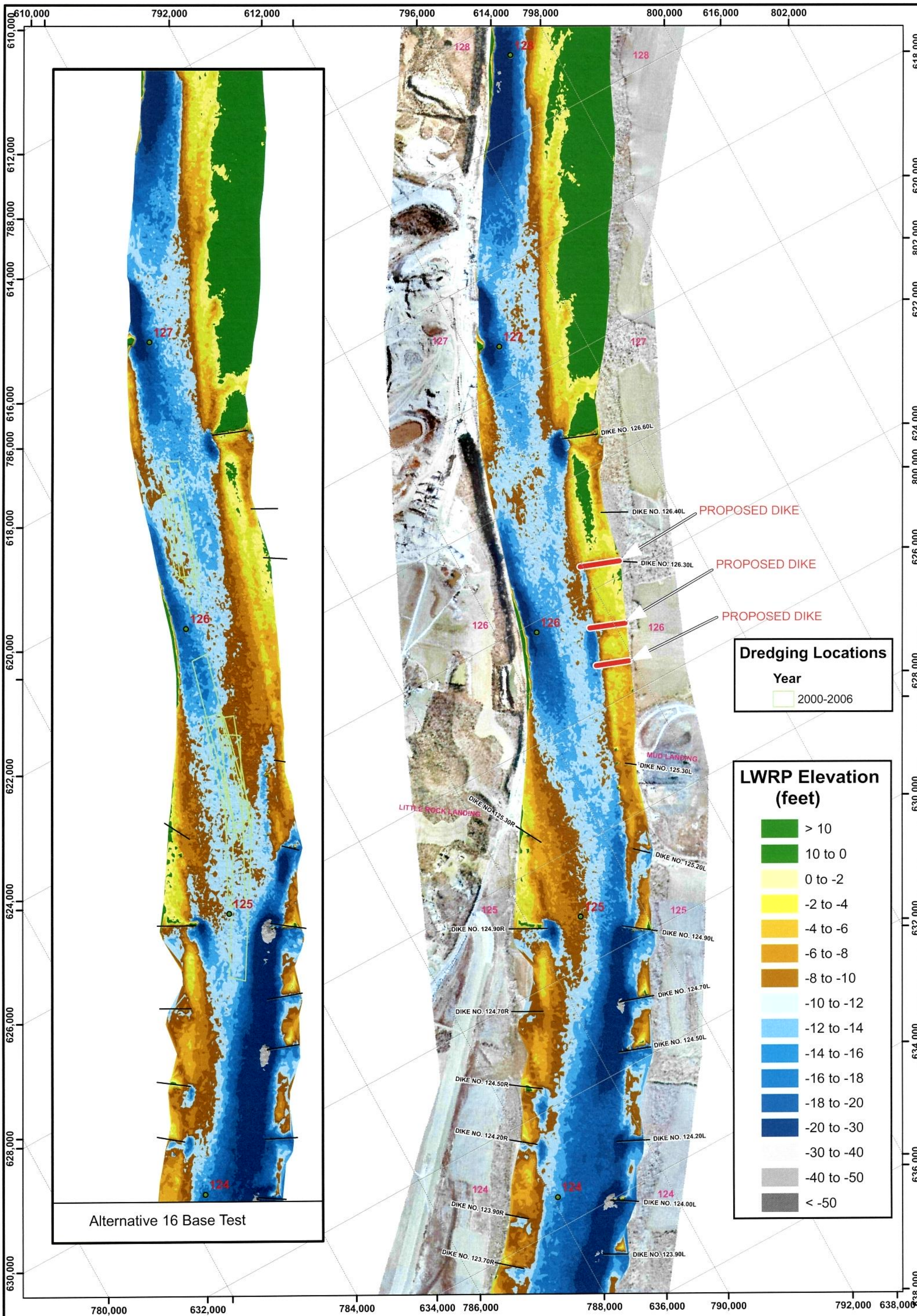

PLATE NUMBER **A 16**

Alternative 16

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

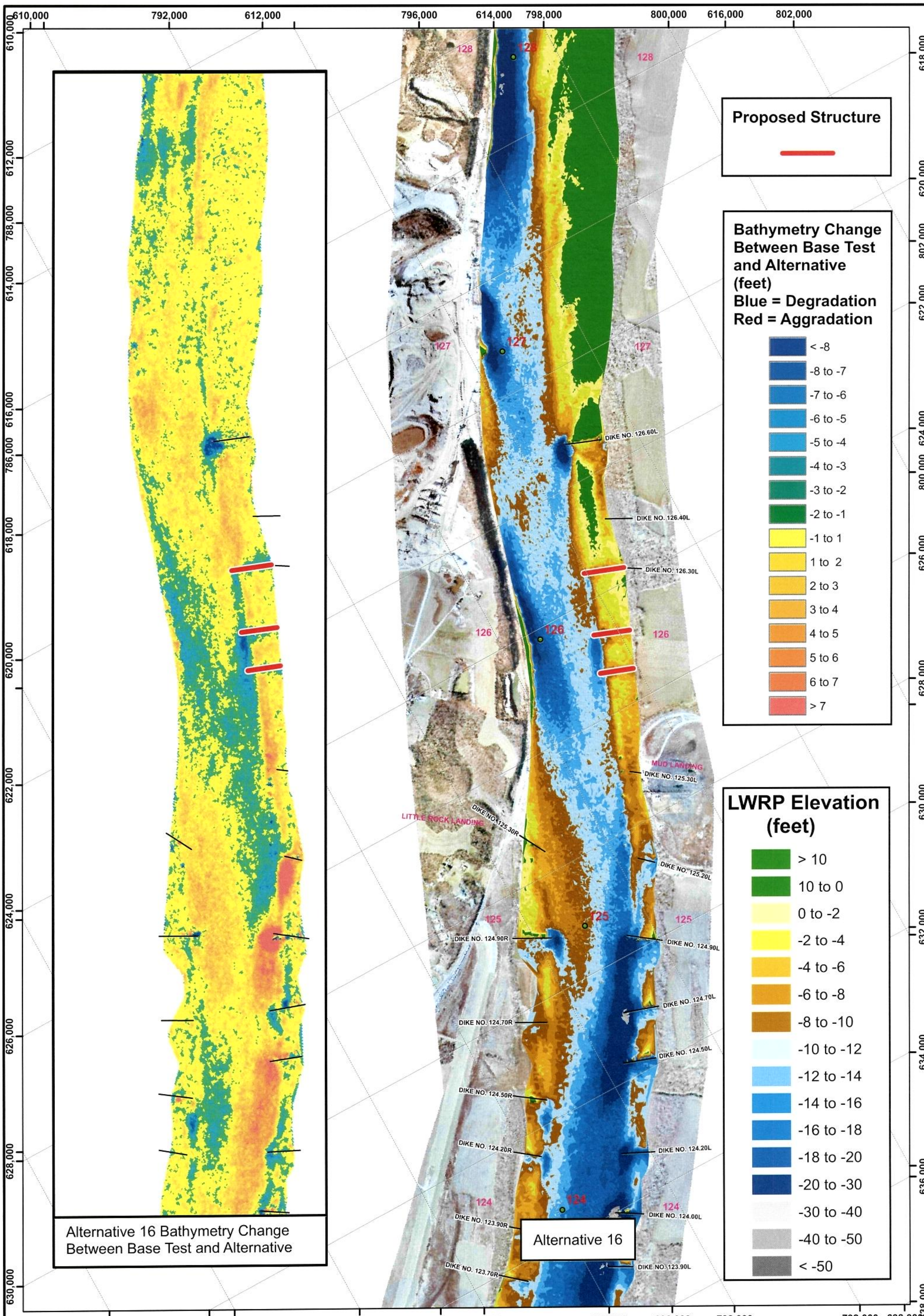

PLATE NUMBER C 16

0 500 1,000 2,000 Feet

Alternative 16 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

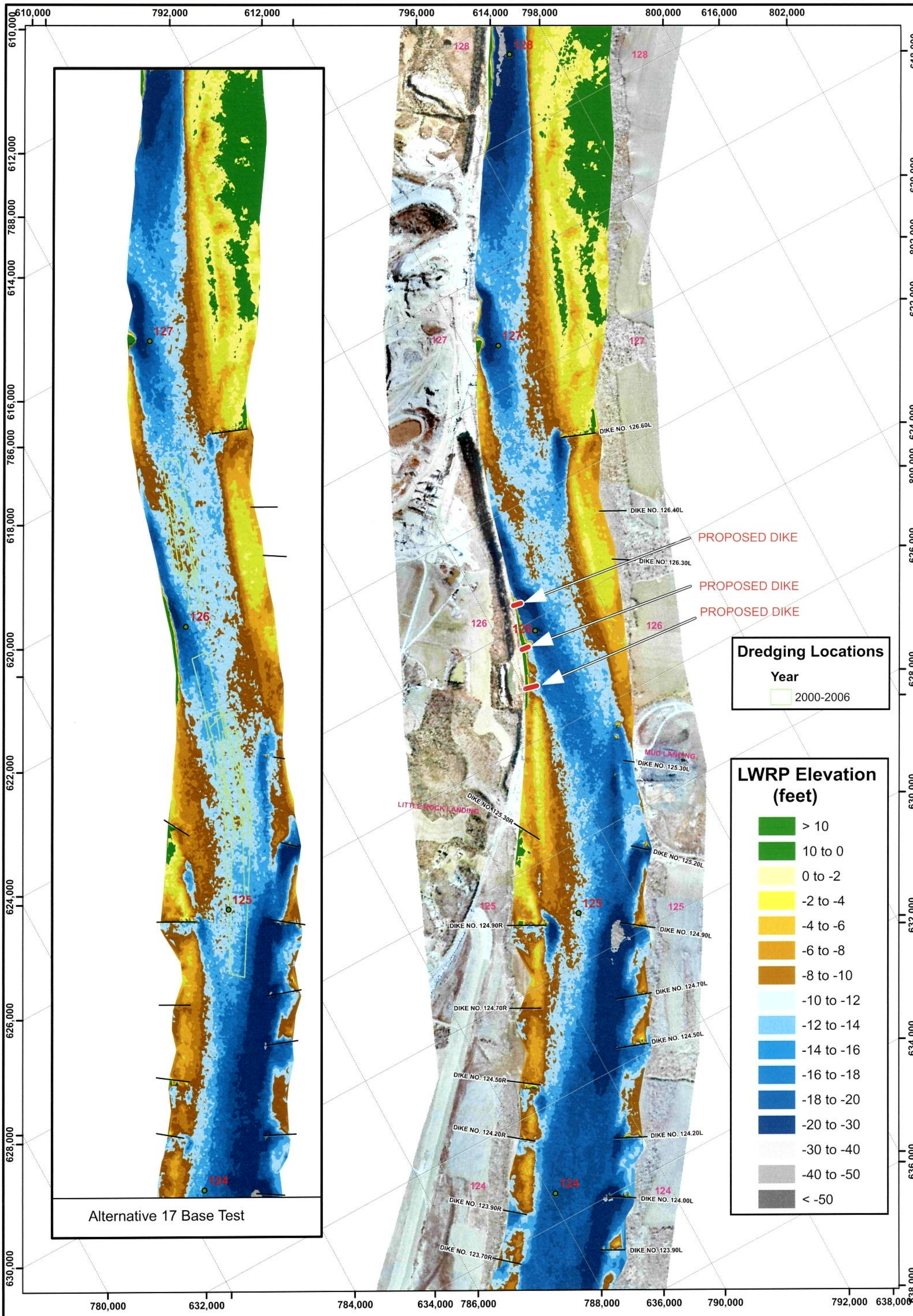

PLATE NUMBER A 17	0 500 1,000 2,000 Feet Alternative 17	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH	APPLIED RIVER ENGINEERING CENTER US Army Corps of Engineers St. Louis District

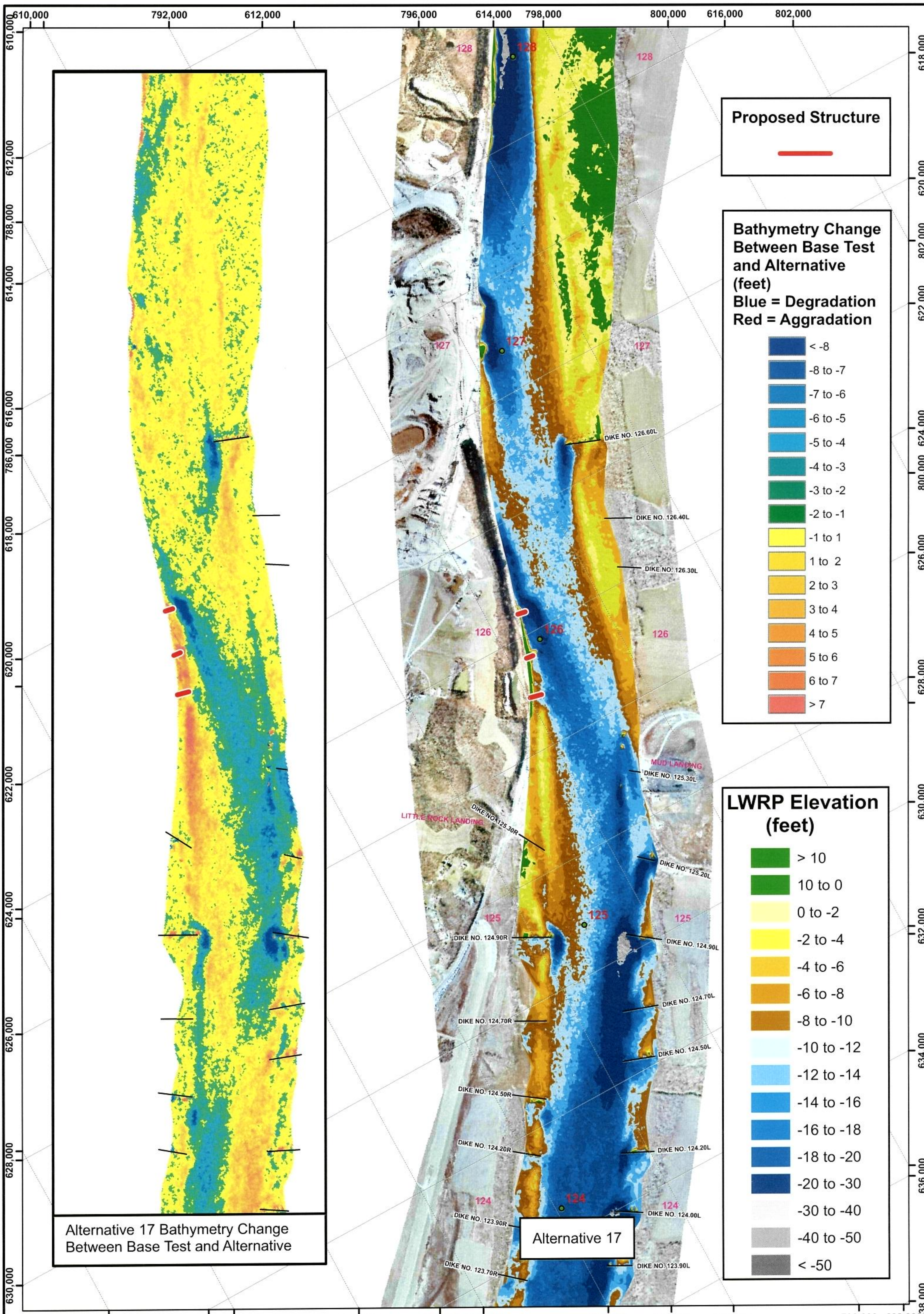

PLATE NUMBER
C 17

0 500 1,000 2,000 Feet

Alternative 17 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

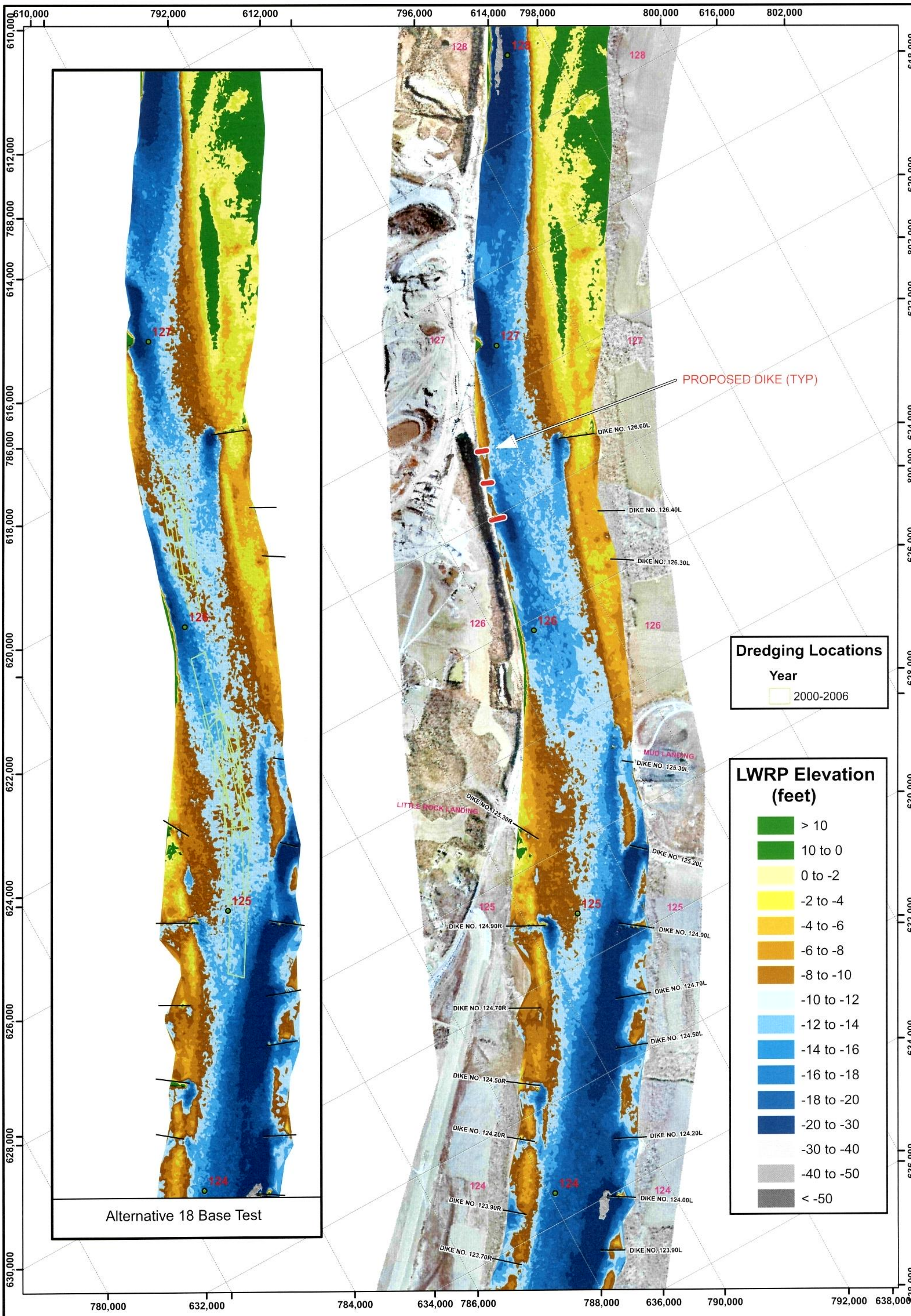

PLATE NUMBER A 18	0 500 1,000 2,000 Feet	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT	PREPARED BY: P. Russell, P.E.	CHECKED BY: J. Brown, P.E.
	Alternative 18	Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	2006 AERIAL PHOTOGRAPH	

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US Army Corps of Engineers
St. Louis District

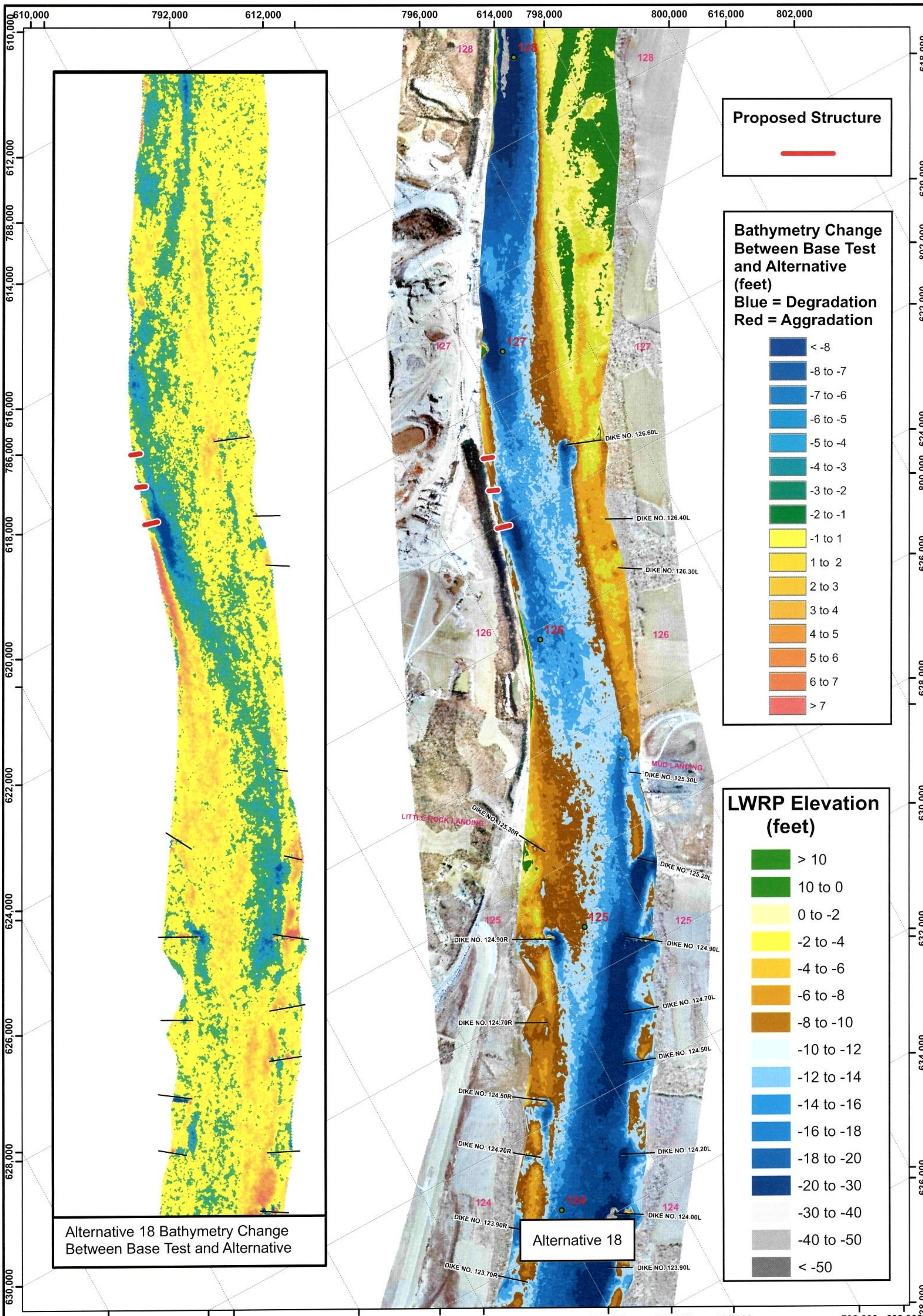

PLATE NUMBER C 18

0 500 1,000 2,000 Feet

Alternative 18 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

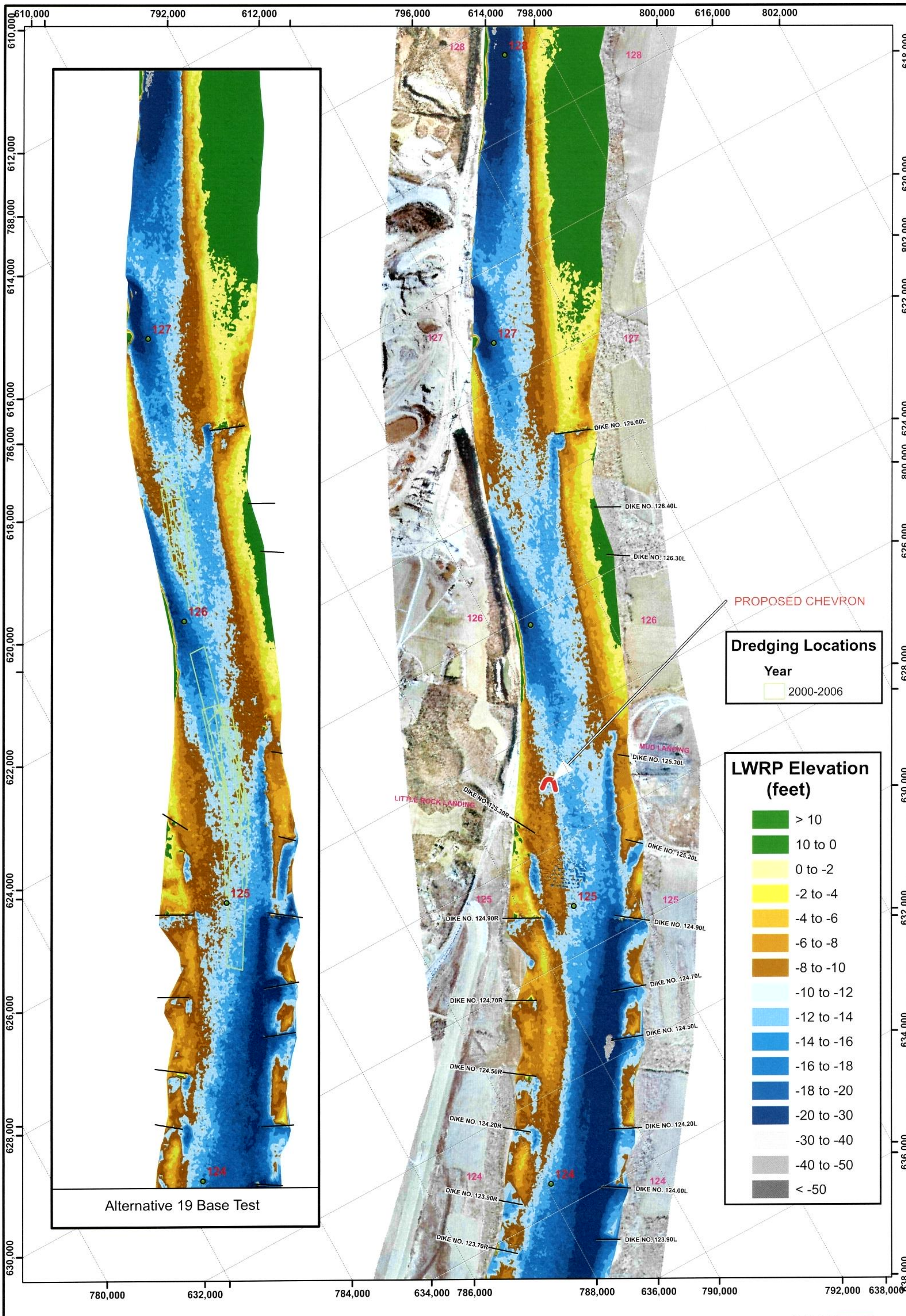

PLATE NUMBER A 19

0 500 1,000 2,000 Feet

Alternative 19

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

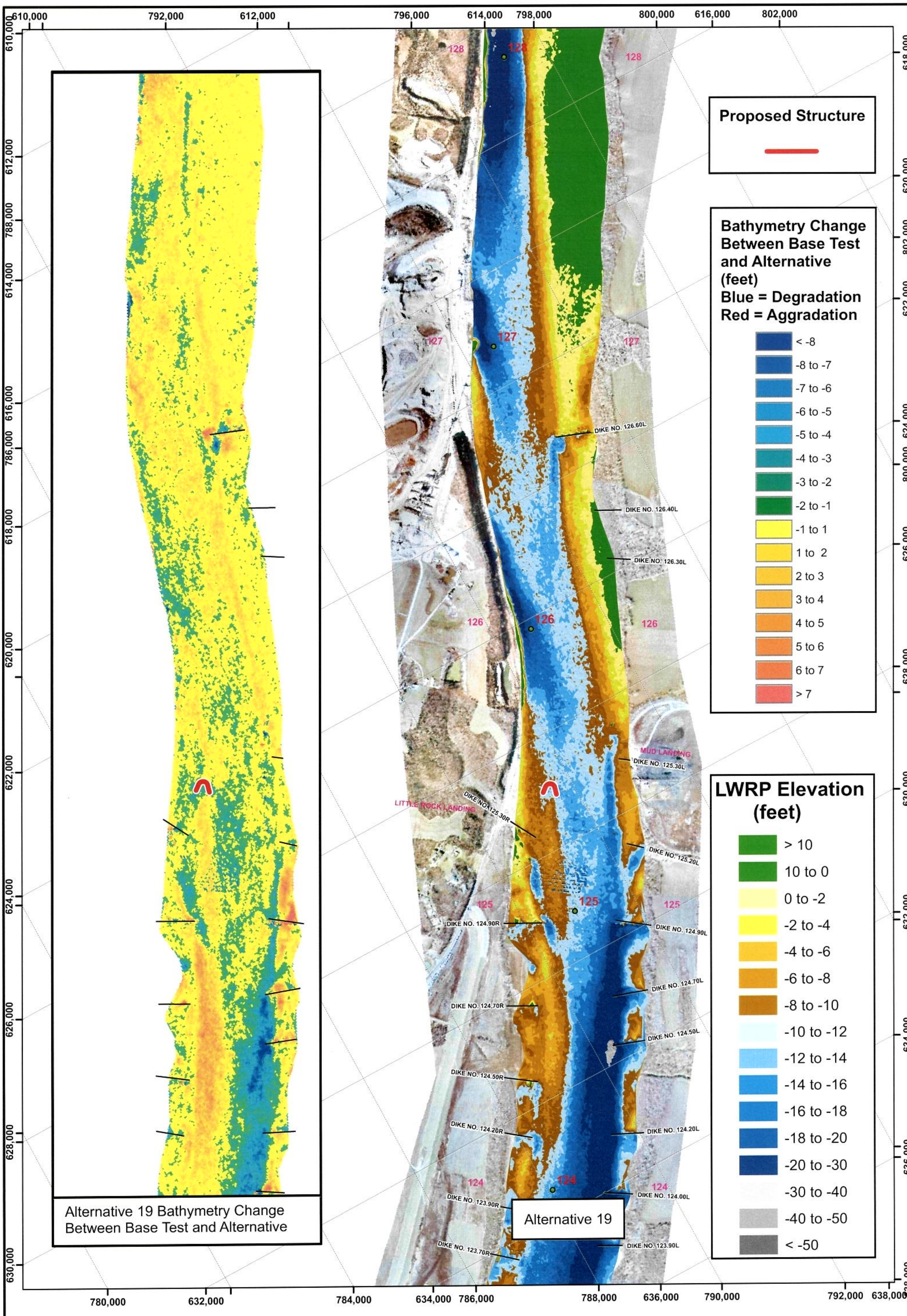

PLATE NUMBER C 19

0 500 1,000 2,000 Feet

Alternative 19 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

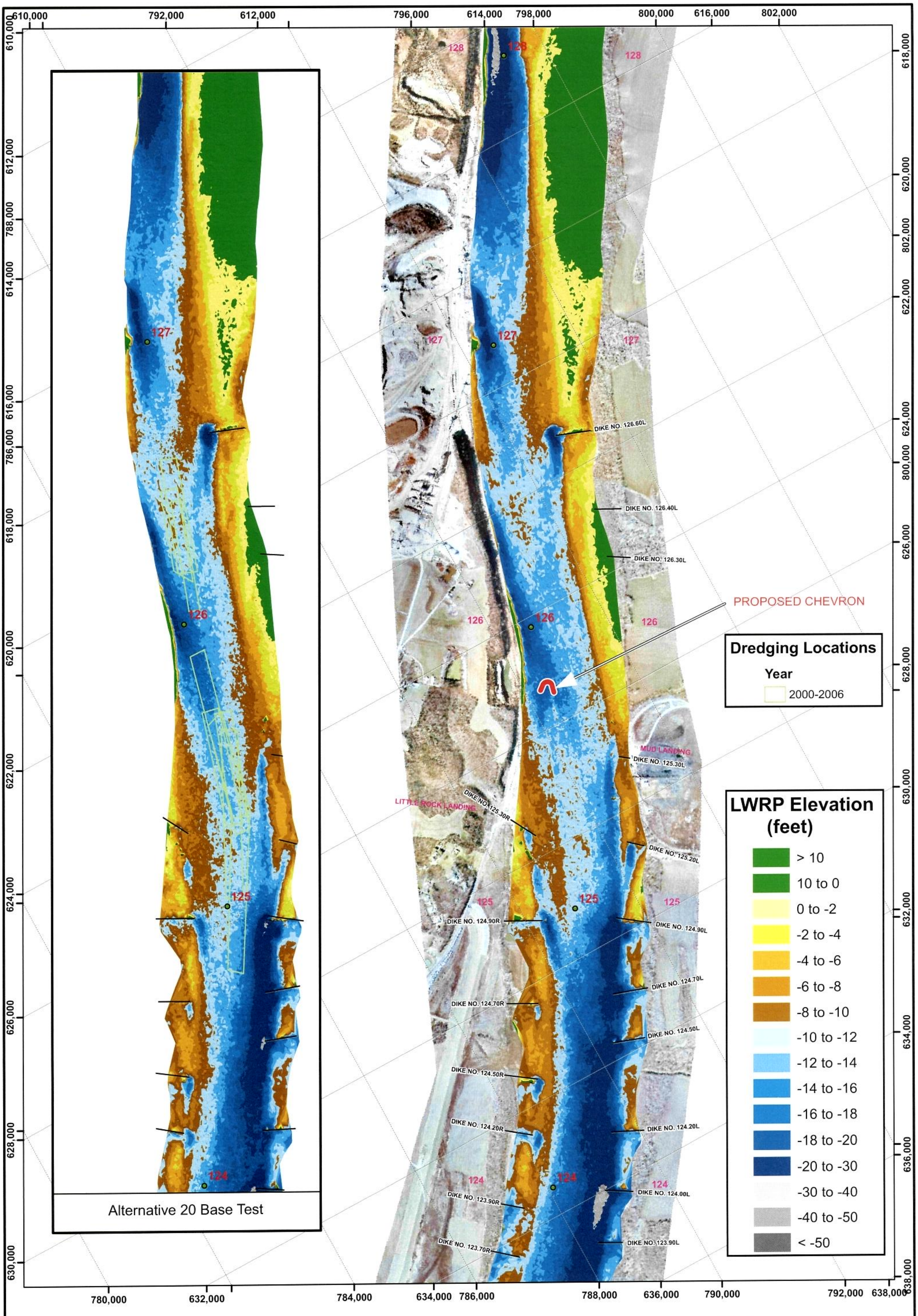

PLATE NUMBER
A 20

0 500 1,000 2,000 Feet

Alternative 20

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

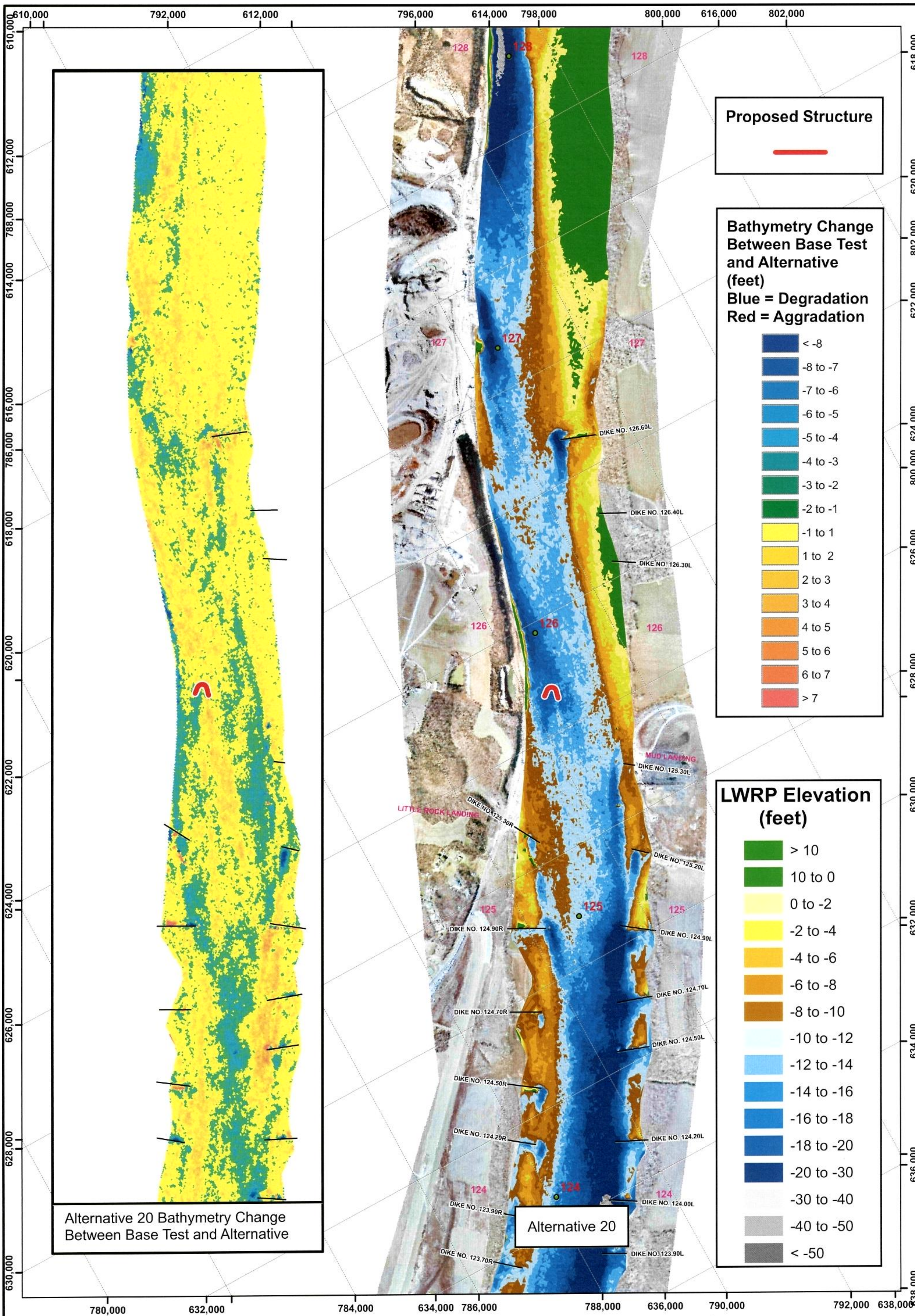

PLATE NUMBER
C 20

0 500 1,000 2,000
Feet

Alternative 20 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

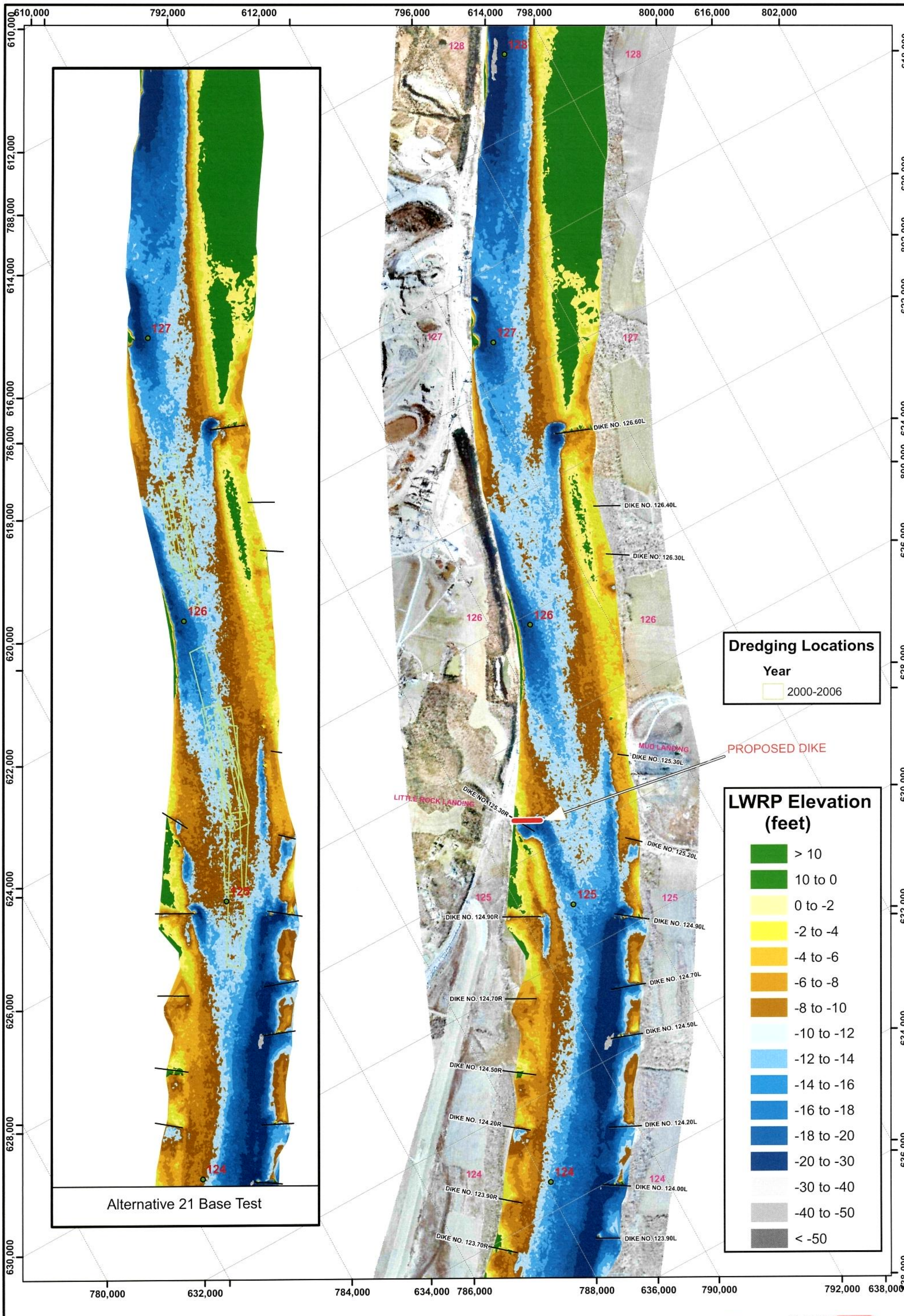

PLATE NUMBER
A 21

0 500 1,000 2,000 Feet

Alternative 21

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

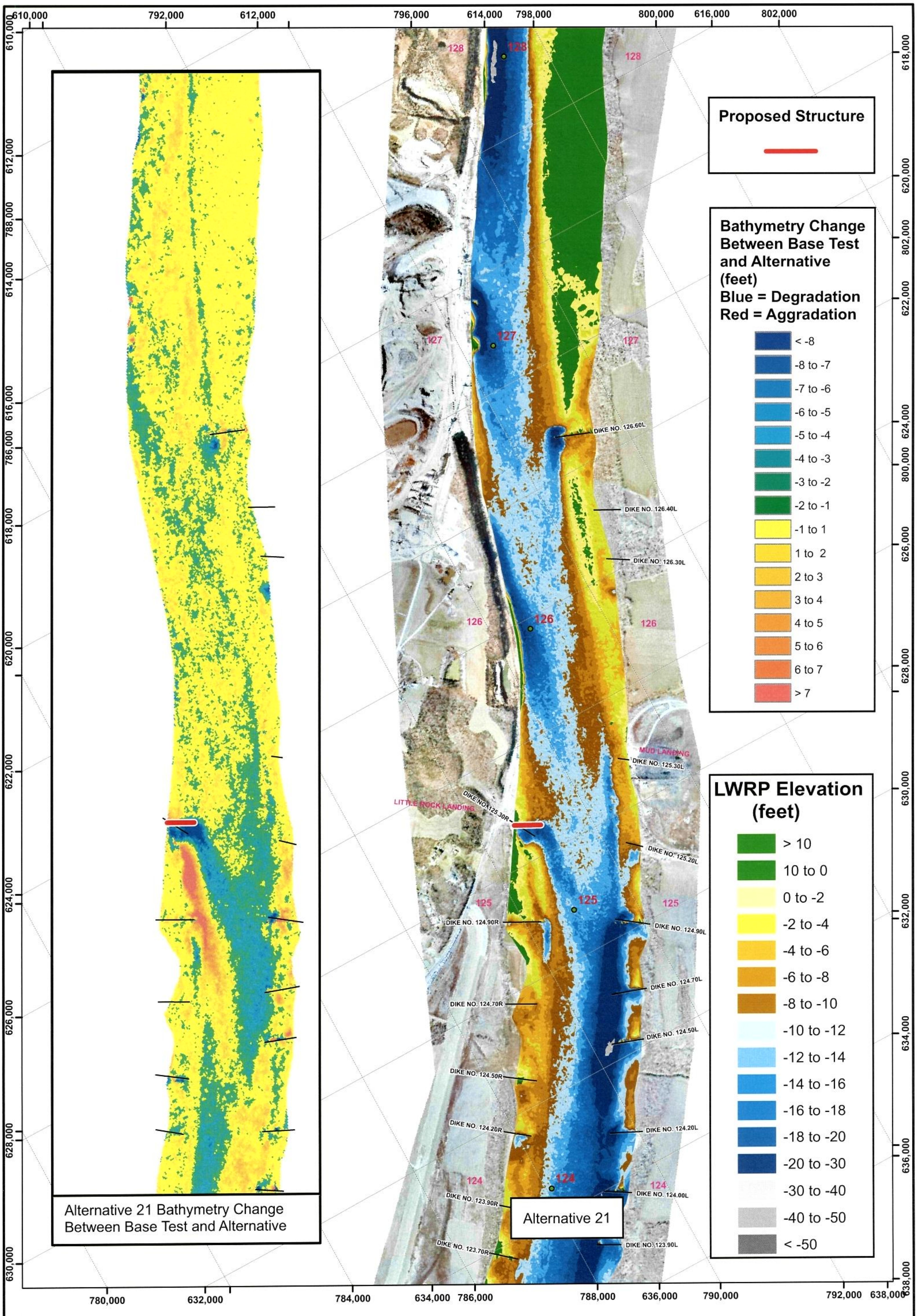

PLATE NUMBER C 21

0 500 1,000 2,000 Feet

Alternative 21 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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St. Louis District

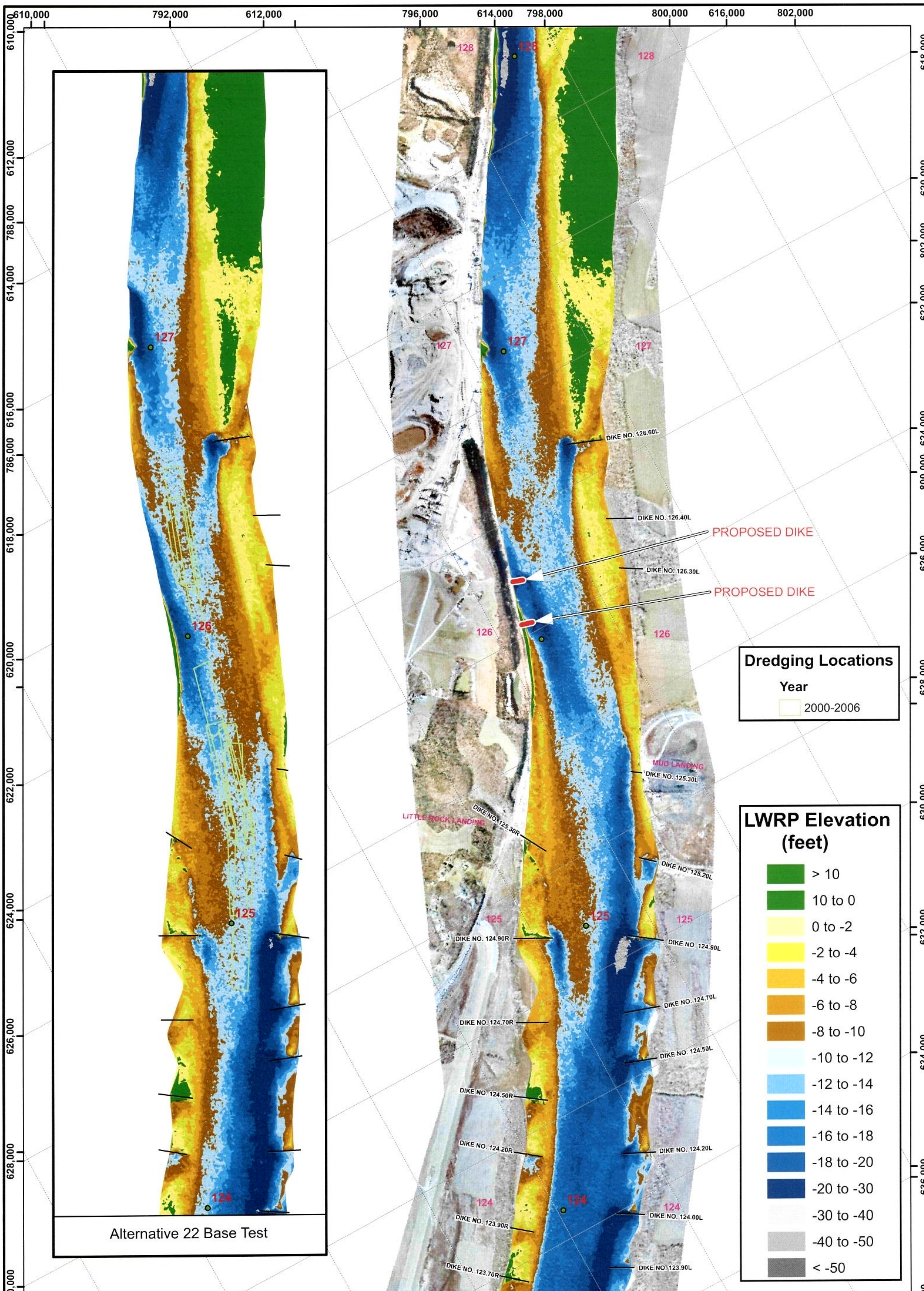

PLATE NUMBER A 22

0 500 1,000 2,000 Feet

Alternative 22

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

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US Army Corps of Engineers
St. Louis District

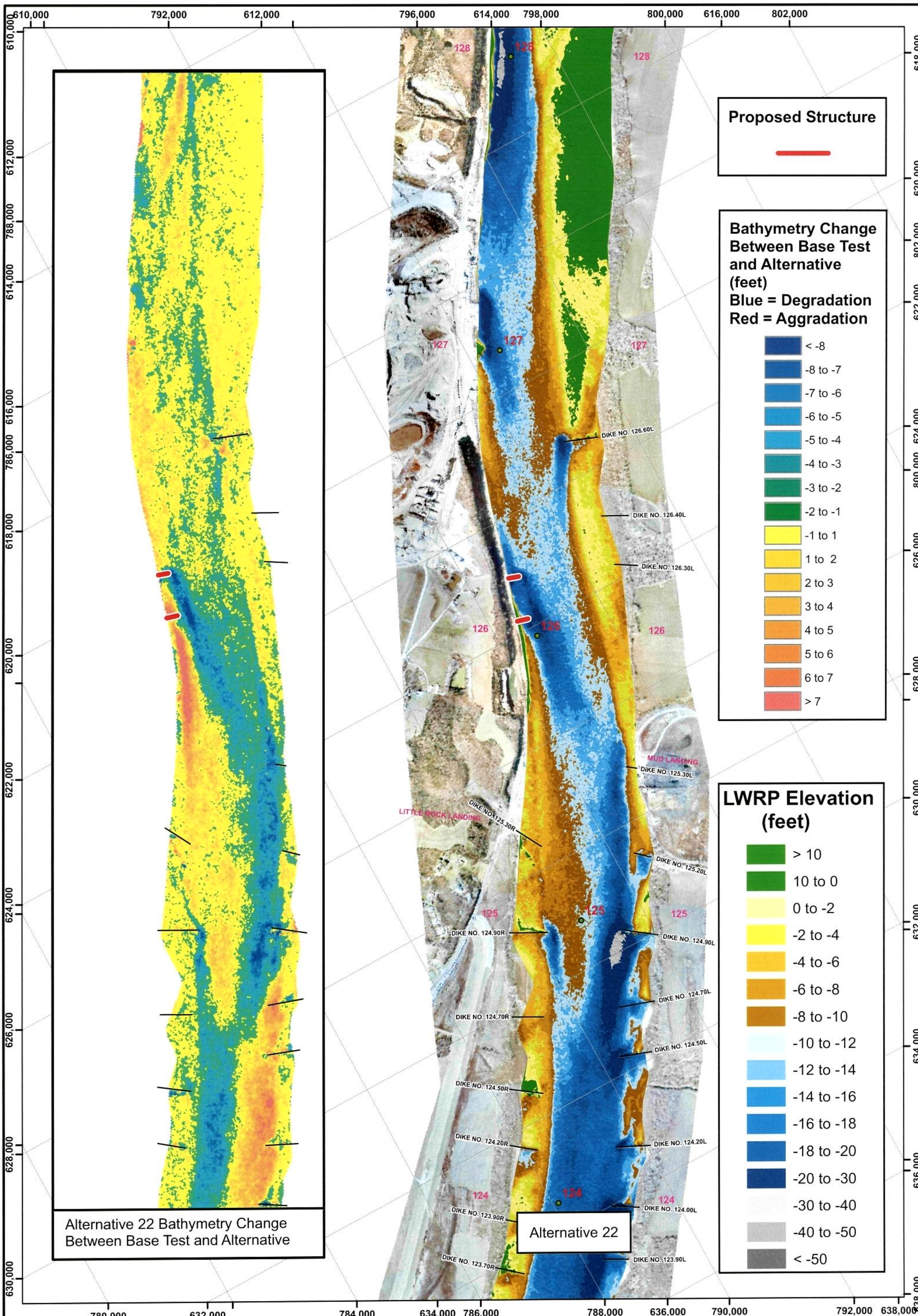

PLATE NUMBER C 22

0 500 1,000 2,000 Feet

Alternative 22 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

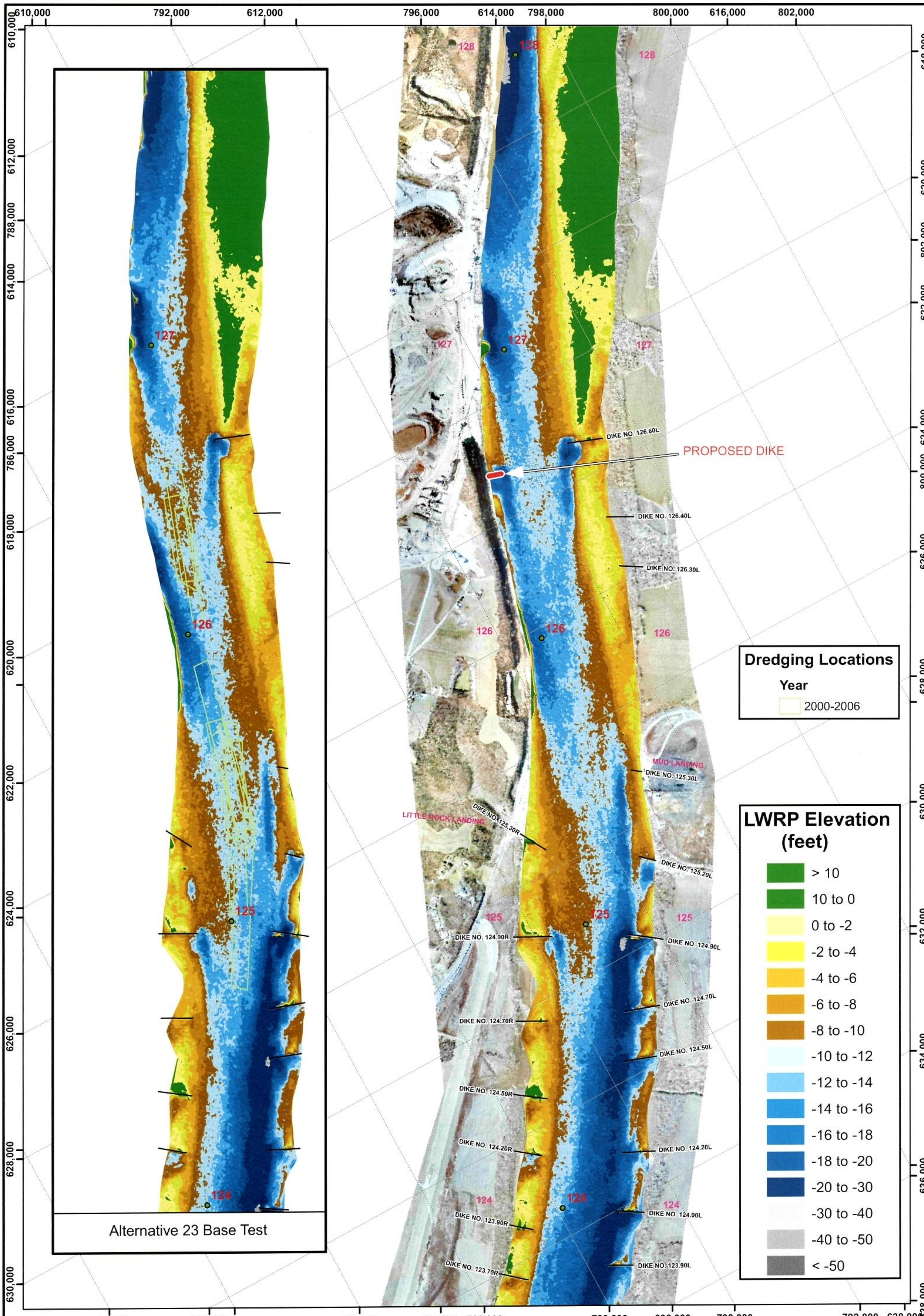

PLATE NUMBER A 23

0 500 1,000 2,000 Feet

Alternative 23

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

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St. Louis District

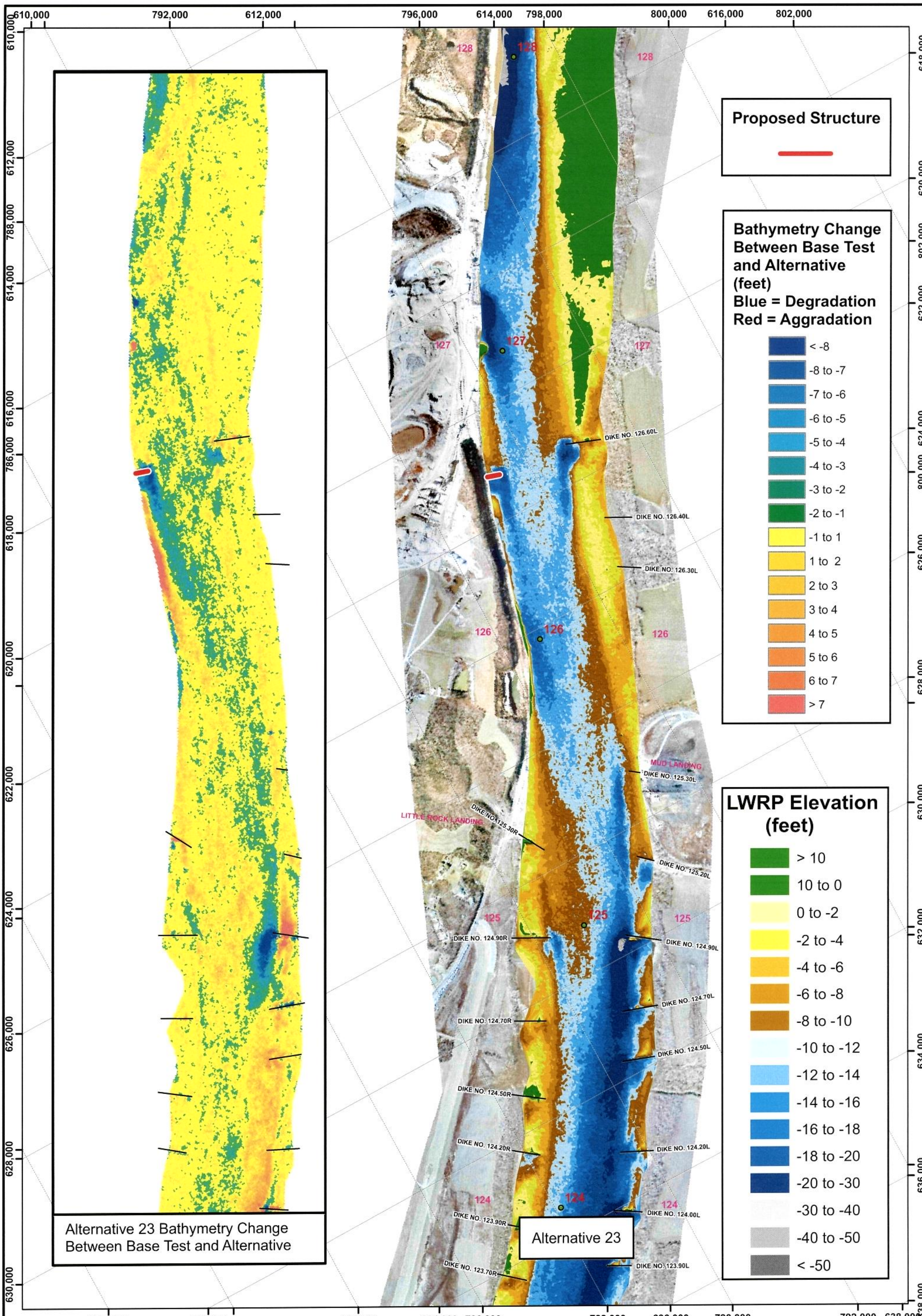

PLATE NUMBER C 23

0 500 1,000 2,000 Feet

Alternative 23 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

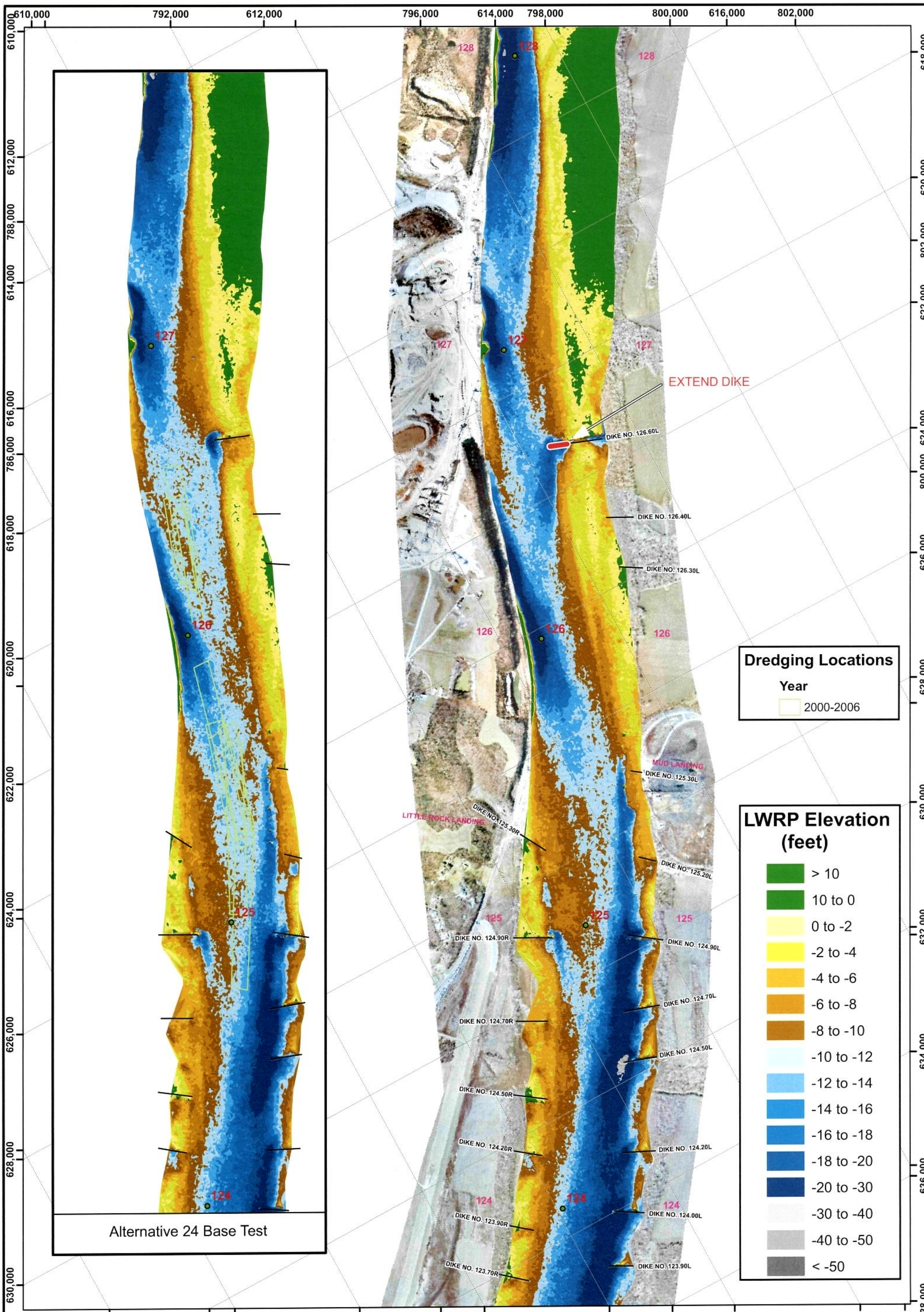

PLATE NUMBER	0 500 1,000 2,000 Feet	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E.
A 24	Alternative 24	Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

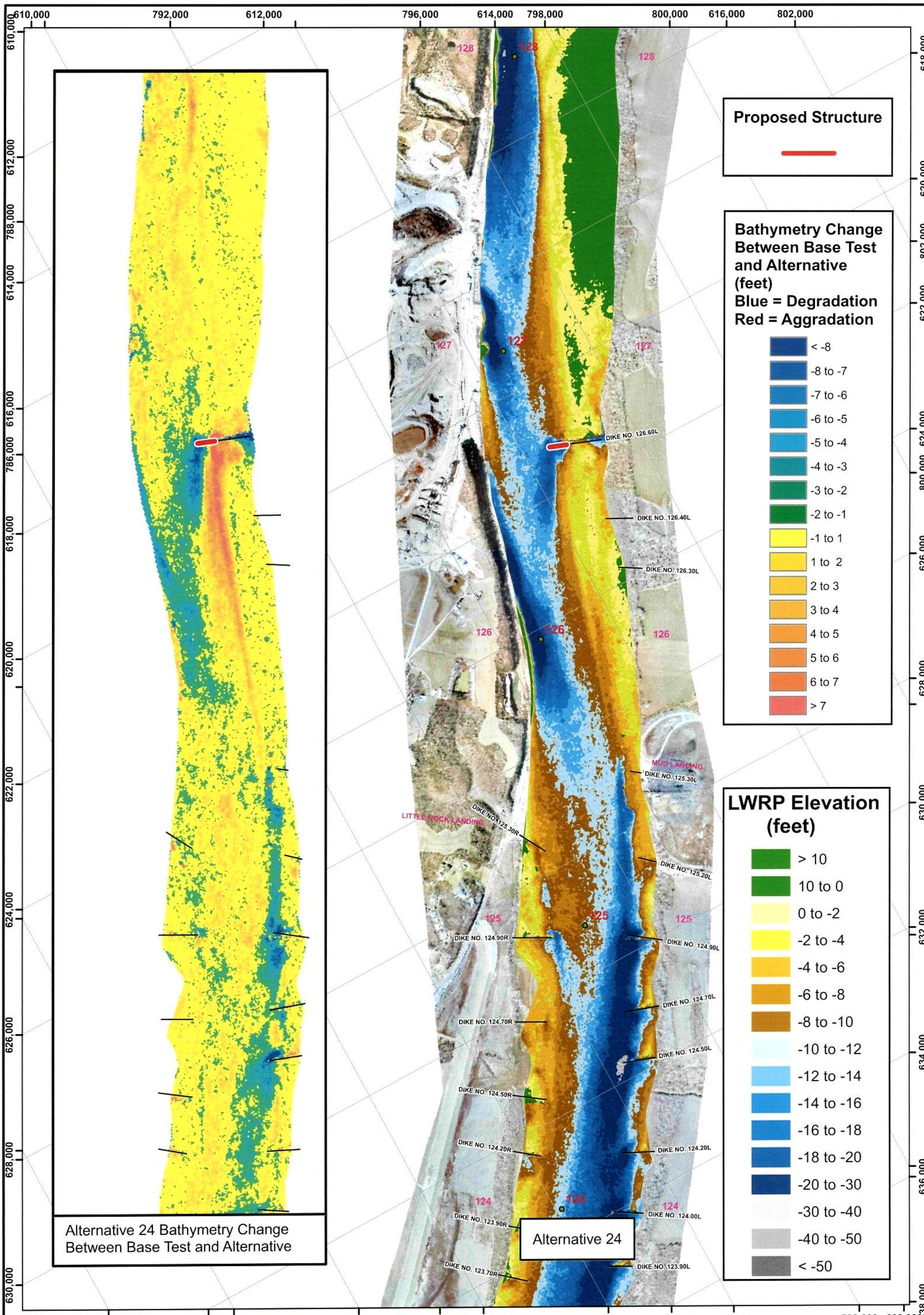

PLATE NUMBER
C 24

0 500 1,000 2,000 Feet

Alternative 24 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.
CHECKED BY:
J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

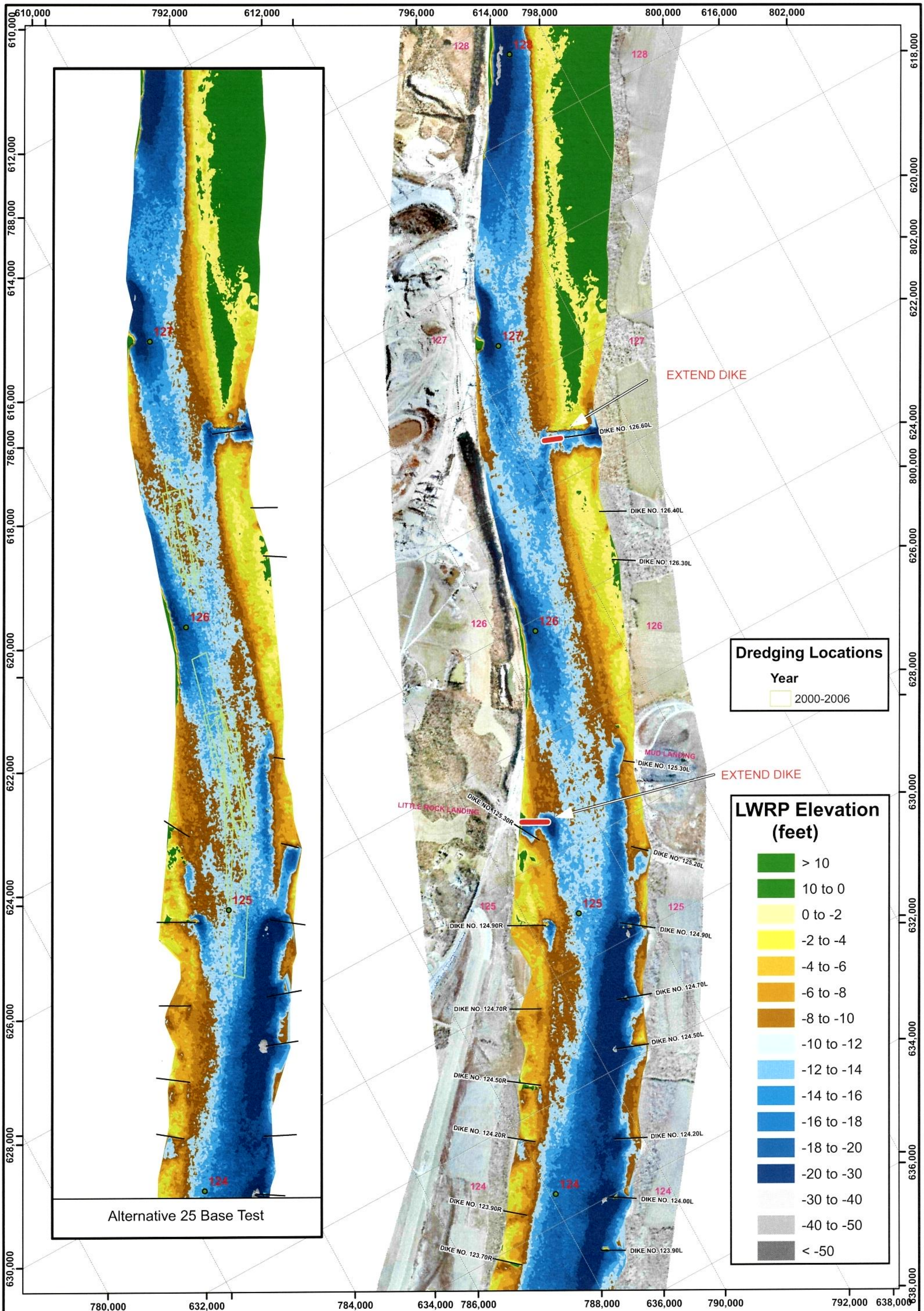

PLATE NUMBER A 25

0 500 1,000 2,000 Feet

Alternative 25

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

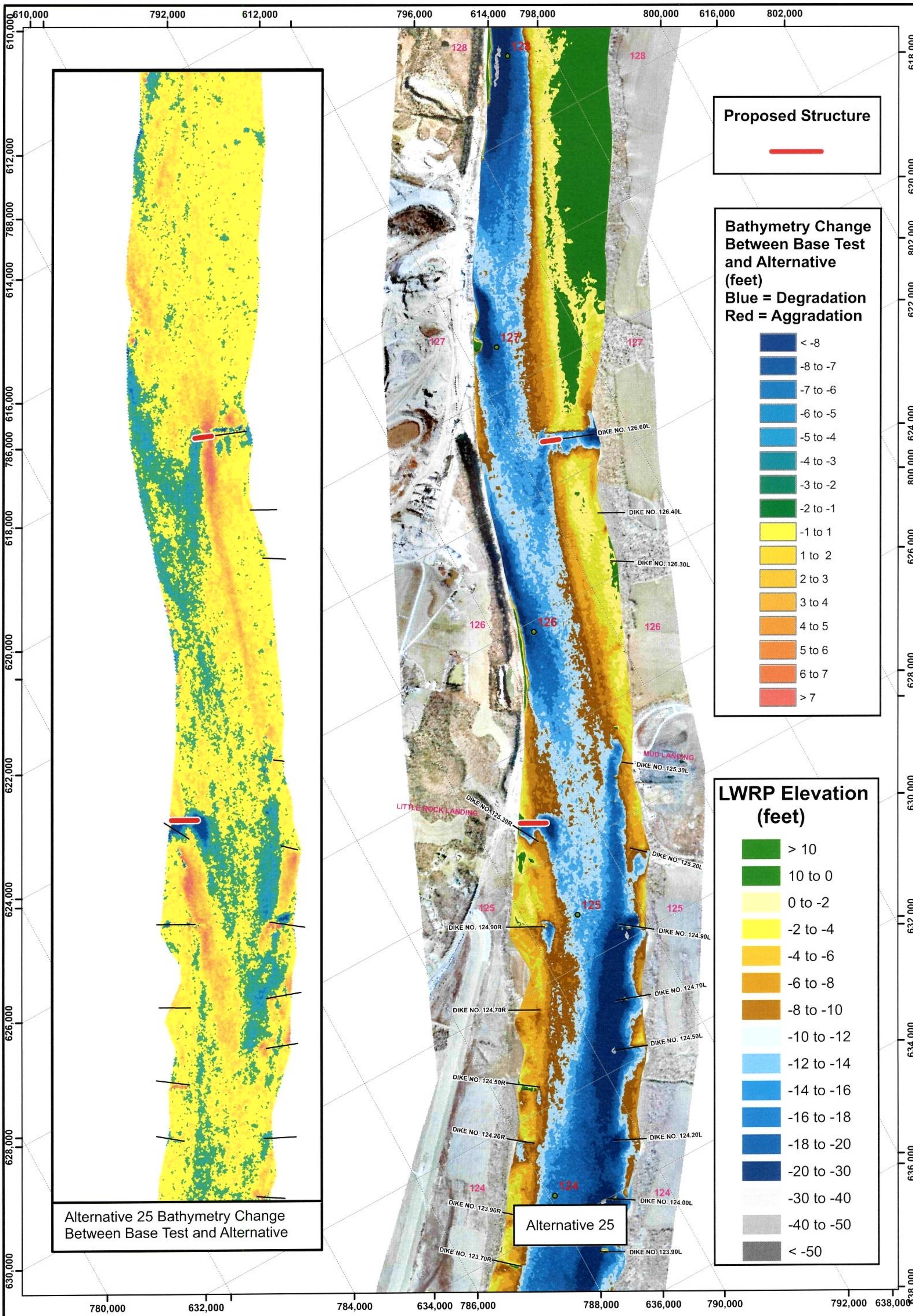

PLATE NUMBER C 25

0 500 1,000 2,000 Feet

Alternative 25 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

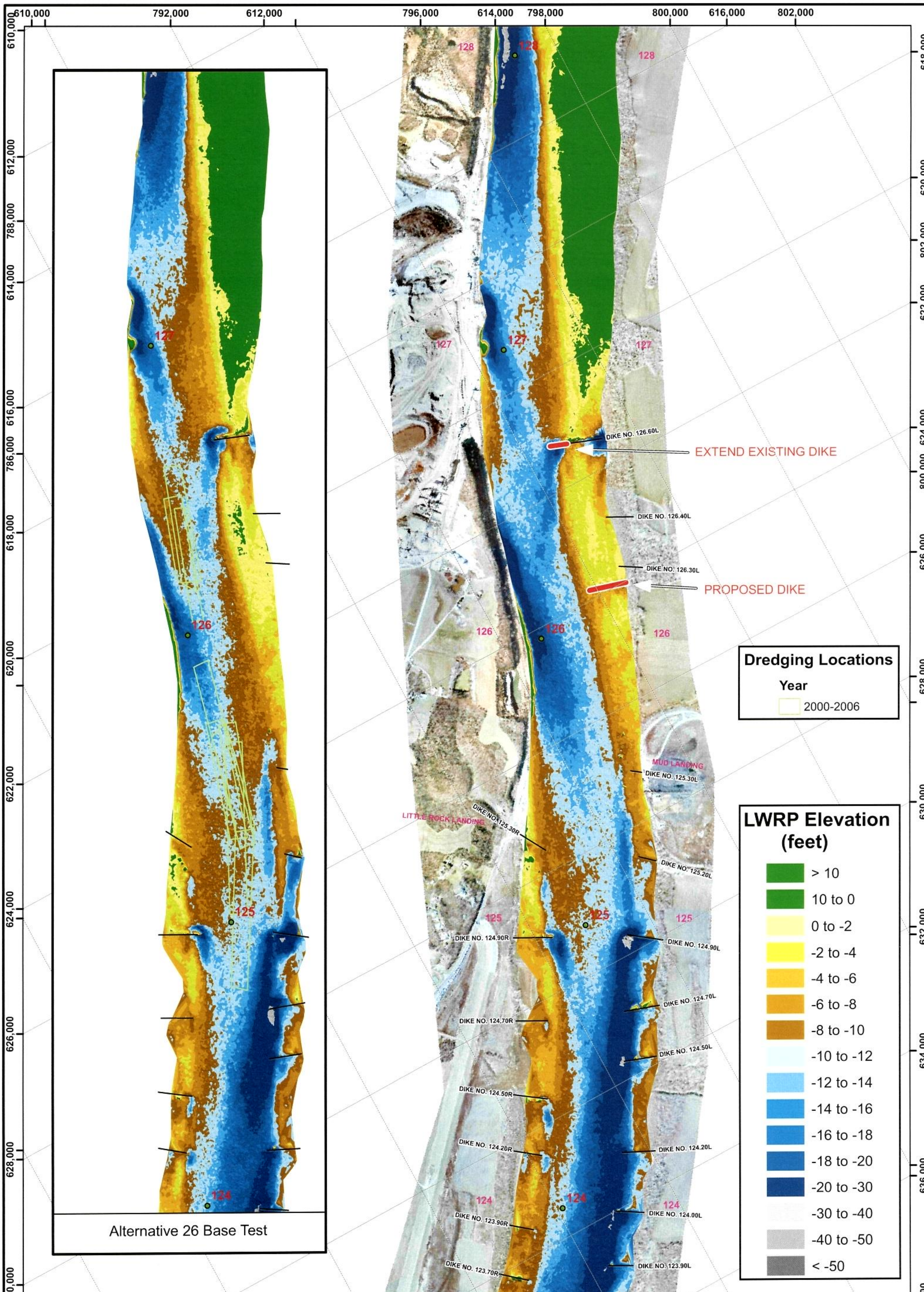

PLATE NUMBER A 26	0 500 1,000 2,000 Feet Alternative 26	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH	APPLIED RIVER ENGINEERING CENTER US Army Corps of Engineers St. Louis District

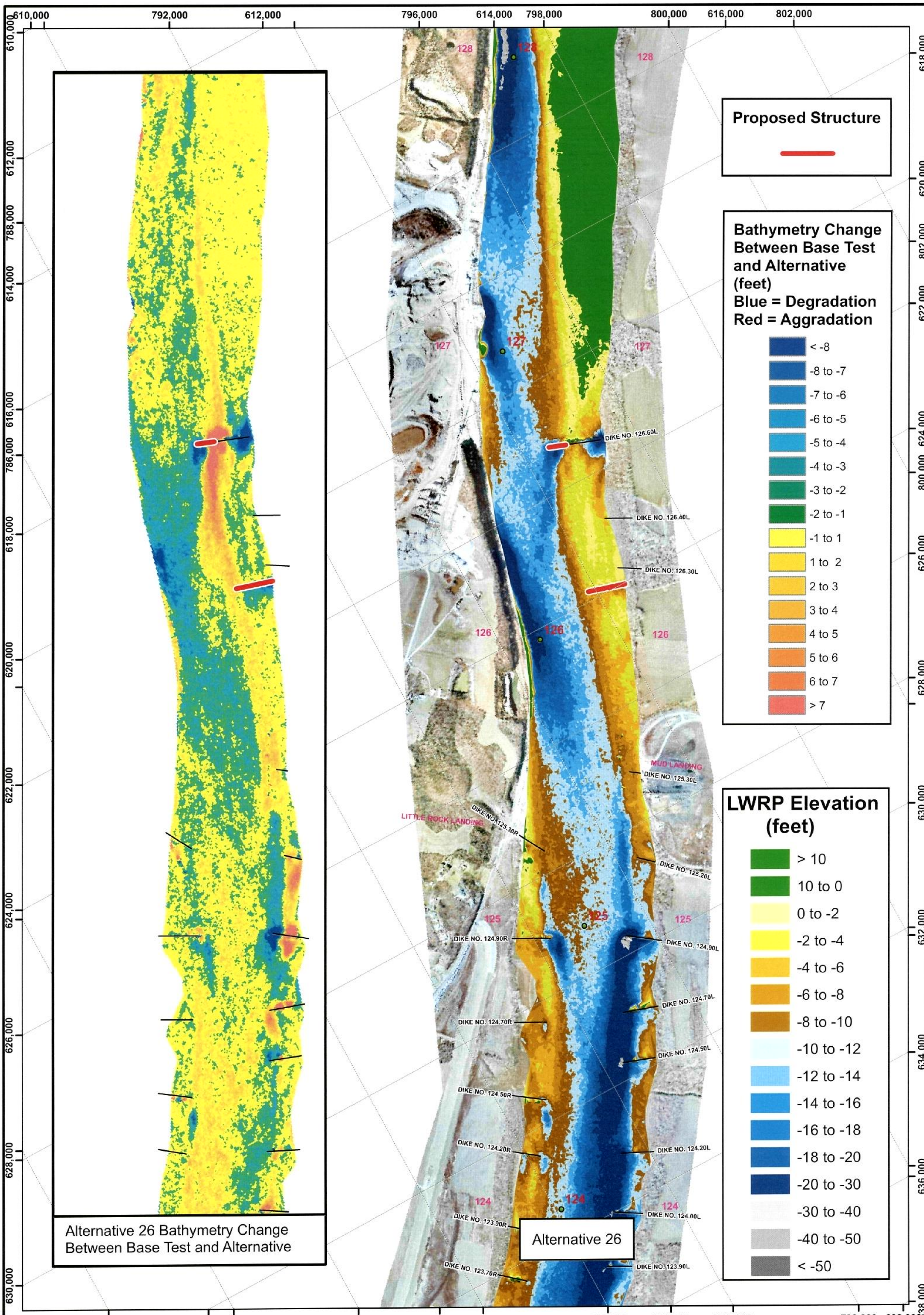

PLATE NUMBER C 26

0 500 1,000 2,000 Feet

Alternative 26 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

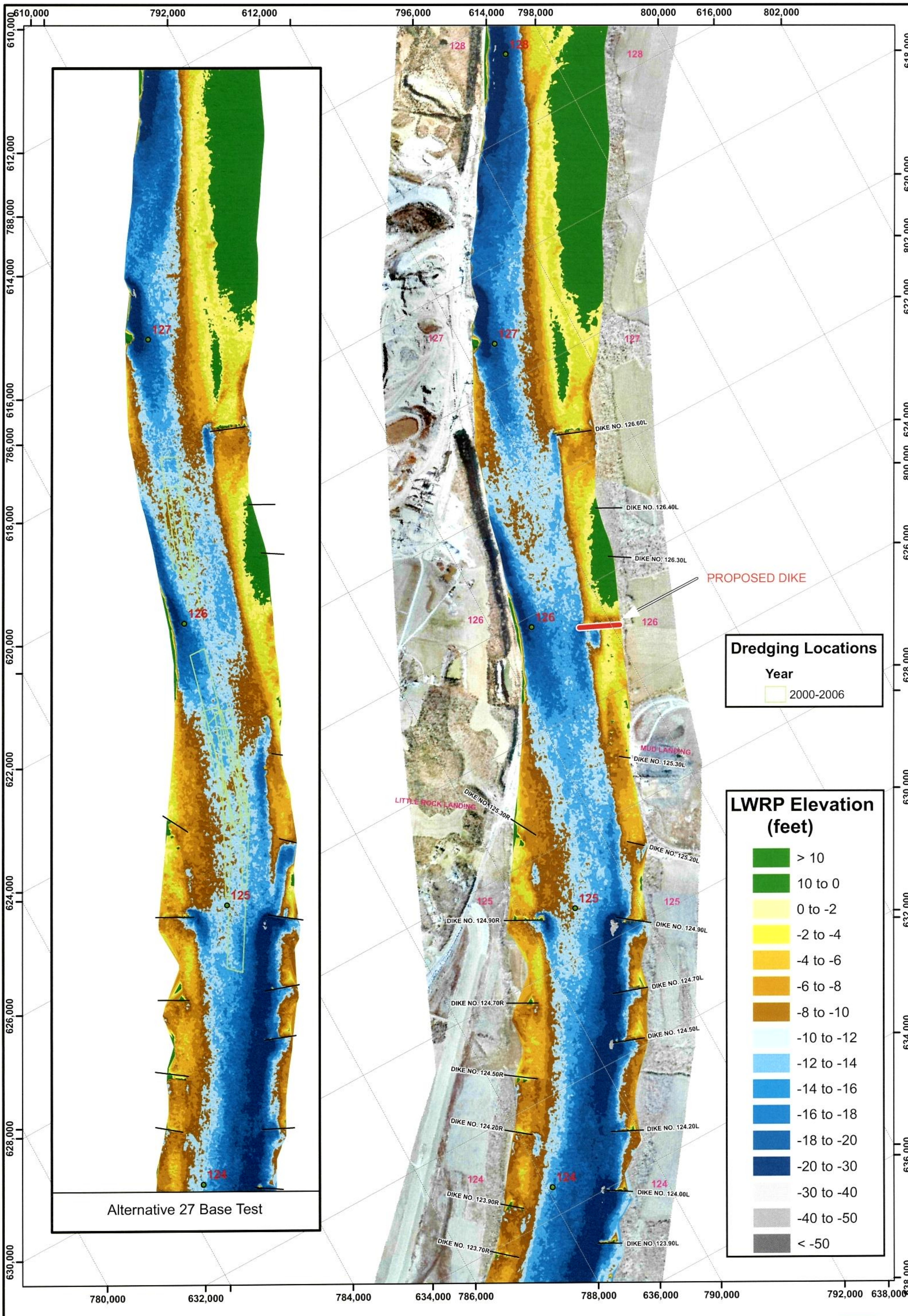

PLATE NUMBER A 27	0 500 1,000 2,000 Feet	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E.	APPLIED RIVER ENGINEERING CENTER
	Alternative 27	Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	2006 AERIAL PHOTOGRAPH	US Army Corps of Engineers St. Louis District

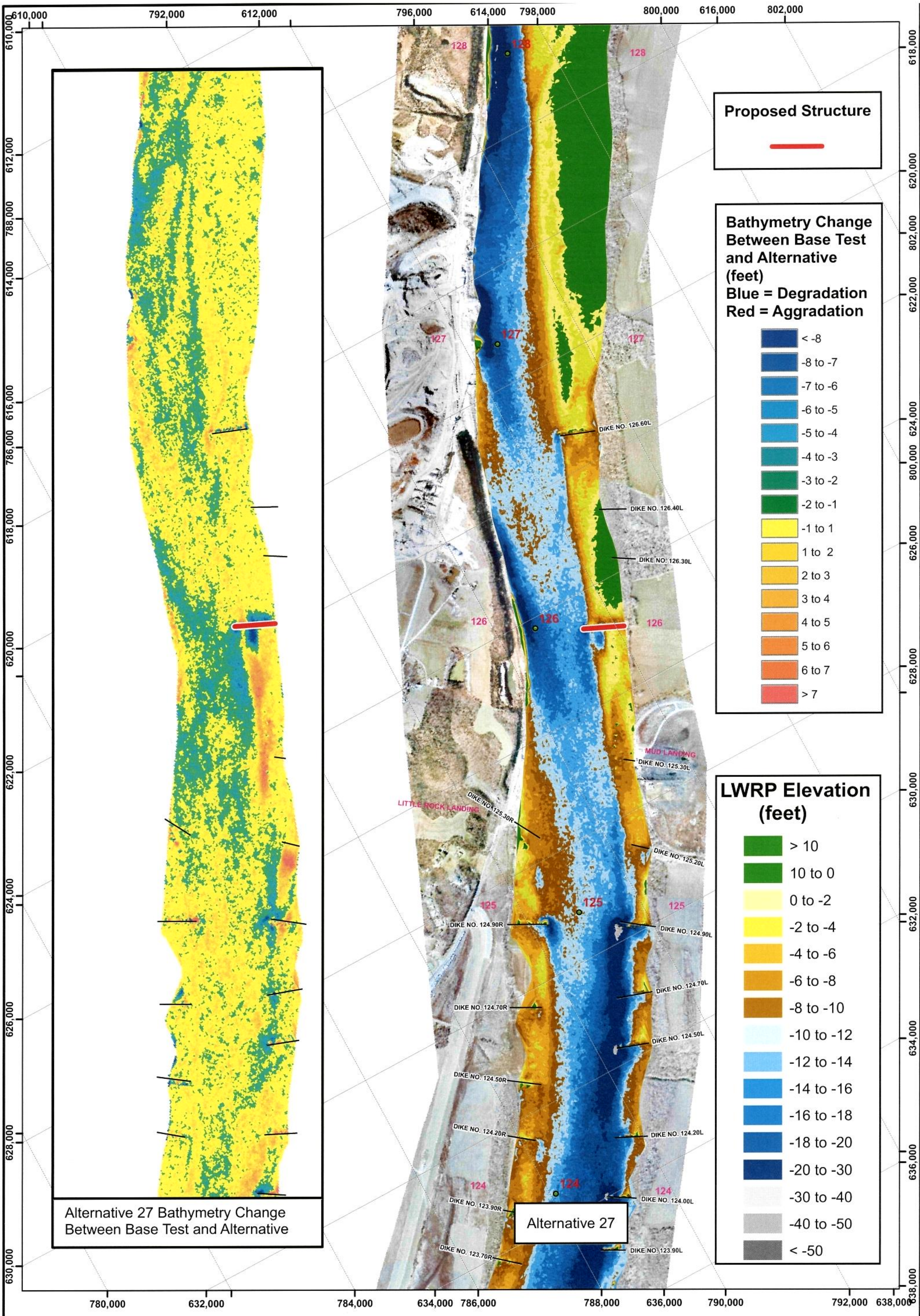

PLATE NUMBER C 27

0 500 1,000 2,000 Feet

Alternative 27 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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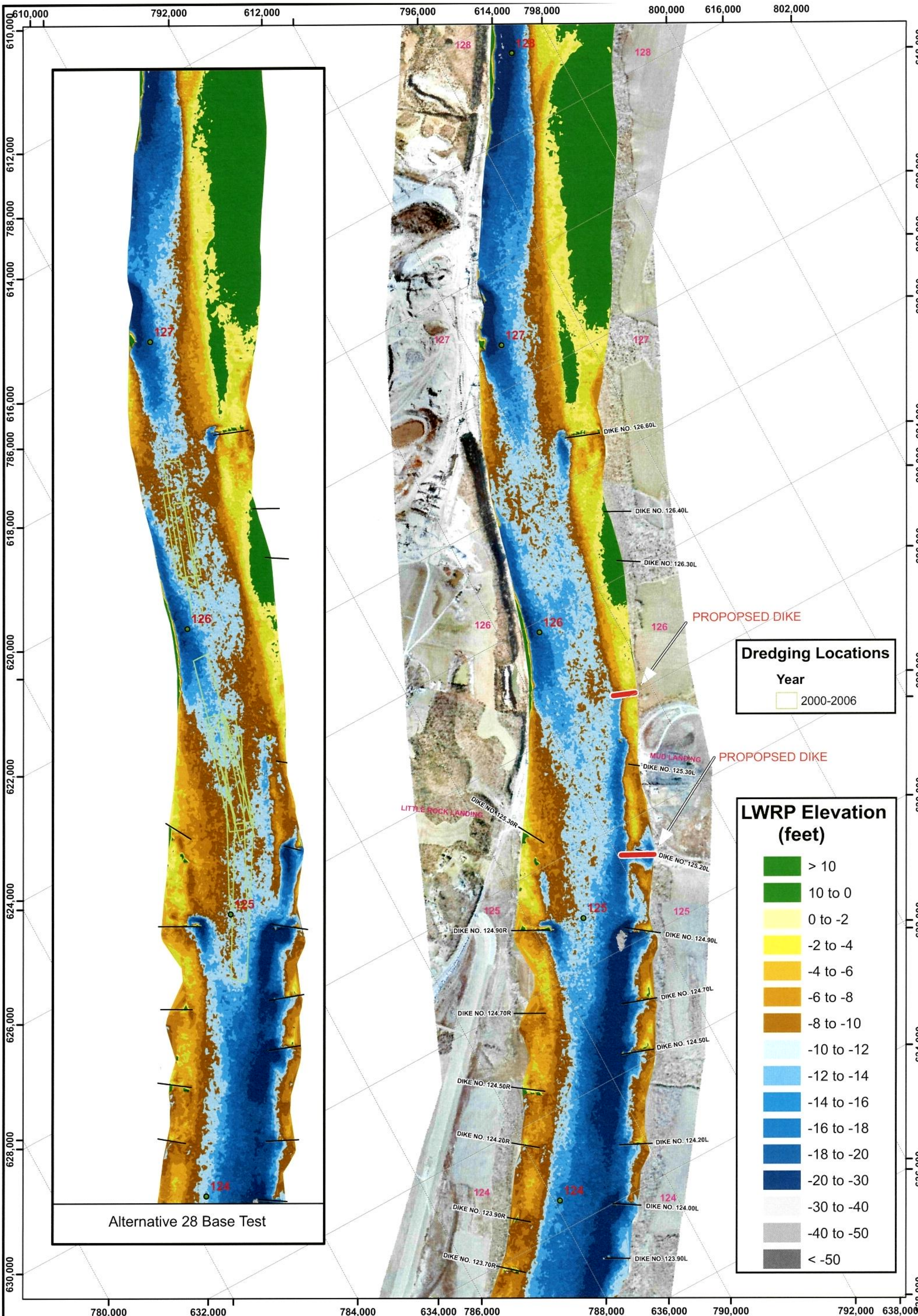
US Army Corps of Engineers
St. Louis District



0 500 1,000 2,000 Feet

PLATE NUMBER A 28

Alternative 28

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

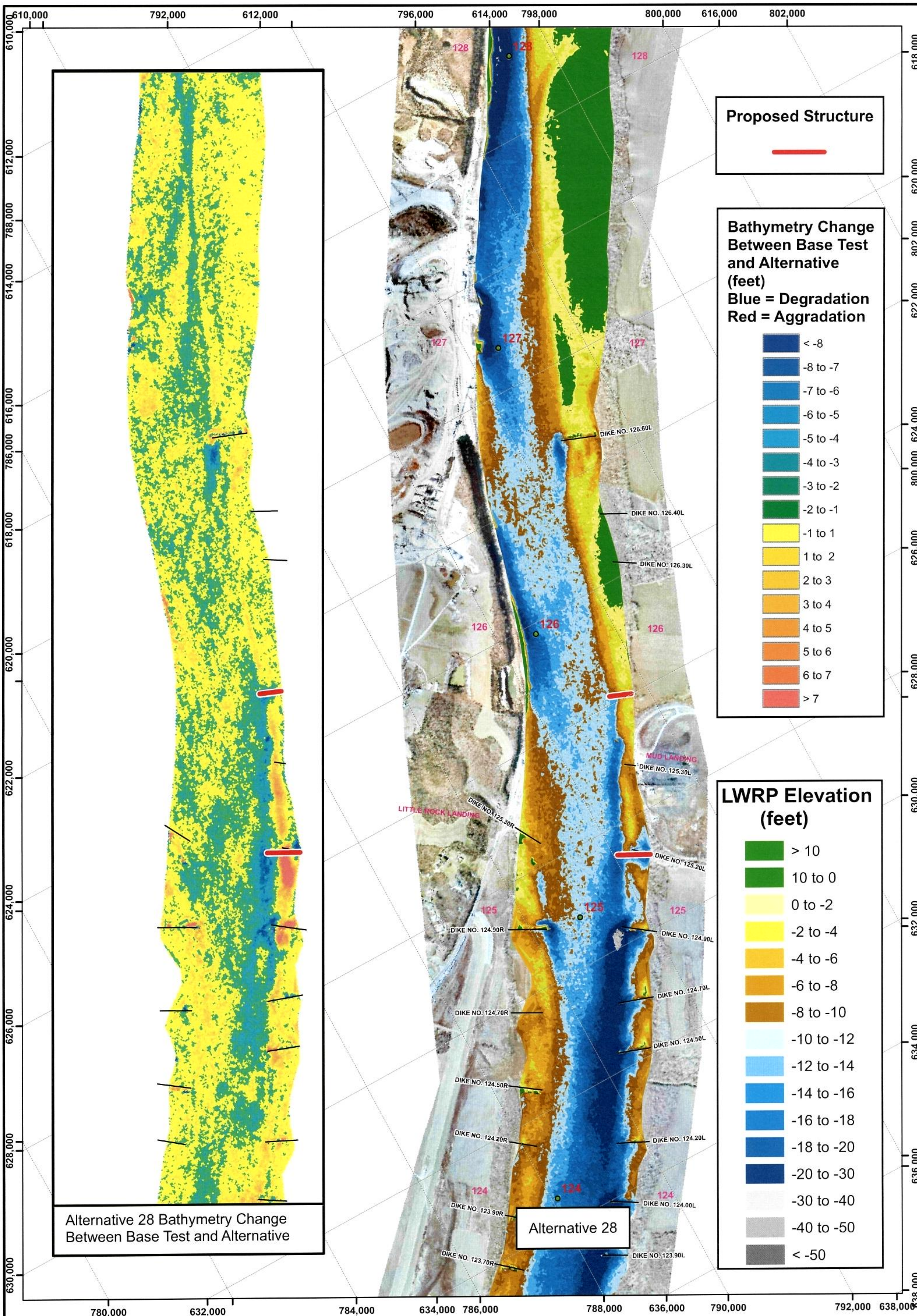

PLATE NUMBER C 28

0 500 1,000 2,000 Feet

Alternative 28 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

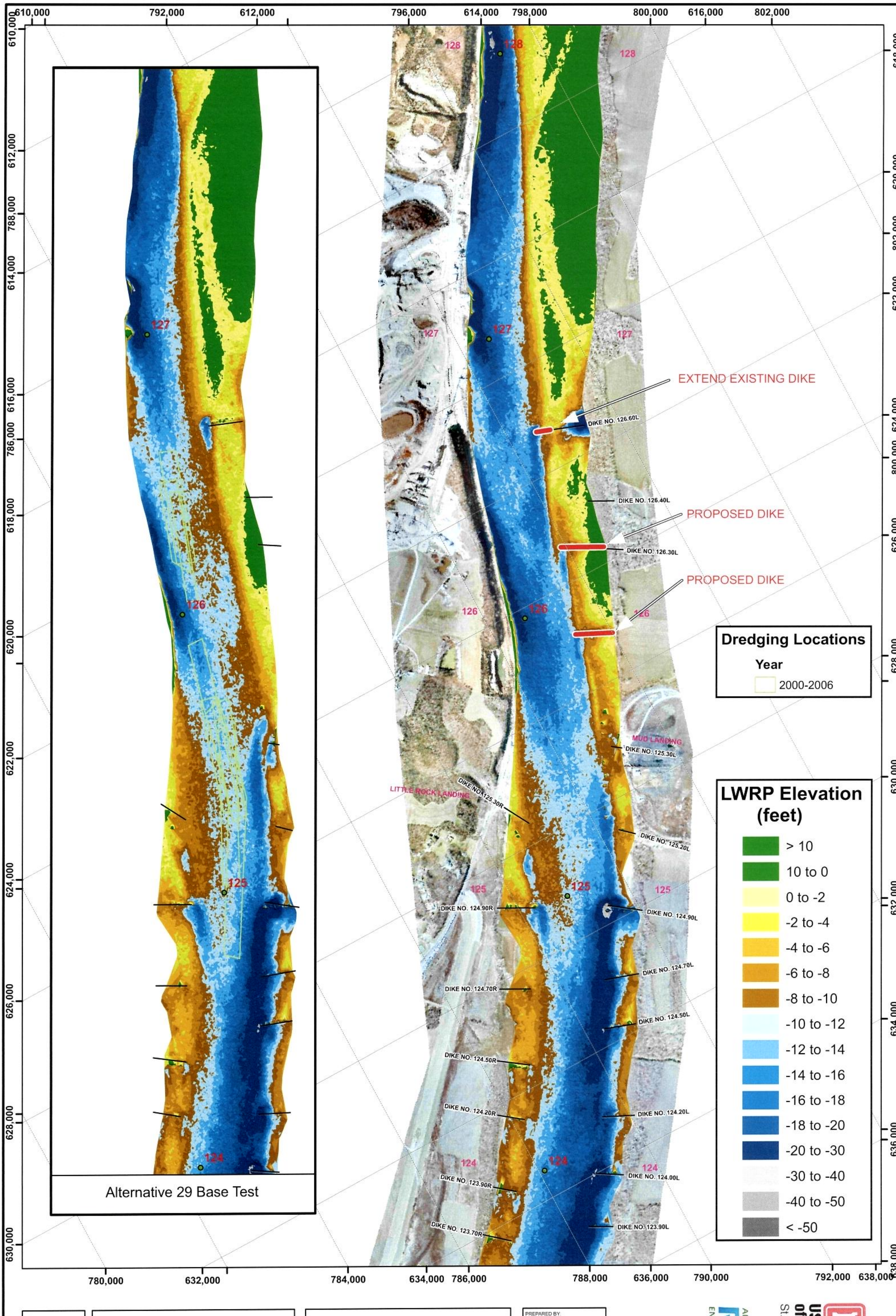

PLATE NUMBER
A 29

0 500 1,000 2,000 Feet

Alternative 29

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
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St. Louis District

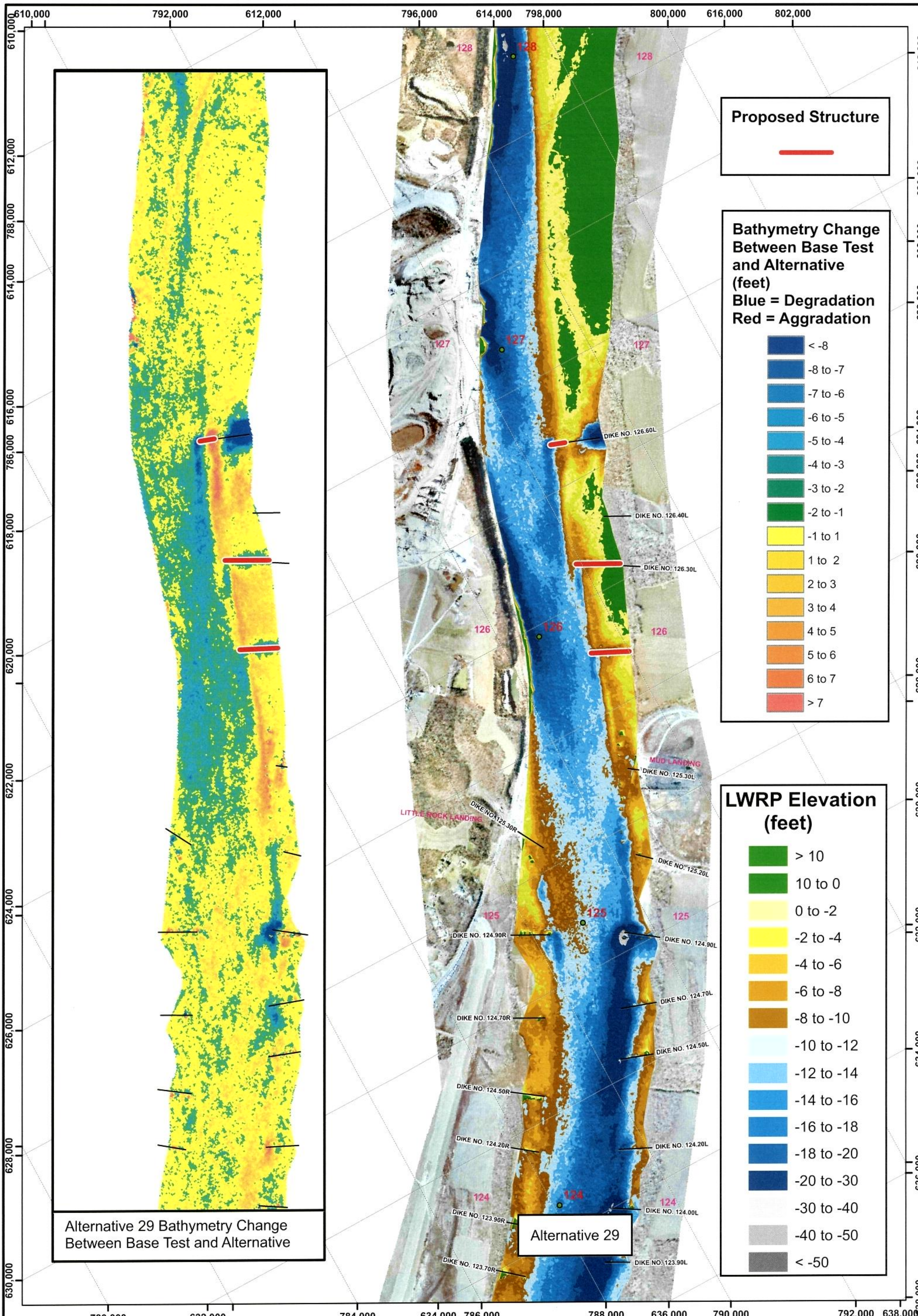

PLATE NUMBER C 29

0 500 1,000 2,000 Feet

Alternative 29 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

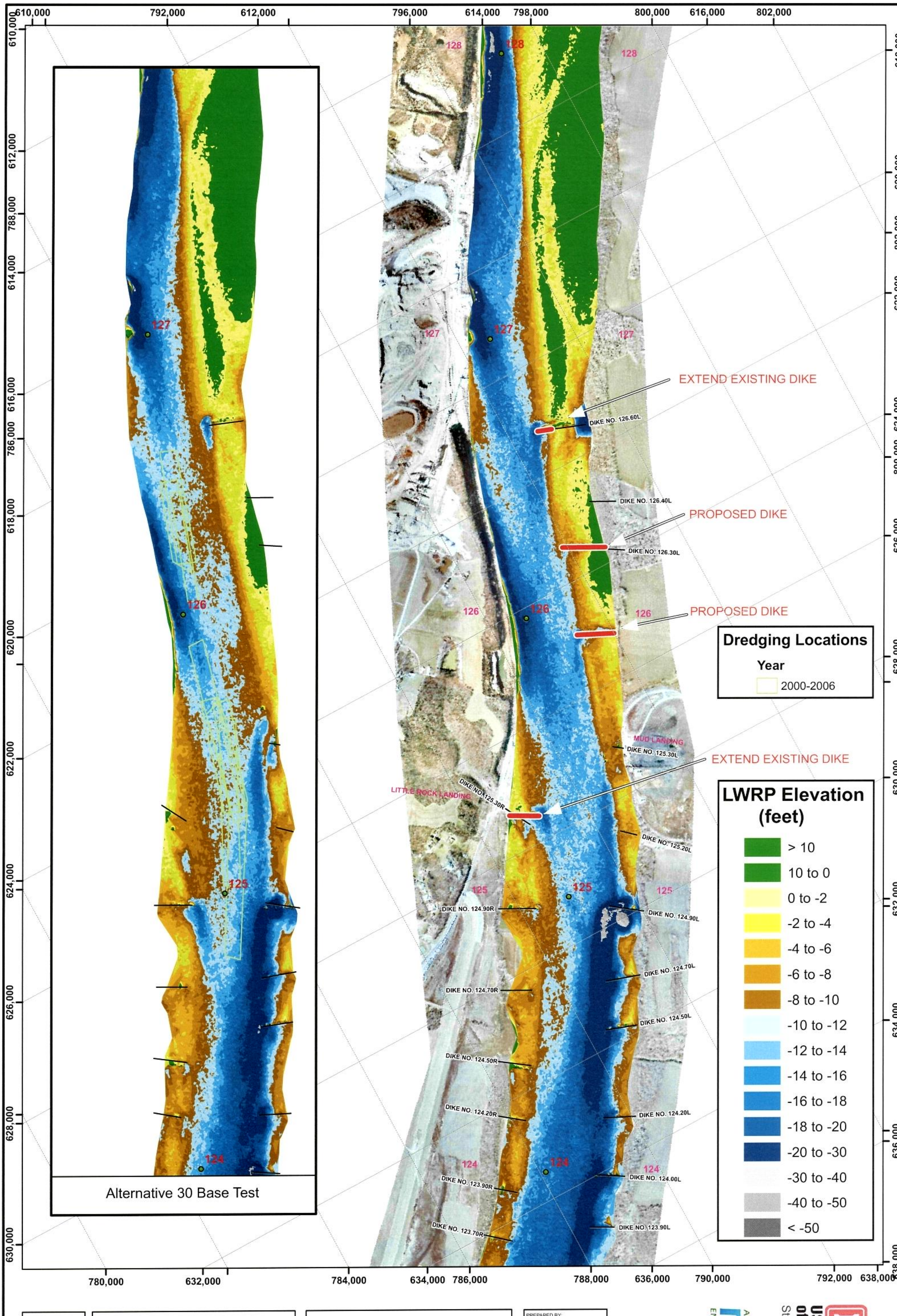

PLATE NUMBER A 30

0 500 1,000 2,000 Feet

Alternative 30

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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St. Louis District

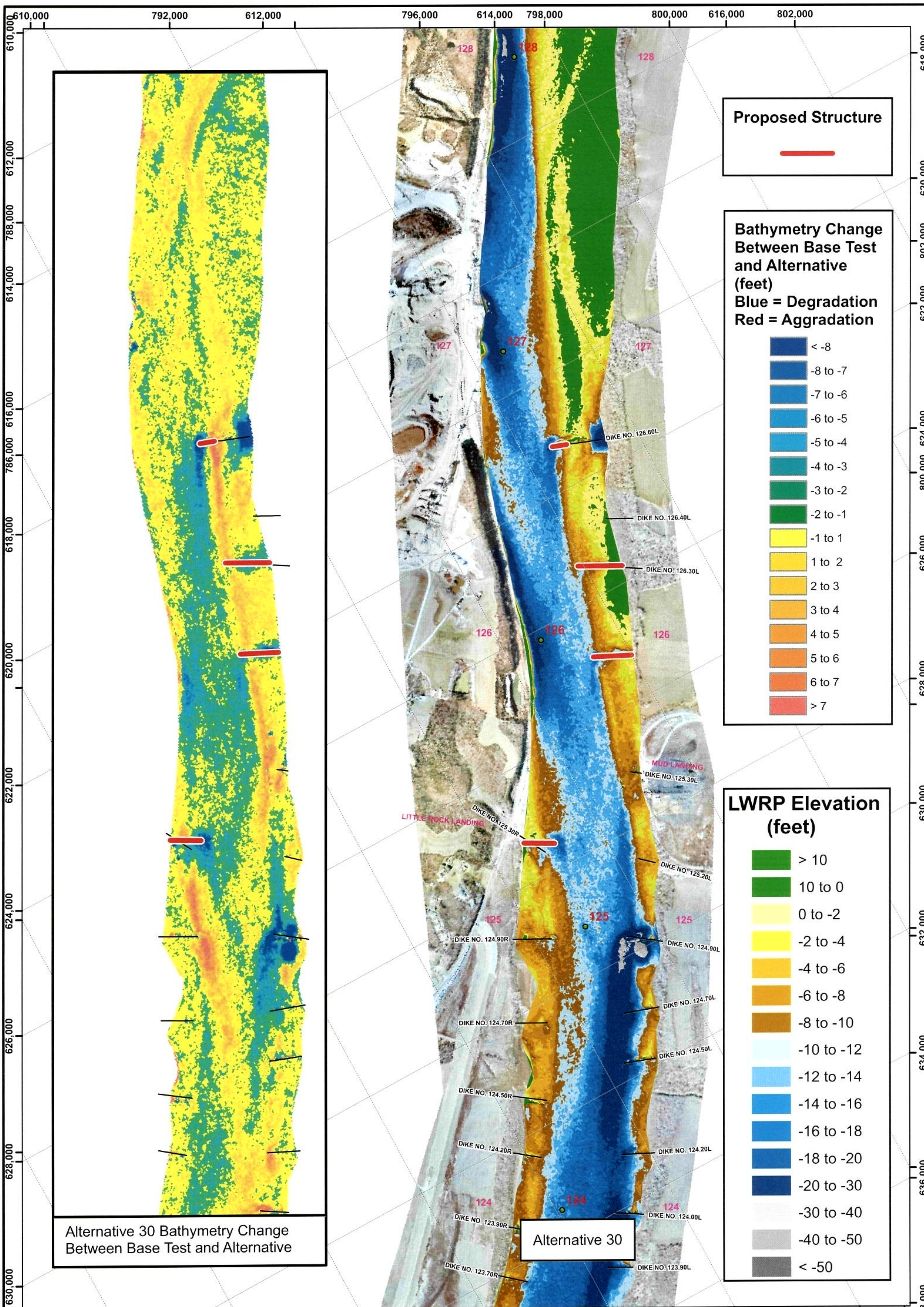

PLATE NUMBER
C 30

0 500 1,000 2,000 Feet

Alternative 30 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.
CHECKED BY:
J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

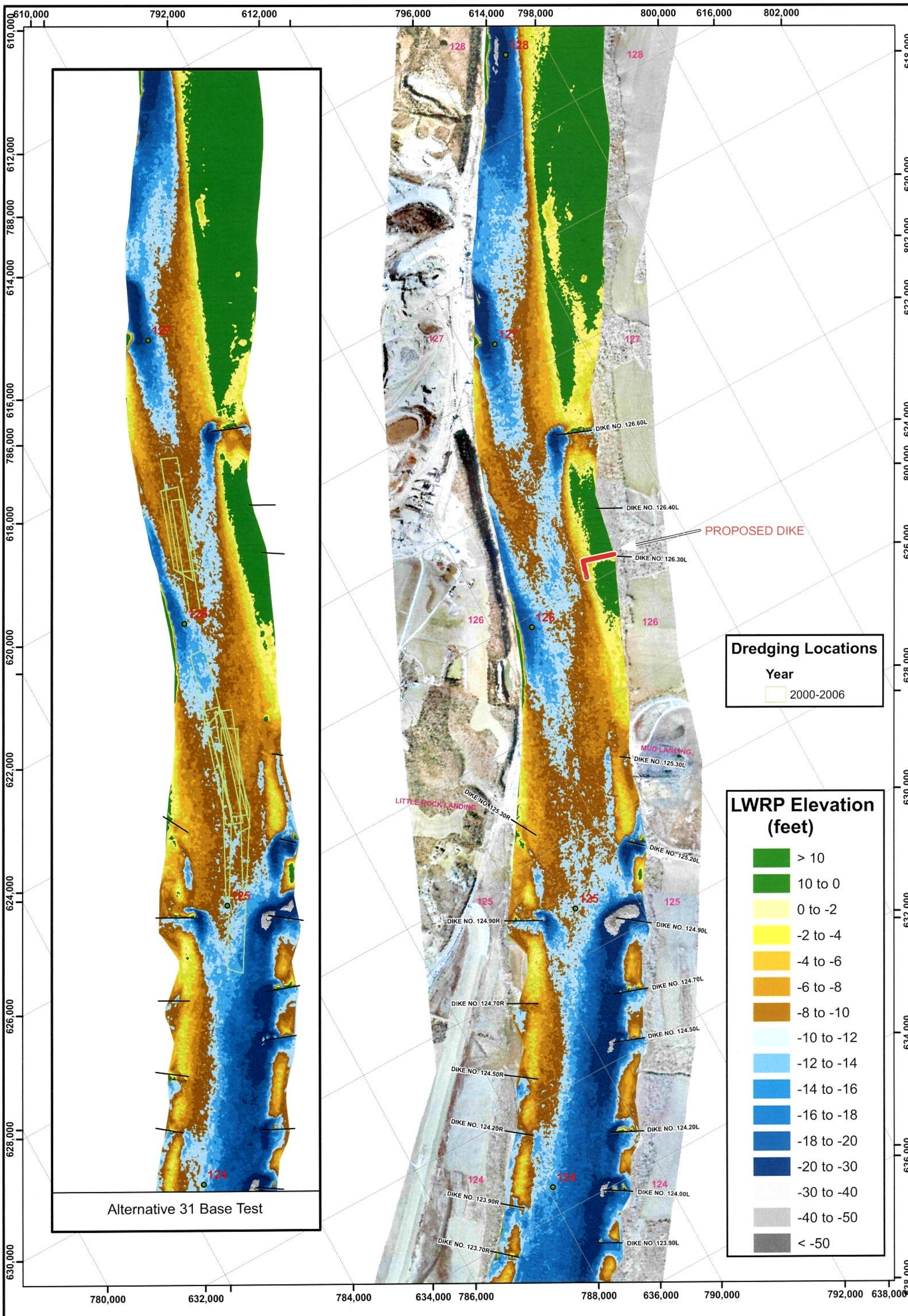

PLATE NUMBER
A 31

0 500 1,000 2,000 Feet

Alternative 31

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.
CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

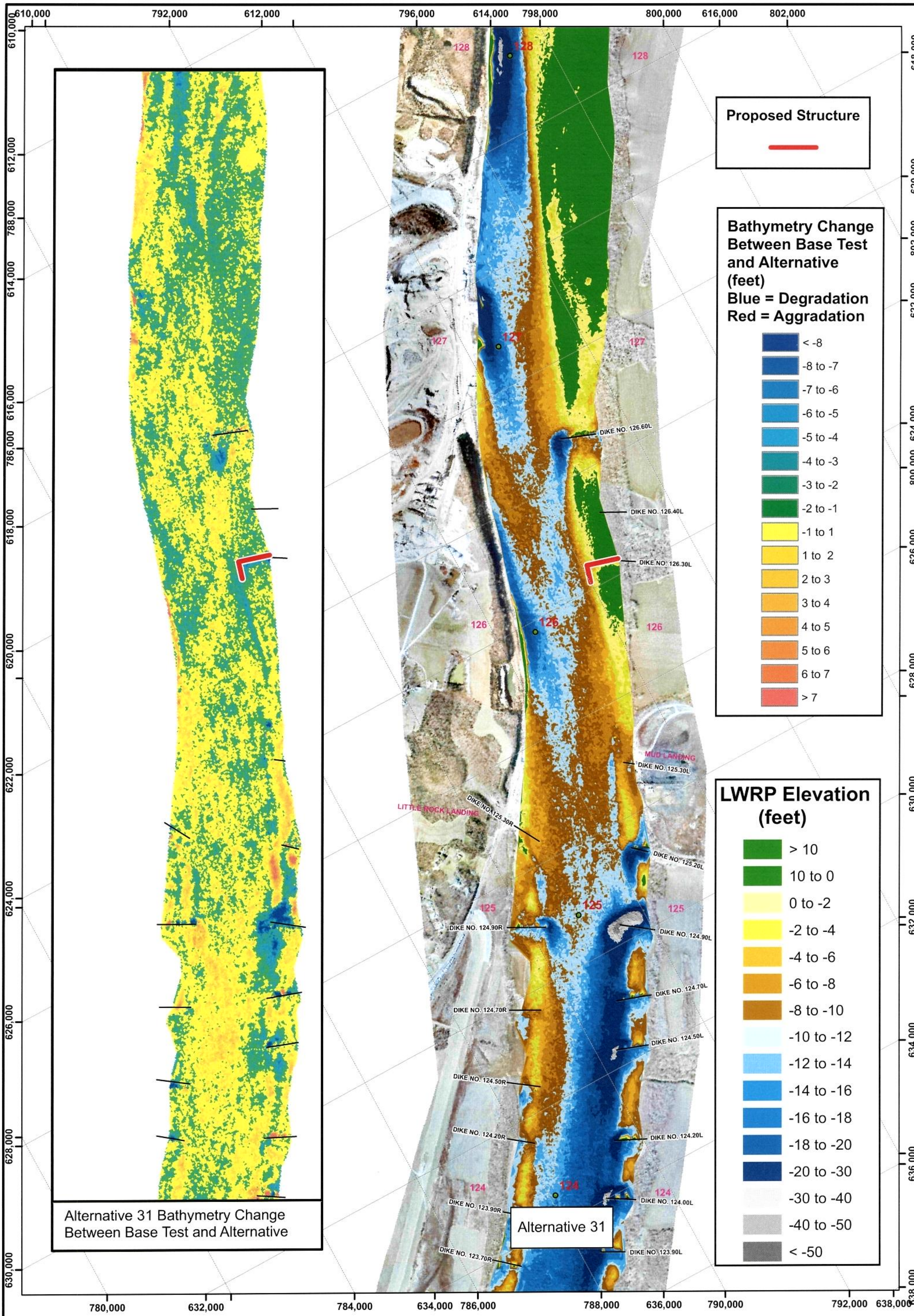

PLATE NUMBER
C 31

0 500 1,000 2,000 Feet

Alternative 31 Bathymetry Change
Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

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St. Louis District

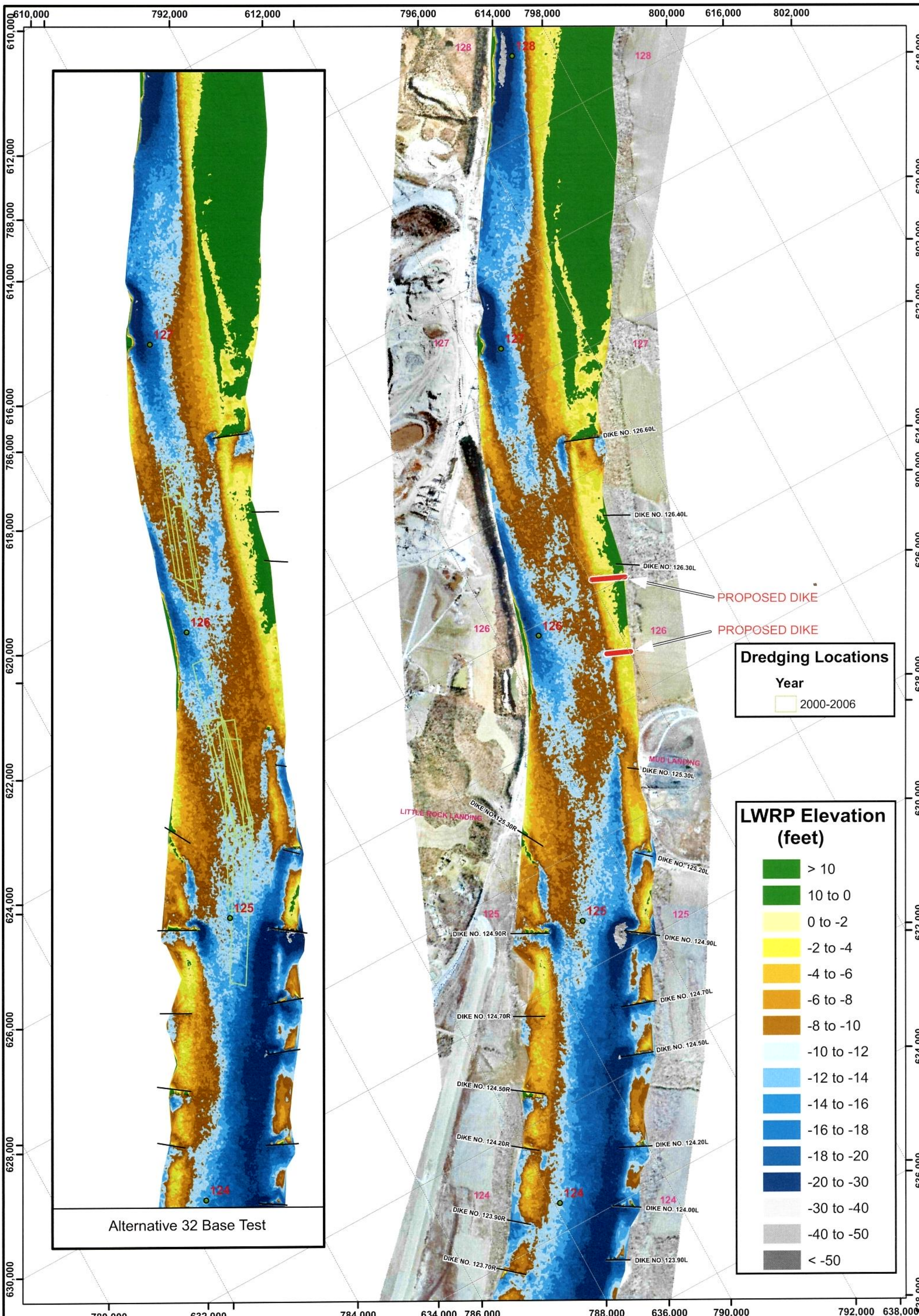

PLATE NUMBER A 32

0 500 1,000 2,000 Feet

Alternative 32

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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St. Louis District

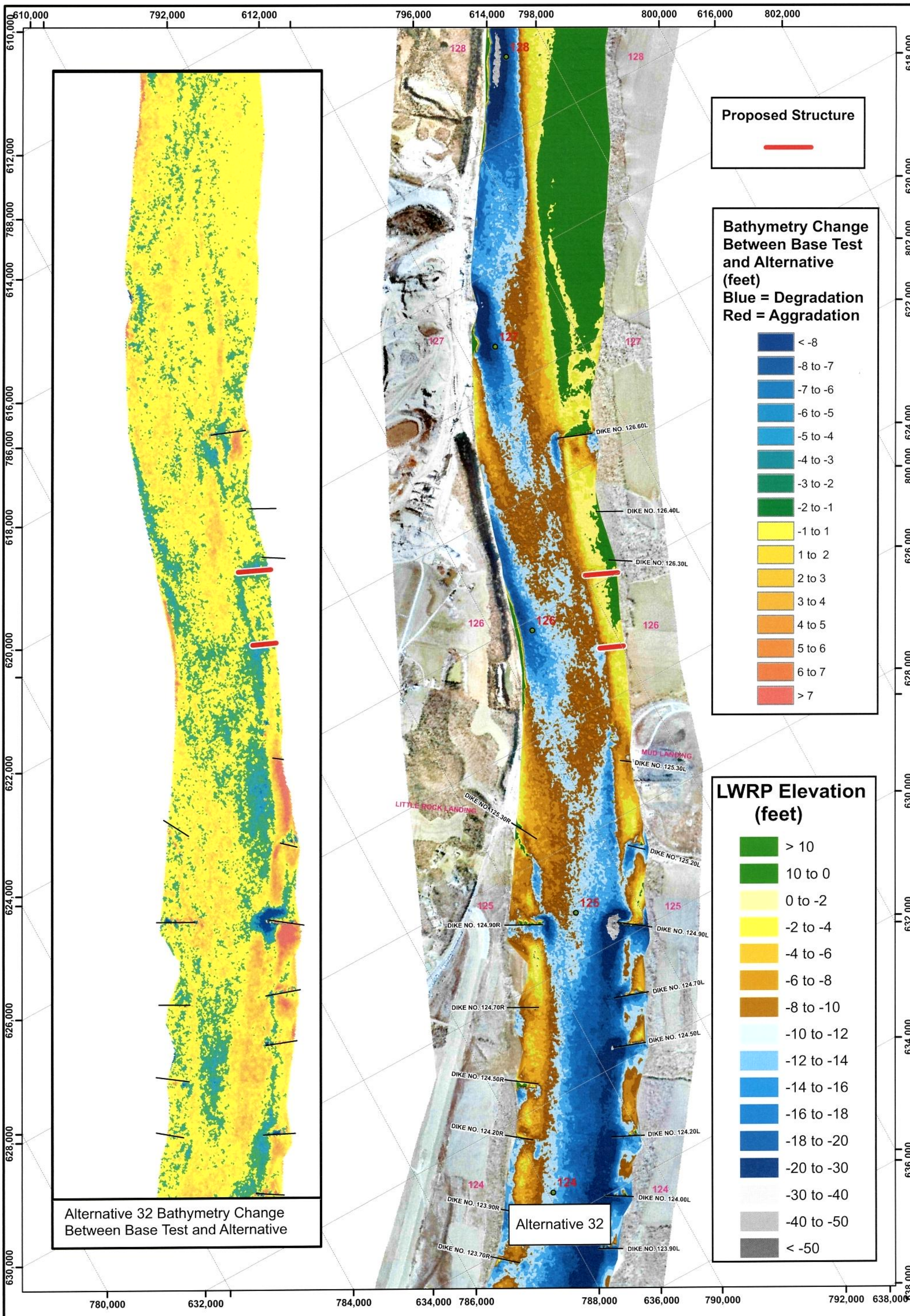

PLATE NUMBER C 32

0 500 1,000 2,000 Feet

Alternative 32 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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St. Louis District

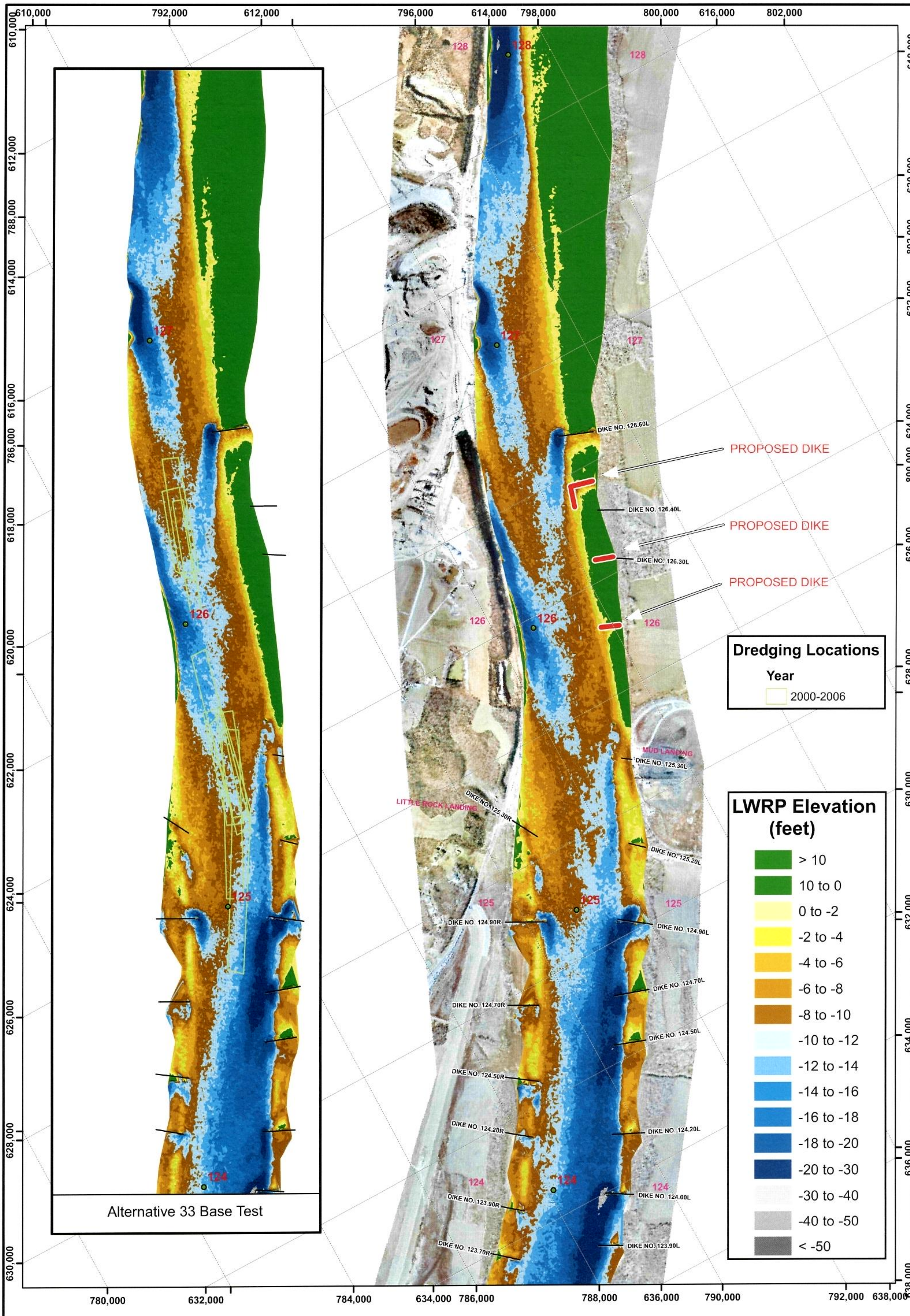

PLATE NUMBER
A 33

0 500 1,000 2,000 Feet

Alternative 33

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District

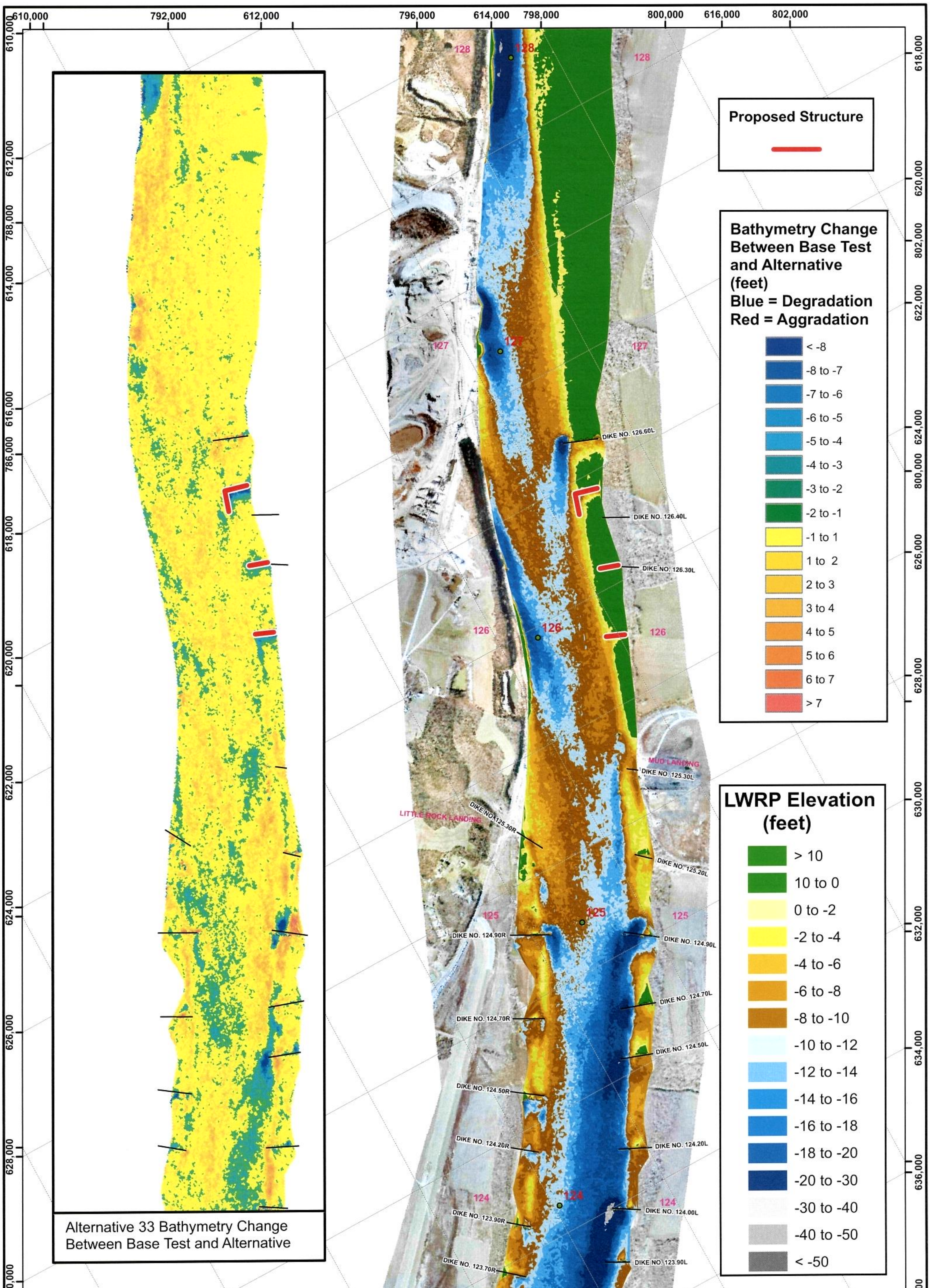

PLATE NUMBER C 33

0 500 1,000 2,000 Feet

Alternative 33 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

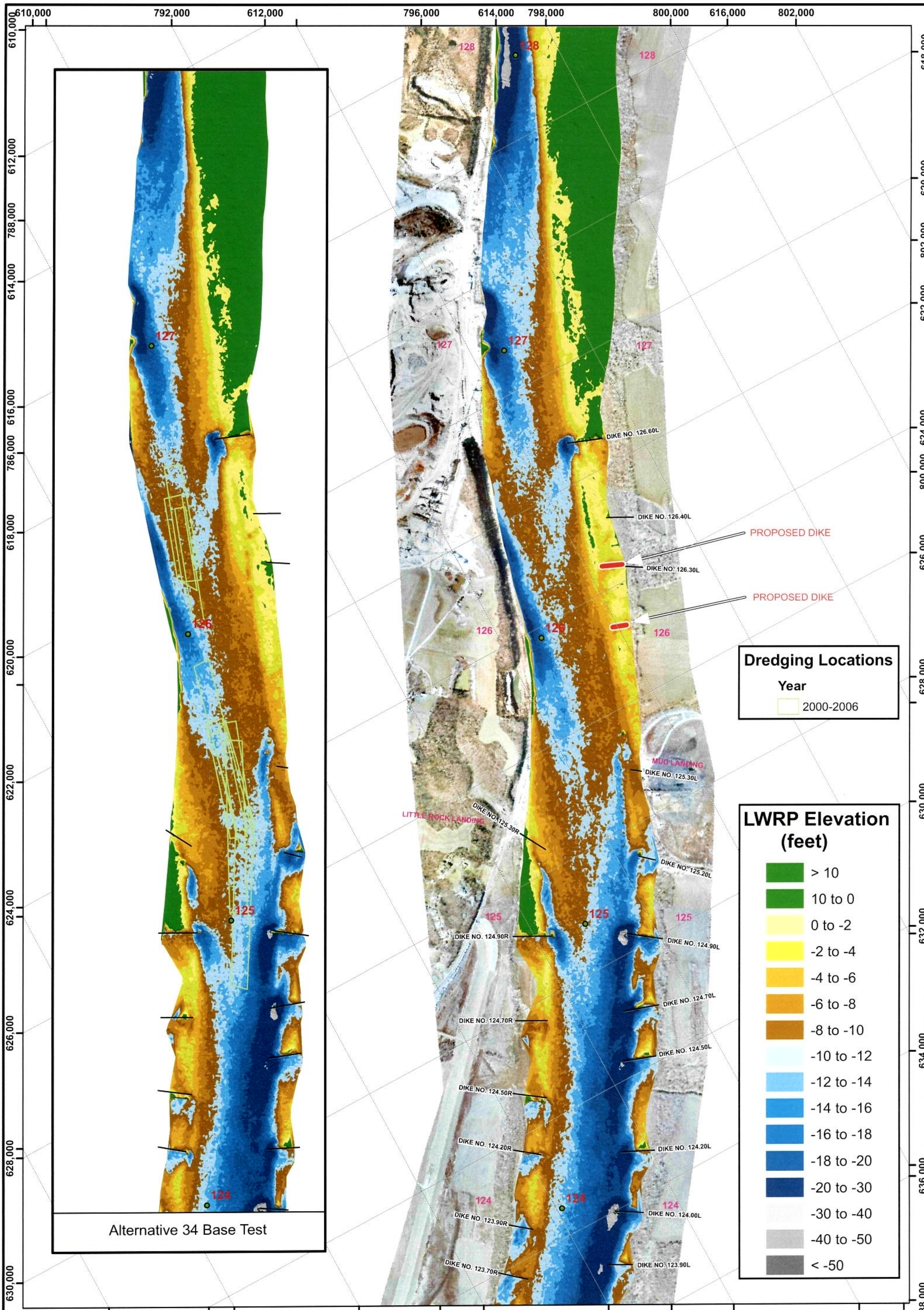

PLATE NUMBER A 34	0 500 1,000 2,000 Feet Alternative 34	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH	APPLIED RIVER ENGINEERING CENTER US Army Corps of Engineers St. Louis District

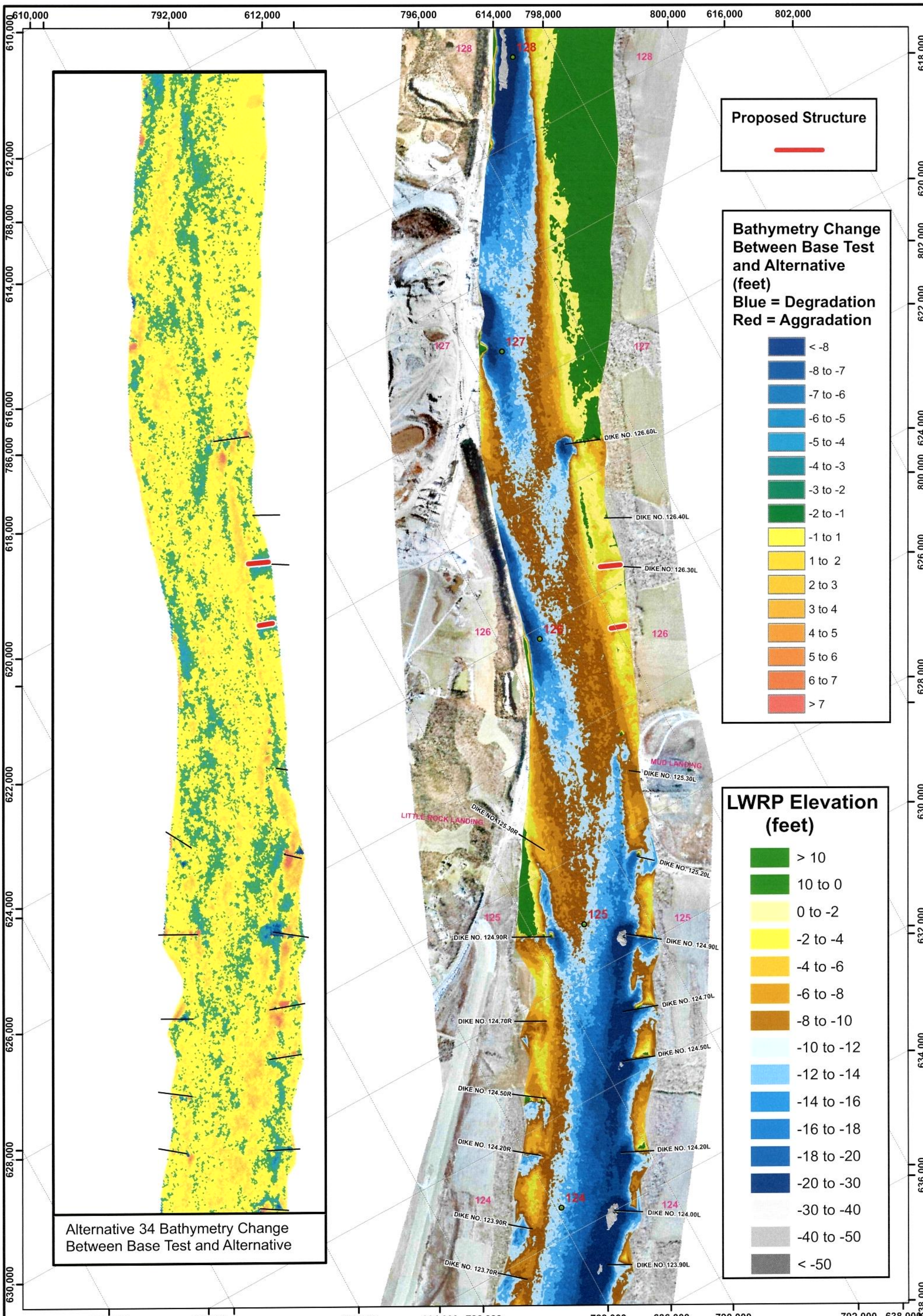

PLATE NUMBER C 34	0 500 1,000 2,000 Feet Alternative 34 Bathymetry Change Between Base Test and Alternative	U.S. ARMY CORPS OF ENGINEERS ST. LOUIS, DISTRICT Ste. Genevieve HSR Model Middle Mississippi River Miles 123 - 129	PREPARED BY: P. Russell, P.E. CHECKED BY: J. Brown, P.E. 2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers St. Louis District

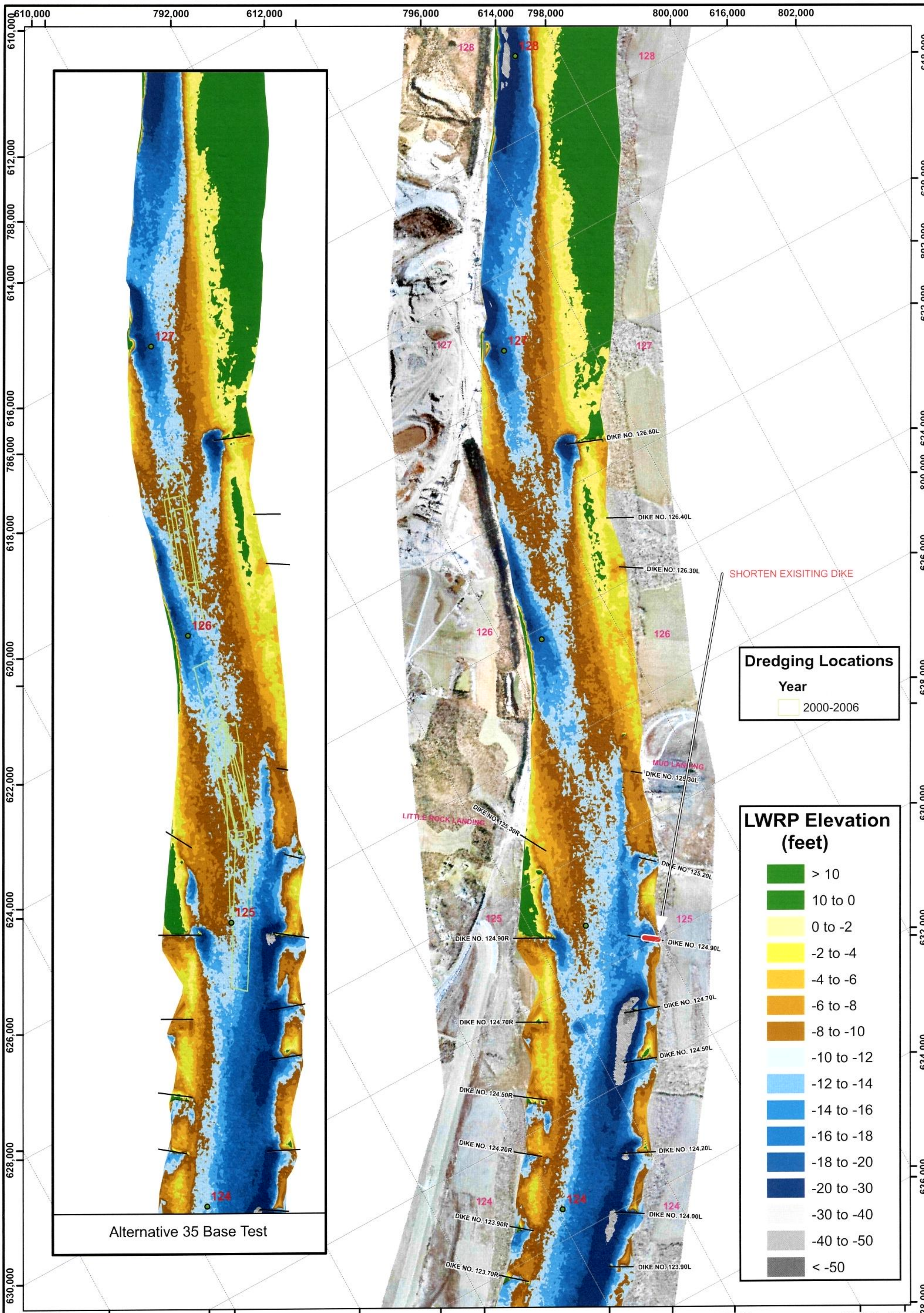

PLATE NUMBER
A 35

0 500 1,000 2,000 Feet

Alternative 35

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY:
P. Russell, P.E.

CHECKED BY:
J. Brown, P.E.

2006 AERIAL PHOTOGRAPH

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

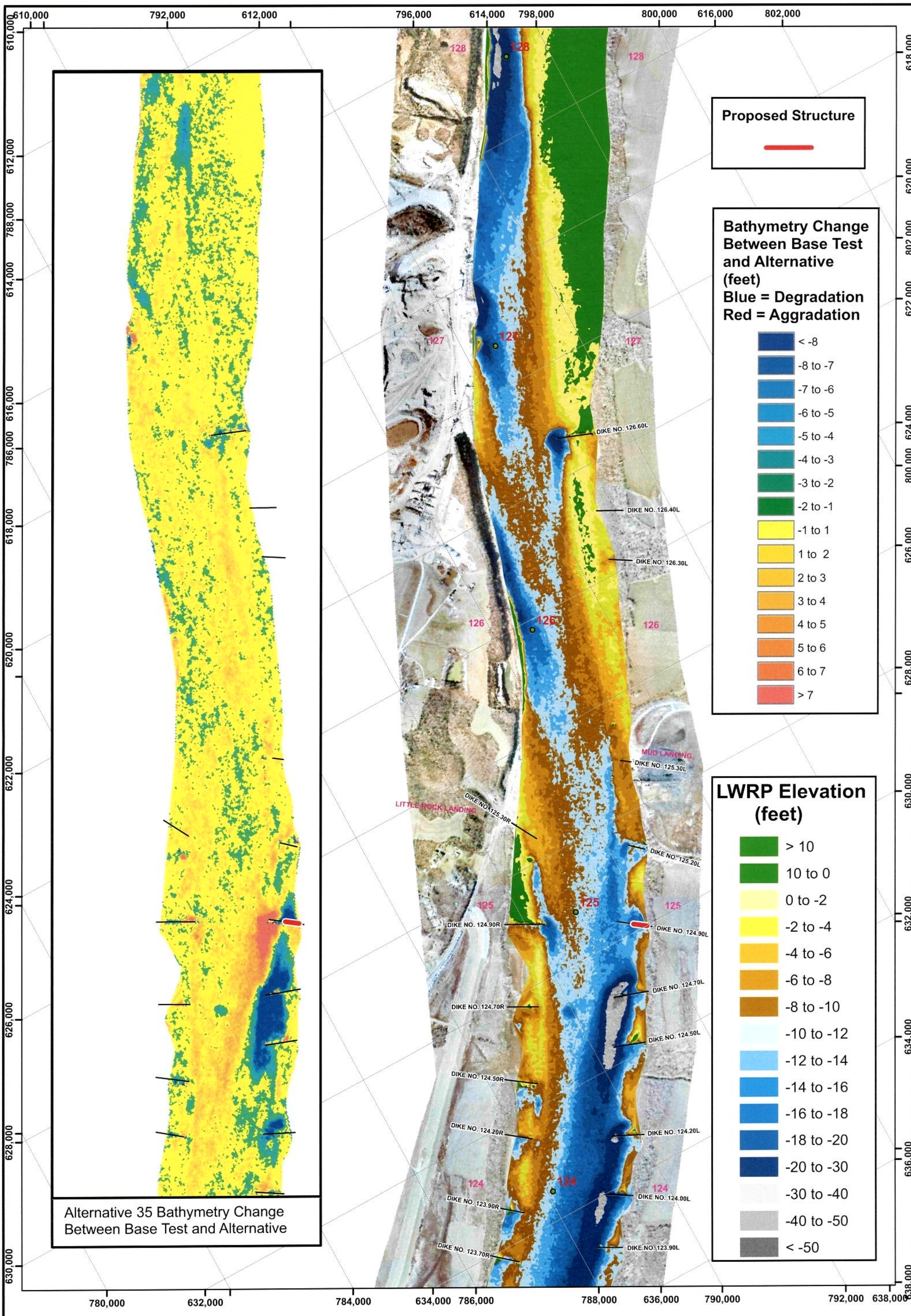

PLATE NUMBER C 35

Alternative 35 Bathymetry Change Between Base Test and Alternative

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

Ste. Genevieve HSR Model
Middle Mississippi River Miles 123 - 129

PREPARED BY: P. Russell, P.E.

CHECKED BY: J. Brown, P.E.

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US Army Corps of Engineers
St. Louis District