DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

29 March 2019

Reply to:
Regional Planning and Environmental Division North
Environmental Compliance Section (PD-C)

Dear Reviewer:

The St. Louis District of the U.S. Army Corps of Engineers has prepared a Draft Environmental Assessment (EA) with and unsigned Finding of No Significant Impact (FONSI) for proposed construction activities known as Red Rock Landing Phase 6, Middle Mississippi River (RM 101.2 – 99.6), Perry County, Missouri, and Randolph County, Illinois. This document serves to notify the public of the Draft EA. You are receiving this letter because you may be interested in the assessment. The Draft EA with unsigned FONSI are available for public review. The electronic version of these document is available through the link below, or you may request a copy of the Draft EA and FONSI be mailed to you.

https://www.mvs.usace.army.mil/Portals/54/docs/pm/Reports/EA/RRL6DraftEA.pdf

We invite your comments related to the content of the attached document. Please note that the FONSI is unsigned. This document will be signed into effect only after having carefully considered comments received as a result of this 30-day public review. The 30-day public review period is open March 29, 2019 through April 29, 2019.

Please address your written comments to:
Shane Simmons
U.S. Army Corps of Engineers (CEMVP-PD-P)
1222 Spruce Street
St. Louis, MO 63103
Email: Shane.M.Simmons@usace.army.mil

Sincerely,

Brian Johnson

Brian L. Johnson
Chief, Environmental Compliance Branch

U.S. Army Corps
Of Engineers
St. Louis District

March 2019

DRAFT ENVIRONMENTAL ASSESSMENT
WITH UNSIGNED FINDING OF NO SIGNIFICANT IMPACT

Red Rock Landing Phase 6
Middle Mississippi River (RM 101.2 – 99.6)
Perry County, Missouri, and Randolph County, Illinois

Regulating Works Project

U.S. Army Corps of Engineers, St. Louis District
Regional Planning & Environmental Division North (CEMVS-PD-P)

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Chapter 1. Introduction

1.1 Overview

The U.S. Army Corps of Engineers (Corps), Mississippi Valley Division (MVD), St. Louis District (District), proposes to undergo construction activities to reduce sediment deposition that is leading to unsafe navigation due to insufficient Mississippi River navigation channel depths at low water between river miles 101.2 – 99.6, in Perry County, Missouri, and Randolph County, Illinois (Figure 1), referred to herein as the Red Rock Landing Phase 6 work area under the Regulating Works Project (described below). It is approximately 1.7 miles south of Rockwood, Illinois and 9 miles southeast of Chester, Illinois.

This Draft Environmental Assessment (EA) and unsigned Finding of No Significant Impact (FONSI) have been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality's Regulations (40 Code of Federal Regulations §1500-1508), as reflected in the Corps Engineering Regulation 200-2-2.

1.2 Authorization, Prior Reports, and Incorporation by Reference

The St. Louis District of the U.S. Army Corps of Engineers is charged with obtaining and maintaining a navigation channel on the Middle Mississippi River (MMR) that is nine feet deep, at least 300 feet wide with additional width in bends as necessary. The MMR is defined as that portion of the Mississippi River that lies between its confluence with the Ohio and the Missouri Rivers (Figure 1). This ongoing Project is also commonly referred to as the Regulating Works Project (Project). As authorized by Congress, the Project utilizes bank stabilization, rock removal, and sediment management to maintain bank stability and ensure adequate navigation depth and width. Bank stabilization is achieved by revetment and river training structures, while sediment management is achieved by river training structures. The Project is maintained through dredging and any needed maintenance to already constructed features. The long-term goal of the Project, as authorized by Congress, is to obtain and maintain a navigation channel and reduce federal expenditures by alleviating the amount of annual maintenance dredging through the construction of regulating works.

This site-specific Environmental Assessment is tiered off of the 1976 Environmental Impact Statement (1976 EIS) covering the Project – *Mississippi River between the Ohio and Missouri Rivers (Regulating Works)*, (USACE 1976), and the supplement to that document completed in 2017: *Final Supplement I to the Final Environmental Statement, Mississippi River between the Ohio and Missouri Rivers (Regulating Works)* (USACE 2017) (2017 SEIS).

Further, the District recently completed a Supplemental EA (SEA) on five (5) tiered site-specific Environmental Assessments (SSEAs) that were completed for the Project during the preparation of the 2017 SEIS. In the SEA, the work done under those SSEAs was reevaluated for impacts to main channel border (MCB) habitat using a certified habitat model because the 2017 SEIS found

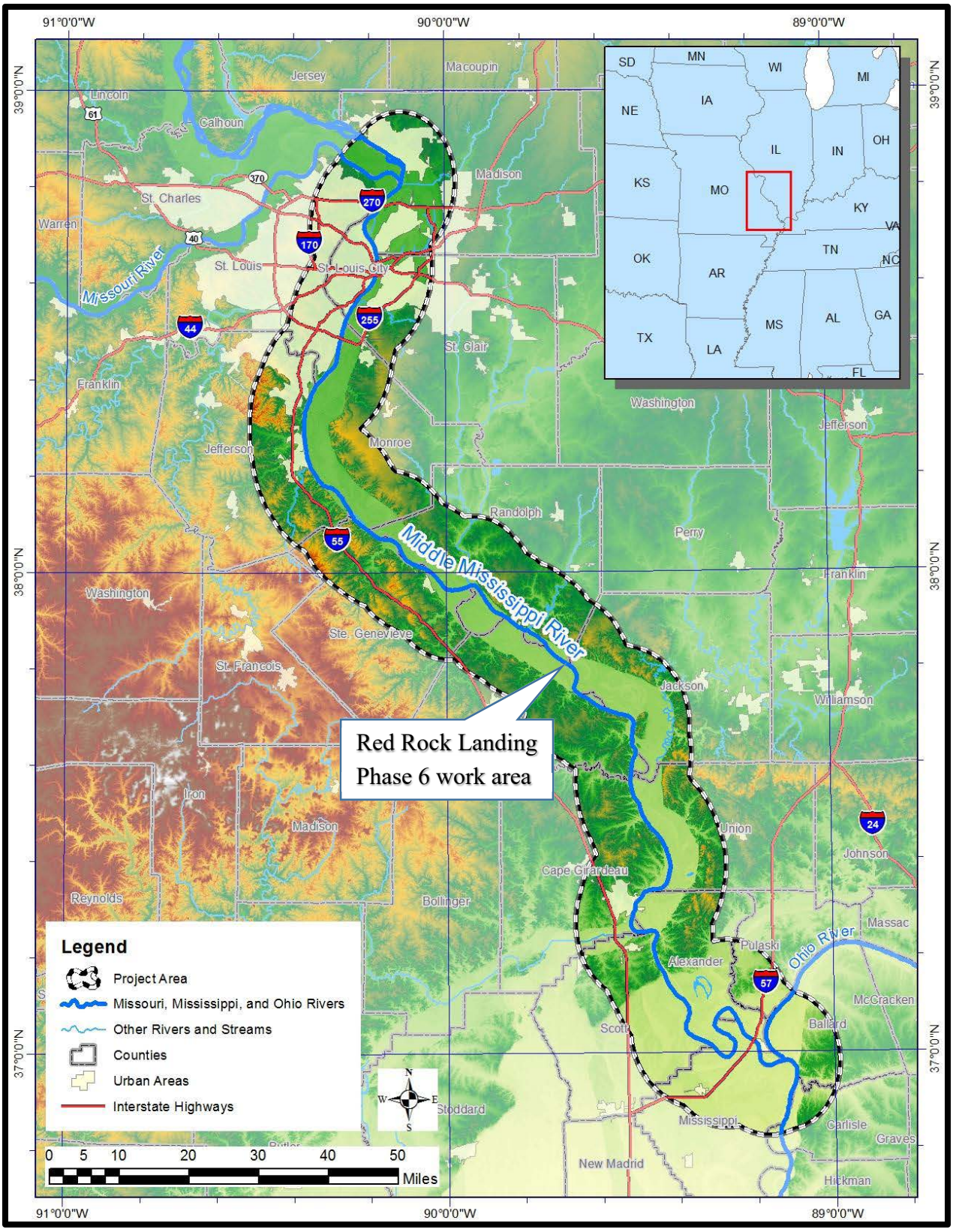

Figure 1. The proposed work area in relation to the Regulating Works Project.

a potentially significant impact to this particular habitat by continuing with new construction to reduce dredging under the Regulating Works Project. The SEA includes a description of the monitoring and adaptive management plan for any potential compensatory mitigation, details on how potential compensatory mitigation was assessed, and the results of the initial assessment of the Project's impacts to MCB habitat. The 1976 EIS, 2017 SEIS, SSEAs, SEA, and all other applicable background information and documentation can be found here and are hereby incorporated by reference into this draft EA:

http://www.mvs.usace.army.mil/Missions/Navigation/SEIS/Library.aspx

Regarding the Red Rock Landing Phase 6 work area, this draft EA discusses the impacts of the particular action on the environment. Site-specific impacts to MCB habitat have been assessed at the work area using the MMR Sturgeon Chub Model (Chub Model) discussed in detail in the SEIS and the SEA. The results of that assessment are included in this draft EA and are discussed in terms of the Project's overall impact on MCB habitat and its associated monitoring and adaptive management plan. Further, any applicable site-specific environmental impacts from this new work not fully covered in the 2017 SEIS are included herein.

1.4 Purpose of and Need for Action

Sediment accumulation occurs within the navigation channel in the proposed work area (Figure 2). Costly dredging has been required during periods of low flow in order to maintain a safe and efficient navigation channel within the proposed work area. From 2000 to 2017, approximately 1.6 million cubic yards of material has been dredged from the navigation channel in the vicinity (Figure 3), costing approximately $2.9 million. The most recent dredging activity occurred in the years 2012 and 2013, when low flow conditions persisted and led to unsafe navigation conditions in the area. The total cost of dredging for 2012 and 2013 alone was $1,433,422.

Through analysis and modeling, the District has concluded that construction and modification of river training structures in the area is reasonable and necessary to address the costly channel maintenance dredging at low water in order to provide a sustainable, less costly navigation channel and to provide consistent, smooth curvature that would complement adjacent work areas such that they work collectively to maintain navigable depths. Therefore, the overall purpose of the proposed federal action is to reduce the amount of costly channel maintenance dredging that has been required in the area at low water and to ensure a safe and dependable navigation channel under the Regulating Works Project in the proposed work area by reducing the amount of sediment deposition within the navigation channel and provide better navigation channel alignment in the proposed work area. Furthermore, by addressing the need for low water dredging in this location, the District's dredging resources will be less strained during prolonged periods of low water, and could be more effectively allocated to other low water dredging areas, thereby reducing the overall risk of channel closures or groundings throughout the District.

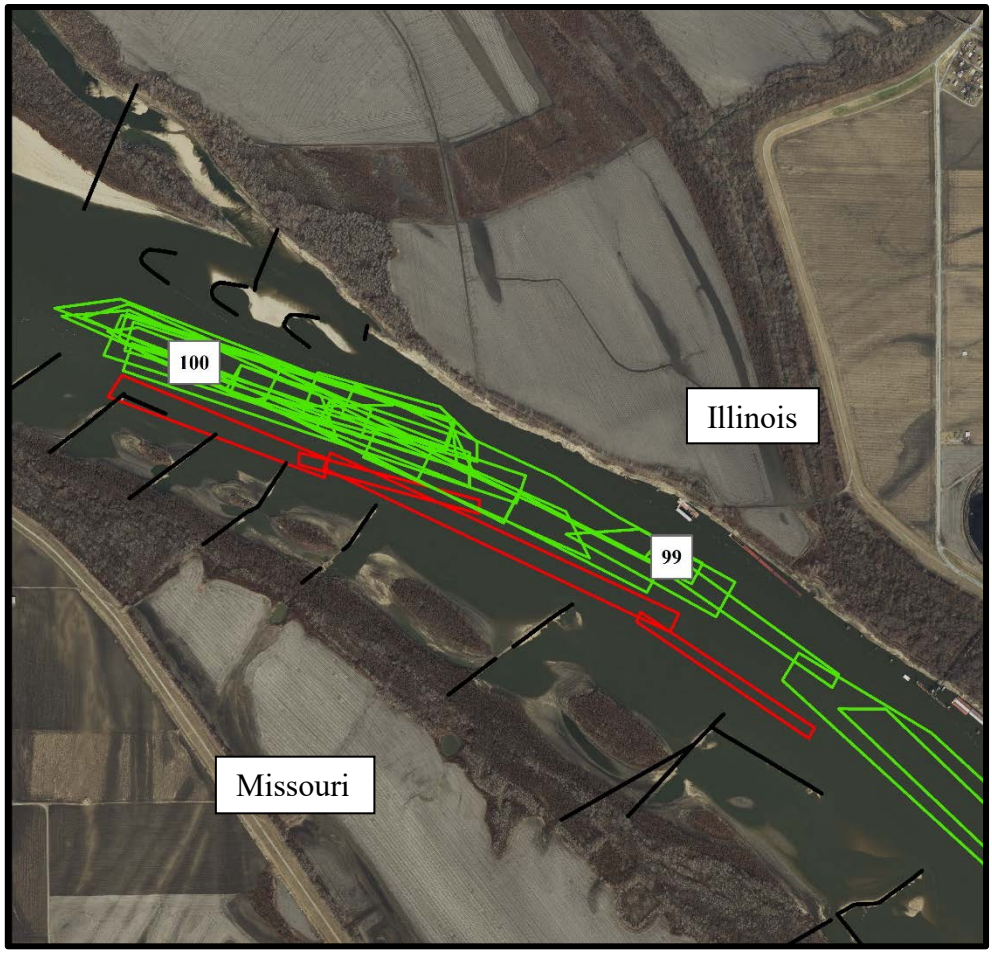

Figure 2. Approximate location of dredging events (green) and dredge disposal locations (red) performed in the work area from 2000 to 2017.

1.5 Scoping

Scoping is an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. Scoping was conducted early in the planning process using a variety of communication methods with affected agencies, organizations, and tribes. The input received during scoping was incorporated in the process of decision making for this work; however, the District must ultimately make the decision what direction the Project will follow.

Tribal Scoping

The United States government has a unique legal relationship with federally recognized American Indian Tribes, based on the inherent powers of Tribal sovereignty and self-government. The District will uphold this special relationship and implement its activities in a manner consistent with it. Communication with 28 federally recognized tribes affiliated with the St. Louis District was initiated by the District's tribal liaison with a Corps letter dated 03 January, 2019 (Appendix D), and they will be notified of the 30-day public review period (see

below). All responses to this coordination received by the District will be included in the final version of this report.

Public Comment
Public scoping activities will be held prior to the development of the Final EA. This environmental assessment will be made available to the public for a 30-day public review period. The report will be made available on the District's website along with mailed letters to interested members of the public addressing where to find the report and how to provide comments.

Agencies and Organization Scoping
The planning of specific construction areas, including the Red Rock Landing Phase 6 work area, requires extensive coordination with resource agency partners and the navigation industry. The U.S. Fish and Wildlife Service (USFWS), Missouri Department of Conservation (MDC), Illinois Department of Natural Resources (IDNR), and the River Industry Action Committee (RIAC) were included in the planning of the Red Rock Landing Phase 6 work area and provided comments related to environmental resources issues, as documented in technical report: UMR 100.5 – 98.5 Hydraulic Sediment Response (HSR) Model Study (Appendix C).

Chapter 2. Alternatives Including the Proposed Action

This section describes the alternatives or potential actions that were considered as ways to address the issues with maintaining the authorized depth, width, and alignment of the navigation channel within the work area vicinity for the purpose of reducing dredging at low water within the work area. Alternatives will be described and their environmental impacts and usefulness in achieving the overall Project objectives are compared.

Alternative 1 - No Action. Under the No Action Alternative, the District would not construct any new river training structures within the work area, nor would it lengthen or reduce any of the existing river training structures in the area. Under this alternative, the District would continue to maintain the existing river training structures in the area to their design specifications and elevations, and continue channel maintenance dredging to ensure a safe and dependable navigation channel exists in the work area.

Alternative 2 - Proposed Action. The Proposed Action Alternative involves modifying the configuration of river training structures within the Red Rock Landing Phase 6 reach of the MMR, between river miles 101.2 – 99.6. As summarized in Table 1, the specific details of the Proposed Action include reducing the length of dikes 101.2 (R), 101.0 (R), 100.4 (R); extending dikes 100.8 (R), 99.8 (R), and 99.6 (R); and degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel. Further, each of the three chevrons along the left descending bank (left bank) would be modified by removing the landward half of each chevron. The aforementioned structures would also be brought back to their design elevations. The majority of the stone used for the extension and raising of structures would be recycled stone from the proposed structure removal. Approximately 8,700 CY of new stone would be added to the system. The volume of stone that comprises each structure would change, this is displayed in Table 1.

Table 1. Features associated with the Proposed Action Alternative. Lengths and stone quantities are approximate, and are subject to revision during structure design. Final elevation of all proposed construction/realignment would be 354 NGVD (+18 LWRP).

Location	Proposed Work	Purpose	Stone (CY)
101.2 (R)	Remove riverward 170 ft of existing trail dike.	Maintain smooth flow alignment along the RDB structures.	-1,578
101.0 (R)	Remove riverward 75 ft of existing dike.	Maintain smooth flow alignment along the RDB structures.	-1,336
100.8 (R)	Extend existing dike by 50 ft.	Maintain smooth flow alignment along the RDB structures.	+2,860
100.6 (R)	Degrade existing trail dike (re-use/recycle stone), rebuild 460 ft trail dike with improved alignment.	Maintain smooth flow alignment along the RDB structures.	No change
100.4 (R)	Remove riverward 175 ft of existing trail dike.	Maintain smooth flow alignment along the RDB structures.	-1,260
100.1 (L)	Remove landward half of structure, 375 ft.	Minimize impacts to the sandbar based upon new flow alignments.	-2,859
100.0 (L)	Remove landward half of structure, 375 ft.	Minimize impacts to the sandbar based upon new flow alignments.	-5,062
99.9 (L)	Remove landward half of structure, 375 ft.	Minimize impacts to the sandbar based upon new flow alignments.	-287
99.8 (R)	Extend existing dike by 75 ft.	Prevent sediment deposition at channel crossing.	+9,431
99.6 (R)	Extend existing dike by 75 ft.	Prevent sediment deposition at channel crossing.	+8,817

Table 2. General description of river training structures included in the Proposed Action.

Spur Dike; Wing Dam; Jetty 	Extends perpendicularly from the riverbank toward the main river channel. This is the most common type of dike and has been constructed on the MMR since the 19th Century.
L-head Dike; Trail Dike 	Extends from the riverbank like a spur dike but also has a section at the dike end that extends downstream. The L-head section spreads the energy of the flow over a larger area and can be used to increase the spacing between dikes, to reduce scour on the end of the dike, or to extend the effects of the dike system further downstream. The L-head also tends to block the movement of sediment behind the dike by reducing the formation of eddies downstream. This type of dike did not become common on the MMR until after 1970.
Chevron 	Blunt-nosed, arch-shaped structures that are constructed parallel to flow, utilizing the energy of the river to redistribute flow and sediment. They are usually placed adjacent to the river bank to allow flow separation and create both channel deepening, side channel development, and middle bar formation. Chevrons were first constructed on the MMR in 2001.

2.1 Development of Alternatives

Pursuant to the Project objectives and authority discussed in the 1976 EIS and the 2017 SEIS, the District's alternative evaluation process for this work area considered only those alternatives that will obtain and maintain a safe and reliable 9-foot navigation channel in the work area through continued maintenance dredging or construction of regulating works to minimize the dredging required.

For the Red Rock work area, the District developed 19 different design configurations using widely recognized and accepted river engineering guidance and practice, and then screened and

analyzed the different configurations with the assistance of a Hydraulic Sediment Response model (HSR models are discussed in detail in the 2017 SEIS). The 19 different configurations of river training structures were considered in the HSR model to determine the best combinations to reduce the need for dredging and improve the navigation channel alignment, while also minimizing environmental impacts. Throughout the HSR modeling process, three specific criteria were used to evaluate each of the alternatives:

- The alternative should reduce or eliminate the need for dredging between RM 100.5 and RM 98.5;

- The alternative should have a minimal impact on the Mile 100 Islands; and

- The alternative should have a minimal impact on the sandbar along the riverward side of Rockwood Island.

Based on the results of the HSR model study, alternatives 4 and 17 were recommended as the most desirable alternatives because of their observed ability to improve navigation channel dimensions in the problematic reach and reduce/eliminate the need for channel maintenance dredging at low water in the future. Alternative 17 is the same as alternative 4, with the addition of partial removal of chevrons along the left bank (discussed below). Model bathymetry for both Alternative 4 and Alternative 17 showed greater depths along the right bank and also significantly improved the crossing at RM 100 when compared to the model replication. The design of alternatives 4 and 17 is based largely on the realignment and modification of existing river training structures in the area, and involves the construction of fewer new structures compared to many of the other alternatives analyzed, meaning the construction footprint and overall environmental impact would be minimized within the work area.

Throughout the alternative evaluation process, the District worked closely with navigation industry personnel and natural resource agency partners to further evaluate potential alternatives in this reach of the river, including the 19 configurations analyzed in the HSR model. All partner concerns were satisfactorily resolved and a consensus was reached on an acceptable design. In particular, HSR model alternatives 3 and 18 also met the criteria listed above. However, navigation industry personnel expressed concern over alternative 3, and its ability to maintain sufficient navigation channel dimensions between RM 99.4 – 98.9. Therefore, it was removed from further consideration. Further, natural resource agency partners were concerned that weirs included in alternative 18 could direct flow into the RM 100 Islands and negatively impact this important resource of the MMR. The natural resource agencies supported implementation of alternative 17 which they felt would minimize impacts to the sandbar along the left bank and increase flow and depth diversity, potentially improving overall habitat, in the direct vicinity of the modified chevron dike field.

Ultimately, this coordination process resulted in selection of alternative 17 from the HSR study as the Proposed Action Alternative, which reasonably met the Project purpose while also avoiding/minimizing environmental impacts. Based on this extensive evaluation of design configurations, the District determined that the Proposed Action Alternative was the only reasonable alternative to minimize dredging during periods of low river stages and that more

extensive analysis of any of the additional configurations of river training structures in the EA would be unnecessary for failure to meet the objectives described above.

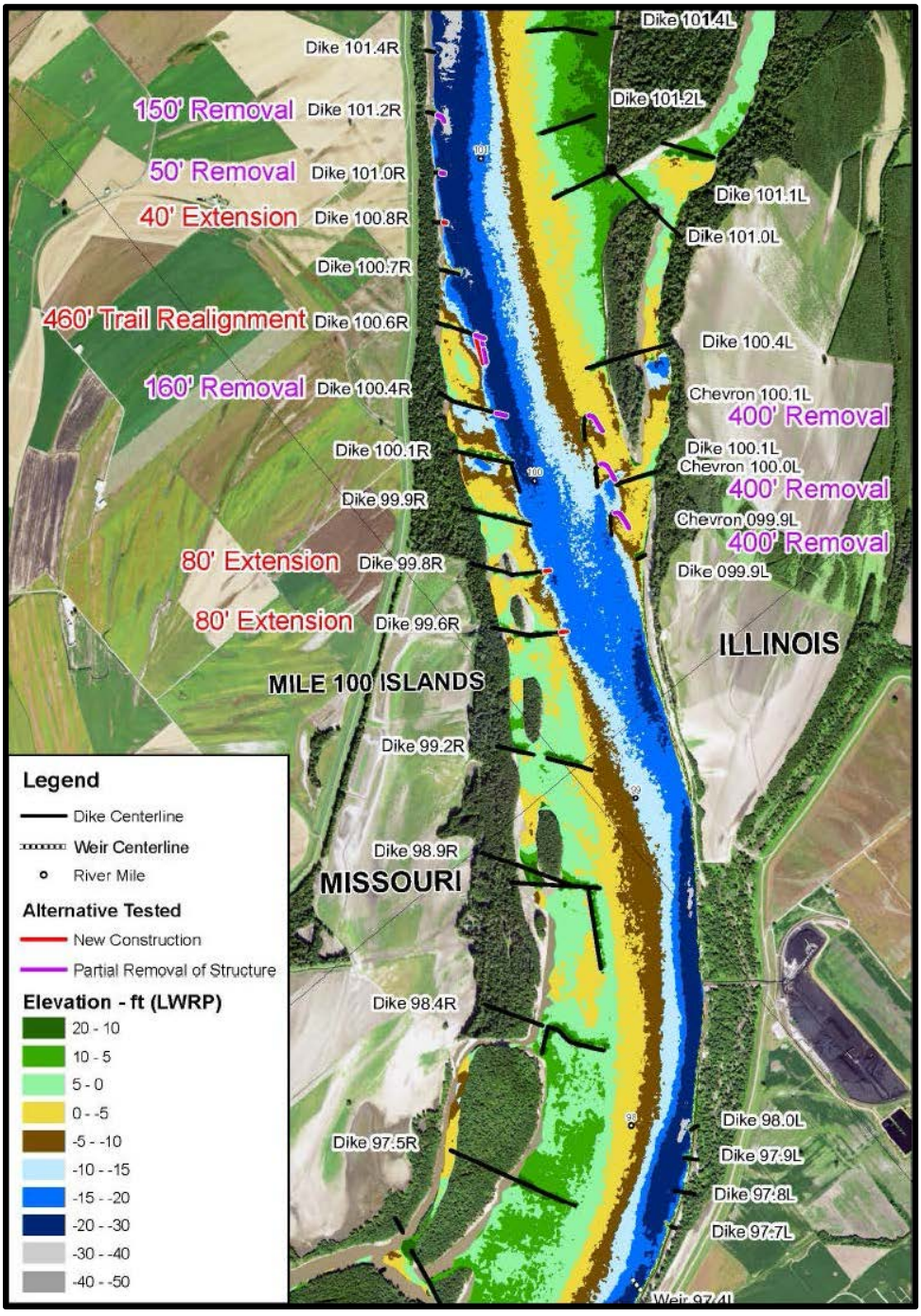

Figure 3. Results of HSR modeling of alternative 17.

Chapter 3. Affected Environment and Environmental Consequences

This section presents details on the historic and existing conditions of resources within the work area that would potentially be affected by the No Action alternative and the Proposed Action alternative, as well as a comparison of the effects that are likely to result from these alternatives.

3.1 Summary of Environmental Consequences

The existing resources in the work area and the anticipated impacts associated with the two Alternatives are both consistent with the information described in the 1976 EIS and 2017 SEIS. As such and pursuant to CEQ regulations and guidance to minimize the size of NEPA documents by not duplicating analyses or presenting redundant information, this section incorporates by reference the description of the affected environment and the environmental consequences included in the aforementioned documents with no need for additional details as to this specific work area. Therefore, many resource categories (e.g., stages, air quality, HTRW) will not be described any further in this document and the analyses and impacts described in the 1976 EIS and 2017 SEIS are incorporated by reference. Other resource categories (e.g., fishery resources, historic and cultural resources) as they relate specifically to this work will be described further with the appropriate amount of additional site-specific details regarding their existing conditions and the associated impacts of both Alternatives.

Further, an analysis of the Project's cumulative effects is presented in the 2017 SEIS, which accurately captures the affected environment and environmental consequences of the No Action Alternative and the Proposed Action Alternative described herein. As such this is incorporated by reference, and an additional cumulative effects analysis has not been prepared for the EA.

3.2 Geomorphology

The physical layout of the Red Rock Landing Phase 6 work area consists primarily of main channel and structured main channel border on the left and right banks. A series of traditional rock dikes extend from the right bank toward the navigation channel within the area, two of which have trail dike segments. The left bank includes unstructured MCB near the downstream end of Rockwood Island, and three chevron structures. The downstream entrance to Liberty Chute is found along the left bank within the work area vicinity. Liberty Chute is one of the better connected side channels in the MMR. Based on median monthly stages and recent bathymetric surveys, Liberty Chute has consistent flowing water and remains connected to the main channel for the majority of the year. A channel crossover exists in the work area; the thalweg meanders from the right bank near RM 101 to the left bank near RM 99.5.

Impacts of the No Action Alternative on Geomorphology - The physical layout of the work area is expected to remain similar to its current condition under the No Action Alternative. All existing river training structures in the area would remain in their current positions and would be maintained to their original design specifications. Sedimentation would likely continue in the navigation channel within the proposed work area. This would cause average bed elevation to increase over time within the navigation channel. Therefore, under this alternative, channel maintenance dredging would likely continue to be necessary in the work area vicinity during

periods of low water. Dredging and disposal areas would presumably be located near their previous locations, as illustrated in Figure 2. This would lead to periodic decreases in bed elevation within the navigation channel and periodic increases to elevation along the right bank, a direct result from dredging and dredge disposal. All other geomorphology characteristics would remain unchanged.

Impacts of the Proposed Action on Geomorphology - The Proposed Action Alternative would slightly alter the geomorphological characteristics of the work area. As described in Chapter 2, one structure would be degraded and rebuilt with different alignment, three would be shortened for flow alignment and sediment transport purposes, and the three chevrons would be partially removed to minimize impacts to the sandbar on the left bank. The Proposed Action would result in a net decrease in the collective length of river training structures in the area.

Further, the Proposed Action would enhance the channel scour effect of the river within the work area, increasing sediment transport within the navigation channel in the area. A lower bed elevation would be maintained within the navigation channel. This alternative would lessen the need for continued channel maintenance dredging at low water within the work area, meaning the bed elevations of the navigation channel and sandbar would fluctuate less frequently as a result of sediment accretion and channel maintenance dredging.

3.3 Fishery Resources

The existing condition of fishery resources within the Red Rock work area vicinity is consistent with the description provided in the 2017 SEIS. Namely, the assemblage of aquatic organisms (i.e., fish and macroinvertebrates) that is likely to occur within the work area is presumably the same as what commonly occurs throughout the MMR. Fish macrohabitat features in the area are also similar to the descriptions provided in the 2017 SEIS. Habitat types in the area fall under common Mississippi River habitat classifications (see Barko et al. 2004, Phelps et al. 2010), including the main channel, unstructured main-channel border, structured main-channel border, and a side channel. Because of this, the work area likely fulfills the habitat requirements for the major habitat guilds of large river fishes: fluvial specialists, fluvial dependents, and macrohabitat generalists.

Impacts of the No Action Alternative on Fishery Resources - Under the No Action Alternative, fishery resources in the work area vicinity would likely remain unchanged from their current condition. However, given that the area has a continued need for channel maintenance dredging during periods of low water, and that the Proposed Action is specifically designed to alleviate this issue, a continued need for channel maintenance dredging would be expected with implementation of the No Action Alternative. A thorough description of the effects of channel maintenance dredging on aquatic organisms and aquatic habitat is provided in the 2017 SEIS. Those effects would be expected to be the same for the Red Rock Landing Phase 6 work area, and while these effects are mostly temporary, the rate and frequency of these temporary effects would be increased under the No Action Alternative. Examples include entrainment of fish and macroinvertebrates, smothering of benthic macroinvertebrates, and temporary re-suspension of sediment.

Impacts of the Proposed Action on Fishery Resources - Multiple impacts to fishery resources are likely to occur with implementation of the Proposed Action Alternative. These impacts align with the described effects of river training structure construction outlined in the 2017 SEIS. The planned construction would alleviate the continued need for channel maintenance dredging during low flows, thereby reducing its associated impacts, i.e., less fish and macroinvertebrate entrainment, less disturbance of sediment, and less smothering of benthic organisms with dredge disposal material.

While collaborating with natural resource agency partners, much consideration was given to aquatic habitat within the work area. This resulted in the selection of alternative 17 from the HSR modelling in lieu of alternatives 4 or 18. The Proposed Action Alternative includes the partial removal of the three chevrons along the left bank in order to minimize impacts to the sandbar along the left bank.

The aforementioned impacts on fishery resources that would likely result from the Proposed Action are beneficial in nature. This was corroborated by the initial mitigation assessment of the Proposed Action, which revealed it would positively affect shallow to moderate-depth, moderate-to high-velocity habitat within the vicinity of the work area. This specific habitat type is important for fluvial specialist and fluvial dependent fish species that occur in the MMR, which was found to likely be significantly impacted by the Continue Construction Alternative of the overall Project analyzed in the 2017 SEIS. However, by removing infrastructure and modifying the local hydraulic patterns, the Red Rock Landing Phase 6 work area would improve the aquatic habitat for fluvial specialist/dependent species as well as generalist species. Given that loss of this habitat type was deemed significant on a Project-wide basis in the 2017 SEIS, the changes to this habitat type at the Red Rock Landing Phase 6 work area must be discussed and assessed as such. More detail on this impact is provided in Chapter 4.

3.4 Threatened and Endangered Species

A programmatic (Tier I) consultation (USACE 1999), conducted under Section 7 of the Endangered Species Act, considered the systemic impacts of the operation and maintenance of the 9-Foot Channel Navigation Project on the Upper Mississippi River System (including the MMR) and addressed listed species as projected 50 years into the future (USFWS 2000). Since the aforementioned consultation process, additional species that could potentially occur within the Project Area have been listed threatened or endangered. These species were addressed in an additional programmatic (Tier I) consultation that accompanied the 2017 SEIS. These consultations did not include individual, site specific effects or new construction. It was agreed that site specific impacts and new construction impacts would be handled under separate Tier II consultations. Although channel structure impacts were covered under the Tier I consultations, other site and species specific impacts could occur. As such, the Red Rock Landing Phase 6 work requires Tier II consultation. Accordingly, this section of this report is being used to satisfy the requirements of completing a Tier II Biological Assessment for this work.

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, the St. Louis District consulted with the U.S. Fish and Wildlife Service, Marion Ecological Services Sub-Office and the Missouri Ecological Services Sub-office. Through the Service's Information, Planning, and Conservation (IPaC) System they provided a list of threatened and endangered

species that could potentially occur within the vicinity of the work area. According to the Service, four federally endangered species and two federally threatened species may occur within the work area (Table 3). There is no federally designated critical habitat in the proposed work area.

This section will also serve as the effects determination portion of the Biological Assessment required by the Endangered Species Act. This satisfies the requirement for Section 7 Consultation under the Endangered Species Act. The gray bay, Indiana bat, northern long-eared bat, least tern, pallid sturgeon, and small whorled pogonia are listed as federally threatened or endangered species that may occur within the vicinity of the work area.

Table 3. List of threatened and endangered species that may occur in the work area vicinity.

Species	Status	Habitat
Gray bat (Myotis grisescens)	Endangered	Caves, forages near rivers and reservoirs adjacent to forests.
Indiana bat (*Myotis sodalis)*	Endangered	Hibernates in caves and mines. Maternity and foraging habitat: small stream corridors with well-developed riparian woods; upland and bottomland forests
Northern long-eared bat (*Myotis septentrionalis)*	Threatened	Hibernates in caves and mines; swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests during spring and summer.
Pallid sturgeon (*Scaphirhynchus albus*)	Endangered	Mississippi and Missouri Rivers
Least tern (*Sterna antillarum*)	Endangered	Large rivers - nest on bare alluvial and dredge disposal islands.
Small Whorled Pogonia (*Isotria medeoloides*)	Threatened	Dry woodlands

Gray Bat - The gray bat (*Myotis grisescens*) is listed as endangered and occurs in several Illinois and Missouri counties where it inhabits caves during both summer and winter. This species forages in riparian forest canopy and over rivers and reservoirs adjacent to forests. All proposed construction activity would be completed by river-based equipment and will not result in the disturbance of any caves. As such, the proposed action would have *no effect* on the gray bat.

Indiana Bat - The range of the Indiana bat (*Myotis sodalis*) includes much of the eastern half of the United States, including southern Missouri. Indiana bats migrate seasonally between winter hibernacula and summer roosting habitats. Winter hibernacula include caves and abandoned mines. Females emerge from hibernation in late March or early April to migrate to summer roosts. During the summer, the Indiana bat frequents the corridors of small streams with well-developed riparian woods, as well as mature upland forests. It forages for insects along stream corridors, within the canopy of floodplain and upland forests, over clearings with early successional vegetation (old fields), along the borders of croplands, along wooded fencerows, and over farm ponds in pastures. Females form nursery colonies under the loose bark of trees (dead or alive) and/or cavities, where each female gives birth to a single young in June or early July. A maternity colony may include from one to 100 individuals. A single colony may utilize a number of roost trees during the summer, typically a primary roost tree and several alternates. Some males remain in the area near the winter hibernacula during summer months, but others disperse throughout the range of the species and roost individually or in small numbers in the same types of trees as females. The leading causes of the Indiana bat population decline includes disturbance, vandalism, improper cave gates and structures, natural hazards such as flooding or freezing, microclimate changes, land use changes in maternity range, and chemical contamination (USFWS 2000, 2004).

To avoid incidental take of this species, the Service recommends tree clearing activities should not occur during the period of 1 April to 30 September. In addition, trees suitable for bat roosts or maternity colonies should not be removed without first performing a bat survey.
The Proposed Action does not call for the removal of any trees; all construction would be completed by river-based equipment and will not result in the destruction of any forested riparian habitat. However, unforeseen effects from construction activities (e.g., noise), could potentially disturb Indiana bats roosting on the land adjacent to the work area. As such, the proposed action *may affect, but is not likely to adversely affect* the Indiana bat.

Northern Long-Eared Bat - The northern long-eared (*Myotis septentrionalis*) bat is a federally threatened bat species. The northern long-eared bat is sparsely found across much of the eastern and north central United States, and all Canadian provinces from the Atlantic Ocean west to the southern Yukon Territory and eastern British Columbia. Northern long-eared bats spend winter hibernating in large caves and mines. During summer, this species roosts singly or in colonies underneath bark, in cavities, in crevices of both live and dead trees. Foraging occurs in interior upland forests. Forest fragmentation, logging and forest conversion are major threats to the species. One of the primary threats to the northern long-eared bat is the fungal disease, whitenose syndrome, which has killed an estimated 5.5 million cave-hibernating bats in the Northeast, Southeast, Midwest and Canada. Suitable northern long-eared bat summer habitat may occur in the forested areas adjacent to the work area.

The Proposed Action does not call for the removal of any trees; all construction would be completed by river-based equipment and will not result in the destruction of any forested riparian habitat. However, unforeseen effects from construction activities (e.g., noise), could potentially disturb northern long-eared bats roosting on the land adjacent to the work area. As such, the Proposed Action *may affect, but is not likely to adversely affect* the northern long-eared bat.

Pallid Sturgeon - The pallid sturgeon is federally endangered big-river fish species. It is the position of the Service that over time, river training structures have adversely affected pallid sturgeon by impacting the quality and quantity of habitats in the MMR to which the species is adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity, and turbid waters). According to the Service, this loss of habitat has reduced pallid sturgeon reproduction, growth, and survival by (1) decreasing the availability of spawning habitat; (2) reducing larval and juvenile pallid sturgeon rearing habitat; (3) reducing the availability of seasonal refugia; and (4) reducing the availability of foraging habitat (USFWS 2000).

In addition to the habitat changes, reduction in the natural forage base for the pallid sturgeon is likely another factor contributing to the species decline (Mayden and Kuhajda 1997, USFWS 2000). The Service states that river training structures have also altered the natural hydrograph of the MMR by contributing to a downward trend in annual minimum stages (Simons et al. 1974, Wlosinski 1999, USFWS 2000). As a result, areas that were historically aquatic habitats are now dry at low discharges (Wlosinski 1999). This has potentially reduced the availability of pallid sturgeon spawning habitat through the loss of habitat heterogeneity (USFWS 2000). Working in coordination with the USFWS, potential adverse impacts to the pallid sturgeon associated with the Proposed Action have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits (i.e., partial chevron removal). Further, as discussed in Section 2.1 of this report, one of the design criteria used to select the Proposed Action included not adversely impacting the sandbar adjacent to Rockwood Island. The Proposed Action met that criterion, and would therefore not negatively affect this important pallid sturgeon aquatic habitat. Additionally, given that one of the primary purposes of the Proposed Action is to reduce the need for channel maintenance dredging, implementation of the Proposed Action would reduce the likelihood of pallid sturgeon entrainment within the work area.

Although adverse impacts to pallid sturgeon associated with this work area have been avoided and minimized to the greatest extent possible, pallid sturgeon may still be adversely affected by the overall Project. However, the adverse effects of the Project on the pallid sturgeon are consistent with those anticipated in the programmatic Biological Opinion (USFWS 2000) and the District has implemented the Reasonable and Prudent Alternative, Reasonable and Prudent Measures, and Terms and Conditions prescribed therein as appropriate for the Project.

Least Tern - The interior population of the least tern (*Sterna antillarum*) is characterized as a colonial, migratory waterbird, which resides and breeds along the Mississippi River during the spring and summer. Least tern arrive on the Mississippi River from late April to mid-May. Reproduction takes place from May through August, and the birds migrate to the wintering grounds in late August or early September (USACE 1999). Sparsely vegetated portions of sandbars and islands are typical breeding, nesting, rearing, loafing, and roosting sites for least tern along the MMR. Nests are often at higher elevations and well removed from the water's edge, a reflection of the fact that nesting starts when river stages are relatively high (USACE 1999).

Given the highly dynamic nature of the historic MMR planform, the ability to return to previously used colony sites is not likely a critical life history requirement. The availability of sandbar habitat to least terns for breeding, nesting, and rearing of chicks from 15 May to 31 August is a key variable in the population ecology of this water bird. Only portions of sandbars that are not densely covered by woody vegetation and are emergent during the 15 May to 31 August period are potentially available to least terns (USACE 1999).

Least terns are almost exclusively piscivorous (Anderson 1983), preying on small fish, primarily minnows (Cyprinidae). Prey size appears to be a more important factor determining dietary composition than preference for a particular species or group of fishes (Moseley, 1976; Whitman, 1988, USACE 1999). Fishing occurs close to the nesting colonies and may occur in both shallow and deep water, in main channel and backwater habitats. Radiotelemetry studies have shown that least tern will travel up to 2.5 miles to fish (Sidle and Harrison, 1990, USACE 1999). Along the Mississippi River, individuals are commonly observed hovering and diving for fish over current divergences (boils) in the main channel, over eddies, and other areas with turbulent conditions (e.g., downstream of MRSs).

Potential adverse impacts to the least tern associated with the Proposed Action have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits (i.e., partial chevron removal). Additionally, as discussed in Section 2.1 of this report, not impacting the sandbar adjacent to Rockwood Island was one of the design criteria during the development phase. The Proposed Action met this criteria, and would therefore not negatively affect the sandbar, which could serve as least tern nesting and rearing habitat.

Although adverse impacts to the least tern associated with this work area have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits, the least tern may still be adversely affected by the overall Project. However, the adverse effects of the Project on the least tern are consistent with those anticipated in the programmatic Biological Opinion and the District has implemented the Reasonable and Prudent Measures and Terms and Conditions prescribed therein as appropriate for the Project.

Small Whorled Pogonia - The small whorled pogonia (*Isotria medeoloides)* is a member of the orchid family. This orchid grows in older hardwood stands of beech, birch, maple, oak, and hickory that have an open understory. It prefers acidic soils with a thick layer of dead leaves, often on slopes near small streams. This species' preferred habitat (older hardwood stands of beech, birch, maple, oak, and hickory that have an open understory) does not exist within the Red Rock work area. The Proposed Action would occur entirely over open water habitat, no construction would occur on land, and no terrestrial habitat is expected to be impacted. Therefore, the Proposed Action would have *no effect* on the small whorled pogonia.

Bald Eagle - Although the bald eagle was removed from the federal list of threatened and endangered species in 2007, it continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA). The BGEPA prohibits unregulated take of bald eagles, including disturbance. The USFWS developed the National Bald Eagle Management

Guidelines (USFWS 2007) to provide landowners, land managers, and others with information and recommendations regarding how to minimize potential impacts to bald eagles, particularly where such impacts may constitute disturbance. No bald eagle nest trees are known to occur in the immediate vicinity of the work area at this time. If any nest trees are identified in the work area, the National Bald Eagle Management Guidelines will be implemented to minimize potential impacts and appropriate coordination with the USFWS will be conducted.

Impacts of the No Action Alternative on Threatened and Endangered Species – Under the No Action Alternative, significant impacts to threatened and endangered species would not be expected. The Red Rock work area would remain in its current condition, and the temporary effects due to construction (e.g., noise, sediment disturbance) would not occur. However, continued channel maintenance dredging would be expected in the vicinity with implementation of the No Action Alternative. This would increase the risk of pallid sturgeon entrainment. Therefore, the No Action Alternative may pose a greater threat to pallid sturgeon than the Proposed Action.

Impacts of the Proposed Action on Threatened and Endangered Species- As outlined above, the District has determined that the Proposed Action would have no effect on the gray bat or the small whorled pogonia, is not likely to adversely affect the Indiana bat, northern long-eared bat, and that potential effects to least tern and pallid sturgeon are consistent those discussed in programmatic (Tier 1) consultations discussed above. Ultimately, the consideration of environmental resources (e.g., fish and wildlife habitat) during the design and modeling phase has largely resulted in avoidance and minimization of impacts to threatened and endangered species. Furthermore, the localized reduction in channel maintenance dredging that would result from the Proposed Action could ultimately benefit pallid sturgeon by reducing the likelihood of entrainment.

3.5 Socioeconomics

The Middle Mississippi River is a critically important navigation corridor that enables transportation of a wide variety of commodities of local, national, and international importance. Within the work area vicinity, channel maintenance dredging at low water has been necessary in the proposed work area. Figure 4 shows the annual amount of material removed from 2000 to 2017. The annual amount of material dredged in the area fluctuates due to a myriad of reasons that are discussed in the 2017 SEIS (e.g., hydrograph and sedimentation variability). Figure 5 shows the associated cost for the same time period. Since the year 2000, approximately 1.6 million cubic yards of material has been removed between RM 100.5 - 98.5 at a cost of approximately $2.9 million. The total cost of dredging for 2012 and 2013 alone was $1,433,422. Annual dredging costs are also prone to fluctuation for a number or reasons, including fuel cost, labor cost, mobilization (i.e., distance traveled to reach site).

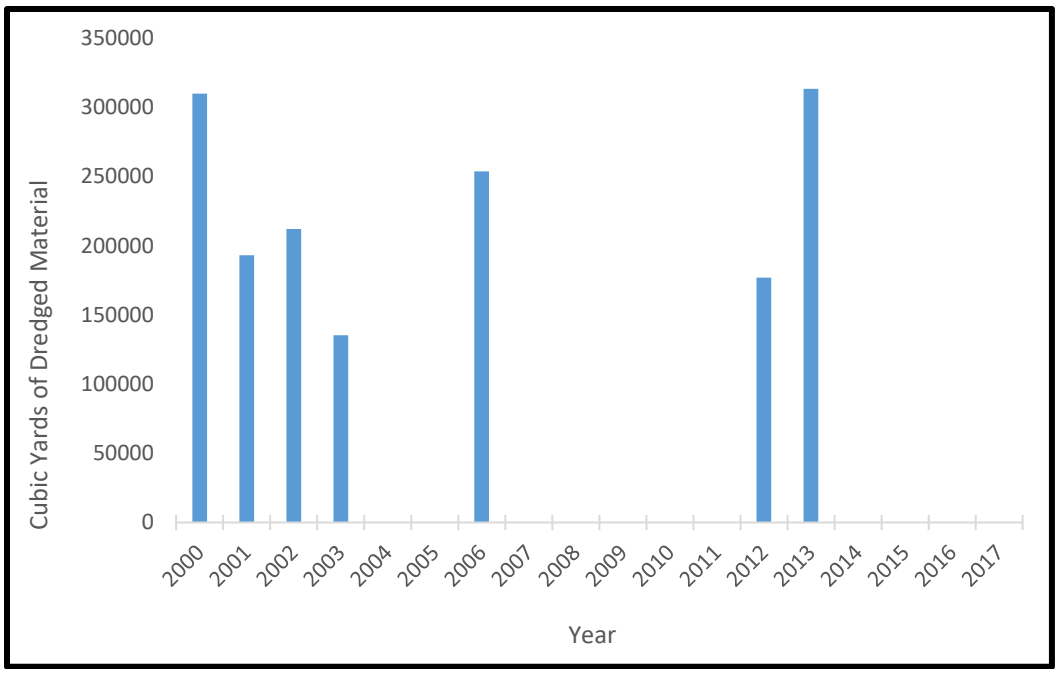

Figure 4. Annual volume of material dredged in the work area from 2000-2017.

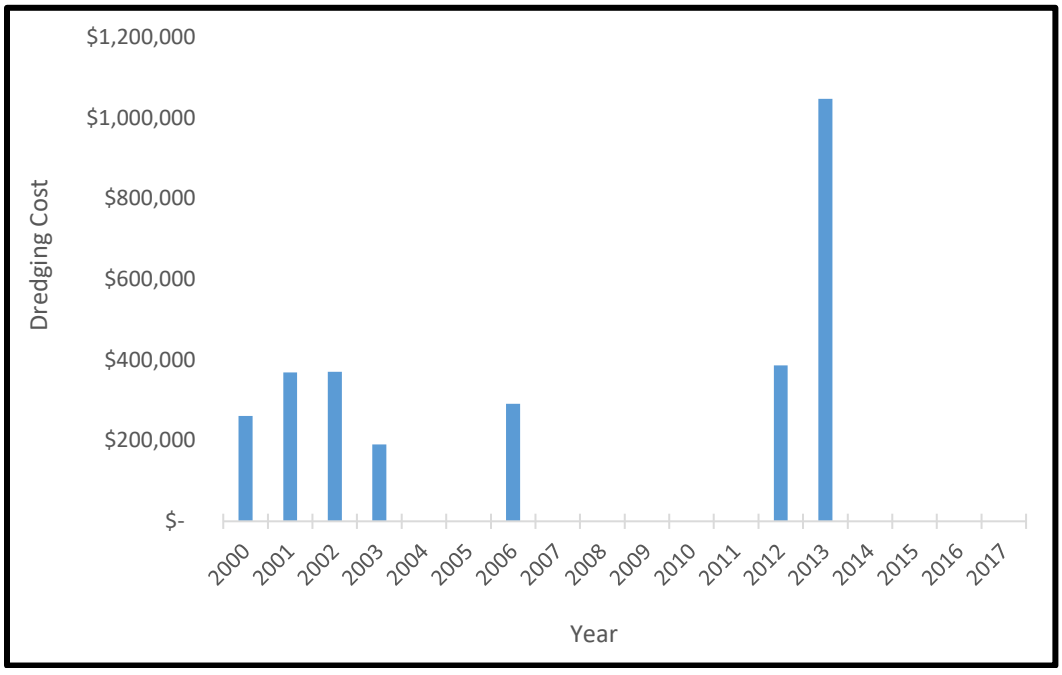

Figure 5. Annual cost of dredging in the work area from 2000-2017.

Impacts of the No Action Alternative on Socioeconomics - With the No Action Alternative, periodic maintenance dredging activities would be expected to continue at a rate similar to recent history, required largely during prolonged periods of low water. Low water years that require

high cost channel maintenance dredging would be expected to continue in the future. Further, channel maintenance dredging has been adequately funded and thus far addressed the sedimentation and sandbar encroachment that result from the inefficiency of river training structures in the area, ensuring the navigation channel remains open. However, the No Action Alternative would result in an increased risk of potential groundings and/or channel closure during periods of low flow. For example, just-in-time dredging[1] could become necessary in the area, but a dredge might not be able to reach the site in a timely manner, resulting in groundings or channel closure.

Impacts of the Proposed Action on Socioeconomics - Implementation of the Proposed Action is expected to reduce the amount and frequency of maintenance dredging necessary in the area during periods of low water. It has been observed at other work locations that maintenance dredging has been reduced by approximately 85%. This reduction is a projected average based on previous work in chronic dredging locations on the MMR (See Table 1-1 in the 2017 SEIS). Actual reductions in the amount and frequency of dredging are dependent on a number of natural factors including the hydrograph, the amount of sediment entering the system, as well as the frequency and duration of low flow conditions in the future. Further, the Proposed Action would complement previous work completed under the Regulating Works project immediately upstream of the work area. Modifying the configuration of river training structures in this area would help to achieve a more synchronized network of river training structures that work collectively to create and maintain a navigation channel with consistent and smooth curvature throughout a longer reach of the MMR. This would result in a safer and more navigable channel throughout this reach that requires less maneuvering by barge industry vessels, as well as enhanced sediment transport and a more reliable and self-sustaining navigation channel throughout this greater reach.

3.4 Historic and Cultural Resources

Landform History - The bankline of the proposed work area has not significantly changed in the past century and a half (Figure 6). The Missouri bankline has, however, expanded eastward as Liberty Bar was captured and incorporated into the Missouri bank of the river after 1890. Therefore many of the features to be modified are located in what was once, in the 19th century, the center of the Mississippi River.

The structures to be modified are directly adjacent to the navigation channel of the Mississippi River. The reach has been regularly dredged over the years, and it is likely that any unrecorded

[1] Just-in-time dredging refers to dredging during low water to ensure that problematic areas are dredged prior to the river levels falling to critical depths. This process entails proper scheduling and sequencing of the dredge projects using the best available survey data and forecast data to ensure that the dredge will arrive on each project site just prior to the river reaching critical depth. There are several risks involved when just-in-time dredging is used to maintain the navigation channel. Due to the dynamic nature of the river, survey data are only good at the time of survey and depths can change rapidly, the forecasts can change based on new information, the dredge equipment is prone to mechanical breakdowns, and new dredging locations can affect the schedule. Just-in-time dredging requires that the schedule, sequencing, and project parameters are constantly adjusted to account for the changing variables. Advanced maintenance dredging is the preferred method but changing channel conditions sometimes dictate that just-in-time dredging is required.

wreckage located in the path of those dredge events was destroyed and removed during the process. While exact location information is not available for dredging events prior to 1979, USACE has been conducting such activities to deepen the navigation channel of the MMR since 1896 (Manders and Rentfro 2011).

All the river training structures are constructed via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed in this work area.

Potential Shipwrecks - During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District Corps of Engineers conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck to the work area was located approximately a mile downstream and in a side channel.

The District performs periodic bathymetric channel surveys to monitor the depths of the navigation channel, with the latest survey having been completed in 2018. The single beam survey was conducted with range lines spacing of 200 feet. No topographic anomalies suggesting wrecks are visible on the resulting bathymetric map within this work area.

Impacts of the No Action Alternative on Historic and Cultural Resources - Continued dredging operations under the No Action Alternative are not anticipated to impact any known historic and cultural resources in the work area. Any undocumented historic and cultural resources that may have existed in the work area likely would have been destroyed by previous dredging activities. Future maintenance dredging under the No Action Alternative would likely occur in the same locations as previous dredging, and, therefore, would be unlikely to impact undocumented historic and cultural resources.

Impacts of the Proposed Action on Historic and Cultural Resources - All construction work on the dikes will be carried out via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. The continual river flow and associated sedimentary erosion, deposition, and reworking make it highly unlikely that any more ephemeral cultural material remains on the river bed.

Given the features' construction method (with no land impact), the previous disturbance of the riverbed, and the lack of any survey evidence for extant wrecks, it is the District's opinion that the Proposed Action will have no significant effect on cultural resources. The Missouri State Historic Preservation Officer concurred that the Proposed Action would not affect listed or eligible historic properties. A copy of the correspondence is included in Appendix D. If, however, cultural resources were to be encountered during construction, all work would stop in the affected area and further consultation would take place.

Via a letter dated 03 January, 2019, consultation with twenty-eight federally recognized tribes affiliated with the St. Louis District was initiated and will continue as necessary during

implementation. All corresponding documents associated with this consultation have been included in Appendix D. A copy of the consultation letter is included in Appendix D. If cultural resources were to be encountered during construction, all work would stop in the affected area and further consultation would take place.

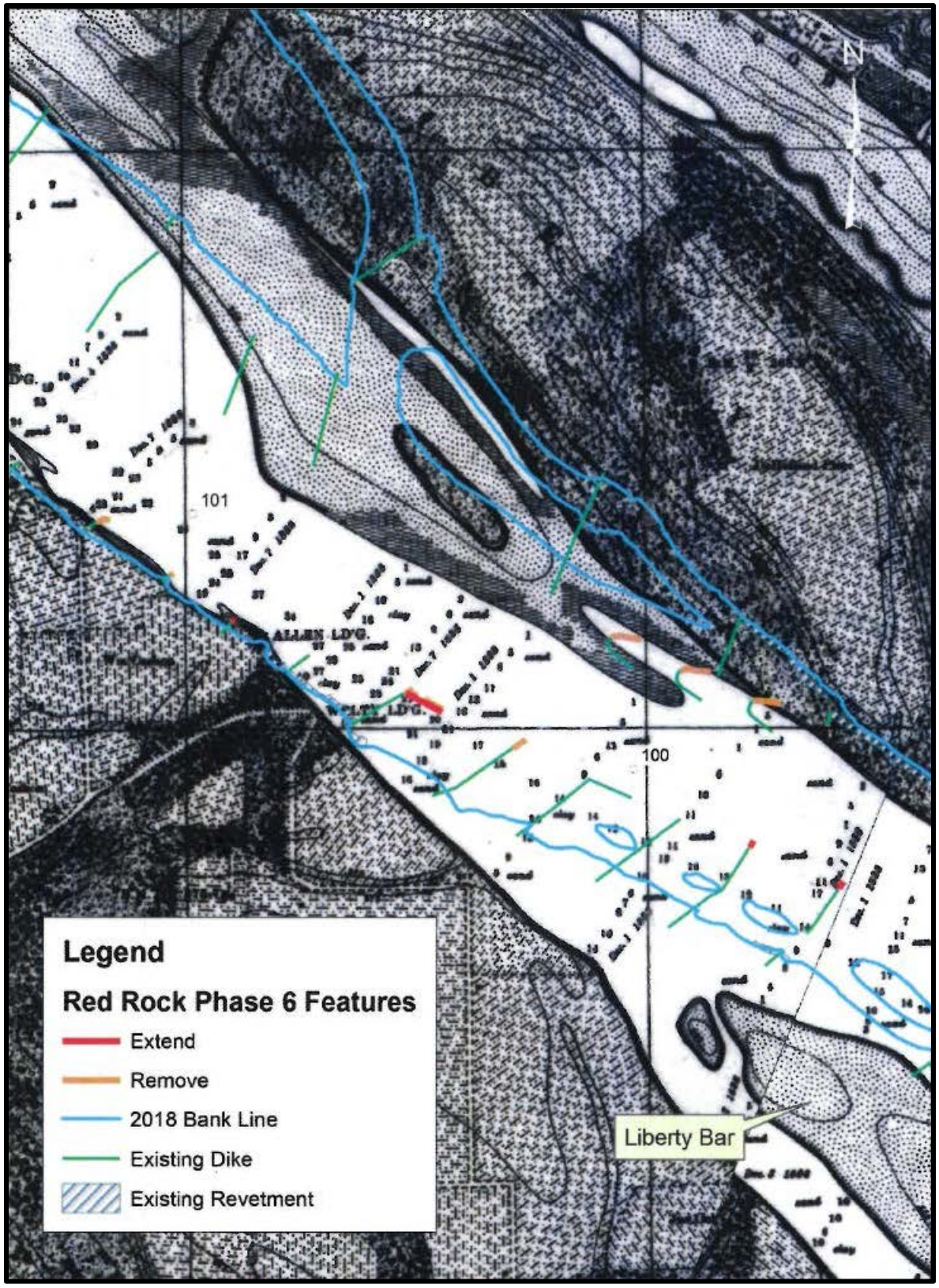

Figure 6. Work area features imposed on the 1890 MRC map.

Chapter 4. Mitigation

Mitigation measures are used to avoid, minimize, or compensate for adverse impacts to environmental resources. Throughout the alternative development process, potential adverse impacts associated with the Red Rock Landing Phase 6 work have been avoided and minimized to the extent possible. As demonstrated by the HSR model and numeric model simulations, the Proposed Action would not adversely impact the RM 100 Islands. The HSR modeling also demonstrated that the sandbar on the riverward side of Rockwood Island would not be adversely impacted by the Proposed Action, largely due to the partial removal of the three chevrons in order to minimize impacts to the sandbar along the left bank.

However, as previously discussed, analyses completed as part of the 2017 SEIS process revealed that the Continue Construction Alternative for the overall Project would likely have a significant adverse effect on shallow to moderate-depth, moderate-to high-velocity habitat along the main channel border that warrants consideration of compensatory mitigation for the Project. As discussed in both the 2017 SEIS and the SEA, the Chub Model has been developed and certified to further evaluate the quantity and quality of this particular habitat impacted by new construction. The SEA includes results and discussion of the initial assessment of the Project's new work area impacts to MCB habitat, as well as an update to the Project's monitoring and adaptive management plan for any compensatory mitigation for this adverse impact.

The following sections provide the details on the site-specific mitigation assessment for the Proposed Action at the Red Rock Landing Phase 6 work area, as well as an update to the overall Project's impacts and the monitoring and adaptive management plan for the Regulating Works Project. Details of the Chub Model and a thorough explanation of how it is applied to construction activity completed under the Project are provided in the SEA. That document includes an explanation of Habitat Suitability Index (HSI) scores and Average Annual Habitat Units (AAHUs), the performance metric by which mitigation will be assessed. For complete details and background information on the Project's monitoring and adaptive management plan, as well as its initial mitigation assessment, refer to those respective sections found within the 2017 SEIS and the Project's SEA incorporated herein by reference.

4.1 Site Specific Assessment for Mitigation Considerations

In general, the Proposed Action at the Red Rock Landing Phase 6 work area is not as intensive as other construction activities carried out under the Project. It relies heavily on structure reduction and realignment. The minimal amount of new or extended structures included in the Proposed Action is ultimately reflected in the results of this mitigation assessment, which documents an increase to shallow to moderate-depth, moderate- to high-velocity habitat. Further, the mitigation assessment for the Red Rock Landing Phase 6 work area was split into two separate areas of influence because the proposed work would occur on both the left and right banks, and the proposed actions would only influence MCB habitat on their respective banks. For example, the partial removal of the chevrons on the left bank would not influence MCB habitat on the right bank, and therefore should not influence the HSI score within that area. As such, two distinct HSI scores and areas of influence were assessed.

Figure 7. 2012 Aerial imagery of the proposed work at the Red Rock Landing Phase 6 area, including new and realigned river training structures (white), structure removal (yellow), the right bank total area of influence (blue), and the left bank total area of influence (green).

Structure Parameter - River training structures already exist along the right bank of the work area, meaning this area is assigned the low-quality structure HSI score (0.3) for its pre-construction condition. The adjacent area riverward from the dike field is assigned the moderate structure HSI score (0.7), given that this area is highly influenced by the existing structures. The presence of existing structures within the majority of the work area results in a relatively low overall structure HSI score (0.46) for the pre-construction condition. The proposed removal and realignment of structures along the right bank increases some acreage from the low-quality structures score to the high-quality (1.0) structure score, and the extension of dikes 99.6 and 99 decreases the structures score downstream of those structures. The overall structure HSI score within the right bank area of influence would rise (0.46 to 0.48) as a result of the Proposed Action. This is primarily due to the proposed dike removal, as well as the fact that the Proposed Action does not include a significant amount of new structure.

The area surrounding the chevrons on the left bank was assigned the moderate-quality structure score (0.7), given that this area is highly influenced by the existing structures; this score did not change between pre and post-construction. The partial removal of the chevrons along the left bank boosts the area downstream of the chevrons from the low-quality structure score (0.3) to the high-quality structure score (1.0). This increased the overall structure score within the left bank area of influence (0.41 to 0.50).

Depth Parameter - The pre-construction depth HSI scores for both the right and left bank work areas were based on bathymetric survey data collected during the District's last completed periodic channel survey from 2016. The pre-construction score for the right bank was relatively low (0.32) because much of the work area includes the navigation channel, which has the

minimal depth HSI score (0.0). The HSR model results for the Proposed Action (Figure 3) were used to develop the post-construction depth HSI score. The results of the HSR model demonstrate that the Proposed Action would increase the average depth within the work area, slightly reducing the overall depth HSI score to 0.27.

The left bank pre-construction depth score (0.61) also dropped significantly due to the proposed action. HSR modeling revealed that the partial removal of the chevrons would induce scouring downstream of the removed portions, lowering the average depth within the left bank area of influence, and dropping the overall depth score for the area (0.48).

Velocity Parameter - The pre-construction velocity HSI scores for both the right and left bank work areas were derived from 2-D numerical modeling efforts used to estimate pre- and post-construction velocities. The score within the right bank increased between the pre- and post-construction conditions (0.40 to 0.50), largely due to modifying areas downstream of the dike extension, changing high-velocity low-scoring areas to low-velocity high-scoring areas. The overall score within the left bank work area also increased between pre- and post-construction (0.56 to 0.65), but due to the opposite effect. The slackwater areas within the chevrons produce low HSI scores because velocities are too low. Partial removal of these structures would allow more flow through these previously slackwater areas, increasing velocities just enough to boost the velocity HSI scores.

Substrate Parameter - Due to substrate data not being available for the work are, it was therefore assumed that the substrate in the work areas was mostly sand (HSI = 0.5) for both the pre- and post-construction conditions. However, new pre- and post-construction substrate data may become available as data are collected and visual observations are made at planned and completed work sites. Therefore, this assumption may be revisited during future planning and mitigation assessments, at which time the pre- and post-construction substrate category could be updated for the work site assessed herein, potentially altering the overall change in AAHUs.

Overall HSI Score - Due to the anticipated changes to structures, depth, and velocity within the Red Rock Landing Phase 6 work areas, this initial mitigation assessment suggests the Proposed Action would increase the overall HSI scores within both the right and left bank areas of influence; 0.42 to 0.44 and 0.53 to 0.54, respectively. Coupled with the acreage of both the areas (right: 178.12; left: 71.04), and annualized over a fifty year period of analysis, this results in a net increase of 2.8 AAHUs from the right bank and 0.60 AAHUs from the left bank. An overall increase of approximately 3.4 AAHUs would result from the Proposed Action (Appendix A).

4.2 Monitoring and Adaptive Management

Since the District's initial compensatory mitigation assessment, which is documented in the SEA, post-construction monitoring activities have not yet resulted in changes to the initial compensatory mitigation calculations. As such, the HSI scores of the previously completed Project work areas have not been updated. However, a recent reevaluation of the areas of influence for work areas completed under the Project resulted in a change to acreage for the initial Red Rock Landing Phase 4 mitigation assessment, which was completed in 2018. The District determined that the total area of influence was too large and included areas that would not actually be affected by the proposed work in the area. The area of influence was adjusted

from 239.5 acres to 184 acres, resulting in an immediate change to the Project's overall AAHUs: 5.87 to 7.74.

Further, the initial pre-construction mitigation assessment for the Proposed Action described above results in an additional increase to the overall AAHUs for the Regulating Works Project (Appendix A). The Proposed Action would increase the overall Project's AAHUs from 7.74 to 11.14, due to anticipated positive impacts on shallow to moderate-depth, moderate- to high-velocity MCB habitat at the Red Rock Landing Phase 6 work area.

As stated in the SEA, the District is committed to using the best available data for site-specific mitigation assessments related to the Project. At this time, the data produced by 2-D numerical modeling represents the best available data to assess the pre-construction velocity HSI score for the Proposed Action at the Red Rock work area. The District will continue to monitor Mississippi River stage and discharge data and attempt to collect pre-construction ADCP (velocity) field data from the work area if an adequate stage and discharge window is presented. If the District can successfully collect pre-construction field data at the target flow rates prior to construction of the Proposed Action Alternative, the mitigation assessment of the Red Rock work area would be reassessed and the overall AAHUs would be updated in subsequent NEPA documentation for the Project.

Presently, a net gain in AAHUs still results from implementation of the overall Project. However, as discussed in the SEA, the District is proceeding with potential mitigation site planning and ranking through a collaborative effort with the Adaptive Management Team (AMT), in anticipation of the future need for compensatory mitigation. At this time, the District will proceed forward with the post-construction monitoring of the previously assessed work sites (Appendix A), which will rely heavily on the periodic channel bathymetry surveys performed by the District. A comprehensive bathymetric channel survey is currently being collected by the District survey team, once completed, the survey will be analyzed to determine if the work areas have reached dynamic equilibrium (DE). If the work areas are in DE, the depth parameter HSI scores of the completed work areas will be reassessed. Information from these surveys taken after the work area is in DE will be used to update the AAHUs in each work area as it becomes available for continued monitoring of the overall Project's impact to MCB habitat.

Chapter 6. Relationship to other Environmental Laws and Regulations

Table 4. Federal policy and compliance status.

Federal Laws[1]	**Compliance Status**
Abandoned Shipwreck Act of 1987, as amended, 43 USC § 2101, et seq.	Full
American Indian Religious Freedom Act, as amended, 42 USC § 1996	Full
Archaeological and Historic Preservation Act, as amended, 54 USC § 312501, et seq.	Partial[4]
Bald and Golden Eagle Protection Act, as amended, 16 USC § 668, et seq.	Full
Clean Air Act, as amended, 42 USC § 7401, et seq.	Full
Clean Water Act, as amended, 33 USC § 1251, et seq.	Partial[4]
Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 USC § 9601, et seq.	Full
Endangered Species Act, as amended, 16 USC § 1531, et seq.	Partial[4]
Farmland Protection Policy Act, as amended, 7 USC § 4201, et seq.	Full
Federal Water Project Recreation Act, as amended, 16 USC §460l-12, et seq. and 16 USC § 662	Full
Fish and Wildlife Coordination Act, as amended, 16 USC § 661, et seq.	Full
Flood Control Act of 1944, as amended, 16 USC § 460d, et seq. and 33 USC § 701, et seq.	Full
Food Security Act of 1985, as amended, 16 USC § 3801, et seq.	Full
Land and Water Conservation Fund Act of 1965, as amended, 16 USC § 460l-4, et seq.	Full
Migratory Bird Treaty Act of 1918, as amended, 16 USC § 703, et seq.	Full
National Environmental Policy Act, as amended, 42 USC § 4321, et seq.	Partial[3]
National Historic Preservation Act, as amended, 54 USC § 300101, et seq.	Full
National Trails System Act, as amended, 16 USC § 1241, et seq.	Full
Noise Control Act of 1972, as amended, 42 USC § 4901, et seq.	Full
Resource Conservation and Recovery Act, as amended, 42 USC § 6901, et seq.	Full
Rivers and Harbors Appropriation Act of 1899, as amended, 33 USC § 401, et seq.	Full
Wilderness Act, as amended, 16 USC § 1131, et seq.	Full
Executive Orders[2]	
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, EO 12898, February 11, 1994, as amended	Full
Floodplain Management, EO 11988, May 24, 1977, as amended	Full
Invasive Species, EO 13112, February 3, 1999, as amended	Full
Protection and Enhancement of Environmental Quality, EO 11991, May 24, 1977	Full
Protection and Enhancement of the Cultural Environment, EO 11593, May 13, 1971	Full
Protection of Wetlands, EO 11990, May 24, 1977, as amended	Full
Recreational Fisheries, EO 12962, June 7, 1995, as amended	Full
Responsibilities of Federal Agencies to Protect Migratory Birds, EO 13186, January 10, 2001	Full
Trails for America in the 21st Century, EO 13195, January 18, 2001	Full

[1] Also included for compliance are all regulations associated with the referenced laws. All guidance associated with the referenced laws were considered. Further, all applicable Corps of Engineers laws, regulations, policies, and guidance have been complied with but not listed fully here.

[2] This list of Executive Orders is not exhaustive and other Executive Orders not listed may be applicable.

[3] Full compliance after submission for public comment and signing of FONSI.

[4] Required permits, coordination will be sought during public review.

Chapter 7. List of Preparers

Table 5. List or report preparers, including their role and level of experience.

Name	Role	Experience
Mike Rodgers, P.E.	Project Manager	17 years, hydraulic engineering
Shane Simmons	Environmental Lead	6 years, biology
Corey Tabbert	Hydraulic Engineering	6 years, hydraulic engineering
Edward Brauer, P.E.	Engineering Lead	15 years, hydraulic engineering, Regional Technical Specialist-River Engineering
Mark Smith, Ph.D.	Historical and Cultural Resources	25 years, archaeology
Keli Broadstock	Legal Review	13 years, legal
Travis Schepker	Water Quality	6 year biology

Chapter 8. Literature Cited

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FINDING OF NO SIGNIFICANT IMPACT

Red Rock Landing Phase 6 – Regulating Works Project
Middle Mississippi River (RM 101.2 – 99.6)
Perry County, Missouri, and Randolph County, Illinois

I. In accordance with the National Environmental Policy Act, I have reviewed and evaluated the documents concerning the Red Rock Landing Phase 6 – Regulating Works Project, Middle Mississippi River (RM 101.2 – 99.6) Perry County, Missouri, and Randolph County, Illinois, I have considered:

a. Existing resources and the No Action Alternative; and

b. Impacts to existing resources from the Proposed Action.

II. The possible consequences of these alternatives have been studied for physical, environmental, cultural, social and economic effects, and engineering feasibility. My evaluation of significant factors has contributed to my finding:

a. The work would address costly dredging at low water in the area. This would be accomplished by the modification and extension of river training structures in the area;

b. No significant impacts to federally listed threatened or endangered species are anticipated;

c. No significant impacts are anticipated to natural resources, including fish and wildlife resources. The proposed work would have no effect upon significant historic properties or archaeological resources. There would be no appreciable degradation to the physical environment (e.g., stages, air quality, and water quality) due to the work;

d. The "no action" alternative was evaluated and determined to be unacceptable as costly low water dredging expenditures would continue; and

e. Beneficial impacts to shallow to moderate-depth, moderate- to high-velocity main channel border habitat are anticipated as a result of the Proposed Action.

III. Based on the evaluation and disclosure of impacts contained within the Environmental Assessment, I find no significant impacts to the human environment are likely to occur as a result of the Proposed Action. Therefore, an Environmental Impact Statement will not be prepared prior to proceeding with the proposed Red Rock Landing Phase 6 construction.

_____
(Date)

_____
BRYAN K. SIZEMORE
COL, EN
Commanding

Appendix A. Compensatory Mitigation Assessment Record

Project Work Area	FWOP HSI	FWP HSI	Net Change
Mosenthein-Ivory Landing Phase 4 (71 acres) – last assessed November 2017			
Velocity	0.63	0.68	+0.05
Depth	0.57	0.53	-0.04
Substrate	0.50	0.50	0.00
Structured/Unstructured	1.00	0.63	-0.37
Overall HSI Score	0.67	0.58	-0.09
AAHUs	**47.5**	**41.32**	**-6.19**

Monitoring

Construction was completed in April 2015. Post-construction depth and velocity field data have already been collected once, and applied to the latest mitigation assessment. Progress to dynamic equilibrium (DE) will be determined after the current comprehensive channel survey is complete and the data are processed. If the site has reached DE, velocity field data will be collected and all HSI scores and AAHUs will be updated and finalized. If the site has not reached DE, it will continue to be monitored and will be reassessed after future channel surveys are performed.

Eliza Point-Greenfield Bend Phase 3 (52 acres) – last assessed November 2017			
Velocity	0.63	0.68	+0.05
Depth	0.72	0.34	-0.38
Substrate	0.50	0.50	0.00
Structured/Unstructured	1.00	0.61	-0.39
Overall HSI Score	0.71	0.53	-0.19
AAHUs	**37.25**	**28.09**	**-9.16**

Monitoring

Construction was completed in March, 2017. Post-construction depth field data have already been collected once, and were applied to the latest mitigation assessment. Progress to dynamic equilibrium will be determined after the current comprehensive channel survey is complete and the data are processed. If the site has reached DE, velocity field data will be collected and all HSI scores and AAHUs will be updated and finalized. If the site has not reached DE, it will continue to be monitored and will be reassessed after future channel surveys are performed.

Dogtooth Bend Phase 5 (25 acres) – last assessed November 2017			
Velocity	0.37	0.52	+0.14
Depth	0.31	0.25	-0.06
Substrate	0.50	0.50	0.00
Structured/Unstructured	0.70	0.60	-0.10
Overall HSI Score	0.45	0.46	+0.01
AAHUs	**11.21**	**11.45**	**+0.24**

Monitoring

Construction was completed in May, 2015. Post-construction depth field data have already been collected once, and applied to the latest mitigation assessment. Progress to dynamic equilibrium will be determined after the current comprehensive channel survey is complete and the data are processed. If the site has reached DE, velocity field data will be collected and all HSI scores and AAHUs will be updated and finalized. If the site has not reached DE, it will continue to be monitored and will be reassessed after future channel surveys are performed.

Mosenthein-Ivory Landing Phase 5 (122 acres) – last assessed November 2017			
Velocity	0.50	0.74	+0.24
Depth	0.46	0.55	+0.09
Substrate	0.50	0.50	0.00
Structured/Unstructured	0.60	0.47	-0.13
Overall HSI Score	0.52	0.56	+0.05
AAHUs	**63.38**	**68.11**	**+4.73**

Monitoring

Construction was completed in November 2016. Post-construction depth and velocity field data have already been collected once, and applied to the latest mitigation assessment. Progress to dynamic equilibrium will be determined after the current comprehensive channel survey is complete and the data are processed. If the site has reached DE, velocity field data will be collected and all HSI scores and AAHUs will be updated and finalized. If the site has not reached DE, it will continue to be monitored and will be reassessed after future channel surveys are performed.

Grand Tower Phase 5 - Crawford Chevrons (175 acres) – last assessed November 2017			
Velocity	0.41	0.64	+0.23
Depth	0.54	0.46	-0.07
Substrate	0.50	0.50	0.00
Structured/Unstructured	0.54	0.44	-0.10
Overall HSI Score	0.50	0.51	+0.01
AAHUs	**87.49**	**89.18**	**+1.70**

Monitoring

Construction was completed in December, 2016. Post-construction field data has not been collected for any of the parameters. This is a more recent construction activity, meaning it is unlikely the site has reached dynamic equilibrium. The initial assessment of post-construction depth field data will occur after the current comprehensive channel survey is complete and the data are processed. Status to DE will be assessed after an additional channel survey is performed (2020 or 2021). Once the site has reached DE, post-construction velocity field data will be collected and assessed.

Grand Tower Phase 5 - Vancill Dikes (257 acres) – last assessed November 2017			
Velocity	0.38	0.56	+0.18
Depth	0.51	0.57	+0.06
Substrate	0.50	0.50	0.00
Structured/Unstructured	0.51	0.54	+0.03
Overall HSI Score	0.48	0.55	+0.07
AAHUs	**123.36**	**140.81**	**+17.45**

Monitoring

Construction was completed in March 2017. Post-construction field data has not been collected for any of the parameters. This is a more recent construction activity, meaning it is unlikely the site has reached dynamic equilibrium (DE). The initial assessment of post-construction depth field data will occur after the current comprehensive channel survey is complete and the data are processed. Status to DE will be assessed after an additional channel survey is performed (2020 or 2021). Once the site has reached DE, post-construction velocity field data will be collected and assessed.

Red Rock Landing Phase 4 (184.1 acres) – last assessed January 2019			
Velocity	0.44	0.46	+0.02
Depth	0.44	0.35	-0.09
Substrate	0.50	0.50	0.00
Structured/Unstructured	0.45	0.49	+0.05
Overall HSI Score	0.47	0.46	-0.01
AAHUs	**85.6**	**84.6**	**-1.03**

Monitoring Plan

Pre-construction: The District will attempt to collect pre-construction ADCP field data in 2019, prior to any performing any construction activity. If ADCP data can be collected during a period of median discharge, these data would be used to update the pre-construction HSI score and overall AAHUs. Pre-construction velocity monitoring would also be expanded to include the upper portion of Liberty Chute, in order to monitor flow entering the side channel.

Post-construction: If the Proposed Action is implemented, and after construction is completed, post-construction depth field data will be assessed after multiple periodic channel surveys have been performed, such that temporal changes to bathymetry can be observed, and DE status can be assessed. Once the site has reached dynamic equilibrium (DE), post-construction velocity field data will be collected and assessed.

Post-construction velocity field data is not likely to be collected for another 4-6 years. The work must be fully completed, then multiple channel surveys must be completed to assess DE status.

Red Rock Landing Phase 6 - Right bank (178.12 acres) – last assessed January 2019			
Velocity	0.40	0.50	+0.10
Depth	0.32	0.27	-0.04

Substrate	0.50	0.50	0.00
Structured/Unstructured	0.46	0.48	+0.02
Overall HSI Score	0.42	0.44	+0.02
AAHUs	**75.1**	**78.3**	**+2.8**
Red Rock Landing Phase 6 – Left Bank (71.04 acres) – last assessed January 2019			
Velocity	0.56	0.65	+0.08
Depth	0.61	0.48	-0.13
Substrate	0.50	0.50	0.00
Structured/Unstructured	0.41	0.50	+0.09
Overall HSI Score	0.53	0.54	+0.01
AAHUs	**37.4**	**38.0**	**+0.60**

Monitoring Plan

Pre-construction: The District will attempt to collect pre-construction ADCP field data in 2019, prior to any performing any construction activity. If ADCP data can be collected during a period of median discharge, these data would be used to update the pre-construction HSI score and overall AAHUs.

Post-construction: If the Proposed Action is implemented, and after construction is completed, post-construction depth field data will be assessed after multiple periodic channel surveys have been performed, such that temporal changes to bathymetry can be observed, and DE status can be assessed. Once the site has reached dynamic equilibrium (DE), post-construction velocity field data will be collected and assessed.

Post-construction velocity field data is not likely to be collected for another 4-6 years. The work must be fully completed, then multiple channel surveys must be completed to assess DE status.

Overall AAHUs	**+11.14**	**Jan-2019**

Appendix B. Clean Water Act Section 404(b)(1) Evaluation

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

Red Rock Landing Phase 6
Middle Mississippi River (RM 101.2 – 99.6)
Perry County, Missouri, and Randolph County, Illinois

Regulating Works Project

March 2019

Contents

CLEAN WATER ACT
SECTION 404(b)(1) Evaluation

1. PROJECT DESCRIPTION

A. Location. The Red Rock Landing Phase 6 (Red Rock) work area is located in the Middle Mississippi River (MMR) between river miles 101.2 – 99.6, in Perry County, Missouri, and Randolph County, Illinois. It is approximately 1.7 miles south of Rockwood, Illinois and 9 miles southeast of Chester, Illinois.

B. General Description. The U.S. Army Corps of Engineers St. Louis District is proposing to construct the Red Rock Landing Phase 6 work as part of its Regulating Works Project (Project). The Regulating Works Project utilizes bank stabilization and sediment management to maintain bank stability and ensure adequate navigation depth and width. Bank stabilization is achieved by revetments, while sediment management is achieved by river training structures, i.e. dikes. The Proposed Action Alternative involves modifying the configuration of river training structures within the Red Rock Landing Phase 6 reach of the MMR, between river miles 101.2 – 99.6. As summarized in Table 2, the specific details of the Proposed Action include reducing the length of dikes 101.2 (R), 101.0 (R), 100.4 (R); extending dikes 100.8 (R), 99.8 (R), and 99.6 (R); and degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel. Further, each of the three chevrons along the left descending bank (left bank) would be modified by removing the landward half of each chevron. The aforementioned structures would also be brought back to their design elevations. The majority of the stone used for the extension and raising of structures would be recycled stone from the proposed structure removal. Approximately 8,700 CY of new stone would be added to the system. The volume of stone that comprises each structure would change, this is displayed in Table 2.

C. Authority and Purpose. The St. Louis District of the U.S. Army Corps of Engineers is charged with obtaining and maintaining a navigation channel on the MMR that is nine feet deep, 300 feet wide with additional width in bends as necessary. The MMR is defined as that portion of the Mississippi River that lies between its confluence with the Ohio and the Missouri Rivers. This ongoing Project is also commonly referred to as the Regulating Works Project. As authorized by Congress, the Project utilizes bank stabilization, rock removal, and sediment management to maintain bank stability and ensure adequate navigation depth and width. Bank stabilization is achieved by revetment and river training structures, while sediment management is achieved by river training structures. The Project is maintained through dredging and any needed maintenance to already constructed features. The long-term goal of the Project, as authorized by Congress, is to obtain and maintain a navigation channel and reduce federal expenditures by alleviating the amount of annual maintenance dredging through the construction of regulating works.

D. General Description of the Fill Material.

Fill material for dike construction would include quarry run limestone consisting of graded "A" stone. Size requirements for graded "A" stone are shown in Table 1 below. The majority of the stone used for the extension and raising of structures would be recycled stone from the proposed structure removal. Approximately 8,700 CY of new stone would be added to the system. The volume of stone that comprises each structure would change, this is displayed in Table 2. The original source of the recycled stone was commercial stone quarries in the vicinity of the Project area capable of producing stone which meets USACE specifications.

Table 1. Size requirements for graded "A" stone.

Stone Weight (LBS)	Cumulative % Finer by Weight
5000	100
2500	70-100
500	40-65
100	20-45
5	0-15
1	0-5

E. Description of the Proposed Action Alternative.

The proposed work would consist of the following (see Table 2):

Table 2. Description of the Proposed Action Alternative.

Location	Proposed Work	Purpose	Stone (CY)
101.2 (R)	Remove riverward 170 ft of existing trail dike.	Maintain smooth flow alignment along the RDB structures.	-1,578
101.0 (R)	Remove riverward 75 ft of existing dike.	Maintain smooth flow alignment along the RDB structures.	-1,336
100.8 (R)	Extend existing dike by 50 ft.	Maintain smooth flow alignment along the RDB structures.	+2,860
100.6 (R)	Degrade existing trail dike (re-use/recycle stone), rebuild 460 ft trail dike with improved alignment.	Maintain smooth flow alignment along the RDB structures.	No change

Location	Proposed Work	Purpose	Stone (CY)
100.4 (R)	Remove riverward 175 ft of existing trail dike.	Maintain smooth flow alignment along the RDB structures.	-1,260
100.1 (L)	Remove landward half of structure, 375 ft.	Minimize impacts to the sandbar based upon new flow alignments.	-2,859
100.0 (L)	Remove landward half of structure, 375 ft.	Minimize impacts to the sandbar based upon new flow alignments.	-5,062
99.9 (L)	Remove landward half of structure, 375 ft.	Minimize impacts to the sandbar based upon new flow alignments.	-287
99.8 (R)	Extend existing dike by 75 ft.	Prevent sediment deposition at channel crossing.	+9,431
99.6 (R)	Extend existing dike by 75 ft.	Prevent sediment deposition at channel crossing.	+8,817

F. Description of the Placement and Removal Method.

Placement and removal of dike material would be accomplished by track hoe or dragline crane. Stone would be transported to placement sites by barges. All construction would be accomplished from the river and all work would be performed below the ordinary high water mark.

2. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

I. Elevation and Slope.

There would be an immediate change in substrate elevation and slope over the areal extent of dike construction and dike removal between RM 101.2 – 99.6. The dikes consist of a rock mound of uniform shape, placed off existing bankline and existing dikes. The final elevation of newly constructed and realigned dikes would be 354 ft. (NGVD). The final elevation of dike removal would be 335 ft. (NGVD).

Side slopes would be approximately 1 vertical on 1.5 horizontal. After placement, sediment patterns in the immediate vicinity of the structures would change with scour occurring off both

ends of the dikes. Areas immediately downstream of the dikes would experience some areas of accretion and some areas of scour. The structures consist of Graded A-Stone (Limestone), and would be placed and removed by floating plant (no bankline access needed). Much of the proposed work consists of simply realigning existing structures, meaning benthic habitat would be exposed and covered simultaneously.

II. Sediment Type.
The work area is located within the main stem of the MMR, which is composed mainly of sands with some gravels, silts, and clays. The stone used for construction would be Graded "A" limestone.

III. Fill Material Movement.
No bank grading or excavation would be required for placement of stone. Draglines and/or track hoes would pull rock from floating barges and place the material into the river and on the banks. Fill materials would be subject to periodic high flows which may cause some potential movement and dislodging of stone. This may result in the need for minor repairs; however, no major failures are likely to occur.

IV. Physical Effects on Benthos.
Rock placement and dredge disposal should not significantly affect benthic organisms. Shifting sediments at structure placement sites are likely harbor oligochaetes, chironomids, caddisflies, turbellaria, and other macroinvertebrates. High densities of hydropsychid caddisflies and other macroinvertebrates would be expected to colonize the large limestone rocks after construction. Fish are likely to avoid the work areas during dike construction and removal.

V. Actions Taken to Minimize Impacts.
Best Management Practices for construction would be followed.

B. Water Circulation, Fluctuation, and Salinity Determinations

I. Water.
Some sediments (mostly sands) would be disturbed when the rock is deposited onto the riverbed, and during dike removal. This increased sediment load would be local and minor compared to the natural sediment load of the river, especially during high river stages.

II. Current Patterns and Circulation.
The construction, realignment, and restoration of trail dikes along the right bank would help maintain flow energy within the navigation channel, and enhance the local scouring effect of the channel. The modification of structures along the right bank would help to maintain flow energy within the navigation channel.

III. Normal Water Level Fluctuations.
Stages at average and high flows both in the vicinity of the work area and on the MMR are expected to be similar to current conditions. Stages at low flows on the MMR show a decreasing trend over time and this trend is expected to continue with or without implementation of the Proposed Action Alternative.

IV. Actions Taken to Minimize Impacts. Best Management Practices for construction would be followed.

C. Suspended Particulate/Turbidity Determinations

I. Expected Changes in Suspended Particles and Turbidity Levels in Vicinity of Placement Site.

Increases in suspended particulates and turbidity due to construction are expected to be greatest within the immediate vicinity of the rock structures. The increased sediment load would be local and minor compared to the natural sediment load of the river. This would cease soon after construction completion.

II. Effects on Chemical and Physical Properties of the Water Column

a. Light Penetration. There would be a temporary reduction in light penetration until sediments suspended as part of construction activities settled out of the water column.
b. Dissolved Oxygen. No adverse effects expected.
c. Toxic Metals and Organics. No adverse effects expected.
d. Aesthetics. Aesthetics of work sites are likely to be adversely affected during construction, but are expected to return to normal after construction.

III. Effects on Biota.

The work would likely result in some short-term displacement of biota in the immediate vicinity of construction activities due to temporary decreases in water quality and disturbance by construction equipment.

IV. Actions Taken to Minimize Impacts. Impacts are anticipated to be minimized by the use of clean, physically stable, and chemically non-contaminating limestone rock for construction.

D. Contaminant Determinations.

It is not anticipated that any contaminants would be introduced or exposed as a result of the Proposed Action Alternative.

E. Aquatic Ecosystem and Organism Determinations

I. Effects on Plankton.

The work could have a temporary, minor effect on plankton communities in the immediate vicinity of the work area. This would cease after construction completion.

II. Effects on Benthos.

Sediments at structure placement sites likely harbor oligochaetes, chironomids, caddisflies, turbellaria, and other macroinvertebrates. Construction activities would eliminate some of these organisms. High densities of caddisflies and other macroinvertebrates would be expected to

colonize the large limestone rocks after construction. Fish would be expected to temporarily avoid the area during construction.

III. Effects on Nekton.
Nekton would be temporarily displaced during construction activities, but would return shortly after completion.

IV. Effects on Aquatic Food Web.
Temporary reductions in macroinvertebrate and fish communities during construction in the relatively small work area should not significantly impact the aquatic food web in the MMR. Improvements in lower trophic levels (macroinvertebrates) subsequent to completion should benefit the aquatic food web.

V. Effects on Special Aquatic Sites.
There are no special aquatic sites within the work area.

VI. Threatened and Endangered Species.
Presence of, or use by, endangered and threatened species is discussed in the Environmental Assessment and Biological Assessment for the Proposed Action Alternative. The effects likely occur are consistent with the programmatic (Tier I) consultations that have been conducted for the Regulating Works Project, and the Tier 2 Biological Assessment that has been prepared for the Proposed Action Alternative.

VII. Other Wildlife.
The work would likely result in localized, short-term displacement of wildlife in the immediate vicinity of construction activities. Displacement would end immediately after construction completion.

VIII. Actions Taken to Minimize Impacts.
Best Management Practices for construction would be followed.

F. Proposed Placement Site Determinations

I. Mixing Zone Determinations.
The fill material is inert and would not mix with the water. The lack of fine particulate typically contained in rock fill and main channel sediments indicates negligible chemical or turbidity effects resulting from the Proposed Action Alternative.

II. Determination of Compliance with Applicable Water Quality Standards.
The application for Section 401 water quality certification has been submitted. All permits necessary for the completion of the work would be obtained prior to implementation.

III. Potential Effects on Human Use Characteristics.
The proposed work would have no adverse impact on municipal or private water supplies; water-related recreation; aesthetics; or parks, national and historic monuments, national seashores,

wilderness areas, research sites or similar preserves. During construction the area would not be available for recreational and commercial fishing.

G. Determinations of Cumulative Effects on the Aquatic Ecosystem.

Dikes and weirs have been used extensively throughout the Lower, Middle, and Upper Mississippi River System to provide a safe and dependable navigation channel. Due to concerns from natural resource agency partners about the potential cumulative impacts of river training structures, and other actions within the watershed, on the aquatic ecosystem, the St. Louis District has been utilizing innovative river training structures such as side channel enhancement dikes as well as dike removal which is included in the Proposed Action to increase habitat diversity in the MMR while still maintaining the navigation channel. The District conducts extensive coordination with resource agency and navigation industry partners to ensure that implementation is accomplished effectively from an ecological and navigation viewpoint. Although minor short-term construction-related impacts to local fish and wildlife populations are likely to occur, only minimal cumulative impacts on the aquatic ecosystem are identified for the Proposed Action Alternative at the Red Rock Landing Phase 6 work area.

H. Determinations of Secondary Effects on the Aquatic Ecosystem.

No adverse secondary effects would be expected to result from the Proposed Action Alternative.

3. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON PLACEMENT

A. No significant adaptations of the 404(b)(1) guidelines were made relative to this evaluation.

B. Alternatives that were considered for the Proposed Action Alternative included:

1. No Action Alternative - Under the No Action Alternative, the District would not construct any new river training structures within the work area, nor would it lengthen or reduce any of the existing river training structures in the area. Under this alternative, the District would continue to maintain the existing river training structures in the area to their design specifications and elevations, and continue channel maintenance dredging to ensure a safe and dependable navigation channel exists in the work area.

2. Proposed Action Alternative - The Proposed Action Alternative involves modifying the configuration of river training structures within the Red Rock Landing Phase 6 reach of the MMR, between river miles 101.2 – 99.6. As summarized in Table 2, the specific details of the Proposed Action include reducing the length of dikes 101.2 (R), 101.0 (R), 100.4 (R); extending dikes 100.8 (R), 99.8 (R), and 99.6 (R); and degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel. Further, each of the three chevrons along the left descending bank (left bank) would be modified by removing the landward half of each chevron. The aforementioned structures would also be brought back to their design elevations.

C. Certification under Section 401 of the Clean Water Act has been applied for.

D. The proposed fill activity is in compliance with Applicable Toxic Effluent Standards of Prohibition under Section 307 of the Clean Water Act.

E. No significant impact to threatened or endangered species is anticipated from this work. Prior to construction, full compliance with the Endangered Species Act would be documented.

F. No municipal or private water supplies would be affected by the Proposed Action Alternative, and no degradation of waters of the United States is anticipated.

G. The work area is situated along an inland freshwater river system. No marine sanctuaries are involved or would be affected by the Proposed Action Alternative.

H. The materials used for construction would be chemically and physically stable and non-contaminating

I. The proposed construction activity would not have a significant adverse effect on human health and welfare, recreation and commercial fisheries, plankton, fish, shellfish, wildlife, or special aquatic sites. No significant adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems are expected to result. The proposed construction activity would have no significant adverse effects on aquatic ecosystem diversity, productivity, and stability. No significant adverse effects on recreational, aesthetic, and economic values would occur.

J. No other practical alternatives have been identified. The Proposed Action Alternative is in compliance with Section 404(b)(1) of the Clean water Act, as amended. The Proposed Action Alternative would not significantly impact water quality and would improve the integrity of an authorized navigation system.

_____ (Date)

_____
Bryan K. Sizemore
COL, EN
Commanding

Appendix C. UMR 100.5 – 98.5 Hydraulic Sediment Response (HSR) Model Study

US Army Corps of Engineers®
St. Louis District

UMR 100.5 – 98.5 Hydraulic Sediment Response (HSR) Model Study

Technical Report M74

January 2019

Brad Krischel, P.E.
Cory Tabbert
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Executive Summary

The U.S. Army Corps of Engineers, St. Louis District, is responsible for providing a navigation channel at low water on 195 miles of the Upper Mississippi River (UMR) between the confluences of the Missouri River near St. Louis, MO and the Ohio River near Cairo, IL. Pursuant to the authority for this stretch of the UMR, of the District constructs river training structures to minimize the need for repetitive channel maintenance dredging in order to accomplish this task.

The depths throughout the reach between UMR 100.5 and 98.5 have not been sufficient for navigation during the most recent low water periods. From 2000 to 2018, approximately 1.6 million cubic yards of material was dredged between UMR 100.5 and 98.5 at a cost of approximately $2.9M. For 2012 and 2013 alone, the total cost of dredging was $1,433,422, which was during a low water event.

In June 2018, the U.S. Army Corps of Engineers, St. Louis District began conducting a physical hydraulic sediment response (HSR) model at the Applied River Engineering Center (AREC) in St. Louis, Missouri to analyze the use of river training structures in this reach to reduce the need for costly dredging at low water.

Alternative testing involved testing 19 different potential solutions to help alleviate the dredging issues observed in the UMR 100.5 – 98.5 reach. Of the 19 alternatives tested, it was determined that Alternative 4 and Alternative 17 were the most effective in reducing or eliminating the need for repetitive channel maintenance dredging in the future while avoiding and minimizing adverse effects to fish and wildlife.

Model bathymetry for Alternatives 4 and 17 demonstrated improved navigation channel depths and widths between UMR 100.5 and 98.5 when compared to the model base test. Model testing results for Alternatives 4 and 17 demonstrated no significant negative environmental impacts. River training structure construction and modification associated with Alternatives 4 and 17 are shown on Plates 19 and 33, respectively, and also detailed in the tables below. A separate mitigation analysis will be completed to analyze the environmental impact of each alternative on shallow to moderate-depth, moderate-to high-velocity habitat along the main channel border.

Table E-1: Alternative 4 Recommended Construction and Modifications

Type of Structure	Location (River Mile)	Left Descending Bank (LDB) or Right Descending Bank (RDB)	Dimensions in Feet (Plan View)
Degrade Riverward Section of Existing Dike	101.2	RDB	150
Degrade Riverward Section of Existing Dike	101.0	RDB	50
Extend Existing Dike	100.8	RDB	40
Realign Existing Trail Dike	100.6	RDB	460
Degrade Riverward Section of Existing Dike	100.4	RDB	160
Extend Existing Dike	99.8	RDB	80
Extend Existing Dike	99.6	RDB	80

Table E-2: Alternative 17 Recommended Construction and Modifications

Type of Structure	Location (River Mile)	LDB or RDB	Dimensions in Feet (Plan View)
Degrade Riverward Section of Existing Dike	101.2	RDB	150
Degrade Riverward Section of Existing Dike	101.0	RDB	50
Extend Existing Dike	100.8	RDB	40
Realign Existing Trail Dike	100.6	RDB	460
Degrade Riverward Section of Existing Dike	100.4	RDB	160
Partial Chevron Removal	100.1	LDB	400
Partial Chevron Removal	100.0	LDB	400
Partial Chevron Removal	99.9	LDB	400
Extend Existing Dike	99.8	RDB	80
Extend Existing Dike	99.6	RDB	80

1 - Introduction

The U.S. Army Corps of Engineers, St. Louis District, conducted a study of the flow and sediment transport response conditions of the Upper Mississippi River (UMR) between River Miles (RM) 100.5 and 98.5 near Rockwood, Illinois. This study was funded by the St. Louis District's Regulating Works Project. The objective of the model study was to provide a recommended course of action based upon an analysis of the effectiveness of various river engineering measures intended to reduce or eliminate the need for repetitive channel maintenance dredging during low water. The recommended alternative should avoid and minimize negative environmental impacts whenever reasonably possible.

The study was conducted between June, 2018 and October, 2018 using a physical hydraulic sediment response (HSR) model at the St. Louis District Applied River Engineering Center in St. Louis, Missouri. The model operation and study was conducted by Bradley Krischel, P.E., Hydraulic Engineer, and Cory Tabbert, Hydraulic Engineer. James Wallace, P.E., Chief, Hydraulic Design provided direct supervision of the effort. Other personnel involved in this study are shown in Table 1-1, below.

Table 1-1: Other Personnel Involved in the Study.

Name	Position	District / Company
Bernie Heroff	Vessel Manager	American River Transportation Co.
Butch Atwood	Mississippi River Fisheries Biologist	Illinois Department of Natural Resources
Dave Herzog	Biologist	Missouri Department of Conservation
Dave Ostendorf	Biologist	Missouri Department of Conservation
Molly Sobotka	Biologist	Missouri Department of Conservation
Matt Vitello	Biologist	Missouri Department of Conservation
Matthew Mangan	Biologist	U.S. Fish & Wildlife Service
Alison Anderson	Aquatic Ecologist	USACE - St. Louis District
Eddie Brauer	Regional Technical Specialist – River Engineering, Mississippi Valley Division	USACE - St. Louis District
Lance Engle	Dredge Project Manager	USACE - St. Louis District
Leonard Hopkins	Chief of Hydrologic and Hydraulic Branch	USACE - St. Louis District
Brian Johnson	Chief of Environmental Compliance Section	USACE - St. Louis District
Brad Krischel	Hydraulic Engineer	USACE - St. Louis District
Dawn Lamm	Hydraulic Engineer	USACE - St. Louis District
Tim Lauth	Regulating Works Project Technical Lead	USACE - St. Louis District
Mike Rodgers	Regulating Works Project Manager	USACE - St. Louis District
Shane Simmons	Fisheries Biologist	USACE - St. Louis District
Cory Tabbert	Hydraulic Engineer	USACE - St. Louis District
John Vest	Hydraulic Engineer	USACE - St. Louis District
James Wallace	Chief of Hydraulic Design Section	USACE – St. Louis District

2 - Background

2.1 Problem Description

The authorized minimum channel dimensions for ensuring the safe passage of commercial vessels on the UMR are 9 feet of depth and 300 feet of width with additional width in bends at low water. Additional width in bends can be required as barge tows use flanking maneuvers to transit through river bends. As authorized, the Corps has established a Low Water Reference Plane (LWRP) to use for measuring low water river depths.

River training structures and revetments have previously been utilized in the reach between UMR river miles 100.5 and 98.5 to reduce the need for repetitive channel maintenance dredging. The reach between UMR 100.5 and 98.5 contains a river crossing where deposition occurs in the middle of the navigation channel leading to insufficient channel depths at low water. Plate 3 shows the locations of dredging and dredge material placement.

The depths throughout the reach between UMR 100.5 and 98.5 have not been sufficient for navigation during the most recent low water periods. Figure 2-2 shows the Chester, Illinois gage hydrograph for the time period of 2000 to 2017. During this time period, approximately 1.6 million cubic yards of material was dredged between UMR 100.5 and 98.5 at a cost of approximately $2.9M (Figures 2-3 and 2-4). For 2012 and 2013 alone, the total cost of dredging was $1,433,422, which was during a low water event.

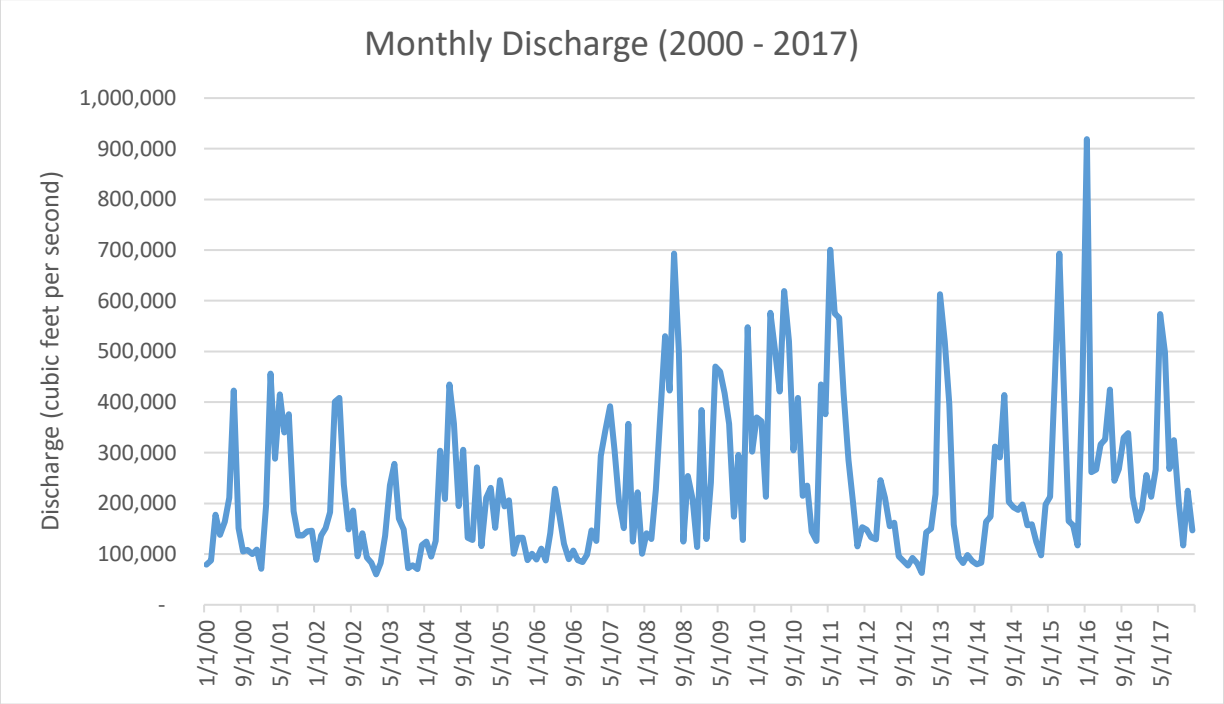

Figure 2-1: Monthly Discharge at Chester, Illinois

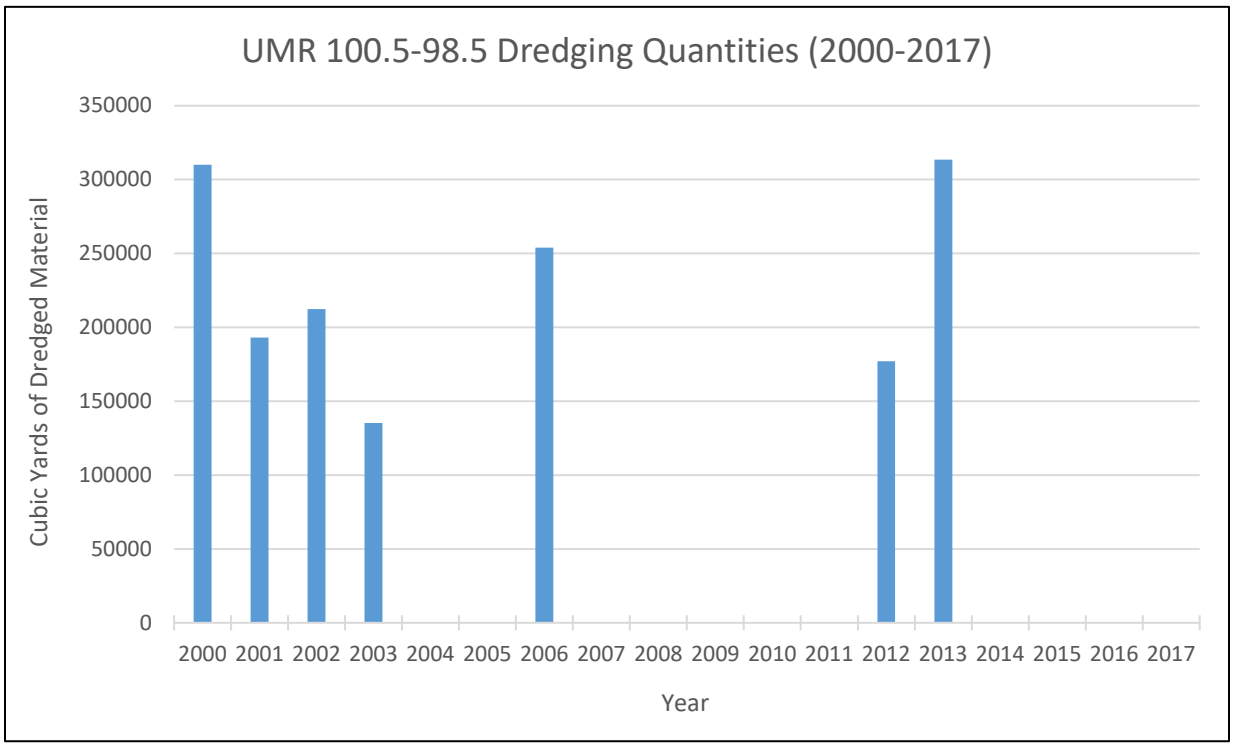

Figure 2-2: Dredging Quantities (2000 – 2017)

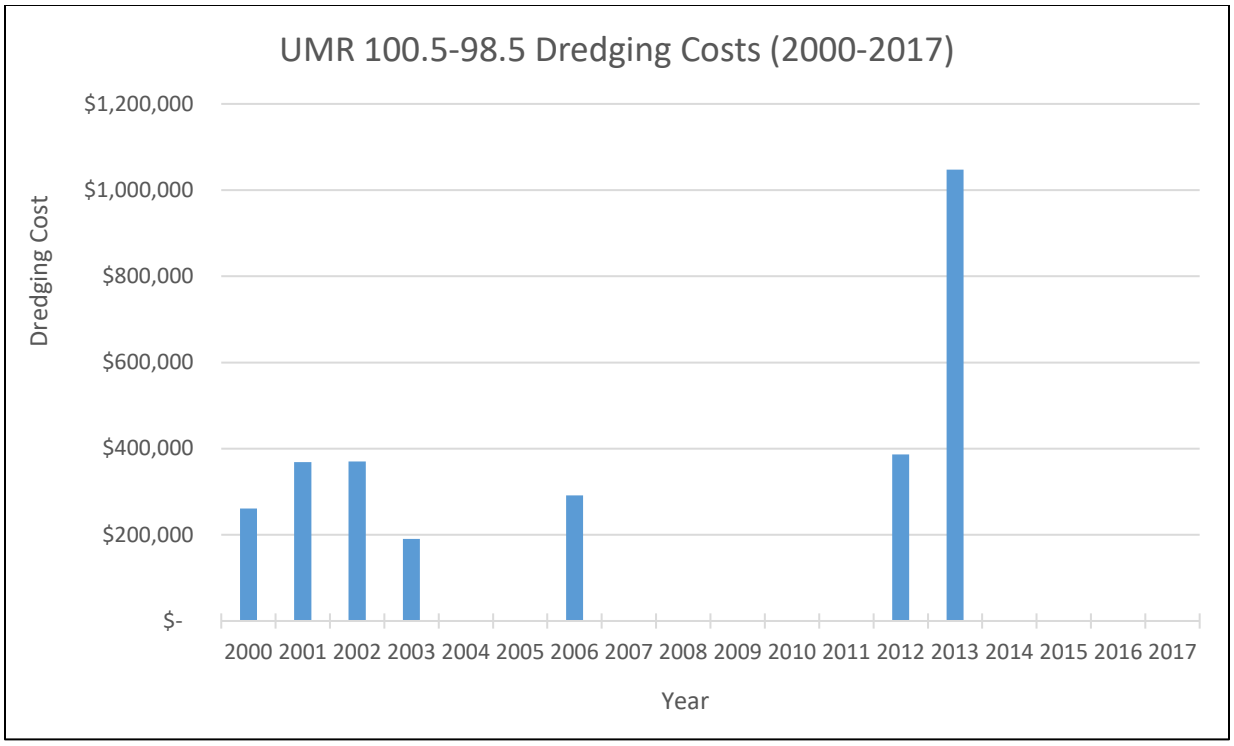

Figure 2-3: Dredging Costs (2000 – 2017)

2.2 Environmental Features

USACE biologists and partnering natural resource agency representatives indicated that there are two important areas of habitat along the LDB between UMR 100.5 and 98.5. The environmental areas in this model study are:

a. Rockwood Island Sandbar – The sandbar located at the upstream end and river side of Rockwood Island serves as important shallow water habitat for various fish species prevalent on the MMR. Sandbars on the MMR are also potential nesting areas for local birds (including the Least Tern).

b. Mile 100 islands – The Mile 100 Islands provide an existing diversity of habitat types for fish, birds, and other wildlife on the MMR.

2.3 Study Purpose and Goals

The purpose of this study was to evaluate various design alternatives intended to reduce or eliminate repetitive dredging between UMR river miles 100.5 and 98.5. HSR modeling technology was used to test the changes in geomorphology.

The goals of this study were to:

i. Investigate and provide analysis on the existing geomorphology.

ii. Evaluate a variety of remedial measures utilizing an HSR model with the objective of identifying the most effective and economical plan to reduce or eliminate the need for dredging between RM 100.5 to RM 98.5 while avoiding and minimizing adverse effects to fish and wildlife. In order to determine the best alternative, the following criteria below were used to evaluate each alternative:

   a. The alternative should reduce or eliminate the need for dredging along the RDB sandbar between RM 100.5 and RM 98.5.

   b. The alternative should have a minimal impact, if possible, on the sandbar along the river side of Rockwood Island.

   c. The alternative should have a minimal impact, if possible, on the Mile 100 Islands.

2.4 Study Reach

The study comprises a 2.0 mile stretch of the UMR between RM 100.5 and RM 98.5 near Rockwood, Illinois. Counties located around the study reach are Randolph and Jackson in Illinois and Perry in Missouri. Additional river miles, both upstream and downstream of the study area, were modeled to allow for adequate entrance and exit conditions. Plate 1 is a location and vicinity map of the study reach. Plate 2 is a planform and nomenclature map of the study reach. Plate 4 illustrates geomorphological changes to the river banklines in the study reach over the time period from 1968 to 2011. Overall, the planform of the reach remained stable since 1968. One notable change to the planform within the reach is the RM 100 Islands that formed along the RDB due to a series of notches in existing dikes. The islands can be seen for years 2003 and 2011 on Plate 4. One other change is the island along the LDB between RM 101.1 – 100.0 appears to have decreased in size between 1968 and 2011.

Present and historic hydrographic surveys of the Mississippi River in the HSR model study area are shown on Plates 5-9. The plates show bathymetric surveys from 2005, 2007, 2010, 2013, and 2015. These comprehensive, single beam surveys were used to determine the general bathymetric trends observed through the reach over time.

The following trends and features within the reach have remained relatively constant after comparison of the above mentioned hydrographic surveys:

Table 2-1: Study Reach Characteristics

River Miles	Description
101.5 – 100.4	The thalweg, with depths ranging between -20 ft to -40 ft LWRP, was concentrated along the RDB from RM 101.5 through RM 100.0. There were structures on both sides of the river. The structures along the outside of the bend along the RDB that were spaced approximately 1100' apart. The average effective length of these structures was approximately 200'. The structures along the sandbar on the inside of the bend are spaced approximately 1700' apart. These structures had little to no effective length as they were completely covered in sand. Elevations between the structures along the LDB were mostly greater than +10 ft LWRP. Liberty Chute reconnects to the main channel at RM 100.7 and RM 100.0.
100.4 - 99.0	The thalweg, with depths ranging between -5 ft to -30 ft LWRP, crossed from the RDB to the LDB in this reach. There was a set of chevrons along the LDB at the downstream end of Liberty Chute near RM 100.0. Along the RDB, there was a series of notched dikes where the Mile 100 islands formed. These structures were spaced approximately 800' – 2000' apart with effective lengths of approximately 900' – 1300'. Elevations between structures along the RDB were generally greater than 0 ft LWRP with some scour holes and additional depth diversity ranging from -15 ft to -30 ft LWRP. The average width from the dike tips to the LDB in this reach was approximately 1500'.
99.0-97.5	The thalweg, with depths ranging between -20 ft to -30 ft LWRP, was concentrated along the LDB from RM 99.0 through RM 97.5. Along the LDB, there was a series of short dikes between RM 98.0 and 97.70 followed by a series of bendway weirs near RM 97.5. The structures along the inside of the bend along the RDB were spaced approximately 1,800– 2,700' apart with effective lengths of approximately 900' – 1300'. Elevations between the structures along the RDB ranged between 0 ft to +10 ft LWRP.

In addition to the typical main channel trends referenced above, the four pre-dredge surveys for the year of 2013 are shown on Plates 10-13. These surveys demonstrate the shallow crossing trends within the reach that led to costly dredging events during the most recent low water period.

3 - HSR Modeling

3.1 Model Calibration and Replication

The HSR model seen on Plate 14 was calibrated to replicate the general conditions of the river at the time of the model study. The general conditions replicated by the model were determined from comprehensive prototype surveys of the years 2005, 2007, 2010, 2013, and 2015 and are described in Table 2.1. Model replication involved a 3 step process.

First, planform "fixed" boundary conditions of the study reach, i.e. banklines, islands, side channels, tributaries and other features were established according to recent available high resolution aerial photographs. Various other fixed boundaries were also introduced into the model including any channel improvement structures, underwater rock, clay and other non-mobile boundaries. These boundaries were based off of documentation such as plans and specifications, the hydrographic surveys mentioned above, and LiDAR data collected between December 5, 2012 and January 15, 2013.

Second, "loose" boundary conditions, or bed material response, of the model was replicated. Bed material was introduced into the channel throughout the model to an approximate level plane. The combination of the fixed and loose boundaries served as the starting condition of the model.

Third, model tests were run using a steady state discharge. Adjustment of the discharge, sediment volume, model slope, fixed boundaries, and entrance conditions were refined during these tests as part of calibration. The bed progressed from a static, flat, arbitrary bed into a fully-formed, dynamic, and three-dimensional (3D) mobile bed. Repeated tests were simulated for the assurance of model stability and repeatability. When the general trends of the model bathymetry were similar to observed recent river bathymetry and the tests were repeatable, the model was considered calibrated and alternative testing began.

A previous HSR model study for Red Rock Phase 4 was completed in 2017 studying a repetitive dredging issue between UMR 103.9 – 102.0. Results of that study recommended an alternative to include new river training structures and modifications to existing structures within that reach. See Table 3-1 for a description of the Red Rock Phase 4 recommended construction. Since the Red Rock Phase 6 study reach is located immediately downstream of the planned Red Rock Phase 4 construction, the planned structures were included in the HSR model. Red Rock Phase 6 is a continuation of modifying existing river training structures through the

reach to create a smoother curvature and transition by creating better dike tip alignments. Structure misalignments in the reach can be attributed to different construction time periods, leading to an uncomprehensive structure set, as well as natural degradation over time. Modifications to better align the dike tips will allow energy to continue downstream, which will make the channel more efficient in this reach. Incorporating the Red Rock Phase 4 design in the model allowed the development of a comprehensive solution that incorporated upstream modifications into the downstream alternatives and allowed engineers and stakeholders to evaluate changes on a larger scale.

The Red Rock Phase 4 modifications and construction include the following:

Table 3-1: Red Rock Phase 4 Modifications and Construction

Type of Structure	Location (River Mile)	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.80	LDB	350
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Degrade Riverward Section of Existing Dike	103.10	LDB	425
Install Rootless MRS Dike	102.30	LDB	550
Install Rootless MRS Dike	102.00	LDB	550

See Appendix 2: HSR Modeling Theory for more details on the use of HSR Models.

3.2 Scales and Bed Materials

The model employed a horizontal scale of 1 inch = 600 feet, or 1:7,200, and a vertical scale of 1 inch = 68 feet, or 1:816, for a 7.4 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. Some areas of the model bed were determined to consist of non-erodible materials. These areas were modeled

using heavy steel pellets that would not translate downstream during model calibration and testing.

3.3 Appurtenances

The HSR model insert was constructed according to the 2012 high-resolution aerial photography of the study reach (Plate 14). The insert was then mounted in a hydraulic flume that recirculates water and sediment in a closed, steady state loop. The riverbanks of the model were constructed from dense polystyrene foam, and modified during calibration with clay (banklines). Steel pellets were utilized in the model as non-erodible material. River training structures in the model were made of galvanized steel mesh. Rotational jacks located within the hydraulic flume controlled the slope of the model. The measured slope of the insert and flume was approximately 0.01 inch/inch.

3.4 Flow Control

In all model tests, a 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 1.48 Gallons per Minute (GPM) during model calibration and for all design alternative tests. The Krohne Optiflux IFC 010 Flow Converter was used to measure flowrate for this study.

3.5 Data Collection

The river bed in the model was surveyed with a high definition, 3D laser scanner that collects a dense cloud of xyz data points. These xyz data points were then geo-referenced to real world coordinates and triangulated to create a 3D surface. The surface was then color coded by elevation using standard color tables that were also used in color coding prototype surveys. This process allowed a direct visual comparison between HSR model bathymetric surveys and prototype bathymetric surveys. The Hexagon Manufacturing Intelligence ROMER Absolute Arm and Perceptron Scanworks V5 laser scanner were used for this study.

4 - HSR model tests

4.1 Replication Test

Once the model adequately replicated general prototype trends, the resultant bathymetry served as a benchmark for the comparison of all future model alternative tests. In this manner, the actions of any alternative, such as new channel improvement structures, realignments, etc., were compared directly to the replicated condition. General trends were evaluated for any major differences positive or negative between the alternative test and the replication test by comparing the surveys of the two and also carefully observing the model while the actual testing was taking place. The resultant bathymetry of this bed response served as the base test of the HSR model. Plate 15 shows the bed configuration of the HSR Model Replication.

Results of the HSR model base test bathymetry and a qualitative comparison to the aforementioned prototype surveys between Mile 101.5 and Mile 97.5 indicated the model compared well with prototype trends. Any variances noted in Table 4-1 between the model and the prototype are considered minimal and the variances are taken into consideration when analyzing each alternative result described in Section 4.2. Overall, comparison of the model and prototype bathymetric trends indicated the following:

Table 4-1: Comparison of Model and Prototype Bathymetric Trends

River Mile	Comparison
101.5 – 100.4	Both the model and the prototype surveys showed the thalweg located along the RDB with depths ranging between -20 to -40 LWRP. Along the LDB, a large depositional bar, with depths mostly greater than +10 ft LWRP was apparent in both the model and the prototype.
100.4 – 99.0	The transition of the thalweg from the RDB to the LDB was observed in both the model and the prototype. The crossing was moderately deeper in the prototype, with depths ranging between -5 ft to -30 ft LWRP, than in the model, where depths ranged between -10 to -20 ft.
99.0 – 97.5	Both the model and the prototype surveys showed the thalweg located along the LDB with depths ranging between -20 ft and -30 ft LWRP. In the model, the scour hole off of the tip of Dike 98.0L is

	approximately 5 ft to 10 ft deeper than in the prototype. Along the RDB, a large depositional bar, with depths ranging between 0 ft to +10 ft LWRP, was apparent in both the model and the prototype. The depositional bar extended further into the channel in the model than in the prototype.

4.2 Design Alternative Tests

The testing process consisted of using best engineering practice and knowledge by installing alternative structure configurations in the model in an attempt to alter the model bathymetry and in a manner intended to alleviate the repetitive dredging in the UMR 100.5 – 98.5 reach of the Mississippi River. Given that the reach experiences its most significant dredging issues during low water periods, the approach to the alternatives testing was to make small structure modifications to improve the crossing at RM 100 while maintaining depths and environmental features throughout the reach. Alternative designs began with an evaluation of concept-level river engineering solutions based on the judgment of the design engineer and input from consultation of other engineers. These concept level designs were generally evaluated in the model via high impact and high-cost designs to progressively less impact and lower cost designs before reaching an optimized design for a given concept. Evaluation of each alternative was accomplished through a qualitative comparison to the model base test bathymetry.

Alternative 1: (Plate 16)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Extend Dike	100.8	RDB	175
Extend Dike	100.7	RDB	125

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative uses two dike extensions immediately upstream of the repetitive dredging location. The extensions will constrict the channel, and therefore,

increase the energy through the dredging location. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 2: (Plate 17)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	101.2	RDB	365
Install Trail Dike	101.0	RDB	250
Install Trail Dike	100.8	RDB	480
Install Trail Dike	100.7	RDB	500

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative used a series of trail dikes to constrict the channel upstream of RM 100. Other than slightly more depth off of the tip of Dike 100.6R, this alternative displayed overall bathymetric results that are comparable to the model replication.

Alternative 3: (Plate 18)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Partial Dike Removal	100.0	RDB	50
Dike Extension	100.8	RDB	40
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
Yes	Yes	Yes

Additional Comments
This alternative included modifying multiple structures upstream of RM 100 in an effort to create a more smooth transition for the crossing. Most significantly, Dike 100.6R and Dike 100.4R were shortened. The crossing appears to have shifted downstream to approximately RM 99.6. Depths also increased along the LDB between RM 99.6 and RM 98.9. The alternative showed significant improvement and increased depth through the repetitive dredging location.

Alternative 4: (Plate 19)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Partial Dike Removal	101.0	RDB	50
Dike Extension	100.8	RDB	40
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160
Dike Extension	99.8	RDB	80
Dike Extension	99.6	RDB	80

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
Yes	Yes	Yes

Additional Comments
This alternative was identical to Alternative 3 except the two 75 foot extensions for Dike 99.8R and Dike 99.6R. The crossing appears to have shifted downstream to approximately RM 99.6. Depths also increased along the LDB between RM 99.6 and RM 98.9. The alternative showed improvement and increased depth through the repetitive dredging location. The results from Alternative 3 and Alternative 4 were very similar. One difference is the bar along the RDB between RM 99.4 – 98.9 appears to extend slightly further into the channel for Alternative 3. Therefore, Alternative 4 would be preferred over Alternative 3.

Alternative 5: (Plate 20)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	101.2	RDB	365
Install Trail Dike	101.0	RDB	250
Install Trail Dike	100.8	RDB	480
Install Trail Dike	100.7	RDB	500
Dike Extension	99.9	LDB	300

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative was identical to Alternative 2 with the addition of the 300 foot extension to Dike 99.9L. Depths increased slightly off of the tip of the Chevron 99.9L and the Dike 99.9L extension located along the LDB. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 6: (Plate 21)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	101.2	RDB	365
Install Trail Dike	101.0	RDB	250
Install Trail Dike	100.8	RDB	480
Install Trail Dike	100.7	RDB	500
Repair Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	100

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative was identical to Alternative 2 with the addition of the repair to Dike 100.6R. Depths increased slightly off of the RDB dike tips between RM 100 – 99.6. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 7: (Plate 22)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	101.2	RDB	365
Install Trail Dike	101.0	RDB	250
Install Trail Dike	100.8	RDB	480
Install Trail Dike	100.7	RDB	500
Dike Extension	99.6	RDB	90

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative was identical to Alternative 2 with the addition of the extension to Dike 99.6R. Depths increased slightly along the LDB near RM 99.6. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 8A: (Plate 23)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Realign Trail Dike	100.6	RDB	460

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative included modifying Dike 100.6R by shortening the dike and realigning the trail. In addition, Dike 101.2R was shortened to better align with the location of the dike tips located immediately upstream and downstream. Increased deposition was visible upstream of the LDB chevrons near RM 100.1. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 8B: (Plate 24)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	85

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative included modifying Dike 100.6R by shortening the dike and realigning the trail. In addition, Dike 101.2R and Dike 100.4R were shortened to better align with the location of the dike tips located immediately upstream and downstream. Increased deposition was visible upstream of the LDB chevrons near RM 100.1. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 9: (Plate 25)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Dike Extension	101.4	RDB	105
Dike Extension	101.0	RDB	90

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative included dike extensions to Dike 101.4R and Dike 101.0R. These extensions were to better align the dike lengths with Dike 101.2R, which would create smoother alignment. The crossing showed slightly increased depths in the repetitive dredging location, but overall the alternative displayed bathymetric results that are comparable to the model replication.

Alternative 10: (Plate 26)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Dike Extension	100.8	RDB	240
Dike Extension	100.7	RDB	270

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative included partial removal of a dike and dike extensions upstream of the repetitive dredging location. The alternative was focused on shifting the crossing upstream from its current location in an effort to reduce deposition. The crossing showed slightly increased depths in the repetitive dredging location, but overall the alternative displayed bathymetric results that are comparable to the model replication.

Alternative 11: (Plate 27)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Remove Chevron	100.1	LDB	800

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
The goal of Alternatives 11-13 were to evaluate the significance of Chevrons 100.1L, 100.0L, and 99.9L and effectiveness in constricting the channel. To test this, the chevrons were removed one at a time, starting from Chevron 100.1L, the most upstream chevron of the set. Overall, this alternative displayed bathymetric results that are comparable to the model replication.

Alternative 12: (Plate 28)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Remove Chevron	100.1	LDB	800
Remove Chevron	100.0	LDB	800

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
The goal of Alternatives 11-13 were to evaluate the significance of Chevrons 100.1L, 100.0L, and 99.9L and effectiveness in constricting the channel. To test this, the chevrons were removed one at a time, starting from the most upstream chevron. Slightly increased deposition was observed in the repetitive dredging location. The point bar extended further into the channel along the RDB between RM 99.6 – 98.7.

Alternative 13: (Plate 29)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Remove Chevron	100.1	LDB	800
Remove Chevron	100.0	LDB	800
Remove Chevron	99.9	LDB	800

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
The goal of Alternatives 11-13 were to evaluate the significance of Chevrons 100.1L, 100.0L, and 99.9L and effectiveness in constricting the channel. To test this, the chevrons were removed one at a time, starting from the most upstream chevron. Increased deposition was observed in the repetitive dredging location. The point bar extended further into the channel along the RDB between RM 99.8 – 98.7.

Alternative 14: (Plate 30)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Chevron Removal	100.1	LDB	400
Partial Chevron Removal	100.0	LDB	400
Partial Chevron Removal	99.9	LDB	400

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative analyzed if modifications to the chevrons could provide additional environmental benefits to the reach. Furthermore, modifications to the chevrons could be combined with other successful alternatives to create additional alternatives. This alternative analyzed modifications to the land-side of the chevrons. It appeared the reach was comparable to the model replication in the area of the crossing at RM 100, but the point bar along the RDB between RM 99.6 – 98.9 extended further into the channel.

Alternative 15: (Plate 31)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Chevron Removal	100.1	LDB	400
Partial Chevron Removal	100.0	LDB	400
Partial Chevron Removal	99.9	LDB	400

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative builds on what was trying to be accomplished in Alternative 14 by analyzing modifications to the set of chevrons. However, instead of removing the land-side portion of each chevron, the river-side portion of Chevron 100.0 was removed instead creating an alternating series of "J-hook" structures. Some additional scour was observed off the tip of Dike 100.1L and along the LDB near RM 99.6. The point bar along the RDB between RM 99.6 – 98.9 extended further into the channel.

Alternative 16: (Plate 32)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Partial Dike Removal	101.0	RDB	50
Dike Extension	100.8	RDB	40
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160
Partial Chevron Removal	100.1	LDB	400
Partial Chevron Removal	100.0	LDB	400
Partial Chevron Removal	99.9	LDB	400
Dike Extension	99.8	RDB	80
Dike Extension	99.6	RDB	80

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
No	Yes	Yes

Additional Comments
This alternative combined Alternative 4 (the preferred alternative so far) and Alternative 15 (removing the land-side portion of the chevron set). The crossing appears to have shifted to approximately RM 99.8 and appears to have a slight increase in depths.

Alternative 17: (Plate 33)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Partial Dike Removal	101.0	RDB	50
Dike Extension	100.8	RDB	40
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160
Partial Chevron Removal	100.1	LDB	400
Partial Chevron Removal	100.0	LDB	400
Partial Chevron Removal	99.9	LDB	400
Dike Extension	99.8	RDB	80
Dike Extension	99.6	RDB	80

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
Yes	Yes	Yes

Additional Comments
This alternative combined Alternative 4 (the preferred alternative so far) and Alternative 14 (removing the land-side portion of the chevron set). The crossing appears to have shifted downstream to approximately RM 99.7. Depths also increased along the LDB between RM 99.6 and RM 98.9. The alternative showed increased depth through the repetitive dredging location.

Alternative 18: (Plate 34)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Construct Weir	101.1	RDB	715
Partial Dike Removal	101.0	RDB	50
Construct Weir	100.9	RDB	735
Dike Extension	100.8	RDB	40
Construct Weir	100.75	RDB	710
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160
Dike Extension	99.8	RDB	80
Dike Extension	99.6	RDB	80

Bathymetry Analysis

Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
Yes	Yes	Yes

Additional Comments
This alternative combined Alternative 4 (the preferred alternative so far) with the addition of three weirs at RM 101.1, RM 100.9, and RM 100.75. The crossing shifted downstream to approximately RM 99.7 and showed improvement and increased depth through the repetitive dredging location. Depths also increased along the LDB near RM 98.9. There were concerns from environmental partners regarding the amount of flow the weirs would direct toward the RM 100 islands, and therefore, this alternative would not be recommended.

5 - Conclusions

5.1 Evaluation and Summary of the Model Tests

Table 5-1: Summary of Model Test Results

Test	Likely to Reduce Dredging at UMR 100.5-98.5 Channel Crossing?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?	Minimal Impact on the RM 100 Islands along the RDB?
Alternative 1	No	Yes	Yes
Alternative 2	No	Yes	Yes
Alternative 3	Yes	Yes	Yes
Alternative 4	Yes	Yes	Yes
Alternative 5	No	Yes	Yes
Alternative 6	No	Yes	Yes
Alternative 7	No	Yes	Yes
Alternative 8A	No	Yes	Yes
Alternative 8B	No	Yes	Yes
Alternative 9	No	Yes	Yes
Alternative 10	No	Yes	Yes
Alternative 11	No	Yes	Yes
Alternative 12	No	Yes	Yes
Alternative 13	No	Yes	Yes
Alternative 14	No	Yes	Yes
Alternative 15	No	Yes	Yes
Alternative 16	No	Yes	Yes
Alternative 17	Yes	Yes	Yes
Alternative 18	Yes	Yes	Yes

Many alternatives were tested in the model to encourage the thalweg to follow a path closer to the RDB at RM 100 but also create a crossing that transitions later than currently observed in the prototype. This was accomplished by creating an improved structure alignment with slight modifications to previously existing structures. With this new alignment, the thalweg remained closer to the RDB over a longer sustained time, which will create a deeper crossing.

5.2 Recommendations

Of all the alternatives tested in this model study, the following alternatives were deemed the most successful in achieving the overall project goals: 3, 4, 17 and 18. These alternatives focused on working with the existing river trends of the reach and modifying existing structures to become more effective in establishing a dependable navigation channel.

Considerations when choosing the preferred alternative between the successful alternatives included the following:

- The results from Alternative 3 and Alternative 4 were very similar - one difference is the bar along the RDB between RM 99.4 – 98.9 extends slightly further into the channel for Alternative 3. Therefore, Alternative 4 was preferred over Alternative 3.

- Alternative 4 and Alternative 17 yielded similar results. The difference being the added environmental benefit potentially created by removing the land-side half of each chevron allowing for additional secondary flow and depth diversity between the structures and the bankline.

- There were concerns from environmental partners regarding Alternative 18 and the amount of flow the weirs would direct toward the RM 100 islands, and therefore, the alternative was not recommended.

Of the tested alternatives, it was determined that Alternative 4 and 17 were the most effective in improving navigation channel dimensions in the problematic reach and accordingly reduced/eliminated the need for repetitive channel maintenance dredging in the future. Model bathymetry for both Alternative 4 and Alternative 17 showed greater depths along the RDB and also significantly improved the crossing at RM 100 when compared to the model replication. It should be reiterated that the reach has only experienced sedimentation issues during the most recent low water periods, and

therefore, the modeling approach was to make small modifications to existing structures.

Alternative 4 and Alternative 17 are both being recommended as successful alternatives for the reach. A separate mitigation analysis will be completed to analyze the environmental impact of each alternative on shallow to moderate-depth, moderate-to high-velocity habitat along the main channel border.

Construction of Alternative 4 and Alternative 17 will involve reconfiguring the planform layout of Dike 100.8R, Dike 100.6R, Dike 99.8R, and Dike 99.6R. Each of these structures should be restored to a height equal to the height of the newly configured dike in order to prevent river flows from flanking the structure. Table 5-2 details any construction that would be involved for Alternative 4, and Table 5-3 details any construction required for Alternative 17.

Table 5-2: Alternative 4 Construction and Modifications

Type of Structure	Location (River Mile)	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Partial Dike Removal	101.0	RDB	50
Dike Extension	100.8	RDB	40
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160
Dike Extension	99.8	RDB	80
Dike Extension	99.6	RDB	80

Table 5-3: Alternative 17 Construction and Modifications

Type of Structure	Location (River Mile)	LDB or RDB	Dimensions in Feet (Plan View)
Partial Dike Removal	101.2	RDB	150
Partial Dike Removal	101.0	RDB	50
Dike Extension	100.8	RDB	40
Realign Trail Dike	100.6	RDB	460
Partial Dike Removal	100.4	RDB	160
Partial Chevron Removal	100.1	LDB	400
Partial Chevron Removal	100.0	LDB	400
Partial Chevron Removal	99.9	LDB	400
Dike Extension	99.8	RDB	80
Dike Extension	99.6	RDB	80

A meeting took place on November 1, 2018 at the Applied River Engineering Center to discuss the results of the HSR model study and the recommended plan with stakeholders. A list of attendees and notes from that meeting can be found in Appendix 3.

5.3 Interpretation of Model Test Results

Model test results are 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 an engineering tool to evaluate the general long term trends that may be expected to occur 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.

6 - For more information

For more information about micro modeling or the Applied River Engineering Center, please contact Brad Krischel or James Wallace at:

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James.K.Wallace@usace.army.mil

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

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8 - Appendix 2: HSR Modeling Theory

The principle behind the use of a hydraulic sediment response model is similitude, the linking of parameters between a model and prototype so that behavior in one can predict behavior in the other.

There are two different types of similitude; mathematical similitude and empirical similitude. Mathematical similitude is founded on the scale relationship between all linear dimensions (geometric similarity), a scale relationship between all components of velocity (kinematic), or both geometric and kinematic similarity with the ratio of all common point forces equal (dynamic similarity).

In contrast to mathematical similitude, empirical similitude is based on the belief that the laws of mathematical similitude can be relaxed as long as other more fundamental relationships are preserved between the model and the prototype. All physical models used in the past by USACE employed, to some degree, empirical similitude. Numerous definitions of what relationships must be preserved have been put forward concerning physical sediment models. These relationships often deal with the scalability of elements of sediment transport processes or surface or structure roughness. Hydraulic sediment response models depend on similitude in the morphologic response, i.e. the ability of the model to replicate known prototype parameters associated with the bed response in the river under study. Bed response includes thalweg location, scour and deposition within the channel and at various river structures, and the overall resultant bed configuration. These parameters are directly compared to what is observed from prototype surveys.

Detailed cross-sectional analysis of prototype and model surveys defining bed response and bed configuration have shown that HSR model variation from the prototype is often approximately that of the natural variation observed in the prototype. This correspondence allows hydraulic engineers to use the HSR model with confidence and introduce alternatives in the model to approximate the bed response that can be expected to occur in the prototype.

HSR models were developed from empirical large scale coal bed models utilized by the USACE Waterways Experiment Station (now named the Environmental Research and Development Center, or ERDC). These models were used by MVS from 1940 to the mid-1990s. For a more thorough explanation of the early ERDC model development, please refer to the following link:

http://www.erdc.usace.army.mil/

9 - Appendix 3: HSR Meeting – November 1, 2018

Red Rock Landing Phase 6 HSR Model RRAT Meeting – 1 November 2018 - AREC

Attendees:

Butch Atwood	Illinois Department of Natural Resources
Molly Sobotka	Missouri Department of Conservation
Dave Ostendorf	Missouri Department of Conservation
Matt Vitello	Missouri Department of Conservation
Shane Simmons^	U.S. Army Corps of Engineers
Allison Anderson	U.S. Army Corps of Engineers
Tim Lauth	U.S. Army Corps of Engineers
Brad Krischel	U.S. Army Corps of Engineers
Corey Tabbert	U.S. Army Corps of Engineers
Eddie Brauer	U.S. Army Corps of Engineers
John Vest	U.S. Army Corps of Engineers
Mike Rodgers	U.S. Army Corps of Engineers
Dawn Lamm	U.S. Army Corps of Engineers
Matt Mangan*	U.S. Fish and Wildlife Service

^ note taker * briefed a few days later via webinar

Brad – Discussed the background conditions of the area as well as prototype surveys used to determine trends used for calibration (main channel surveys: 2005, 2007, 2010, 2013, 2015; dredge surveys: Aug 7, 2013, Sep 20, 2013, Nov 18, 2013, Dec 20, 2013). Noted the Red Rock Landing Phase 4 planned construction immediately upstream of our study area. Red Rock Landing Phase 4 construction would be included in the model, so future upstream conditions will be accounted for in the design for Red Rock Phase 6. Focus of model study is addressing the repetitive dredging in the river crossing at River Mile (RM) 100 during recent low water periods. Since this area is only an issue during low water, we want the model study to focus on small structure modifications – not major changes to the reach.

Corey – The idea is to utilize our existing infrastructure. In a similar method to the Red Rock Landing Phase 4 design, we are looking to realign and modify existing structures in the reach. Specifically we're trying to achieve a better dike tip to dike tip alignment. Discussed alternatives: **Alt 1**, little change in bathymetry. **Alt 2-5**, discussed the logic behind the design modifications (small modifications to existing structures in order to provide a better dike tip to dike tip alignment). **Alt 6 and 7** similar to **Alt 2 and 5**, simply slight modification. **Alt 8a** and **Alt 8b**, small modifications upstream. **Alt 9** – small dike extensions. **Alt 10** similar, dike extensions and some removal. **Alt 11 through 15** – alternative suggestions from the RRAT trip, including chevron modifications. The tests were to determine the effectiveness of the chevrons for the reach. Seems like chevrons play a role in the channel constriction – complete removal made repetitive dredging location worse, J-hooks (half removal) didn't appear to negatively affect the dredging location.

Brad – after running **Alt 1 through 15**, we took some successful features and combined them into a few new alternatives. **Alt 16** was a combination of **Alt 4** and **Alt 15**. **Alt 17** was a combination of **Alt 4** and **Alt 14**. **Alt 18** was an additional alternative that was a request from the RRAT trip trip. Explained that the weirs were placed nearly perpendicular to the bankline because it would direct flow more downstream and cause the channel crossing to happen further downstream. The alternative appeared to direct too much flow toward the River Mile 100 Islands, so many didn't prefer the alternative. Offered to adjust how the weirs are oriented if anyone thought it would be a beneficial test.

Brad/Cory – we prefer Alt 4 because gets lots of depth in channel and only requires modifications to existing structures to achieve better dike tip to dike tip alignment through the reach.

Eddie – We've had years of dike modifications, and you can see we're burning up a lot of energy with some of these structures due to poor alignment of dike tips. Some of this misalignment is due to degradation of the dikes over time. Modifications and better aligning the dike tips will allow energy to head downstream, which will make channel more efficient in

this reach. We tested all of the suggestions brought up at the RRAT trip. Chevrons are important for the channel constriction in this reach, but we can make subtle adjustments.

Matt V– With the Red Rock Phase 4 work in currently in the model, did this impact the model base condition?
Brad – No, we are still seeing the shoaling trends similar near RM 100.

Molly – What image survey best represents right now?
Brad – Our model replication
Eddie – One thing to note between the 2015 and model replication survey: the 2015 survey doesn't include the Red Rock Landing Phase 4 work, but the model replication does.

Eddie – Are there any concerns with **Alt 4**?

Grouped looked closely at **Alt 4**,
Matt V – asked about what exactly realignment means in terms of the structures.
Brad – explained the dike tip to dike tip alignment we are trying to achieve by pointing out specific structures on the prototype surveys.

Butch – asked about **Alt 17**.
Eddie – explained the logic behind **Alt 17**. It's doable, but it's a net zero in terms of the navigation channel. **Alt 17** did appear to increase flow along LDB. Grouped seemed to focus in on **Alt 17** and chevron manipulation.

Molly – have these alternatives been run through the chub model?
Eddie – we have to look at velocity for chub model, not complete yet. The way this would go forward, we would take **Alt 4** and run the chub model to make sure it doesn't put us in the negative. We could run both **Alt 4** and **Alt 17** in the chub model.

Shane – asked about the chevrons. Why can't we look at them regardless of the mitigation effect? Discussed with **Tim** about how we did this in the past. Discussed differences between

Alt 4 and **Alt 17**. Can't justify chevron modification from a purely navigation purpose point of view.

Eddie- plan is to run **Alt 4** and **Alt 17** through chub model independently to understand the impact of both portions of the project on AAHU's,. Discussed how the AAHU impact of these alternatives could affect whether we want to pursue j hook stuff. Alt 17 will only be pursued if there is not a negative imp act on AAHUs. A very large increase in AAHUs could impact the amount of mitigation done elsewhere on the MMR in the future.

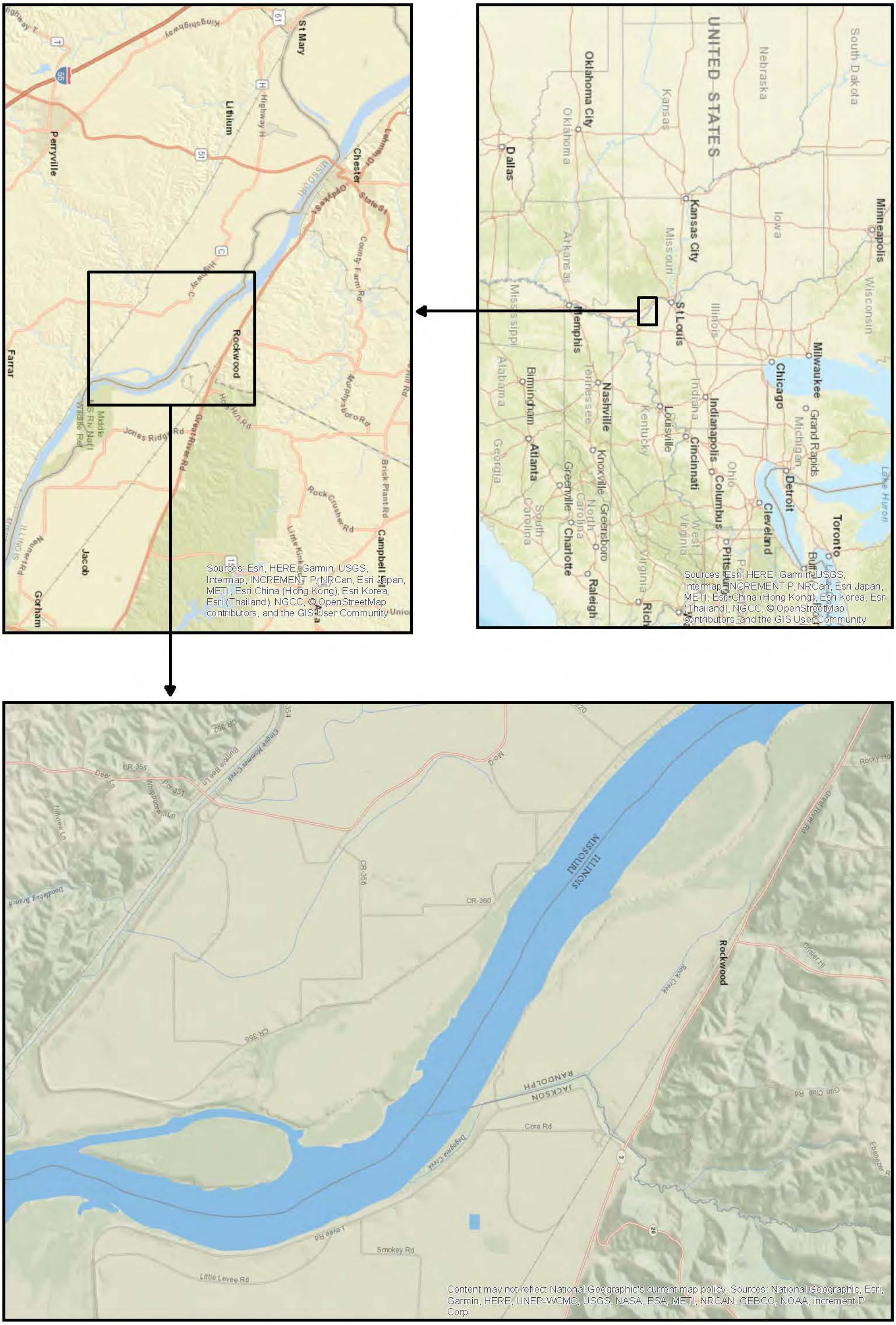

PLATE NUMBER 01

Location and Vicinity Map
River Mile 101.5 - 97.0
2015 Aerial Imagery

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI	DRAWN BY: C. Tabbert REVIEWED BY: B. Krischel, P.E. APPROVED BY: James Wallace, P.E.
Mississippi River Basin St. Louis District UMR 100.5 - 98.5	PLOT DATE: 1/17/2019 FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

720000

720000

735000

735000

720000

Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 99.8R

Dike 099.9L

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

PLATE NUMBER 02

0 370 740 1,480 2,220
Feet

Planform and Nomenclature
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/17/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

720000

720000

735000

735000

720000

Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dredging Locations
- Disposal Locations
- Dike Centerline
- Weir Centerline
- River Mile

PLATE NUMBER 03

0 370 740 1,480 2,220

Feet

Dredge & Disposal Locations
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/17/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

720000

720000

735000

735000

720000

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

MISSOURI

ILLINOIS

Legend

- Dike Centerline
- Weir Centerline
- River Mile
- 1968
- 1976
- 1986
- 2003
- 2011

PLATE NUMBER 04

0 370 740 1,480 2,220
Feet

Geomorphology (1968 - Present)
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/17/2019
FILE LOCATION: L:\MSR\Modeling\MSR Model Study\UMR 100 - 105, LMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

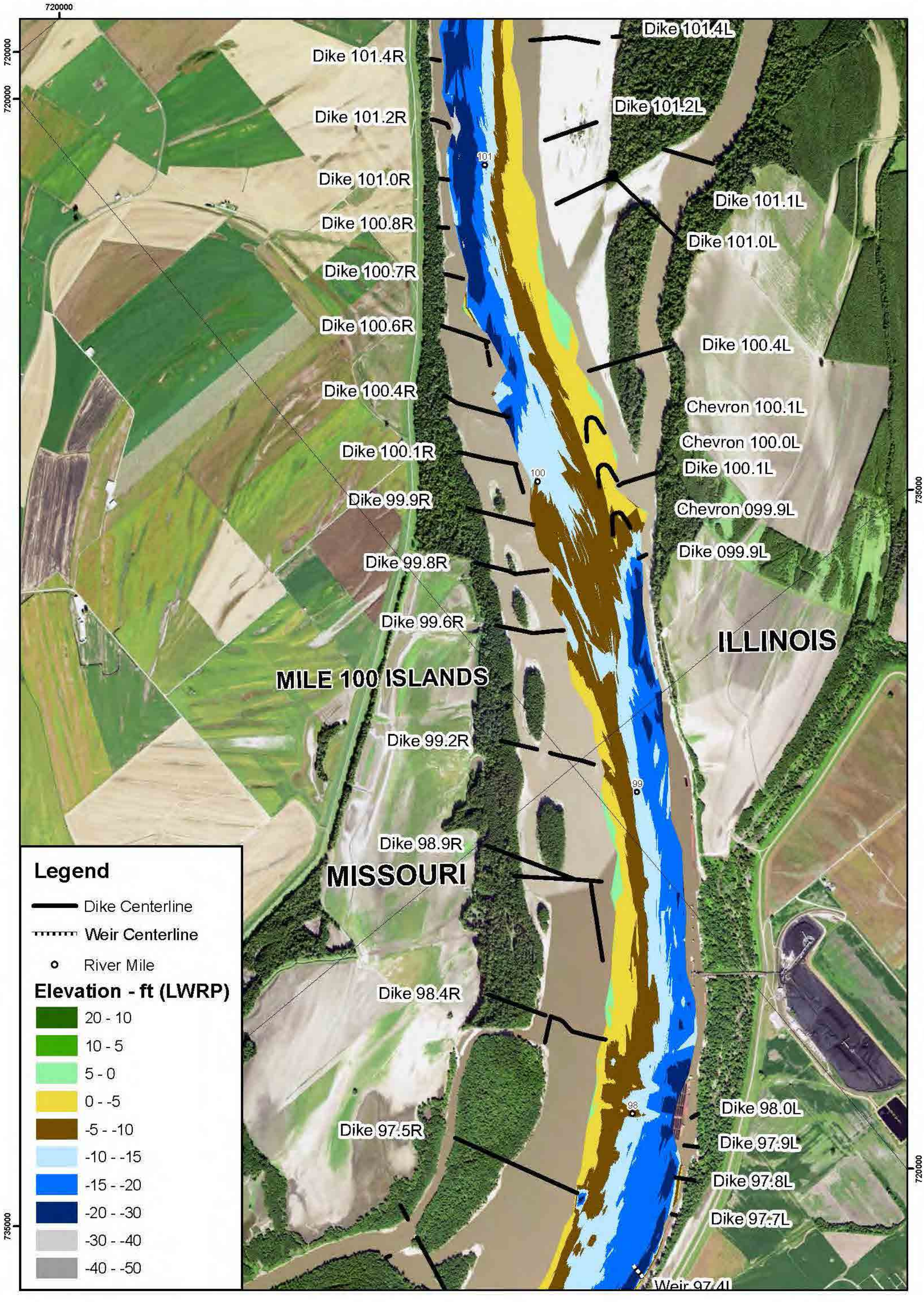

PLATE NUMBER
05

0 370 740 1,480 2,220
Feet

2005 Hydrographic Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 95.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

W N S E

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 90

0 370 740 1,480 2,220 Feet

2007 Hydrographic Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\HSR Model Set\...\UMR 110 - 95\UMR 100\Plate Maps\...

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 07

0 370 740 1,480 2,220

Feet

2010 Hydrographic Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 08

0 370 740 1,480 2,220 Feet

2013 Hydrographic Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Models\UMR Models\South\UMR 110 - 105, UMR 100\Final Plates\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 60

0 370 740 1,480 2,220 Feet

2015 Hydrographic Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MVS\Hydro\UMR Mile\South\UMR 110 - 100, UMR 100\Final Maps\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 10

0 370 740 1,480 2,220

Feet

August 7, 2013 Pre-Dredge Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\HSR Model Study\UMR 110 - 105, UMR 100\Final Plates\

APPLIED RIVER ENGINEERING CENTER

N W E S

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

100

Dike 100.1L

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4I

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 11

0 370 740 1,480 2,220 Feet

September 20, 2013 Pre-Dredge Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\HSR Model Study\UMR 110 - 105, UMR 100\Final Plates\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

100

Dike 100.1L

Dike 99.9R

Chevron 099.9L

735000

Dike 99.8R

Dike 099.9L

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

Dike 98.4R

Dike 97.5R

98

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

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PLATE NUMBER 12

0 370 740 1,480 2,220

Feet

November 18, 2013 Pre-Dredge Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\HSR Model Study\UMR 110 - 105, UMR 100\Final Plates\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

PLATE NUMBER 13

0 370 740 1,480 2,220

Feet

December 20, 2013 Pre-Dredge Survey
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\HSR Model Study\UMR 110 - 105, UMR 100\Final Plates\...

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

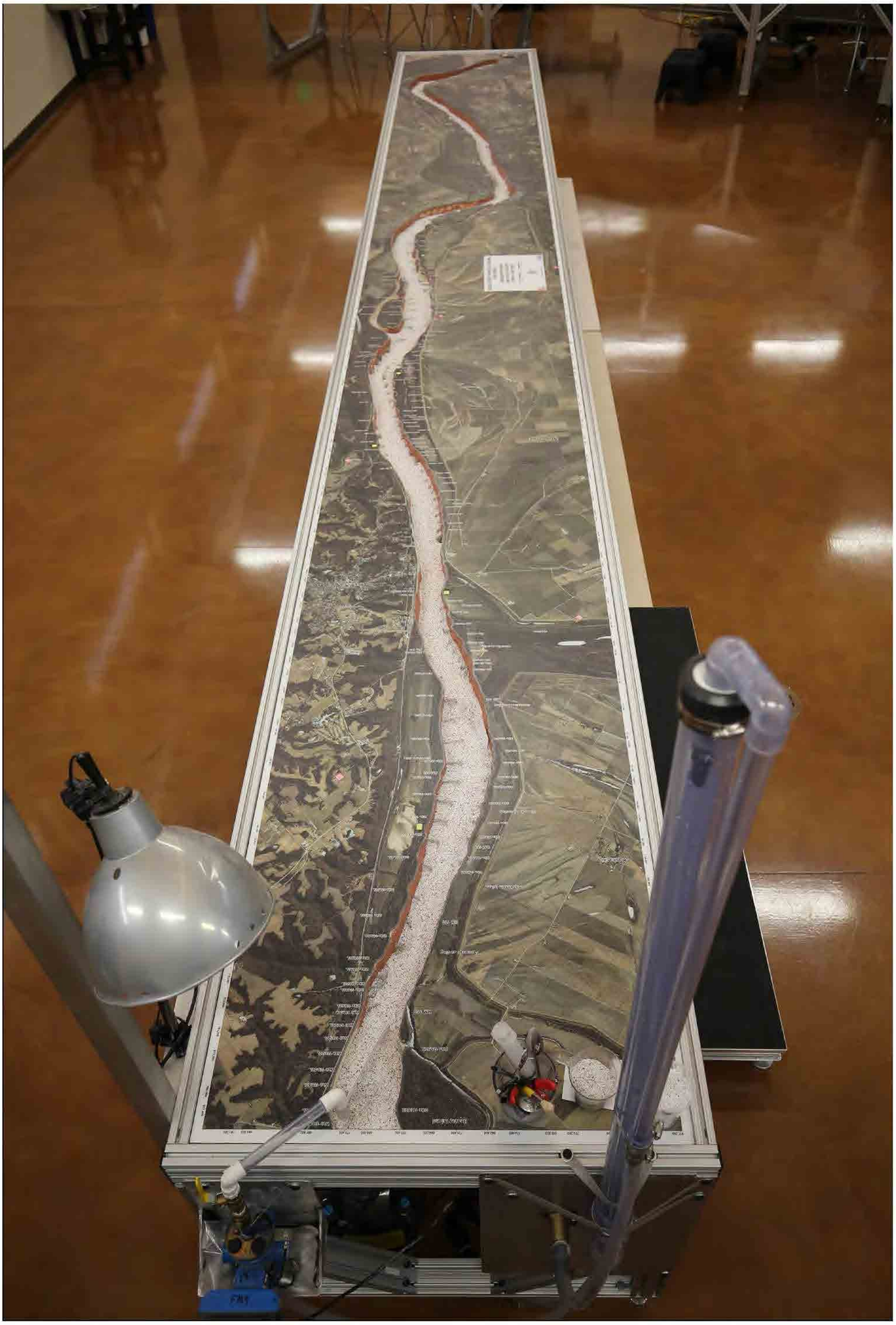

PLATE NUMBER 14

HSR Model
River Mile 116.8 - 80.0

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 12/14/2018
FILE LOCATION: L:\HSR Model\HSR Model Scans\UMR 110 - 80\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

MISSOURI

ILLINOIS

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 15

0 370 740 1,480 2,220 Feet

HSR Model Replication Scan
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4R

Dike 101.4L

Dike 101.2R

Dike 101.2L

101

Dike 101.0R

Dike 101.1L

175' Extension

Dike 100.8R

Dike 101.0L

125' Extension

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

100

Dike 100.1L

735000

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

720000

Dike 97.7L

735000

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 16

0 370 740 1,480 2,220 Feet

Alternative 01
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Modeling\MSR Mod Tasks\...\UMR 100-98\...

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4R

Dike 101.4L

Dike 101.2L

365' Trail

Dike 101.2R

250' Trail

Dike 101.0R

Dike 101.1L

480' Trail

Dike 100.8R

Dike 101.0L

500' Trail

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

Dike 98.9R

MISSOURI

Dike 98.4R

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 17

0 370 740 1,480 2,220
Feet

Alternative 02
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Modeling\MSR Model Setup\UMR 100-98\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4R

150' Removal Dike 101.2R

50' Removal Dike 101.0R

40' Extension Dike 100.8R

Dike 100.7R

460' Trail Realignment Dike 100.6R

160' Removal Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

MISSOURI

ILLINOIS

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 18

0 370 740 1,480 2,220 Feet

Alternative 03
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\UMR Model Study\UMR 110 - 95\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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150' Removal

50' Removal

40' Extension

460' Trail Realignment

160' Removal

80' Extension

80' Extension

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

MISSOURI

ILLINOIS

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 19

0 370 740 1,480 2,220
Feet

Alternative 04
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

720000

720000

735000

735000

720000

Dike 101.4L

Dike 101.4R

Dike 101.2L

365' Trail

Dike 101.2R

101

250' Trail

Dike 101.0R

Dike 101.1L

480' Trail

Dike 100.8R

Dike 101.0L

500' Trail

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Chevron 100.0L

Dike 100.1R

Dike 100.1L

100

Chevron 099.9L

Dike 99.9R

Dike 099.9L

300' Extension

Dike 99.8R

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 20

0 370 740 1,480 2,220 Feet

Alternative 05
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Mississippi\MSR Work\South\UMR 110 - 85\UMR 100\Plate Layout\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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Dike 101.4R

365' Trail Dike 101.2R

250' Trail Dike 101.0R

480' Trail Dike 100.8R

500' Trail Dike 100.7R

460' Repair Trail Dike 100.6R

100' Removal Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

ILLINOIS

MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 21

0 370 740 1,480 2,220 Feet

Alternative 06
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Modeling\MSR Work\South\UMR 110 - 95\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

Dike 101.4R

Dike 101.4L

365' Trail

Dike 101.2R

Dike 101.2L

250' Trail

Dike 101.0R

Dike 101.1L

480' Trail

Dike 100.8R

Dike 101.0L

500' Trail

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

Dike 100.1R

Chevron 100.0L

Dike 100.1L

Dike 99.9R

Chevron 099.9L

Dike 099.9L

Dike 99.8R

90' Extension

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

Dike 98.9R

MISSOURI

Dike 98.4R

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 22

0 370 740 1,480 2,220 Feet

Alternative 07
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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150' Removal

460' Trail Realignment

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

ILLINOIS

MISSOURI

Legend

Dike Centerline

Weir Centerline

River Mile

Alternative Tested

New Construction

Partial Removal of Structure

Elevation - ft (LWRP)

20 - 10

10 - 5

5 - 0

0 - -5

-5 - -10

-10 - -15

-15 - -20

-20 - -30

-30 - -40

-40 - -50

PLATE NUMBER 23

0 370 740 1,480 2,220

Feet

Alternative 8A
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

150' Removal

460' Trail Realignment

85' Removal

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

ILLINOIS

MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 24

0 370 740 1,480 2,220
Feet

Alternative 8B
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILELOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

105' Extension

90' Extension

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

ILLINOIS

MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 25

0 370 740 1,480 2,220 Feet

Alternative 09
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

150' Removal

240' Extension

270' Extension

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

Chevron 100.0L

Dike 100.1L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

ILLINOIS

MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 26

0 370 740 1,480 2,220
Feet

Alternative 10
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\UMR Mod\Sed...\UMR 110 - 95\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

800' Removal

Dike 100.1L

Chevron 100.0L

Chevron 099.9L

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

ILLINOIS

MISSOURI

Legend

Dike Centerline

Weir Centerline

River Mile

Alternative Tested

Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 27

0 370 740 1,480 2,220

Feet

Alternative 11
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

800' Removal

Dike 100.1R

Dike 100.1L

Chevron 100.0L

100

800' Removal

Dike 99.9R

Chevron 099.9L

735000

Dike 99.8R

Dike 099.9L

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

720000

Dike 97.7L

735000

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 28

0 370 740 1,480 2,220 Feet

Alternative 12
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Modeling\MSR Work\South\UMR 110 - 90\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

800' Removal

Dike 100.1L

Chevron 100.0L

800' Removal

Chevron 099.9L

800' Removal

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

MISSOURI

ILLINOIS

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 29

0 370 740 1,480 2,220

Feet

Alternative 13
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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720000

Dike 101.4L

Dike 101.4R

Dike 101.2L

Dike 101.2R

101

Dike 101.0R

Dike 101.1L

Dike 100.8R

Dike 101.0L

Dike 100.7R

Dike 100.6R

Dike 100.4L

Dike 100.4R

Chevron 100.1L

400' Removal

Dike 100.1R

Dike 100.1L

Chevron 100.0L

100

400' Removal

Dike 99.9R

Chevron 099.9L

400' Removal

Dike 99.8R

Dike 099.9L

Dike 99.6R

ILLINOIS

MILE 100 ISLANDS

Dike 99.2R

99

Dike 98.9R

MISSOURI

Dike 98.4R

98

Dike 98.0L

Dike 97.5R

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 30

0 370 740 1,480 2,220

Feet

Alternative 14
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

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Dike 101.4R

Dike 101.2R

Dike 101.0R

Dike 100.8R

Dike 100.7R

Dike 100.6R

Dike 100.4R

Dike 100.1R

Dike 99.9R

Dike 99.8R

Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

400' Removal

Dike 100.1L

Chevron 100.0L

400' Removal

Chevron 099.9L

400' Removal

Dike 099.9L

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

MILE 100 ISLANDS

MISSOURI

ILLINOIS

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 31

0 370 740 1,480 2,220
Feet

Alternative 15
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION:

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

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Dike 101.4R

150' Removal Dike 101.2R

50' Removal Dike 101.0R

40' Extension Dike 100.8R

Dike 100.7R

460' Trail Realignment Dike 100.6R

160' Removal Dike 100.4R

Dike 100.1R

Dike 99.9R

80' Extension Dike 99.8R

80' Extension Dike 99.6R

MILE 100 ISLANDS

Dike 99.2R

Dike 98.9R

MISSOURI

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

101

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L

400' Removal

Dike 100.1L

Chevron 100.0L

400' Removal

100

Chevron 099.9L

400' Removal

Dike 099.9L

ILLINOIS

99

98

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 32

0 370 740 1,480 2,220

Feet

Alternative 16
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 96.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\HSR Modeling\UMR Model Study\UMR 110 - 95\UMR 100\Final Report A

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

720000

720000

735000

735000

720000

Dike 101.4R

150' Removal Dike 101.2R

50' Removal Dike 101.0R

40' Extension Dike 100.8R

Dike 100.7R

460' Trail Realignment Dike 100.6R

160' Removal Dike 100.4R

Dike 100.1R

Dike 99.9R

80' Extension Dike 99.8R

80' Extension Dike 99.6R

Dike 99.2R

Dike 98.9R

Dike 98.4R

Dike 97.5R

Dike 101.4L

Dike 101.2L

Dike 101.1L

Dike 101.0L

Dike 100.4L

Chevron 100.1L
400' Removal

Dike 100.1L
Chevron 100.0L
400' Removal

Chevron 099.9L
400' Removal

Dike 099.9L

ILLINOIS

MILE 100 ISLANDS

MISSOURI

Dike 98.0L

Dike 97.9L

Dike 97.8L

Dike 97.7L

Weir 97.4L

101

100

99

98

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 33

0 370 740 1,480 2,220
Feet

Alternative 17
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Modeling\MSR Work\South\UMR 110 - 95\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

720000

720000

720000

735000

735000

720000

150' Removal
715' Weir
50' Removal
735' Weir
40' Extension
710' Weir
460' Trail Realignment
160' Removal
80' Extension
80' Extension

Dike 101.4R
Dike 101.2R
Dike 101.0R
Dike 100.8R
Dike 100.7R
Dike 100.6R
Dike 100.4R
Dike 100.1R
Dike 99.9R
Dike 99.8R
Dike 99.6R
Dike 99.2R
Dike 98.9R
Dike 98.4R
Dike 97.5R

Dike 101.4L
Dike 101.2L
Dike 101.1L
Dike 101.0L
Dike 100.4L
Chevron 100.1L
Dike 100.1L
Chevron 100.0L
Chevron 099.9L
Dike 099.9L
Dike 98.0L
Dike 97.9L
Dike 97.8L
Dike 97.7L
Weir 97.4L

101
100
99
98

MILE 100 ISLANDS
ILLINOIS
MISSOURI

Legend

- Dike Centerline
- Weir Centerline
- River Mile

Alternative Tested

- New Construction
- Weir Construction
- Partial Removal of Structure

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 34

0 370 740 1,480 2,220
Feet

Alternative 18
River Mile 101.5 - 97.4
2015 Aerial Imagery

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

Mississippi River Basin
St. Louis District
UMR 100.5 - 98.5

DRAWN BY: C. Tabbert
REVIEWED BY: B. Krischel, P.E.
APPROVED BY: James Wallace, P.E.
PLOT DATE: 1/23/2019
FILE LOCATION: L:\MSR Models\UMR Models\South\UMR 110-95\UMR 100\Final Report\

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

Appendix D. Agency and Tribal Government Coordination

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

REPLY TO
ATTENTION OF:

January 3, 2019

Engineering and Construction Division
Curation and Archives Analysis Branch (EC-Z)

Heather Gibb – Review, Compliance, Records Coordinator
Office of Historic Preservation
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

Subject: Red Rock Landing Phase 6: River Training Structures

Dear Ms. Gibb:

The United States Army Corps of Engineers (USACE) is presently planning the modification of ten (10) river training structures in the Red Rock Landing Reach of the Mississippi River between river miles 101 and 105 and partially located in Perry County, Missouri (Figure 1). The structures comprise the Red Rock Landing Phase 4 Project. We are contacting your office to initiate consultation under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), and its implementing regulation 36 CFR 800.

Background

Beginning in 1824, the Congress of the United States authorized the Secretary of the Army, by and through USACE, to make improvements to the Mississippi River, and some of its major tributaries, for the purpose of obtaining and maintaining an inland navigation channel for waterway commercial transportation throughout the United States. Ultimately for the Mississippi River, Congress authorized obtaining and maintaining at least a nine foot deep navigation channel from the Gulf of Mexico to Minneapolis, Minnesota, through multiple projects by various methods and management.

Congress authorized the ultimate plan for how the navigation channel should be obtained and maintained for a majority of the Middle Mississippi River (from the confluence of the Ohio River to the confluence of the Missouri River) in the Rivers and Harbors Act of 1910 and eventually established the current navigation channel dimensions of 9 feet deep and not less than 300 feet wide, with additional width in the bends as required, in the Rivers and Harbors Act of 1927.

There are a number of types of river training structures, including dikes, revetments, bendway weirs, and chevrons. Dikes redirect the river's own energy to manage sediment distribution within the river channel to provide adequate depth for navigation. While the original dikes of the nineteenth century were largely pile structures, by the middle of the twentieth century most had been converted to stone-fill types. Revetments are structures placed along the river bank to stabilize or protect the bank from erosion. They are usually constructed out of stone, but a variety of other materials have historically been used, including concrete-mat, willow mattresses, and gabions. First constructed in 1989, submerged bendway weirs widen the navigation channel in river bends by creating a favorable redistribution of current velocities and sediments. A more-recent development is chevrons built in the river itself. Chevrons create and promote split flows rather than unidirectional deflections and provide more diverse aquatic habitats.

River training structures continue to be constructed, as they provide a more cost-effective and environmentally friendly solution for moving sediment through the river system than dredging alone.

Project

It is proposed to modify 10 existing river training structures in the Red Rock Landing Reach of the Mississippi River (Figure 2). Seven of the structures are located in Perry County, Missouri (Table 1).

Table 1. Proposed Features

River Mile	Structure	Action	County	State
101.20R	Dike	Partial Removal	Perry	Missouri
101.00R	Dike	Partial Removal	Perry	Missouri
100.80R	Dike	Extend	Perry	Missouri
100.60R	Dike Trail	Re-Align	Perry	Missouri
100.40R	Dike	Partial Removal	Perry	Missouri
101.10L	Chevron	Partial Removal	Randolph	Illinois
100.00L	Chevron	Partial Removal	Randolph	Illinois
99.90L	Chevron	Partial Removal	Randolph	Illinois
99.80R	Dike	Extend	Perry	Missouri
99.60R	Dike	Extend	Perry	Missouri

Potential Effects on Cultural Resources

The bankline of the Red Rock Landing Reach has not drastically changed in the past century and a half (Figure 3). The Missouri bankline has, however, expanded eastward as Liberty Bar was captured and incorporated into the Missouri bank of the river after 1890. Therefore many of the features to be modified are located in what was once, in the 19th century, the center of the Mississippi River.

The structures to be modified are directly adjacent to the dredged channel of the Mississippi River, which doubtless resulted in channel slump and sediment reworking in the locations. The reach has been regularly dredged over the years, and it is likely that any unrecorded wreckage located in the path of those dredge events was destroyed and removed during the

process. While exact location information is not available for dredging events prior to 1979, USACE has been conducting such activities to deepen the navigation channel of the Middle Mississippi since 1896 (Manders and Rentfro 2011:61).

All the river training structures are constructed via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed.

During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District, USACE, conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck project features was in Liberty Chute on the Illinois side of the river.

The river bed in the project area is surveyed every year or two, with the latest multi-beam survey having been completed in October 2018. No topographic anomalies suggesting wrecks are visible on the resulting bathymetric map (Figure 4).

Summation

Given the proposed actions (partial removal and modest extensions of existing structures rather than new construction locations), construction method (with no land impact), and the lack of any survey evidence for extant wrecks, it is our opinion that the proposed undertaking will have no significant effect on cultural resources.

If you have any questions or comments, please feel free to contact me at (314) 331-8784 or Dr. Mark Smith at (314) 331-8831 (e-mail: mark.a.smith4@usace.army.mil).

Sincerely yours,

Rochelle Hance

Rochelle Hance
Chief, Curation and Archives Analysis Branch

Enclosure

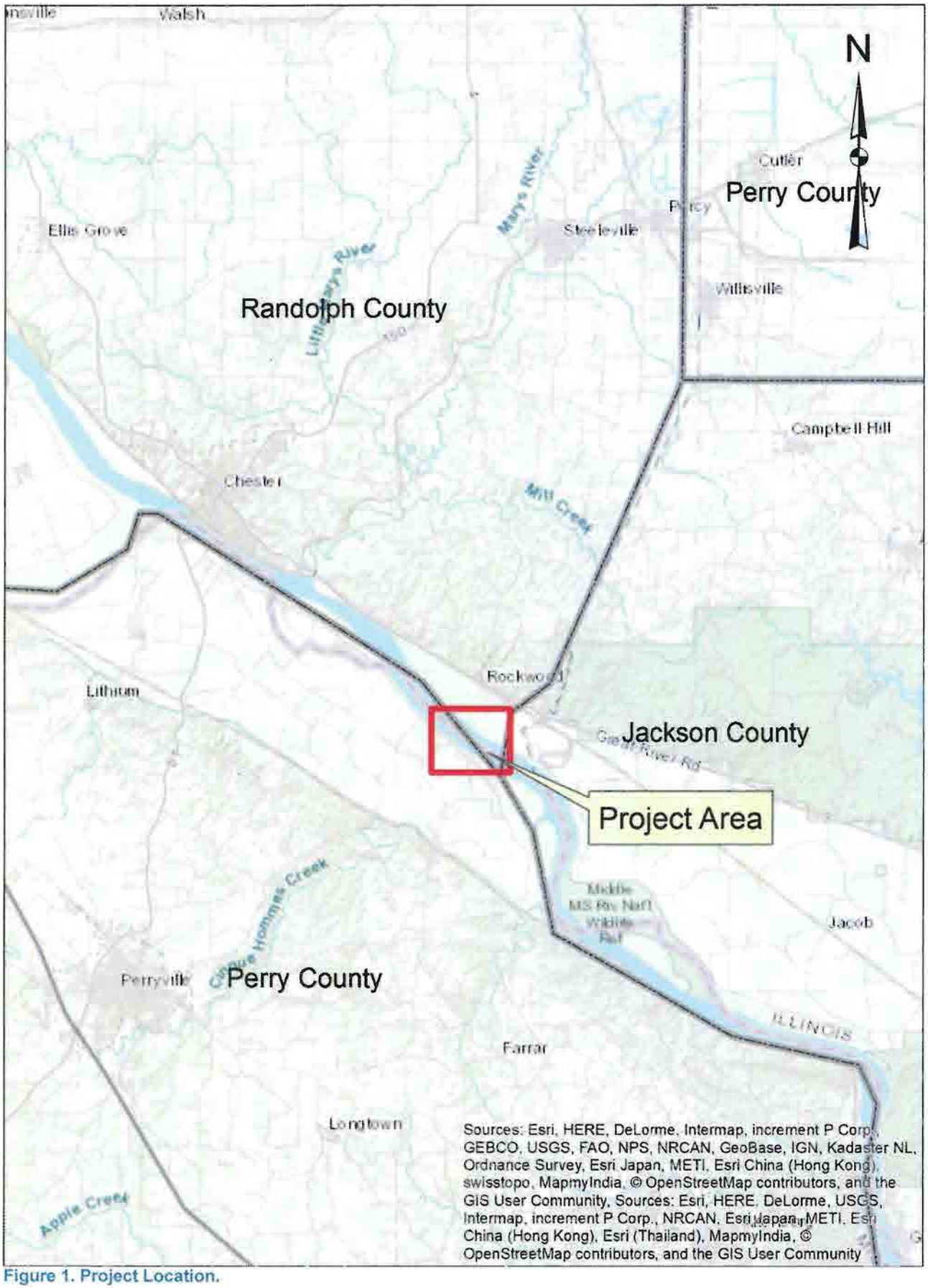


Figure 1. Project Location.

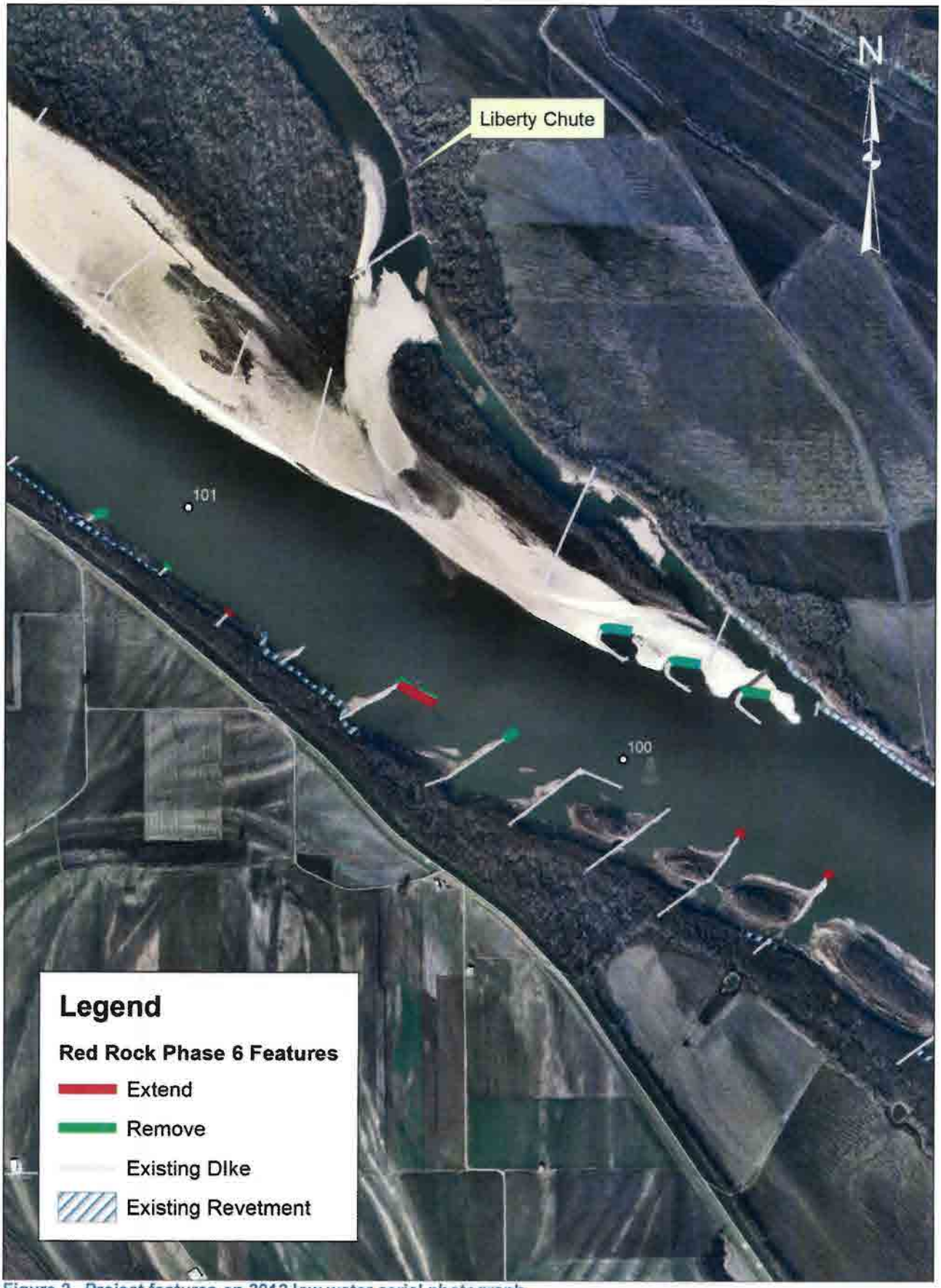


Figure 2. Project features on 2012 low water aerial photograph.

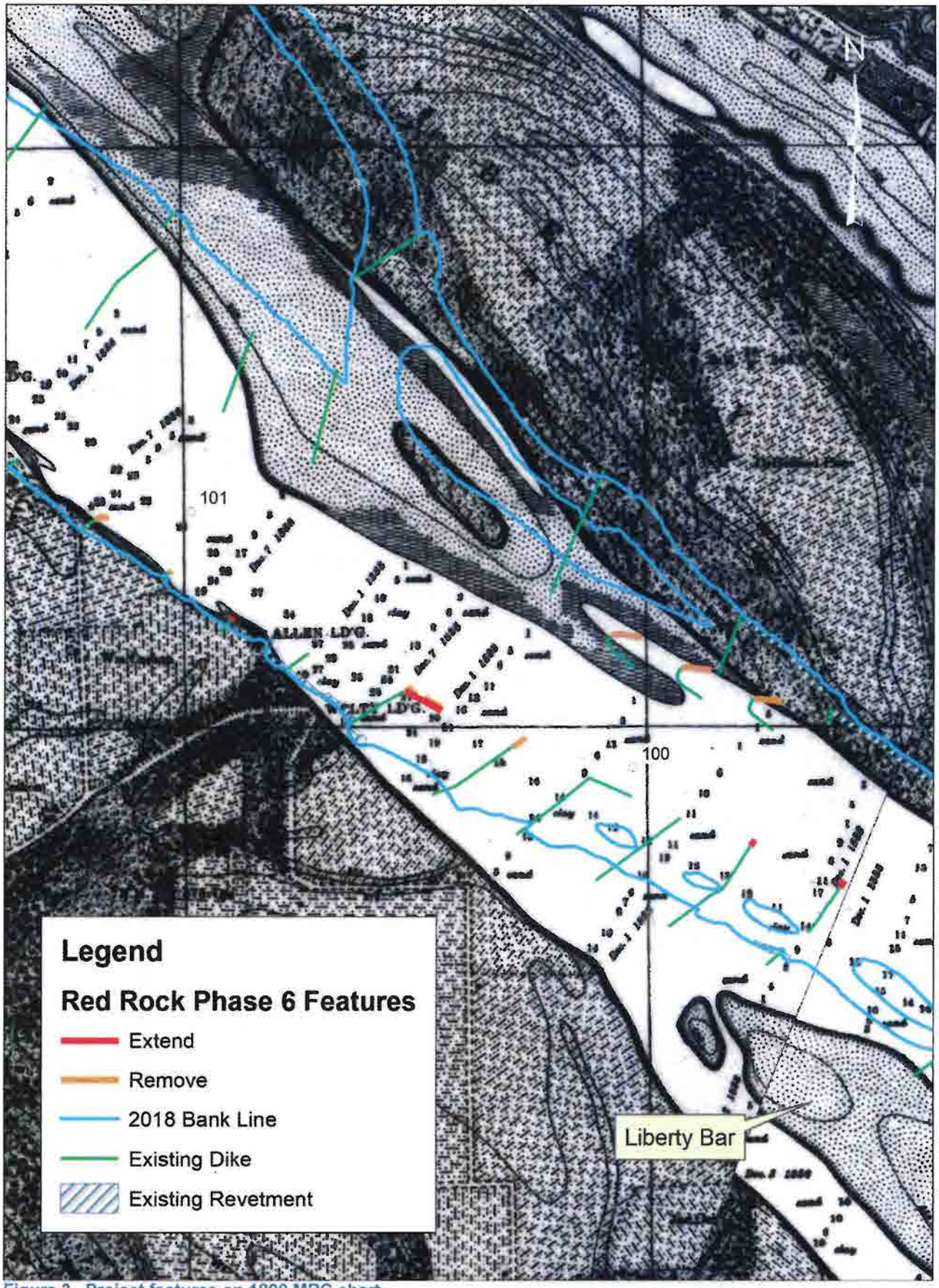


Figure 3. Project features on 1890 MRC chart.

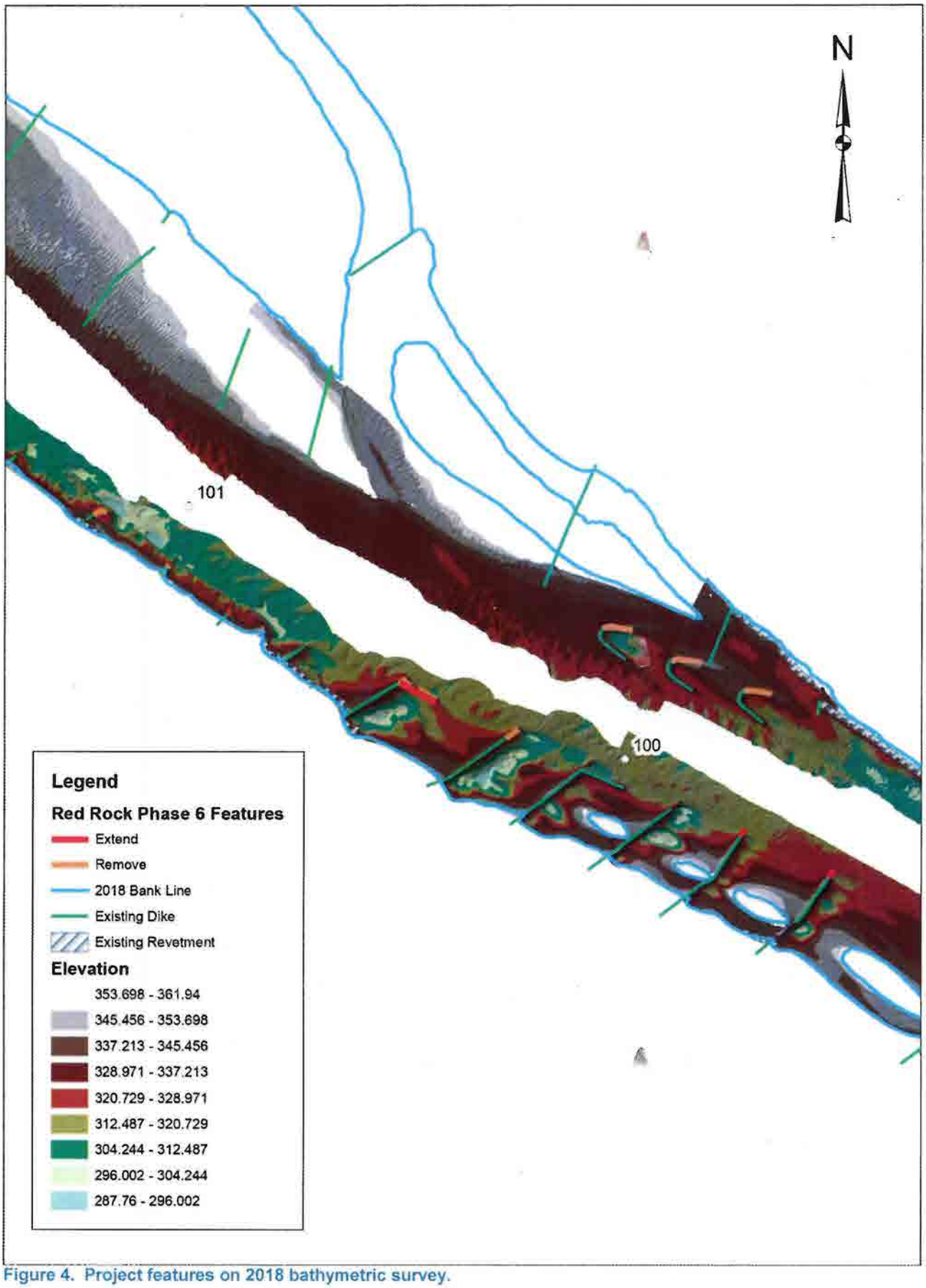


Figure 4. Project features on 2018 bathymetric survey.

References Cited

Manders, D., & B. Rentrfro
2011 Engineers *Far From Ordinary*. St. Louis District USACE, St Louis, MO.

Mississippi River Commission (MRC)
1881 Chart No 109. Survey of the Mississippi River.

Norris, F. T.
2003 Historical Shipwrecks on the Middle Mississippi and Lower Illinois Rivers. Curation and Archives Analysis Branch, St. Louis District, USACE.

CULTURAL RESOURCE ASSESSMENT
Section 106 Review

CONTACT PERSON/ADDRESS

Rochelle Hance
1222 Spruce Street
St. Louis, Missouri 63103-2833

C:

Ms. Amber Tilley, EPA

PROJECT:

Red Rock Landing Phase 6: River Training Structures

FEDERAL AGENCY

COE

COUNTY:

Perry

The State Historic Preservation Office has reviewed the information submitted on the above referenced project. Based on this review, we have made the following determination:

[X] After review of initial submission, the project area has a low potential for the occurrence of cultural resources. A cultural resource survey, therefore, is not warranted.

[ ] Adequate documentation has been provided (36 CFR Section 800.11). There will be "no historic properties affected" by the current project.

[ ] An adequate cultural resource survey of the project area has been previously conducted. It has been determined that for the proposed undertaking there will be "no historic properties affected".

For the above checked reason, the State Historic Preservation Office has no objection to the initiation of project activities. PLEASE BE ADVISED THAT, IF THE CURRENT PROJECT AREA OR SCOPE OF WORK ARE CHANGED, A BORROW AREA IS INCLUDED IN THE PROJECT, OR CULTURAL MATERIALS ARE ENCOUNTERED DURING CONSTRUCTION, APPROPRIATE INFORMATION MUST BE PROVIDED TO THIS OFFICE FOR FURTHER REVIEW AND COMMENT. Please retain this documentation as evidence of compliance with Section 106 of the National Historic Preservation Act, as amended.

By: Toni M. Prawl **January 18, 2019**
Toni M. Prawl, Ph.D., Deputy State Historic Preservation Officer **Date**

MISSOURI DEPARTMENT OF NATURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE
P.O. Box 176, Jefferson City, Missouri 65102
For additional information, please contact Heather Gibb, (573) 751-7862. Please be sure to refer to the project number: 002-PY-19

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

REPLY TO
ATTENTION OF:

January 3, 2019

Engineering and Construction Division
Curation and Archives Analysis Branch (EC-Z)

Jeffrey D. Kruchten
State Historic Preservation Office
Illinois Dept. of Natural Resources
Attn: Review & Compliance
1 Old State Capitol Plaza
Springfield, Illinois 62701

Subject: Red Rock Landing Phase 6: River Training Structures

Dear Mr. Kruchten:

The United States Army Corps of Engineers (USACE) is presently proposing the modification of ten (10) river training structures in the Red Rock Landing Reach of the Mississippi River between river miles 101 and 105 and partially located in Randolph County, Illinois (Figure 1). The structures comprise the Red Rock Landing Phase 4 Project. We are contacting your office to initiate consultation under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), and its implementing regulation 36 CFR 800.

Background

Beginning in 1824, the Congress of the United States authorized the Secretary of the Army, by and through USACE, to make improvements to the Mississippi River, and some of its major tributaries, for the purpose of obtaining and maintaining an inland navigation channel for waterway commercial transportation throughout the United States. Ultimately for the Mississippi River, Congress authorized obtaining and maintaining at least a nine foot deep navigation channel from the Gulf of Mexico to Minneapolis, Minnesota, through multiple projects by various methods and management.

Congress authorized the ultimate plan for how the navigation channel should be obtained and maintained for a majority of the Middle Mississippi River (from the confluence of the Ohio River to the confluence of the Missouri River) in the Rivers and Harbors Act of 1910 and eventually established the current navigation channel dimensions of 9 feet deep and not less than 300 feet wide, with additional width in the bends as required, in the Rivers and Harbors Act of 1927.

There are a number of types of river training structures, including dikes, revetments, bendway weirs, and chevrons. Dikes redirect the river's own energy to manage sediment distribution within the river channel to provide adequate depth for navigation. While the original dikes of the nineteenth century were largely pile structures, by the middle of the twentieth century most had been converted to stone-fill types. Revetments are structures placed along the river bank to stabilize or protect the bank from erosion. They are usually constructed out of stone, but a variety of other materials have historically been used, including concrete-mat, willow mattresses, and gabions. First constructed in 1989, submerged bendway weirs widen the navigation channel in river bends by creating a favorable redistribution of current velocities and sediments. A more-recent development is chevrons built in the river itself. Chevrons create and promote split flows rather than unidirectional deflections and provide more diverse aquatic habitats.

River training structures continue to be constructed, as they provide a more cost-effective and environmentally friendly solution for moving sediment through the river system than dredging alone.

Project

It is proposed to modify 10 existing river training structures in the Red Rock Landing Reach of the Mississippi River (Figure 2). Three of the structures are located in Randolph County, Illinois (Table 1).

Table 1. Proposed Features

River Mile	Structure	Action	County	State
101.20R	Dike	Partial Removal	Perry	Missouri
101.00R	Dike	Partial Removal	Perry	Missouri
100.80R	Dike	Extend	Perry	Missouri
100.60R	Dike Trail	Re-Align	Perry	Missouri
100.40R	Dike	Partial Removal	Perry	Missouri
101.10L	Chevron	Partial Removal	Randolph	Illinois
100.00L	Chevron	Partial Removal	Randolph	Illinois
99.90L	Chevron	Partial Removal	Randolph	Illinois
99.80R	Dike	Extend	Perry	Missouri
99.60R	Dike	Extend	Perry	Missouri

Potential Effects on Cultural Resources

The bankline of the Red Rock Landing Reach has not drastically changed in the past century and a half (Figure 3). The Illinois bank has, however, regressed moderately in places so that the three Illinois structures now in the river were directly adjacent to the bank in 1890. The erosion causing the regression would have destroyed any cultural features existing on the landform prior to that time.

All the river training structures are constructed via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary

erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed.

Possible Shipwrecks

During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District, USACE, conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck to the Illinois project features was located approximately a mile upstream in Liberty Chute. The location of the three Illinois structures is visible at times of low flood stage. Visual examination of imagery taken at that time show no indications of wrecks at or near those locations (Figure 2).

Summation

Given the proposed action (partial removal of existing structures rather than new construction), removal method (with no land impact), and the lack of any survey evidence for extant wrecks, it is our opinion that the proposed undertaking will have no significant effect on cultural resources.

If you have any questions or comments, please feel free to contact me at (314) 331-8784 or Dr. Mark Smith at (314) 331-8831 (e-mail: mark.a.smith4@usace.army.mil).

Sincerely yours,

Rochelle Hance

Rochelle Hance
Chief, Curation and Archives Analysis Branch

Enclosure

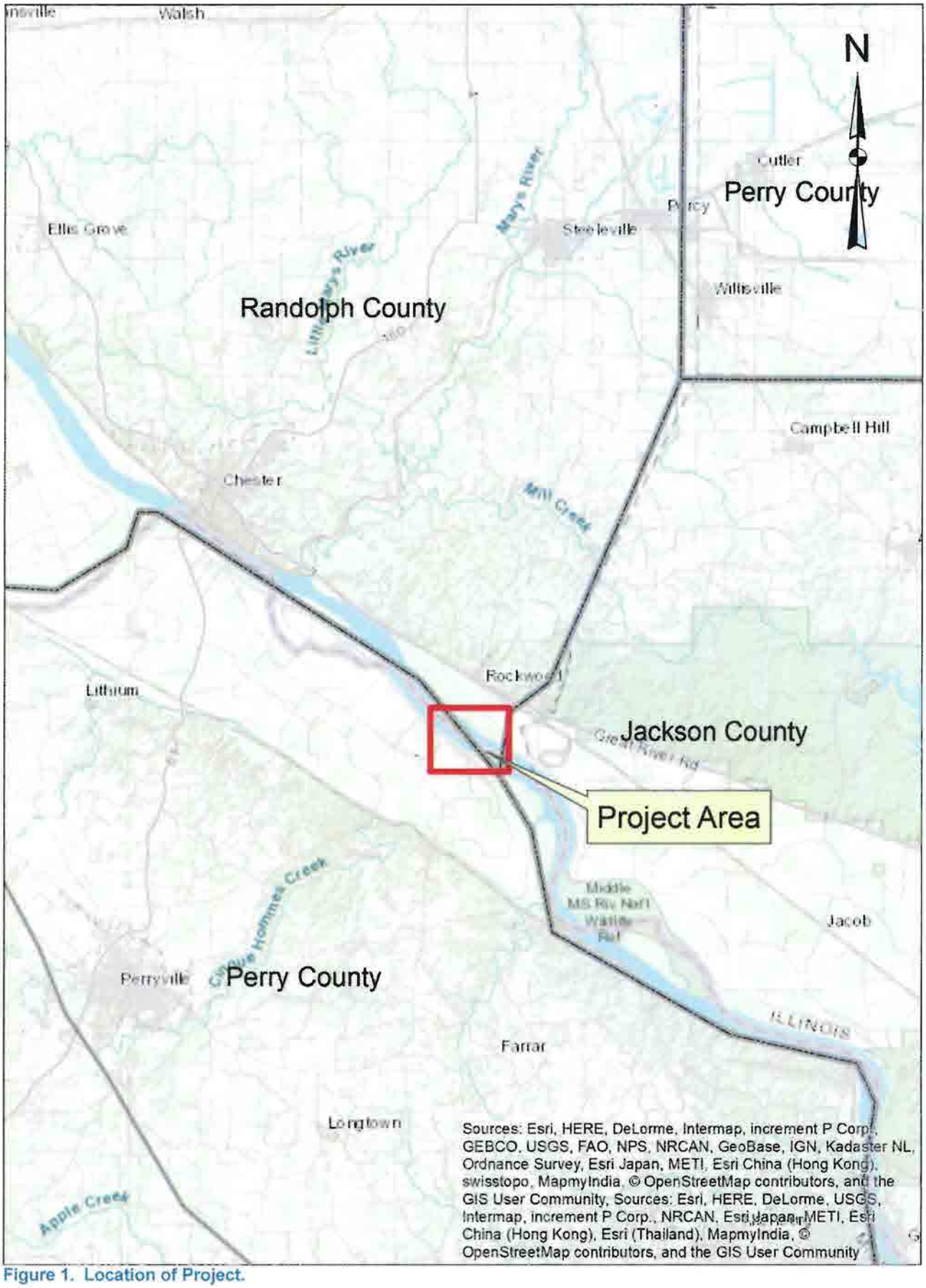


Figure 1. Location of Project.

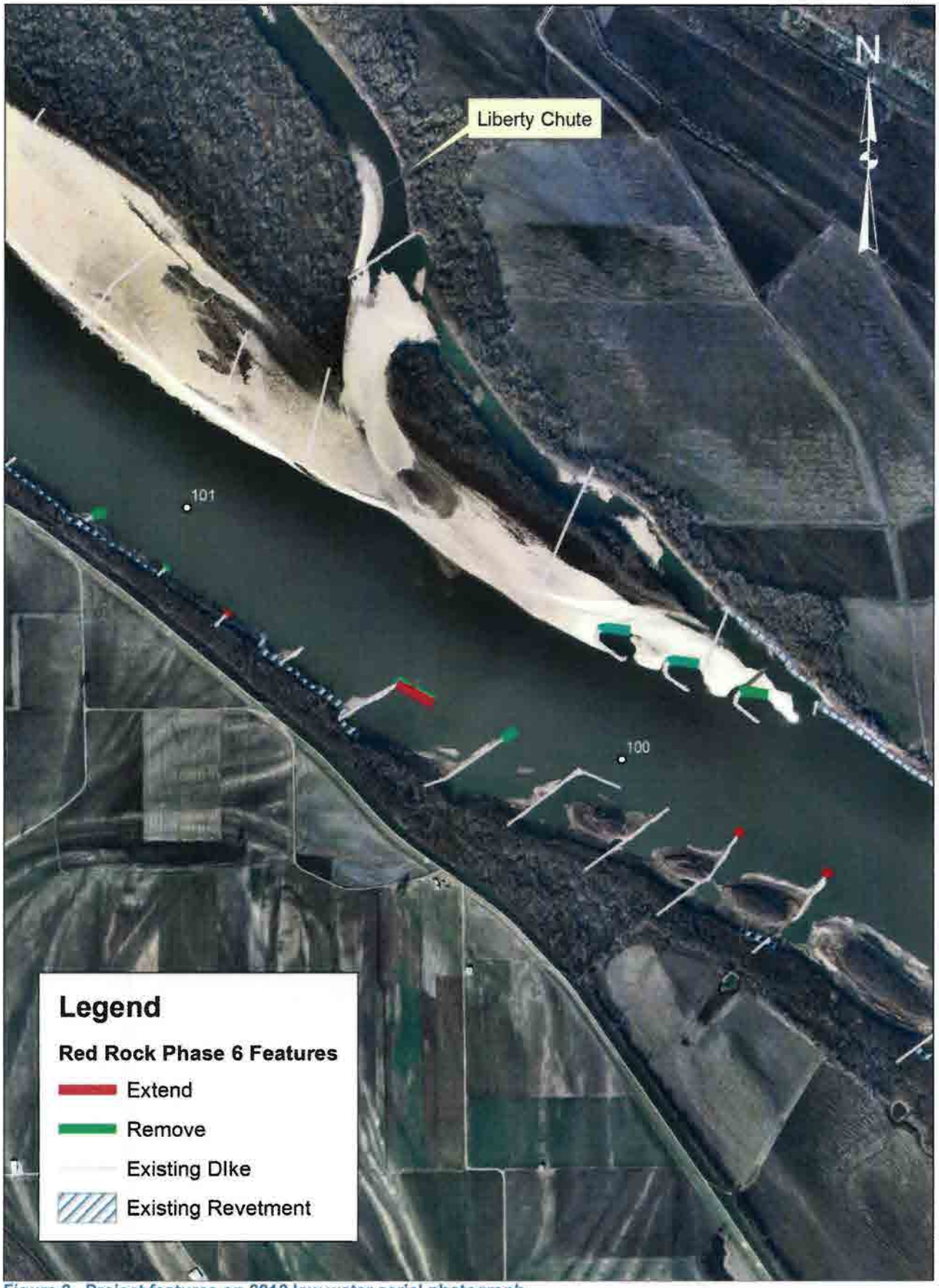


Figure 2. Project features on 2012 low water aerial photograph.

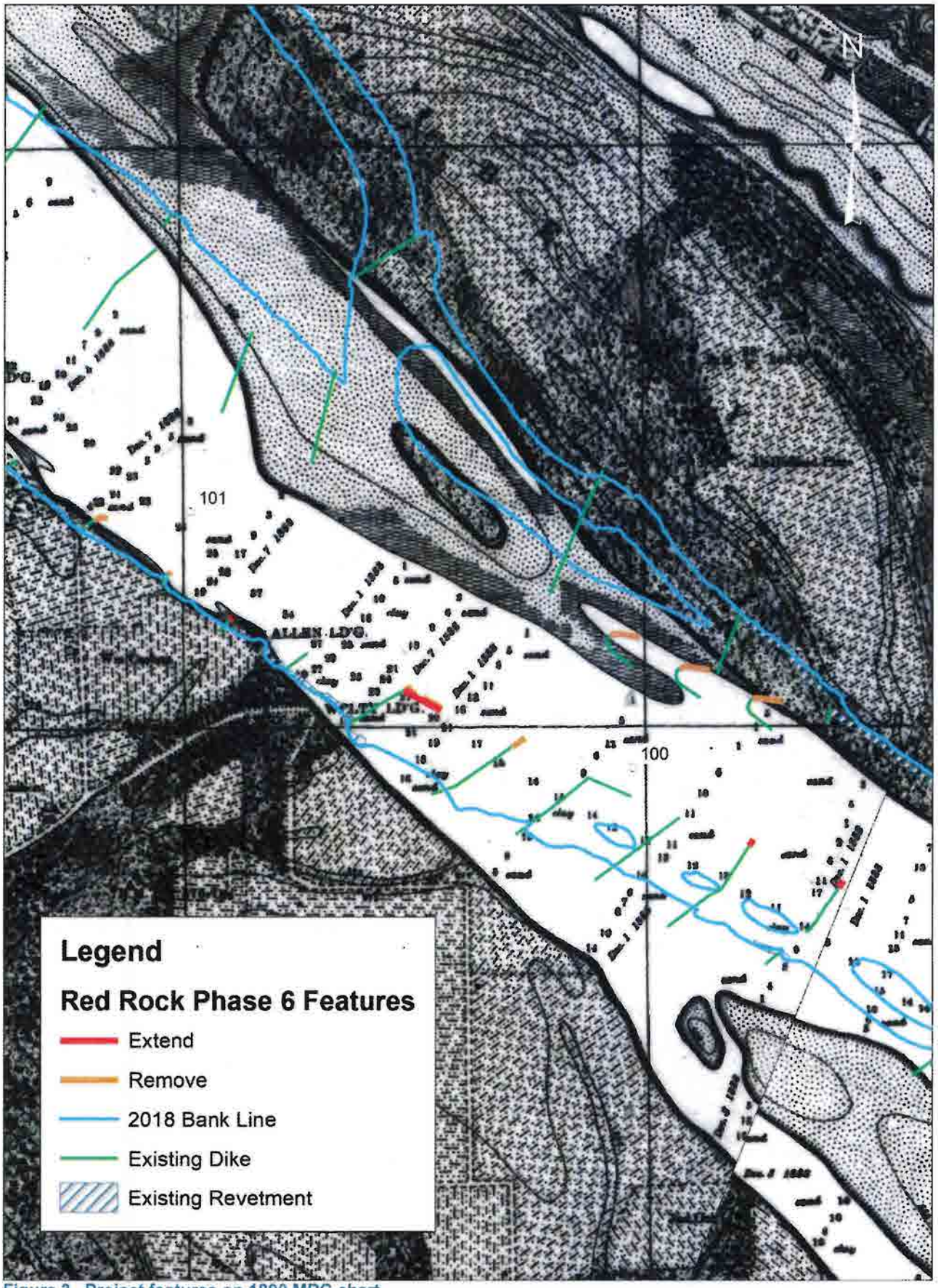


Figure 3. Project features on 1890 MRC chart.

References Cited

Mississippi River Commission (MRC)
1881 Chart No 109. Survey of the Mississippi River.

Norris, F. T.
2003 Historical Shipwrecks on the Middle Mississippi and Lower Illinois Rivers. Curation and Archives Analysis Branch, St. Louis District, USACE.

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

January 3, 2019

Engineering and Construction Division
Curation and Archives Analysis Branch (EC-Z)

Ms. Devon Frazier
Tribal Historic Preservation Officer
Absentee-Shawnee Tribe
2025 S. Gordon Cooper Drive
Shawnee, OK 74810-9381

Subject: Red Rock Landing Phase 6: River Training Structures

Dear Ms. Frazier:

The United States Army Corps of Engineers (USACE) is presently proposing the modification of ten (10) river training structures in the Red Rock Landing Reach of the Mississippi River between river miles 101 and 105 and located in Perry County, Missouri, and Randolph County, Illinois (Figure 1). The structures comprise the Red Rock Landing Phase 4 Project. We are contacting your tribe to initiate consultation under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), and its implementing regulation 36 CFR 800.

Background

Beginning in 1824, the Congress of the United States authorized the Secretary of the Army, by and through USACE, to make improvements to the Mississippi River, and some of its major tributaries, for the purpose of obtaining and maintaining an inland navigation channel for waterway commercial transportation throughout the United States. Ultimately for the Mississippi River, Congress authorized obtaining and maintaining at least a nine foot deep navigation channel from the Gulf of Mexico to Minneapolis, Minnesota, through multiple projects by various methods and management.

Congress authorized the ultimate plan for how the navigation channel should be obtained and maintained for a majority of the Middle Mississippi River (from the confluence of the Ohio River to the confluence of the Missouri River) in the Rivers and Harbors Act of 1910 and eventually established the current navigation channel dimensions of 9 feet deep and not less than 300 feet wide, with additional width in the bends as required, in the Rivers and Harbors Act of 1927.

There are a number of types of river training structures including, dikes, revetments, bendway weirs, and chevrons. Dikes redirect the river's own energy to manage

sediment distribution within the river channel to provide adequate depth for navigation. While the original dikes of the nineteenth century were largely pile structures, by the middle of the twentieth century most had been converted to stone-fill types. Revetments are structures placed along the river bank to stabilize or protect the bank from erosion. They are usually constructed out of stone, but a variety of other materials have historically been used, including concrete-mat, willow mattresses, and gabions. First constructed in 1989, submerged bendway weirs widen the navigation channel in river bends by creating a favorable redistribution of current velocities and sediments. A more-recent development is chevrons built in the river itself. Chevrons create and promote split flows rather than unidirectional deflections and provide more diverse aquatic habitats.

River training structures continue to be constructed, as they provide a more cost-effective and environmentally friendly solution for moving sediment through the river system than dredging alone.

Project

It is proposed to modify 10 existing river training structures in the Red Rock Landing Reach of the Mississippi River (Figure 2). Seven of the structures are located in Perry County, Missouri, while three are in Randolph County, Illinois (Table 1).

Table 1. Proposed Features

River Mile	Structure	Action	County	State
101.20R	Dike	Partial Removal	Perry	Missouri
101.00R	Dike	Partial Removal	Perry	Missouri
100.80R	Dike	Extend	Perry	Missouri
100.60R	Dike Trail	Re-Align	Perry	Missouri
100.40R	Dike	Partial Removal	Perry	Missouri
101.10L	Chevron	Partial Removal	Randolph	Illinois
100.00L	Chevron	Partial Removal	Randolph	Illinois
99.90L	Chevron	Partial Removal	Randolph	Illinois
99.80R	Dike	Extend	Perry	Missouri
99.60R	Dike	Extend	Perry	Missouri

Potential Effects on Cultural Resources

The bankline of the Red Rock Landing Reach has not drastically changed in the past century and a half (Figure 3). The Missouri bankline has, however, expanded eastward as Liberty Bar was captured and incorporated into the Missouri bank of the river after 1890. Therefore many of the features to be modified are located in what was once, in the 19th century, the center of the Mississippi River. The Illinois bank, in comparison, has regressed moderately in places so that the three Illinois structures now in the river were directly adjacent to the bank in 1890.
The structures to be modified are directly adjacent to the dredged channel of the Mississippi River, which doubtless resulted in channel slump and sediment reworking in

the locations. The reach has been regularly dredged over the years, and it is likely that any unrecorded wreckage located in the path of those dredge events was destroyed and removed during the process. While exact location information is not available for dredging events prior to 1979, USACE has been conducting such activities to deepen the navigation channel of the Middle Mississippi since 1896 (Manders and Rentfro 2011:61).

All the river training structures are constructed and modified via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed.

During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District, USACE, conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck project features was in Liberty chute on the Illinois side of the river.

The river bed in the project area is surveyed every year or two, with the latest multi-beam survey having been completed in October 2018. No topographic anomalies suggesting wrecks are visible on the resulting bathymetric map (Figure 4). Additionally the location of the three Illinois structures is visible at times of low flood stage. Visual examination of imagery taken at that time show no indications of wrecks at or near those locations (Figure 2).

Summation

Given the proposed actions (partial removal and modest extensions of existing structures rather than new construction locations), construction method (with no land impact), and the lack of any survey evidence for extant wrecks, it is our current opinion that the proposed undertaking will have no significant effect on cultural resources.

If your tribe has any questions or comments, please feel free to contact me at (314) 331-8784 or Chris Koenig at (314) 331-8151 (e-mail: christopher.j.koenig@usace.army.mil).

Sincerely yours,

SIGNED

Rochelle Hance
Chief, Curation and Archives Analysis Branch

Enclosure

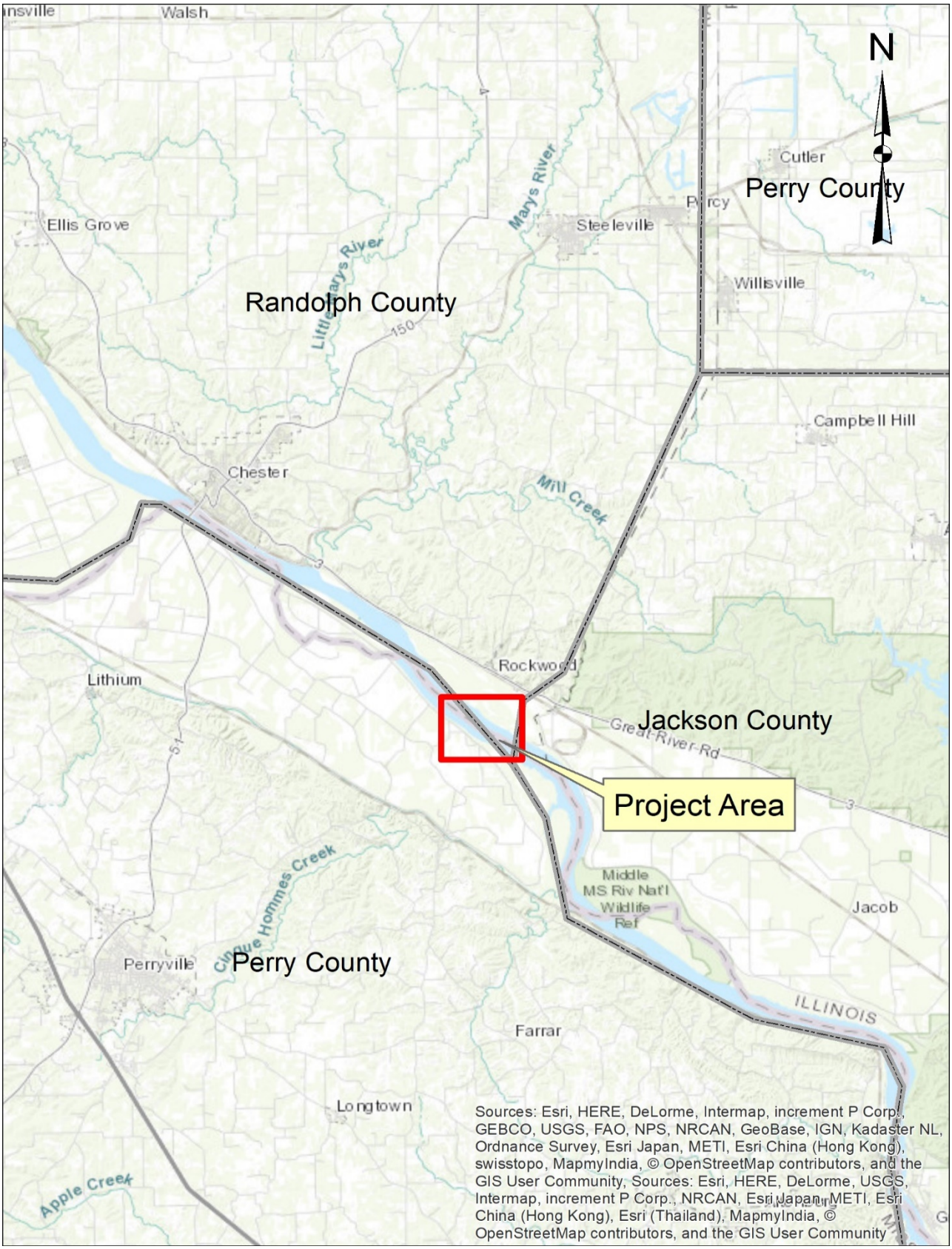


Figure 1. Project Location.

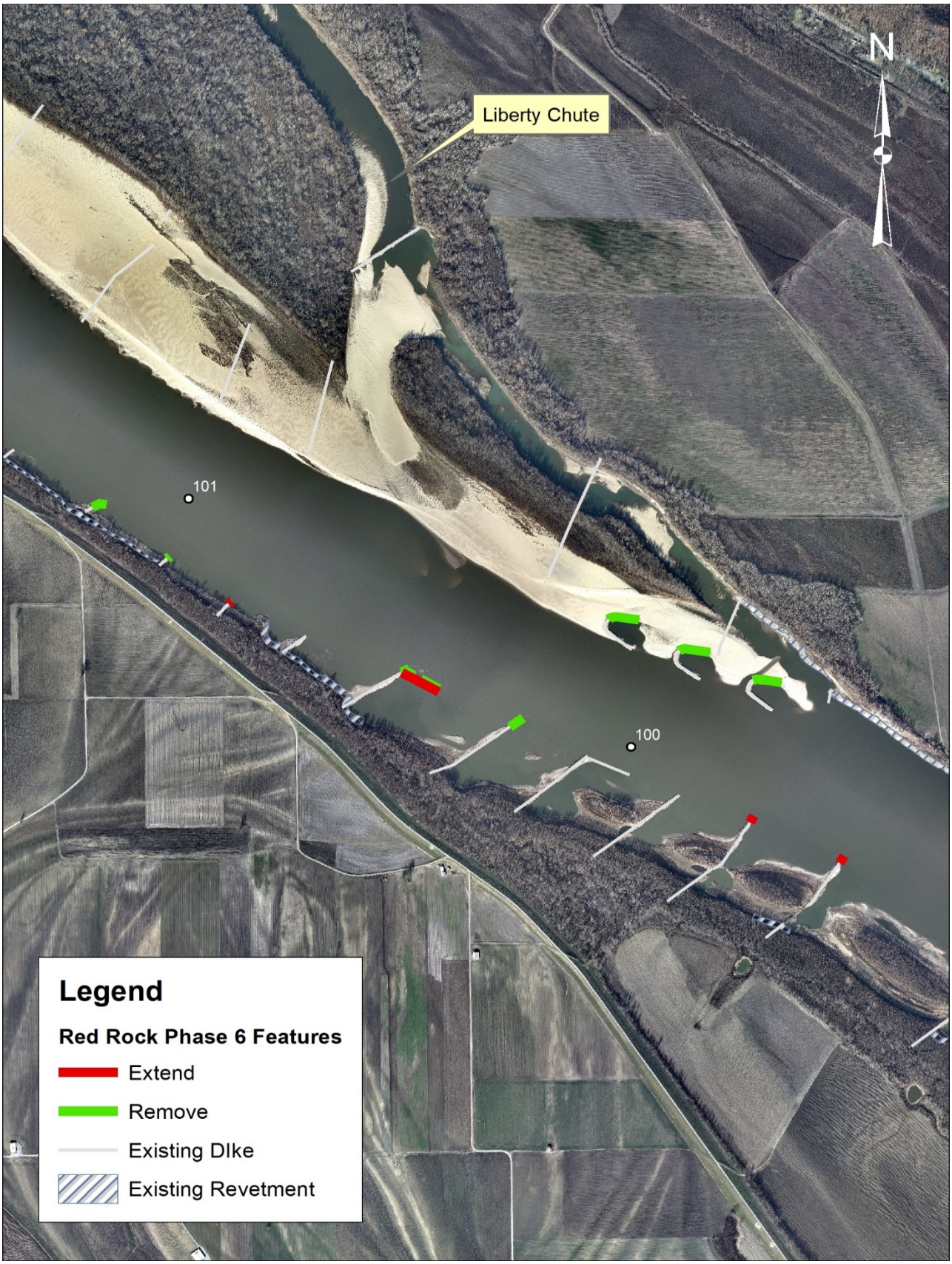


Figure 2. Project features on 2012 low water aerial photograph.

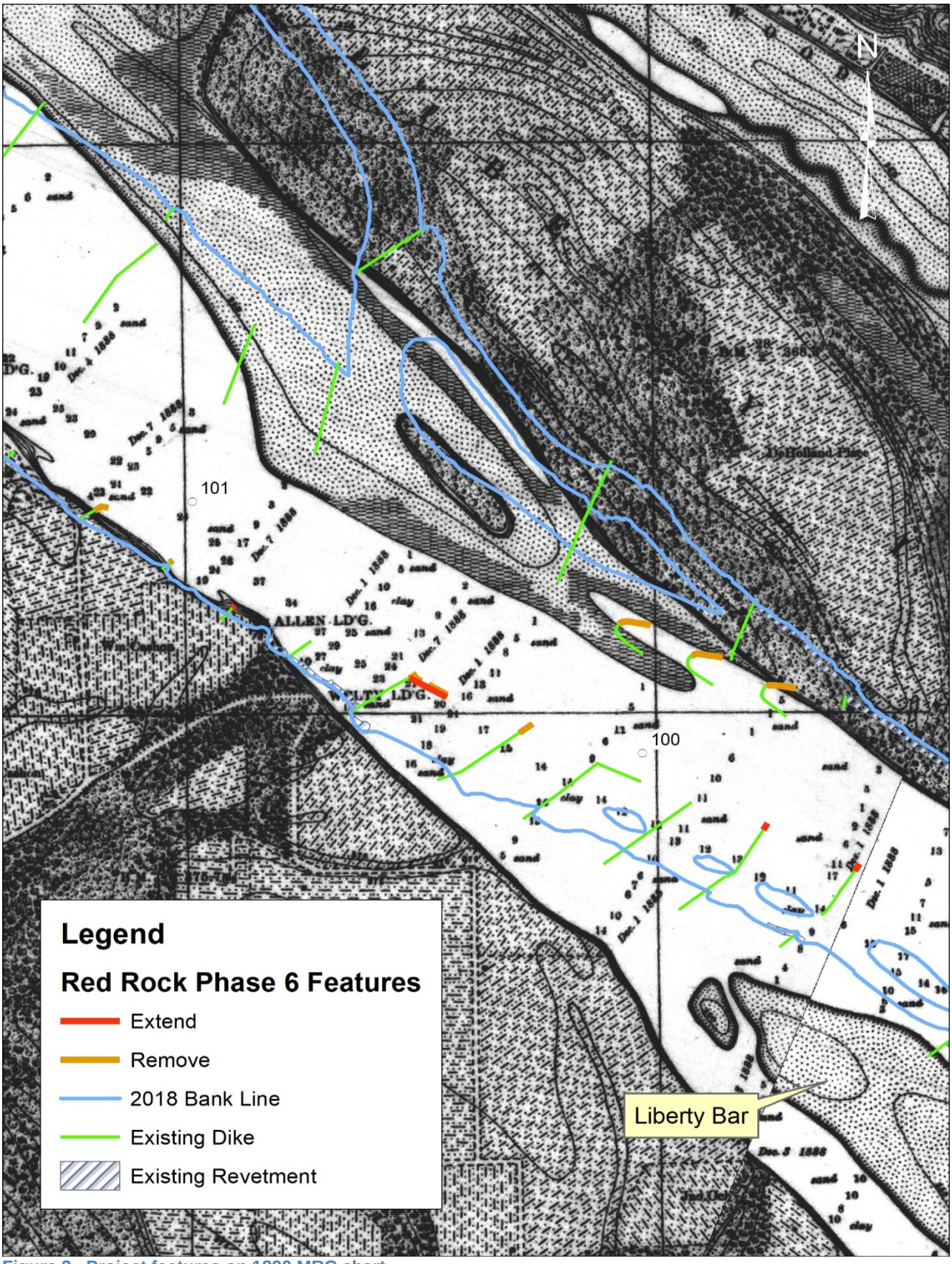


Figure 3. Project features on 1890 MRC chart.

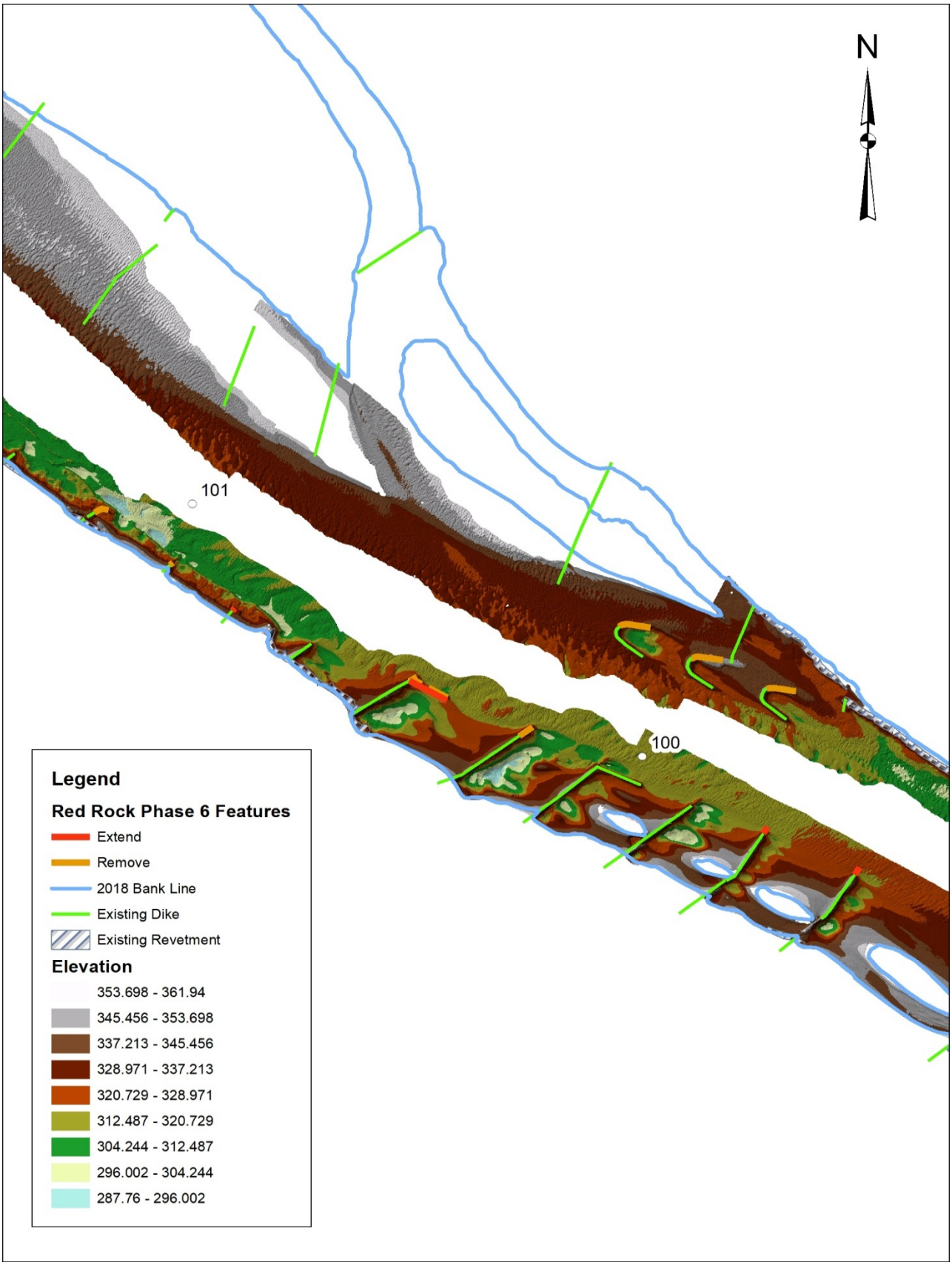


Figure 4. Project features on 2018 bathymetric survey.

References Cited

Manders, D., & B. Rentrfro
2011 Engineers *Far From Ordinary*. St. Louis District USACE, St Louis, MO.

Mississippi River Commission (MRC)
1881 Chart No 109. Survey of the Mississippi River.

Norris, F. T.
2003 Historical Shipwrecks on the Middle Mississippi and Lower Illinois Rivers. Curation and Archives Analysis Branch, St. Louis District, USACE.

United Keetoowah Band
Of Cherokee Indians in Oklahoma
Office of Historic Preservation
P.O. Box 746 • Tahlequah, OK 74465
18263 W Keetoowah Circle • Tahlequah, OK 74464
Phone: (918) 871-2800 • Fax: (918) 414-4000
www.ukb-nsn.gov

2/21/2019

RE: Red Rock Landing Phase 6: River Training Structures

To Whom It May Concern:

Thank you for consulting with the United Keetoowah Band of Cherokee Indians in Oklahoma (UKB). This response is regarding the request from your office for a review of the project listed above. We have reviewed the information provided in your letter of January 3, 2019. We find after review of the information we concur with your findings of no adverse effect.

We remain interested in further communication regarding this project due to the location. The UKB people have a documented historical presence in Perry County, Missouri. While there are no documented village sites within the project site or within a close proximity outside the project site, there still remains the potential of finding unknown sites in and surrounding the project location.

It is further advised that if the area of potential effect changes or in the event of an inadvertent discovery of human remains or other cultural items that we receive notification within 48 hours. As well, any inadvertent discovery of human remains or other cultural resources should remain in situ until consultation with interested tribes and agencies is undertaken.

Please note that these comments are based on information available to us at the time of the project review. We reserve the right to revise our comments as information becomes available. If you have any questions or concerns, please contact our Tribal Archaeologist/NAGPRA Coordinator, Erin Thompson at (918) 871-2838 or by email ethompson@ukb-nsn.gov.

Best Regards,

Sheila Bird
Director of Natural Resources
NAGPRA and THPO
United Keetoowah Band of Cherokee Indians
Office (918) 871-2852 Fax (918) 414-4052

The Delaware Nation
Cultural Resources /106 Department
31064 State Highway 281
Anadarko, OK 73005
Phone (405)247-2448 Fax (405) 247-8905

8 February 2019

To Whom It May Concern:

The Delaware Nation Cultural Preservation Department received correspondence regarding the following referenced project(s).

Project: Red Rock Landing Phase 6: River Training Struction

Our office is committed to protecting tribal heritage, culture and religion with particular concern for archaeological sites potentially containing burials and associated funerary objects.

The Lenape people occupied the area indicated in your letter during prior to European contact until their eventual removal to our present locations. According to our files, the location of the proposed project does not endanger cultural, or religious sites of interest to the Delaware Nation. **Please continue with the project as planned** keeping in mind during construction should an archaeological site or artifacts inadvertently be uncovered, all construction and ground disturbing activities should immediately be halted until the appropriate state agencies, as well as this office, are notified (within 24 hours), and a proper archaeological assessment can be made.

Please note the Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge Munsee Band of Mohican Indians are the only Federally Recognized Delaware/Lenape entities in the United States and consultation must be made only with designated staff of these three tribes. We appreciate your cooperation in contacting the Delaware Nation Cultural Preservation Office to conduct proper Section 106 consultation. Should you have any questions, feel free to contact our offices at 405/247-2448.

Dana Kelly

Dana Kelly
Historic Preservation/106 Asst.
Delaware Nation
31064 State Highway 281
Anadarko, OK 73005
Ph. 405-247-2448
dkelly@delawarenation.com

Miami Tribe of Oklahoma

3410 P St. NW, Miami, OK 74354 ● P.O. Box 1326, Miami, OK 74355
Ph: (918) 541-1300 ● Fax: (918) 542-7260
www.miamination.com

February 4, 2019

Rochelle Hance
Chief, Curation and Archives Analysis Branch
Department of the Army
St. Louis District Corps of Engineers
1222 Spruce Street
St. Louis, MO 63101-2833

Re: Red Rock Landing Phase 6: River Training Structures – Comments of the Miami Tribe of Oklahoma

Dear Ms. Hance:

Aya, kikwehsitoole – I show you respect. My name is Diane Hunter, and I am the Tribal Historic Preservation Officer for the Federally Recognized Miami Tribe of Oklahoma. In this capacity, I am the Miami Tribe's point of contact for all Section 106 issues.

The Miami Tribe offers no objection to the above-mentioned project at this time, as we are not currently aware of existing documentation directly linking a specific Miami cultural or historic site to the project site. However, as this site is within the aboriginal homelands of the Miami Tribe, if any human remains or Native American cultural items falling under the Native American Graves Protection and Repatriation Act (NAGPRA) or archaeological evidence is discovered during any phase of this project, the Miami Tribe requests immediate consultation with the entity of jurisdiction for the location of discovery. In such a case, please contact me at 918-541-8966 or by email at dhunter@miamination.com to initiate consultation.

The Miami Tribe accepts the invitation to serve as a consulting party to the proposed project. In my capacity as Tribal Historic Preservation Officer I am the point of contact for consultation.

Respectfully,

Diane Hunter

Diane Hunter
Tribal Historic Preservation Officer

EASTERN SHAWNEE
CULTURAL PRESERVATION DEPARTMENT
12755 S. 705 Road, Wyandotte, OK 74370

March 19, 2019

Department of the Army St. Louis District Corps of Engineers
1222 Spruce Street
St. Louis, MO 63103-2833

RE: ***Red Rock Landing Phase 6 River Training Structures, Perry/Randolph County, MO***

Dear Mr. Koenig,

The Eastern Shawnee Tribe has received your letter regarding the above referenced project(s) within Perry/Randolph County, MO. The Eastern Shawnee Tribe is committed to protecting sites important to Tribal Heritage, Culture and Religion. Furthermore, the Tribe is particularly concerned with historical sites that may contain but not limited to the burial(s) of human remains and associated funerary objects.

As described in your correspondence, after further research and review of our records, we find that **No Known Properties** of Historical and/or Cultural significance to the Tribe will be impacted by this project. Please continue Project as planned. However, should this project inadvertently discover an archeological site or object(s) we request that you immediately contact the Eastern Shawnee Tribe, as well as the appropriate state agencies (within 24 hours). We also ask that all ground disturbing activity stop until the Tribe and State agencies are consulted.

In accordance with the NHPA of 1966 (16 U.S.C. § 470-470w-6), federally funded, licensed, or permitted undertakings that are subject to the Section 106 review process must determine effects to significant historic properties. As clarified in Section 101(d)(6)(A-B), historic properties may have religious and/or cultural significance to Indian Tribes. Section 106 of NHPA requires Federal agencies to consider the effects of their actions on all significant historic properties (36 CFR Part 800) as does the National Environmental Policy Act of 1969 (43 U.S.C. § 4321-4347 and 40 CFR § 1501.7(a). This letter evidences NHPA and NEPA historic properties compliance pertaining to consultation with this Tribe regarding the referenced proposed projects.

Thank you, for contacting the Eastern Shawnee Tribe, we appreciate your cooperation. Should you have any further questions or comments please contact our Office.

Sincerely,

Brett Barnes,

Tribal Historic Preservation Officer (THPO)
Eastern Shawnee Tribe of Oklahoma
12755 S. 705 Road
Wyandotte, OK 74370
(918) 666-5151 Ext:1845

The Delaware Nation
Cultural Resources /106 Department
31064 State Highway 281
Anadarko, OK 73005
Phone (405)247-2448 Fax (405) 247-8905

8 February 2019

To Whom It May Concern:

The Delaware Nation Cultural Preservation Department received correspondence regarding the following referenced project(s).

Project: Red Rock Landing Phase 6: River Training Struction

Our office is committed to protecting tribal heritage, culture and religion with particular concern for archaeological sites potentially containing burials and associated funerary objects.

The Lenape people occupied the area indicated in your letter during prior to European contact until their eventual removal to our present locations. According to our files, the location of the proposed project does not endanger cultural, or religious sites of interest to the Delaware Nation. **Please continue with the project as planned** keeping in mind during construction should an archaeological site or artifacts inadvertently be uncovered, all construction and ground disturbing activities should immediately be halted until the appropriate state agencies, as well as this office, are notified (within 24 hours), and a proper archaeological assessment can be made.

Please note the Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge Munsee Band of Mohican Indians are the only Federally Recognized Delaware/Lenape entities in the United States and consultation must be made only with designated staff of these three tribes. We appreciate your cooperation in contacting the Delaware Nation Cultural Preservation Office to conduct proper Section 106 consultation. Should you have any questions, feel free to contact our offices at 405/247-2448.

Dana Kelly

Dana Kelly
Historic Preservation/106 Asst.
Delaware Nation
31064 State Highway 281
Anadarko, OK 73005
Ph. 405-247-2448
dkelly@delawarenation.com

EcoCAT
Ecological Compliance Assessment Tool

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Applicant:	U.S. Army Corps of Engineers, St. Louis District	*IDNR Project Number:*	1907447
Contact:	Shane Simmons	*Date:*	02/04/2019
Address:	1222 Spruce St. St. Louis , MO 63103		
Project:	Regulating Works - Red Rock Landing Phase 6		
Address:	Randolph County, Rockwood		

Description: The U.S. Army Corps of Engineers proposes to undergo construction activities to reduce sediment deposition that is leading to unsafe navigation due to insufficient Mississippi River navigation channel depths between river miles 101.2 – 99.6, in Perry County, Missouri, and Randolph County, Illinois. The Proposed Action involves modifying the configuration of river training structures between river miles 101.2 – 99.6. The specific details of the Proposed Action include reducing the length of dikes 101.2 (R) and 101.0 (R), slightly extending dike 100.8 (R), degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel, reducing the length of dike 100.4 (R), and extending dikes 99.8 (R) and 99.6 (R). Further, each of the three chevrons along the left descending bank would be modified; the landward half of each chevron would be completely removed. The work is expected to begin in 2019 or 2020.

Natural Resource Review Results

The Illinois Natural Heritage Database contains no record of State-listed threatened or endangered species, Illinois Natural Area Inventory sites, dedicated Illinois Nature Preserves, or registered Land and Water Reserves in the vicinity of the project location.

Consultation is terminated. This consultation is valid for two years unless new information becomes available that was not previously considered; the proposed action is modified; or additional species, essential habitat, or Natural Areas are identified in the vicinity. If the project has not been implemented within two years of the date of this letter, or any of the above listed conditions develop, a new consultation is necessary. Termination does not imply IDNR's authorization or endorsement.

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Randolph

Township, Range, Section:
8S, 5W, 19

IL Department of Natural Resources Contact
Bradley Hayes
217-785-5500
Division of Ecosystems & Environment

Government Jurisdiction
U.S. Army Corps of Engineers

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

Terms of Use

By using this website, you acknowledge that you have read and agree to these terms. These terms may be revised by IDNR as necessary. If you continue to use the EcoCAT application after we post changes to these terms, it will mean that you accept such changes. If at any time you do not accept the Terms of Use, you may not continue to use the website.

1. The IDNR EcoCAT website was developed so that units of local government, state agencies and the public could request information or begin natural resource consultations on-line for the Illinois Endangered Species Protection Act, Illinois Natural Areas Preservation Act, and Illinois Interagency Wetland Policy Act. EcoCAT uses databases, Geographic Information System mapping, and a set of programmed decision rules to determine if proposed actions are in the vicinity of protected natural resources. By indicating your agreement to the Terms of Use for this application, you warrant that you will not use this web site for any other purpose.

2. Unauthorized attempts to upload, download, or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act.

3. IDNR reserves the right to enhance, modify, alter, or suspend the website at any time without notice, or to terminate or restrict access.

Security

EcoCAT operates on a state of Illinois computer system. We may use software to monitor traffic and to identify unauthorized attempts to upload, download, or change information, to cause harm or otherwise to damage this site. Unauthorized attempts to upload, download, or change information on this server is strictly prohibited by law.

Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

Privacy

EcoCAT generates a public record subject to disclosure under the Freedom of Information Act. Otherwise, IDNR uses the information submitted to EcoCAT solely for internal tracking purposes.

Missouri Department of Conservation

Missouri Department of Conservation's Mission is to
protect and manage the forest, fish, and
wildlife resources of the state and to
facilitate and provide opportunities for all citizens to
use, enjoy and learn about these resources.

Natural Heritage Review Level Three Report: Species Listed Under the Federal Endangered Species Act

There are records for species listed under the Federal Endangered Species Act, and possibly also records for species listed Endangered by the state, or Missouri Species and/or Natural Communities of Conservation Concern within or near the the defined Project Area. Please contact the U.S. Fish and Wildlife Service and the Missouri Department of Conservation for further coordination.

Foreword: Thank you for accessing the Missouri Natural Heritage Review Website developed by the Missouri Department of Conservation with assistance from the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, Missouri Department of Transportation and NatureServe. The purpose of this website is to provide information to federal, state and local agencies, organizations, municipalities, corporations and consultants regarding sensitive fish, wildlife, plants, natural communities and habitats to assist in planning, designing and permitting stages of projects.

PROJECT INFORMATION

Project Name and ID Number: Regulating Works Project - Red Rock Landing Phase 6 #5358
Project Description: The U.S. Army Corps of Engineers proposes to undergo construction activities to reduce sediment deposition that is leading to unsafe navigation due to insufficient Mississippi River navigation channel depths between river miles 101.2 – 99.6, in Perry County, Missouri. The Proposed Action includes reducing the length of dikes 101.2 (R) and 101.0 (R), slightly extending dike 100.8 (R), degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel, reducing the length of dike 100.4 (R), and extending dikes 99.8 (R) and 99.6 (R). Further, each of the three chevrons along the left descending bank (Illinois) would be modified; the landward half of each chevron would be completely removed. lat 37.814725 lon -89.702450 T36N R12E S21
Project Type: Water Use, Transfer, and Channel Activities, Water diversion/channelization
Contact Person: Shane Simmons
Contact Information: Shane.M.Simmons@usace.army.mil or (314)331-8496

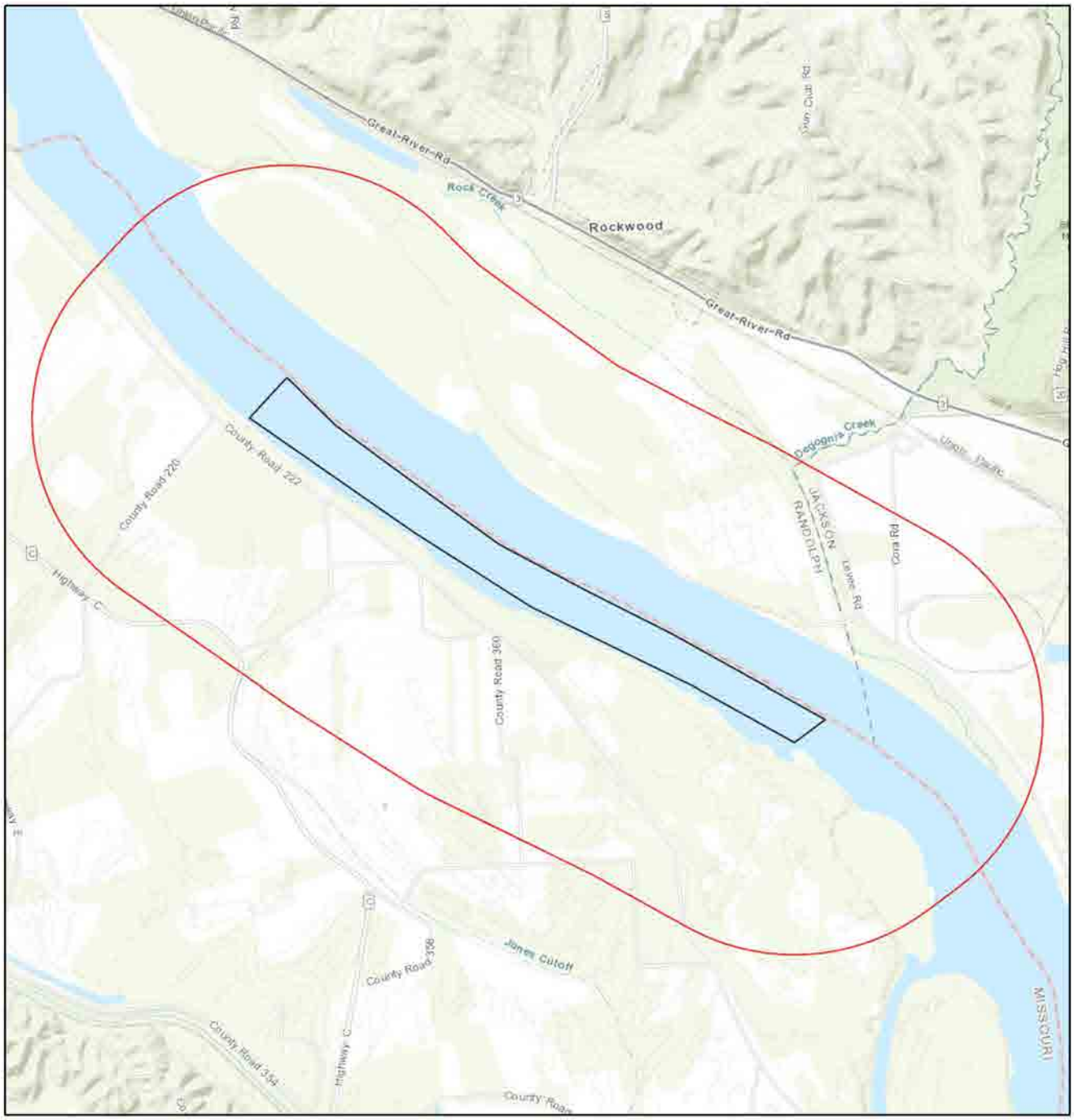
Disclaimer: The NATURAL HERITAGE REVIEW REPORT produced by this website identifies if a species tracked by the Natural Heritage Program is known to occur within or near the area submitted for your project, and shares suggested recommendations on ways to avoid or minimize project impacts to sensitive species or special habitats. If an occurrence record is present, or the proposed project might affect federally listed species, the user must contact the Department of Conservation or U.S. Fish and Wildlife Service for more information. The Natural Heritage Program tracks occurrences of sensitive species and natural communities where the species or natural community has been found. Lack of an occurrence record does not mean that a sensitive plant, animal or natural community is not present on or near the project area. Depending on the project, current habitat conditions, and geographic location in the state, surveys may be necessary. Additionally, because land use conditions change and animals move, the existence of an occurrence record does not mean the species/habitat is still present. Therefore, Reports include information about records near but not necessarily on the project site.

The Natural Heritage Report is not a site clearance letter for the project. It provides an indication of whether or not public lands and sensitive resources are known to be (or are likely to be) located close to the proposed project. Incorporating information from the Natural Heritage Program into project plans is an important step that can help reduce unnecessary impacts to Missouri's sensitive fish, forest and wildlife resources. However, the Natural Heritage Program is only one reference that should be used to evaluate potential adverse project impacts. Other types of information, such as wetland and soils maps and on-site inspections or surveys, should be considered. Reviewing current landscape and habitat information, and species' biological characteristics would additionally ensure that Missouri Species of Conservation Concern are appropriately identified and addressed in planning efforts.

U.S. Fish and Wildlife Service – Endangered Species Act (ESA) Coordination: Lack of a Natural Heritage Program occurrence record for federally listed species in your project area does not mean the species is not present, as the area may never have been surveyed. Presence of a Natural Heritage Program occurrence record does not mean the project will result in negative impacts. The information within this report is not intended to replace Endangered Species Act consultation with the U.S. Fish and Wildlife Service (USFWS) for listed species. Direct contact with the USFWS may be necessary to complete consultation and it is required for actions with a federal connection, such as federal funding or a federal permit; direct contact is also required if ESA concurrence is necessary. Visit the USFWS Information for Planning and Conservation (IPaC) website at https://ecos.fws.gov/ipac/ for further information. This site was developed to help streamline the USFWS environmental review process and is a first step in ESA coordination. The Columbia Missouri Ecological Field Services Office may be reached at 573-234-2132, or by mail at 101 Park Deville Drive, Suite A, Columbia, MO 65203.

Transportation Projects: If the project involves the use of Federal Highway Administration transportation funds, these recommendations may not fulfill all contract requirements. Please contact the Missouri Department of Transportation at 573-526-4778 or www.modot.mo.gov/ehp/index.htm for additional information on recommendations.

Regulating Works Project - Red Rock Landing Phase 6



February 4, 2019

1:41,365

0 0.35 0.7 1.4 mi

0 0.5 1 2 km

Project Boundary

Buffered Project Boundary

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

Species or Communities of Conservation Concern within the Area:

There are records for species listed under the Federal Endangered Species Act, and possibly also records for species listed Endangered by the state, or Missouri Species and/or Natural Communities of Conservation Concern within or near the the defined Project Area. Please contact the U.S. Fish and Wildlife Service and the Missouri Department of Conservation for further coordination.

MDC Natural Heritage Review
Resource Science Division
P.O. Box 180
Jefferson City, MO
65102-0180
Phone: 573-522-4115 ext. 3182
NaturalHeritageReview@mdc.mo.gov

U.S. Fish and Wildlife Service
Ecological Service
101 Park Deville Drive
Suite A
Columbia, MO
65203-0007
Phone: 573-234-2132

Other Special Search Results:

The project occurs on or near public land, MIDDLE MISSISSIPPI RIVER NATIONAL WILDLIFE REFUGE, please contact USFWS.

Project Type Recommendations:
Water Use, Transfer, and Channel Activities: . Recommendations to help avoid and minimize impacts to fish, forest and wildlife resources are under development.

Project Location and/or Species Recommendations:

Endangered Species Act Coordination - Indiana bats *(Myotis sodalis*, federal- and state-listed endangered) and **Northern long-eared bats** (*Myotis septentrionalis,* federal-listed threatened) may occur near the project area. Both of these species of bats hibernate during winter months in caves and mines. During the summer months, they roost and raise young under the bark of trees in wooded areas, often riparian forests and upland forests near perennial streams. During project activities, avoid degrading stream quality and where possible leave snags standing and preserve mature forest canopy. Do not enter caves known to harbor Indiana bats or Northern long-eared bats, especially from September to April. **If any trees need to be removed for your project, please contact the U.S. Fish and Wildlife Service (Ecological Services, 101 Park Deville Drive, Suite A, Columbia, Missouri 65203-0007; Phone 573-234-2132 ext. 100 for Ecological Services) for further coordination under the Endangered Species Act.**

The project location submitted and evaluated is within the geographic range of nesting Bald Eagles in Missouri. Bald Eagles (*Haliaeetus leucocephalus*) may nest near streams or water bodies in the project area. Nests are large and fairly easy to identify. Adults begin nesting activity in late December and January and young birds leave the nest in late spring to early summer. While no longer listed as endangered, eagles continue to be protected by the federal government under the Bald and Golden Eagle Protection Act. Work managers should be alert for nesting areas within 1500 meters of project activities, and follow federal guidelines at: http://www.fws.gov/midwest/MidwestBird/EaglePermits/index.html if eagle nests are seen.

The project location submitted and evaluated is located within or adjacent to the Mississippi or Missouri rivers. Pallid Sturgeons (*Scaphirhynchus albus*, federal- and state-listed endangered) are big river fish that range widely in the Mississippi and Missouri River system (including parts of some major tributaries). Any project that modifies big river habitat or impacts water quality should consider the possible impact to pallid sturgeon populations. See http://mdc.mo.gov/124 for Best Management Practices. Additional coordination with the U.S. Fish and Wildlife Service under the Endangered Species Act may be necessary (U.S. Fish and Wildlife Service, Ecological Services, 101 Park DeVille Drive, Suite A, Columbia, Missouri 65203-0007; phone 573-234-2132.)

Invasive exotic species are a significant issue for fish, wildlife and agriculture in Missouri. Seeds, eggs, and larvae may be moved to new sites on boats or construction equipment. Please inspect and clean equipment thoroughly before moving between project sites. See http://mdc.mo.gov//9633 for more information.

- Remove any mud, soil, trash, plants or animals from equipment before leaving any water body or work area.
- Drain water from boats and machinery that have operated in water, checking motor cavities, live-well, bilge and transom wells, tracks, buckets, and any other water reservoirs.
- When possible, wash and rinse equipment thoroughly with hard spray or HOT water (?140° F, typically available at do-it-yourself car wash sites), and dry in the hot sun before using again.

Streams and Wetlands – Clean Water Act Permits: Streams and wetlands in the project area should be protected from activities that degrade habitat conditions. For example, soil erosion, water pollution, placement of fill, dredging, in-stream activities, and riparian corridor removal, can modify or diminish aquatic habitats. Streams and wetlands may be protected under the Clean Water Act and require a permit for any activities that result in fill or other modifications to the site. Conditions provided within the U.S. Army Corps of Engineers (USACE) Clean Water Act Section 404 permit (http://www.nwk.usace.army.mil/Missions/RegulatoryBranch.aspx) and the Missouri Department of Natural Resources (DNR) issued Clean Water Act Section 401 Water Quality Certification (http://dnr.mo.gov/env/wpp/401/index.html), if required, should help minimize impacts to the aquatic organisms and aquatic habitat within the area. Depending on your project type, additional permits may be required by the Missouri Department of Natural Resources, such as permits for stormwater, wastewater treatment facilities, and confined animal feeding operations. Visit http://dnr.mo.gov/env/wpp/permits/index.html for more information on DNR permits. Visit both the USACE and DNR for more information on Clean Water Act permitting.

For further coordination with the Missouri Department of Conservation and the U.S. Fish and Wildlife Services, please see the contact information below.

MDC Natural Heritage Review
Resource Science Division
P.O. Box 180
Jefferson City, MO
65102-0180
Phone: 573-522-4115 ext. 3182
NaturalHeritageReview@mdc.mo.gov

U.S. Fish and Wildlife Service
Ecological Service
101 Park Deville Drive
Suite A
Columbia, MO
65203-0007
Phone: 573-234-2132

Miscellaneous Information

FEDERAL Concerns are species/habitats protected under the Federal Endangered Species Act and that have been known near enough to the project site to warrant consideration. For these, project managers must contact the U.S. Fish and Wildlife Service Ecological Services (101 Park Deville Drive Suite A, Columbia, Missouri 65203-0007; Phone 573-234-2132; Fax 573-234-2181) for consultation.

STATE Concerns are species/habitats known to exist near enough to the project site to warrant concern and that are protected under the Wildlife Code of Missouri (RSMo 3 CSR 1 0). "State Endangered Status" is determined by the Missouri Conservation Commission under constitutional authority, with requirements expressed in the Missouri Wildlife Code, rule 3CSR 1 0-4.111. Species tracked by the Natural Heritage Program have a "State Rank" which is a numeric rank of relative rarity. Species tracked by this program and all native Missouri wildlife are protected under rule 3CSR 10-4.110 General Provisions of the Wildlife Code.

Additional information on Missouri's sensitive species may be found at http://mdc.mo.gov/discover-nature/field-guide/endangered-species . Detailed information about the animals and some plants mentioned may be accessed at http://mdc4.mdc.mo.gov/applications/mofwis/mofwis_search1.aspx . If you would like printed copies of best management practices cited as internet URLs, please contact the Missouri Department of Conservation.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Missouri Ecological Services Field Office
101 Park Deville Drive
Suite A
Columbia, MO 65203-0057
Phone: (573) 234-2132 Fax: (573) 234-2181

In Reply Refer To: February 04, 2019
Consultation Code: 03E14000-2019-SLI-0750
Event Code: 03E14000-2019-E-01724
Project Name: Regulating Works Project - Red Rock Landing Phase 6

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

This response has been generated by the Information, Planning, and Conservation (IPaC) system to provide information on natural resources that could be affected by your project. The U.S. Fish and Wildlife Service (Service) provides this response under the authority of the Endangered Species Act of 1973 (16 U.S.C. 1531-1543), the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d), the Migratory Bird Treaty Act (16 U.S.C. 703-712), and the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.).

Threatened and Endangered Species

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and may be affected by your proposed project. The species list fulfills the requirement for obtaining a Technical Assistance Letter from the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. N**ote that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days.** The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

Consultation Technical Assistance

Refer to the Midwest Region S7 Technical Assistance website for step-by-step instructions for making species determinations and for specific guidance on the following types of projects: projects in developed areas, HUD, pipelines, buried utilities, telecommunications, and requests for a Conditional Letter of Map Revision (CLOMR) from FEMA.

Federally Listed Bat Species

Indiana bats, gray bats, and northern long-eared bats occur throughout Missouri and the information below may help in determining if your project may affect these species.

Gray bats - Gray bats roost in caves or mines year-round and use water features and forested riparian corridors for foraging and travel. If your project will impact caves, mines, associated riparian areas, or will involve tree removal around these features particularly within stream corridors, riparian areas, or associated upland woodlots gray bats could be affected.

Indiana and northern long-eared bats - These species hibernate in caves or mines only during the winter. In Missouri the hibernation season is considered to be November 1 to March 31. During the active season in Missouri (April 1 to October 31) they roost in forest and woodland habitats. Suitable summer habitat for Indiana bats and northern long-eared bats consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags 5 inches diameter at breast height (dbh) for Indiana bat, and 3 inches dbh for northern long-eared bat, that have exfoliating bark, cracks, crevices, and/or hollows), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Tree species often include, but are not limited to, shellbark or shagbark hickory, white oak, cottonwood, and maple. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of other forested/wooded habitat. Northern long-eared bats have also been observed roosting in human-made structures, such as buildings, barns, bridges, and bat houses; therefore, these structures should also be considered potential summer habitat and evaluated for use by bats. If your project will impact caves or mines or will involve clearing forest or woodland habitat containing suitable roosting habitat, Indiana bats or northern long-eared bats could be affected.

Examples of unsuitable habitat include:

- Individual trees that are greater than 1,000 feet from forested or wooded areas;
- Trees found in highly-developed urban areas (e.g., street trees, downtown areas);
- A pure stand of less than 3-inch dbh trees that are not mixed with larger trees; and
- A stand of eastern red cedar shrubby vegetation with no potential roost trees.

Using the IPaC Official Species List to Make No Effect and May Affect Determinations for Listed Species

1. If IPaC returns a result of "There are no listed species found within the vicinity of the project," then project proponents can conclude the proposed activities will have **no effect** on any federally listed species under Service jurisdiction. Concurrence from the Service is not required for **No Effect** determinations. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records. An example "No Effect" document also can be found on the S7 Technical Assistance website.

2. If IPaC returns one or more federally listed, proposed, or candidate species as potentially present in the action area of the proposed project other than bats (see #3 below) then project proponents can conclude the proposed activities **may affect** those species. For assistance in determining if suitable habitat for listed, candidate, or proposed species occurs within your project area or if species may be affected by project activities, you can obtain Life History Information for Listed and Candidate Species through the S7 Technical Assistance website.

3. If IPac returns a result that one or more federally listed bat species (Indiana bat, northern long-eared bat, or gray bat) are potentially present in the action area of the proposed project, project proponents can conclude the proposed activities **may affect** these bat species **IF** one or more of the following activities are proposed:

a. Clearing or disturbing suitable roosting habitat, as defined above, at any time of year;
b. Any activity in or near the entrance to a cave or mine;
c. Mining, deep excavation, or underground work within 0.25 miles of a cave or mine;
d. Construction of one or more wind turbines; or
e. Demolition or reconstruction of human-made structures that are known to be used by bats based on observations of roosting bats, bats emerging at dusk, or guano deposits or stains.

If none of the above activities are proposed, project proponents can conclude the proposed activities will have **no effect** on listed bat species. Concurrence from the Service is not required for **No Effect** determinations. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records. An example "No Effect" document also can be found on the S7 Technical Assistance website.

If any of the above activities are proposed in areas where one or more bat species may be present, project proponents can conclude the proposed activities **may affect** one or more bat species. We recommend coordinating with the Service as early as possible during project planning. If your project will involve removal of over 5 acres of suitable forest or woodland habitat, we recommend you complete a Summer Habitat Assessment prior to contacting our office to expedite the consultation process. The Summer Habitat Assessment Form is available in Appendix A of the most recent version of the Range-wide Indiana Bat Summer Survey Guidelines.

Other Trust Resources and Activities

Bald and Golden Eagles - Although the bald eagle has been removed from the endangered species list, this species and the golden eagle are protected by the Bald and Golden Eagle Act and the Migratory Bird Treaty Act. Should bald or golden eagles occur within or near the project area please contact our office for further coordination. For communication and wind energy projects, please refer to additional guidelines below.

Migratory Birds - The Migratory Bird Treaty Act (MBTA) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Service. The Service has the responsibility under the MBTA to proactively prevent the mortality of migratory birds whenever possible and we encourage implementation of recommendations that minimize potential impacts to migratory birds. Such measures include clearing forested habitat outside the nesting season (generally March 1 to August 31) or conducting nest surveys prior to clearing to avoid injury to eggs or nestlings.

Communication Towers - Construction of new communications towers (including radio, television, cellular, and microwave) creates a potentially significant impact on migratory birds, especially some 350 species of night-migrating birds. However, the Service has developed voluntary guidelines for minimizing impacts.

Transmission Lines - Migratory birds, especially large species with long wingspans, heavy bodies, and poor maneuverability can also collide with power lines. In addition, mortality can occur when birds, particularly hawks, eagles, kites, falcons, and owls, attempt to perch on uninsulated or unguarded power poles. To minimize these risks, please refer to guidelines developed by the Avian Power Line Interaction Committee and the Service. Implementation of these measures is especially important along sections of lines adjacent to wetlands or other areas that support large numbers of raptors and migratory birds.

Wind Energy - To minimize impacts to migratory birds and bats, wind energy projects should follow the Service's Wind Energy Guidelines. In addition, please refer to the Service's Eagle Conservation Plan Guidance, which provides guidance for conserving bald and golden eagles in the course of siting, constructing, and operating wind energy facilities.

Next Steps

Should you determine that project activities **may affect** any federally listed species or trust resources described herein, please contact our office for further coordination. Letters with requests for consultation or correspondence about your project should include the Consultation Tracking Number in the header. Electronic submission is preferred.

If you have not already done so, please contact the Missouri Department of Conservation (Policy Coordination, P. O. Box 180, Jefferson City, MO 65102) for information concerning Missouri Natural Communities and Species of Conservation Concern.

We appreciate your concern for threatened and endangered species. Please feel free to contact our office with questions or for additional information.

Karen Herrington

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Missouri Ecological Services Field Office
101 Park Deville Drive
Suite A
Columbia, MO 65203-0057
(573) 234-2132

This project's location is within the jurisdiction of multiple offices. Expect additional species list documents from the following office, and expect that the species and critical habitats in each document reflect only those that fall in the office's jurisdiction:

Southern Illinois Sub-Office
Marion Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
(618) 997-3344

Project Summary

Consultation Code: 03E14000-2019-SLI-0750

Event Code: 03E14000-2019-E-01724

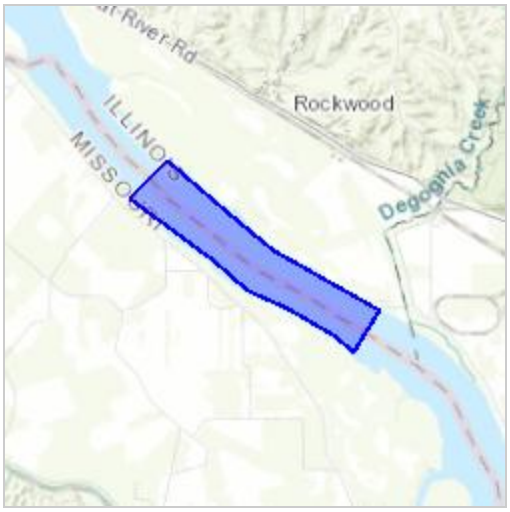
Project Name: Regulating Works Project - Red Rock Landing Phase 6

Project Type: STREAM / WATERBODY / CANALS / LEVEES / DIKES

Project Description: The U.S. Army Corps of Engineers proposes to undergo construction activities to reduce sediment deposition that is leading to unsafe navigation due to insufficient Mississippi River navigation channel depths between river miles 101.2 – 99.6, in Perry County, Missouri, and Randolph County, Illinois. It is approximately 1.7 miles south of Rockwood, Illinois and 9 miles southeast of Chester, Illinois. The Proposed Action involves modifying the configuration of river training structures between river miles 101.2 – 99.6. The specific details of the Proposed Action include reducing the length of dikes 101.2 (R) and 101.0 (R), slightly extending dike 100.8 (R), degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel, reducing the length of dike 100.4 (R), and extending dikes 99.8 (R) and 99.6 (R). Further, each of the three chevrons along the left descending bank would be modified; the landward half of each chevron would be completely removed. The work is expected to begin in 2019 or 2020.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/37.818953513576794N89.70585993824594W



Counties: Randolph, IL | Perry, MO

Endangered Species Act Species

There is a total of 4 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Gray Bat *Myotis grisescens* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6329	Endangered
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Fishes

NAME	STATUS
Pallid Sturgeon *Scaphirhynchus albus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7162	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

RIVERINE

- R2UBH
- R2USC

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Southern Illinois Sub-Office
Marion Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
Phone: (618) 997-3344 Fax: (618) 997-8961
http://www.fws.gov/midwest/Endangered/section7/s7process/step1.html

In Reply Refer To: February 04, 2019
Consultation Code: 03E18100-2019-SLI-0172
Event Code: 03E18100-2019-E-00454
Project Name: Regulating Works Project - Red Rock Landing Phase 6

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The attached species list identifies any federally threatened, endangered, proposed and candidate species that may occur within the boundary of your proposed project or may be affected by your proposed project. The list also includes designated critical habitat if present within your proposed project area or affected by your project. This list is provided to you as the initial step of the consultation process required under section 7(c) of the Endangered Species Act, also referred to as Section 7 Consultation.

Section 7 of the Endangered Species Act of 1973 requires that actions authorized, funded, or carried out by Federal agencies not jeopardize federally threatened or endangered species or adversely modify designated critical habitat. To fulfill this mandate, Federal agencies (or their designated non-federal representative) must consult with the Service if they determine their project “may affect” listed species or critical habitat. Under the ESA, it is the responsibility of the Federal action agency or its designated respresentative to determine if a proposed action "may affect" endangered, threatened, or proposed species, or designated critical habitat, and if so, to consult with the Service further. Similarly, it is the responsibility of the Federal action agency or project proponent, not the Service to make "no effect" determinations. If you determine that your proposed action will have "no effect" on threatened or endangered species or their respective critical habitat, you do not need to seek concurrence with the Service. Nevertheless, it is a violation of Federal law to harm or harass any federally-listed threatened or endangered fish or wildlife species without the appropriate permit.

Under 50 CFR 402.12(e) (the regulations that implement Section 7 of the Endangered Species Act) the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally. You may verify the list by visiting the ECOS-IPaC website

http://ecos.fws.gov/ipac/ at regular intervals during project planning and implementation and completing the same process you used to receive the attached list. As an alternative, you may contact this Ecological Services Field Office for updates.

Please use the species list provided and visit the U.S. Fish and Wildlife Service's Region 3 Section 7 Technical Assistance website http://www.fws.gov/midwest/endangered/section7/s7process/index.html. This website contains step-by-step instructions which will help you determine if your project will have an adverse effect on listed species and will help lead you through the Section 7 process.

For all wind energy projects and projects that include installing towers that use guy wires or are over 200 feet in height, please contact this field office directly for assistance, even if no federally listed plants, animals or critical habitat are present within your proposed project or may be affected by your proposed project.

Although no longer protected under the Endangered Species Act, be aware that bald eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*) and Migratory Bird Treaty Act *(*16 U.S.C. 703 *et seq*), as are golden eagles. Projects affecting these species may require measures to avoid harming eagles or may require a permit. If your project is near an eagle nest or winter roost area, see our Eagle Permits website http://www.fws.gov/midwest/midwestbird/EaglePermits/index.html to help you determine if you can avoid impacting eagles or if a permit may be necessary.

We appreciate your concern for threatened and endangered species. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Southern Illinois Sub-Office
Marion Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
(618) 997-3344

This project's location is within the jurisdiction of multiple offices. Expect additional species list documents from the following office, and expect that the species and critical habitats in each document reflect only those that fall in the office's jurisdiction:

Missouri Ecological Services Field Office
101 Park Deville Drive
Suite A
Columbia, MO 65203-0057
(573) 234-2132

Project Summary

Consultation Code: 03E18100-2019-SLI-0172

Event Code: 03E18100-2019-E-00454

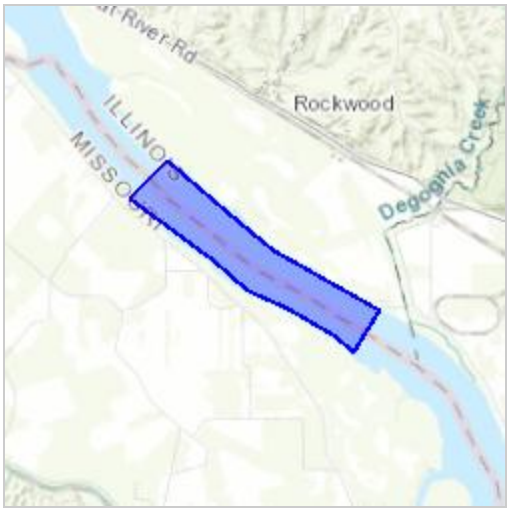
Project Name: Regulating Works Project - Red Rock Landing Phase 6

Project Type: STREAM / WATERBODY / CANALS / LEVEES / DIKES

Project Description: The U.S. Army Corps of Engineers proposes to undergo construction activities to reduce sediment deposition that is leading to unsafe navigation due to insufficient Mississippi River navigation channel depths between river miles 101.2 – 99.6, in Perry County, Missouri, and Randolph County, Illinois. It is approximately 1.7 miles south of Rockwood, Illinois and 9 miles southeast of Chester, Illinois. The Proposed Action involves modifying the configuration of river training structures between river miles 101.2 – 99.6. The specific details of the Proposed Action include reducing the length of dikes 101.2 (R) and 101.0 (R), slightly extending dike 100.8 (R), degrading the trail portion of dike 100.6 (R) and realigning it with the navigation channel, reducing the length of dike 100.4 (R), and extending dikes 99.8 (R) and 99.6 (R). Further, each of the three chevrons along the left descending bank would be modified; the landward half of each chevron would be completely removed. The work is expected to begin in 2019 or 2020.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/37.818953513576794N89.70585993824594W



Counties: Randolph, IL | Perry, MO

Endangered Species Act Species

There is a total of 5 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Birds

NAME	STATUS
Least Tern *Sterna antillarum* Population: interior pop. No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8505	Endangered

Fishes

NAME	STATUS
Pallid Sturgeon *Scaphirhynchus albus*	Endangered

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/7162

Flowering Plants

NAME	STATUS
Small Whorled Pogonia *Isotria medeoloides*	Threatened

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/1890

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Appendix E. Distribution List

The following individuals and organizations received e-mail notification of the Public Notice:

Absentee-Shawnee Tribe
Adrian, D
Alexander County Highway Department
Amato, Joel
Andria, Kathy
Atwood, Butch
Baldera, Patrick
Banner Press
Barnes, Robert
Bax, Stacia
Beardslee, Thomas
Bellville, Colette
Beres, Audrey
Berland, Paul
Boaz, Tracy
Boehm, Gerry
Brescia, Chris
Brinkman, Elliot
Brown, Doyle
Buan, Steve
Buffalo, Jonathan
Burlingame, Chuck
Caddo Nation
Caito, J
Campbell-Allison, Jennifer
Carney, Doug
Chicago Commodities
Chief John Red
City of Portage des Sioux
Clements, Mark
Clover-Hill, Shelly
Coder, Justin
Congressman Clay
Congressman Graves
Corker, Ashley
Cruse, Lester
Curran, Michael
Deel, Judith
Delaware Nation
Dewey, Dave
Senator Blunt
Dorothy, Olivia
Dotts, Glenn
Dougherty, Mark
Eastern Shawnee Tribe of Oklahoma
Ebey, Mike
Elmestad, Gary
Escudero, Marisa
Fabrizio, Christi
Favilla, Christine
Forest County Potawatomi
Foster, Bill
Francis, Tamara
Fung, Jenny
Genz, Greg
Gibbs, Heather
Glenn, S
Goode, Peter
Grider, Nathan
Hall, Mike
Hanke Terminals
Hannahville Indian Community
Hanneman, M
Hansens Harbor
Harding, Scott
Held, Eric
Henleben, Ed
Henry, Donovan
Heroff, Bernard
Herrington, Karen
Herschler, Mike
Herzog, Dave
HMT Bell South
Ho-Chunk Naiton of Wisconsin
Hoppies Marine
Hubertz, Elizabeth
Hunt, Henry
Jamison, Larry
JBS Chief
Jefferson Port Authority
Johnson, Frank
Kickapoo Tribe of Indians of Kansas
Kickapoo Tribe of Oklahoma
Knowles, Kim

Knuth, Dave
Kowal, Kathy
Kovarovics, Scott
Kristen, John
Lange, James
Leary, Alan
Ledwin, Jane
Lavalle, Tricia;
Lipeles, Maxie
Lorberg, Jerry
Louis Marine
Manders, Jon
Mangan, Matthew
Mannion, Clare
Marquardt, Shauna
Marrs, T. Bruce
Mauer, Paul
McGinnis, Kelly
McPeek, Kraig
Melgin, Wendy
Miller, Jeff
Miller, Kenneth
Missouri Corn Growers Association
Missouri Department of Natural Resources
Morgan, Justin
Morrison, Bruce
Muench, Lynn
Muir, T
Nash-Mayberry, Jamie
Nelson, Lee
Nichols, Larry
Nottawaseppi Band of Huron Potawatomi
Novak, Ron
O'Carroll, J
Orstad, Carl
Osage Nation
Pehler, Kent
Peper, Sarah
Peoria Tribe of Indians of Oklahoma
Pokagon Band of Potawatomi
Popplewell, Mickey
Porter, Jason
Potawatomi Nation
Quapaw Tribe of Indians
Randolph, Anita
Reitz, Paul
Roark, Bev
Sac & Fox Nation of Missouri in Kansas and Nebraska
Sac & Fox Nation of Oklahoma
Sac & Fox Tribe of the Mississippi in Iowa
Samet, Melissa
Sauer, Randy
Schranz, Joseph Standing Bear
Schulte, Rose
SEMO Port
Senator Blunt's Office
Shepard, Larry
Shoulberg, J
Skrukrud, Cindy
Slay, Glen
Smith, David
Southern Illinois Transfer
Spoth, Robert
Stahlman, Bill
Staten, Shane
Sternburg, Janet
Stokes, David
SUMR Waterways
Taylor, Susan
Teah, Philip
Todd, Brian
Tow Inc
Tyson, J
Urban, David
USEPA Region 5
USEPA Region 7
Vitello, Matt
Walker, Brad
Welge, Owen
Werner, Paul
Westlake, Ken
Wilmsmeyer, Dennis
Winnebago Tribe of Nebraska
Winship, Jaci
York Bridge Co.
Zupan, T

The following individuals received a hard copy mailing of the Public Notice:

Blankenship, Tina
Campbell, Leon
Congressman Bost
Congressman Luetkemeyer
Congressman Smith
Congresswoman Wagner
Damptz, Amanda
Governor Rauner
Governor Parson
Knupp, Virgil
Korando, David
Houghton, Fay
Houston, Elena
Mezo, Braden
Randall, Lester
Salazar, Tony
Schranz, Joseph Standing Bear
Senator Blunt
Senator Durbin
Senator Duckworth
Senator Hawley
Shepard, Ron
Spurlock, Jessica
Standing Bear, Geoffrey
Taflinger, Jim
Verble, Kenneth
Verble-Whitaker, LaRae